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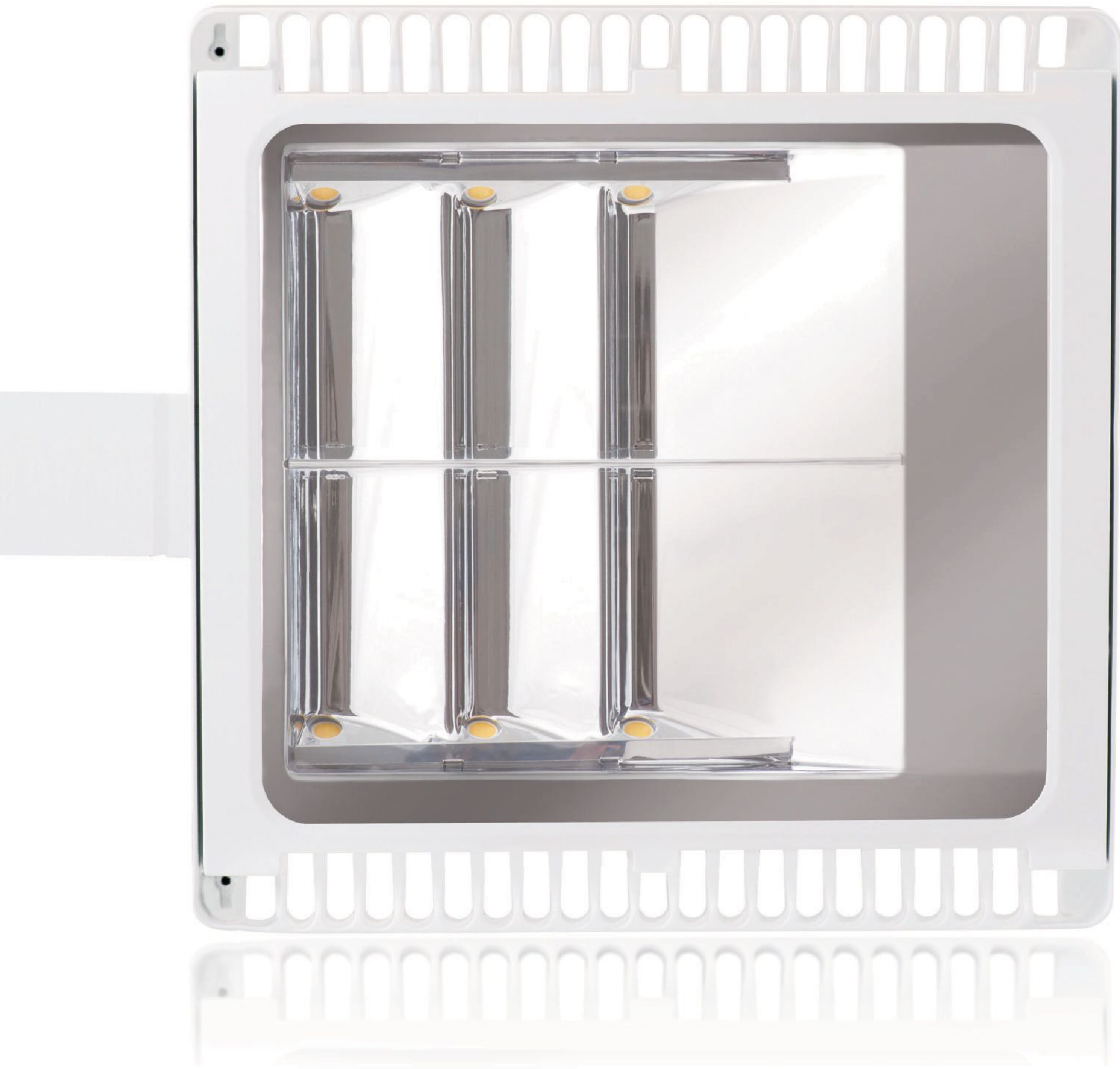

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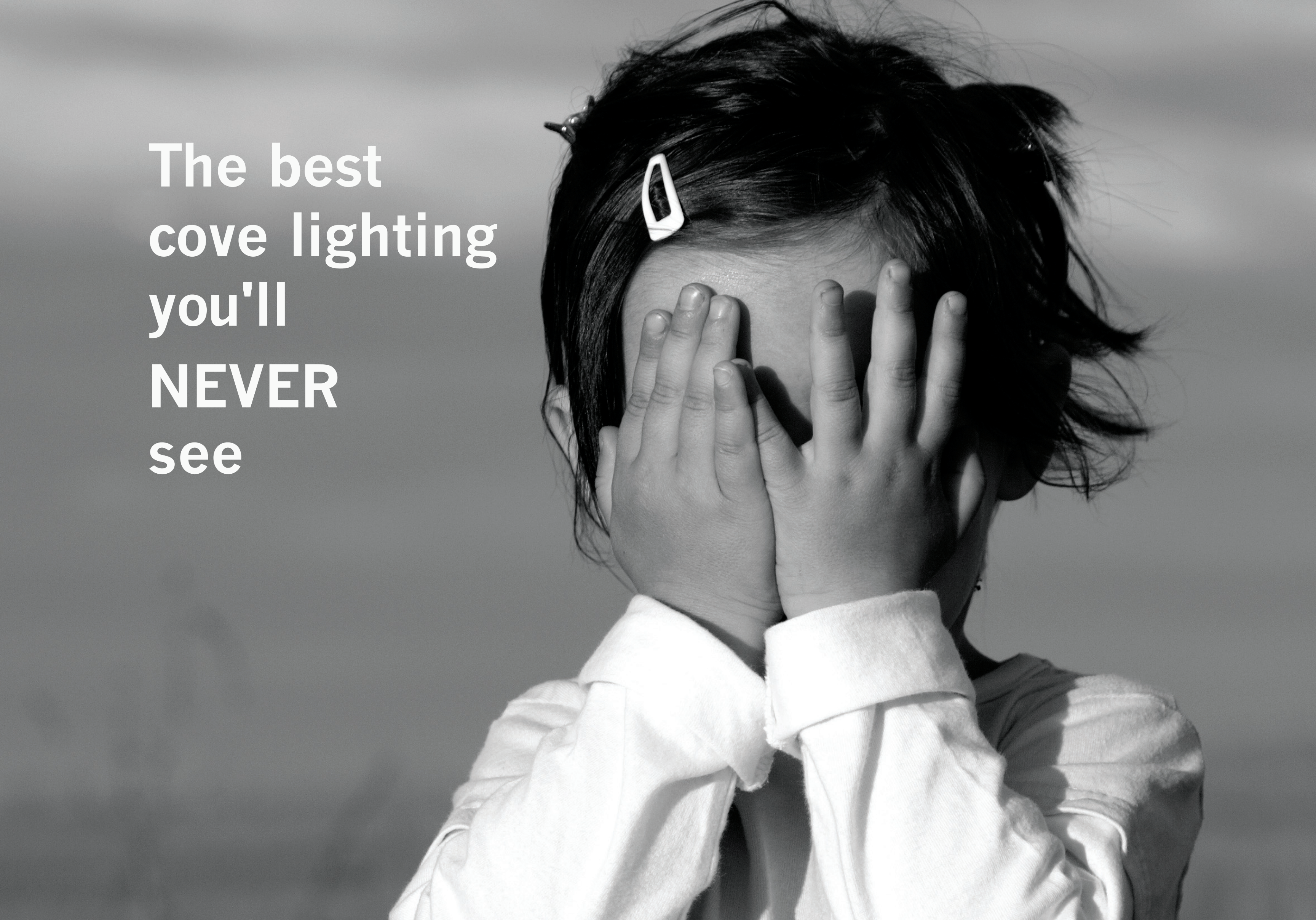
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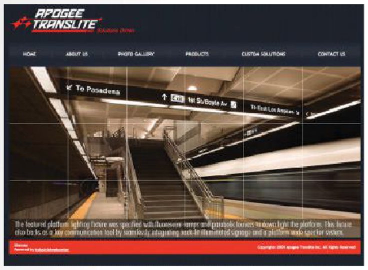

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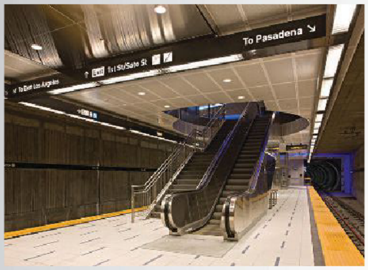

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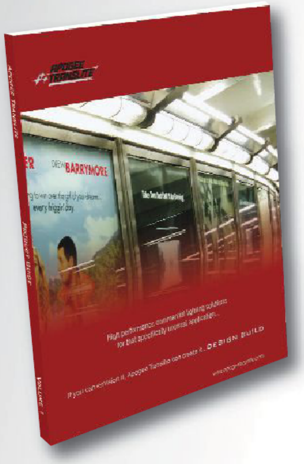

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Clockwise from left: Mark Herboth; Tang Yau Hoong; Tim Hursley

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"The larger question, really, is: How do we become the stewards of our own history? Addressing this question has never been more urgent than it is now, since the industry as a whole is currently experiencing a significant technological shift to solid-state lighting and we see new players entering the industry every day."

BUILDING A COLLECTIVE HISTORY

This winter, the architecture and design community lost several leading figures—legendary designer Eva Zeisel, and architects Ricardo Legoretta, Yoshiko Sato, and Jacques Brownson. Closer to home, the lighting industry also lost some notable leaders—Marvin Gelman, founder of lighting company Lighting Services Inc, and William Blitzer, whose family founded lighting manufacturer Lightolier.

In all of these instances, their deaths represent profound loss for their families, friends, and colleagues. But it also signals an immense void for their professions. In the case of the lighting community, the industry lost two immensely talented individuals who in many ways helped to shape the lighting industry that we know today. So how do we ensure that their knowledge and experience about so many vital areas in the industry, from design to manufacturing to business, continues in today's discussions about lighting?

This is not always an issue that is easy to talk about, or that one wants to bring up, but the truth is that the lighting profession, while still very young, has lost many of its pioneers and founding members. I am often reminded of this when researching articles, and it was particularly acute while working on ARCHITECTURAL LIGHTING's 25th anniversary issue (Nov/Dec 2011).

The larger question, really, is: How do we become the stewards of our own history? Addressing this question has never been more urgent than it is now, since the industry as a whole is currently experiencing a significant technological shift to solid-state lighting and we see new players entering the industry every day.

Part of the challenge in building a collective history of the industry, from the perspective of both design and manufacturing, is that there is no one definitive source of information. Yes, there have been several books written about the history of light, such as David DiLaura's *A History of Light and Lighting* (IESNA, 2006), but that covers only one aspect—the evolution of light source technology—of lighting's history.

Certainly, the various lighting design publications serve as an archive of the people, projects, and events that have shaped the profession. So do the milestone anniversary celebrations of lighting organizations such as the Illuminating Engineering Society or the International Association of Lighting Designers. Still, these are set moments in time that produce pieces of information that will need to be assembled later for archive purposes.

And what about the daily transfer of knowledge and project experience? How does this occur between firm principals and junior staff? Or between a product developer and his or her team? Or a teacher and student? I'm sure individual firms and manufacturers have their own processes for the sharing of information, and to some extent it is the kind of thing that probably takes place organically in the course of everyday discussion about work and projects. Still, it is something to be mindful of and not to take for granted.

This transfer of knowledge requires a certain level of diligence from us all. The practitioner with many years of experience must find the time to share that experience, no matter the pressures of practice. Younger designers shouldn't be afraid to ask questions and take notes. Industry conferences and trade shows serve as outlets for the dissemination of information; perhaps a history track, or something like it, should be added as a regular feature at Lightfair? And all entities in the industry—professional organizations, firms, publications—have to be more willing to share the information that they have gathered, with the goal in mind to create one central archive for a history of lighting design devoid of any specific organizational association.

Building a collective history of the architectural lighting design profession is not only in our interest, but it should be seen as a necessity. Without it, continuity of design and manufacturing processes will be lost, and future generations will be cheated out of a knowledge base that will provide them with the foundations for their own practices.

Elizabeth Donoff
Editor


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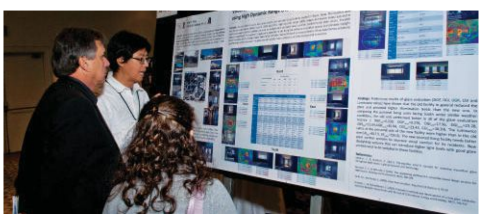
VISUAL ACUITY

An IES research symposium looks at light, vision, and the aging eye.

text by Elizabeth Donoff



As we age, so do our eyes. But how the illuminated environment needs to respond to our changing eyesight is often not a focus of discussions about lighting design. It should be. According to the U.S. Department of Health & Human Services' Administration on Aging, by 2030 there will be 72.1 million individuals over the age of 65 in this country alone. So how then do we best address the needs of this demographic without sacrificing design or lighting quality?

Lighting designers, researchers, educators, students, manufacturers, regulators, and other interested parties gathered in Washington, D.C., on March 6 and 7 for an IES research symposium, Light + Seniors—A Vision for the Future. The symposium, which also included several poster sessions, began with a keynote presentation by Dr. Donald Klein, professor emeritus of psychology and surgery (ophthalmology) at the University of Calgary. He discussed the biological changes that occur in the eye and visual system as the body ages. Typically, an older eye is more sensitive to glare and high contrast. Older adults also experience a shift in color perception and experience a yellow cast that can, in some individuals, completely alter their ability to read the color accuracy of objects. And yet designing space for older individuals, said Klein, is not always about making things larger (such as text). He illustrated this point by discussing a case study involving the layout of highway traffic signs and the positioning of the graphic symbols.

Another standout presentation was Dr. George Brainard's, director of the Light Research Program at Thomas Jefferson University in Philadelphia. A leading expert and researcher in the field for more than 25 years, Brainard discussed how the biological and behavioral effects of light impact human health. Our bodies need light to regulate our bodily systems and functions. In particular, light impacts our ability to produce and regulate key hormones such as melatonin. Failure to produce this hormone critically impairs our sleep-wake cycle—known as the circadian cycle—which affects our ability to properly function. Anyone who has ever been sleep-deprived knows firsthand just how important proper sleep and light are to one's general well-being.

Dr. Peter Boyce, professor emeritus at Rensselaer Polytechnic Institute in Troy, N.Y., summarized the symposium by asking participants to consider what we do know, what we don't know, and what we should do when it comes to addressing the light and vision issues of an older and aging population. All agreed that more education for consumers, as well as for designers and manufacturers, is needed, as is greater accessibility to products. As Klein had stated during his opening keynote, "Design for an older eye is good for all eyes, because you are designing for your future self." •

• IES Makes *Leukos* Articles Available Online

Leukos, The Journal of the Illuminating Engineering Society of North America, the society's research publication, is now making one article from its current issue available online for free. The current issue is Vol. 8, No. 3, Jan. 2012, and the available article is "Lighting Controls in Commercial Buildings" (ies.org/leukos/samples/1_jan12.pdf). This paper discusses how researchers have been quantifying energy savings from lighting controls in commercial buildings for more than 30 years, and it provides an analysis of lighting energy savings identified in the literature—240 savings estimates from 88 papers and case studies, categorized into daylighting strategies, occupancy strategies, personal tuning, and institutional tuning.

Robert Horner, Courtesy IES

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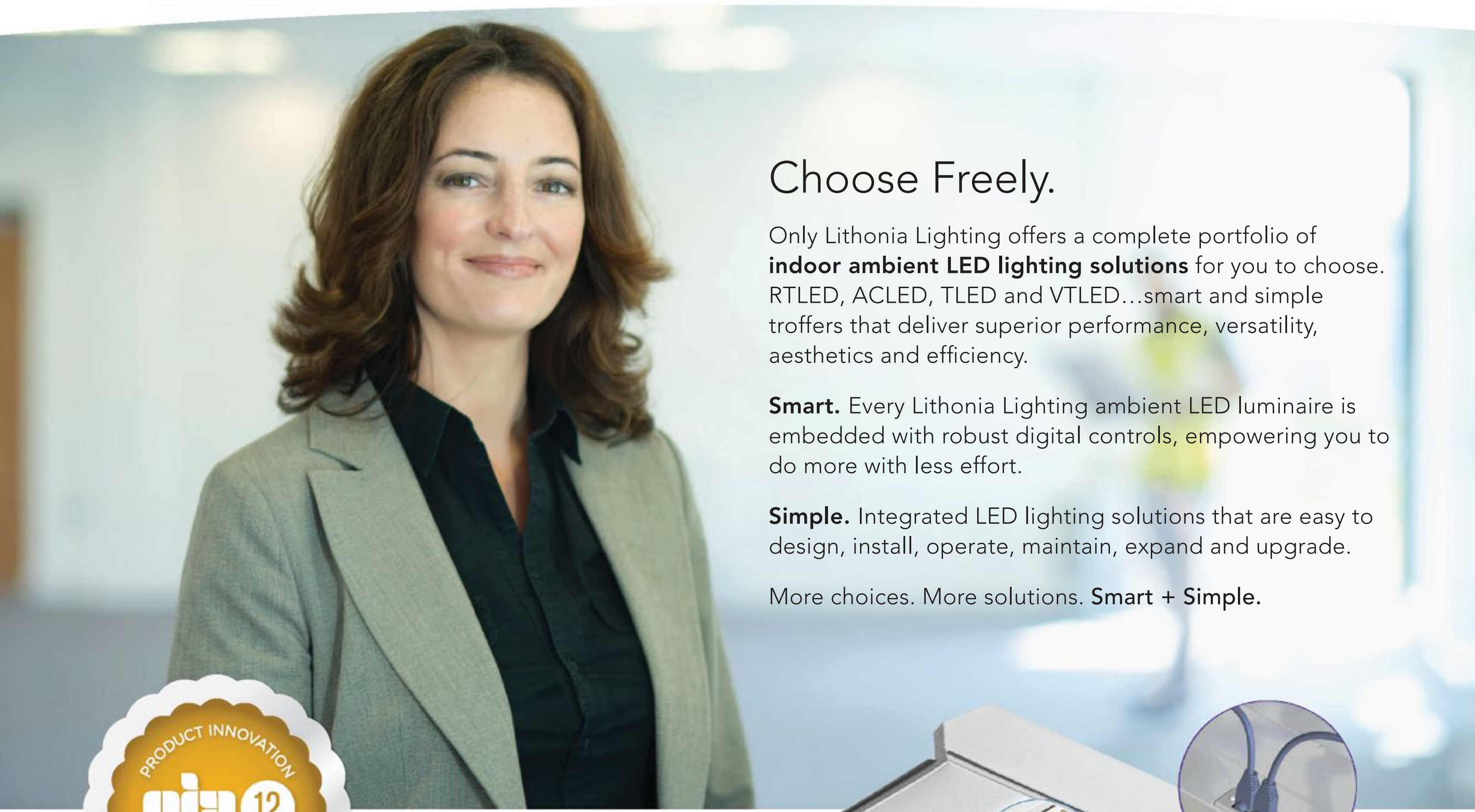

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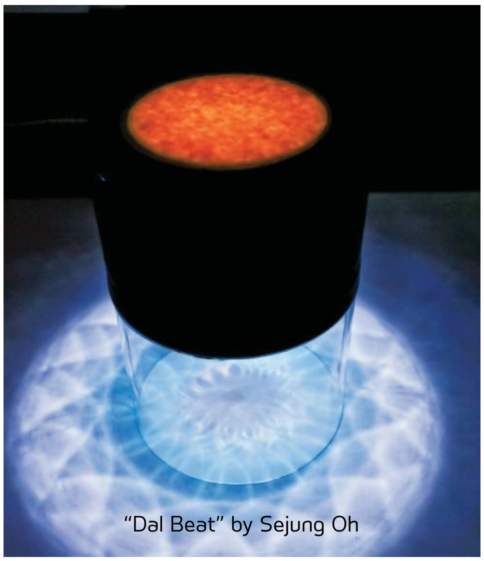
STUDENTS SHINE IN LIGHTING COMPETITION

The IESNYC's lighting competition continues to engage area design students in the fundamentals of light.



"Dal Beat" by Sejung Oh

text by Elizabeth Donoff

Now in its 12th year, the Illuminating Engineering Society's New York City Section's annual student competition continues to promote a greater awareness of lighting by engaging with New York–area students who are enrolled in design programs. Each year, the competition brief focuses on a specific property of light and asks students to interpret the idea by designing a 3D-built model. The 2012 competition, titled "Fraction/Refraction," challenged students to think about light in terms of texture, directionality, and contrast. "The competition is designed to be an exercise in exploration," says Shaun Fillion, chair of the Student Competition Committee.

The grand prize was awarded to Pratt Institute student Sejung Oh for his entry "Dal Beat." Oh constructed an acrylic drum filled with water and an LED striplight. When tapped, it mimicked the effect of moonlight reflecting on water. "The name Dal Beat is derived from dal bit, which is Korean for moonlight," Oh explained in the IESNYC's press release. "I changed the name of my project as an invitation to viewers to tap or beat the drum to see the movement of light." For winning the competition, Oh received a $2,000 cash prize and a trip to Paris courtesy of sponsor Debbas International. There, he will meet with lighting engineers and designers at Debbas International's new Paris showroom and visit the company's factory.

Second prize went to another Pratt student: Sang Yoon-Lee received a cash prize of $1,000 for his project "Ivre." Yoon-Lee configured two wine bottles to each house a light source. When the bottle corks were rotated, light passed through overlapping lenses and created a kaleidoscope effect. Third prize and a check for $500 was awarded to New York School of Interior Design student Farnaz Hamedanchian. Her untitled project was a tableau of natural materials—branches, twigs, and glass—that produce a dual refraction of light. In all, seven prizes were awarded, including four honorable mentions, from a pool of more than 100 entries.

Students, faculty, and guests were able to view the projects during an evening event on Feb. 29, which also featured a keynote lecture given by Dietrich Neumann, the Royce Family Professor for the History of Modern Architecture and Urban Studies at Brown University. Neumann discussed the work and impact of legendary lighting designer Richard Kelly. Students were also invited to attend a panel presentation and listen to lighting industry professionals discuss the lighting designer's role on a project.

The competition is supported by a number of sponsors: Bartco Lighting, Enterprise Lighting Sales, Osram Sylvania, Philips Lighting, A&L Lighting, Amerlux Lighting Solutions, the Dulanski Group, Edison Price, GE Lighting, Nulux, Universal Lighting Technologies, and USAI. For more information about the competition program, go to iesnyc.org. •

Courtesy IESNYC

LEDUCATION 6

More than 2,000 industry professionals gather to see and discuss the latest in solid-state lighting.

text by Elizabeth Donoff

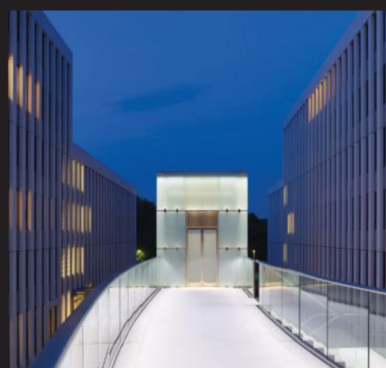
Naomi Castillo Photography

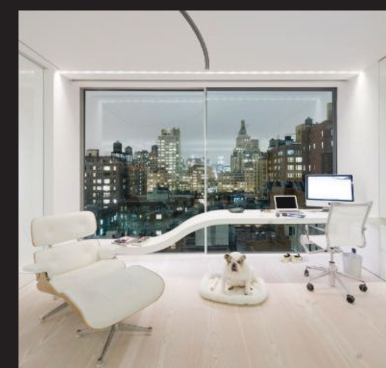
In just six short years, the Designers Lighting Forum of New York's LEDucation has grown from an intimate look at the latest in LED lighting options to a day-long regional seminar and table-top product showcase. This year, attendance was up 20 percent, with more than 2,000 attendees who came from all major cities along the Northeast corridor and beyond.

On view were the latest LED lighting products from more than 92 manufacturers that covered all aspects of luminaire design—light sources, components, and controls—and all application types. The table-top format allows designers to speak one-on-one with manufacturers and view some of the newest lighting technologies.

Educational seminars offered throughout the day provided both the novice and the expert an overview of the issues and the impact that the transition to solid-state lighting (SSL) is having on the industry. Department of Energy and Energy Star initiatives that promote SSL were presented by Naomi Miller of Pacific Northwest National Laboratory and Alex Baker from Energy Star. Lighting designer Nelson Jenkins moderated a panel of lighting designers and an interior designer who spoke to the specific issues involved in lighting jewelry stores. Chad Stalker of Philips Lumileds presented what the move to LED means in terms of digitalization. And a final panel of lighting designers and manufacturer representatives discussed the new possibilities that LEDs are creating for lighting controls. For more information about the event, go to LEDucation.org. •





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PROFESSIONAL PRACTICE

INTERNATIONAL WATERS

A primer for lighting designers interested in working overseas.

text by Peter J. Lamont
illustration by Headcase

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).

Over the past several years there has been a dramatic increase in the number of lighting designers contracting to provide services in foreign countries. This expansion from work in the United States to projects outside the U.S. is primarily the result of globalization.

A number of other factors have also contributed to the increase in international design work. One such factor is a combination of the continued recovery of the U.S. economy, and the rapid growth and development of countries such as China, India, and Mexico. Additionally, many non-Western countries are looking to move away from their local architectural styles in a desire to embrace a more Western look. Of course, rapid developments in technology have also contributed to the growth of lighting design on an international scale. Easier communication protocols, including video-conferencing, flat-rate international telephone calling packages, and online collaborative tools have increased lighting designers' abilities to operate outside the bounds of their home countries.

However, global practice is not for everyone and can be extremely risky. There are a number of cultural, financial, and legal pitfalls that can bankrupt lighting designers, or otherwise severely restrict the profitability of international work. Still, the prospect of engaging in international projects has a large appeal among design firms of every size, and for good reason; it is an opportunity to experience new concepts and ideas at the broadest global scale.

Business Dealings and Cultural Differences

A great deal of preparation and research is necessary prior to committing yourself or your firm to an international project. There are vast differences in the legal systems between the U.S. and Canada, Europe, the Middle East, and Asia. Foreign governments have a great deal more influence over construction projects in their countries than we see in North America, especially when the foreign architect or contractor is retaining the services of a lighting designer from the U.S. Any designer or design firm endeavoring to conduct international business should retain the services of a qualified accountant and an attorney with international law experience. While some may consider it an unnecessary up-front expense, it will save you a tremendous amount of time, money, and aggravation in the long run.

Country-specific tax requirements and foreign currency have a drastic impact on profitability. Unless you have a sufficient understanding of both, a job that was expected to produce a generous amount of revenue could result in not only a loss of profit, but tax liabilities and potential foreign fines. For example, in China, a Chinese company is not permitted to issue any payment to a foreign contractor or designer until all relevant taxes are paid. Only then can the Chinese company exchange its own currency—renminbi—for U.S. dollars and transfer the funds out of the country.

Another area of concern is licensing. Many countries, including many in the Middle East, impose serious monetary and criminal penalties and fines for unauthorized work conducted by foreigners. It is critical that designers fully comply with all foreign licensing and registration requirements. This can be accomplished by retaining an international law attorney, by collaborating with U.S. firms that are already doing business in that particular country, or by collaborating with foreign design firms.

Another critical factor of success with design projects in other countries is mitigating the difference in cultural expectations between the U.S. and the country with whom the designer seeks to become involved, as well as a difference in communication styles between the foreign company or contractor and the designer. English will not necessarily be the common business language. This language barrier can be


SUCCESS BEGINS WITH MIRO.

Make certain that the contract specifies the exact scope of the lighting designer's work. This helps eliminate scope creep—when a designer believes that his or her role in the project is limited to a particular series of designs or project elements, and that belief is not shared by the individual or company who hired the designer.

remedied by making certain that both you and your foreign business associate fully understand what each other expects and the terms and conditions of any contracts or other documents.

Contracts

One of the most important ingredients in making foreign design work profitable is the use of proper and effective contracts. The AIA has various international contracts, but many of these documents will need to be modified and translated for your foreign counterparts. Separately, international AIA contracts may be of no use on certain foreign jobs. In fact, many countries, including China, require foreign lighting designers to sign Chinese contracts.

Even if a country does require the use of its own contract, you do still have the opportunity to negotiate some of the terms of the contract. Additionally, although professional organizations such as the International Association of Lighting Designers cannot provide international contracts, per se, they can provide useful networking support.

The expectations of the designer is another item to address in the contract. Make certain that the contract specifies the exact scope of the lighting designer's work. This helps eliminate scope creep—when a designer believes that his or her role in the project is limited to a particular series of designs or project elements, and that belief is not shared by the individual or company who hired the designer. Often, the hiring company will demand that the designer complete additional elements and withhold payments until such additional work is completed. Using plain language and explicit expectations in a contract can help you avoid problems.

Fees and Payments

It is good practice for a lighting designer who is approached by an architect or builder with whom he or she is unfamiliar to conduct some basic research concerning that company's financial profile. This is important to determine the viability of the company and the likelihood that the designer will get paid for his or her work. While it is relatively easy to research a U.S. company, it is nearly impossible to properly analyze the viability of small to mid-size foreign companies.

In addition to the difficulty of determining the asset profile of a particular foreign company, the ability to enforce a judgment against a foreign company is difficult at best. Issues concerning suing a foreign entity and the collection of judgments are discussed in greater detail later in this article.

Cultural differences also weigh heavy in international work. In some countries, it is not uncommon for the lighting designer's last invoice to go unpaid. In fact, it is assumed in these countries that the final invoice is a formality and that all fees were covered by the initial retainer. Still, it is possible for a lighting designer to have a lucrative international practice so long as he or she understands how to collect money on international transactions. So, when analyzing the profitability of a foreign project, it is important for a lighting designer to understand his or her cash flow needs, the economic condition in that foreign country, any foreign tax implications, and the weights and currency adjustment factors.

Assuming that the designer has conducted such an analysis and has decided to proceed with the project, he or she must follow the golden rule of international business: Demand payment in advance. No matter what is promised to you, it should always be your policy when handling an international design project to demand payment up front, typically in an amount that would cover your costs. It is advisable to walk away from a foreign project if the architect or contractor refuses your request for an up-front or retainer payment. Also, any up-front payments should be provided to you via wire transfer and made payable in U.S. dollars. It is not uncommon for lighting designers engaging in foreign projects to request half of the total contract price up front, via direct wire transfer, prior to conducting any work on the project.

An alternative to the up-front or retainer payment is a letter of credit. In a typical version of this scenario, there are four participants: the lighting designer, the foreign company, the issuing bank, and the paying bank. The foreign company would receive a projected invoice from the lighting designer for the entire project, and then take that proposed invoice to its issuing bank who assumes all of the responsibility for payment on behalf of the company. The paying bank is a bank that makes the actual transfers of payment under the established credit.

There are two general types of letters of credit. The first type is an irrevocable letter of credit, which can only be modified with the consent of both parties. The paying bank would have to pay the designer even if the foreign company defaults on payments. This type should be confirmed by a bank in the U.S., and then the U.S. bank must pay the lighting designer even if the foreign bank defaults on payments. An irrevocable letter of credit, confirmed by a U.S. bank, is one of the most secure methods of payment outside of up-front or retainer payments.

The second type, a revocable letter of credit, should rarely be agreed to by a U.S. lighting designer engaged in a foreign project. This can be modified at the request of one party and does not require the consent of the other party. It also can be revised at any point during the contract or afterward. In this scenario, the foreign bank is under no obligation to pay if the architect or contractor defaults.

Staffing and Travel

Even with advances in technology, travel is inevitable when engaging in a foreign design project. Expenses which should be considered and negotiated as part of the contract include airfares, hotels, meals, Internet access, and ground transportation. If the foreign entity refuses to provide travel expenses to the designer, he or she must conduct a risk-to-benefit analysis of the potential expenses involved in traveling and determine whether the costs of travel will be covered by his or her profit.

Laws and Litigation

International business transactions can be very complex, and even more so for a small to mid-size lighting design firm who has limited experience with international business transactions.

Consider this scenario: A lighting designer in New York is hired by an architect based in London to prepare a lighting scheme for a project in Dubai. Separately, the architect retains the services of a firm in Saudi Arabia to prepare the architectural drawings. In the event that the foreign contractor defaults on payments, who would the U.S. lighting designer sue, and which country would have jurisdiction over the matter?

In a case such as this, it is also important to remember that foreign governments frequently have more control over private construction projects than the U.S. government does. For example, in China, all contracts with U.S. designers must be reviewed and approved by the Ministry of Foreign Affairs before they can become effective.

Separately, there are a variety of other U.S. and foreign laws that may impact a U.S. designer's international business transactions. One example is the U.S. Foreign Corrupt Practices Act, which makes it illegal for an American company to make any payment or give anything else of value to an agency or official of a foreign government in order to gain approval for a business project overseas. This act imposes monetary penalties on U.S. companies and possible imprisonment for the corporate officers who violate it. While this act is typically applied to U.S. manufacturing companies who engage in foreign manufacturing, it is possible that a lighting designer could unknowingly violate certain national or international laws. To avoid such a violation, you should retain the services of an international attorney.

Foreign laws also have a significant impact on the ability of a U.S. lighting designer to sue or collect monies from a foreign entity. As mentioned above, it is nearly impossible to enforce a monetary judgment obtained in the U.S. against a Chinese entity. This is why it is critical for the designer to have an adequate contract and to insist on the payment of monies up front or be covered by an irrevocable letter of credit confirmed by a U.S. bank.

Jurisdiction

Let's assume for the purposes of this discussion that a U.S. lighting designer has engaged in a project with a Chinese architect and builder in Hong Kong. We will also assume that the designer only obtained a small retainer fee, which does not cover her costs. In the event that the Chinese company defaults on its payment agreement, the designer has two choices as to where to sue the company.

The first choice is in Hong Kong. This may not be affordable since it would involve the retention of one or more attorneys, including an attorney licensed to practice in China, travel expenses, and the fact that the Chinese government always rules in favor of the Chinese corporation when dealing with contracts and other litigation matters involving individuals located outside of the country.

The other alternative is for the lighting designer to sue the Chinese company in the Federal District Court of New York. It is well-known by international lawyers that the likelihood of recovering money from a Chinese company when suit is brought in the U.S. is slim at best. The exception would be if that Chinese corporation holds assets in the U.S.

After filing the lawsuit in the New York District Court, the plaintiff (the lighting designer) would have to effectuate service of the complaint on the foreign company. The typical way to serve a foreign entity is through the use of the Hague Convention. The lighting designer would have to comply with all of the terms of this, which requires the service of the complaint through the designated Chinese Central Authority in Beijing, and then she must provide various documents and a fee to the Ministry of Justice of the People's Republic of China. Service of a complaint can take anywhere from two months to a year.

Assuming that the Chinese company has been properly served with the complaint via the Hague Convention, the lighting designer would have the opportunity to engage in discovery with the foreign company. As part of the discovery process, the designer's attorney would serve the Chinese company with various requests for document production and attempt to obtain oral testimony of particular witnesses at a deposition. The problem is that China has been known to take up to a year to respond to various written discovery requests and also has refused to be bound by Articles 16 through 22 of the Hague Convention, which require a foreign country to appear at a deposition. In fact, China has made it unlawful for a foreign plaintiff to conduct depositions on Chinese soil.

In the event that the lighting designer is somehow successful in obtaining a judgment over the Chinese company, she will not be able to enforce that judgment in China unless it is nothing more than a paper judgment. There is no treaty or reciprocal arrangement between China and the United States regarding the recognition or enforcement of judgments in civil litigation matters, and Chinese courts routinely disregard U.S. judgments. In this hypothetical scenario, the U.S. lighting designer will have spent tens of thousands of dollars on legal fees to obtain a worthless judgment and will not be able to recover the unpaid contract fees. In general, the U.S. is not a party to any international convention or treaty governing the recognition and enforcement of foreign judgments. In the absence of an applicable bi- or multi-lateral agreement or convention, recognition and enforcement of U.S. judgments abroad is determined in accordance with the domestic law of the recognizing country.

While lawsuits against Chinese entities may be an extreme example of the limitations of lawsuits against foreign entities, most of these issues concerning the difficulties of litigation also apply to countries in the Middle East, Asia, and throughout certain portions of Europe.

So what's the take-away for those designers seeking to do business abroad? Take all precautions in the negotiation of the project to ensure a positive experience and so that you get paid for your work. You cannot always rely on the law. •

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Thoughts on the Future of Light
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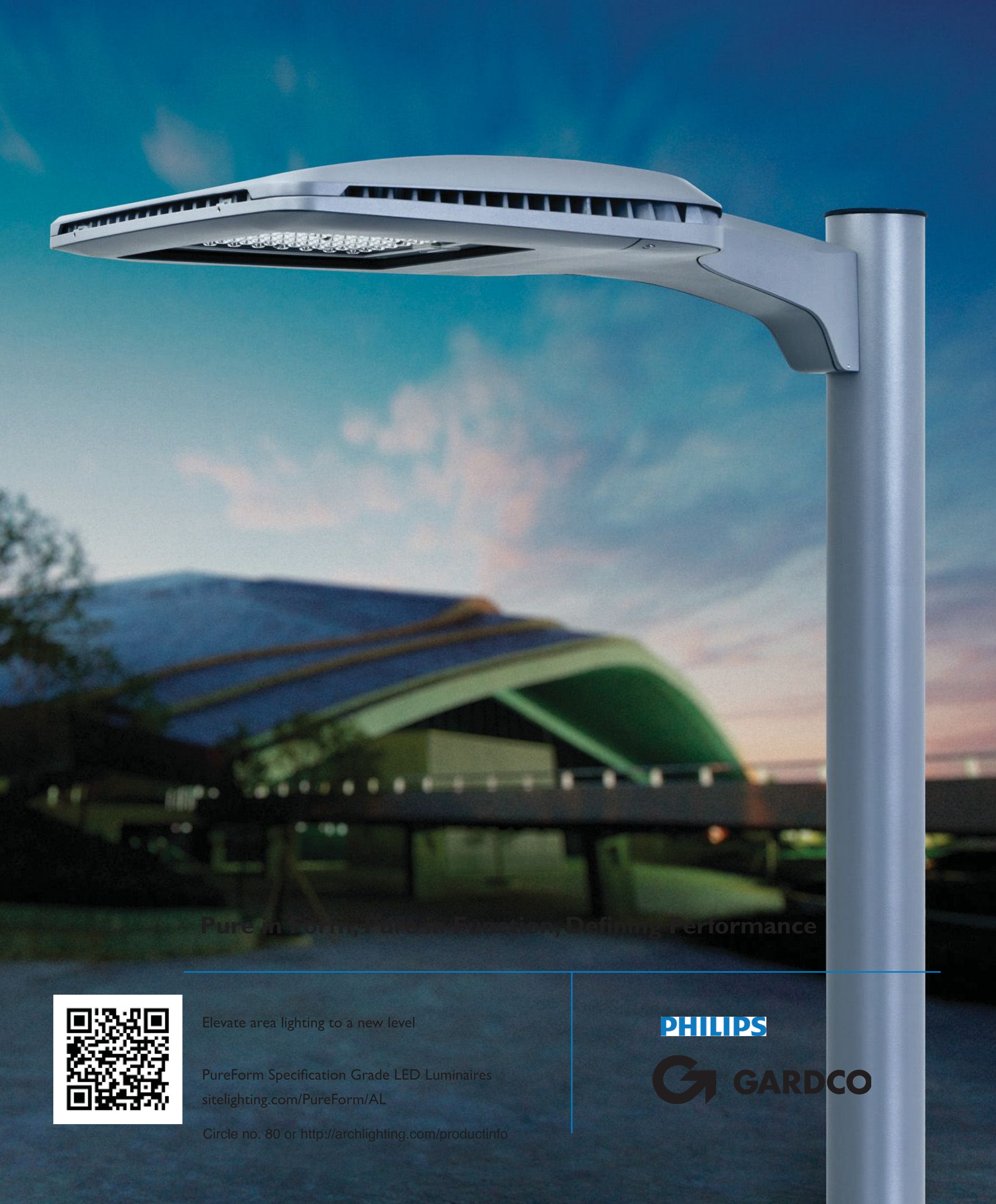
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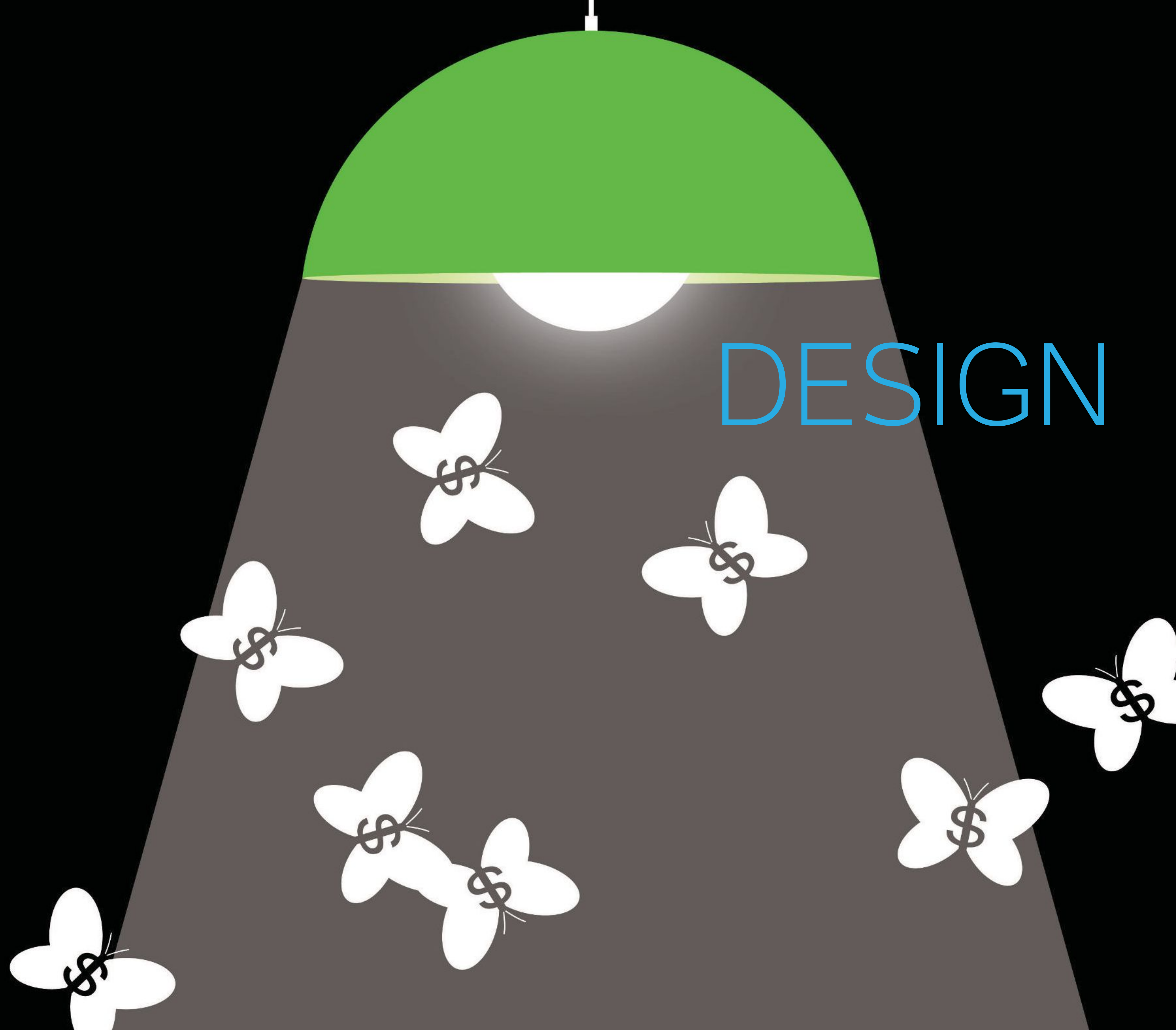


DESIGN

REPORT

NOTHING VENTURED, NOTHING GAINED

With visions of transforming a $100 billion market, investors are flocking to lighting startups. How will venture capital change the lighting industry?

text by Jeffrey Lee
illustration by Patrick George

Lighting manufacturer Soraa is on the verge of shipping the first of its potentially revolutionary line of LED MR16 lamps. Based on a technology that grows an LED's photon-producing gallium nitride crystal on gallium nitride itself, allowing the LED to run on more current and generate 10 times more light, the lamps will be the first to offer quality performance equivalent to that of a 50W halogen MR16, according to the company. And without $100 million in venture capital funding, it's unlikely that the company, or its ability to pursue this line of research, ever would have existed.

Founded when Silicon Valley–based venture capital investor Vinod Khosla approached the technology's inventors, professor Shuji Nakamura and two of his colleagues at the University of California, Santa Barbara, and provided them with seed money to start the company, Soraa is just one example of how venture capital is changing the lighting industry. With disruptive LED and high-tech control technologies set to reinvent lighting in the years ahead, investors are flocking to lighting entrepreneurs and startups, hoping to claim a slice of a market with a huge potential for growth. And while the stream of cash is likely to fuel innovation and help subsidize capital-intensive research and development, the return-driven investment mind-set could change the way the industry operates.

Global venture capital investments in lighting have been steadily increasing over the past four years, according to Brian Carey, U.S. cleantech advisory leader for PricewaterhouseCoopers (PwC). PwC, which conducted an analysis for ARCHITECTURAL LIGHTING of venture capital investment data from the January 2012 "MoneyTree Report" (by PwC and the National Venture Capital Association based on data from Thomson Reuters), found that U.S. venture capital investments in LED lighting grew 83 percent from 2010 to 2011, rising to $304.4 million across 24 deals last year (go.hw.net/ALMoneyTree).

"The global lighting market is very large," he says—approximately $75 billion to $100 billion

"Especially in this cleantech area, you get investors who come in and don't understand a market yet," Black Coral Capital's Rob Day says. Some of their efforts bear fruit, "but some of them fall flat on their face[s]."

or more in annual revenues—"so breakthrough technologies such as LED lighting have a huge potential for growth if they are cost-competitive."

LED lighting and lighting-control businesses are also riding a wave of investor interest in clean technology, or cleantech for short, says Rob Day, a partner with Boston-based Black Coral Capital and a cleantech private equity investor since 2004. Basing their investment strategy on long-term natural resource trends and rising energy costs, cleantech investors seek out new technologies in fields like alternative energy or conservation. Because of its potential energy savings in commercial building lighting, a major source of energy use, LEDs are naturally gaining attention, says Day, whose company provided venture capital to Digital Lumens, which manufactures LED lighting systems for industrial applications.

Although the LED industry receives government subsidies in many countries, such as the United States, Japan, and China, it is less reliant on government incentives than other global cleantech sectors such as solar energy, Carey notes. And with many venture capital investors coming from high-tech sectors, the technology risk for LED lighting is relatively low, he says. "It's similar to semiconductors, and VCs are familiar with these technologies."

Fueling Innovation

Venture capitalists often specialize in startups at certain stages of development. Soraa, for instance, went through multiple rounds of financing. Khosla provided the startup seed money in 2008 to hire the company's core technical leaders and set up a research-oriented laboratory near Santa Barbara. By 2010, the company had developed the technology enough to begin product development, so they raised another round of financing from venture capital investor NEA. That funding allowed the company to move to Silicon Valley and build two fabrication plants, one for engineering and one for production. Today, with a third investor, NGEN, on board, the company has raised a total of over $100 million in venture capital.

"VCs are ideally suited for early-stage technology investment and bringing the company to the marketplace," says Eric Kim, Soraa's CEO. "VCs tend to bet with very high risk and very early, but if the risk pans out, they win very, very big. The upside multiple is huge."

In a sense, venture capital has filled the void left by cutbacks in research and development at large companies, says Barry Weinbaum, who has managed several venture capital–funded startups and is now president and CEO of Lumenergi, a Newark, Calif.–based developer

Understanding Venture Capital

Venture capital investment is just one form of a larger category of private equity investment. While private equity also encompasses hedge funds and buyout funds that invest in mature companies, venture capitalists are generally distinguished by their interest in investing in startups and entrepreneurs with varying levels of risk. They're also distinct from angel investors, who are typically former entrepreneurs providing seed funding and mentorship to an entrepreneur at an even earlier stage, to help them get their company running.

Within venture capital, there are firms that specialize in specific industries, as well as in different stages of business. A firm might focus on early-stage businesses, providing seed capital to start a business from scratch; mid-stage venture capital, to grow a company's sales development or complete its product line; or late-stage capital for a company on the way to profitability, to expand the product line and grow into new markets.

Venture capitalists typically take a meaningful minority or majority shareholding position in the startup. The venture capitalist's goal is to grow the company to a point where it can make an "exit" by taking the company public or selling it to a larger company at a price that greatly exceeds the amount of capital invested.

of lighting control and energy management technology that is backed by venture capital funding. "Venture capitalists have given inventors, entrepreneurs, and academics the ability to incubate and grow businesses that would have had very little chance to grow otherwise," he says.

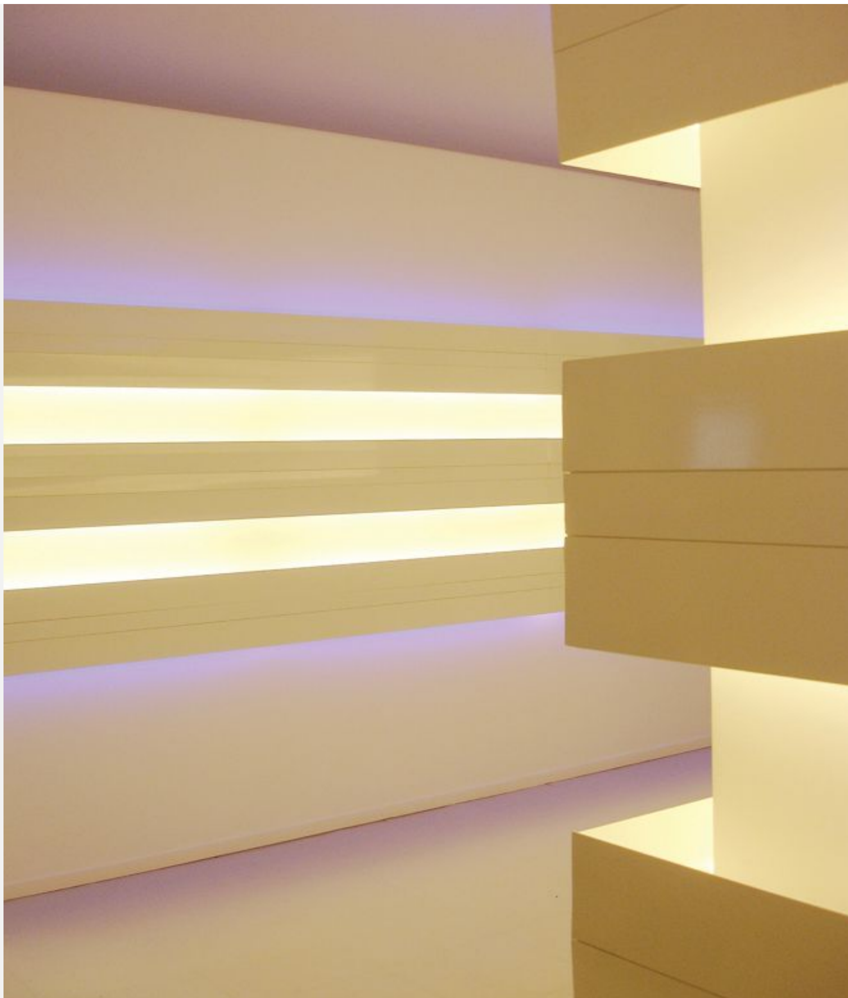
Venture capital investors can also bring diverse skill sets and business relationships to balance the expertise of lighting experts, Weinbaum says. "Venture capitalists, being as well-connected as they are, are very important for opening doors for bigger kinds of relationships."

Venture capital is also vital in a fast-moving industry like LED lighting, says Keith Ward, president and CEO of Luminus Devices, an LED manufacturer focusing on "big chip" technology that has received $127 million in seed money and venture capital since its founding in 2002. "VC money has funded aggressive R&D and operational expenses at Luminus, above what the revenue and margin that the company creates would typically cover in our early years," he says. "When you're small, and in a transformative environment like LED or lighting, you need funding fast so that you can invest very aggressively. Small companies can't typically afford to do that on their own." Unlike banks, venture capitalists will take the risk with a pre-profitable startup to provide the up-front capital that fuels innovation and accelerates sales development.

The role of venture capital in transforming lighting into a growth industry is one reason why many welcome the influx of capital, Ward says. In addition to allowing small businesses to grow faster and owners to take some equity from their startup, the trend provides an opportunity for larger companies as well. "They latch onto some of these smaller businesses that have had heavy doses of VC participation, and they buy at a reasonable value for their business, and then they take that technology and they spread it across an infinitely greater business profile," Ward says. Interest from consumer electronics manufacturers, such as Samsung, LG, and Toshiba, could bring new sales channels and products to the traditional lighting industry and speed up the pace of change, he adds—a development that could benefit both sides.

High-Risk, High-Reward

As with any change, however, some in the industry are likely to feel threatened, Ward says. "There's, I'm sure, the old school, that doesn't want to change and doesn't want to evolve," he says. "If they're hanging onto an old technology, they're going to get eventually passed by."



The venture capital model also is not right for every company. While every investor is different, venture capitalists typically fund businesses with the idea of exiting the investment through a sale or public offering in a set time frame, often three to five years, says François-Xavier (FX) Souvay, president and CEO of LED luminaire manufacturer Lumenpulse. For an entrepreneur, he says, the risk is that their company may never go as far as it could have if the entrepreneur had remained more independent. Lumenpulse, in fact, was seeded with money Souvay earned from a previously owned company, and he raised funding for market expansion from private investors rather than venture capitalists. Young entrepreneurs who use venture capital should try to think about their exit plan ahead of time and find a strategic partner who will help them continue to drive innovations, he says.

Entrepreneurs should also make sure their goals are in line with the goals of venture capital before taking their investments, Rob Day says. A mentor who has been through the process can help them know what to expect.

"A horror story for an entrepreneur is that they have something that they want to grow into a good, steady business, and they've taken money from VCs who want to drive this thing to be just a huge win or a swing and a miss," Day says. "I would absolutely encourage entrepreneurs who think that they have a huge, world-changing idea to go for venture capital, and I would absolutely discourage entrepreneurs who think they want to grow a good business for them and their family from trying to go get venture capital."

A necessary corollary of the high-risk, high-reward venture capital mind-set is that not every venture will succeed. "Especially in this cleantech area, you get investors who come in and don't understand a market yet," Day says. Some of their efforts bear fruit, he says, "but some of them fall flat on their face[s]."

Designer Due Diligence

The potential volatility of startup lighting companies means that lighting designers and distributors must be wary of companies without a long track record. At lighting distributor Wiedenbach-Brown, director of technology and national account executive Lara Cordell launched a program called LED PASS (short for Product Assessment and Screening System) that reviews and qualifies LED products and manufacturers.

Venture capital backing can be a positive or a negative for a manufacturer, she says. "From a positive standpoint, if they've got the VC and it's sizable, then I see them sustaining themselves for the near term, and we don't worry about them ramping up" to meet the needs of a large client.

"The potential negative is, if they are to sell, will the product still be supported the same?" she says. Large clients are often unwilling to risk trying a new product unless they know someone is backing it, she says, so if she's working with a company that's brand-new to the market, she'll ask for an insurance policy to back the product warranty in the event that the company ceases to exist, or they get purchased and the new company does not uphold the warranty terms.

In general, however, Cordell says she's not concerned about working with a startup as long as it is driven by an inventor or engineer with unique, proprietary lighting technology and is financially solvent. "As long as the company doesn't get too big too quick and lose who it is, then we can hope innovation will remain their focus," she says. "If a company is based on venture capital only, that's when I get concerned about their market objective and ultimate longevity."

Venture capital has helped to transform lighting from a mature industry to a growth market. For designers and manufacturers alike, adapting to the changing environment will be key to claiming their share of that growth. •

Tim Hursley

IN FOCUS

KAUFFMAN CENTER FOR THE PERFORMING ARTS

A world-class performance venue makes Kansas City a cultural destination.

text by Elizabeth Donoff

Kansas City, Mo., is not necessarily a city that comes to mind when you think of an arts destination, but nothing could be farther from the truth. Home to several museums, including the nationally recognized Nelson-Atkins Museum of Art, the city also boasts a symphony orchestra, an opera, and a ballet company. And now, with the opening of the Kauffman Center for the Performing Arts this past fall, the city's spot as an arts powerhouse has been solidified.

The building was a labor of love for the project's chairwoman, philanthropist Julia Irene Kauffman, as she saw her mother's vision through to completion. Muriel McBrien Kauffman had wanted a performing arts center for the city, and started planning it in 1994. In 2000, Julia Kauffman and the Muriel McBrien Kauffman Foundation—a fund established by Julia's late mother to support arts organizations in Kansas City—made a gift of $105 million to launch the project.

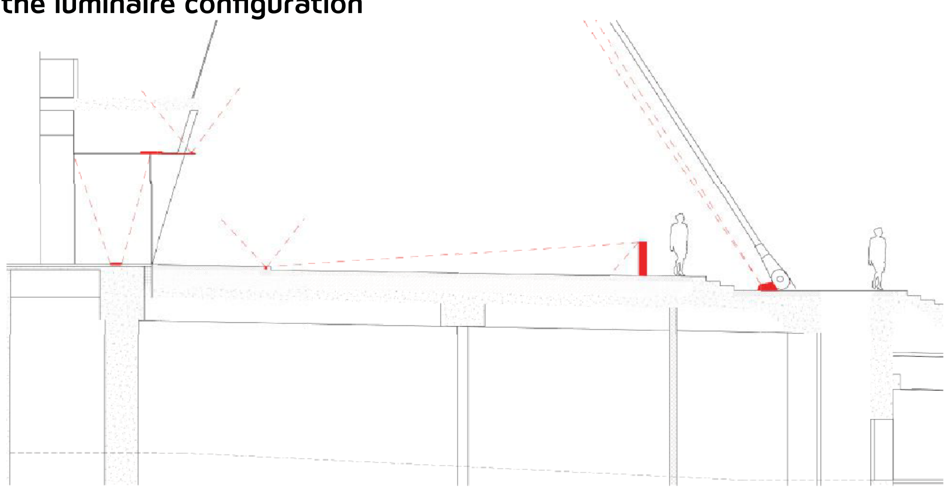
Located on a five-acre site in the heart of the city, the building helps weave together three distinct neighborhoods: downtown, the Crossroads Arts District, and the Power & Light District. Designed by architect Moshe Safdie and his firm, Cambridge, Mass.–based Safdie Architects, the project sits confidently on the city's horizon, and its unique architectural form—a ribbed, helmetlike shape—gives Kansas City a notable landmark.

While the Kauffman Center as a whole strikes a sizeable urban presence, the real cause for celebration is its technical prowess, most of which is hidden in its structure, acoustical performance, and lighting. The center is made up of several buildings in one, wrapped in an envelope of metal and glass. It has two main performance halls, Helzberg Hall, which will be the Kansas City Symphony's permanent new home, and the Muriel Kauffman Theater, which will be the performance space for the Kansas City Ballet and the Lyric Opera of Kansas City.

Each hall is structurally independent of one another as well as the main glass-enclosed lobby area known as Brandmeyer Hall. This was done to assure state-of-the-art acoustical conditions in each of the performance venues, something

The Kauffman Center's 65-foot-tall by 330-foot-wide glass curtainwall reveals the interiors to passersby (above). The entry drive is anchored by 27 high-tension steel cables (previous page).

Section at the entry drive showing the luminaire configuration



not lost on the world-class musicians, vocalists, and dancers who performed during the building's opening celebrations.

The same attention to detail that is paid to the architecture, structure, and acoustics is also paid to the lighting, both inside and out. Safdie Architects worked with Cambridge, Mass.–based Lam Partners on the architectural lighting, and with Los Angeles–based Theatre Projects Consultants on the theatrical lighting.

As Glenn Heinmiller, Lam Partners' principle-in-charge of the project, explains, his firm has a long history of working with Safdie's office. In designing the lighting for the Kauffman Center, he knew it would need to be about keeping the lighting to a focused minimum in order to highlight the architectural features.

One of the most dynamic of these features is the building's 65-foot-tall by 330-foot-wide glass curtainwall, which wraps the front of the building and reveals the interiors to passersby. This dramatic expanse of glass is further highlighted by 27 high-tension steel cables that anchor both the glass wall and the sloping metal roof above it, and this canopy of cables is one of the key elements of the entry drive.

Heinmiller and his team, with the assistance of local lighting firm Derek Porter Studio, have artfully lit this exterior space in a seemingly simple, yet technically sophisticated, way. Five different luminaires work in concert to illuminate the drive and its architectural features. To start, 70W metal halide (MH) floodlights with a narrow beam spread wash the structural cables. A 39W MH forward-throw bollard lights the driveway surface, and the luminaire acts as a guide to demarcate the walkway from the roadway. In-ground LED marker lights provide the edge for the building side of the roadway. And at the building base, the architectural niches along the façade are highlighted with 20W in-ground MH lensed wallwashers and soffit-recessed MR16 halogens with an adjustable gimbal.

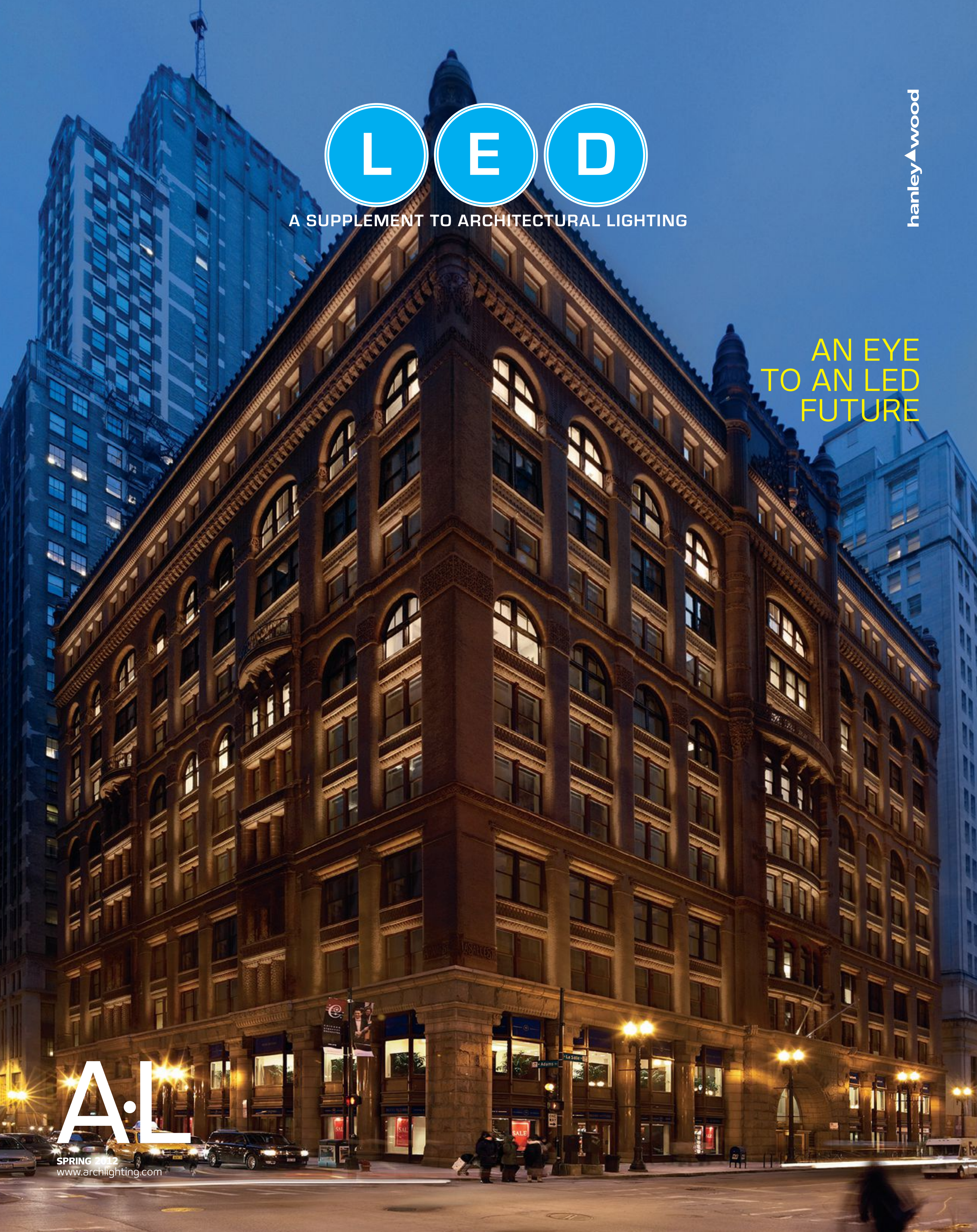
Despite the scale of the building, the lighting design provides an intimate feel and sets the stage for the spectacle within. It perfectly complements the center, and helps to complete Muriel Kauffman's vision for Kansas City's ascendance in the arts. •

Details

Project: The Kauffman Center for the Performing Arts, Kansas City, Mo. **Architect:** Safdie Architects, Cambridge, Mass. **Associate Architect:** BNIM Architects, Kansas City, Mo. **Acoustics:** Nagata Acoustics, Tokyo and Los Angeles **Structural Engineer and M/E/P Engineers:** Arup, New York **Lighting Designer:** Lam Partners, Cambridge, Mass., in association with Derek Porter Studio, Kansas City, Mo. **Theater Design and Theater Lighting:** Theatre Projects Consultants, Los Angeles **Project Size:** 285,000 square feet (total); Muriel Kauffman Theatre (18,900 square feet); Helzberg Hall (16,800 square feet); Brandmeyer Great Hall (15,000 square feet); Arts District Terrace (113,000 square feet) **Project Cost:** $413 million **Manufacturers:** Acolyte; Bartco Lighting; Bega; Cooper Lighting, Lumiere; Cooper Lighting, RSA; Dasal; DesignPlan; Edison Price; Edge Lighting; ELP; Erco; ETC; Eureka Lighting; Finelite; Focal Point; Insight Lighting; Intense Lighting; Kurt Versen; Leviton; Litecontrol; Targetti Poulsen; Lucifer Lighting; Philips Daybrite; Philips Lightolier; Philips Omega; The Lighting Quotient/Elliptipar; Selux; Tivoli; We-ef.

• For the full project detail info, see the online version of the article

Tim Hursley



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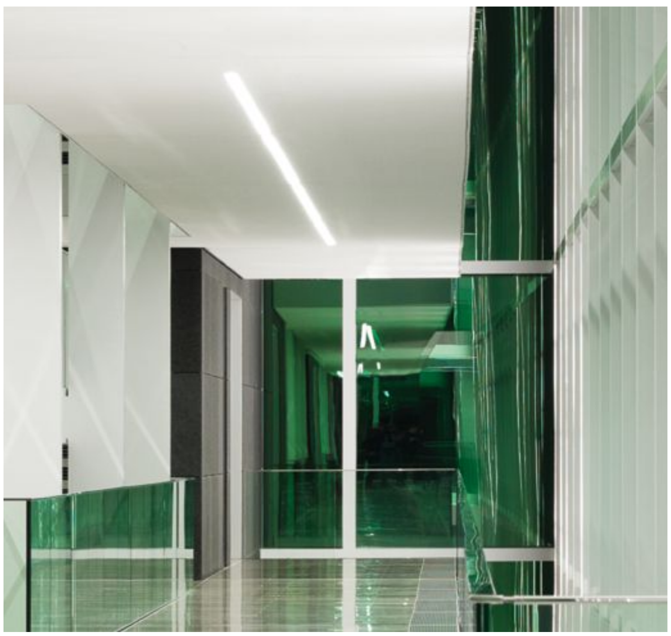

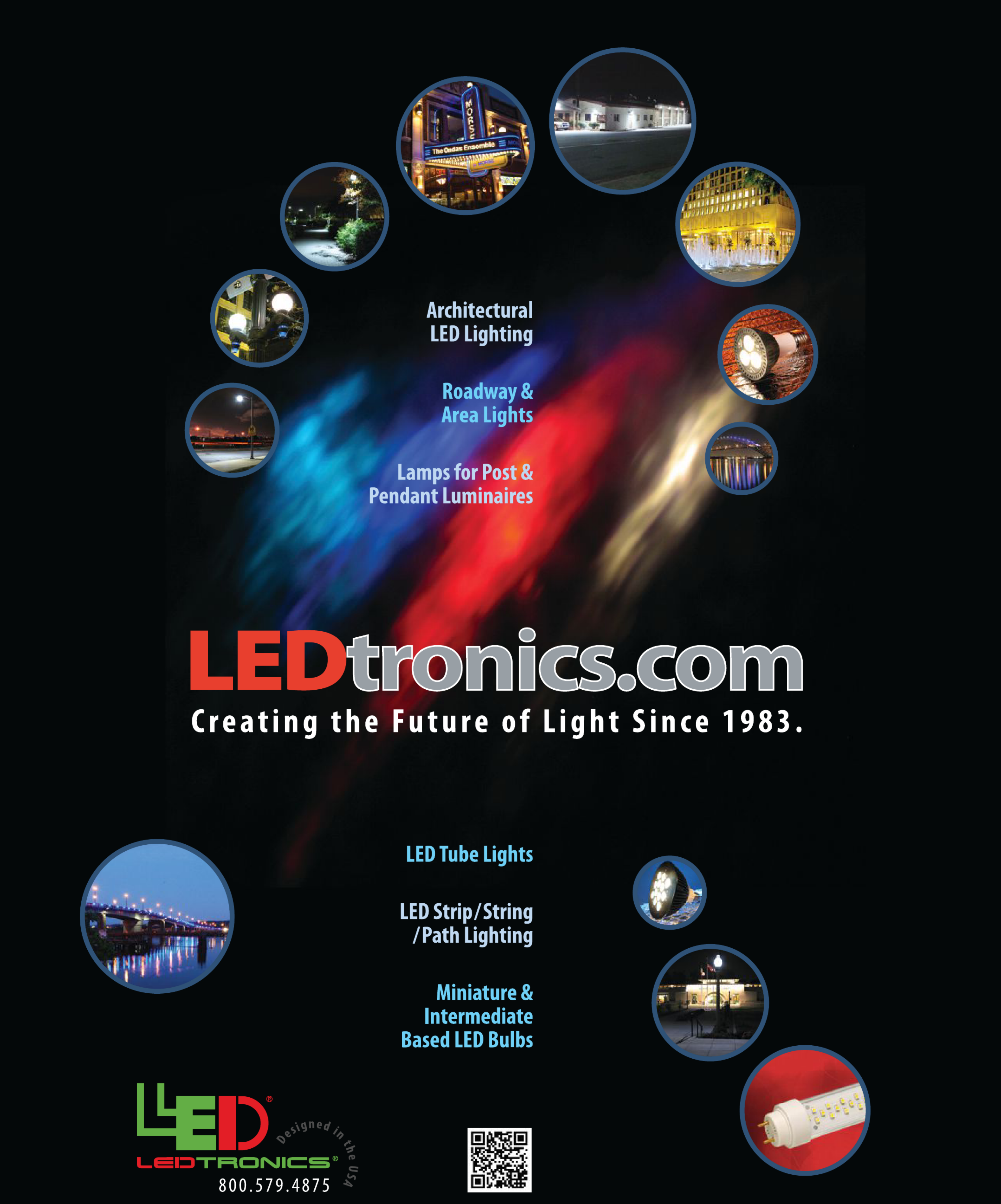

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You can always look to our site for expanded article content, the latest news, and calendar listings and blogs. Also, read e-notes and ARCHITECTURAL LIGHTING's new digital edition.

Dave Burk, Hedrich Blessing (top left); Neil Webb (top right)

"The analog-to-digital transformation under way in lighting should be seen as an opportunity to fix processes and procedures that no longer serve the industry well."

A LARGER OPPORTUNITY

The lighting industry is undergoing a transformation, and the root of this change is the light source itself. The filament sources that have been the mainstay of the industry for more than 100 years are giving way to an electronically driven form of light—light-emitting diodes (LEDs).

And as this transformation occurs, the entire lighting community—designers, manufacturers, and everyone in between—is trying to figure out how to navigate the uncertain lighting landscape. At moments, the path seems clear, at other times, not so much.

Clearly, the rise of solid-state lighting is challenging designers and manufacturers to think about how the LED and its specific characteristics in delivering light can be the starting point to create new form factors for luminaire design. But the changes that LED lighting technology is bringing to the industry should be viewed as a greater opportunity than just reimagining the design of new fixtures. It should be seen as an opportunity to reenvision the industry as a whole and all its components, including but not limited to the R&D process, the supply chain, and the communication process between designers and manufacturers.

The analog-to-digital transformation under way in lighting presents an opportunity to fix processes and procedures that no longer serve the industry well. The potential that LEDs (or any other new lighting technology for that matter) provide should allow the lighting industry to become more flexible and open to adaptation and change. It shouldn't force designers to retreat and not specify LED luminaires until all the intricacies of the technology are solved, or force lighting companies to choose between maintaining or abandoning their still-in-use and in-demand legacy product lines and their investigation of new LED-based product options.

New technology can and should provide direction for the industry to move forward, while still being responsive to external pressures such as the economy, new investment opportunities and partners, and inquiries from other non-lighting industries. The potential to be gleaned from solid-state lighting should cause a level of excitement throughout the lighting community and create an environment where designers and manufacturers are open to new types of collaborations in the creation and delivery of lighting goods.

Yes, there is always a degree of uncertainty with any new development. But if the past six years and the steady increase of LED product introductions and application studies have proven anything, it's that the lighting industry has bet on LEDs and it will have to see this industry and market transformation through.

Here is the chance to lead and determine the industry's destiny, and to show others outside of lighting, such as electronic manufacturers and venture-capital investors, how fantastic an industry this is and what types of opportunities exist. Light isn't just about the light source or the light fixture; it encompasses optics, human factors, aesthetics, emotions, materials, security, energy savings, and so much more.

The evolution to solid-state lighting requires building on existing skill sets and creating new ones, ones that respond to the technical requirements for producing a new generation of lighting products and information sharing.

The transformation to LED lighting is providing the industry with an exciting opportunity to reimagine and reinvent itself. It doesn't mean throwing the baby out with the bath water—specifically the scientific research, ingenuity, and entrepreneurship that have been a huge part of the industry's development and success. But it should be seen as way for the industry to invest in its future and carve out a path for the next 100 years.

Elizabeth Donoff
Editor

700

In 2010, lighting accounted for approximately 700 terawatt-hours, or approximately 19 percent of total U.S. electricity use.

71

Residences account for 71 percent of all lamp installations nationwide, at 5.8 billion lamps.

25

The commercial buildings sector is the second-largest sector with 25 percent of all installations and 2.1 billion lamps.

180

The outdoor and industrial sectors are significantly smaller, each accounting for roughly 2 percent of all lamps installed, 180 million and 140 million lamps, respectively.

51

The average number of sockets per U.S. household went from 43 in 2001 to 51 in 2010.

58

The average system efficacy of installed lighting increased from 45 lumens per watt in 2001 to 58 lumens per watt in 2010.

Source: 2010 U.S. Lighting Market Characterization report

STATE OF THE LIGHTING UNION

The 2010 U.S. Lighting Market Characterization *report breaks down the nation's installed lamp base.*

text by Elizabeth Donoff

With technology and information constantly changing, as well as its varied availability, it is often difficult to get an accurate read on lighting-industry metrics. But now, thanks to a recently released Department of Energy (DOE) report—the *2010 U.S. Lighting Market Characterization*—a big-picture view of U.S. lighting is a little clearer. The report provides an overview by sector (residential, commercial, industrial, and outdoor) and detailed information on the current inventory of installed lamps by type (incandescent, halogen, compact fluorescent, linear fluorescent, high-intensity discharge, and solid state or other), along with their energy use and lumen output.

Although the 2010 report might already appear out of date—though it was just released in Jan. 2012—it does represent the first significant update of this information since the DOE released a similar report in 2001–2002.

As the DOE, and the department's Solid-State Lighting program, pushes forward with its mandate to champion energy-efficient, white-light LED technology and integration, one must understand the trends in the overall lighting market. This report helps put those conditions into perspective.

The two most noticeable developments this past decade have been a "push toward higher-efficacy lighting" and an "increased demand for light." Improved efficacy directly correlates to evolving lamp technologies.

And while the report indicates that LED lighting for general-illumination applications is still below the 1 percent mark, that percentage will increase greatly as more and more LED luminaires make their way to market in the future. •

2010 U.S. Lighting Market Characterization The Department of Energy's detailed report analyzes the U.S. lighting market by technology and sector, and provides an assessment of the installed lamp inventory and their associated energy use. The report is available at 1.usa.gov/yr0cQb.

SOLID-STATE DIRECTIVE

The Department of Energy continues to oversee and push forward the adoption, testing, and market delivery of solid-state lighting.

• The DOE has completed Round 13 of product testing through its CALiPER (Commercially Available LED Product Evaluation and Reporting) program. This latest round focused on LED and benchmark high-bay luminaires, LED wallpacks, and LED and benchmark 2-foot-by-2-foot troffers. The summary report can be downloaded at 1.usa.gov/wZ2qI4.

• The DOE has published the findings of two recent Gateway demonstration projects. The first, *Demonstration Assessment of Light-Emitting Diode (LED) Roadway Lighting*, reports on a roadway lighting installation along a portion of the FDR Drive in New York City. The project, done in conjunction with the New York City Department of Transportation and the Climate Group, evaluated four different types of LED roadway luminaires in comparison to existing high-pressure sodium (HPS) fixtures: The LED fixtures provided a 26 to 57 percent energy savings. Three of the LED roadway lights equaled the initial illuminance of the HPS luminaire, but only two met the required maintained illuminance level described in Illuminating Engineering Society RP-8-00 (*ANSI Practice for Roadway Lighting*). The LED luminaires did provide better color rendering and emitted no uplight.

The other Gateway demonstration report—*Assessment of LED Technology in Ornamental Post-Top Luminaires*—examines a test case in Sacramento, Calif., conducted by the DOE Municipal Solid-State Street Lighting Consortium, in conjunction with the Sacramento Municipal Utility District and the City of Sacramento. Four different LED replacement luminaires were evaluated, limited to lamp-ballast retrofit kits and complete luminaire replacements that would maintain the daytime appearance of the existing acorn-style streetlights. None of the LED products matched the performance of the 100W HPS luminaires. Both reports are available at 1.usa.gov/wF6SXk.•

THE SOLID-STATE SCENE

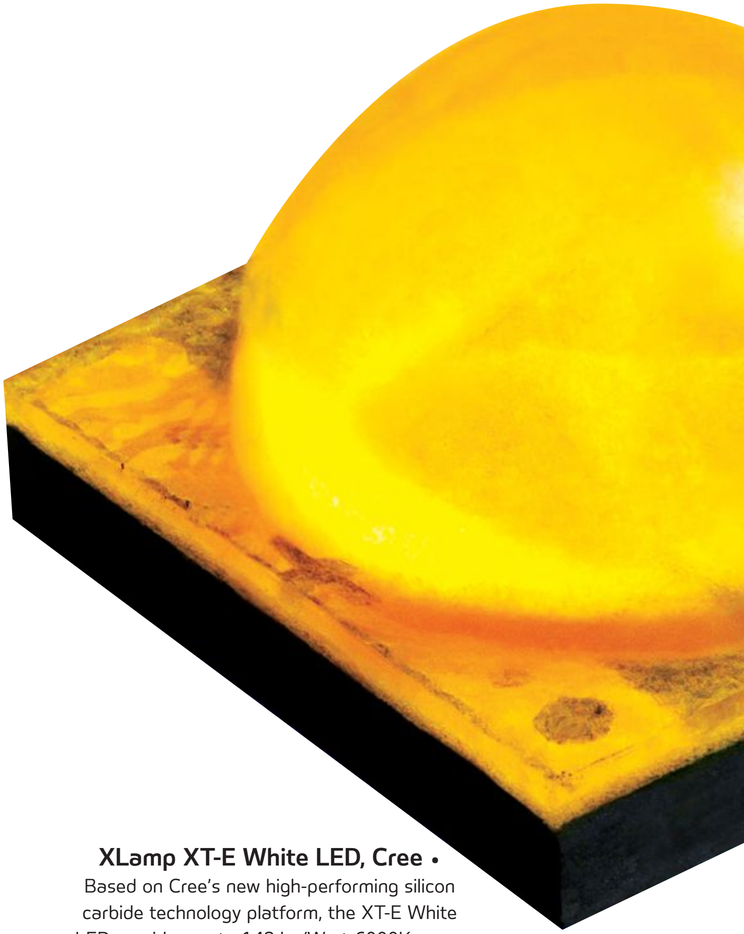
New LED products for a range of architectural lighting applications.

text by Wanda Lau

Cori,N oraL ighting • Finished in black, silver, or white, the Cori LED track head may be installed in Nora track systems and H-style tracks, or retrofitted into L- or J-style tracks. The 23W model uses nine LEDs and has a 3 5/8-inch-diameter head and a length of 4 1/4 inches with a maximum extension of 8 1/2 inches. The 12W model uses seven LEDs and has a 2 5/8-inch-diameter head and a length of 3 5/8 inches with a maximum extension of 7 1/2 inches. With a color-rendering index (CRI) exceeding 80, both models are available with 3000K or 4000K LEDs, and with a 25-degree or 40-degree beam spread. • *noralighting.com* • Circle 140

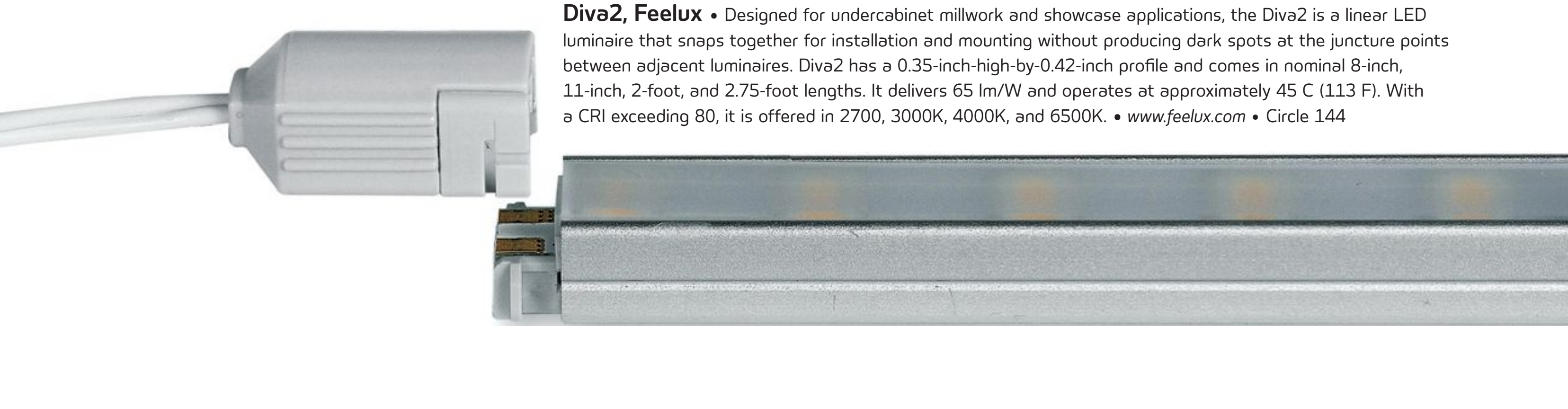
LED Steplights, Creative Systems Lighting • Suitable for use on outdoor stairways and pathways, the LED Steplight family of luminaires is available in four finish options: natural antique bronze (model SS3001-BZ shown), unfinished stainless steel, unfinished brass, and unfinished copper. The steplight has a pull-out socket for relamping, and a frosted-glass lens for multiple mounting options. The circular-shaped models measure 6 inches in diameter and 1 1/2 inches deep. The square-shaped models measure 4 1/2 inches wide by 3 inches tall by 1.63 inches deep. Depending on the model and style, the fixtures have a light output of between 3W to 6W. All models are UL and C-UL listed for wet locations. • *csllighting.com* • Circle 141

Cove-15 and Cove-16, Litecontrol • Litecontrol's Cove-15 (shown) and Cove-16 concealed luminaires, which measure 1 3/8 inches high and 4 1/2 inches wide, respectively, both use 12 LEDs in a 2-foot interchangeable LED module. The LEDs are offered in four color temperatures: 2700K, 3000K, 3500K, and 4000K. The Cove-15 fits into a field-constructed architectural cove, while the Cove-16 can be mounted to the wall directly. Achieving 54 lm/W at 2700K, both fixtures have an optional high-performance reflector that helps provide uniform illumination on ceiling surfaces. • *litecontrol.com* • Circle 142



XLamp XT-E White LED, Cree • Based on Cree's new high-performing silicon carbide technology platform, the XT-E White LED provides up to 148 lm/W at 6000K, or up to 114 lm/W at 3000K, at 85 C (185 F) and 350 milliamps. The lamp is offered in cool, neutral, and warm-white, as well as other options. The typical CRI for the 3700K to 5000K LED is 75; the 2600K to 3700K LED has a typical CRI of 80. The XT-E uses the same 3.45mm-square footprint as its predecessor, Cree's XP-E High Efficiency LED. As a result, applying for Energy Star qualification requires only 3,000 hours of LM-80 data instead of 6,000 hours. Cree also offers the XLamp XT-E LED in royal blue. • *cree.com* • Circle 143

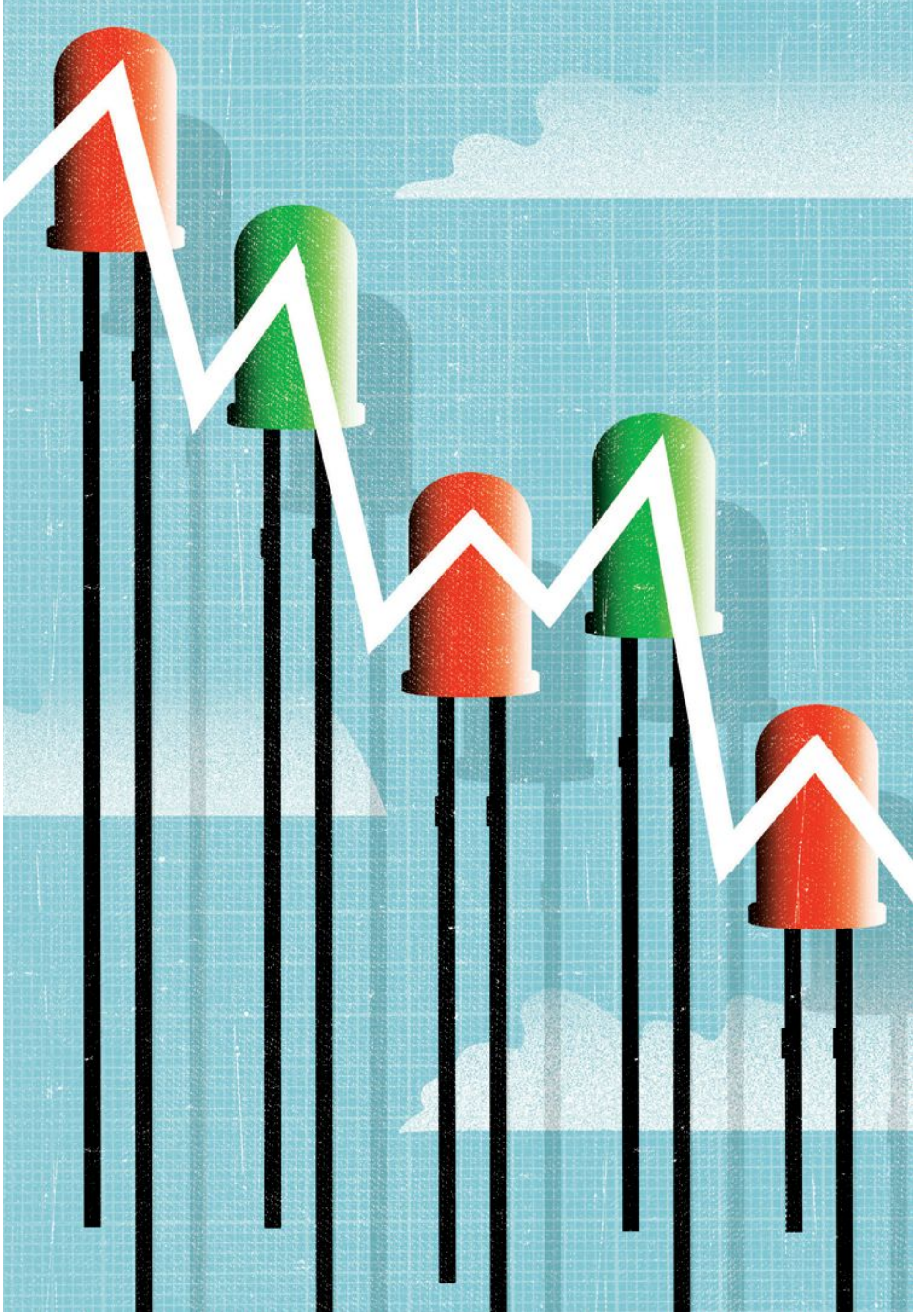
Diva2, Feelux • Designed for undercabinet millwork and showcase applications, the Diva2 is a linear LED luminaire that snaps together for installation and mounting without producing dark spots at the juncture points between adjacent luminaires. Diva2 has a 0.35-inch-high-by-0.42-inch profile and comes in nominal 8-inch, 11-inch, 2-foot, and 2.75-foot lengths. It delivers 65 lm/W and operates at approximately 45 C (113 F). With a CRI exceeding 80, it is offered in 2700, 3000K, 4000K, and 6500K. • *www.feelux.com* • Circle 144



Arca,C erno • This linear decorative-style pendant features an oiled or dark-stained walnut frame, which morphs from solid to open cage, depending on one's sight lines. The housing measures 49 inches long by 24 inches wide by 17 inches tall and surrounds a black-anodized- or brushed-aluminium LED light bar with a polymer enclosure. The light bar contains five 2700K, 16W LEDs, and achieves a CRI of 85-plus. For ceiling-mounted installations, a canopy is also included with the fixture. • *cernogroup.com* • Circle 145

Tesla High Output Recessed Downlights, WAC Lighting • The Tesla LED downlight is available in two sizes: a 2-inch aperture and a $3\frac{1}{2}$ inch version. Offered with 15-, 26-, and 45-degree beam spreads, the LED downlight has a CRI of 85 at 3000K or a CRI of 82 at 4000K. The luminaire comes with a replaceable LED module and reflector. Its round or square aluminum housing may be finished in brushed nickel, copper bronze, or white. • *waclighting.com* • Circle 147

Line Voltage Linear LED Engine, TerraLux • The self-contained Line Voltage Linear LED Engine is a plug-and-play module that does not require additional LED drivers or wiring. Suitable for indoor and outdoor applications, the IP65-rated engine is a UL-recognized component for original equipment manufacturers (OEMs) and for UL1598c LED retrofit kits. The patented LED Sense thermal-management circuity enables the driver to be installed in any sealed fixture. It is available as a 120V input unit compatible with phase dimming or as a 100V-to-277V-input unit compatible with 1V to 10V dimming. The driver comes in three sizes—4, 6, or 8 inches—and four color temperatures: 2700K, 3000K, 3500K, and 4000K. • *terralux.com* • Circle 146



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 Neil Webb

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. Today's 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

> **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**

manager at io Lighting, a division of Cooper Lighting that focuses on architectural LED lighting. The DOE's *MYPP* 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."

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." •

"There's now legitimately an energy story where I can justify using an LED downlight. That changes everything."

—Jeff Gerwing, principal and director of operations for SmithGroupJJR

UNDER THE MAGNIFYING GLASS

A look at the continuing advancements in solid-state lighting for illuminating artworks in museum settings.

text by Wanda Lau

In the 30-foot-tall Grand Salon in the Smithsonian American Art Museum's Renwick Gallery, LEDs replaced 30 percent of the incandescent lamps.

The dust has yet to settle on the argument over whether LEDs are suitable for museum lighting. In his Jan/Feb 2011 ARCHITECTURAL LIGHTING article "Museum Lighting in the Second Decade of the 21st Century," Kevan Shaw, design director of Edinburgh, Scotland–based KSLD noted that while LED technology has advanced, it was not ready to "replace the best low-voltage tungsten halogen lamps, and limitations in the technology may prevent us from getting there." To reduce energy usage, he added, museums "might have to accept a loss in lighting quality" or increase restrictions on exposure times and lighting controls.

While lighting and conservation experts generally agree that no silver bullet has emerged in the past year, they do note that museums' willingness to explore LED source and fixture options has increased significantly. Solid-state lighting is where manufacturers' research and development dollars will continue to flow, and it is likely that museum settings will be part of the discussion.

Performance Matters

As more art museums open their doors to LED testing, both the technology's potential and its limitations are moving from speculation to observation. Five years ago, Daniel Gelman, president of Lighting Services Inc in Stony Point, N.Y., was an LED skeptic. "It was difficult for me to first grasp LEDs and buy into it, as a company," he says. After visiting several test sites, he had a watershed moment when he heard a curator comment, "I've looked at this painting for the last 15 years and I haven't seen some of this detail that I'm seeing now."

Matthew Siegel, chair of conservation and collections management at the Museum of Fine Arts (MFA) in Boston, agrees that LED developments in recent years "have been fast and furious." With white LEDs' color-rendering indexes now in the mid-80s and 90s, Siegal says, "The products are [now] to [a point] where it is reasonable to step in."

Though LED efficacies now surpass 100 lm/W, Shaw says that with high-quality

PAR30 and MR16 retrofit LEDs illuminate the early Modernism gallery in the Smithsonian American Art Museum. The results are “fabulous,” says the museum’s lighting specialist, Scott Rosenfeld.

Lighting manufacturers have balanced out the high blue peaks in early LEDs’ spectral power-distribution curves, which have the potential to fade yellow-colored dyes.

color rendering comes sacrifices in energy performance. “We’re still not seeing much better than the best products ranging between 40 and 60 lm/W for a high-quality color-rendering device, and 60 to 70 lm/W for a less-high-quality color-rendering device.”

Clint Paugh, lighting designer at the Nelson-Atkins Museum of Art in Kansas City, Mo., wishes that manufacturers would focus less on illuminance and more on improving retrofit products. “Their selling point is more light for less, but we want less light for less,” he says. (Paugh generally doesn’t light anything over 25 footcandles in the museum.)

However, LEDs have made some strides in flexibility, says David Clinard, principal at Clinard Design Studio in New York. Fixtures “cool enough to touch in front of the light source” have given designers greater control through the use of media such as color-filtering gels and holographic films. For display lighting, fixtures connecting fiber-optic illuminators to LED sources allow “long lamp life and a small illuminator footprint.” In some LED–fiber-optic hybrid systems, each optical head has its own LED source, allowing for greater individual control and enhanced dynamic displays.

Discussions sparked by a 2010 letter written by Dale Kronkright, head of conservation at the Georgia O’Keeffe Museum in Santa Fe, N.M., cautioning the display of light-sensitive materials under LEDs have also subsided, and for good reason, says Jim Druzik, senior scientist at Los Angeles’s Getty Conservation Institute (GCI). The warnings were based on studies of narrow-band LEDs, a technology that was virtually replaced by white LEDs within about a year. “The initial concern is no longer relevant,” he says. Manufacturers have balanced out the high blue peaks in early LEDs’ spectral power-distribution curves, which have the potential to fade yellow-colored dyes. As director of the Museum Lighting Research Project at the GCI, Druzik found no significant differences between the fading effects for 15 dyes on silk or paper caused by exposure to two white LEDs or a tungsten halogen lamp.

Testing the Waters

Perhaps the most significant progress made in LED lighting for lighting artworks in museums the past year was in part a result of the U.S. Department of Energy (DOE)’s Solid-State Lighting Gateway demonstration projects. The projects investigate the use of LEDs in several exterior and interior lighting applications.

Previous page: Scott Rosenfeld
This page: Courtesy Smithsonian American Art Museum

To date, five Gateway projects have focused on lighting museum artwork. The three projects cover a range of issues, including artwork conservation, human perception, and gallery installations. A fourth and ongoing investigation at the Burden Iron Works Museum in Troy, N.Y., looks at the compatibility of dimming systems with LEDs, and should wrap up at the end of 2012. "As a group, they're going to be a wonderful and complete study on the state of LEDs at this point in time," says Naomi Miller, senior lighting engineer at the Pacific Northwest National Laboratory.

Along with the fading studies conducted by Druzik and the GCI's Museum Lighting Research Project, one of the Gateway projects examined the potential degradation of installed artwork under LED lamps. At two-week intervals between March and September 2011, Druzik studied the prints displayed at the "In Search of Biblical Lands: From Jerusalem to Jordan in Nineteenth-Century Photography" exhibition at the J. Paul Getty Museum, which was illuminated by LED PAR38 lamps, for color changes. No degradation was visibly detectable and the museum curators were satisfied with the quality of illumination from the LEDs. The Gateway report on the GCI studies will be published this spring.

For the Gateway project at the Jordan Schnitzer Museum of Art at the University of Oregon, LEDs were tested at two locations. In the first location, a gallery displaying photographs by artist Chris Jordan, the museum installed 54 12W LED PAR38 replacement lamps as accent lighting. During the exhibition, which ran through winter and spring 2011, the LED lamps only used 14 percent of the energy that standard halogen lamps would have consumed, according to the September 2011 Gateway report.

For its second location, the nearby Gordon Gilkey Study Center Gallery, the museum installed a blind side-by-side comparison of three LED lamps and one halogen lamp on oil paintings, and invited museum staff members and visitors to assess the lamps' performance. Museum staff preferred the same LED lamp that was used in the Jordan exhibit, while visitors favored another test LED replacement lamp. Both user groups noted an "improved ability to see blue colors." Lamp preferences did not correlate with the color-rendering index (CRI); while the halogen lamp had a CRI of 99, the museum staff–selected LED had a CRI of 93, and the visitors' choice LED had a CRI of 85. The report concluded "that carefully chosen LED replacement lamps can provide an

For 26 weeks, Getty Conservation Institute senior scientist Jim Druzik monitored the prints in the "In Search of Biblical Lands: From Jerusalem to Jordan in Nineteenth-Century Photography" exhibition at the J. Paul Getty Museum for potential degradation under LED lamps (above). Druzik and Canadian Conservation Institute senior conservation scientist Stefan Michalski recently published *Guidelines for Selecting Solid-State Lighting for Museums* (available at bit.ly/zqGs7I). To date, Druzik has received more than 330 requests for the document.

equivalent or even preferred appearance of art in comparison to halogen lamps" at a fraction of the energy used by the latter.

In 2010, museum lighting specialist Scott Rosenfeld collaborated with Naomi Miller on a Gateway project at the Smithsonian American Art Museum (SAAM) in Washington, D.C. In 2011, after a series of mock-ups, they selected LED lamps to test in four sites: the early Modernism gallery and the Luce Foundation Center for American Art at the SAAM's main building, and two spaces in the Renwick Gallery, SAAM's branch for American craft.

In the early Modernism gallery, Rosenfeld and Miller installed PAR30 retrofit LEDs with 10-, 25-, and 40-degree beam spreads and MR16 retrofit LED lamps with a 4-degree beam spread. "The range of beam spreads was key," says Rosenfeld, who used a custom-made AR111 adapter ring with a GX5.3 base to integrate the MR16 lamps into PAR36/AR111 fixtures. After "tweaking the chromaticity" of the lamps with filters, they found the artworks' illumination by the LEDs to be successful.

At the Renwick Gallery, PAR38 LED lamps with 10- and 25-degree beam spreads, along with MR16 retrofit LED lamps with a 4-degree beam spread, illuminated a gallery that first hosted a glass sculpture installation and then a display of artworks in different media. The results were "fabulous," Rosenfeld says. "I was able to maintain the illuminance by going to LED and saved about 75 percent on electricity."

In roughly 30 percent of the Renwick's 30-foot-tall Grand Salon, Rosenfeld and Miller installed 16W LED PAR38 lamps with a 10-degree beam spread to replace 50W to 120W incandescent spotlights. For the most part, the changes were imperceptible as each bank of fixtures was switched out. But for the existing 250W floodlights and most of the 4-degree PAR46 lamps, "there was no LED option," Rosenfeld says.

For the fourth test site at the Luce Center, Rosenfeld and Miller searched for LED lamps that would match the chromaticity of the existing halogen MR16s. However, because of compatibility issues between the components, the contenders flickered with the electric transformers used in the tracklighting (the MR16 lamps installed in the early Modernism gallery were powered on a magnetic transformer) and the test was declared a no-go.

The LED lamps for the four SAAM sites were first tested by an independent laboratory in their initial new state, and then will undergo additional testing after a year in the field. The Gateway report with these results is expected to be published this coming June.

The DOE's Gateway projects and museum-specific studies have "had a catalytic effect on other museums," Druzik says. The Museum of Fine Arts in Boston, for example, installed LED fixtures in its second-floor Koch Gallery last November. Lighting the Baroque paintings, hung salon style, with tracklighting in the 30-foot-tall space has always been difficult. Matthew Siegal says, "Some of the paintings disappeared as they climbed up the wall." Traditional MR16s—150W fixtures dimmed down to about 25W—lit half of the gallery, while 2700K LED fixtures—approximately 15W brought down to about 5W—illuminated the other half.

The results are "fantastic," Siegal says. "The paintings are really popping under the LEDs," and "the intensity of light on a throw that long is 10 times what it is on an incandescent."

The MFA is now looking for funding to relamp the entire gallery. Siegal estimates that the energy savings from LEDs could significantly reduce the museum's annual utility bill, 37 percent of which goes toward lighting and 15 percent to cooling. "The potential is unbelievable," he says.

The Future Awaits

On the one hand, LED technology is advancing extremely fast; on the other hand, related lighting technologies and components are not necessarily advancing quickly enough to keep pace with the recent crop of LEDs. With more art institutions exploring the potential of solid-state lighting in their galleries and exhibits, museums now have the beginnings of a body of research findings that they can use to evaluate their options. Still, many designers would like to see improvements in areas such as performance, product offerings, costs, size, and standardization before making the investment.

Druzik, who equates the progress of LEDs to that of the personal computer, takes a more laissez-faire approach. "If you have an idea of what you'd like to see, it might not be that useful in five years," he says. "Instead, it'll probably be improved, and it'll be surprising in the way it's been improved." •

Rebecca Vera-Martinez

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NIGHT LIGHT

Office for Visual Interaction creates an exterior lighting scheme for a Chicago architectural landmark.

text by Elizabeth Evitts Dickinson

photos by Dave Burk, Hedrich Blessing

Details

Project: Rookery façade lighting, Chicago
Client: John Buck Co., Chicago
Original Building Architect: Burnham & Root, Chicago
Lighting Designer: Office for Visual Interaction, New York
Structural Engineer: Klein and Hoffman, Chicago
Electrical Engineer: Environmental Systems Design, Chicago
Total façade area: 55,300 square feet
Lighting cost: $250,000 for lighting hardware only, ($4.52 per square foot)
Energy-code requirements: Compliance with Chicago Landmarks Commission
Watts: 2,304W (entire façade)
Manufacturer: Zumtobel provided all the exterior façade custom luminaires and mounting brackets

In 1888, Chicago welcomed a feat of architectural ingenuity to the Loop—a building constructed of hung masonry on a steel frame, the most advanced engineering technique of the day. The Rookery building, designed by architects Daniel Burnham and John Root, of the renowned architecture firm Burnham & Root, was 12 stories tall, making it one of the earliest commercial high-rises. Inside, a central light court flooded offices with sun, a critical element for such a tall building. As Erik Larson describes in the book *The Devil in the White City* (Crown Publishers, 2003), both Burnham and Root each oriented their offices south "to satisfy their craving for natural light, a universal hunger throughout Chicago, where gas jets, still the primary source of artificial illumination, did little to pierce the city's perpetual coal-smoke dusk."

Electric lamps were just beginning to be used to illuminate buildings, but the new technology was unreliable, and Burnham & Root opted not to illuminate the exterior. So every evening, the intricate façade of the Rookery faded with the sun. Over the years, the building underwent alterations (the most famous being a lobby redesign in 1905 by Frank Lloyd Wright). In 1970, the Rookery was added to the National Register of Historic Places; in 1972, it was designated a Chicago landmark. Yet still, that famous red exterior remained dark at night.

This past November, for the first time in its 123-year history, the Rookery finally saw the light, thanks to a design by New York–based Office for Visual Interaction (OVI). The exterior lighting was part of a restoration undertaken by the Rookery's current owners, the John Buck Co. Just as the building was a technical achievement for its time, the lighting scheme and the custom luminaire used are a triumph of today's best technical and artistic abilities. It takes a mere 2,304W to light the Rookery's 55,300-square-foot edifice through a series of LED fixtures, each the size of an index card.

"We thought long and hard about what would be appropriate for the building," says Jean Sundin, principal of OVI. The firm wanted to create a historically sensitive response, and not flood the Rookery's exterior with spotlights in a garish display, especially because of the building's complex detail. "Wherever you put light, that's where your eye goes, and you run the risk of creating something disjointed," Sundin says. Another challenge was that the building is in a dense urban area, so installing exterior floodlights on a busy sidewalk was a logistical impossibility.

The solution was the design of a custom luminaire that produces a flat beam of light and creates a glow around the window frames. But achieving that glow effect, even with the custom luminaire, turned out to be a complicated endeavor. "You think the building is symmetrical, but there is nothing symmetrical about it," Sundin says. "Even the window ledges have a different contour."

The existing elevations and other historic building drawings were of little help, so OVI first conducted an on-site field study, measuring every surface of the façade. From this study, they discovered that, in addition to random-sized window ledges, the building also had an uneven exterior wall. This was due in part to construction materials and processes of the 19th century. Capping stones were used to join pieces of the stone wall together, creating a raised rib (a design trick to keep water from entering the stone). These ribs pop up all over the exterior ledges, making symmetrical placement of light fixtures problematic.

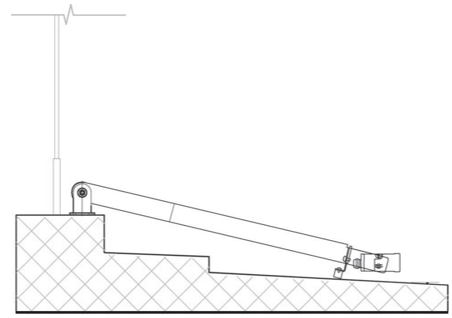
There were also constraints owing to the structure's status as a landmark, one of which was that nothing could be affixed to the terra-cotta surfaces. It soon became evident that an off-the-shelf solution was out of the question. "There were no standard products meeting our requirements, so a custom solution was required," Sundin explains.

OVI engaged lighting company Zumtobel to create a fixture in response to both the physical limitations on the historic façade and the firm's desire to create an appropriate lighting scheme. Zumtobel was "interested in modifying their platform in order to accommodate our needs, including specific optics and beam distribution, small overall size, and a special mounting device," Sundin says. OVI and Zumtobel developed a 1.5-inch LED luminaire with a custom telescoping arm capable of anchoring into the granite windowsills. The mounting bracket includes polyurethane feet to minimize contact with the ledges themselves. The assembly was then finished in "Rookery red" to match the color of the façade.

The resultant LEDs emit a soft glow with low-energy wattage—each luminaire uses just 14.4W—and the 3000K warm-white color temperature enhances the terra-cotta. "The biggest throw of light is three stories high," Sundin says. "This little fixture does a great job."

On Nov. 30, building tenants and guests gathered together at dusk inside the light court before stepping out onto South LaSalle Street to watch the building come to life at night for the first time. "I believe we did the building justice," Sundin says. "I think the architects would love that it [the Rookery] is finally being appreciated at night just as much as it has been during the day." •

Lighting-detail diagram at the fifth-floor ledge condition



The Rookery building in 1905

FX Souvay

interview by Elizabeth Donoff
portrait by Dominique LaFond

"LEDs are changing the way we design fixtures. LED is not another source. It's a component that creates light, and that component has to be integrated into a system. It's no longer about a 'new lamp in an old box' mentality, you have to redesign your product and that is capital intensive."

Possessing a mixture of business acumen and design sensitivity, FX Souvay has established one of today's leading architectural lighting companies—Lumenpulse. The fact that its product base is focused on LEDs is a testament to Souvay's foresight. He first started thinking about launching his own lighting company in 2002, but at the time, he knew that LED technology wasn't stable enough. By 2006, though, that had changed, and advances, particularly in white light, were finally at a place where Souvay believed that he could offer something new to the existing industry matrix: uncompromising LED-specific luminaires.

What makes a great luminaire?
Our desire is to deliver the designer a toolbox.

What do you consider innovation in lighting?
The opportunity with solid-state lighting is that it is a networkable fixture. This means the fixture can serve as a communications gateway. That opens up exciting possibilities.

Does it matter how many lumens per watt an LED produces?
Lumens per watt is the most misleading metric in the industry right now. You don't choose any architectural or high-performance product based on lumens per watt. You choose those products based on candela distribution—how the fixture will distribute the light.

How do we get back to appropriate metrics?
We need to establish common metrics that are meaningful for the lighting industry.

Where do you see lighting heading?
There is a new skill set required, one that requires not just mechanical engineering and optics but an understanding of firmware, software, and the electronics supply chain.

What's the next big hurdle for SSL to tackle?
To create a more stable manufacturing process for white LEDs so you don't have to go through sophisticated binning methods to deliver consistent color and temperature.

What advice would you offer lighting designers who are frustrated by LEDs?
Lighting designers should evaluate the fixture's overall delivered performance. And work with manufacturers who are providing test results from independent laboratories only. •

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The Designers Lighting Forum of New York (DLFNY) would like to invite you to join us at our sixth annual LEDucation program.

Wednesday, March 21, 2012 –
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(*New Extended Hours for 2012)
11:00 a.m. – 7:00 p.m LED presentations

Visit *LEDucation.org* for Registration and Event Details.

PRESENTATIONS BY:

LED Standards Update & Energy Star - Naomi J. Miller, from PNNL and Alex Baker, from Energy Star will provide an update on the latest requirements and advancements in LED Standards and Energy Star.

LED in the Retail Environment - a panel discussion of RGBs and White LEDs in Retail applications.

Moderator: Nelson Jenkins, from Lumen Architecture.
Panel Members:
- Sean Hennessy from Hennessy Design
- Renee Cooley from Cooley Monato Studio
- Ruth Mellergaard, FIIDA from GRID/3 International

LED's: The Move to a Digital World - Chad Stalker from Philips Lumileds will help attendees gain an understanding and clear impression of how to consider and evaluate illumination grade LEDs.

LED Control: Turn Off the Dark - an informative panel discussion aimed at helping demystify the often complex issues surrounding "how to control and dim LEDs."

Moderator: Craig Fox from Electronic Theatre Control
Panel Members:
- Gabe Gulliams from Buro Happold
- Sleiman Zogheib from Redwood Systems
- Andrew Lawler from Lutron
- Gilles Abrahamse from eldoLED America, Inc.
- John Gebbie from Barbizon Lighting Company

LEDucation 6

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TAKING AIM AT REFLECTOR LAMPS

Upcoming regulations are set to have a large-scale impact on reflector lamp availability as the least-efficient and lowest-cost options give way to higher-efficacy models.

text by Craig DiLouie
illustration by Tang Yau Hoong

As with similar regulations, a technology is not specifically being banned, but it is being asked to step up in terms of efficiency. A small group of halogen PAR lamps already complies with the new regulations. Due to similar performance and a typically lower cost than other alternatives, such as CMH and LED, these lamps are expected to form the new baseline in this category of halogen-preferred applications.

Directional lighting is typically used to produce a higher light level on a task or focal point. For directional lighting in many retail and similar applications, halogen is frequently preferred for its excellent color quality, good modeling, and tight beam control. This light source is packaged with a reflector in a configuration suitable for aiming in a desired direction and pattern for accent, track, landscape, and downlighting.

Regulation coming in July will put millions of directional lamp sockets for halogen sources up for grabs. Energy standards covering incandescent reflector lamps, first instituted by the Department of Energy (DOE) in 2009, and going into effect starting in July, will eliminate a majority of the least-efficient and lowest-cost options from the market in favor of higher-efficacy alternatives. The compliant alternatives include today's most efficient infrared-reflecting (IR) halogen reflector lamps, as well as LED, ceramic metal halide (CMH), and compact fluorescent (CFL) directional lamps.

The Regulations

The Energy Policy Act of 1992 imposed energy standards on a range of reflector lamps. Fifteen years later, the Energy Independence and Security Act of 2007 strengthened these standards and covered a broader range of lamps, including R, PAR, BPAR, BR (BR30 and BR40), and ER (ER30 and ER40) lamps. Several popular lamps were eliminated, including the 50W and 75W R20, 85W BR30, and 120W BR40.

Two years later, in 2009, the DOE announced new energy standards that will become effective on July 14, 2012, and will cover 40W to 205W lamps with a 2 ½ inch-wide reflector; R20 and PAR20 lamps; and 2 ½ wide-reflector PAR30, PAR38, BR30 and ER30, and BR40 and ER40 lamps (120V or 130V, standard or modified color output). Lamps that do not comply cannot be manufactured in, nor imported into the United States after the July deadline.

Exceptions, which are expected by many manufacturers to remain in effect until at least Dec. 31, 2014, include 45W or smaller wattages of R20; 50W or smaller wattages of ER30, BR30, BR40, and ER40; and 65W BR30, BR40, and ER40 lamps. These lamps (particularly the 65W BR30 and BR40 lamps) are popular in residential accent and downlight applications. Additional exceptions, which are expected to remain beyond Dec. 31, 2014, include colored lamps, rough- and vibration-service lamps, and other specialty lamps.

To make a long story short, today's standard incandescent reflector lamps are on their way out. This will vacate millions of sockets that will have to be filled with more-efficient sources.

The New Baseline

As with similar regulations, a technology is not specifically being banned, but it is being asked to step up in terms of efficiency. A small group of halogen PAR lamps already complies with the new regulations. Due to similar performance and a typically lower cost than other alternatives, such as CMH and LED, these lamps are expected to form the new baseline in this category for halogen-preferred applications. A selection of compliant 120V PAR30 and PAR38 lamps is offered by the major lamp manufacturers under the respective proprietary designations HIR (GE), IRC (Philips), and IR (Osram Sylvania). (See the online version of this article for a chart listing these lamps and their respective data.) PAR lamps tend to be used in applications requiring tight beam control, such as accent and tracklighting, while R lamps are used for applications that require a broader spread of light, such as downlights and landscape lighting.

These halogen lamps have a metallic IR coating on the light-emitting capsule, which allows visible light to pass through while reflecting, or recycling, infrared output back to the filament. Although line-voltage halogen lamps are generally hot, this recycling improves the efficiency of the halogen cycle by enabling the lamp to achieve its required temperature using less energy, and it can be used in the lamp's design to increase efficiency, to extend service life, or both. The most efficient IR halogen lamps that pass the DOE regulations produce similar light output as a standard halogen lamp and use as much as 20 to 30 percent less energy. For example, a 120V 55W IR PAR30 lamp can replace a 75W halogen PAR30, creating a 26 percent energy savings.

Otherwise, these lamps operate similarly to standard halogen, with a CRI rating of 98 to 100, tight beam control, good modeling, and lumen maintenance of more than 80 percent at end of life for most. Lamp life is rated from 3,000 to 4,200 hours. The primary trade-off is higher initial cost.

Compact Fluorescent

The potential for CFLs is limited, when it comes to narrower beam spreads and increased beam control. Because of their size and their distribution as a linear source, coupled with flatter modeling and difficulty in dimming, CFLs are better suited to applications requiring very wide flood distribution, and where modeling, dimming, and color quality are less important.

Self-ballasted integral CFL reflector lamps are available in 9W to 14W R20; 23W R25; 15W R30; and 26W R40 configurations—in addition to 15W to 16W BR30; 19W to 23W BR40; and 23W to 26W PAR38 floods. Typically, these lamps offer 60 to 70 percent energy savings over halogen lamps. A 14W CFL R20, for example, might replace a 50W halogen R20 for 70 percent energy savings.

Ceramic Metal Halide

CMH lamps come in several choices: MR16, PAR20, PAR30LN, and PAR38 configurations. PAR30LN versions are available in 20W to 70W, and PAR38 versions are available in 22W to 150W, including 23W and 24W self-ballasted products in a range of beam spreads. (See the online version of this article for more about these two lamps.)

The ability of CMH lamps to deliver a brilliant, concentrated beam of light makes them well-suited to accent and tracklighting, in which they can replace incandescent spots on a one-to-one basis for a 50 to 70 percent energy savings. CMHs can also reduce the number of units needed by leveraging their ability to deliver two to three times more light for the same energy level. One 70W metal halide trackhead, for example, is claimed by manufacturers to be able to replace up to three 90W incandescent trackheads, resulting in a cleaner appearance.

While the color temperature of these CMH lamps is a little cooler than halogen (3000K to 4000K, compared to 2900K or lower), the lamps do have good color rendering (80 to 94), minimal lamp-to-lamp color variations, and stable color throughout their lives. To ensure good, ongoing color quality, group relamping is recommended. As a point source, CMH delivers good modeling, sparkle, and depth. These lamps are rated at 9,000 to 15,000 hours (at 10-plus hours per start, with lamp life being an average expected for a large population of lamps) compared to typically 3,000 to 4,200 for the most efficient IR halogen lamps.

CMH does not turn on instantly, however, requiring a warm-up of two to four minutes and restrike of four to six minutes, depending on the product. Also, consider its center-beam candlepower (CBCP) carefully to avoid substitutions that are overly bright for the application. CMH lamps require a ballast, which may be integrated or mounted separately.

Note that most CMH systems are not dimmable, so dimming of the track will severely shorten lamp life in tracklighting applications. Lumen maintenance at end of life can be as low as 60 percent or less. Finally, CMH lamps tend to produce some spill light, so they are best suited to applications where you want to light not just an object, but also its surroundings. When choosing CMH for a retail application, be sure that the product has a satisfactory R9 CRI to ensure good rendering of saturated reds.

LEDs

This technology is ideally suited to directional lighting applications because the light source is inherently directional, resulting in very high efficiency. Additionally, the general form of the directional lamp allows ample heat sinking (which may or may not be aesthetically desirable for tracklighting, depending on the project). The most recent series of reports from the DOE's CALiPER testing has demonstrated that LED PAR30 and PAR38 lamps can be more efficacious than IR halogen while providing similar performance, resulting in 70 to 80 percent savings in energy use.

Several LED options are available in AR111, MR11, and MR16; R12, R16, R20, and R30; BR and ER; and PAR16, PAR20, PAR30, PAR30LN, PAR36, and PAR38 configurations. (A small selection of PAR30 spots and PAR38 floods can be seen in a third chart in the online version of this article.)

A wide variety of lumen output levels and beam angles is available with directional LEDs, offering greater flexibility than conventional products. These lamps offer excellent beam control, and typically render saturated colors well. Lamps are available in a variety of color temperatures from 2700K to 6500K, and some luminaires are available with color tuning.

LED directional lamps have additional benefits, including long-rated service life (typically with no spot-relamping needed for years) of 25,000 to 50,000 hours; a failure mode based on lumen depreciation (L70) instead of outages; no radiated heat and ultraviolet output (will not cause colors to fade over time); and no mercury content. Some products are available with a black or white finish at the back of the lamp for heat sinking, which results in an integrated trackhead appearance.

While LEDs are a good option for directional lamp replacements, it is important to note that LEDs are still a young technology. The quality of the light may not produce the same texturing effects as halogen, and LED cannot match CMH and IR halogen at the high end of the range of light output and luminous intensity. Not all LED products are dimmable, and those that are may not be compatible with selected controls.

Some LED products have low CRI ratings, but are good at rendering the saturated colors typically found in retail—pastel colors are used in the standard CRI test. A new color metric, the Color Quality Scale, is being vetted by the lighting industry as an alternative to CRI. This scale takes into account the color-rendering characteristics of white-light LEDs better than does the CRI scale. (See "After CRI," Jan/Feb 2012.)

This is a get-what-you-pay-for time in LED technology. High-performing products come with a significant initial cost; low-end products may exhibit flicker, color distortion over time, and other performance issues. Some products have lamp dimensions—diameter, maximum overall length, neck geometries—that do not meet the ANSI-defined formats of the lamps they are supposed to replace. (Even if they do, they may not fit the same luminaires as a given halogen lamp; it's best to check.) Note that the lamp's performance warranty may include limitations on the daily number of operating hours. Also, product performance may vary significantly from manufacturer to manufacturer, and equivalency claims may be exaggerated or misleading.

There are benefits to requesting samples of LED products and producing mock-ups prior to making final decisions. Doing this gives the designer the opportunity to see the quality of the light, including its texturing, brightness, and color effects, while verifying compatibility with controls, space constraints, aesthetic needs, and so on. Designers can also reduce risk by looking for products that are properly tested to industry standards such as LM79 and LM80, and those that carry the Energy Star quality mark, which provides assurance that the product performs similarly to the product it is intended to replace, but using less energy. Specify lamps listed to UL standards, and consider specifying lamps that have performance warranties that cover lumen maintenance and color shift over time.

This July, regulations will make higher-end options such as LEDs more economically attractive. Ultimately, the right choice for a halogen replacement will depend first on the lighting needs of the application—beam spread and control, color quality, dimmability—and then on the economic factors involved, such as energy, maintenance, and first costs. •

Tools for Comparison

For PAR lamps used in accent lighting applications, the principal metric used to measure output is often not lumens but center-beam candlepower (CBCP), a gauge of maximum luminous intensity, expressed in candela, at the center of the beam. A related unit of measurement is beam angle—the angle at which the luminous intensity measures half of CBCP. Beam angle determines whether the given lamp has a narrow, medium, or wide distribution. Among PAR lamps, typical beam spreads—the distance from one beam angle to the beam angle on the other side of the lamp—include narrow spot (9 to 10 degrees), narrow flood (25 to 30 degrees), and wide flood (40 degrees). Some lamps are available with a very wide flood (45 degrees-plus) emission. A PAR spot and a PAR flood may have the same light, but the spot will have a much higher center-beam candlepower luminous intensity.

Additional metrics, if available, include field angle and spill. Field angle, or cutoff angle, is the angle at which intensity measures 10 percent of total CBCP, and spill represents where emission outside the field angle fades to zero percent of CBCP. These tell us how well the lamp controls the beam pattern. Two lamps, for example, might have similar CBCP and beam angles, but the first lamp may have a smaller field angle and close spill, which means it offers a tighter beam (a harder edge) than the second lamp. Suppose a designer needs to light an object in front of a color backdrop. If the goal is to light the object only, he or she may choose the first lamp; if the goal is to light both the object and some of its surroundings, he or she may choose the second.

In addition to luminous intensity, beam spread, and optical control, other criteria to consider when selecting a directional lamp include color output and rendering, lumen maintenance, modeling, ease of dimming, energy and maintenance costs, and initial cost.

PRODUCTS

INSIDE SOURCE

New products to help illuminate our interiors.

text by Wanda Lau

Aro, Leucos USA • Designed by Jorge Pensi for Leucos, the Aro pendant uses a 55W T5 circular fluorescent tube as the light source. It is made of a hand-blown, reflective chrome or glossy black Murano-glass diffuser with a raised accent band, and matt-white internal structure. Weighing 20 pounds, the 7.87-inch-tall fixture has a diameter of 17.32 inches and suspends a maximum of 118 inches. • *leucosusa.com* • Circle 126

Universal Dimmers, Leviton • Compatible with incandescent lamps as well as dimmable CFLs and LEDs, Universal Dimmers are designed to address performance issues such as flickering and low-level start-up that can occur when energy-efficient fixtures are used with conventional dimmers. They feature an on/off switch to preserve dimmer settings and a slide bar to adjust light levels. Suitable for use on single-pole or three-way configurations, the dimmers are rated up to 600W for incandescent lamps and 150W for CFLs and LEDs. Two models are available: SureSlide uses a rocker switch while the IllumaTech model uses a push-button switch. Both are available in five colors including white (shown). • *leviton.com* • Circle 125

iLine Accent, OptoLum • Designed to provide directional and accent lighting for retail and exhibition spaces, the iLine Accent combines miniature spotlights with linear LED infill strips in an anodized aluminum housing. The LED spotlights and accentlights are available in six color temperatures: 2700K, 3000K, 3500K, 4000K, 4500K, and 5000K. The 2700K through 4000K lamps have a color-rendering index (CRI) of 75 to 85, and the 4500K and 5000K lamps have a CRI of 70 to 75. The 1-inch-diameter spotlight heads are available with beam spread options of 11, 15, and 26 degrees; an elliptical option offers an angle of 38 degrees by 23 degrees. The accentlight model has a beam spread of 110-degrees and comes in lengths of 4 or 6 inches. • *optolum.com* • Circle 127

A collaborative effort by the lighting designer and architect helps the Anacostia Public Library maximize daylight and become a compelling, inviting destination.

text by Jeffrey Lee
photos by Mark Herboth


stia Library
1800

metal screen that provides filtered light while still offering views to the neighboring park.

The bright, lime-green roof that helps define the Anacostia Neighborhood Public Library in Washington, D.C., serves as both an iconic visual form and a sun control device. The perforated, corrugated metal plane wraps down over the building's western glass wall—opaquely reflective during the day, glowing transparently at night. From the library's interior, it offers views to an adjacent park while providing controlled, filtered daylight, which is key to making the library a healthy, sustainable building.

It's also a testament to the power of teamwork. Maximizing the effectiveness of the shade, as well as the daylighting potential of the library itself, was the result of an integrated, collaborative, and cooperative effort between the architect, the Freelon Group, and lighting design firm Horton Lees Brogden Lighting Design (HLB), says Hayden McKay, HLB's principal in charge of the building's daylighting design.

Welcoming to the Neighborhood

The team's focus on daylighting reflects the D.C. Public Library system's desire to make its new Anacostia branch an appealing, transparent space. "They wanted to really make this feel welcoming and inviting and bring in the community," McKay says. "So the issue of transparency, being able to see inside, being able to know that it's open, making it feel exciting—that led to a lot of glass."

Project architect Michael Rantilla, associate principal at the Freelon Group, also envisioned the library as a beacon in the historic, but traditionally underserved, Anacostia neighborhood. "We had a fixed, somewhat modest footprint to work with," he says, "but we still wanted to bring this excitement, and grand space, and views and light, and just make it a very airy experience that people would want to be in."

With the library mandated by the client to achieve LEED Silver certification, creating a healthy and sustainable environment was also a vital goal. The focus on daylighting helped the building to achieve its sustainable mission on multiple fronts: lowering the luminaire's electrical usage while also reducing the heat load they generate, and providing views and daylight for a more cheerful indoor setting. By using daylight as the primary source for ambient illumination, the team reduced the interior lighting system's power usage by at least 50 percent over an equivalent electric lighting system, and the library surpassed the client's expectations by achieving LEED Gold certification.

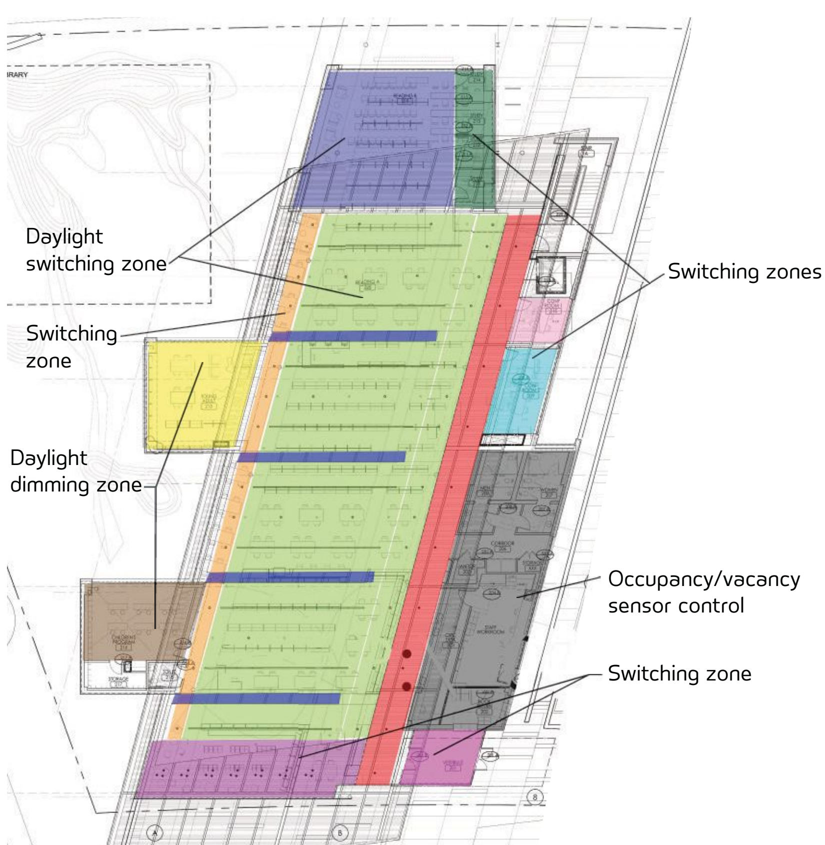
Sunny Disposition

A highlight of the team approach, McKay says, was a productive, two-day charrette in New York that included the Freelon Group, McKay, and Teal Brogden, the HLB principal who led the project's electric lighting design. The Freelon Group included sun control in the initial forms and space planning of the library design, and McKay says her team wanted to make sure the building optimized daylighting and connection to the outdoors.

"We spent two days looking at every possible option," she says. Afterwards, the two teams continued to have regular, remote meetings to discuss details like materials, color, reflectivity, and finishes. HLB's daylight analyses helped guide a number of design decisions, including details about the windows, the design and location of the skylights, and the shape, materiality, and geometry of the roof shade.

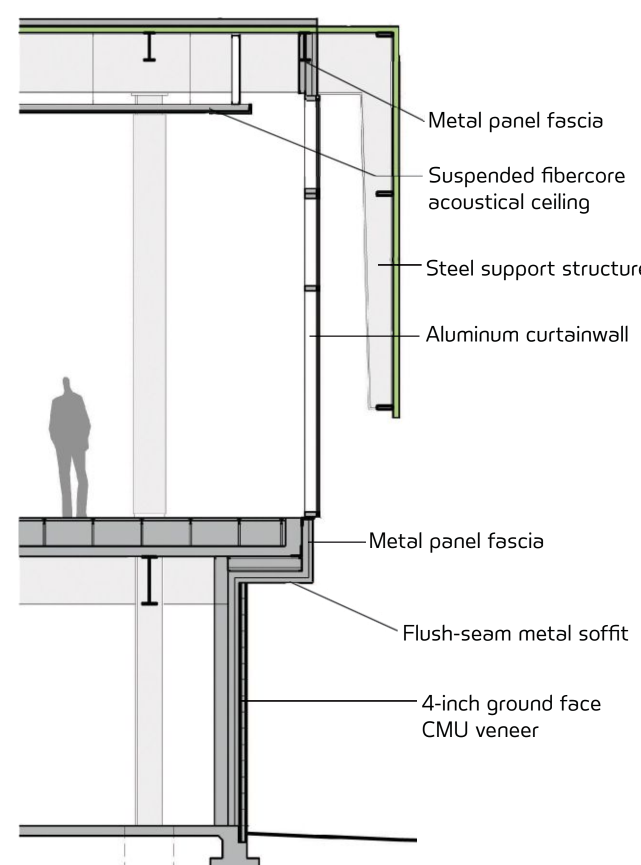
The roof, for instance, had to address the building's north–south orientation and shape—an unusual parallelogram angled away from the true cardinal directions. The original plan was designed with an

Floor plan and control zoning diagram



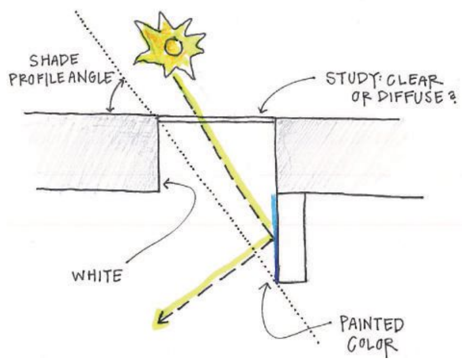
Floor plan: Courtesy HLB; Section: Courtesy Freelon Group

Western wall section with metal screen

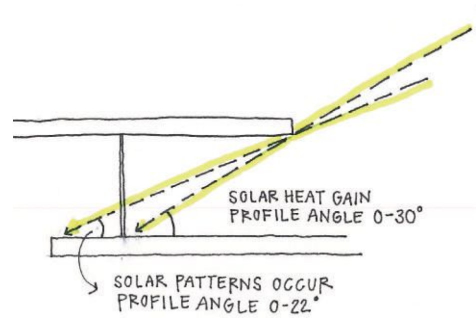


the green roof to provide reflected light in the “main street” area, while skylights are evenly spaced throughout the reading room to bring daylight deep within the space.

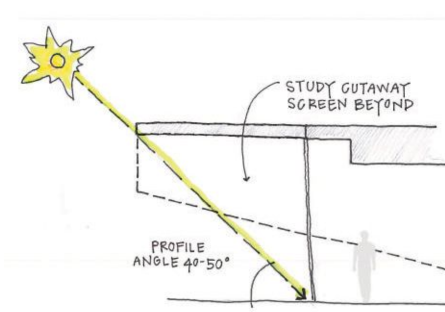
Skylight sketch



Clerestory sketch



Southern overhang sketch



overhang above the southern plaza to shade the summer sun, but HLB recommended an asymmetrical shape, coming to a point in the southwest corner, to extend shade coverage in the afternoon. The team studied the climate and used a sun chart, plotting the "overheated period"—the times of day and year when the outdoor temperature is above 70 F—for Washington, D.C. "The objective is to keep the sun off of the exterior of the glass as much as possible in that overheated period," McKay says.

HLB also studied the color, shape, and perforation pattern of the screen on the western side to balance views and avoid distracting sun patterns. The screen functions like a theatrical scrim, becoming transparent or opaque depending on the direction of the light. The architect had originally looked at having very large (6-to-10-inch) perforations, but McKay says her team was concerned that the light from those large circles would create strong, high-contrast patterns that would be visually distracting for readers. HLB recommended smaller perforations that would still allow a view of the park to the west. The design team also considered using a more extreme corrugation for the material or fins instead of perforations—a strategy they eventually employed at a sister library in Tenleytown—but for Anacostia, the perforated screen provided a solution that balanced aesthetics and cost.

The building's shaded glass structure was supplemented with four skylights evenly spaced throughout the reading room to bring light deep within the large space, and clerestories and a light-shelf on the eastern wall. The clerestories bounce light up against the green roof to provide reflected light and a bright, playful "main street" area that borders the stacks and reading room.

Thoughtful Moments

Even the building's electric lighting is intended to mirror the feel of daylight. Linear fluorescent, 28W T5, 3500K slot fixtures mimic the path of the skylights, providing seamless illumination from the same direction in the evening hours. A semi-custom, 21W T5, 3500K fluorescent, cantilevered stacklighting system provides dedicated illumination for book finding so that supplemental ambient lighting is unnecessary. A daylight harvesting and lighting control system dims the electric lights when the building has adequate daylight.

Creating a poetic, luminous atmosphere with areas of highlight and drama was a priority for both the client and the architect, Brogden says, and the Freelon Group committed to a lighting budget that allowed for more than just traditional 2x2s. In the front of the library, a cluster of linear pendants creates a sparkle and an offset to the soft light in the rest of the space. The 36W, 3500K compact fluorescent fixtures are kept on during the day to counterbalance the shadow from the roof's south overhang and to make it clear that the library is open. At night, 70W T6, 3000K metal halide uplighting on the south overhang highlights its bold, architectural color.

The four pavilions that jut out from the glass structure, used for children's, young adult, and other programming, are lit with playful, multiple-diameter circular fluorescent fixtures (powered by 28W T5 lamps or 36W CFLs at 3500K) that extend the feel of daylight. Finally, a luminous tower near the entrance is a free-standing, pure form, detailed with frosted backlit glass and LED lights operating at 3500K and 4W per foot, that provides an unexpected visual welcome, setting the building apart from a typical library.

The common element all of these lighting "moments" share is that they are highly visible from the outside. "These aren't hidden moments, they're public moments," Rantilla says. "It's really about inviting the community in."

Today's libraries face more competition as gathering spaces from national chain bookstores and other retailers, which is one reason why creating warm, inviting, and comfortable spaces is critical to a library's success. "Coffee shop retailers, for example, have done a great job of creating an atmosphere where it's okay to sit and spend time and work on your computer or read a book," Brogden says. Lighting can help draw in patrons by making a library seem less stuffy and imposing and more dynamic and fun, she says. "That culture of having a welcoming environment that has a bit of decorative sparkle to it, people have come to feel comfortable with [that] in the coffee shop world, and I think libraries are moving to embrace that." •

Details

Project: Anacostia Neighborhood Public Library, Washington, D.C. **Client:** District of Columbia Public Library, Washington, D.C. **Architect:** The Freelon Group, Research Triangle Park, N.C. **Lighting Designer:** Horton Lees Brogden Lighting Design, New York and Culver City, Calif. **Associate Architect:** R. McGhee & Associates, Washington, D.C. **Civil Engineers:** Delon Hampton & Associates, Washington, D.C. **Landscape Architect:** Lappas & Havener, Durham, N.C. **Structural Engineer:** Stewart Engineering, Raleigh, N.C. **M/E/P Engineer:** John J. Christie & Associates, Washington, D.C. **Geotechnical Engineer:** Professional Consulting Corp., Gaithersburg, Md. **Project Cost:** $9.5 million **Lighting Cost:** $400,000 (including dimming installation) **Project Size:** 23,000 square feet **Watts Per Square Foot**: 1.3 **Code Compliance:** ASHRAE 90.1-2004 **Manufacturers/Applications:** Alko (undercabinet fluorescent); Bega (decorative compact fluorescent pendant at corridor and children's reading area); Hydrel (in-ground metal halide uplight at flagpole and under canopy and LED uplight at tree); LED Power (LED backlighting at glass tower); Lutron (daylight harvesting and lighting control); Pace Illumination (pole at parking lot); Philips Lightolier (linear fluorescent at bookstacks; recessed linear fluorescent at conference room, power wall, and exterior overhang; recessed metal halide downlight at multipurpose area and corridor); Prudential Lighting (lensed fluorescent strip at staircase; ceiling-recessed round fluorescent at multipurpose area; ceiling-recessed linear fluorescent at reading room); Selux (recessed linear fluorescent at conference room, restroom, and corridor); Sistemalux (recessed compact fluorescent steplight and bollard at site); Spring City (pole at sidewalk, city standard)

Drawings courtesy HLB

arthouse
Arthouse at the Jones Center

ILLUMINATED INGENUITY

An ingenious (and economical) combo of glass and light transforms Austin, Texas's AMOA–Arthouse at the Jones Center.

text by Elizabeth Evitts Dickinson
photos by Michael Moran

“Innovative” is a descriptor bandied about so frequently in the design field these days that it should enjoy a hiatus from the lexicon. But if we consider its literal meaning—to invent and successfully apply a new method—then the lighting design at the AMOA–Arthouse at the Jones Center in Austin, Texas, truly merits the designation. Conceived by New York–based Lewis.Tsurumaki. Lewis (LTL) Architects, in response to a complicated renovation, the lighting concept—177 laminated glass blocks perforating the building’s façade—uses basic materials (glass and light), but employs unique technology to great effect.

Like most innovative outcomes, the $4.3 million renovation and expansion of Arthouse, completed in 2010, succeeded because of collaboration and a willingness to experiment. At the helm, LTL was tasked with transforming a dark and dowdy 1926 building in downtown Austin into dynamic multifunctional galleries, offices, and events spaces. The structure, which Arthouse (originally known as the Texas Fine Arts Association) took over in 1995, had once been a theater and later a department store. “It is a very important civic location—we dubbed it the Corner of Main and Main—but with a very undistinguished building,” says Sue Graze, director emeritus of Arthouse.

The building sits at the corner of N. Congress Avenue and 7th Street. A priority for the renovation was to triple the usable space by opening up a previously inaccessible second floor. Rather than denude the interior and start from scratch, LTL scraped away years of alterations to expose and celebrate the history of the space, preserving large stucco murals original to the theater, wood ceilings, and steel trusses. A new sculptural plaster awning at the entrance on N. Congress Avenue gives a nod to the former department store.

The renovated building also needed to speak to the cutting-edge activities taking place inside. Of particular concern was a large, blank wall along 7th Street with no windows, which wasn’t an issue for the building’s previous iterations as a theater and a department store. “We wanted LTL to enliven the exterior and make the building come alive 24/7,” Graze says. “That meant the solution had to be more than just some architectural gesture.”

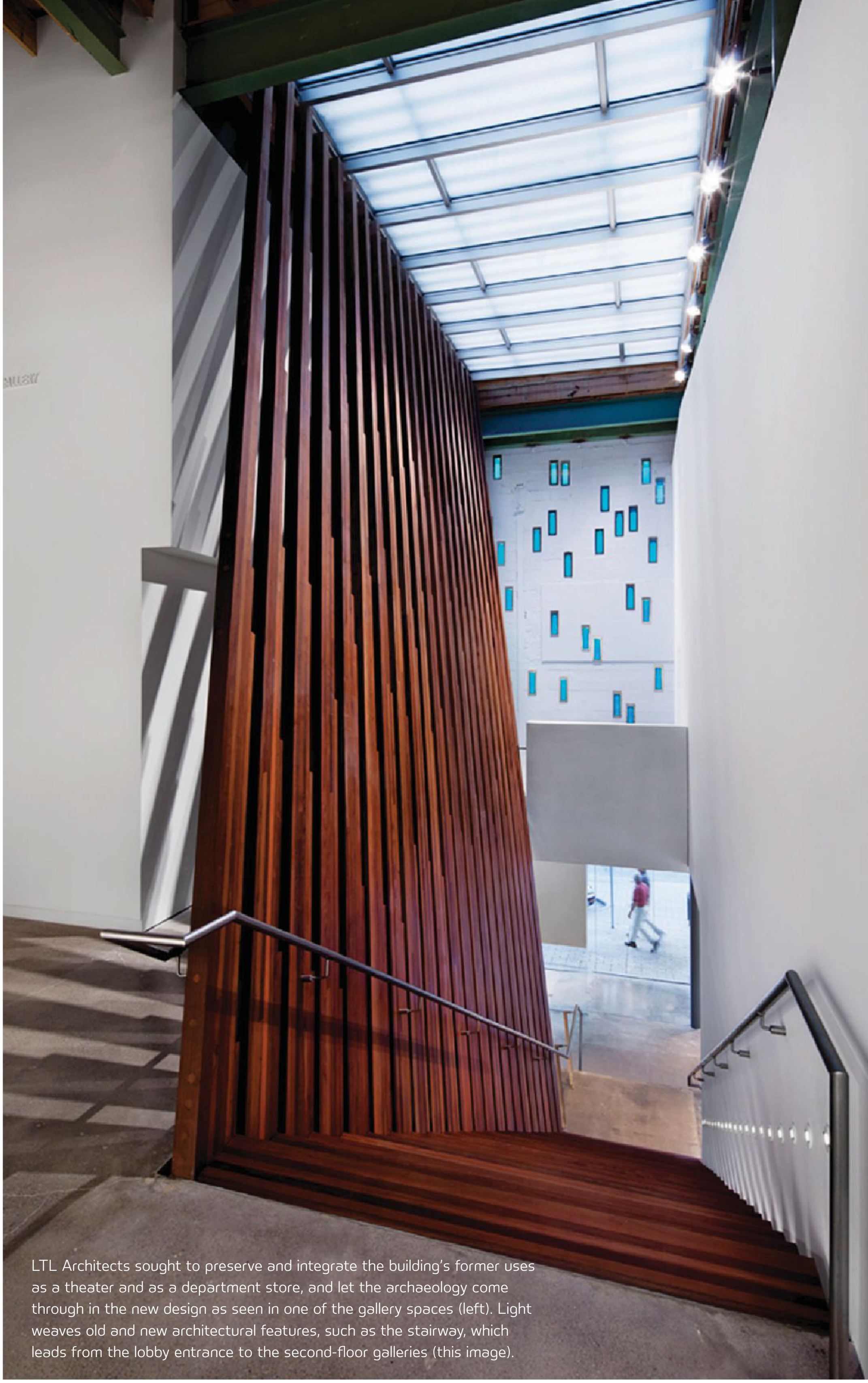
LTL knew that installing large windows along the Seventh Street elevation might flood interior galleries with too much light and fail to achieve a show-stopping result for passersby. “We needed to change the image of the building to have some kind of symbolic registry,” says Paul Lewis, principal of LTL.

The architects decided on small blocks of glass—roughly 4 by 16 inches—that puncture the building and bring light to offices and studios, while creating an arresting visual at night. “As a firm, we’re interested in light less as an object and fixture, than how it gets embedded in architectural surfaces,” Lewis says. The concept had been revealed to the public in 2008 after a multi-year design phase.

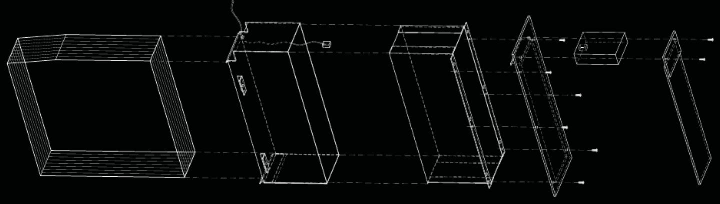
LTL turned to New York’s LumenArch for help. A young lighting designer named Alejandro Bulaevsky took charge of figuring out how to light the glass blocks, bring electricity to multiple locations, and still adhere to the electrical code. One early idea, according to Nelson Jenkins, principal of LumenArch, was to wash the walls with light, thus lighting the blocks, using power from a solar array. But the urban setting made an unfettered solar source tricky. Instead, Bulaevsky tinkered with Ethernet wires capable of transmitting both electricity and data to circuit boards that would power LEDs. Each glass block would have

• **LED Ingenuity** The technical lighting solution for the glass blocks was the brainchild of lighting designer Alejandro Bulaevsky. He designed a custom LED circuit board (with three white and two green LEDs, each of which could be dimmed separately) and an Ethernet port to power each block and make it individually and remotely addressable.

Left: courtesy Nelson Jenkin’s; Bottom right: courtesy LTL Architects



LTL Architects sought to preserve and integrate the building's former uses as a theater and as a department store, and let the archaeology come through in the new design as seen in one of the gallery spaces (left). Light weaves old and new architectural features, such as the stairway, which leads from the lobby entrance to the second-floor galleries (this image).

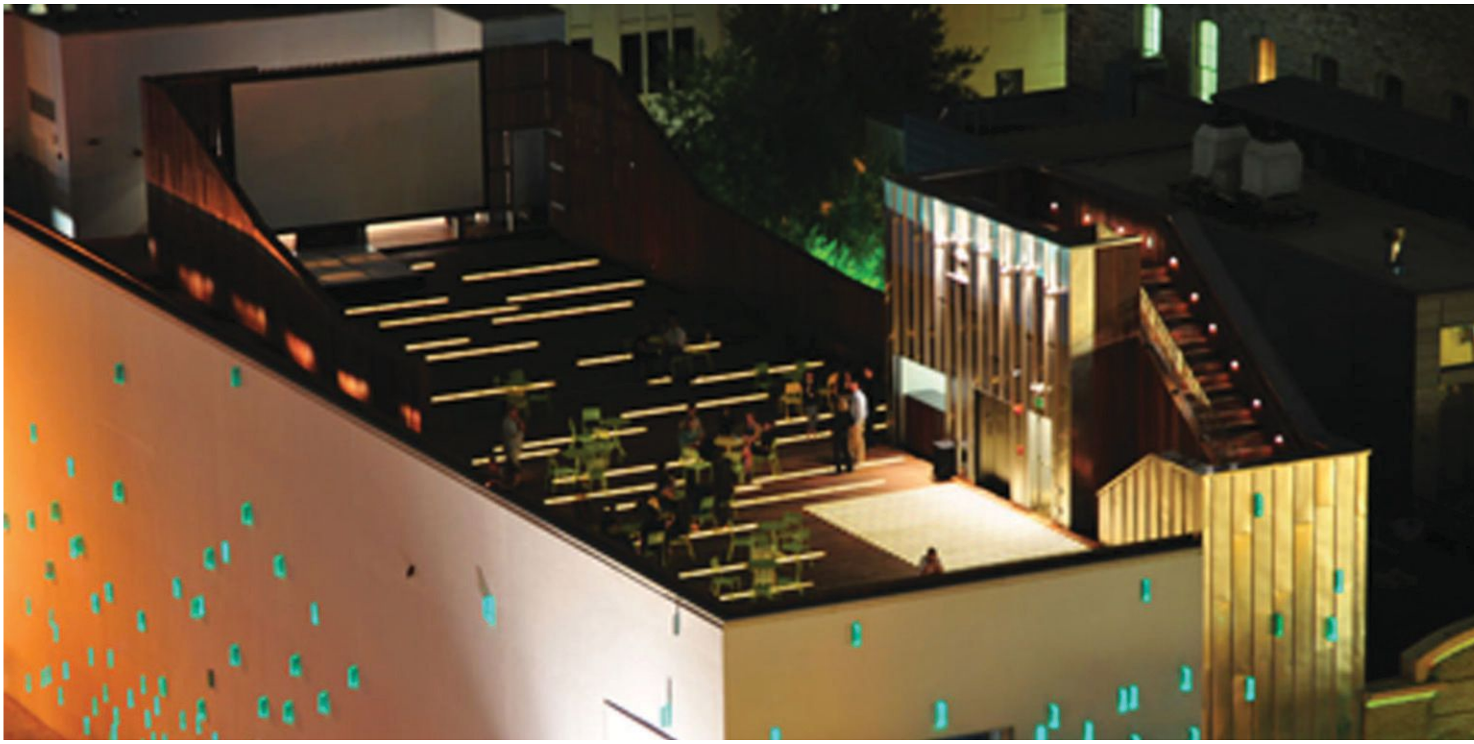


• **Glass Block Feature** The project's signature architectural feature along the façade walls is 177 glass blocks, each composed of half-inch laminated sheets of glass to create a "structural box" to hold the LED circuit board and Ethernet wiring. By day the blocks allow natural light into the building's interior spaces. At night, the illumination transforms into a green accent light, thanks to the LED circuitry.

Austin, Texas, cultural landscape (this page). At night the building comes to life as the accent of glass blocks glows across the façade, and the roof deck, lit with a combination of illuminated pavers and perimeter steplights, serves as a lounge and performance and screening space—a nod to the building's former life as a theater (right).

Details

Project: AMOA–Arthouse at the Jones Center, Austin, Texas **Client:** Arthouse at the Jones Center, Austin, Texas **Architect:** Lewis.Tsurumaki.Lewis Architects, New York **Lighting Designer:** LumenArch, New York **Structural Engineer:** MJ Structures, Austin, Texas **M/E/P Engineer:** Kent Consulting Engineers, Austin, Texas **Civil Engineer:** Garrett-Ihnen Civil Engineers, Austin, Texas **Project Cost:** $4.3 million **Lighting Cost:** $136,000 **Project Size:** 20,830 square feet **Code Compliance:** Tracklighting exempt per code, gallery lighting is supplemental (ASHRAE 90.1-2007, Sec. #9.2.2.3. Exemption A **Watts per Square Foot:** 0.82 (non-tracklighting load) **Manufacturers/ Applications:** Alcko (undercabinet lighting); Amerlux Lighting Solutions (interior downlights); Bartco Lighting (gallery linear fluorescents); DesignPlan (exterior sign lighting south façade); Edison Price (interior downlights); Humanscale (desk tasklighting); LaMar Lighting (egress stair lighting); Linear Lighting (offices and studio lighting); Lighting Services Inc (gallery lighting); Lucifer Lighting (interior downlights); Matirical/Lumen Architecture (custom glass-block façade luminaires); HK Lighting Group (egress stair accentlights); Winona Lighting, An Acuity Brand (ipe-stair accentlighting and roof deck parapet lighting); Selux (donor wall lighting); USAI (awning canopy and entry lobby downlights)



a circuit board of diodes. It was a novel idea at the time. "At that point, we knew it was possible to run power through Ethernet to all of the LEDs on the boards, but we had never seen this used in a commercial application," Jenkins says. Bulaevsky selected the brightest and most powerful LED available at the time while allowing the circuit board to be the only heat-dissipating device. "Any more powerful [of] an LED would have required heat sinks," Jenkins says.

Bulaevsky created mock-ups of circuit boards and took them to the LTL offices, where the architects were playing with the structure for the glass blocks. "We built mock-ups of glass blocks in the office to test the LED iterations and the ways to fabricate the glass in order to achieve the best refractive qualities," says Jason Dannenbring, associate at LTL. "Did we want to sandblast surfaces of the glass? Would an opaque layer reflect more light? There was a lot of discussion about it not looking like a 1980s glass block installation." Ultimately, the architects settled on multiple sheets of half-inch glass, creating a palimpsest effect up close, but a solid glowing box of green at a distance.

Dannenbring says that the LED circuit board became a pet project for Bulaevsky, and that "he worked on [it] at home and late at night." Bulaevsky even found it necessary to turn his Manhattan apartment into a workshop with special equipment, such as a reflow soldering machine, to conduct research. Fellow LumenArch employees, such as Nelson Downend, were intrigued and wanted to learn from his methods. One Sunday night, Downend tagged along to watch Bulaevsky tinker with the technology, and solder, test, and program the LED boards. Unbeknownst to either of them, it would prove to be a critical moment for the project.

Trial and error made it clear that white light alone didn't transmit through the glass blocks with the desired effect, so Bulaevsky created a circuit board with LEDs capable of being lit in varying combinations. Dannenbring then flew to Austin to test the light combos on site.

A diamond-tipped chainsaw was used to cut through the wall of the Arthouse for a prototype glass block. Graze remembers standing outside at night in an alley with Lewis as Dannenbring tested different light combos of white and green. "We needed to see the quality of the lights and how the building looked at night on the street with the streetlights," Graze says. They settled on a combo of three white and two green.

Bulaevsky had dreamed of creating a unique wireless IP address for each block so that he could "talk" to the circuit boards, but ultimately he hardwired the lights. "He thought the hard part was figuring out how to make the thing, but it was actually the programming of the lights that was hard," Dannenbring says.

It was so hard, in fact, that when Bulaevsky died unexpectedly in April 2010, Jenkins had to consult with nine software, engineering, and lighting specialists to reverse-engineer the complex system. At the time, only half of the circuit boards were ready. The shocking loss of the brainchild behind the lighting system and software nearly derailed the endeavor. "If Nelson Downend had not gone to the apartment one Sunday or retained the information acquired during that brief tutorial, it is doubtful the project would have been able to be completed," Jenkins says.

The final installation of 177 glass blocks appears random. Inside, though, the logic becomes evident: more glass blocks clustered in the administrative offices for more natural light, fewer blocks in the galleries where light might compete with the art. The placement of the light boxes took months of on-site tinkering. Custom-fabricated based on measurements of the varying thicknesses of the walls, the glass blocks ended up being 48 different sizes. At street level, the blocks are flush to the building to avoid vandalism and deter climbing. But at about 10 feet above ground, they break through the exterior plane. The top of each block cluster is sloped to avoid water accumulation.

The design saves Arthouse, which recently merged with the Austin Museum of Art, from being a staid, white-box gallery. "It ended up being a sculpture because of the light. The building is its own object," Graze says. "At night they [the glass blocks] glow. During the day and during different seasons, the blocks cast amazing shadows on the gray stucco. People really notice them. They are strong but lyrical at the same time."

Jenkins believes that Bulaevsky would have been proud of the result. "It feels like a nice tribute to the very creative mind that Alejandro had," he says. •

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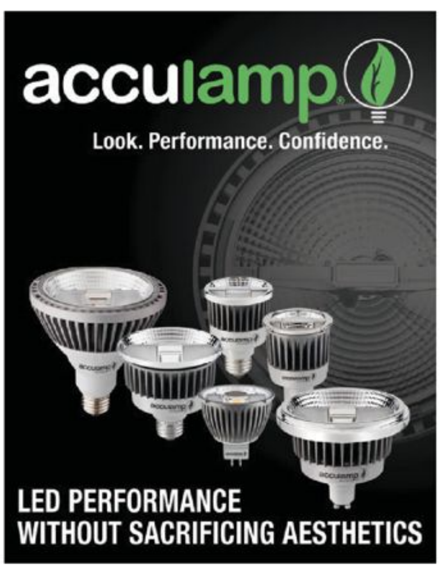

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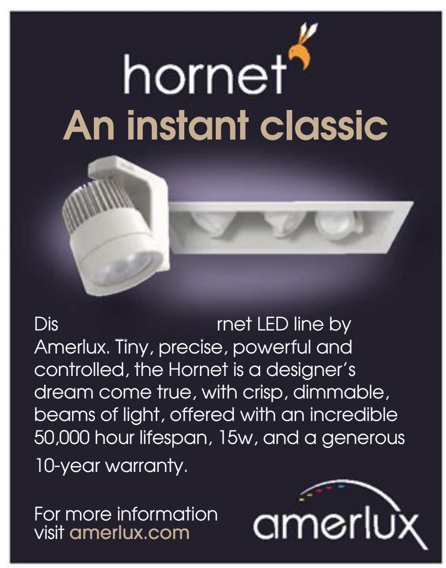

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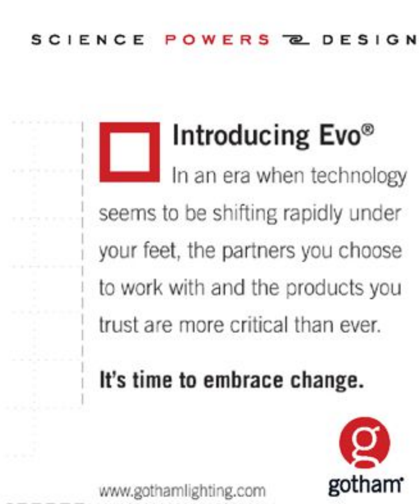

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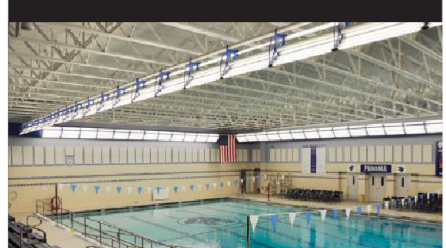

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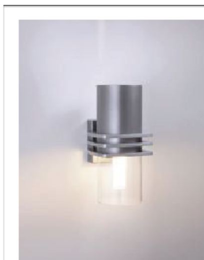

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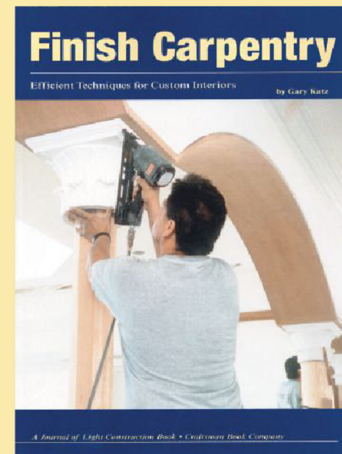

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Richard Renfro

interview by Elizabeth Donoff

"Humor and the design process go together. A lot of times, you throw out a wacky idea. Everyone laughs about it, but, at the same time, you've expanded your thoughts by considering something that is ridiculous. It helps you see and think about the design problem in a different way."

Although trained as an architect, Richard Renfro's focus has never been far from lighting. One of his early introductions to the medium was as an architecture student at the University of Arkansas, Fayetteville, in a photography class. Knowing of Renfro's interest in light, a professor recommended that, as part of his post-graduation plans, he apply for the IALD intern program, then in its second year (1979). The internship brought him to New York and the office of Jules Fisher and Paul Marantz. Renfro thought he'd spend a few months in New York and then move on. That was more than 30 years ago, and he's never left. A partner for 14 years, when the firm was known as Fisher Marantz Renfro Stone, Renfro then decided to start his own practice—Renfro Design Group—in 1998. Work has taken him all over the world and he has produced an award-winning portfolio of sensitively designed cultural and civic lighting projects, often with roots in daylighting, and always using the design fundamentals he learned in architecture school.

Why did you choose to pursue lighting?
Lighting allows me the opportunity to work collaboratively and in multiple vocabularies.

How do you start the design process?
By listening to the architect.

What text has influenced you?
There have been many, but one of the firsts was Bill Lam's book *Perception and Lighting as Formgivers for Architecture* (McGraw-Hill, 1977). It provided me with a foundation for thinking about light.

How has the practice of lighting design changed since you first started working?
Design time continues to be compressed; it's problematic because there is still a process that needs to be seen through to completion.

What is misunderstood about lighting design?
The appreciation of what is necessary to do the job right. It comes down to value—value of time and value of design services.

What are some of the challenges facing the lighting design profession?
Lighting always takes a bad rap when it comes to energy usage. But it's not the buildings where a lighting designer is involved that are the energy culprits. We have to figure out a way to reach buildings that don't have a lighting designer involved.

What are important characteristics for a designer to have?
Creativity, curiosity, and dedication. •

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