

# Light Matters

Evaluating LED Light Output

# Delivered Light

## The Right Way to Measure LED Output

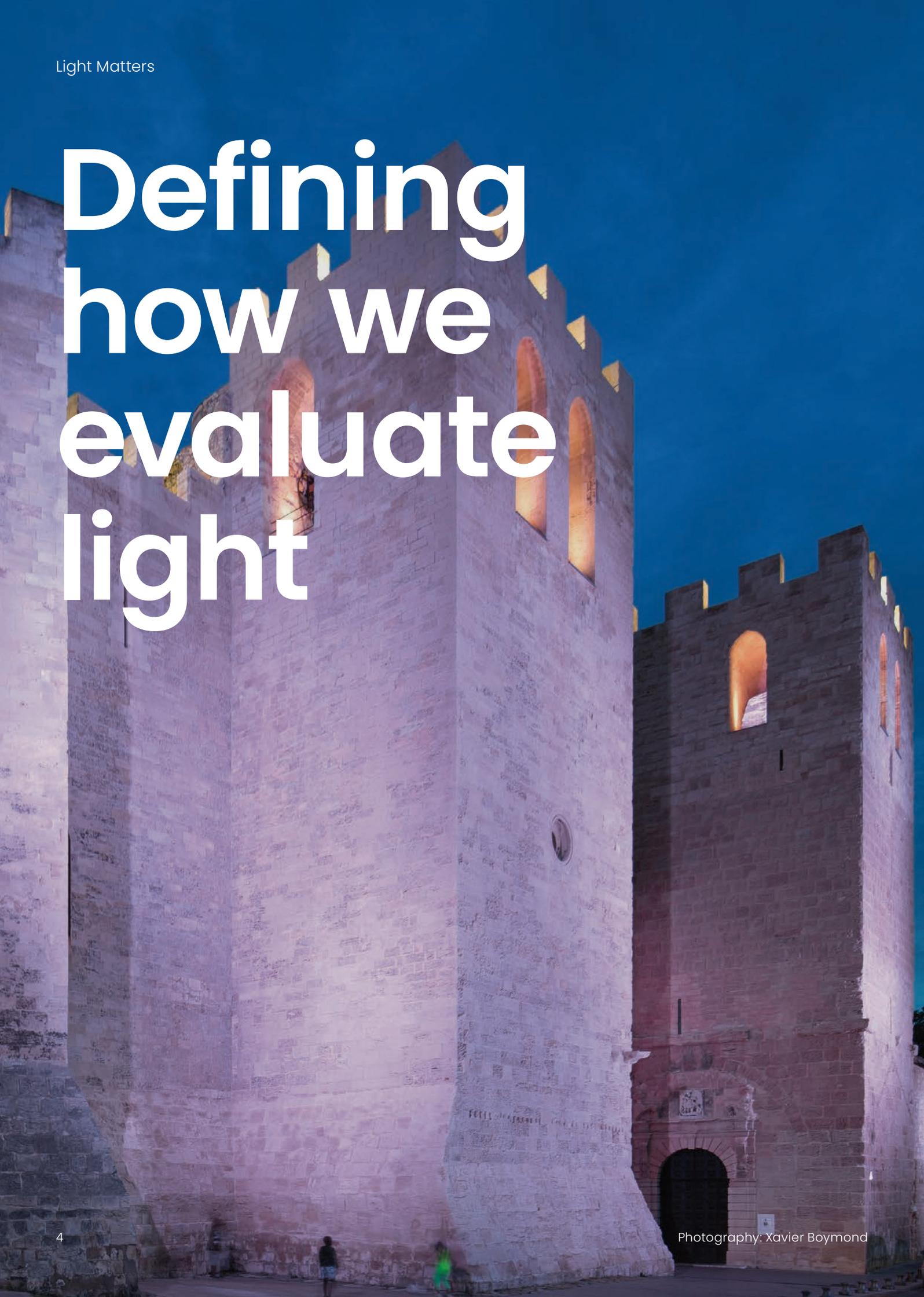
Traditional methods of evaluating light focused on lumen output, which defined by the output capabilities of a light source, such as an incandescent lamp. The advent of LED lighting changed all that, since lumens were no longer the best measurement of a luminaire's capabilities.

Now the more accurate, relevant measurement is delivered light, which determines and records illuminance, the amount of light falling on a surface area. Measuring light output has shifted from testing the lighting fixture in a lab environment to measuring how light actually falls on the chosen surface in the real world.

What does this mean for lighting professionals? Delivered light is the best way to evaluate whether a luminaire will deliver the right amount of light – and the proper color – for a specific task.



# Defining how we evaluate light



## It's important to know the various terms used to describe light.

**Light output** is an informal term for how much light a luminaire produces, and how it emits and distributes light. **Photometrics** is the formal term for data describing the quantity and distribution of the visible light produced by a light source or fixture.

Manufacturers report key photometrics about luminaires via online specification sheets or data sheets. These statements usually include basic charts and graphs that describe the power or intensity of a lamp or light fixture, the way it distributes light in space or over an area, and its energy efficiency.

Lighting specifiers, designers, and other lighting professionals use this data to make preliminary evaluations of a luminaire's capabilities and its potential suitability for a particular task or lighting application. Manufacturers often make more detailed information available for deeper analysis, creating computer renderings, building mock-ups, and more. It's important to note that much of this information focuses on the luminaire itself, not the area or structure being illuminated.

### Lumen output vs. brightness

The specification most commonly used for evaluating and comparing the performance of conventional lighting fixtures is lumen output. Technically, a lumen is the measure of the total quantity of visible light emitted by a specific light source. But in practice, lighting professionals, purchasers, and users often refer more casually to a fixture's brightness. This designation is not only inaccurate, but also misleading, especially when evaluating LED lighting fixtures.

### Lumen output in the LED era

There are many valid reasons why lumen output is not the best measurement of an LED luminaire's capabilities (see page 8). Evaluating an LED luminaire solely or primarily on the basis of its lumen output can underestimate or otherwise give a distorted picture of the fixture's performance and suitability for a given task or application.

### Delivered light defined

Instead of lumen output, the best and most relevant measurement for evaluating LED lighting fixtures is delivered light. The formal term for measurements of delivered light is illuminance. Generally defined, illuminance is the amount (or quantity) of light falling on a surface area. If the area is measured in square feet, the unit of illuminance is footcandles (fc). If measured in square meters, the unit of illuminance is lux (lx). While delivered light describes how much useful light a lighting fixture can deliver to a task area, useful light is the portion of a luminaire's light output that is effectively directed to a task area, discounting any wasted light.

One way to think of illuminance is that it's the density of light upon a surface. Generally, the denser the light on an object, the brighter that object will appear. Lumens can be envisioned as the total quantity of light, without describing directionality and the resulting density. Density – as measured by illuminance – is the most important factor when specifying light. If you are putting light in a defined location (e.g., a library reference room), enabling a specific task (e.g., reading), you need to know if there will be the right amount of light to perform that task – now and in the future.

This definition of illuminance covers any space or surface that needs to be illuminated, from an entrance hallway to a retail environment to an iconic building or national monument, such as the Eiffel Tower or the Empire State Building.

### **Evaluating delivered light**

Historically, lighting designers described fixtures by their wattage to serve as the basis for comparison of brightness. At the beginning of the LED era, manufacturers started to highlight cd/W and center beam footcandles as a way to define how much light could reach the side of a building. This limited approach ignores beam quality and does not address application efficiency. It also ignores the total power needed to light the space to the specified footcandles, as well as the uniformity to ensure maximum usability of the space being illuminated.

The real measure of application uniformity is the total wattage for the delivered footcandles of the space, or fc/W. This measurement factors in lumens, beam shape, system losses and the efficacy of the luminaire, including optical, thermal, electrical, and control – as well as the distance and placement of the luminaires.

Beam and application uniformity must be considered in conjunction with fc/W when evaluating luminaires for a specific application. Typically, as the footcandles rise, illuminance uniformity lowers. Color and beam uniformity also need to be evaluated to ensure that color and beam non-uniformities do not distract from the design intent or the ability to maximize use of the given space.

### **How can light be wasted?**

Light can be wasted in a number of ways. It can be partially blocked or dispersed within the fixture housing, emitted in a direction away from the task area, or lost through filtering, lensing, fixture positioning, or any of a number of other factors relevant to a specific installation. Light can also be partially directed to a surface not intended to be illuminated. And if beam quality and color quality are poor, more luminaires will be needed to meet minimum application requirements.

The issue of wasted light remains an important issue when evaluating luminaires and their suitability for various applications. Do manufacturers highlight how much light their luminaires waste? Probably not, leaving lighting professionals with an incomplete picture of a luminaire's real-world capabilities.

### **Reducing misdirected light**

Trespass/spill light is a related issue that comes into play in outdoor environments – one addressed by efforts such as the Dark Sky Association. This group and others encourages lighting manufacturers and designers to produce fixtures and designs with no wasted light. In short, the goal is to put light where it's needed, so it doesn't affect the visual environment. Color Kinetics supports this effort with improved luminaire and design efficiency that maximizes fc/W – ensuring that light is delivered where it's intended.



### **Delivered Light: How many footcandles do you need?**

A review of The **IESNA lighting Handbook**, the 900-page standard reference work from the Illuminating Engineering Society of North America (IES), reinforces the importance of delivered light as an appropriate way to measure light, especially for white-light and everyday applications. Along with chapters that describe in detail how to deliver the right amount of useful light in an application, the Handbook includes an extensive lighting design guide that specifies ideal light levels for every conceivable interior, industrial, outdoor, sports, transportation, and emergency lighting application.

For example, the Handbook recommends a delivered light level of around 30 footcandles (300 lx) for an open plan office with extensive computer use, as well as for the ticket counter of a transportation terminal. Freight elevators should have a level of around 5 footcandles (50 lx), while serious reading in a chair at home requires a level of around 50 footcandles (500 lx). Lecture halls where demonstrations are being performed should have a light level of around 100 footcandles (1000 lx).

These measurements confirm that delivered light is the critical measurement for evaluating light. And different applications require different amounts of delivered light.

# The Trouble with Lumens?

## **They Don't Apply in an LED World.**

Lumen output – the traditional method of measuring, reporting, and interpreting light – poses many potential problems when evaluating and comparing LED lighting fixtures. Here are just a few of the key issues.

## New Standards

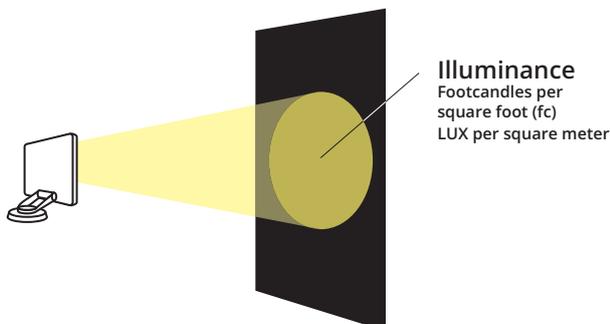
LM-79 – an accepted standard for photometric testing for LED luminaires – fundamentally changed how lighting designers understand photometric measurements and eliminated the need for common light loss factors (LLF) to be included in calculations. This IESNA document establishes the procedures that photometric laboratories must follow to test LED luminaires, and report the findings.

## Confusing Terms

Complex, similar-sounding terms, such as luminance and illuminance, make understanding photometrics challenging, and can create confusion when evaluating and understanding the unique properties of LED lighting sources.

## Optics Matter

Even if two luminaires are measured as providing the same lumens, they may not result in the same illuminance. Why? Because one may have narrow optics that deliver high-density light to a small area, while the other may have broad diffusion optics that apply a small density of light over a very large area. Different optics deliver very different results, and must be considered carefully during design.



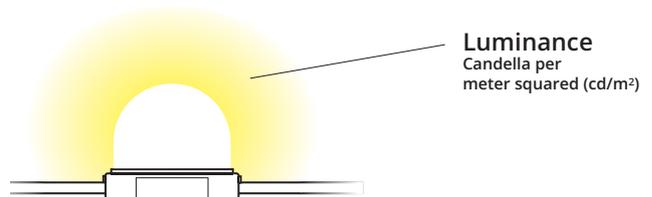
## Difficult Comparisons

Conventional lighting fixture manufacturers often report total lamp lumens more prominently than (or instead of) total fixture lumens. Some even talk about the LED's potential LED wattage, avoiding how it's implemented in the luminaire design, and the resulting output and efficacy. Because many LED light sources do away with the distinction between lamp and luminaire, only total fixture lumens can serve as a basis for valid comparisons between lighting fixtures.

## Varying Testing and Reporting

Many manufacturers still do not provide certified measurements for all luminaire varieties. Instead, they may offer calculated photometrics, which describe results that are scaled simply by the expected design – not from a test luminaire that was actually measured. Or they may provide a test from a single variation of multiple options. These manufacturers often provide IES files, where the admission of calculation is only included in the header if you open the .txt file. When using lighting design programs such as AGI32, you may not even notice this information is included in the file.

This inaccurate (and potentially deceptive) practice is fairly commonplace, almost as common as providing estimated measurements of early LED luminaires. To rectify this situation, all IES files provided by Color Kinetics are measured and certified in laboratories using a representative fixture from our manufacturing line – providing accurate estimations of the performance lighting designers can expect.



# Color Kinetics

## Committed to Maximizing and Optimizing Delivered Light.

Providing exceptional delivered light isn't a function of simply boosting the power or number of LED light sources. It's the direct result of smart decisions at every stage of design and development, as well as manufacturing. Color Kinetics offers a wide range of luminaires, each designed to maximize delivered light. In short, the kind of bright, consistent light that makes lighting professionals and their clients very, very happy. And the kind of light that looks just as exceptional in the real world as it does in simulations.

Color Kinetics luminaires deliver highly uniform, high-quality white light to support a range of business, retail, hospitality, and other applications. And they can transform spaces with intensely saturated, dynamic accent and full-color effect lighting for dramatic presentations, theatrical atmospheres, and special occasions and events.

Here are just some of the Color Kinetics innovations that make exceptional results a reality:

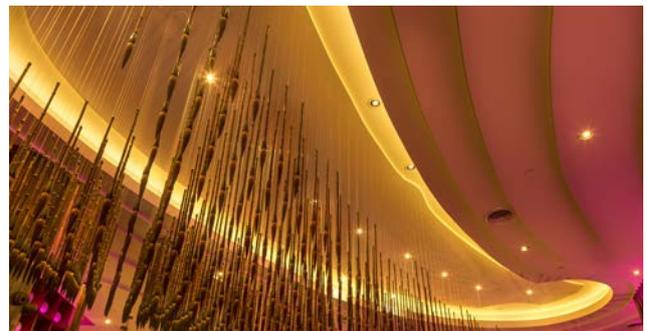


### **Optimized LED Selection: Bright from the Start**

Optibin, our proprietary binning process, ensures color consistency – and consistent delivered light – by grouping (binning) LEDs by flux, as well as chromaticity/colorpoint. Optibin uses an advanced bin selection formula that exceeds industry standards for chromaticity to guarantee uniformity and consistency for Color Kinetics lighting products. With Optibin, our luminaires deliver bright, consistent light right from the start – and throughout long use.

### **Advanced Optics: Unequaled Expertise**

Color Kinetics makes a major ongoing investment in optical research, creating innovative optics that meet the varying and evolving needs of the marketplace. Our range of optics are optimized for the specific LED, ensuring higher illuminance with the same power. We create unique beam shapes ideally suited for specific applications – including grazing, forward throw, flood, washing, direct view, spot, cove, indirect illumination, and task lighting. The result? Our advanced optics provide exceptional delivered light, precisely where it's needed with minimal waste and maximum punch, as well as greater efficiency. And we can even create custom optics to meet specialized needs.



### **Color Quality and Mixing: Optimized Color**

Optics also play a key role in achieving high color quality and precision mixing. For example, our PureStyle interior linear LED luminaire features a unique optical cluster that enables narrow beams and reduced mixing distances. And our ColorBurst Powercore spotlighting luminaires integrate a family of specially designed optics to optimize color mixing in the far field beam. Competitive solutions that use the same optics for the RGB channels often exhibit a red ring.

### **Chromasync: Advanced Color Consistency**

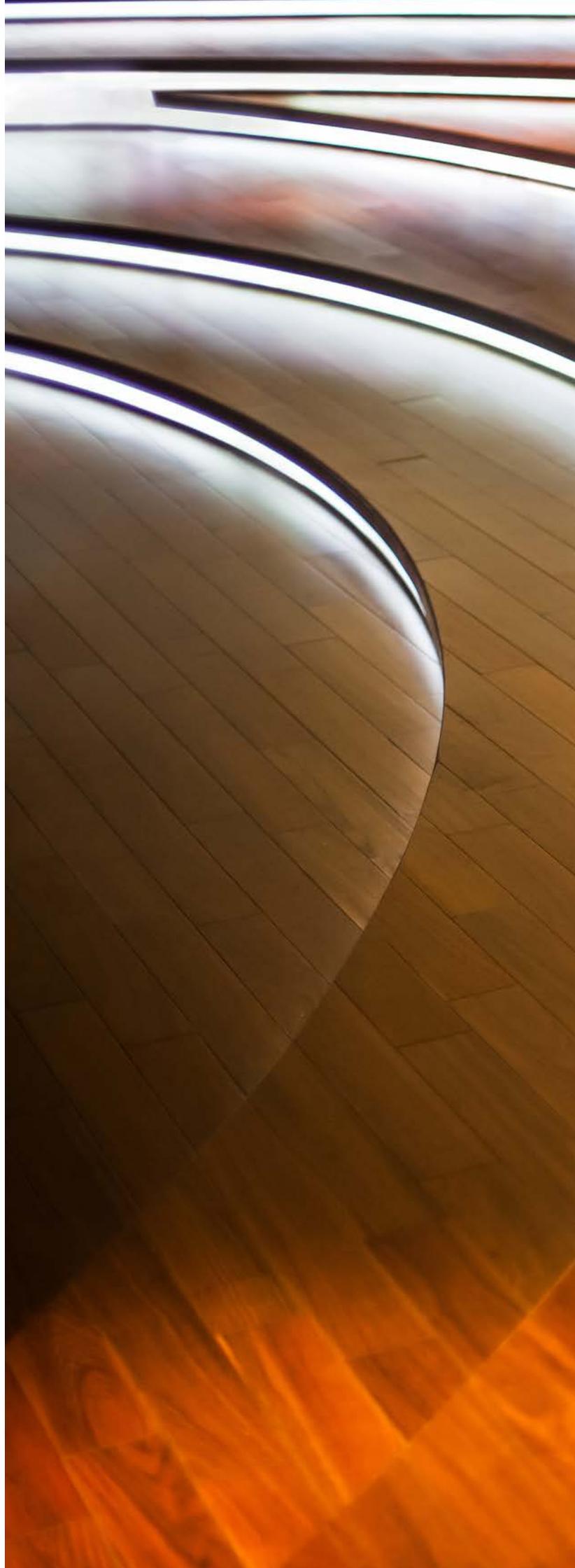
Chromasync capability is available on many Color Kinetics LED lighting systems, enabling them to achieve advanced color consistency. The Chromasync color control algorithm outputs the maximum possible flux based on the color command by managing how best to use the multiple channels and color LEDs inside the fixture. The result? Optimized, great-looking, accurate light delivered with accuracy and efficiency.

# Delivered Light Portfolio

The ever-expanding range of diverse lighting projects and environments makes designing and implementing lighting challenging, as well as rewarding, since no two installations are exactly the same.

Each situation creates different illumination requirements – from residential to retail to public lighting. However, all share the need for delivered light in the right amount and quality.

Here we present a portfolio of real-world examples, highlighting the specific delivered light challenges for each situation, as well as the Color Kinetics innovations that meet those challenges.





# White- washing wall light

**The challenge:**

Even illumination of a large multi-story shape or facade.

**The solution:**

eW Blast Powercore gen4

**The innovations:**

Our solution delivers a high-quality beam of white light, free from beam striations. Easy-to-use controls simplify installation and reduce complexity and cost.





# Increasing impact and safety

**The challenge:**

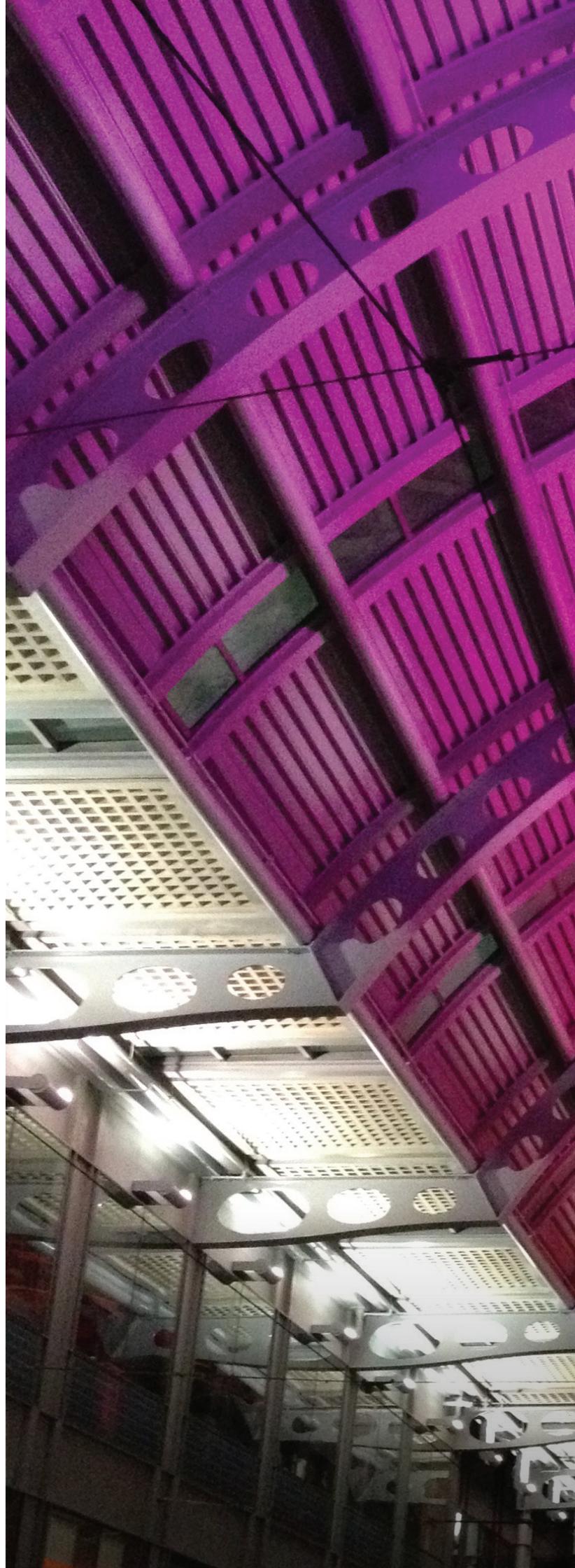
To increase light levels and uniformity – increasing safety, reducing maintenance and energy costs, and revitalizing San Diego, California.

**The solution:**

ColorBlast IntelliHue Powercore gen4 and ColorBlast Powercore gen4, RGB

**The innovations:**

Our solution enables the city to brand itself with dynamic color light, while provide safe urban lighting at all times.





# Uniform illumination

**The challenge:**

Provide powerful and uniform illumination of the unique fan-like geometry of the Sony Center roof in Berlin, Germany.

**The solution:**

ColorReach Powercore gen2 and ColorBlast Powercore gen4

**The innovations:**

Our solution delivers subtle shades of light and high punch to a complex architectural detail - creating powerful visual impact in a high-traffic area.





# Lighting a textured surface

**The challenge:**

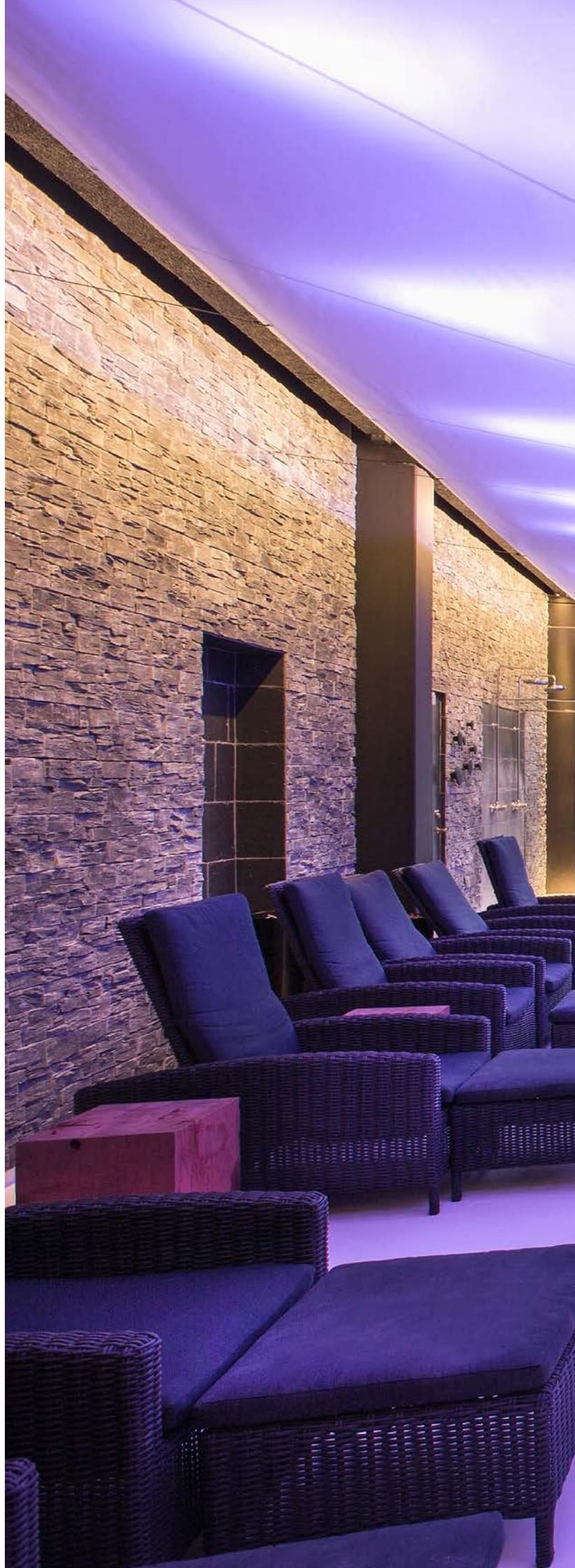
Light a textured wall without much room for a standard interior linear luminaire.

**The solution:**

PureStyle

**The innovations:**

Innovative optics enable PureStyle to be installed extremely close to the surface being illuminated. This short throw distance helps conceal the source of the light, enhancing the effect.





# Interactive light show

**The challenge:**

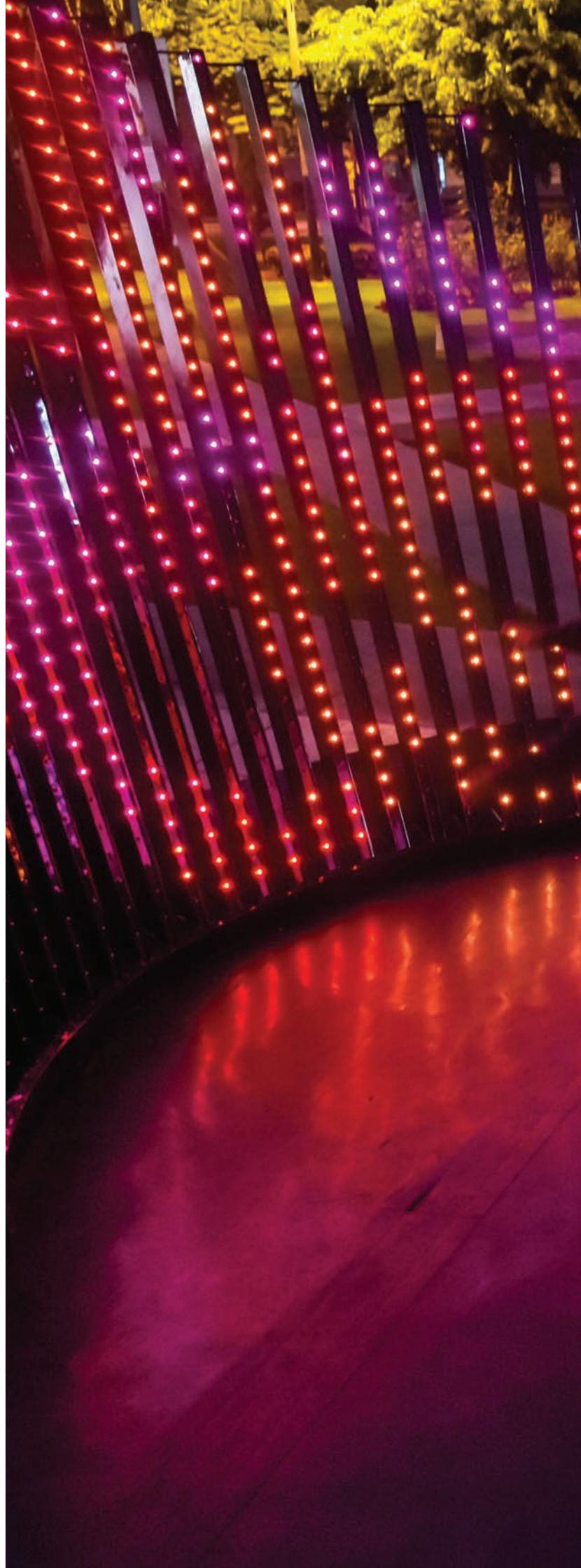
Create an interactive, engaging installation to draw people to the parks of the San Isidro district, Lima, Peru.

**The solution:**

iColor Flex gen2 and a unique control solution allow people to create and experience memorable lighting effects.

**The innovations:**

Interactive controls allow visitors to experience light in a whole new way.





# Large-scale grazing

**The challenge:**

Grazing a large object or architectural detail from the ground.

**The solution:**

ColorReach Compact Powercore, RGBW.

**The innovations:**

Simple control and installation design uses a single row of ColorReach Compact Powercore, RGBW to illuminate more than 10 stories of this iconic building in Dallas, Texas.





# Even wash lighting

**The challenge:**

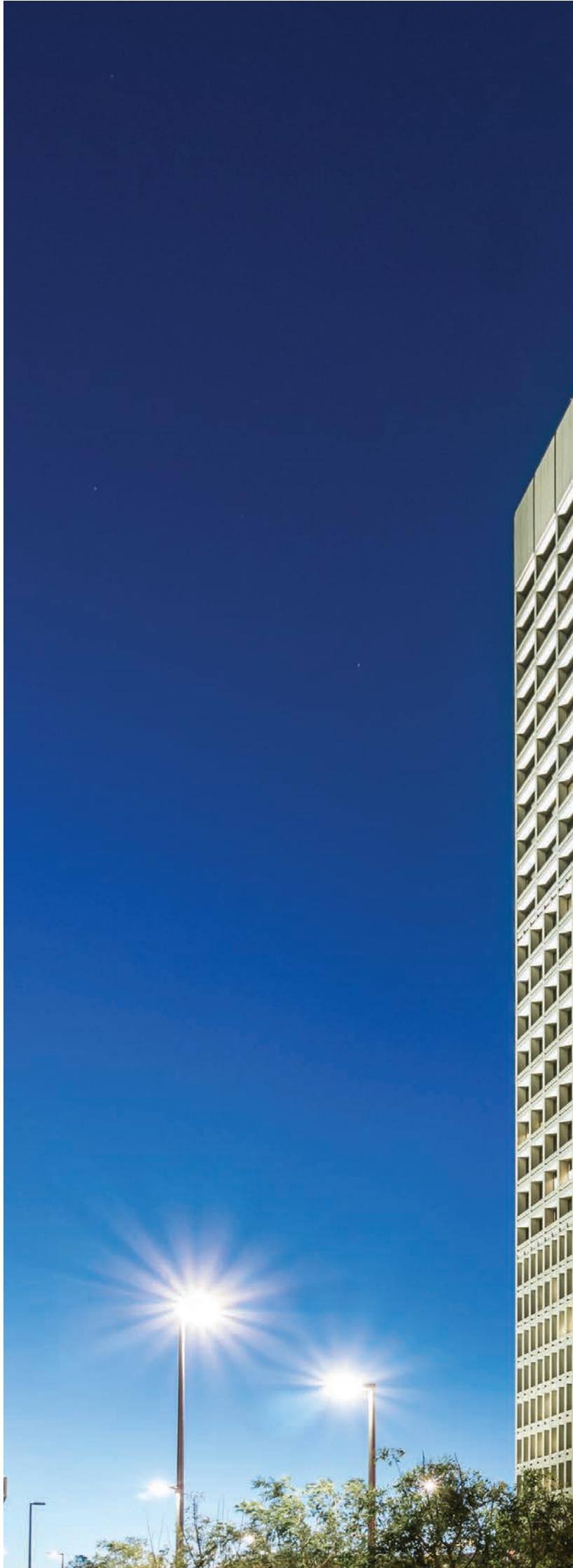
Even wash lighting to illuminate a large, 400-foot building facade.

**The solution:**

eW Reach Powercore gen2.

**The innovations:**

This solution provides a consistent look to the complex façade, day or night. More compelling, memorable lighting helps differentiate this site from similar buildings in the area.





# Highlighting an historic landmark

**The challenge:**

Turning an overlooked part of Brockville, Ontario, Canada into a safe, energetic and vibrant attraction.

**The solution:**

ColorGraze MX4 Powercore and ColorBlast Powercore gen4

**The innovations:**

Our luminaires transform a 1722 ft (525 m) long tunnel into a visually stunning walkway. Grazing luminaires showcase the unique architectural and geological features.





# Revealing architectural details

**The challenge:**

Creating a destination for business and retail stores, helping attract pedestrians to this part of Philadelphia.

**The solution:**

ColorGraze MX4 and ColorBlast Powercore gen4, RGBW.

**The innovations:**

Precise grazing highlights beautiful architectural details in subtly shaded light, without spilling distracting light into the interior of the building.





GREAT STORES IN A GREAT CITY

Photography: Jeffrey Totaro, 2016

LIT BROTHERS

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# What matters in professional lighting?

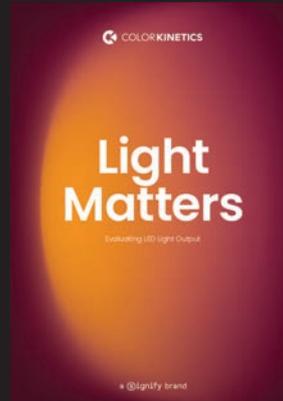
Our series of guides explores key topics in professional lighting—color science, light, quality, optics, and more.

It's part of our commitment to passing on our deep technical knowledge and decades of expertise to help you achieve your vision.



## Color Science

Color science serves as an underlying technical foundation for the entire lighting industry. It establishes a consistent way of thinking about light—how it is created, controlled, and delivered in real-world implementations. A core understanding of the science of color is critical to lighting professionals, who must be able to specify the right light—color, technology, luminaire, and more—clearly and accurately.



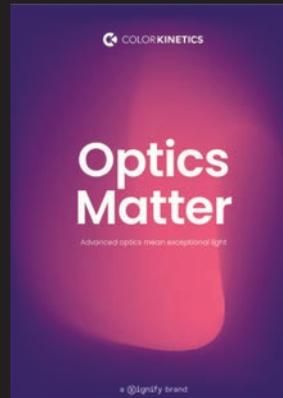
## Light Matters

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## Quality Matters

What does quality mean to you? The answer depends on what you do within the lighting industry. Quality has different meanings for building and site owners/managers, lighting designers, and installers. We delve into the needs of each of these groups as we take a holistic approach to quality, one that begins and ends with the customer.



## Optics Matter

It's safe to say that few lighting designers, building owners/managers, or other lighting professionals have ever seen the optical system housed inside an LED luminaire. But the optical system, or optics, play a vital, but often hidden role in performance, efficiency, and more. The right optics within a luminaire make a big difference in the final results—for both interior and exterior applications.



## Control Matters

Controlling light used to be simple. It was on or off. Then came dimming, which raised or lowered the intensity of light. The invention of LED luminaires added another dimension, color—and new capabilities, such as the digitalization of lighting, including the ability to zone dimming and control the spectral content of color-changing light.



## Sustainability Matters

By raising efficiency to new heights, our solutions help our customers do more with less energy. And since we design our solutions for long, useful lives, they create less waste. So, our customers get great results, year after year. All with less impact on the planet.

# We're in this— all together.

**Contact us** to learn more about how our innovative lighting solutions can help you achieve your vision.



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