

# Let There Be LIGHT

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Nearly every type of lighting technology available on the market today is demonstrated in Lighting Design Alliance's (LDA) new studio in Long Beach, Calif. From the color-changing LED skylight to the solar-fed fiber-optic accent lights, it's clear that light is the most important design element. The key was to integrate all of the "teaching" features cleanly and seamlessly. A studio that showcases lighting might not seem to be an obvious choice for a high performance facility, but careful planning and robust controls have resulted in one of the most efficient buildings in California.

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The design began with a dark, windowless warehouse originally used for cosmetics manufacturing. However, employees expressed concerns about their new windowless workplace.

LDA's previous building had multiple windows in every office, but employees kept their blinds closed. The owner assumed that daylight wasn't important to employees, so he bought a windowless building with two common walls. He found that his assumption was wrong.

### Lighting Solutions

To address employee concerns, designers focused on providing a glare-free daylit space.

All lighting teaching tools and techniques are integrated into the project as a permanent art installation. Custom patented hybrid electrical/daylight systems introduce sunlight into the interior of all spaces during daylight hours, while the integrated electric lights slowly energize as light is needed in the evenings. By combining daylighting and electric lighting into one unit, visual clutter is eliminated within the ceiling.

Designed to meet LEED Platinum requirements, fully connected lighting loads are 0.8 watts/ft<sup>2</sup>. Further

**Lighting Design Alliance in Long Beach, Calif., transformed a windowless warehouse by adding windows, skylights and shading to create a daylit glare-free space. Nearly every lighting technology is used in the space, allowing designers to test and experience the systems firsthand.**

reduction through daylight harvesting and dynamic dimming results in the actual average documented lighting load of 0.07 watts/ft<sup>2</sup> compared to California's strict Title 24 energy code that allows 1.1 watts/ft<sup>2</sup>.

All electric lighting loads are monitored through a green screen energy monitoring system, which calculates energy savings from the lighting dimming system. Savings are displayed on a monitor in the building lobby for building guests to see daily, weekly, monthly and yearly monitoring. To explore other sustainable technologies in a real-world application, 10 kW of photovoltaic panels are mounted to the sloped roof of the west façade and the flat roof above the open office space and warehouse. The photovoltaic panels can easily offset remaining lighting demands.

An entry with soaring 22 ft ceilings was added to the building's front to increase the scale and make it a more inviting space. Translucent glass at the reception area reduces glare and heat gain, while transom windows and light shelves bounce natural daylight deep into the interior. The transom windows are electrically operated and automated, as are the rear clerestory windows.

### Preventing Heat Gain

The building is naturally ventilated most of the year by cool ocean breezes. Custom vertical translucent luminous louvers block the western sun on the front façade and provide



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### BUILDING AT A GLANCE

**Name** Lighting Design Alliance

**Location** Long Beach, Calif.

**When Built** 1960

**Major Renovation** 2007–08

**Principal Use** Corporate office and design studio

**Includes** lighting technology showcase, open offices, conference rooms, kitchen, gym, volleyball court and warehouse

**Employees/Occupants** 20

**Gross Square Footage** 22,000

**Conditioned Space** 16,000

**Total Renovation Cost** \$1,600,000

**Cost Per Square Foot** \$73

**Renovation Scope** Lighting, electrical distribution and HVAC replaced; restrooms renovated; accessible restrooms added

**Occupancy** 50%

**Distinctions/Awards** 2008 GE Edison Awards: Award of Excellence in Environmental Design, Award of Merit

some privacy in the front offices without sacrificing views and daylight.

The panels are vertically oriented to allow for unobstructed views during most of the day. In the afternoon, the automated louvers shift to redirect the natural light without blocking views while the translucent



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panels glow softly. This minimizes the typical extreme brightness ratios that cause visual glare. The alternate systems considered for blocking the setting sun used horizontal louvers, but these had to be completely closed. The problem with vertical static louvers is that from the interior they seem like security bars.

**Left** Vertical translucent louvers allow daylight without glare. Photovoltaic panels are installed on the sloped roof of the west façade and on the flat roof above the open office space and warehouse.

**Below** The mezzanine was purchased in Mexico, dismantled, transported and reconstructed.



All office spaces are 100% daylit, with no electric lights used during working hours. A total of 52 skylights are incorporated into the lighting design. Long Beach, Calif., experienced record rainfall in 2009–10, and the skylights did not leak. By using triple-layer heat stopping acrylic or double-pane low-e glass, the amount of daylight used was maximized while minimizing the amount of heat gain. Even the decorative chandelier in the entry lobby is illuminated by a fiber-optic daylight system with 72 sun-tracking mirrors on the roof.

#### ENERGY AT A GLANCE

Annual Total (Site) Energy 19 kBtu/ft<sup>2</sup>  
 Electricity 15.3 kBtu/ft<sup>2</sup>  
 Natural Gas 1.15 kBtu/ft<sup>2</sup>  
 Renewable Energy 2.55 kBtu/ft<sup>2</sup>  
 (PV-estimated)

Annual Source Energy 54.5 kBtu/ft<sup>2</sup>

Annual Energy Cost Index (ECI)  
 \$0.65/ft<sup>2</sup>

Savings vs. Standard 90.1-2004  
 Design Building 25%

#### ELECTRICITY USE 2009-10

	kWh
July	7,903
Aug	9,514
Sept	9,650
Oct	9,663
Nov	8,750
Dec	8,116
Jan	7,404
Feb	8,361
March	7,427
April	6,610
May	7,702
June	7,807
<b>Total</b>	<b>98,907</b>

Note: Net electricity use. Gross electricity use includes power generated by photovoltaic panels.

Eight foot by eight foot clerestory monitors wrapped with special UV/heat rejection film refract low angle daylight while rejecting heat. North-facing, clear windows electrically open for ventilation and allow occupants direct view of the sky.

#### Maximizing Daylighting

In an office, typical lighting guidelines recommend between 25 and 50 footcandles. High daylight levels coincide with circadian rhythm requirements making open offices places where people want to work. The monitors at Lighting Design Alliance were designed to provide a maximum of more than 400 footcandles of glare-free natural daylight (under full daylighting conditions at midday).

The space appears friendly and inviting while promoting worker productivity. The firm plans to track health issues, missed work, and overall office productivity as part of an in-house circadian rhythm study.

A frosted acrylic ceiling system illuminated by a clear continuous skylight above spans the entire length of the building from the lobby to the rear exit, forming a bright central corridor. The ceiling provides 100% of the required light for this transition space, even on cloudy days.

Color-changing LEDs between the acrylic and the skylight come on after sunset to provide a variety of slowly changing light shows during evening events. The corridor also allows for natural convection to cool the building if the front and back doors are open.

The visual terminus of the corridor has a light art sculpture by Stephen

#### KEY SUSTAINABLE FEATURES

**Occupancy Controls** Astronomical time clock provides overall building controls, Crestron controller turns off all lights when building is vacant, Lutron EcoSystem provides occupancy sensors and daylight sensors for all spaces

**Lighting** 100% daylit during working hours, hybrid electrical/daylighting systems

**Water** Low-flow fixtures, drought-tolerant landscaping

#### BUILDING ENVELOPE

##### Roof

Type Wood  
 Overall R-value R-38  
 Reflectivity (SRI) 88 Acu-Shield (acrylic elastomeric coating)

##### Walls

Type Masonry  
 Overall R-value R-20 for conditioned space  
 Glazing percentage 6.4% total  
 5.6% west elevation  
 2.7% north elevation  
 0% east elevation  
 17.2% south elevation

##### Windows

U-value 0.34  
 Solar Heat Gain Coefficient (SHGC) 0.30  
 Visual Transmittance 0.8

Latitude 33.8073 N

Knapp that only consumes 50 watts of power, but creatively lights most of the wall surface using dichroic glass. The lounge at the end of the corridor has 4 ft by 4 ft clear skylights that house sun-tracking mirrors, which focus high light levels down to the social gathering area below. During an evening event, remote-controlled ceramic metal halide downlights illuminate the same areas.



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## Controls

All lamp sources throughout the building were selected for long lamp life and high efficiency for reduced maintenance and wattage. Photocells, occupancy sensors, an astronomical time clock, and local controls at each workstation provide full building control to suit the needs of each employee. Every applicable light source was dimmed to allow for minimal energy use

while still providing necessary illumination for visual tasks.

How occupants control their environment is sometimes more critical than what that environment actually is. LDA's office uses 12 distinct HVAC zones. This allows the north side of the building to be treated separately from the south side of the building, and allows the HVAC to be used only in occupied spaces. To meet LEED Platinum

A daylight transfer fiber-optic system lights the chandelier during the day. Metal halide lights spotlight it and the lobby atrium at night. The corridor (rear of room) is lit at night by color-changing LEDs integrated into the 60 ft skylight. The LEDs also avoid the "black hole" effect that skylights usually create at night.

requirements, all of the units are designed to be CFC-free.

Automated shading devices, automatic operable ventilation systems, a smart building computer, and local touch screen system create a space that can be customized for anyone in the office. The automated system combined with an external thermostat actually allows for the building to be automatically precooled. Insulation values exceed R-38, more than double what was required by code, and



Left A 60 ft translucent skylight provides this area and the adjacent corridor with 100% of its lighting during the day. Water walls are used to create white noise typically during evening events involving a large number of attendees. A closed loop system reuses the water, pumping it back to the top. The social space encourages carpooling by giving employees a source of entertainment until their fellow carpoolers are ready to leave.

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a high albedo (solar reflectance) roof helps minimize heat gain.

The building's nonlighting load includes computers, HVAC, two refrigerators, plotters and printers and miscellaneous plug loads. In addition to lighting efficiencies, the building's reduced electricity use from the grid is attributed to the occupancy sensors under each desk, the office's 50% occupancy

rate and the electricity produced by its photovoltaic panels.

### Conserving Water, Materials

As the Los Angeles basin enters its ninth year of drought, water is a critical resource. The small area of landscaping is drought tolerant, native to the region, and can be hand watered, if necessary. Artificial turf installed in the planters looks like a lush grass

**Left** The original concrete masonry unit (CMU) wall was repainted for a cost-effective, but clean look. One lesson learned from this room is the need for soundproofing in rooms used for video conferencing. A rug will be added to improve the acoustics.

**Right** Light fixtures dim down and up, supplementing daylight to keep light levels consistent. The office is 100% daylit during working hours. Fans circulate air and draw hotter air upward and out through the roof monitors when the automated windows are opened for natural ventilation. The blue soundproofing wall is made from sawdust, seaweed and recycled blue jeans.

## LESSONS LEARNED

Daylighting equipment, like electric lighting equipment, is always evolving. The solar tubes are now larger and more efficient. New optical prisms have been added to maximize illumination in early morning and late afternoon, but they also reduce midday illumination levels. Solar tubes that extend above the roof are available to help eliminate shadowing from architectural elements or mechanical equipment. Automated daylighting systems are becoming more robust and reliable.

The fine-tuning of occupancy sensors and daylight tuning was time consuming. The designers wanted to ensure the lighting did not stay on too long after an employee left her office or lights turned on when an occupant walked by an office door. Likewise, the designers wanted to ensure the daylighting prompted the lights to dim as soon as possible and turn off completely to recover maximum savings. The designers recommend a second commissioning after the building has been occupied for some time to fine-tune it for maximum savings and employee comfort.

Commissioning is an evolving need. The control system is being updated and modified regularly to maximize lighting efficiency and increase the level of savings. Lamps,

ballasts, occupancy/vacancy sensors and daylight sensors are regularly tested, which piques the curiosity of employees and guests.

Fiber-optic daylight transfer systems, such as the one that lights the lobby chandelier, are expensive for their level of illumination, and have quite a few limitations, including distance to the source, low light levels on anything except the brightest days—or none in the case of a cloud passing over—and relative difficulty of installation for proper function.

Sometimes the best solution doesn't exist yet. That does not mean it should not be explored. LDA president and coauthor Chip Israel designed hybrid solar/electric systems using different manufacturers' standard products. The hybrid systems keep the ceilings looking clean aesthetically and help LDA designers maintain constant light levels at their desks and conserve energy. The hybrid system was not much more expensive than having the two systems side by side, as would be done traditionally, because it was a single installation. Learning from its experience, LDA is now looking at modifying this concept for an upscale 2 by 4 system for spaces such

as schools, which have many of the same lighting needs as commercial spaces.

Being sustainable is about long-term goals and daily maintenance. Building infrastructure for goals such as rainwater collection and piping for a future shower (installed February 2010), allows LDA to keep striving for LEED Platinum without great cost or inconvenience. Daily sustainable initiatives such as recycling and carpooling remind and educate employees of the company's dedication to sustainability. Having a LEED-certified building is about creating a responsible office culture, not about a checklist of construction requirements.

The most important lesson was that the needs of the users, as described by them, and not just as assumed by the design team, should be the defining factors from the beginning of design. The assumption that no one cared about having windows, and the subsequent discussions with LDA's designers regarding daylight and glare, created an opportunity to develop and learn about the many options for daylight in the everyday office environment and resulted in this energy-efficient innovative space.

## BUILDING TEAM

**Owner** Lighting Design Alliance

**Architect** Archint International, Lighting Design Alliance

**Project, Facility Manager**  
Lighting Design Alliance

**General Contractor**  
Unlimited General Contractors

**MEP Engineer**  
Perfect Design and Development

**Energy Modeler**  
Lighting Design Alliance: Sandra Novales

**Structural Engineer** Bruce McVey

area between parking stalls, but requires no water.

All plumbing is ultra-low water use, including the faucets, toilets and urinals. A tankless hot water heater was installed to save energy. While

under construction, water seeped up through the foundation. Rather than deal with future mold issues, the owners had a portion of the floor removed. French drains and lateral drain pipes were added. At the same time, the large roof drains were rerun to the rear of the property to facilitate future rainwater harvesting.

Most of the finishing touches in the building are either recycled

Long life and efficient lamps are used in the reception area and throughout the building. New technologies, like LED MR16 bulbs, are installed and tested in a real-world setting.

materials or reused. All furniture was bought used, and a mezzanine brought from a demolished building in Mexico created the upper level for future expansion. A wall covering made from recycled blue jeans, seaweed and sawdust particle board creates a bold statement in



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*Advertisement formerly in this space.*



**Above** Occupancy and HVAC controls reduce energy use when the conference room is vacant. Low-volatile organic compound paint promotes good air quality.

**Right** Automated shades reduce glare. Variable light settings, zones and dimming allow for the correct lighting scenario for each use of the conference room.

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the design studios and also acts as soundproofing for the open office space. A bridge between the in-house gym and the storage room reuses glue-laminated beams from a local high school basketball court that was being replaced.

A recycling program includes plastic, paper, cardboard, aluminum and glass. Each desk has a trash can and a recycling bin nearby. Larger recycling containers for full size architectural drawings are distributed throughout the building. A soda gun was even installed in the kitchen to eliminate the consumption of soda in aluminum cans. Additionally, computers that are being phased out are donated through an employee's family to a school in South America.

While the building used LEED-NC as a guide during construction,

stringent documentation from the beginning of construction did not exist, so the building is registered for LEED Existing Buildings and plans to become certified within one year. LEED-EB encapsulates not only the building shell, but the day-to-day operation of the building, which is perhaps more enduring.

### Design Resolution

The designers of Lighting Design Alliance were a little apprehensive when they saw that their future office was a windowless warehouse with 8 ft ceilings, but no one feels that way now. ●



### ABOUT THE AUTHORS

Veronica Garretton, Assoc. AIA, is a designer at Lighting Design Alliance.

Chip Israel is founder and president of Lighting Design Alliance.

Sandra Novales is a designer at Lighting Design Alliance and teaches lighting design at the University of Southern California.