

LED Architectural Lighting Comes of Age

By Vrinda Bhandarkar & Robert Steele, Strategies Unlimited

Illuminating built environments has been possible only since the advent of electricity, starting in late nineteenth century. Although once considered a luxury, lighting design is now a routine part of architectural design. It is used both indoors and outdoors; it can be functional as well as decorative. Lighting provides an added dimension of nighttime experience to architecture.

Architects and city managers are aware of the importance of lighting to the image of a place to attract tourists and businesses. Thus many large architectural lighting projects are undertaken by local government agencies. As cities vie to improve the business climate, lighting enhances the appeal of the urban environment. The urban look at night is an important aspect of this effort. The building facade can become an interactive light source to reflect the mood, the weather, the occasion or a unique presence in a crowded urban environment.

The vocabulary of architectural illumination extends from the light from the windows of the towering buildings in urban landscape to lighting building facades to hotels, restaurants and retail spaces and even to high-end homes. The advent of HB LED has only enriched this vocabulary. Typical LED architectural lighting fixtures are:

- Wall washers
- Floodlights
- Strip lights
- Accent lights
- Cove lights
- Spotlights
- Path lights
- In-ground lights
- Step lights
- Pool and spa lights
- Flexible lights
- Festoon lights

Opportunities to Use Color

LEDs offer saturated color and flexibility with color, a means for color-changing scenarios without physical movement. Metal halide lamps offer opportunities to use color, but it is not possible to change color without using gels or color wheels. In terms of maintenance, heat generation and variability of color, LEDs have an advantage over other lighting solutions.

It could be argued that use of color is a passing fad. However, the opportunity to use color was limited before the advent of HB LEDs because of the cost of using color-changing technology. Color changing is still expensive, but LEDs have made it possible for high-end applications (and even some low-end applications) to use color changing in a straightforward manner. The growth trend in color-changing applications continues to be strong, with no evidence of a slowdown in the near term. Over time, the use of color-changing LED fixtures could plateau as the market begins to saturate, but there is no indication of that happening soon.

With DMX controllers it is possible, for example, to make light dance to music. RGB color-changing fixtures offered by the participants in this market require some customization and an investment in the control infrastructure. As of 2006, color-changing applications are limited to upscale shopping areas, landmarks, monuments and airports. In retail spaces it is being used to promote brand identity and in the hospitality industry, there are efforts to create ambience. The retail (outside of display) and hospitality markets are among the largest and fastest growing architectural lighting

markets for HB LEDs around the world.

Increasing Use of White LEDs

The price/performance situation of white LEDs continues to improve. LED lighting is competing with other entrenched technologies, such as incandescent and HID lamps, on the basis of the cost of the light fixture as measured in terms of lumens per dollar. In applications where color and color changing is an important issue, price per lumen may not be the most important criterion.

Currently, white LEDs are not competitive in terms of lumens per dollar, but they have become an option for applications located in hard-to-reach and difficult-to-maintain places such as bridges. Recent development of higher lumen output white LEDs has awakened lighting designers to new possibilities with this light source. As the price of LEDs declines and the lumen efficiencies improve, LEDs will become competitive to other lighting technologies in white light applications. In addition, LEDs will provide the added features of reliability and flexibility.

White LEDs are mostly used as accent lights and for lighting paths and stairways because of their low lumen output. With higher performance white LEDs, the design possibilities for LEDs will contribute to growth in other architectural applications. As the market matures, white LEDs are expected to have a universal appeal while preserving the choice of using color as demanded by the applications.

Cost-Consciousness

While the possibilities for adding to architectural appeal have improved with LED lighting technology, cost considerations have been a deterrent in introducing LED lighting. As the cost of construction is increasing, estimated at about 10 percent to 20 percent per annum, faster than the rate of inflation, lighting designers have to confront cost management issues. With LED lighting, the up-front investment is relatively high, but ongoing operation and maintenance costs are low. The two generally are part of different budgets and different management jurisdiction. Even though the cost of ownership is lower for LED lighting, it is often difficult for the project developers to accommodate the higher initial cost.

Lighting designers are now part of this cost-consciousness. When the basic cost of construction increases, the lighting budgets shrink. This is true of the construction frenzy in Asia, where it is common to discard desirable architectural details and finishes due to their high cost. Architectural lighting is one of the first victims of this process. However, as the cost of LEDs continues to decline and awareness of lower cost of ownership of LED lighting spreads, LED lighting will at some point become the preferred technology.

Outdoor Lighting Trends

There is increased awareness of both the general public and the design community regarding light trespass and Dark Sky issues, coupled with lighting code requirements, which prescribe the quantity and directionality of light emitted by outdoor luminaires. LEDs will have a significant role in outdoor lighting as this initiative spreads globally. Issues of light pollution dominate outdoor lighting design. Many of

the new luminaires are designed and manufactured with full cut-off optical systems. Industry standards on luminaire efficiency are no longer measured only by the amount of light luminaires can generate and their spatial distribution, but also by their impact on light pollution, including cut-off and veiling luminance, and glare. Improving the directionality of lighting is easier with LEDs.

Exterior lighting regulation is also finding its way into many energy codes and regulations such as California's Title 24 and ASHRAE's 90.1-2004. Even the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system has a credit for reducing light pollution. IESNA TM-15-07 "Luminaire Classification System for Outdoor Luminaires" describes the lumen distribution within solid angles required to limit the amount of light (lumens) emitting from luminaires in backlight, upward and glare zones (the BUG rating for luminaires). Because of the inherent directionality of LEDs it is easier to design cutoffs to comply with regulations.

Energy Consciousness

Although low in lumen output (not bright enough), the energy consumption of LED luminaires is lower than alternative incandescent technologies and if properly designed could be the cheapest of the alternative technologies in terms of cost of ownership. If combined with solar power, LEDs would be the most efficient solution for landscape lighting. Unlike other energy efficient technologies, LEDs can be turned on and off or dimmed instantly. LEDs in conjunction with other control technology can reduce energy usage during low-activity times.

LEDs in lab settings have demonstrated high efficiencies (well over 100 lm/W), and thus LEDs are the most promising technology that can potentially offer better efficiencies than fluorescent and even ceramic metal halide. While lighting design is an integral part of architectural design, there is an increasing awareness about incorporating energy efficiency in lighting design. In 2006, the competition for LEDs is from conventional technologies, especially in architectural applications that require high lumen output. This situation is not likely to change until 2008, when LED fixture efficiencies (not just device efficiencies) are likely to become competitive and will offer viable alternative to conserve energy.

Markets

The market for high brightness white LEDs in illumination is in its nascent stage but LEDs have been used in commercial applications for their color and ability to change color since the late 1990s. Architectural lighting was the largest application segment for LED lighting in 2006. The total revenues to LED manufacturers from architectural lighting applications are estimated to be more than \$93 million in 2006. The compound average growth rate for this segment is forecast to be 38 percent for 2006 to 2011. As the lumen output improves and as volumes increase the prices are expected to decline. The process has already begun. LED technology will be on full display at the 2008 Olympics when the Chinese government will attempt to dazzle the world with its "green modernity".