Maximizing Daylighting

Attention to design techniques can improve daylight usage, reduce energy use, and improve ambience and productivity

— By Michael Ytterberg, PhD, AIA, LEED AP

Using the sun to illuminate and brighten building interiors has been a factor in the design of buildings since the beginning of time. The advent of electric lighting reduced that need, but today's focus on energy reduction and efficiency has led more owners to try to maximize daylighting techniques through every avenue possible. Designers can aid this goal if they consider daylight techniques from the beginning of the design process. But they also must be careful that, in maximizing daylight for building interiors, they don't lose control of it and allow it to become a hazard.

Historical Trends

Daylighting became a concern in the 1970s, as the first national energy crisis impacted every aspect of American life. Buildings that were designed in the 1950s and 1960s, the era of cheap and seemingly unlimited energy, became "energy hogs." Offices with deep floor plates, endless dropped ceilings, and fluorescent light fixtures ignored the benefits of natural illumination. Factories, shops, schools, and other building types were built as windowless, one-story boxes that emphasized security. These designs were led by misguided concepts that focused the attention of workers, consumers, and students on those tasks that would make them more productive.

These design trends were necessarily reconsidered as energy costs rose in the 1970s and 1980s. Incorporating free sunlight and reducing heat generated by electrical lighting became the primary ways to make a building environmentally friendly by saving energy.

Architects went to great lengths to make sunlight available to all inhabitants of residences, office buildings, hotels, and other building types. Both passive and active techniques were developed to manipulate architecturally the play of sunlight over and into buildings. A typical feature was the "light shelf," which helped pull daylight deep into facilities by shading those close to windows and reflecting light to those further away.

Large areas of glass let heat in, along with a variety of other associated problems such as drafts, energy loss, and glare. Glass walls were expensive, as were the added-on structures intended to shade and manipulate the light. And glass at the time was of limited structural value. These were just some of the challenges and advantages of the first attempts at leveraging daylighting to save energy.

Today, a number of rating systems guide the design of energy-efficient structures. The most popular in the U.S. is LEED certification. These systems are more holistic in approach than the efforts of the 1970s and 1980s, focusing on all aspects of building and site design. They drill deeper into the design and construction process to include disposal of waste, transportation systems, and light pollution of the night sky. Daylighting, while still important, is no longer the single most important tool in the "green" toolbox.

Benefits to Daylight

There are still many significant advantages to incorporating daylighting into all building types. It has been demonstrated that people have a physiological need for sunlight, which can have an impact on mood, productivity, health, energy, and overall happiness. Though zoning and building codes around the world regulate the supply of light and air to building occupants, European countries do more to govern issues of how far workers can sit from a window and other factors. The result is the creation of buildings that, by law, have thinner sections than comparable buildings elsewhere, and which may have elaborate double-skin walls that buffer the inside from outside environments and control light, ventilation, and temperature.

The situation is different in the U.S., some of which appears to be cultural. Americans seem to prefer large, open collaborative spaces in office buildings, favoring deeper floor plates that make close proximity to windows for every building occupant difficult. More extreme weather conditions make the performance of double-skin walls more problematic here. There is always the constraint of building costs, particularly when energy has a lower cost here than in Europe. Regardless, it is possible to incorporate daylight into all building types, more so now than ever before.

New developments in glass technology mean that it can be used in a variety of ways previously unimagined. New coatings let in tremendous amounts of modulated light while restricting the ultraviolet light and transmitted heat. This is helpful in residential and office settings, as well as in industrial, retail, and hospitality settings, where temperature control can be crucial. Tinted glass and reflective coatings were once relatively

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The Hamilton Gardens social space atop Philadelphia's landmark Kimmel Center for the Performing Arts is being enclosed in a carefully crafted glass and metal enclosure that will modulate environmental conditions after its original glass-roof design proved too difficult to control. BLT Architects served as the architect and interior designer. Rendering: BLT Architects

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crude tools to control daylight passing through glass walls that had decisive visual implications for buildings, not all of which were positive.

Shading techniques have also improved to help reduce solar heat gain, while maximizing daylighting and views. These can be incorporated directly into the design of the building, such as horizontal or vertical screens, or they can be mechanical, designed to adjust with the occupants' needs.

Daylight Hazards

Daylight exploitation must be carefully considered. Hamilton Garden, which sits on top of the Perelman Theater inside of Philadelphia's landmark Kimmel Center for the Performing Arts, was intended as a revenue-generating social space underneath the vast, signature glass barrel-vaulted roof that covers the entire building, with views both to the city beyond and into the performing arts center below. Unfortunately, an exposed space beneath a vast glass roof proved impossible to condition, and was simply too hot, bright, and noisy to be used on a regular basis, in spite of the fabulous views and magnificent architecture.

The Garden is now being enclosed in a carefully crafted glass and metal enclosure that will modulate environmental conditions to preserve the spectacular attributes of the space while making it comfortable and commodious for frequent use. Here, both sophisticated glass coatings, as well as the full range of architectural shading devices and dramatic exposed structure, were used to modulate sunlight and aurally isolate the space.

If necessary, motorized blinds and shades will be installed to move with the sun throughout the day and modulate daylight to control air and energy flow. Controls are automated and sensors can turn on artificial lighting when enough daylight is not available or off when the space is vacant. At last it will be possible to use this dramatic aerie to meet its originally intended function.

Combining Glass and Concrete

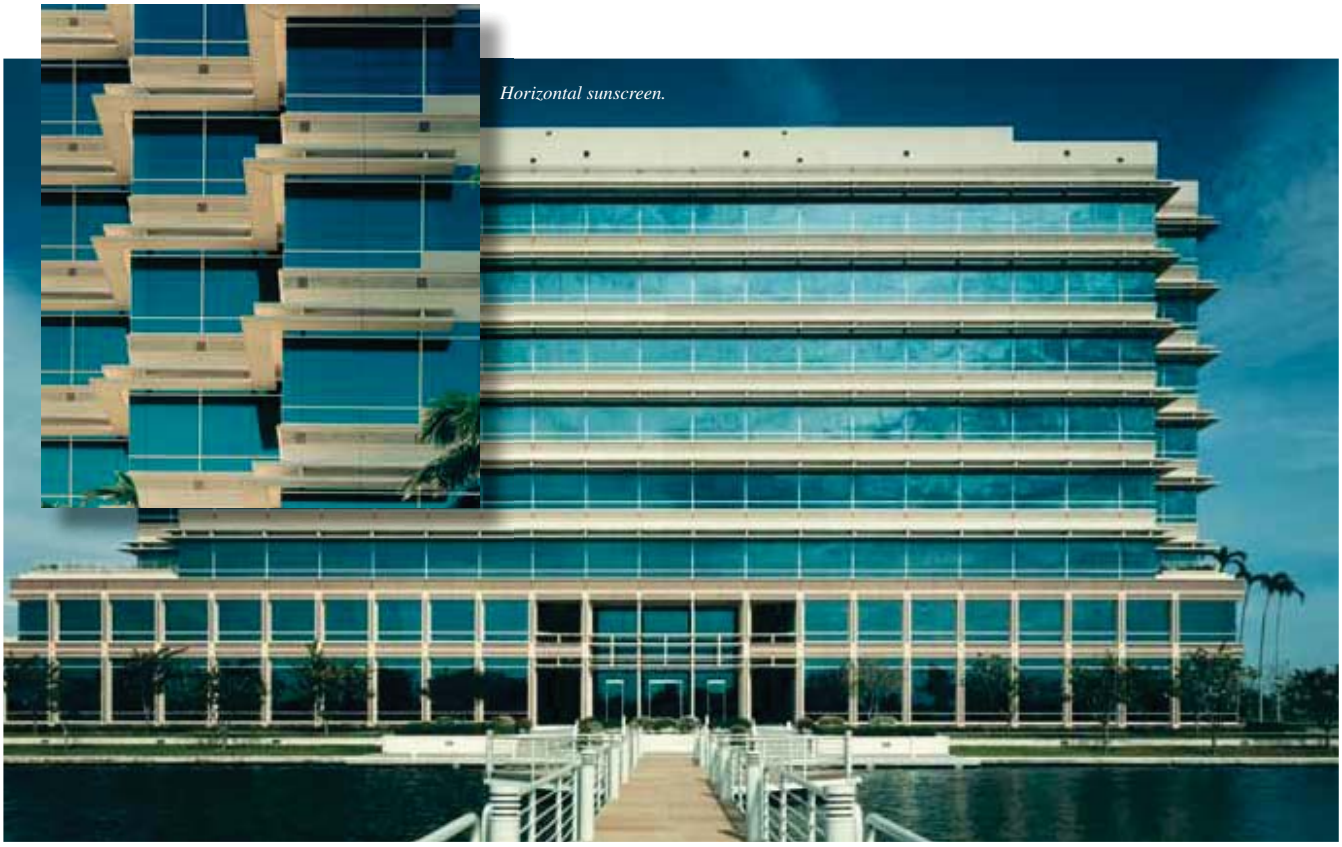
Glass facades are often seen as expressive of technology and therefore sometime desired by businesses wanting to project an image of being forward-looking and up-to-date. On the other hand, masonry and concrete buildings connote solidity, comfort, and domesticity. These two materials can be combined to create exciting projects that blend the two messages on dramatic facades.

For instance, the 32-story Symphony House condominium tower in Philadelphia features a skin of architectural precast concrete panels with a preponderance of "punched" windows and just the occasional relief of floor-to-ceiling glass where it really counts. In such residential projects, too much glass can mean too much light and exposure to heat and cold, not to mention the cost of window treatments that, at the end of the day, can cover up the glass that cost so much to include in the first place.

The carbon-fiber reinforced panels used in this project were extremely thin and lightweight yet extensively insulated, cutting down on the cost of structure and foundations while increasing energy efficiency. Manufactured under factory-controlled conditions, their use facilitated construction while also reducing waste and energy usage, providing a host of green benefits.

Specially coated glass was incorporated into the design. The windows

The 32-story Symphony House condominium tower in Philadelphia combines carbon-fiber reinforced architectural precast concrete panels with "punched" windows to leverage the use of daylight while providing sunlight control and high energy efficiency. BLT Architects served as the architect and interior designer. Photos: Michael Ytterberg.



A horizontal sunscreen is used on the Cornerstone office building in Florida to reduce solar heat gain, while permitting daylighting and views. Photo by Brian Gassel/TVS

were designed and placed to balance the simultaneous needs for privacy and spectacular views, while reducing heat loss/gain and the glare caused by sunlight. The windows were placed within a wall panel and tested as a unit to verify the highest possible standards of performance. Thus, the tools of a traditional wall, even in the context of a high-rise building, were shown to have "green" benefits and to produce an environment that is simultaneously up to date and comfortable, physically and psychologically.

Daylight For All Building Types

Daylighting techniques are also beginning to be used in building types previously considered best as totally controlled environments without any outside interference. Big-box retail stores are an example. This is not just a matter of environmental preferences but of dollars and cents. A recent experiment by Walmart showed that when skylights were added to a store, the natural light made shoppers perceive products in a more positive light and buy more. The daylighting also resulted in better employee moods and increased productivity.

Revel, a 6.3-million-square-foot beachfront resort destination opening later this year in Atlantic City will open part of its casino floor to the outside, letting natural light shine in and giving guests a view of the ocean. This is dramatized by floor-to-ceiling glass areas. The new approach relies on sophisticated glazing technology that can help modulate light and temperature, creating an experience that does not distract from the rest of the facility design.

While technology and tools have advanced to promote more daylighting in all buildings, there must still be careful design consideration for bringing the outside environment inside. All of the projects mentioned above have been built on urban, brownfield sites, in itself an important aspect of sustainable practice. In a perfect world, all buildings would be built in the middle of a field so they could be oriented to maximize exposure to the sun, with spaces oriented north, south, east, or west as appropriate for the activities housed within. However, an idyllic rural environment is not the case for most of the world's buildings.

The reality of urban and increasingly dense suburban environments means that architects must be creative in how a building is positioned and designed to get the most, best sunlight throughout the day. The architecture of daylight is still very much an art while the materials that are used have advanced with the help of science.

Each of the projects mentioned has taken into account shadows cast both into and out of the site. Each has used the appropriate techniques to modulate the environment of specific functions wherever the functional arrangement and site conditions allowed them to be placed, keeping out negative environmental impacts while accepting and accentuating the positive.

Daylighting is a powerful tool in design, one that can make buildings more pleasurable and more efficient places to live, work, and play. This is as true now as when people first began to build. Moreover, techniques first developed in recent years in response to the realization that nonrenewable energy sources have a steadily increasing cost and, ultimately, a limited life, will become the standard by which future architecture will be built, ensuring an efficient, productive, and pleasurable built environment for human lives. ■

For more information on these or other projects, visit www.pci.org/ascent.