LIGHTER DAYS, BRIGHTER DAYS

Daylighting as an Energy-saving Tool

By Randy Heather

Daylighting, a term that has become synonymous with the use of natural light in buildings, created a flurry of literature beginning in the 1980s and continues to be one of the most researched topics in construction.

New curtain wall systems, sun control products, glazing materials, and skylight technology have created an opening to new design and construction opportunities. And, perhaps not as widely understood, is the fact that daylighting has become an important energy-saving tool.

Effective daylighting design introduces natural light while balancing the elements of artificial lighting, heat loss through glazing, solar heat gain, and internal sources of heat gain. To be an effective energy-saving tool, daylighting must be integrated with electric lighting, lighting controls, and heating, cooling, and ventilation systems.

Many glazing contractors say that daylighting is still perceived as "energy wasting," but in reality it has become an important part of energy conservation programs in construction projects across the country. According to the Public Utilities Commission in California, energy efficiency programs in building construction – many of which are devoted to daylighting – saved 2.3 billion kWh of electricity from 1999 to 2001.

According to the California consultancy Energy Design Resources, skylighting offers potentially large energy savings. Past studies showed that the average grocery store, for example, may save up to 32 cents per square foot in energy savings through daylighting; schools typically save about 23 cents per square foot; and industrial buildings save up to 12 cents per square foot.

According to the U.S. Department of Energy (DOE), artificial lighting accounts for as much as 10 to 20 percent of energy consumption in industry. The DOE also reports that daylighting can reduce those costs significantly.

Once used primarily in museums, boutiques, and architectural showplaces, today, daylighting is an increasingly integral part of building design. Studies have shown that daylighting as part of an integrated design can not only reduce building energy consumption but also improve the health and performance of those who work within it.

Four different studies by the Heschong Mahone Group of Fair Oaks, California, concluded that the presence of natural light can improve student performance in schools, worker performance in office buildings, and sales in retail stores.

The educational study and follow-ups show that elementary students in classes with the most natural light showed about a 20 percent learning improvement over students in classrooms with the least amount of natural light. The Heschong Mahone Group's studies of retail sales concluded that sales were positively affected and that

The use of curtain wall, such as at Empire College in Saratoga Springs, New York, is one way to bring natural light into a building.

the profit from these increased sales could be as much as 19 percent higher in stores with daylighting.

Design and Construction

Due to the fact that natural daylight creates less heat per unit of illumination than many artificial lights, daylighting can reduce cooling costs when it replaces artificial lighting. And, as part of a passive solar heating system, sunlight can provide additional building heat to reduce the cost of heating in winter.

However, if glazed areas that allow daylight into a building are not designed properly, they can contribute to heat loss in the winter and undesirable heat gain in the summer, leading to added heating and cooling costs, which may offset any savings from decreased lighting costs.

Therefore, daylighting designs must be analyzed to ensure that the energy savings achieved from reduced artificial lighting are not lost through increased cooling or heating needs. This analysis involves some understanding of how a given glazing system transmits visible light and heat.

First, visual transmittance (Tvis) is a measure of the portion of visible light that passes through a fenestration product. This is perhaps the most important characteristic to determine when looking to displace the use of artificial lighting for energy savings.

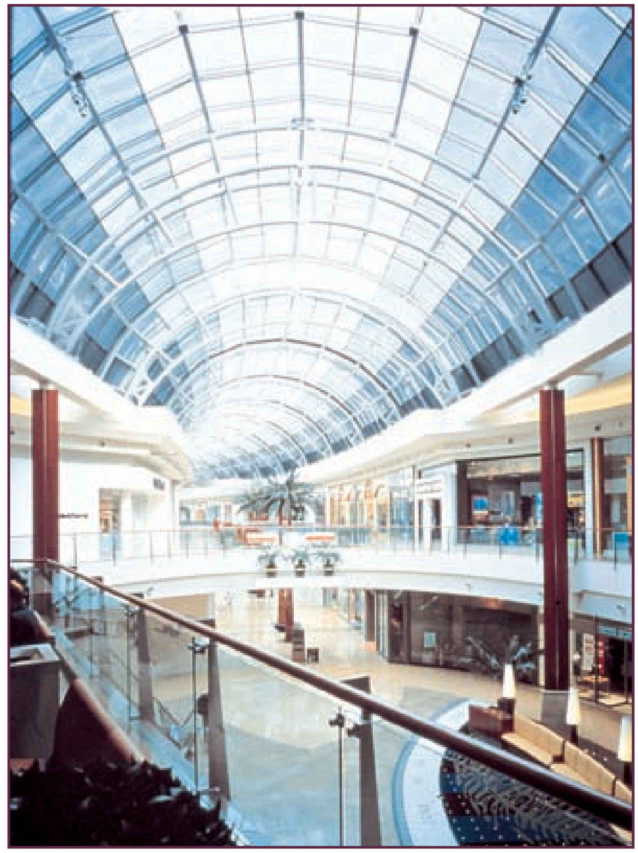
Second, fenestration products transmit heat. The solar heat gain coefficient (SHGC) is the measure of the amount of heat associated with the transmitted light. The higher the SHGC value, the more heat transmitted. Fenestration products also transmit heat through conduction, as well as convection through the material itself. The measure of the amount of heat moved in this manner is denoted as the U-factor. A higher U-factor means that more heat is transmitted this way.

When dealing with buildings in predominantly cold climates where the cost of heating the building is the major cost, the U-factor is the characteristic that should be considered. In predominantly warm climates where air conditioning is the principal cost, the SHGC is more important than the U-factor.

When considering the SHGC, look for a product that has a light-to-solar heat gain (LSG) ratio of more than 1. The LSG is an index of how much light a system offers in proportion to the amount of solar heat transmitted. A ratio of 1 or more indicates the system is producing more light with less heat, thus making for an efficient product.

Vision vs. Daylighting Glazing

It is important that designers and contractors consider vision glazing versus daylighting glazing when planning a building. The two perform different functions. Vision glazings usually use lower transmittances and are transparent to provide views of the outdoors. Daylighting glazings, which are used to provide interior illumination, generally have a higher visible transmittance and are translucent, which allows them to diffuse light. This ability to diffuse the light is known as haze. For effective distribution, the haze percentage of the glazing should be above 90 percent.



The Mall at Millennia in Orlando, Florida, features a massive skylight system.

Daylighting falls into two general categories: sidelighting and toplighting. For buildings with long, shallow floor dimensions, it is feasible to daylight up to 70 percent of the footprint with a sidelighting system. When reviewing a sidelighting system, consider the following options:

- Light shelves to throw the light deeper into the building,
- Orientation of the window with respect to the path of the sun, and
- Exterior light shades to control direct light and heat and provide shaded, indirect light to enter the building.

Toplighting feasibly can light more than 90 percent of a building area through clerestories, skylights, and roof monitors. Natural light through rooftop openings can deliver light deeper and more evenly, and their orientation is not dependent upon the building orientation. When considering toplighting systems, it is necessary to determine how to diffuse the entering light. Use glazings with a haze of more than 90 percent or place diffusing structures below large, clear-glazed openings to break up the direct light.

To be cost-effective, lighting controls are a must. The savings on lighting and cooling must offset the costs of buying, installing, and operating daylighting features in a reasonable amount of time. Usually, the payback period is from two to five years, but this depends on the percentage of the total construction budget that is devoted to daylighting. And the amount of energy savings always depends on location, climate, energy load, and the design of the building.

Randy Heather

Randy Heather is the 2nd vice president of the Skylight Council of the American Architectural Manufacturers Association (AAMA) and is the standard projects manager for Naturalite Skylight Systems of Terrell, Texas. He has almost 30 years of experience in the skylight manufacturing industry.