

Daylighting Strategies Promote Healthy High Performance Buildings

By Steve Gille

There are many reasons to incorporate daylighting into the building or renovation of K-16 learning facilities. Benefits include increased productivity for students and staff, improved health, a better connection to the outdoors, energy savings and better quality of light. Add the role daylighting can play in LEED certification and it's clear that daylighting in education facilities is here to stay.

Benefits to Students and Staff

The positive effect of daylight on students, teachers and staff of education facilities is well documented. A California study showed that students who had access to natural daylight progressed faster in both math and reading, and had significantly higher test scores. One participating district reported that the impact of moving a child from the classroom with the least daylight to one with the most produced the same improvement as moving that child from the lowest to the highest performing school in the district.¹

Daylighting in classrooms also helps improve student health, which in turn leads to reduced absenteeism.² It also positively impacts an elementary-aged student's ability to concentrate and cooperate.³ In addition, teachers and staff benefit from daylighting;

natural light has been demonstrated to enhance productivity and employee morale, memory and recall.⁴

Energy Efficiency

The nation's 17,450 K-12 school districts spend more than \$6 billion annually on energy — more than is spent on computers and textbooks combined.⁵ Daylighting strategies, including the use of sun control products based on the building's physical location and site orientation, can dramatically increase energy efficiency in several ways:

Lower Lighting Costs

Daylit classrooms, media centers, gymnasiums and cafeterias can help lower energy costs by reducing the need for artificial (electric) lighting. Artificial lighting energy use can be reduced by lowered need for electric lights because daylight is

present, or by dimming/switching electric lights automatically in response to the presence of daylight, a process known as daylight harvesting. In some cases, proper daylighting design reduces the total number of lighting fixtures installed in a new building.

Reduced Heating and Cooling Loads

Energy savings can be achieved either from passive solar heating or by reducing cooling loads. In warmer climates, or during warmer months, providing the right balance of daylight can significantly reduce cooling loads. Because the lumens per watt from daylighting are twice that of fluorescent fixtures, daylighting can meet the same lighting need yet produce half the heat. In contrast, cold weather regions can capture passive solar heat to reduce the costs associated with heating learning environments.

¹Heschong Mahone Group. "Daylighting in Schools," Pacific Gas and Electric Company on behalf on the California Board for Energy Efficiency Third Party Program, August 1999.

²Energy Performance of Daylit Schools in North Carolina (Mike Nicklas and Gary Bailey, 1996)

³Kuller R. and Lindsten, C. "Health and Behavior in Classrooms with and without Windows, Journal of Environmental Psychology, (1992) 12, 305-317.

⁴Heschong Mahone Group. "

⁵www.energystar.gov/schools

Glass Options

Solar-reflective glass coatings can be used to dramatically reduce unwanted heat gain by reflecting and absorbing high amounts of infrared and visible light. Schools can optimize glass selection through site orientation by using clear substrates and coatings on north-oriented facades and darker glass on south-, east- and west-facing facades. Similarly, darker glass should be considered for large windows and clearer glass for transom lights. Windows of high-quality construction also can incorporate barriers and insulation to maximize thermal performance and a comfortable indoor temperature for students and staff.

Sun Shades

Exterior sun shades intercept unwanted solar heat gain before it can impact a building's HVAC system load. And, they can make a powerful aesthetic statement in an education facilities' design. Energy savings can be maximized by combining sun shades with interior light shelves and a fine-tuned lighting control system.

Light Shelves

Light shelves bounce visible light up toward the ceiling, which reflects it down deeper into the interior of a room. External light shelves are most useful when they are mounted on the south-facing windows. For interior applications, light shelves are especially effective for relatively clear climates at mid-latitudes with south orientations. Frequently, interior light shelves are attached to mullions - the structural element which divides adjacent window units - and are placed below uppermost transom or clerestory windows. Selecting lighter colors and/or finishes will accentuate the reflection, providing more lighting to the space.

Interior Shades and Blinds

Interior shades and blinds improve visual, acoustical and ther-

mal performance, while maintaining outdoor views and indoor comfort. Blinds are often the most versatile devices for shading. They can be raised or lowered or tilted to match the position of the sun and achieve the right quantity of light at any given time of day. Between-glass blinds contribute to privacy and light control, such as with audio/visual presentations. Blinds made for daylighting feature inverted slats in the top portion of the blind, allowing this section to redirect light further into a room, while the bottom portion blocks direct exposure to light and glare. Wider slats increase outdoor views and may optimize light distribution and daylighting benefits.

Just as daylit classrooms are proven to positively affect students, so do quiet classrooms. Window units with blinds, combined with dual- or triple-glazing, improve noise attenuation and solar heat gain. When teachers and staff have the opportunity to manage noise, glare, indoor temperature and privacy, they can provide a more comfortable learning environment for their students. In areas where safety is a concern, between-glass blinds eliminate the hazard that exposed cords can create for young children. Custodial locks and vandal-resistant screens on operable windows also may be options to consider for enhanced security.

Aesthetics

Window systems add to the visual appeal of schools. This may be accomplished with signature design details that give individual buildings within a district or campus a distinct personality. It also may be achieved with large, clear glass units that present a heightened sense of transparency and greater connection to the community. Within classrooms, windows with low sight lines help connect learners to the outdoors and the surrounding environment.

Architects that effectively incorporate innovative, daylighting strate-

gies into schools not only offer an individualized design, but also deliver efficient performance. For example, sun shades are available in a full range of shapes blades, tubes, catwalk grids solid panels and louvers, and can be further distinguished with colorful finishes and complementary, ornamental elements.

Contribution to LEED Certification

The U.S. Green Building Council's (USGBC's) 2009 LEED® for Schools Rating System™ recognizes the unique nature of the design and construction of K-12 schools. Daylighting and window systems may help schools achieve their LEED goals through:

- Energy and Atmosphere: optimizing energy performance can earn up to 19 of 33 points.
- Sustainable Sites: reducing light pollution can add one point.
- Indoor Environment Quality: control systems, daylight, and views contribute toward the 19 possible points in this category.

Window systems also may contribute to a school's LEED points for Innovation in Design (six possible points), Regional Priority (four possible points), and Materials and Resources (13 possible points). For more information on the LEED Rating System for Schools, visit the USGBC website, www.usgbc.org or their green schools website, GreenSchoolBuildings.org.

Window Systems' Role in Daylighting

Many methods can be used to incorporate daylighting into educational facility plans. Open-air design, atriums, skylights, reflective materials and windows all draw sunlight into learning spaces for students of all ages.

Windows play an integral role in an effective daylighting plan. For example, Toledo Public Schools' newly opened Hawkins Elementary included windows as a key part of



Hawkins Elementary School
Toledo, OH

the building's design and energy efficiency. The building itself is oriented to take advantage of natural lighting, and the more than 85 project-out, project-in and fixed window units in the school's design boosted light levels in 90 percent of the classrooms and teaching spaces to at least 25 foot candles of natural light.

To ensure a smooth running, effective daylight strategy, consideration must be given to several important factors:

Maintaining Historical Integrity

Maintaining aesthetic integrity can be a cause of concern for educational facility professionals planning a major renovation or new construction in a historically-influenced campus. Fortunately, technological advances now allow for energy-efficient modern materials to be seamlessly integrated into windows that replicate the look and feel of original architecture. Brookline High School in Brookline, Mass. and the University of Notre Dame in Indiana are two historical campuses that have successfully installed new windows systems in established buildings.

Timing

Once the decision has been made to move forward with new construction or renovation, time becomes a critical factor. Often, construction timelines need to be coordinated with a district's or university's academic year and scheduled when classes are not in session. Under these tight timelines, relationships with the glazing contrac-

tor and other daylighting partners become critical. If work needs to be done during an academic school year when students and staff are occupying the building, consideration should be given to the possible effects of inclement weather, foot traffic, construction noise and other environmental factors.

Maintenance and Repair

Between-Glass Blinds

Often, the number of moving parts can directly affect the maintenance and repair of a window system. Between-glass blinds offer low maintenance needs and can contribute to significant energy savings.

Durable Finishes and Hardware

Exposed window parts finished with durable materials can go a long way in reducing maintenance. The effects of a cold, harsh winter or a hot, humid summer can quickly cause exposed materials to fade, crack or erode. Durable hardware and weather-stripping contributes to years of service.

Simulated Double-Hung Windows

Combining durability, design flexibility and convenience, simulated double-hung windows are an increasingly popular choice for schools. These mimic the look of traditional double-hung windows with offset glass planes and optional matching sightlines, while offering the reliability and affordability of project-in hopper vents, project-out awning vents and casements. When existing single-glazed double-hung windows are replaced, heavier double- or even triple-insulating glass is specified for energy efficiency. However, counter-balancing hardware may not be up to the challenge of increased sash weight. The compression seals and ease of operation that characterize projected and casement windows may improve functionality of replacement windows, versus replacing "in kind" with double-hung sash. Regardless of which type of window system is

selected, using materials that are successfully tested to meet stringent industry standards and are backed with a comprehensive warranty will help minimize maintenance and repair costs.

Cost

Budgets are constantly top-of-mind for education facility planners. Frequently, the initial cost to purchase and install window systems that provide daylight benefits and contribute to LEED goals can be offset by the significant savings achieved from reduced energy use and increased energy efficiencies. Healthier learning environments also can bring money into the school by lowering absenteeism and increasing funding based on Average Daily Attendance.

According to the USGBC, a typical "green school" saves \$100,000 per year in direct costs. If all new school construction and school renovations went green starting today,



Brookline High School
Brookline, MA



Notre Dame Duncan Hall
South Bend, IN

energy savings alone would total \$20 billion over the next 10 years.

Cost savings, increased efficiencies and academic improvements aside, perhaps the most satisfying benefit comes from the gratitude and amazement of those who enjoy the views and sunshine. As Ann Baker, principal of Hawkins Elementary said, "It is awesome. The thing I enjoyed the most, when the children walked in, and were in awe as they noted, 'wow windows'."⁶ ■

Steve Gille

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⁶Rapin, Kristen "TPS opens new 'green' school at Hawkins Elementary" Toledo Free Press, January 22, 2010