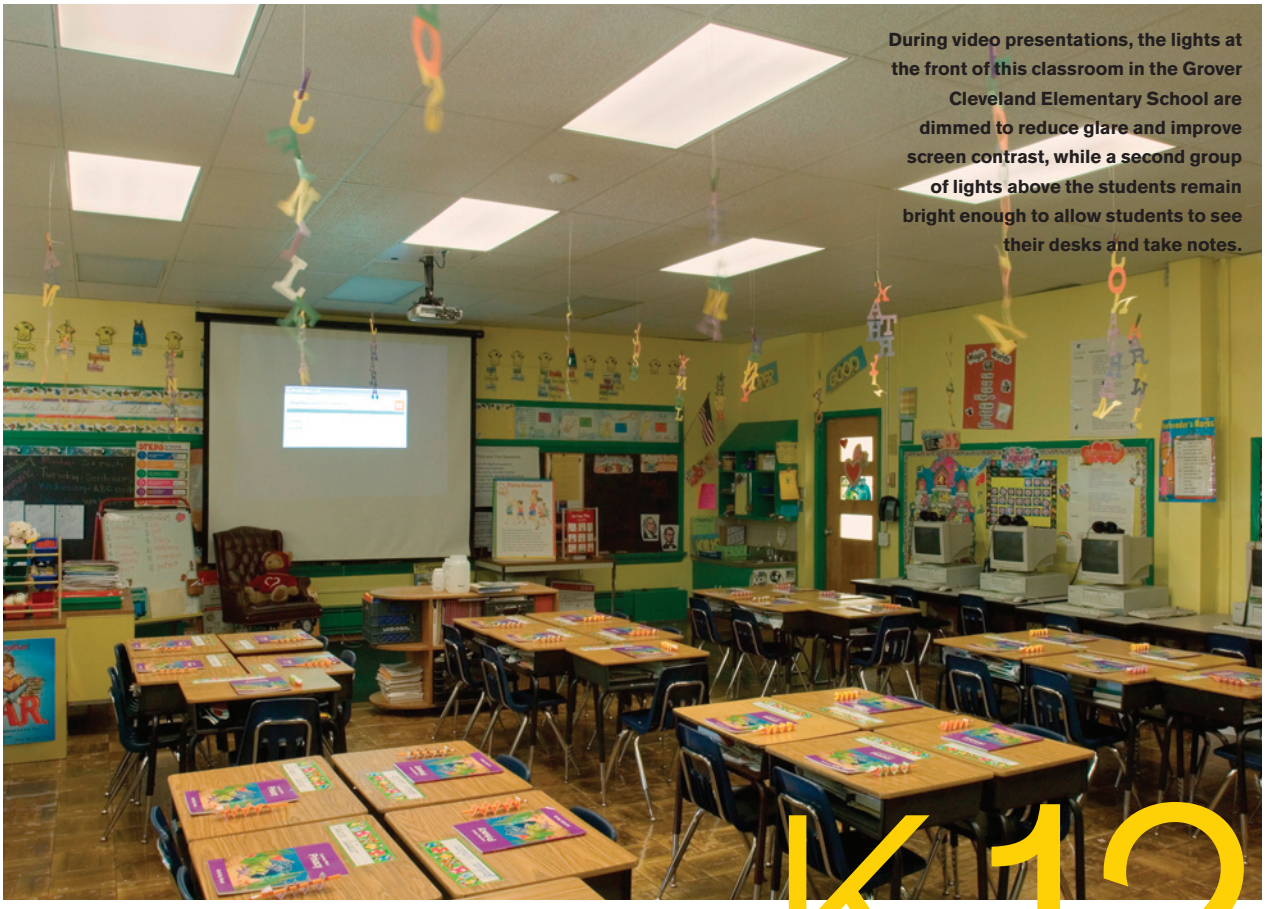


During video presentations, the lights at the front of this classroom in the Grover Cleveland Elementary School are dimmed to reduce glare and improve screen contrast, while a second group of lights above the students remain bright enough to allow students to see their desks and take notes.

CONTROLS IN K-12

The changing nature of the K-12 classroom combined with the 'flex' space in today's schools demands a variety of lighting control strategies

BY STEVE BEEDE

The design of America's K-12 school buildings–from the iconic one-room school house to the multi-building campuses we have today–has followed the evolution of American society itself: explosive population growth with a diversity of needs, matched by a multitude of technological tools available to help meet those needs.

In the process, schools must bear the burden of ever-increasing energy costs–with lighting accounting for the greatest source of consumption. According to the U.S. Energy Information Administration (within the U.S. Department of Energy), lighting accounts for 55 percent of the typical school facility's electricity consumption, far above any other source, including heating, cooling, ventilation or office equipment.

Yet, it is today's state-of-the-art lighting technology that can deliver the greatest potential for energy *savings* in school buildings. The techniques range from daylight and occupancy sensors, to manual control and dimming.

ROOM BY ROOM

In addition to classrooms, schools house a variety of multi-purpose spaces, including the cafeteria or "cafetorium," gymnasium, auditorium and recreation cen-

ter. Flexibility is a key theme in these spaces, as they meet the needs of students during the day and the local community after hours and on weekends. Communities use their local school buildings for a wide variety of needs, including meetings, athletic activities, theatrical performances, concerts, presentations and as polling places. School districts building or retrofitting a K-12 facility should anticipate the full range of functions likely to take place there and incorporate a flexible lighting control system into the design.

Today's building codes, such as ASHRAE/IESNA 90.1, Title 24 or IECC, require some sort of lighting control. The degree of control required by each code varies. In some cases, code compliance might specify A/B switching in a space; in other situations the code might require four zones of passive daylighting with occupancy sensors.

Let's take a walk through a typical school building, room by room, and assess how controls can fit into the design.

General spaces. For general spaces in a school–lobbies, corridors, restrooms, offices, maintenance areas, etc.–there are three important characteristics to consider when designing a lighting control strategy: energy efficiency; life safety/security; and architectural highlights. If a general space is only used at certain times during the day (or sporadically), automated controls such as occupancy sensors can ensure energy savings while the space is unoccupied. Occupancy sensors placed in hallways can be programmed so that fluorescent lights never fully shut off, only dim significantly, when the hallway or corridor is unoccupied so that energy savings are realized while still maintaining the required minimum footcandle level for safety purposes.

In some general spaces, such as parking lots, stadium areas and athletic fields, time-clock control of the lighting is a great strategy to ensure efficiency. Time-clock control can be integrated into the lighting control panel or can stand alone on the system ensuring that lights are turned on/off to a pre-specified level at predetermined times. One of the most common uses of time-clock control is site lighting for parking and exterior areas around the school building. In these cases, most time-clock controls utilize an astronomical time clock that can be programmed to manipulate the light levels based on time of sunrise and sunset, as well the traditional 24-hour schedule.

Architectural highlighting can also influence the lighting control strategy. Time-clock control can incorporate specific lighting control solutions to highlight the architectural features of the school building without sacrificing energy efficiency.

Specialized spaces. Lighting control in specialized spaces–e.g., student commons–helps create architectural detail and ambiance. Student commons have evolved a great deal over the decades and now accommodate a majority of social and educational activities. These areas now serve as a signal of the school's commitment to its students–and they are created to help make students feel comfortable and welcome. As such, the lighting control strategy for the student commons area should include an intuitive manual control that allows the teachers and students to manipulate the light levels based on personal preference and the activity at hand. Additionally, many student commons spaces incorporate a large amount of daylight, as well as shading to control glare. An effective way to maximize the efficiency of the daylit space is to incorporate daylighting controls with the electric lights. Photocells or daylight sensors can compensate for the varying degrees of ambient light in the student commons by switching or dimming the lights down throughout the day so the space is comfortable (not overlit) and is not an unnecessary burden on the school's electric bill.

Multi-purpose spaces. Multi-purpose spaces are the most flexible in the building. They host numerous secondary functions, such as theatrical performances, concerts, presentations and other events. To meet their requirements, school officials must have the ability to completely control the environment–not just lighting, but sound, windows and other technologies that should be integrated. Integration of all these features can be done through dimming and shading interfaces, as well as through traditional preset controls with interfaces that tie into the A/V system.

Classrooms. As classroom/lab spaces have become more dynamic–with computer workstations, traditional instruction, audio/visual systems and interactive white boards–they require greater levels of control. In addition, multiple classrooms can be combined to cre-

Table 1.

Controls For All Spaces

Space	Local Wallbox Control	Window Shades	Time Clock	Occupancy Control	Vacancy Control	Daylight Control	Zone Control	Scene Control	Personal Control	Theatrical Control Interface	
Administrative											
Open Office	X	X	X	X		X			X		
Private Office	X	X			X	X			X		
Classroom											
Interior	X			X	X		X	X			
Perimeter	X	X		X	X	X	X	X			
Exterior Lighting											
Parking			X			X					
Stadium							X	X			
Athletic Fields			X			X	X				
Site Lighting			X			X					
Multi-Purpose											
Auditorium	X	X	X				X	X		X	
Cafeteria		X	X			X					
Cafetorium	X	X	X			X	X	X		X	
Gymnasium			X			X					
Public Spaces											
Corridor	X		X								
Lobby	X	X	X			X					
Restroom				X							
Commons	X	X	X				X	X			

ate a large space for grade-level instruction or multi-class projects. Manual control is the most commonly used classroom lighting control. Traditionally, manual control in the classroom, such as inboard/outboard switching, allows the lights to be turned on or off utilizing a wall control providing three light levels: Full On, Full Off, 50 percent.

Recently, dimming controls have made their way into the classroom space. Dimming allows the teacher to adjust the lighting to a precise level needed for the activity at hand in the classroom. Providing classroom users with access to more than three light levels can not only improve the learning environment by increasing productivity, but dimming can also substantially reduce electricity consumption in the classroom and prolong the life of the lightbulbs.

Occupant sensors are used in many of today's classrooms. Some building codes such ASHRAE/IESNA 90.1-2004 prescribe occupancy sensors in all classroom spaces. Most classroom occupancy sensors employ two technologies to control the lights. The first is passive infrared technology which senses occupancy by detecting the difference between heat emitted from the human body in motion and the background space. The second is ultrasonic technology, which senses occupancy by bouncing ultrasonic sound waves (32KHz-45kHz) off objects in a space and detecting a frequency shift between the emitted and reflected sound waves. Dual-technology occupancy sensors use both passive infrared and ultrasonic technologies for maximum reliability. These sensors minimize the risk of false triggers (lights coming on when the space is unoccupied). Both ultrasonic and passive infrared technologies must detect occupancy to turn on the lighting, while continued detection by only one technology will keep the lighting on.

Daylight sensors (or photo sensors) cause the lights closest to windows to dim or switch off as daylight pouring into the room increases. In most classroom situations, daylight harvesting combined with dimming the fluorescent lighting is ideal because throughout the day it is less distracting than daylight harvesting combined with switching zones. Normally, daylighting applications break the room into three to four zones. Each zone responds differently to the reading that the daylight sensor is taking depending on its programmed required light level. Daylight harvesting is a great way to take advantage of an abundance of natural light in a space from windows, light shelves or skylights, without sacrificing any of the capability of the classroom on days or at times that natural light isn't sufficient.

Ideally, a classroom will use combined control techniques (occupancy control, daylight harvesting and manual control) that offer a blend of automatic and manual control. This allows for the right lighting level for any given task and maximizes energy savings.

Table 1 serves as an example of how one state-of-the-art lighting control system could be set up for a school/campus, addressing a host of different needs.

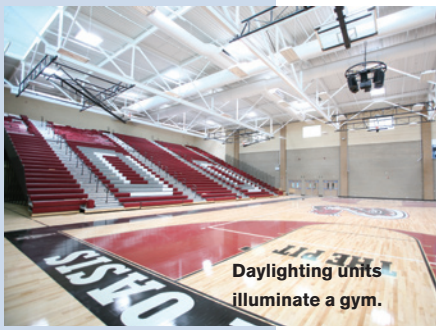
IN ACTION

The Arlington Heights, IL, School District 25 initiated a pilot project by installing a lighting control system in one classroom during the 2007-08 school year. Electricity consumption was reduced by 50 percent without sacrificing the quality of the classroom lighting, reports energy manager Robert Schultz. The lighting is calmer, not as glary and softer, according to the teacher who uses that room.

In Allentown, PA, dimming controls and daylight sensors installed in two classrooms at the 124-year-old Grover Cleveland Elementary School have cut lighting energy by 53 percent. During video presentations, the lights at the front of the classroom are dimmed to reduce glare and improve screen contrast, while a second group of lights positioned above the students remains just bright enough to allow students to see their desks clearly and take notes easily. Daylight sensors measure the amount of natural light entering the room and dim the fluorescent lights accordingly. Greater student attention spans, motivation and attitude seem to be the result. Says principal Robert Wheeler, "The teachers tell me it's now a distraction to use a regular classroom that doesn't have this new technology in it. I can't guarantee any individual student is learning more, but I can guarantee more students are learning."

50 Aces the Test

A score of 50 in school is usually not something to aspire to...unless you're testing footcandle levels. That's the target at Desert Oasis High School in Clark County, NV, which has installed 66 daylighting units in a gymnasium, activity center/cafeteria and five classrooms on the upper level of the two-story building. The 2,400-student school opened in August.



Daylighting units illuminate a gym.

On virtually all school days, the school expects the fluorescent lights to remain off in the areas where the daylighting units are installed. Daylight alone should provide a light level of 50 fc with a CRI of 100.

The SunTracker system was supplied by Ciralight, Park City, UT. Prismatic acrylic units were used, rather than flat skylights, due to the high ceilings (40 ft in the gym and 40 ft in the cafeteria). The shape of the units allows natural light to be more evenly diffused across the room, says Ciralight's Rex Miller. They measure 52.2 in. x 52.2 in. by 26 in. and weigh 58 pounds. The roof opening is 46.5 in. by 46.5 in.

The daylighting units are projected to save the school approximately 95,040 kWh per year, translating to a $7,400 annual saving in energy cost.

—Paul Tarricone

About the Author: Steve Beede is a market development manager for Lutron Electronics Co., Inc., Coopersburg, PA, a designer/manufacturer of lighting controls for residential and commercial applications.