Lighting for Learning

***Barbara Erwine** and **Lisa Heschong** focus on ongoing studies linking daylighting and student performance*

Money spent on K-12 school buildings is at its highest levels ever: Over $20 billion was spent on new construction, additions and renovation completed in 2001. This expenditure is 20 percent higher than it was two years earlier, an expansion that is being driven by increasing public school enrollment. The number of public school students in grades K-12 rose from 41 to 47 million students between 1990 and 2001, and enrollment is expected to set new records every year until 2005. Certain districts are growing especially rapidly. California, Arizona, and New Mexico are expected to have their school-age populations increase by more than 10 percent between 1998 and 2008, while Texas and Virginia are expected to increase by 5 to 10 percent. With an average of two new K-12 school buildings being started on each business day, the market for school lighting installations is robust and expanding.

The lighting designer should be aware of new trends in K-12 education, which will impact lighting design, including increased use of advanced visual display devices, such as flat screen computer monitors, calculators, and computer projectors; use of low-glare white or gray boards for the teaching wall; multi-use of classroom spaces for community and other functions; an increased push for

energy efficiency; and inclusion of daylight into the classroom environment. Furthermore, a need for low initial costs and simplicity of operation and maintenance are almost always constraints in educational design.

Sometimes the demands on the lighting system to support these needs may seem to conflict; but the smart lighting designer can take advantage of new technologies and lighting design

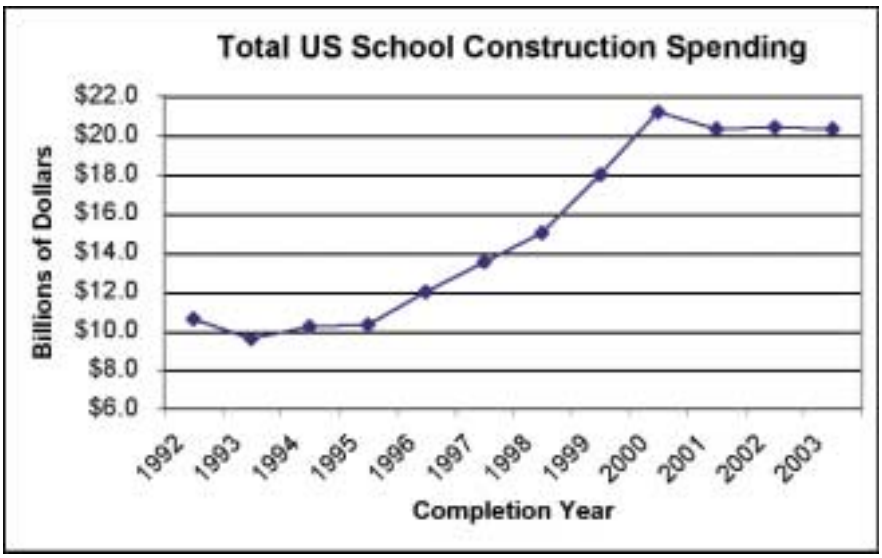
analysis tools to integrate all of these needs into a efficient, flexible and economical system.

Perhaps the most significant recent shift in educational design has been a demand for inclusion of daylight into the design of classrooms. In the past, a number of trends pushed for fewer and darker tinted windows, until daylight was essentially excluded from most classrooms. Proponents of energy efficiency tended to view windows and skylights as net energy losers. But that is because they were only considering thermal impact, not lighting impact. Smaller, more isolated windows also came to be seen as sources of glare, rather than providers of ambient light. Thus, dark glazing tints became popular as a way to reduce both glare and solar heat gain. Often, windows were reduced or removed during classroom renovations in the name of energy efficiency and modernization.

However, there are two important reasons there is a new push for extensive use of daylight in classrooms. The first is energy savings from turning off the electric lights. Since most K-12 classrooms operate during the daytime, with good daylighting design the electric lights can be turned off for most, if not all, of the school day. This provides both reduced elec-

tricity use by the lights and can also reduce the cooling loads generated by internal heat gains in the classroom by about 25 percent.

The second, and even more forceful, reason that has emerged for inclusion of daylight in classrooms comes from a set of recent studies that have shown that the presence of daylight is associated with improved student academic performance. An analysis by the Heschong Mahone Group studied elementary school students in districts from three different states: California, Washington, and Colorado. Although each district had different curriculums, building designs, and climates, students were found to perform significantly better on standardized tests in classrooms where windows and skylights let more daylight in the classroom. In the California district, where test data was available for comparing scores from the beginning and end of the school year, it was shown that, after controlling for a variety demographic and educational variables, students in the most daylit classrooms improved 20 percent in math and 26 percent in reading than the students in classrooms with the least daylight. A re-analysis of this study, completed in February 2002, sought to discover whether better teachers were being assigned to more daylit classrooms and also searched for differing effects by grade level. New information was added about teacher characteristics to the original data set. No teacher bias or grade level effect was found. The re-analysis only reinforced the robustness of the initial results and emphasized the power of the daylight variables. A similar, though smaller, study in North Carolina also found improved student performance associated with daylit classrooms in both elementary and middle schools. These and other studies have motivated the U.S. Department of Education and many state departments of education to strongly encourage the use of daylight in the design of new school buildings.



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Daylit classrooms are likely to have different spatial configurations from non-daylight classrooms that will change the parameters of standard classroom lighting design. Ceilings are likely to be substantially higher. The luminaires, layout and circuiting should be chosen to specifically supplement the daylight illumination patterns, while also providing full illumination needs at night. The energy savings payoff from daylight requires simple, reliable control strategies. These can be either manual or automatic, but must be intuitively easy for teachers to understand and use, and maintenance personnel to reset or repair.

Thus, the lighting designer is faced with a new set of challenges—meeting the needs of all the new visual task conditions created by visual display devices, providing for flexibility of use over time and space, saving energy, complementing daylight—along with the standard educational needs for uniform vertical surface illumination, minimizing glare, and a low cost, low maintenance system. The common theme in most successful solutions is likely to be the use of high efficiency, low glare luminaires combined with advanced lighting controls that can respond to changing daylight conditions, visual task needs, and usage patterns over time and space.

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