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Predicting Daylighting

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How do you know what you are going to get?

Architects and engineers are increasingly using daylighting strategies in the educational environments they design to both save energy and create more comfortable environments for students and faculty.

The positive effects of daylighting on educational environments have been widely publicized. Studies by Heschong Mahone Group have connected the availability of natural light to student achievement, and many environmental codes and sustainability criteria are now requiring that student-occupied spaces be supplied with a minimum level of natural lighting.

Windows, translucent panels, clerestories, skylights and light tubes are all used to introduce natural light into interior spaces; however, daylighting is really aimed at providing a useful amount of light that will adequately illuminate the tasks to be performed in the spaces being lighted.

The presence of natural light alone does not constitute beneficial daylighting since natural light can be challenging to the performance of some tasks if not properly designed. For the introduction of natural light to become a daylighting strategy, the light needs to be controlled. The overall intensity of light must not be too bright. Glare must be controlled, as must contrast. And the daylight in the

room must be balanced across the room. Windows on one side of the room rarely allow for balanced daylighting. Daylight must be coordinated with artificial light either automatically or manually, and the use of projection equipment must be taken into consideration.

The most economical daylighting strategies require that the users of a space participate in controlling their lighting environment, and even with automatic controls, occupants must become accustomed to the quantity and quality of daylight in their environment. Critical to the effectiveness of daylighting strategies is a user commitment to energy conservation.

Many designers formulate daylighting strategies using qualitative analysis with good results. At Mt. View Elementary School in Seattle, Wash., physical models studied on a heliodon helped

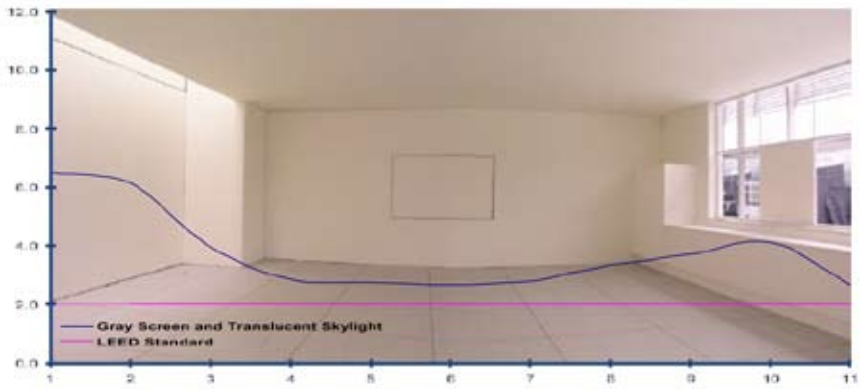
This heliodon model of Mt. View Elementary School was used by designers to formulate daylighting strategies. The physical models studied on a heliodon helped to define appropriate sun control for windows and placement of interior light shelves to let daylight reach into rooms.

to define appropriate sun control for windows and placement of interior light shelves to let daylight reach into rooms. Similarly, translucent skylights in gymnasiums are becoming more common because they provide uniform light without glare. Architectural rendering programs allow designers to perform shadow studies and better understand how light will enter buildings. This modeling is useful for understanding general effects but is not quantitatively predictive.

A physical model was built to simulate a classroom, and then various configurations of sun screens, reflectors and light wells — positioned across from windows — were tested to determine how well they would meet the U.S. Green Building Council's LEED criteria for benchmarking effective daylight strategies.

The next step is combining qualitative modeling with quantitative measurement of daylighting effects. At Wilson High School in Tacoma, Wash., this technique was used to model classrooms. A physical model was built to simulate a classroom, and then various configurations of sun screens, reflectors and light wells — positioned across from windows — were tested to determine how well they would meet the U.S. Green Building Council's LEED criteria for benchmarking effective daylight strategies.

The results identified strategies that met the criteria, but the model could not test every point in the room, only a sampling of points. Additionally, since the model surfaces' reflectivity, which affects the results, could not be perfectly replicated, the model was not a true analogue for the conditions found in the constructed project. The model also could not reproduce the reflective and shadowing effects of surrounding buildings. Nevertheless, users report



The images above show models that were used to predict the amount of natural daylight that would be provided. At the top, is a Mt. View Elementary School model interior on heliodon. The center images are the Wilson High School model on heliodon, representing various angles to mimic movement of the sun and seasonal changes in daylight. The bottom image is a Wilson High School classroom model that was used for light measurement.

that daylighting in the building works very well, producing comfortable, balanced lighting on both north and south exposures of the building, and allowing less use of artificial lights.

With more codes requiring specific daylighting performance, quantitative predictions are becoming more important. LEED offers a calculation approach to predicting daylighting, but mathematical abstractions are not as useful to designers as are visual tools. There are a plethora of programs that predict lighting results, and new ones are being developed all the time. In an effort to determine the accuracy of some of these programs, we have begun to measure the results of our daylighting efforts in the completed buildings and compare those to predictions from models and computer programs.

The results vary considerably. Reasons for this could include how data was entered or measured, assumptions on reflectivity of surfaces both inside and outside of the room, textures and contents of the actual room and the characteristics of each individual program.

We plan to continue studying results for additional projects and plan to publish these findings detailing our methodology so that others can compare their results. What we can say for now is that the tools for predicting daylighting results are continuing to evolve and improve. We believe that daylighting is an effective tool for improving the quality of educational environments and should be seriously considered for educational projects. SPM

A classroom in the Wilson High School takes advantage of natural light by means of a lighting shelf. Models and calculations were used to predict the amount of light this approach would provide.

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