Sweet SPOT™ for Daylighting

The Problem

Daylighting systems, which use natural lighting to supplement electric lighting, can cut energy use, reduce peak demand, and create a more desirable indoor environment, yet these systems often fail to live up to their potential. One reason is that although they are sensitive to photosensor placement and performance, there have been no easy tools to help designers predict performance and determine optimum sensor positioning and settings.

The Solution

The Sensor Placement and Optimization Tool (SPOT™) is a free software package that helps designers analyze electric lighting and annual daylighting conditions and establish correct photosensor placement and settings. It then analyzes and predicts overall system performance prior to field installation and commissioning. SPOT has been validated against experimental data and results from other validated daylighting models. The latest release of the software, version 4.0—which won the Most Innovative Product of the Year award at the 2008 LightFair™ International Trade Show and Conference—adds a number of capabilities including a database of photosensor performance information.

Features and Benefits

Anyone familiar with Microsoft Excel can use SPOT—the user interface is an Excel worksheet. Most of the calculations use a sophisticated daylighting software program known as Radiance but are invisible to the user. Based on user input, the tool calculates nighttime illumination levels and the range of daylight contribution throughout the year. Advanced users can also access Radiance to further customize the calculations.

Input and analysis options enable SPOT to account for many variables.

Project information. To start a project, the user sets the project name and the performance measurement units to be used.

Options. The SPOT user has options to direct the program to create renderings, include a variety of shading devices, set reflectivity and rotation angles of blinds, and specify the types of light shelves to be analyzed.

Geometry input. The user defines the room geometry, window placement, and electric lighting layout for a space. The program lets the user define reflectances of all surfaces in the space and ground outside and specify any overhangs, light shelves, blinds, or window shades to be considered for shading. For electric lighting, the user can define the type of luminaire to be used.

Site and usage. The user can define the location of the building, set schedules for occupancy, and establish the desired control strategy for any window-shading devices. Weekly and annual schedules are accommodated.

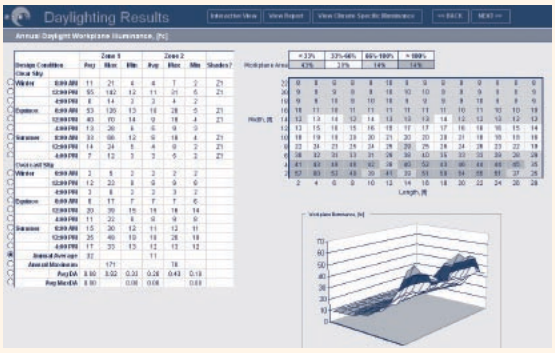
Design tools. Once the project has been fully specified, the software moves into the design phase, which uses the geometry and site information to report three sets of information back to the user: electric lighting performance under nighttime conditions, annual daylighting performance under a sampling of conditions (**Figure 1**), and photosensor placement recommendations for each luminaire zone.

Analysis. The analysis portion allows the user to apply various photosensor placements to the luminaire zones, adjust the photosensor system settings, and run annual performance calculations. Users can mix and match the various photosensor scenarios they defined and analyze how they will perform under a larger set of representative days and sky conditions with the Photosensor Analyzer tool. They can run a more accurate analysis of the photosensor system with the Annual Analysis tool, which accounts for climate conditions, schedules, and the time of day. In addition, a DOE-2 output function has been added, which enables the output from SPOT to be fed into a whole-building energy analysis.

Photosensor data. A database of spatial, spectral, and power curves for products from specific photosensor manufacturers is included. The information is based on the 2007 National

Figure 1: Daylighting results

This output screen from SPOT shows workplane illumination levels as they vary in the course of a day and throughout the year.



Lighting Product Information Program (NLPIP) *Specifier Report: Photosensors* by the Lighting Research Center. The Version 4.0 software also produces commissioning reports for each photosensor system in use for field implementation.

Applications

SPOT was developed for classrooms, but it also may be applied to other spaces, including offices. The software handles top- and side-daylight sources and can model any electric lighting source from Illuminating Engineering Society files. To install SPOT, users must have Windows 2000, NT, or XP; Excel 2000 or higher; an 800-megahertz processor; and 128 megabytes of available disk space.

California Codes and Standards

SPOT helps designers comply with the daylighting requirements in California's Title 24 energy code, which requires separate controls for daylit areas and offers energy budget credits for automatic daylighting controls. The 2005 version of the code favors measures such as daylighting that save energy during periods of likely peak demand. It also now requires skylights with daylighting controls for the top story of spaces larger than 25,000 square feet that have ceilings higher than 15 feet.

SPOT also helps designers comply with Collaborative for High Performance Schools (CHPS) and Leadership in Energy and Environmental Design (LEED™) criteria. The user first selects a target program: CHPS-California, CHPS-Massachusetts/ New York, or LEED. Next, analyses of metrics such as daylight factor and the newer, more dynamic metrics developed for the CHPS program—Daylight Autonomy, Single Point in Time, and Daylight Saturation Percentage—are performed for the user-defined lighting design. Finally, reports of the analyses are generated (**Figure 2**) and, if the lighting design meets the criteria, can be used as evidence of CHPS or LEED compliance.

What's Next

Improvements to SPOT are planned. For example, the current version only allows the input of simple, right-angled space geometries. Future versions may allow more complex geometry to be modeled in other computer-aided design packages and imported into the program. Future versions also may integrate validated skylight candlepower distribution data and include additional control algorithms such as modeling of photosensors with sliding set points. Other goals include continued training of users, encouraging widespread use of the free software for current design professionals and as a teaching tool for the next generation, and ongoing validation activities.

Collaborators

Architectural Energy Corp. developed SPOT with funding from the Public Interest Energy Research (PIER) Program. Support also has been provided by Energy Design Resources, administered by Southern California Edison and Pacific Gas and Electric Company, and by the Northwest Energy Efficiency Alliance.

For More Information

For more information on this project, contact the California Energy Commission researcher listed below.

The software may be downloaded at www.archenergy.com/SPOT. A user forum is available at http://community.archenergy.com/mailman/listinfo/spot.

Contacts

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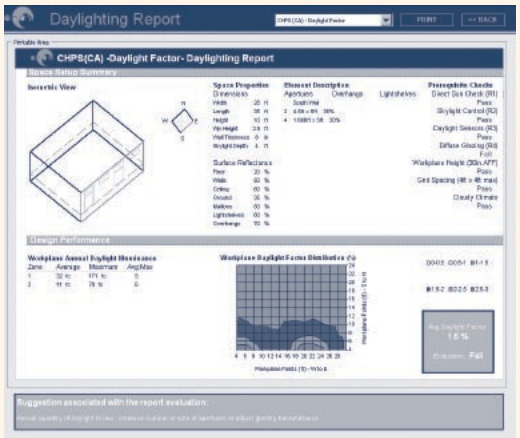
California Energy Commission, Michael Seaman, mseaman@energy.state.ca.us, 916-654-4981, or visit www.energy.ca.gov/pier/buildings.

Figure 2: The CHPS Daylight Factor report

SPOT generates reports like this one to show compliance with California's Collaborative for High Performance Schools (CHPS) rating system.



About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) Program. PIER supports public interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

Arnold Schwarzenegger, *Governor* **For more information see** www.energy.ca.gov/pier

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