# *SPOT*: Sensor, Placement and Orientation Tool

The Public Interest Energy Research (PIER) group has created a Lighting Research Program (LRP) to improve the energy efficiency of lighting-related equipment and lighting design. One element of this project involves the creation of software tools that will aid the newly developed energy-efficient lighting equipment in getting accepted into general lighting practices and penetrate the market. Architectural Energy Corporation (AEC) is responsible for the creation of these tools under PIER Project 6.2. This document summarizes the conceptual proposal for the development of two design tools to assist photosensor system design. Refinement of the scope will occur during software development and will be responsive to schedule and budget limitations.

## Project Overview

Preliminary research identified the photosensor system technology being used in Pier Project 3.3 - classroom photosensor system, researched by Doug Paton of Watt Stopper, as the leading candidate for the creation of a design tool. The goal of Project 3.3 is to develop a photosensor lighting control system that is optimized for common classroom electric lighting solutions (recessed and pendant lighting) and daylighting configurations (side-lighting only, top-lighting only, side- and top-lighting). An optimized system maximizes energy savings while ensuring adequate light levels are provided at all times. In addition, an optimized system can be simply and easily commissioned and operated effectively in conjunction with manual controls and occupancy sensors.

According to research performed by the LRP 3.3 Project Team, the use of photosensor controls is limited in current classroom construction practices. In many schools dimming or lighting controls are viewed as too expensive. In schools where daylight harvesting is considered, photosensor controls are often value-engineered out of the design near the end of the project. The ready acceptance of this value-engineering decision to eliminate the photosensors is due, in part, to the general perception of the industry that photosensors are difficult to successfully integrate into a project. Several generations of photosensors with spotty performance records along with poor photosensor system design have left many design professionals as well as building owners with little confidence in the effectiveness of these systems, and worse yet, with the feeling that the performance might be problematic for the occupants.

Recent strides have been made by the industry to improve the reliability and effectiveness of photosensor performance. Current obstacles to successful photosensor system operation involve improper design and implementation (as well as cost) rather than unreliable photosensor

performance. While proper implementation of photosensor systems depends partly on correct application of the photosensor sensitivity (spectral and spatial) characteristics, it also depends largely on the photosensor placement relative to the daylighting and electric lighting design of a given classroom. Factors such as surface reflectance, window orientation, wall coverings and desk layouts affect optimal photosensor placement. Given the variability in optimal photosensor placement, the need for a software tool that assists in placement is apparent and could prove extremely valuable in furthering market acceptance of photosensor systems. Earlier surveys of lighting design professionals confirmed that the industry has a real need for a design tool that can analyze and assist in the successful implementation of lighting controls.

Under the PIER LRP Project 6.2, AEC intends to create two design tools, contained in the software package, *SPOT—Sensor Placement Orientation Tool*. The AEC Project 6.2 team consists of Architects, Engineers, and Software Programmers. Caroline Clevenger is managing Project 6.2, which encompasses all new energy efficient technology. Zack Rogers is managing the photosensor system software tool development outlined in this memorandum. A Technical Advisory Group (TAG) has been created to provide review and feedback from experts within the industry on the development of this photosensor system design and analysis software program. The team consists of various professionals involved in the lighting field.

## Program Concept

The goal of the software tool, *SPOT*, is to assist in the proper implementation of photosensor electric lighting control systems by providing guidance and analysis for classroom specific photosensor system design. It is comprised of two tools: a design tool and an analysis tool. The design portion of the program will provide recommendations for optimal photosensor placement, photosensor type, photosensor aiming and electric lighting zoning. The analysis portion of the program will perform simulations and provide annual energy savings and lighting performance information.

The program consists of a user interface on top of a Radiance calculation engine. The first phase of software development will consist of a thorough examination of automating of the Radiance engine, and testing its speed and effectiveness in performing daylighting calculations “behind the scenes.” Radiance will rely on previously developed program modules such as “mksens,” “psens,” and “Daydim,” to perform the daylight calculations. Once the successful execution and serviceability of the underlying Radiance engine and associated modules has been established, the user interface for *SPOT* will be developed.

The ultimate goal for the program is to provide viable design solutions for the rather complex problem of photosensor system design. The program will use a simple, user-friendly interface with known inputs and provide specific design directives to the designer. To be effective and

successful in penetrating the market, however, the tool should be accepted and commonly used by a number of industry professionals. The tool, therefore, needs to be simple, flexible and yet capable of handling complex design issues. To accomplish this, the program will provide several levels of sophistication: a simplified scenario where only the most necessary and simplified inputs are required and more complex scenarios where complex CAD geometry can be imported and the space can be defined in more detail.

For widespread industry acceptance, *SPOT*, will need to cater to parties in all stages of electric lighting, daylighting, and lighting control system design and implementation. Hence, the target audience for the software tool will be broad and will include daylighting and lighting designers, lighting manufacturers, lighting product representatives, as well as architects, electrical engineers and electrical contractors. Ideally, photosenor system analysis, design and layout occurs during the design of the building. In reality, the placement and setup of photosensor systems is often left to the contractor during installation. The design portion of the photosensor tool (ie. the determination of critical points), therefore, should be accessible to a wide range of professionals. An example of a software option to be explored at a later date includes making the software compatible with handheld PDAs for use by installers in the field. The current basic software application requirements may be limited by available time and budget. Given limited funding, necessary elements (the elements required for accurate and useful calculations and for a user friendly interface) will be given top priority and more complex features and details will be given secondary priority. In general, the software will be designed with the full feature set in mind. Plans are to distribute the software as freeware available for download by all interested parties on the Web.