Light Scoops

A Design Guide

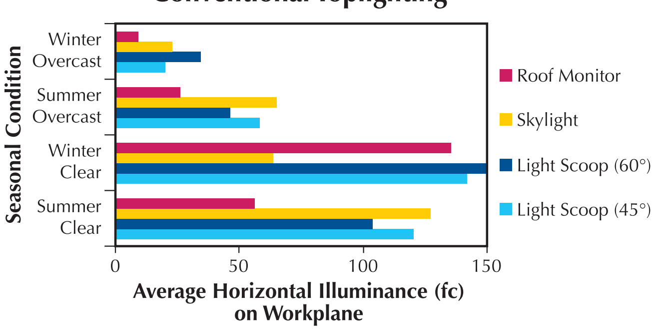
What is a Light Scoop?

A light scoop is a south-facing skylight, developed by the Lighting Research Center (LRC) that uses tilted panels of transparent glass to strategically bring daylight into an interior space. Light scoops allow direct sunlight penetration into a space; this is most appropriate in spaces such as lobbies, shopping malls, and airports, where occupants briefly move through the space. Light scoops offer advantages over conventional horizontal skylights because they provide less light in summer, when direct sunlight can be less desirable, and more light in winter, when direct sunlight is desirable. This also has implications for heating and cooling.

Why Use Light Scoops?

Light scoops are best used in predominantly overcast climates. The tilted, transparent glazing (glass) provides an optimal balance of daylight under both sunny and overcast conditions. In overcast conditions, a light scoop receives light from the brightest part of the sky (zenith). On rare sunny days, the clear glazing maximizes direct sunlight at a time of year when it is most welcome and the tilted glazing receives more sun in winter than vertical or horizontal glazing.

Light Scoop vs. Conventional Toplighting



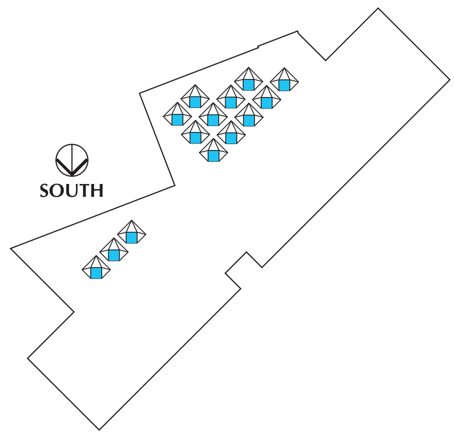
The graph (left) compares performance in upstate New York of four different types of top lighting designs, each with clear glazing of the same visible transmittance and area. These include roof monitors with vertical glazing, horizontal skylights, and two light scoops with glazing mounted at 45° and 60° from horizontal. In the winter, under clear sky conditions, both light scoops and the roof monitor produce higher light levels relative to summer compared to the skylight. Based on their overall performance, this graph shows that light scoops are the optimal choice to bring in daylight year-round, under both clear and overcast skies.

Using light scoops and daylight harvesting controls, electric lights can be turned off or dimmed when adequate daylight is available, thus saving energy and operating costs.

How to Design Light Scoops

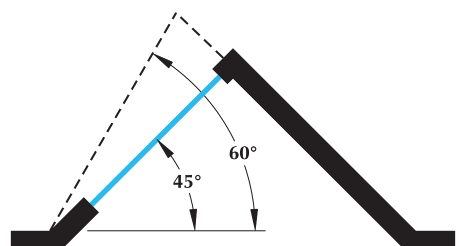
Light scoops must face south in the Northern Hemisphere. Many buildings are not oriented to the cardinal directions, and light scoops must be custom-designed for each site, in collaboration with the architect and the engineering team. As shown in the photo and plan view at right, light scoops may need to be oriented diagonally from the column grid.

Designing a light scoop is an iterative endeavor; each of the following primary features and refinements impact the amount of light collected, and may also impact construction costs.



Primary feature: Angle

The LRC recommends investigating both 45° and 60° angles of glazing for northern latitudes 42° to 50°. For other latitudes, other angles might provide the optimized solution for a light scoop.

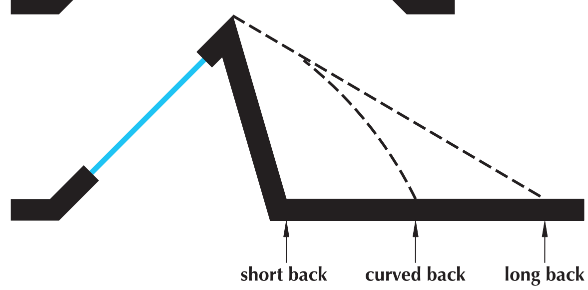


Primary feature: Glazing area

The glazing area of light scoops should be designed to meet the target light levels in the building under average conditions (e.g., at noon on the equinox). This minimizes over-lighting and over-heating and allows electric lights to be dimmed or switched for energy savings. If the designer wishes to pursue a more aggressive daylighting strategy, the light scoops could be designed to meet target light levels at 10 a.m. in December. To increase illuminance, the amount of the glazing area could also be increased. This can be accomplished by increasing the size of individual light scoops, or increasing the quantity of light scoops.

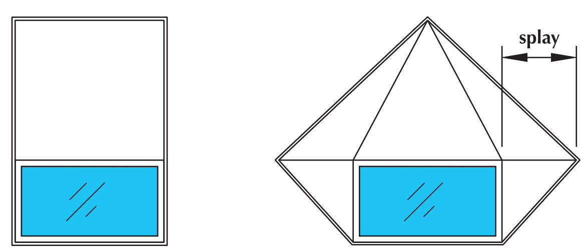
Refinement: Back

The back of the light scoop could have a variety of profiles, all of which impact the amount of light entering the space (see figure at right and graph on the following page).



Refinement: Sides

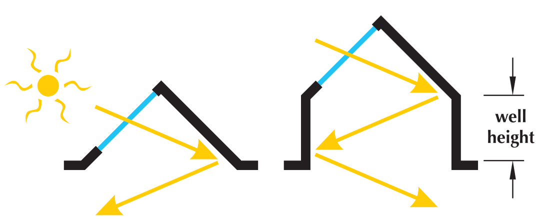
To increase daylight penetration into the space below, under both clear and overcast skies, the sides of the light scoop can be splayed to minimize interreflections. This creates a larger opening in the roof as well as triangular facets that may impact the construction budget.

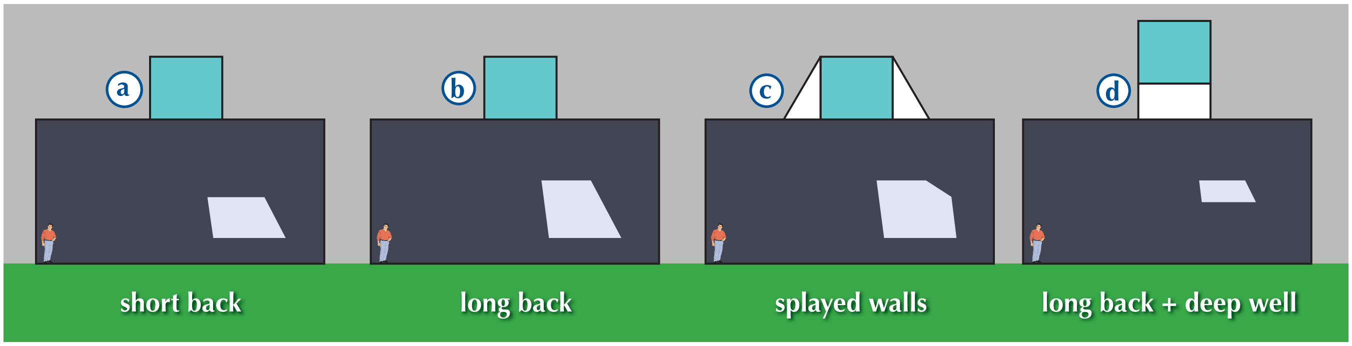


simple (plan) splayed walls (plan)

Refinement: Height

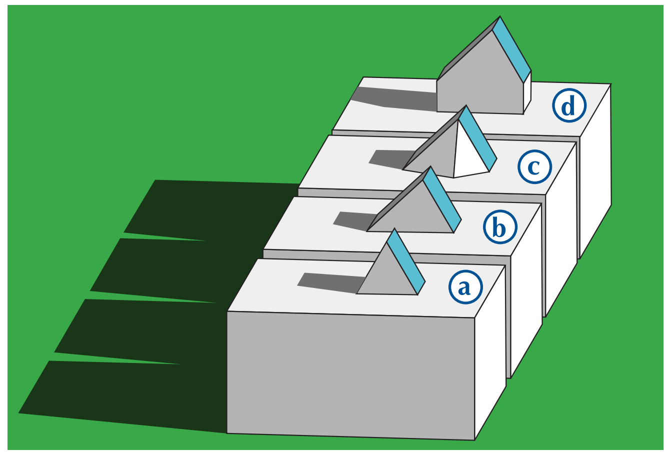
To minimize light interreflection, absorption, and cost, light scoops' well height should be minimized.



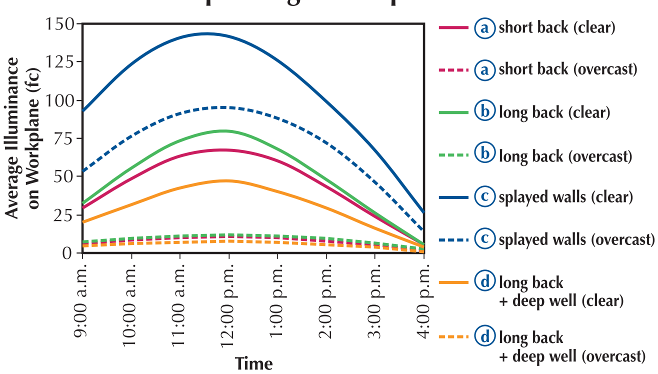


These features should be modeled iteratively using software tools that simulate sun angles over time[1] to investigate where the sun patches fall in the space over the course of a year.

Light scoops should be modeled in photometrically-accurate lighting software[2] to predict light levels in the room. At a minimum, simulations should be calculated for clear and overcast skies, under average conditions (e.g., March 21 or September 21) and extreme conditions (e.g., June 21 and December 21). As shown below, on a winter day in Albany, NY, the light scoop with splayed walls clearly performs better than the other refinement options.



Using Software Simulations*
to Compare Light Scoop Refinements



* Simulating December 21 for a site in Albany, NY

Also consider: Glass specification

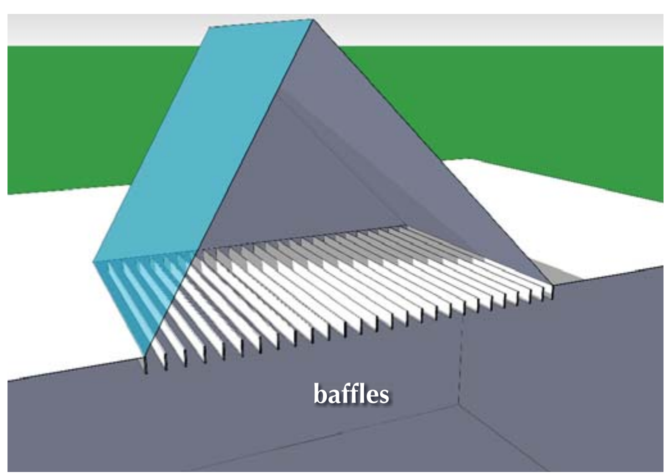
High visible-transmittance glazing should be specified to minimize the amount of glazing required. To minimize solar heat gain, specifiers should look for glazing that has a light-to-solar gain (LSG) ratio of 1.0 or higher. This ensures that the glazing brings in a higher percentage of visible light than infrared (heat) energy.

Also consider: White color

Light colored finishes for the light scoop interior and roof membrane should be used to increase the light scoop efficiency.

After modeling, consider: Adjacent spaces

Direct sunlight should be prevented from penetrating any space where is it not desired. This may be achieved by changing the sunlight angle between the glazing and the bottom of the light scoop (e.g., adding a well or baffles per image at right), or by changing the placement of the light scoop so that adjacent spaces are not impacted by direct sunlight.



[1] For the project shown here, the LRC used Google SketchUp with *shadow settings* function.

[2] Such as AGi32 (Lighting Analysts, Littleton, CO).

Light Scoop Evaluation

In 2012, 14 light scoops were installed on an expansion of a corporate headquarters in Skaneateles, NY. They were installed over a two-story lobby space, as well as over a corridor passageway.

The LRC took light level readings in the fall and winter to compare actual light scoop performance to the software predictions. Under partly cloudy skies, the measured illuminance varied only 5%-25% from the software predictions. This range of variation is expected because sky conditions, surface reflectances, internal obstructions, and dirt depreciation at the site are unlikely to precisely match the software inputs. The site measurements confirmed the software prediction that lighting levels in December were not significantly lower than in September.

Several months after the light scoops were installed, 48 occupants completed a survey. As shown at right, approximately 75% of staff notice the sun and therefore feel connected to the outside environment. Almost 90% "Like" or "Strongly Like" seeing sun patches in the lobby. A few people mentioned that they do not like sitting in sun patches, but the sun was considered a benefit for most respondents.

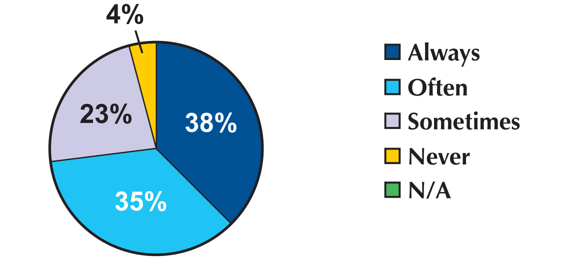
"Sometimes I like to take a mental break, sitting in the sun."

"Sometimes, in the morning, by the fountain, the sun gets in your eyes and you can't see."

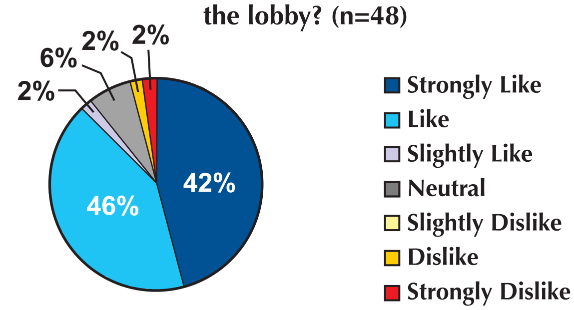
"I just LOVE to have sun, especially with the way it used to be (before renovation)."

"It's very relaxing. Good for informal meetings."

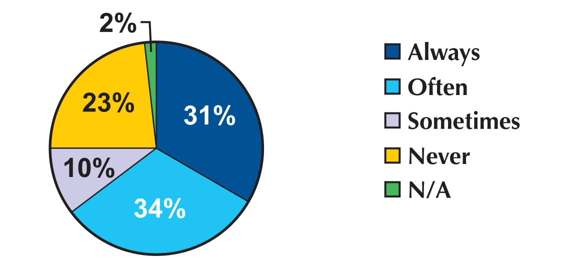
How often do you notice patches of sun in the lobby? (n=48)



Do you LIKE the patches of sun in the lobby? (n=48)



Do patches of sun make you feel connected to the out-of-doors? (n=48)



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Sponsor: New York State Energy Research and Development Authority (NYSERDA)

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