

# designing with daylight

Chris Herman

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Large windows such as these provide an abundance of natural light during the day.

Daylighting is the art and science of using natural light to illuminate indoor spaces. It saves energy, and can make living and working areas more attractive and comfortable. Daylighting in homes is typically accomplished using windows, translucent doors, skylights, light pipes (tubular skylights), and clerestories. A well-designed daylit home on a sunny lot can get by without any electric lighting between dawn and dusk.

## *Benefits*

Daylight is sunlight that is direct or reflected. Sunshine provides us with vitamin D, and also combats seasonal affective disorder, or winter depression. Natural light doesn't change the character of colors the way artificial lights can and, with its subtly changing intensity, daylight is much more interesting. It can make us feel more connected to nature and supports our natural biological rhythms, which contribute to restful sleep.

Using sunlight in your home can decrease heating and cooling loads through passive solar design techniques, as well as eliminate most lighting needs during the day. Its use has been proven, in commercial settings and schools, to decrease absenteeism and increase productivity and test scores. Also, people who work in naturally lit buildings report a sense of well-being.

## *System Types*

When daylighting design is done properly, its goals are easily realized. When it's not, glare, overheating, and

increased energy use for artificial lighting, heating, and cooling can result. The guidelines that follow can help you achieve your daylighting goals with ease.

**Windows.** Windows are the most common daylighting tool. Natural light is mandated for homes built under the International Residential Code, and windows also fulfill requirements for natural ventilation and emergency exits.

Glazing recommendations and percentages vary by climate. There are many kinds of glass and coatings, so you can tailor your choices to your climate's demands. In the Pacific Northwest, double-glazing is required by code, and low-E coatings, which selectively filter the sun's energy and reduce radiant heat loss, are recommended. In the summer, low-E<sup>2</sup> coatings let in visible sunlight, while blocking ultraviolet rays and infrared solar energy, helping to decrease cooling costs. In the winter, these coatings can help reduce heating costs by reflecting room-side heat back into the room.

For south-facing windows in climates with heating loads, a solar heat gain coefficient (SHGC) of 0.76 or greater is recommended. This can be achieved with hard-coat low-E or clear glazing. SHGC is expressed as a number between 0 and 1. The lower a window's SHGC, the less solar heat it transmits. Large west-facing windows should be coated with low-E-squared (SHGC less than 0.6) to prevent



**Well-placed skylights can be useful in achieving daylighting design goals.**

**Cliff and Nancy Herman (the author's parents) enjoy the diffuse natural light of this clerestory.**



Photo by Chris Herman, Winter Sun Design

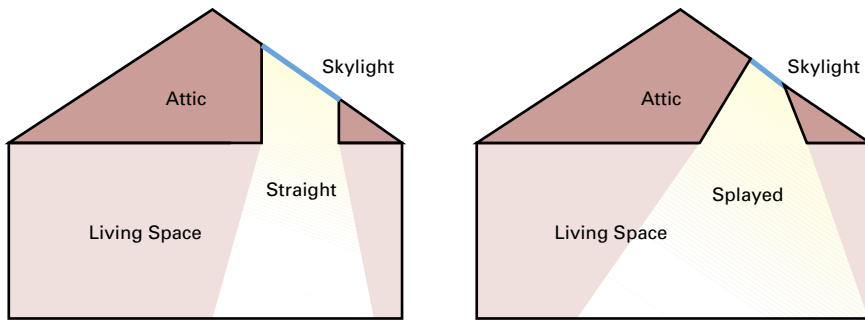
overheating the home. In hot climates where cooling loads dominate, select windows with a SHGC of 0.5 or below, and size overhangs appropriately.

In an energy-efficient home, window area should be equal to no more than 25 percent of the home's floor area, and half of that glass should be located on the south side, if shading is not a factor. In the winter, windows in a house are much more vulnerable to heat loss than walls. Closing blinds can help stop the radiant loss, and using insulating curtains can reduce conductive and convective losses significantly. Just be sure that night insulation fits snugly in the window frame. Curtains with open valances can actually increase heat loss from a window by setting up a convective loop—the cold air against the glass falls to the floor and pulls warm air from the ceiling to replace it.

**Skylights.** Skylights and roof windows are used extensively to bring overhead light into areas in the middle of the home (hallways and closets), where privacy is needed (bathrooms), or where accessible wall space is limited (kitchens). People also like them for sky gazing, and operable units aid natural convective cooling, helping to flush heat from a home's interior.

Skylights are helpful if used very sparingly. Problems can occur with overheating the home in the summer, when the sun is high. And even a north-facing skylight on a low-pitched roof or in northern latitudes will admit heat. Shading a skylight should be done from the outside, with greenhouse shade cloth. Blinds inside skylights don't stop the heat gain effectively and can actually damage the seals of the insulated glass units by increasing heat in the air space between the panes of glass.

## Straight vs. Splayed Skylight Well



**A smaller skylight paired with a splayed lightwell (right) can provide the same amount of light, with fewer thermal disadvantages.**

Skylights also lose lots of heat in the winter. Compared to a code-compliant roof that's insulated to R-30 or R-38, skylights are big losers. The warmest air in the home ends up against the skylight's glass, which has only a minimal insulating capacity between R-2 and R-3. In this case, smaller is better: Instead of buying a skylight that measures 2 by 4 feet (61 x 122 cm), consider installing a 2- by 2-foot unit and splaying the light well (see illustration above).

**Light pipes.** Light pipes (also known as tubular skylights and light tubes) are inside-mirrored "stovepipes" capped with a clear plastic dome that admits sunlight. A special lens on the bottom of the tube helps spread out the light. Transmitted light enters the room through a ceiling fixture that is virtually indistinguishable from a conventional light fixture. Light tubes fit easily between roof framing members, admit little heat gain during the summer, limit heat loss in the winter, and don't transmit glare. Well suited for kitchens, bathrooms, closets, hallways, and stairwells, they can even be ordered with an electric light or an exhaust fan. Unlike skylights, light tubes don't collect dirt you see when you look up. Of course, you also can't look up and see the blue sky or a full moon through them.

**Clerestories.** Clerestory windows are placed on an outside wall that rises above an adjoining roof. They are an effective way of supplying diffused light to a building's interior. With their vertical orientation, they stay much cleaner than skylights, and may be left open during mild rain showers. Awning windows are preferred for ease of operation and rain-shedding ability.

A light-colored roof in front of the clerestory bounces more light into the windows, and light-colored walls inside the home increase their effectiveness. Clerestories can transmit glare with low winter sun angles, and can admit unwanted heat during the

spring and fall. Translucent curtains hung over the windows can mitigate this seasonal glare, and north-facing openings deliver a low but constant source of sunlight with little or no glare.

South-facing clerestory windows can help passive solar heating in the winter. In the summer, a fixed overhang can prevent heat gain through the windows. Vaulted ceilings associated with clerestories contribute to temperature stratification (warm air up high; cold air down low). For increased winter comfort, a ceiling fan placed in the clerestory roof can push warm air down into the rooms. In the summer, operable windows allow

natural convective cooling by helping exhaust hot air that accumulates at ceiling level.

### Design Tips

Designing a daylit home can be very simple. In most regions, provide a long south wall of windows and locate the main living spaces along the south side to take advantage of direct solar gain in the wintertime. In the summer, adequately deep, fixed overhangs will block heat gain but still allow indirect light to enter the windows.

First, arrange rooms based on your preferences. Morning people tend to like their bedrooms located in the southeast corner of a home. Kitchen and breakfast rooms may compete for that corner. Night folks usually don't mind a bedroom on the west; by the time they retire, the room will have cooled off. Artists, especially painters, usually locate their studios on a home's north side to take advantage of the uniformity of northern light.

**A row of clerestory windows on this home in Shoreline, Washington, provides ventilation and admits additional daylight into the home's interior.**



Photo by Chris Herman, Winter Sun Design

Next, select your daylighting strategies. Start with windows for almost every room. Consider light, heat gain, ventilation, views, aesthetics, and emergency exits when making your choices of window sizes and types. Add a clerestory for overhead, private light; increased ventilation; and desirable heat gain. A small operable skylight with a flared light well can provide sky-gazing opportunities and overhead light, with privacy and increased ventilation. Light pipes are a great choice for naturally lighting small interior spaces and dark corners.

Daylight is extremely variable in intensity and duration, changing throughout the day and year. These characteristics can make it challenging to deliver consistent lighting. Light sensors can control artificial light sources, on dimmers, to maintain minimum light levels.

Glare is a potential problem for many systems. Controlling reflected sun by using light shelves (interior “overhangs”) or wide windowsills is effective, and using sheer fabrics to filter incoming light can also help.

Living with natural light helps us feel less isolated from nature, and being indoors seems more like a temporary condition, rather than a permanent sentence. With thoughtful daylighting design incorporated into your home, you’ll find that from dawn to dusk, the best things in light are free.

**Light tubes are well suited to interior rooms with no window access and where privacy is desired.**



Courtesy of Solatube (2)

**Light tubes, which fit easily between roof framing members, are a straightforward solution to lighting interior spaces.**

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