STEP 2

LAY OUT YOUR GLASS AND SHADING

NOTE TO READERS IN THE SOUTHERN HEMISPHERE

To keep the discussion simple, compass directions are stated with respect to locations in the northern hemisphere. For locations in the southern hemisphere, simply substitute "south" where the text says "north," and *vice versa.*

Now, we are ready to select the locations and dimensions of the windows, skylights, and other glazing for each of the spaces that you designed in Step 1.

Glazing is powerful stuff. It performs five essential functions in a home. At the same time, glazing is a major threat to energy efficiency, and it can cause discomfort if it is located and sized carelessly. As a result, your glazing design needs to juggle more factors than any other aspect of your home design. Enjoy the challenge. If you design your windows optimally, your home will be exceptionally efficient, comfortable, and elegant.

Shading should be an integral part of glazing design. Shading keeps occupants comfortable in warm weather with a minimum of cooling cost. And, it makes daylighting pleasant and glare-free.

We lay the groundwork for your glazing design by explaining the five functions that glass performs and the four major types of home glazing. The sun is the source of daylight and solar heat, so we will get to know the sun's behavior. To make it easy for you to deal with all the issues of glazing design, we will cover those issues in a logical sequence.

At the end of this Step, you will learn how to preserve the energy efficiency and comfort of your home if you want to have a large area of glass to enjoy a special view.

We will use the term "glazing" to mean all the parts of your house that transmit light, including windows, skylights, light pipes, glass doors, etc. We will use the terms "glass" and "glazing" interchangeably, unless there is a reason to make a distinction.*

* Architects have a fancy name for glass or glazing. They call it "fenestration," which is a superfluous term that we won't use.

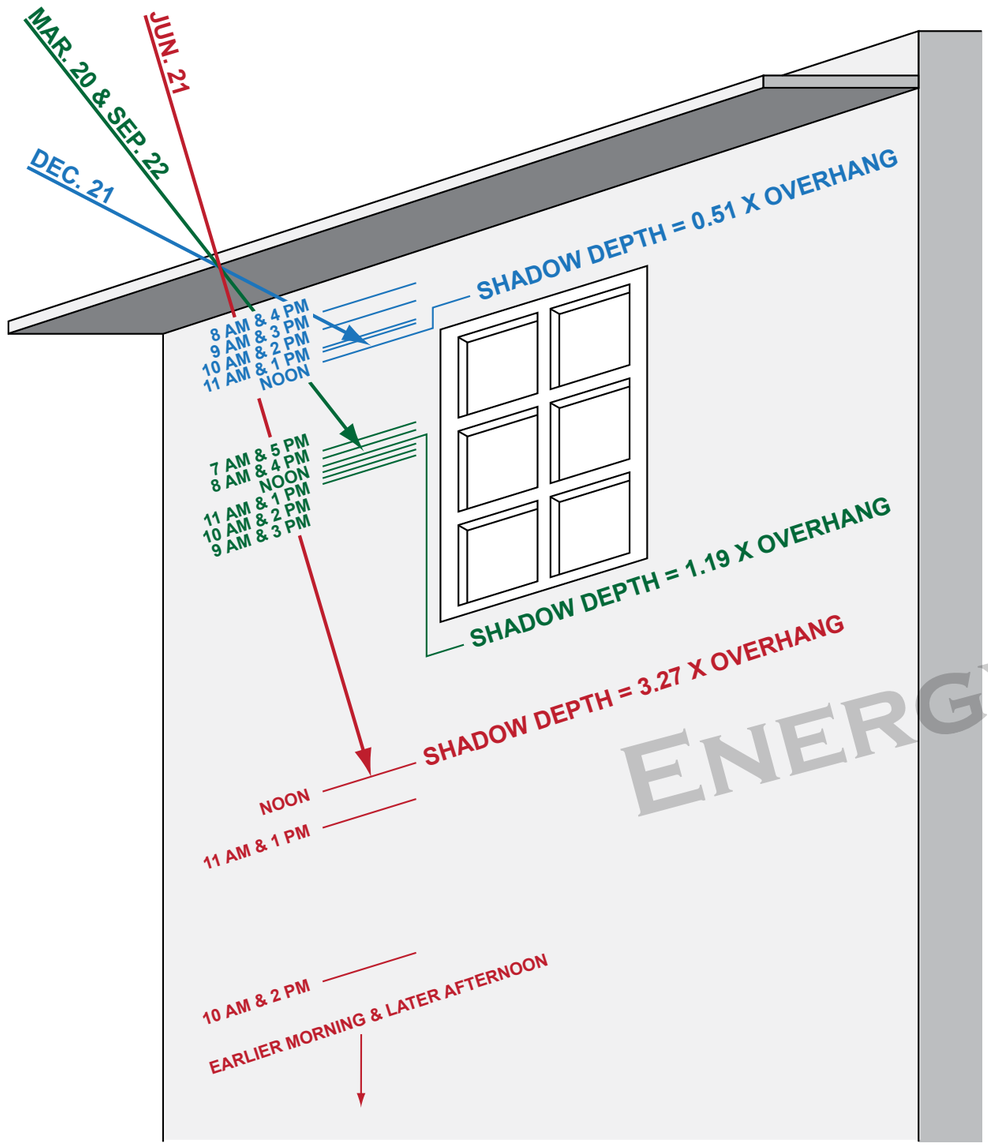

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Figure 2-15. Exterior shading of a window on a south-facing wall, at latitude 40°. The window is shaded at all times during the warmest months. The window is exposed to direct sun during the coldest months. The lines to the left of the window indicate the bottoms of the shadows at the times indicated. The depth of the noon shadows is expressed as a multiple of the depth of the overhang. To provide shading in the morning and evening hours, the shading overhang must extend well beyond the sides of the window.

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Figure 2-17. False eaves on a Florida house. At this sun angle, approximately half of the window area is shaded.

as precisely oriented toward true south as for the other types of exterior shading. Even if the wall is turned as much as 30° from true south, it is still practical to shade the entire wall during the warm months.

This shading geometry is especially valuable in the mid-latitudes and higher, where there are both extended warm and cold seasons. During the warm season, when the sun is high in the southern sky, the gable overhang can shade a relatively large amount of glass throughout the day. During the winter season, the lower winter sun can illuminate the windows for solar heating.

Exploiting the full advantage of an extended end wall overhang requires careful design of the shading angles. It also requires strong carpentry to support the overhang, which we will cover in Step 3.

False Eaves

To shade the windows of lower floors in a multi-story house and to provide the other benefits of roof overhangs, you can design false eaves for the lower floors that match the style of the roof. Figure 2-17 shows an example.

Floor Overhangs

Step 1 explained that overhanging upper floors are a relatively inexpensive way to gain additional living space. An overhanging floor can also serve as a shading fixture for windows that are located below it. However, for structural reasons, it is not desirable to extend a floor overhang very far.

The shadow pattern of a floor overhang is similar to that of a roof overhang. A floor overhang can shade the windows of a lower floor, while the roof overhang shades the windows of the top floor. As with other horizontal shading features, floor overhangs can provide shading throughout the day only if the wall faces almost true south.

Porches and Balconies

A porch roof or a balcony can be an especially effective shading device for the windows below it. Figure 2-18 is an example. The shadow pattern is deep and wide, while most of the view from the windows is preserved. In any orientation, a reasonably deep porch or balcony provides shading for most of the day.

However, as with all horizontal shading, a porch or balcony cannot provide *complete* all-day shading unless the wall faces toward the south. During the warm months, the sun rises and sets in the northern sky, so that not much sunlight leaks underneath a wide porch or balcony that faces south. At higher latitudes, low sun during the winter months will reach part of the window area, providing useful heating.

Awnings

Awnings are most effective on south faces, and they can provide fairly good shading of windows that face east and west. Awnings shade most of the window area because they extend downward over the upper portions of the windows. By the same token, awnings block an upward view.

A common mistake is making awnings the same width as the window, which allows an excessive amount of sunlight to enter from the sides, as in Figure 2-19. The trick is to make awnings substantially wider than the windows, as in Figure 2-20. If windows are clustered closely, use a single awning to shade all of them.

Fabric awnings can be attractive when new, but they begin to look shabby after several years. This makes them expensive in relation to their benefit.

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Figure 2-18. A house that uses both a porch and a balcony for effective shading.

windows can be fitted with inexpensive and convenient manual shades to control glare and unwanted solar heat.

For smaller rooms, windows may provide all the daylighting you would want. For better daylighting coverage in larger rooms, you can supplement the windows with clerestories, skylights, or light pipes. However, in climates that have extended hot or cold seasons, artificial lighting is usually the most economical and efficient way to supplement the daylighting that is provided by windows.

Improving the Daylight Coverage of Windows

The intensity of daylight from windows falls off rapidly with distance from the window. For this reason, in the days before electric lighting, people sat near windows to perform activities that require relatively strong illumination, such as reading and sewing. Your reading chair today probably is located next to a window.

The ability of a window to project daylight into a room is determined mainly by its height above the surfaces that you want to illuminate. Daylight that is adequate for background illumination (but not for reading or other detail work) will penetrate approximately two to three times the height of the windows above the surfaces being viewed.

For example, let's say that the tops of the windows are eight feet (2.4 meters) above the floor, and you want to illuminate table tops that are two feet (0.6 meters) tall. The difference in height is six feet (1.8 meters). Multiply this by two or three, giving a penetration of about 12 to 18 feet (3.6 to 5.4 meters) into the space.

Increasing the ceiling height allows you to install taller windows for better daylight penetration. This is a major stylistic decision for both the interior and exterior appearance of the house.

Increasing the total size of the windows also increases heat loss. To limit the glass area, raise the sill heights to a level that provides privacy while maintaining good sight lines for the available view.

If a room has a long exterior wall, install windows at intervals along the wall to improve daylight coverage. The individual windows can be narrowed to reduce heat loss.

Avoiding Glare from Windows

To avoid glare while maintaining the outdoor view, use exterior shading to keep direct sunlight from entering the windows. You can use the same exterior shading methods that we introduced previously to block unwanted sunlight in a warm climate.

If you rely on interior shading to block glare, avoid materials that are translucent enough to become a source of glare themselves. For most windows, select shade materials that are nearly opaque.

USING CLERESTORIES FOR DAYLIGHTING

Everyone is familiar with windows and skylights, but what's a clerestory?

A ***clerestory*** (or ***clearstory***) is a vertical window or a group of windows that is located above normal window height for the purpose of providing daylight and/or solar heating.* Clerestories can also be used for ventilation. The distinction between ordinary windows and clerestories is mainly a matter of height above the floor level.

Clerestories generally require a beam roof structure to provide light distribution to the space below. They can be installed anywhere in the roof or wall structure that provides a high elevation for the glass. Locations include high side walls under shed roofs, gable end walls, dormers, and roof monitors. Figures 2-33 through 2-39 show a variety of clerestory arrangements.

These examples do not include clerestories that are installed in dormers. The reason is that clerestory dormers look exactly the same as dormers that bring light into the space enclosed by a triangle-frame roof.

Table 2-1, *Glazing Comparison*, summarizes the advantages and disadvantages of clerestories. In comparison with windows, clerestories can provide better penetration of daylight into the interior of large rooms. Some configurations have the unique ability to bring sunlight into rooms that are located on the side of the house opposite the sun. And, their height and size gives them an advantage in collecting sunlight for heating.

In comparison with skylights and light pipes, clerestories have other important advantages. They use conventional window components, which have much longer life than skylights and light pipes. They avoid the leaks that plague skylights, and they are immune to hail and other falling objects. And, the fact that the glass is oriented vertically lowers its heat loss compared to glazing that is installed horizontally or on a slant. This reduces condensation on the glass and reduces falling drafts of cold air.

On the negative side of the ledger, clerestories limit your home's design. You have to adapt the room layout and the roof structure to take advantage of them. They require tall ceilings, which limits your ability to use the space under the roof as living space. If you want to use clerestories, include them in your space planning in Step 1.

* Clerestories were first used in large public buildings to bring light down from the upper parts of tall spaces. They were used about 2,000 years ago in Roman basilicas, and later in large churches. In the 19th century, clerestories became common in civil buildings with tall interior spaces, such as railroad stations. Clerestories rarely appeared in houses until the 1970's, when some houses included them to provide passive solar heating.

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Figure 2-33. Clerestory windows along the top of the high wall under a shed roof. This style is effective for daylighting, but austere in appearance.

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Figure 2-36. The clerestory windows in this gable end wall are well shaded by a deep roof overhang. The result is diffuse daylighting with little solar heat gain. This is efficient for a warm climate, but not for a cold climate.

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Figure 2-34. A house in the Florida Keys with clerestory windows that provide ventilation as well as daylighting. This arrangement provides daylighting for the rooms at the rear of the house.

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Figure 2-37. This house has two sets of clerestory windows. One is between the roof planes. A triangular clerestory is located over the main windows in the side wall.

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Figure 2-35. The upper clerestory, between the two roof planes, provides daylighting for the rear of the house. The clerestory over the front porch provides daylighting for the front of the house.

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Figure 2-38. Clerestories created by extending the roof rafters beyond the ridge. These create a somewhat bugeyed appearance.

Glass Design 5: Exploit Views & Preserve Privacy

In Step 1, you selected the overall orientation of your home and its room layout to exploit your views. Now, lay out your windows to exploit those views. Of the various functions of glass, view of the outside is the one that provides the greatest pleasure, and it usually requires the most glass area. But, glass area conflicts with comfort and energy efficiency, as we have seen. So, exploiting your view deserves clever design.

Let's start with a reality check. Dramatic views that merit big windows are rare. More likely, you will have a nice view of some general vista, such as surrounding lawns or distant hills. Or, in an urban environment, you outdoor view may be limited to a pleasant patch of greenery behind the house. At night, you won't have any view from inside the house unless the outdoor scene is lighted and you turn off the interior lights.

However, if you are fortunate to have a view that deserves a lot of glass, consider a special space from which to enjoy it. This is especially desirable if your climate has a substantial cold or hot season. In that case, design your special space as we discuss later, under the heading, *What If You Want a Space With Lots of Glass?*

WINDOW LOCATION AND SHAPE

The basic design approach is to locate the windows between the occupants and the desirable views outside. Depending on the climate and the nature of the view, you may decide to install a single large window or a succession of smaller windows to "sample" the view.

If the occupants will be enjoying the view mostly while seated, sketch the furniture in the viewing rooms so that you know where the outward looking chairs will be located. If you place a chair near a relatively small window, you can achieve a relatively wide view. However, if you want the view to be visible from a large area of the room, that will require more glass.

A panoramic view does not necessarily require big windows. For example, if you have a view of the ocean, a lake, or distant hills, you may want a wide expanse of windows, but they don't need to be tall. On the other hand, if your view faces a back yard with tall trees, your viewing windows may be tall and narrow.

The height of the window sills is governed by your downward view. In a house on a hillside, windows facing a downhill view should have low sills. But, if your living room windows face a large deck, raise the sill height and don't waste window area for a view of the deck floor.

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Figure 2-55. Tall window sills provide effective daylighting for this bedroom while maintaining privacy. The tall sills also allow furniture to be placed beneath the windows.

SIGHT LINES TO PRESERVE PRIVACY

Consider view and privacy together when designing each window. Light travels through windows in both directions. If the occupants can look out, people outside can look in.

In many houses that have windows designed without regard to privacy, the occupants are forced to achieve privacy by permanently obscuring the windows, as in the previous Figure 2-11. Such windows contribute nothing except higher heating and cooling costs.

The sill height of the windows usually is the most important factor in privacy. Your eyes are in your head, so a tall sill allows you to see the outside view while preventing an outsider from seeing the lower parts of your anatomy. To preserve modesty, make the window sills high enough so that a person standing outside cannot tell whether a woman inside the house is nude or is wearing a sun dress. Consider tall sill heights especially for bedrooms and related rooms where occupants may be undressed. Figure 2-55 shows a bedroom window layout that provides good privacy with tall sill heights.

Tall window sills are often the best way to provide privacy, especially where they can also maintain view and daylighting.

If you can eliminate the need for privacy shades by using tall window sills, view and daylighting are always accessible. You can leave the windows open at night for ventilation. And, in bedrooms, sunlight coming through the windows makes it easier to start the day.

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Figure 2-56. Tall window sills may create a large expanse of exterior wall, as here. Therefore, consider shrubbery or other deco to cover the lower portions of the wall.

Windows on upper floors provide more reliable privacy, and they can do so with somewhat lower sill heights.

For rooms on the ground floor, the height of the foundation has a big effect on privacy. For example, let's say that you select a tall sill height of five feet (150 cm) for your bedroom windows. If the house has a low slab-on-grade foundation, a Peeping Tom can still look into the bedroom if he is standing directly outside the window. In contrast, if the house has a foundation that elevates the floor three feet (90 cm) above grade, the window sills will be eight feet (240 cm) above grade, too tall for Tom.

The slope of the surrounding terrain also has a big effect on privacy. If the terrain slopes downward from the windows, privacy is enhanced. On the other hand, if windows are below the surrounding terrain, the windows will need privacy screens.

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Figure 2-57. The window design of this house provides little privacy because the bottoms of the windows are at floor level. Without curtains or other privacy screens, the occupants have chosen to live in a public showroom.

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Figure 2-58. The same house as in the previous photo. The occupants have made a virtue of their exposure by decorating the house interior so that it can be admired from the street.