Designing With the Sun in Mind

Use your sun savvy for coastal design solutions

by Gordon Tully

Whether you build in sunny Florida, where shading is always a high priority, or along the coast of Maine, where every ray of sun in the winter is a precious gift, designing with the sun in mind can make a routine house come to life. To do so, you first need to familiarize yourself with the sun's location throughout the year.

FINDING THE SUN ON SITE

The chart in **Figure 1** defines where the sun is at various latitudes (from 38° to 46° north) at various times of day on key dates. To apply this information at the site, you need two things: a compass and a way of figuring angles from the horizon.

Because the sun tracks true north, rather than compass north, you want to use true north for your figuring. To find true north, you need to know the local *magnetic declination* — how far off true north a compass needle is in your part of the country. In Boston, for example, true north is 16° to the right of compass north. In Miami, it lies 3° to the right of the compass needle. The chart in **Figure 2** (page 2) shows the magnetic variation for a few cities along the Gulf and East Coasts.

Noon sun on key dates. Imagine that you fix a camera in place facing due south and take a picture of the sun at noon every day of the year. If you show this as a moving picture, the sun will appear to swing up and down, low in the winter, high in the summer.

When it reaches the winter and summer extremes, it appears to stand still and reverse direction. Hence the name for these extremes, which occur each year around June 22 and December 22: "solstice," meaning "sun stands still."

In this motion picture, the middle of the swing occurs at the "equinoxes," which occur around March 21 and September 23 (**Figure 3**, page 2). The angle of the sun from the zenith (straight overhead) on the equinox is equal to your latitude: 42.5° north in Boston; 25.75° north in Miami. So, on the equinox, the sun's altitude in Boston is 47.5° (90° – 42.5°), and in Miami it's 64.25° (90° – 25.75°).

To find the altitude of the noon sun at the solstices, you add or subtract 23.5° (the tilt of the Earth) from the equinox

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SIMPLIFIED SUN ANGLE CHART

	Easy-to-Remember Approximation (±10%)			Latitude 38°			Latitude 42°			Latitude 46°		
Azimuth: *Degrees from South*	Winter Solstice	Equinox	Summer Solstice	Winter Solstice	Equinox	Summer Solstice	Winter Solstice	Equinox	Summer Solstice	Winter Solstice	Equinox	Summer Solstice
@ Sunrise (Sunset)*	60°	90°	120°	60°	90°	120°	60°	90°	120°	60°	90°	120°
@ 8 a.m. (4 p.m.)	50°	70°	90°	53°	70°	92°	53°	70°	91°	53°	69°	91°
@ 10 a.m. (2 p.m.)	30°	45°	60°	30°	43°	69°	29°	42°	66°	29°	41°	63°
Time of Sunrise	7:30	6:00	4:30	7:20	6:00	4:40	7:25	6:00	4:35	7:30	6"00	4:30
Time of Sunset	4:30	6:00	7:30	4:40	6:00	7:20	4:35	6:00	7:25	4:30	6:00	7:30
Altitude: *Angle off the horizon in rise per 12" of run*												
@ 8 a.m. (4 p.m.)	1"	5"	9"	1.4"	5.1"	9.2"	1.2"	5.0"	9.2"	.9"	4.8"	9.2"
@ 10 a.m. (2 p.m.)	5"*	10"*	20"	4.9"	11.2"	21.3"	4.5"	10.6"	20.6"	4.1"	10.1"	19.9"
@ Noon	6"*	12"*	36"*	6.5"	15.4"	46.4"	5.5"	13.3"	35.9"	4.5"	11.6"	29.0"

*More than 10% error for 38° and 46° latitudes.

FIGURE 1. Designing with the sun in mind begins with predicting the path of the sun across the site and over the house. Using this data, a designer can chart the sun's path and angle from the horizon (see Figure 3, page 2), providing specific details about the dimensions and positions of shading walls, overhangs, porches, and windows.

position. For Boston, it comes to 24° in winter and 71° in summer; for Miami, 40.75° in winter and 87.75° in summer. Instead of showing these altitude angles, the chart (**Figure 1**, page 1) shows something you can more easily use in the field: the rise for 12 inches of run. Another way to think of this is the height of a stick that casts a 12-inch shadow with the sun at that altitude. On site, you'd measure this by holding a stick at arm's length, adjusted so you can sight the appropriate rise and run. Approximations are fine.

SUNSHINE SPECIFICS

Once you know how to find the altitude of the sun at different dates and locations, you can use this to analyze a particular site. Here are some considerations to help this assessment.

When does the sun shine? As the sun gets higher in the sky in summer, the days get longer than 12 hours. In the winter, the reverse is true: the days get just as much shorter as they are longer in summer. So the average daily sunshine (above the clouds) all over the world is 12 hours.

From which direction? If you examine the top half of **Figure 1**, you will notice that the sun spends a lot of time in the northern half of the sky vault — that is, whenever the azimuth (the angle

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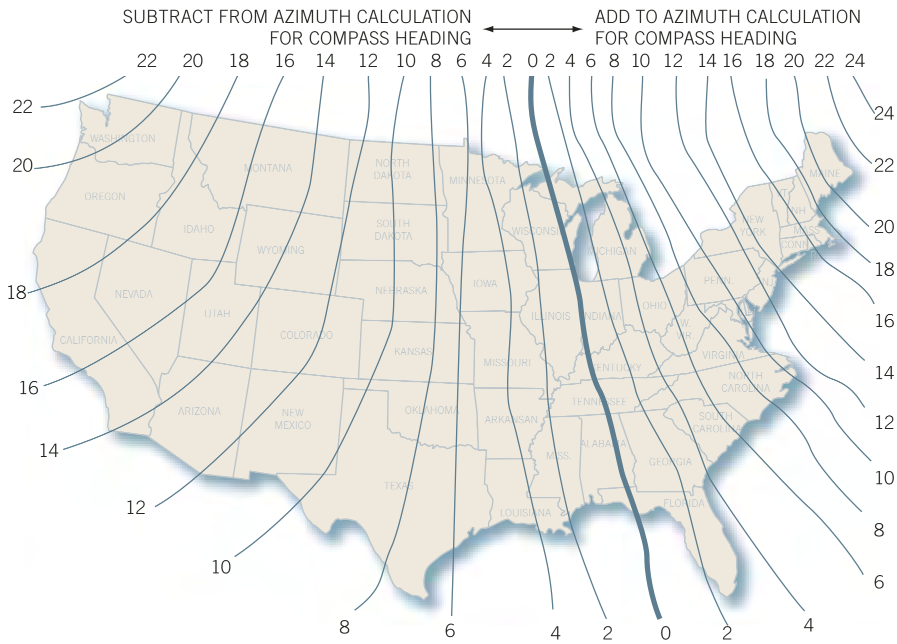

FIGURE 2. The magnetic variation of "true north" from magnetic north (found with a compass) can be found on maps such as U.S. Geological Survey topographic quadrangle maps, aviation charts, and marine charts. If it's an east variation, subtract the number of degrees from the magnetic direction to obtain the true direction. If it's a west variation, add the number of degrees to the magnetic direction to obtain the true direction.

CITY	MAGNETIC DECLINATION
Baltimore	10° W
Boston	16° W
Charleston	15° W
Galveston	6° E
Miami	3° W
New Orleans	3° E
New York	14° W
Portland, Maine	18° W
Pensacola	1° E
Tampa	1° W

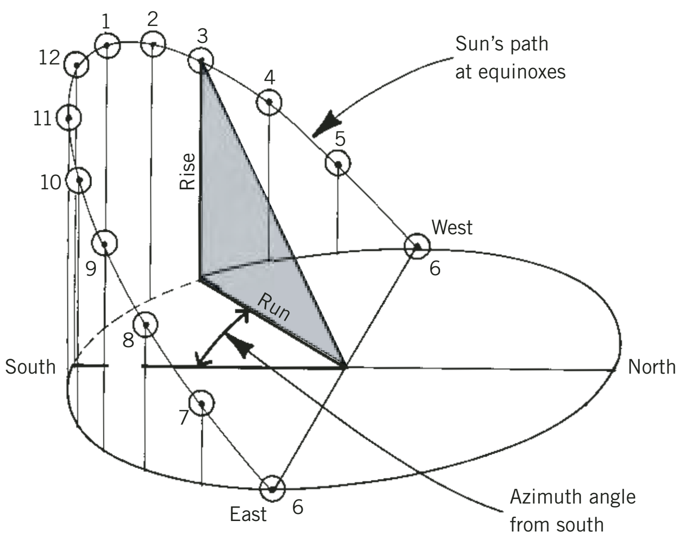

FIGURE 3. To find the sun's location, you need both the azimuth (the angle from true south) and the altitude (the angle off the horizon). The chart in Figure 1 gives altitudes as rise for 12 inches of run, like a roof slope.

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from true south) exceeds 90°. This surprises many people, who think the sun is always in the southern half of the sky. In summer, you get some sun through north-facing windows.

One consequence of this is that on summer afternoons, the sun shines more or less directly into west-facing windows much of the afternoon. Shading is required, and trees are the only reasonable solution, since the sun is too low for overhangs or awnings to be effective. So even if you have a desirable west-facing view, don't overdo unshaded west-facing glass.

Another fact that surprises many people is how far north and south of due east-west the sun rises and sets at the solstices: more than 30° each way here in Boston. This angle gets bigger as you move north. You should memorize this angle for your area, as you will use it a lot.

How much sunshine? Sunshine comes through a window in three forms: *diffuse, reflected,* and *direct.*

Diffuse sunshine comes from the dome of the sky. It doesn't keep you warm, but it is an important source of natural light in our windows and skylights.

Gathering in more diffuse light is a good reason for cutting out trees that are too close to the house.

Reflected sun is very important at the seashore. The reflection of the sun off water comes in from below, causing a lot of glare and defeating an overhang. When you look toward the south, trees and buildings will be in shade and so will look dark. When you look north, you see sunlight reflected off the trees and houses. This reflected light helps compensate for the shortage of direct sun in north windows during the winter months.

Direct solar radiation, the only thing we usually call "sunshine," comes straight from the sun in a beam. Direct sunshine is strongest when it hits something square on at 90°. When sunshine hits a surface at a shallow angle, a lot of it bounces off — especially with low-e glass. Also, less sun hits an angled surface in the first place because the sun "sees" it foreshortened (**Figure 4**).

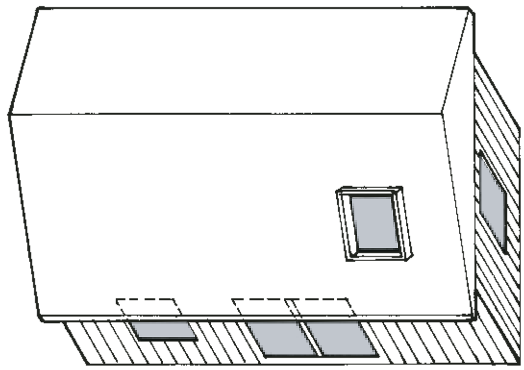

FIGURE 4. The high summer sun "sees" only a small portion of the south-facing windows. Shading from the overhang and reflection off the glass further protect the south windows. By comparison, the roof window gets almost straight-on sun, which can cause overheating.

One consequence is that south-facing windows don't let much sun in during the summer. By contrast, the summer sun shines straight into a south-facing roof window, which can cause overheating.

Sun blockers. The interferences of most concern to the designer are from hills, other houses, or large trees nearby. Part of the need for the compass and sun angle charts is to plot the hours when surrounding trees, hills, and houses block the sun at your site. For example, if the sun is blocked in the morning and not in the afternoon, you might want to skew the house to face toward the southwest. Remember that even leafless deciduous trees cast quite a bit of shadow in the winter.

Clouds and fog are also a concern. In a place with regular morning fog, you might put a porch on the west and not the east.

LET THE SUN IN

Armed with all these facts, how can we use them in our designing? On a heavily treed site, the walls of the house are not going to get much sun. The house will seem gloomy, and in wet climates the lack of sunshine will cause mildew problems. Consider cutting down trees to the south of the house. Also consider roof windows, which are more likely to be sunlit than the windows in the sidewalls; but be careful of overheating.

All other things being equal, it is desirable to face the "south" wall of a house slightly to the southeast in northern parts of the country. This allows the house to heat up early on cold days.

Use south windows. Windows on the south are a good idea. First of all, even if we didn't plan it, solar heating happens automatically through (unshaded) south glass. But don't overdo it: Just install the same total amount of glass you would ordinarily use, but put more of it on the south. South rooms should end up with window areas equal to 10% to 15% of their floor area.

Another advantage of south glass is that it is easy to design overhangs that invite in desirable winter sun but block out undesirable summer sun (**Figure 5, next page**).

Rooms should follow the sun. After properly orienting the house, the next task is to locate the rooms so they get sun at the right time of day. Here are some questions you might ask your client:

- *Does the sun clear obstacles early enough for you to wake up to the sunrise or enjoy a sunlit breakfast?* If so, locate the breakfast room and bed-

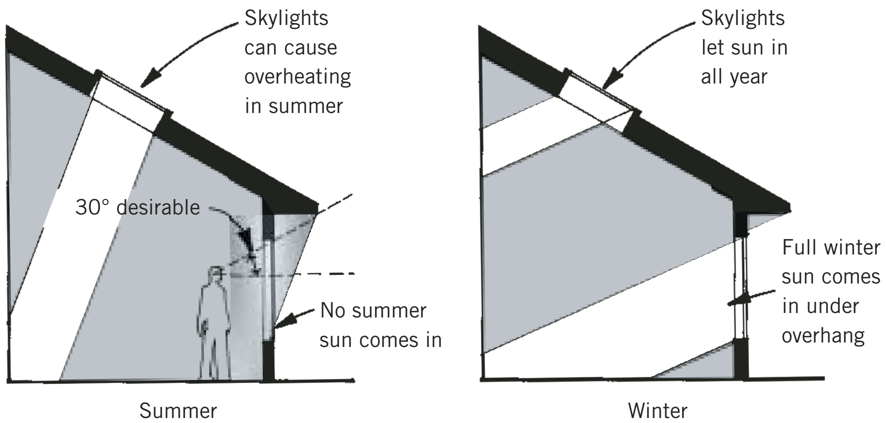

FIGURE 5. Overhangs on south windows can effectively shade summer sun, while allowing in winter sun. The 30° angle shown maintains a desirable sky view.

room so they can see the sunrise, especially in winter.

- *What rooms need sun during the day and what rooms might be used primarily at night?* I think the dining room is a good nighttime room, especially if everyone is away during the day. Conversely, I would not like a north-facing kitchen unless it was open to south-facing rooms.

  Remember weekends, however: Sunday brunch around a sunlit table may be a key experience for some households. Some may want two eating places: one for sunny days, one for intimate nighttime dining.
- *Is there a problem with ice and drifting snow?* In that case, you might want to locate the front door and garage facing southeast, so the sun can help shovel you out.
- *What about valuable possessions?* Any light (not just ultraviolet) will degrade, dry out, and bleach most organic materials. So if there are valuable paintings, musical instruments, or fabrics, these should not be in rooms that are brightly lit.

Our urban lives keep us inside, so few of us know much about the sun and how it moves. Designers and builders should bone up on this forgotten lore to make their houses more livable. — *Gordon Tully is an architect in Norwalk, Conn., and teaches a summer executive education course at the Harvard Graduate School of Design.*