

Overview

Higher density urban living has brought with it two problems - privacy and access to sunlight. We are at the mercy of local government, councils and municipal bodies, who, in their wisdom approve construction projects. When our neighbours decide to extend their home we need to know the consequences for our privacy, sunlight and view. We need accurate information to present to local government authorities if we decide to oppose aspects of the project. If we are considering buying an existing property in an established urban environment we can assess privacy and view by inspection, but sunlight throughout the year is more difficult to assess. With SunShade we can produce a picture of the sun's path across the sky, in perspective, with the outline of a building which may obstruct its rays, for any day of the year anywhere in the world. If we live in the tropics, or other hot areas, we may want to provide more shade, but need to be able to assess what structural alterations are required to achieve it. Good solar design is of increasing importance in an environment-conscious world.

To set up solar hot water or electricity panels we need to know sun angles as well as the effects of obstructions. Fishermen need to know sunrise and sunset times. SunShade can provide accurate information for all these problems.

When you run SunShade you are presented with a table containing rows and columns. Those familiar with databases will recognise it as such (Paradox). Depending on what you want, some of these cells need to be filled in. Clicking on the right mouse button will bring up a help menu that explains which cells need to be filled in and what sort of information is required. You can save these data to a file. You then have three choices - calculate sun angles for a specific day and time; produce a picture on your screen of the sun's path across the sky for a particular day, emerging from, or passing behind an obstruction; or, for a specific time, display a shadow diagram on your screen. You can print out these pictures, together with the data on which they are based.

SunShade provides extensive Help, both in the detail of entering data and step-by-step tutorials. Tutorial 1 is a complete step-by-step guide to producing pictures of the sun's movement being obscured by structures, and includes the display of a shadow diagram; while Tutorial 2 covers other uses of SunShade. Both are supported by examples already entered in the database.

Address

The address of the site. Not essential, but should be included, with enough information to identify the record when printed. Up to 30 characters.

Latitude

Essential. The latitude of the site. Example: The latitude of Sydney is 33degrees, 53minutes. This is entered as 33.88.

N or S

Essential. Enter N for Northern or S for Southern hemisphere.

Longitude

Needed for accurate results, unless your site happens to be on your State's Time Reference Longitude. Range is 0 to 180 (degrees). Example: Sydney's longitude is 151 degrees, 10 minutes, which is entered as 151.17.

E or W

If you entered Longitude you need this one, as well. Enter E or W for your longitude being East or West of Greenwich.

Reference Long.

If you entered Longitude you need this item as well. This is the Time Reference Longitude for your State or Country. Range is 0 to 180 (degrees). Example: The time reference longitude for Sydney is 150 degrees (for Eastern Standard Time).

Date

Essential. Sun angles vary cyclically throughout the year. You want to know the sun's path or angles on this day. Enter dates in the format your computer expects. Example: for 21 June, 1999 in Australia, enter 21/6/99. (Or 21/6/1999 if the millennium bug worries you!).

Time

Essential only if you want to know the sun's azimuth and elevation angles at a particular time, eg. sunrise, sunset, noon; or you want to display a shadow diagram. Enter in the format your computer expects for time. Example: Twelve minutes past six PM in Australia would be entered as 18:12.

Daylight saving?

If daylight saving is in force for the Date you entered then you need to tell the computer.

Enter T for True, otherwise the computer assumes F for False. Daylight saving is assumed to advance the clock by one hour.

Azimuth angle

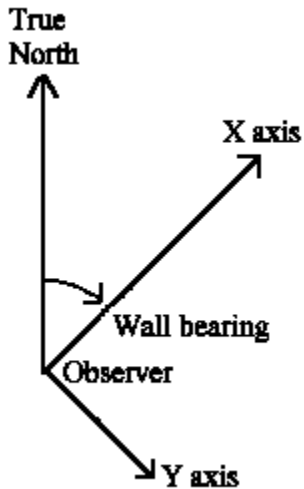
You don't enter anything here. It is read only. If you entered a Time and clicked on the "Calculate Azimuth and Elevation angles" button, the azimuth angle of the sun would appear here. What is the azimuth angle? If you dropped a vertical line from the sun to the horizon, the angle you would observe between that line at the horizon and true North would be the azimuth angle of the sun.

Elevation angle

You don't enter anything here. It is read only. If you entered a Time and clicked on the "Calculate Azimuth and Elevation angles" button, the elevation angle of the sun would appear here. What is the elevation angle? It is the vertical angle you would observe between the sun and the horizon.

Wall bearing

Essential if you want to plot the sun's path and an obstruction, or a shadow diagram. It is the bearing of an imaginary line from the observer on a deck or balcony, or behind a window, normal (ie. at right angles, 90 degrees) to the obstructing wall. Range is 0 to 360 degrees, relative to true north. It might be available from site surveys, but if measured with a magnetic compass, the next two items will need to be filled in. If all you want to see is the sun's path across the sky and are not filling in the X's, Y's, or Z's you can enter values into the Wall bearing field. In the northern hemisphere you would typically enter 90, 180, or 270, while in the southern hemisphere 270, 360, 0, or 90. In the tropics the entry would depend on the season. Press the Plot Sun's path and obstruction button.



Mag. Variation

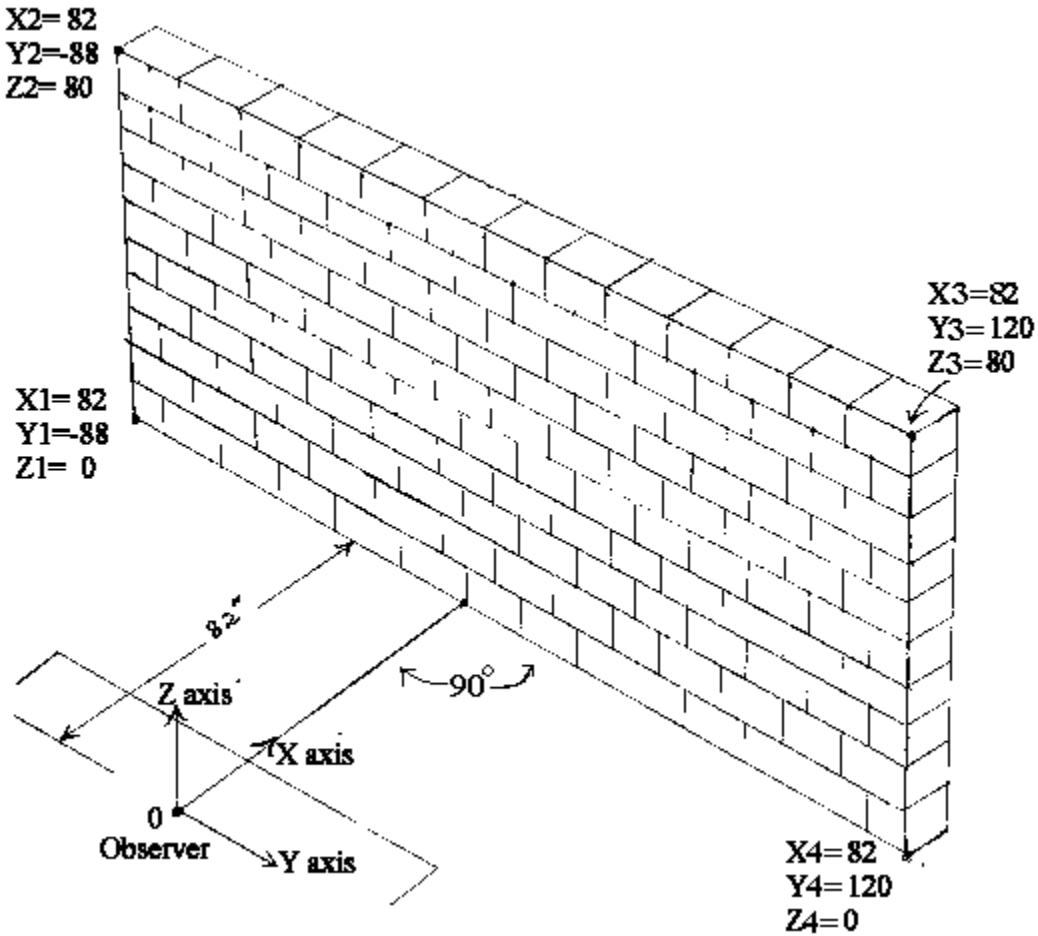
Essential if you measured Wall Bearing with a magnetic compass. It points to the magnetic north pole, not the true North Pole. The difference is called the magnetic variation that varies from place to place and its value is usually shown on maps. Enter the magnetic variation in degrees here.

E or W Var.

Essential if you entered a value for Mag. Variation. If magnetic variation is shown on a map then it will also show whether it is East or West. Enter either E or W.

Xn, Yn, Zn

The obstructing wall or building is defined by a series of coordinate points: X1, Y1, Z1; X2, Y2, Z2 etc. We only need to define the silhouette or outline of the obstruction. The origin of measurements is at the observer, who would usually be at or near the centre of the area likely to be affected by the shadow. The X-axis is along the line defined earlier as Wall bearing. The Y-axis is horizontal and normal to the X-axis, positive to the right (and parallel to the obstructing wall). The Z-axis is vertical, normal to both X and Y and positive up. You can enter up to 8 points. You can use inches or millimetres, but not mixed. The example below shows a wall constructed of 16 by 8-inch blocks. Because it is parallel to the Y-axis, all X distances are the same. Zero or negative X's are not allowed, nor are negative Z's.



Tutorial 1

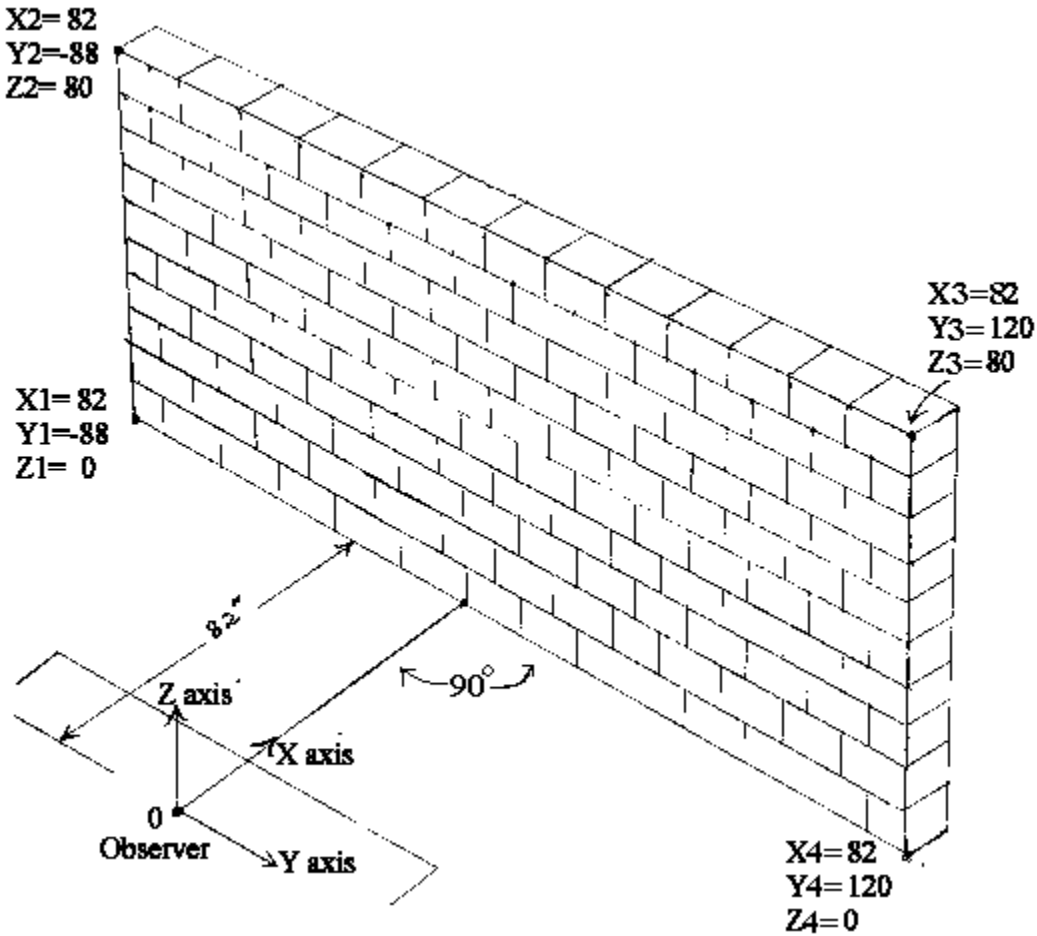
If you have not done so already, click on File/Open and select and Open Examples.DB. You are presented with a table consisting of a number of columns, or fields, ie. Address, Latitude, N or S, etc. Each horizontal row of the table is called a Record and that defines all the input data for a particular computer run to plot the sun's path and obstruction, for the data you have entered in the fields. You fill in the fields of a particular record, working from left to right. Simply click the field, which selects it, and start typing. To find out what to enter, click the right mouse button and select the item from the menu.

Let's start with a simple example. The sketch below shows an observer facing a masonry wall that happens to be parallel to his deck. He is facing due East and wants to know how much the wall (which runs North - South) will block his sunlight in the morning. The wall is constructed of 16 by 8-inch masonry blocks, so we can easily determine dimensions by counting bricks. The observer could choose to be anywhere on the deck (or anywhere above it) where the morning sun is important, but for this example is located near the centre of the deck and 82 inches from the wall.

The first field is called Address; we can enter anything here, since the wall has no fixed address; we called it Example 1. Suppose the wall is in Sydney - so enter Latitude 33.88 (don't enter degrees and minutes, use the excellent Win95 calculator to convert minutes to decimal fractions of a degree). Sydney is in the Southern hemisphere so enter S in the N or S field. If accuracy is not important you can skip the next three fields, but let's suppose it is. Sydney is at Longitude 151.17 degrees and East of Greenwich, so enter that and E in the E or W column. The reference longitude for Australian Eastern Standard Time is 150 degrees, to be entered in that column. Had we ignored these last three fields the error in time would be about 5 minutes.

A Date entry is a must. Our observer would probably be most concerned about loss of sunlight in mid-winter. In the southern hemisphere the shortest day is 21 June, so enter 21/6/99 (or 6/21/99 if that is the way your computer likes it). A Time entry is necessary only if you want to know the exact azimuth and elevation angles of the sun at that time, or display a shadow diagram. Sydney has Daylight saving in the summer; if we had chosen a summer date, enter T for True in that column, otherwise skip Daylight saving. We don't make entries in the Azimuth and Elevation fields; they are purely for results generated by the computer.

In order to describe to the computer the vital statistics of the wall we have to invent an axis system and this is shown in the sketch as X, Y and Z axes. The X-axis is normal to the wall and the wall is 82 inches from the observer, in the X direction. Y is to the right and Z is up. Now we need to know the bearing of this X-axis relative to True North, between 0 and 360 degrees, and enter that value in the Wall bearing field. If you are confused, right click on the popup menu's Wall bearing entry and study the sketch. We have already assumed the wall runs North - South, so we enter 90 in this column, Wall bearing being 90 degrees to the wall. If we had used a magnetic compass to measure the Wall bearing, we would need to fill in the next two fields.



So now we enter the X, Y and Z coordinates of the wall's outline. Starting at the bottom on the extreme left, enter X1, Y1 and Z1. All the X's will be 82 because the wall is parallel to the Y-axis. Note that Y1 is negative, -88, because it is on the left and Y is positive to the right. Z is zero at the bottom of the wall. The computer will draw straight lines between the points we enter, so work around the wall in a clockwise direction, defining each corner, such as at X2, Y2, Z2, until we come to the right hand bottom of the wall at X4, Y4, Z4. The computer automatically enters a point at Y = 0, directly above the X-axis so that it can draw a correct perspective view of the wall.

Example 1 has already been entered in the Address field, so click on Example 1 to select that record and click on the Plot Sun's path and obstruction button to display the result. You can see that the sun emerges from behind the wall at about 08:57. The sun's path is plotted in red for every hour and yellow every 15 minutes. Notice that the perspective effect causes the wall to shrink in height each side of the observer, just like a photograph with a very wide-angle lens. You can zoom in or out on the picture and print it out in black and white, together with the data.

Display of Shadow Diagram

A shadow diagram shows the outline of the shadow cast by an obstruction on to a horizontal surface. For example, the rectangular wall above would be expected to cast a parallelogram of shadow. Since the shadow moves during the day, we need to select a time. The display we produced above covers several hours during the morning, so we can use that to decide on a time entry. The sun emerged from behind the wall at 08:57 so enter that in the Time

field. When we click on the Draw Shadow Diagram button, the expected parallelogram appears in a plan view with the wall at the top and the observer's position below it. Note that, as you would expect, the edge of the shadow runs through the observer's position. The dimensions of the shadow are shown at each of the corners - for example, the corner marked -81.1,86.4 is an X, Y pair, meaning X is -81.1 and Y is 86.4. Because you entered the dimensions of the wall in inches these results are also in inches. That is, this corner of the shadow is 81.1 inches behind the observer and 86.4 inches to the right, so this is where the shadow will fall on his deck, if, as assumed, he is at the centre of the deck. Note that as the entire shadow area cannot be accommodated on the screen we have a Move Left/Right button. We can also print out the screen display.

Tutorial 2

Database Navigator

This is the row of buttons along the top of the form. Placing the cursor on each button provides a hint of its purpose. Note that the post button when clicked posts any changed records to be saved to file when you exit SunShade. Note also to add a new row (record) to the end of the database, select the last record and press your keyboard's down arrow key.

Precise sun angle at a specific time

Suppose we want to know the sun angle at a particular time and place.

London, England on 2 December 1998 at 10:00 AM.

Enter Latitude = 51.5, N or S = N, No need to enter Longitude because London (or rather Greenwich) is on the time Reference Longitude (0 degrees); Enter Date = 2/12/1998, Time = 10:00.

Click Calculate Azimuth and Elevation angles button.

Result: Azimuth angle = 154.13, Elevation angle = 12.72.

Check: The US Navy's Observatory:

Azimuth angle = 154deg, 6min, 53.2sec or 154.11 degrees

Elevation angle = (90 - 77deg,16min,8.9sec) or 12.73 degrees.

See Example 2 in the database.

Sunrise and Sunset times

The definition of sunrise and sunset times may vary. In Sydney, sunrise is when the top edge of the sun appears above the horizon and sunset when the top edge disappears below the horizon. However atmospheric refraction can vary these times in an unpredictable way. SunShade makes no allowance for atmospheric refraction. Published sunrise and sunset times in Sydney assume an average refraction angle of 0.58 degree. Since the sun subtends 0.5 degree, while Sunshade predicts the angle to the centre of the sun's disk, this means that sunrise and sunset occur at an elevation angle of -0.83 degree, i.e. when the sun is really below the horizon. So you can enter times in the Time field and press the Calculate Azimuth and Elevation button to find by trial and error when the Elevation angle is -0.83 degree.

Check: On 25/1/1999 in Sydney the published sunrise was at 6:09am, SunShade predicted 6:08:39. See Example 3 in the database.

Shadowing by own structure.

The procedure for producing a plot showing when the sun is visible in any part of a room, through a window, is the same as that described in Tutorial 1. Except that the wall is regarded as transparent; it is now the window, while the surrounding areas are considered to be opaque. It is a good idea to do the plots for shadowing by your own structure first. That way you can save yourself time by narrowing the part of the blocking structure to be plotted. Note that if you want to move the observer to the right, say by 60 inches, all you need do is subtract 60 from each of the Y coordinates (remembering the rules concerning subtracting negatives from negatives). Likewise adjusting the X values can move the observer forward or back. The height of the observer can be set at any level, but the Z coordinates must all be above that level (no negative Z's or X's, or zero X's).

It is worth mentioning here that most of the shadow diagrams that I have seen only show if a window is in shadow or not. If there is sun on the window such diagrams provide no information on where it penetrates in the room.

