Tree Shadow Position

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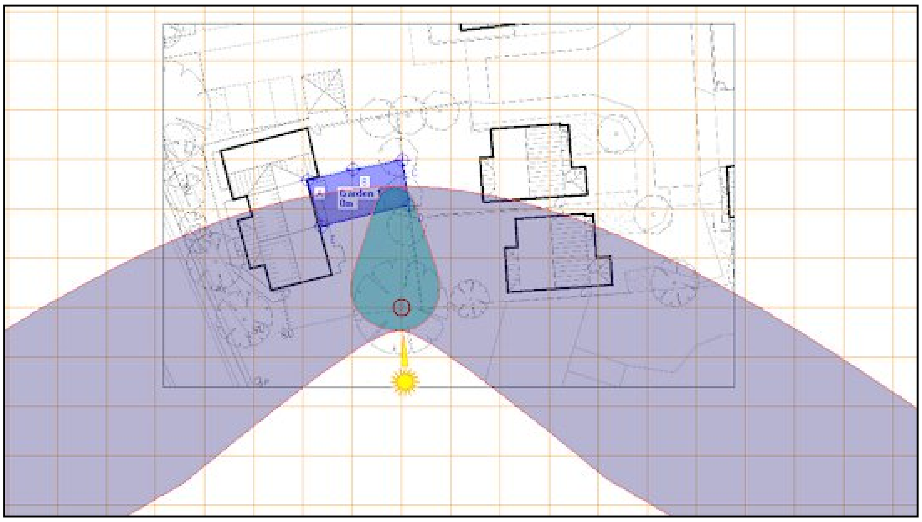
April 2006

I have recently received a few queries regarding the trace pattern that Arbor-Shadow produces. The queries relate to the large 'boomerang' shaped trace shadow produced for say June and the question arises, "should the shape not be more upright, or reversed, and should it not be fully located above the east to west axis of the site"?



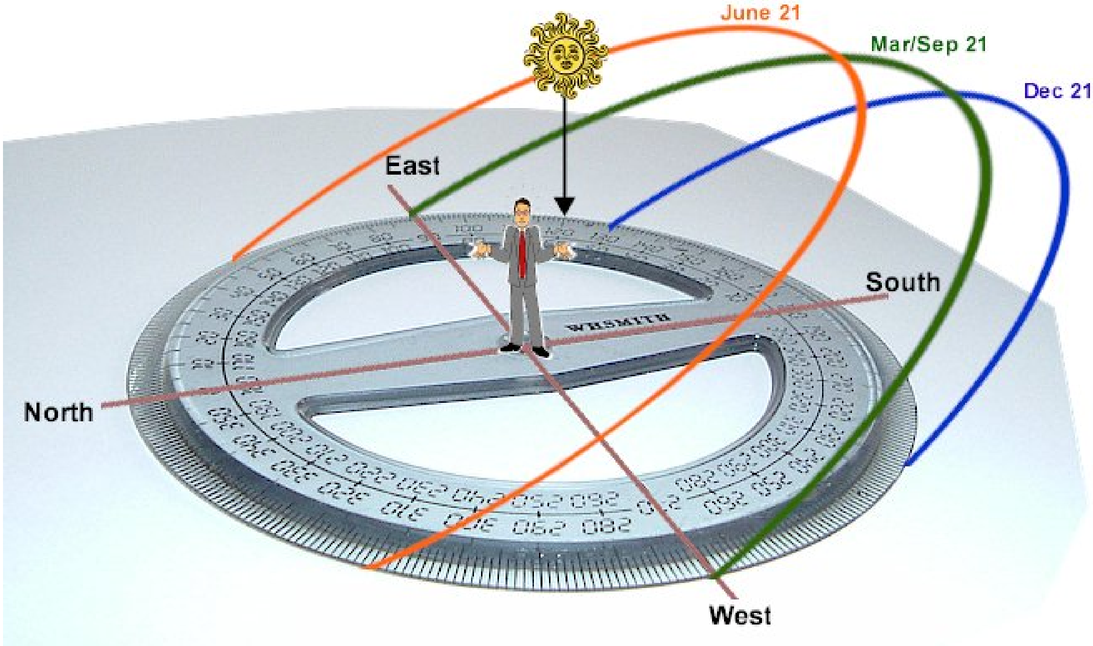
Hopefully the following text may help explain.

Firstly, Arbor-Shadow shows the suns trace shadow for all hours of the day. If you ignored the hours before 9am and after 9pm then the trace would actually look 'more upright' and be located in the northern sectors of the site.

To explore the shadow trace further we need to undo the commonly accepted concept that the sun rises in the east and sets in the west. It doesn't! Oh ok, it actually does… but only for a few days of the year. It is ever changing. Most of the year it will be rising north or south of due-east and setting north or south of due-west.

Around June 21-22nd (the longest day of the year) the sun rises at around 3.45am very close to actual north-east. During the shortest day of the year (approximately 21-22nd December) the sun rises at around 8.15am very close to the south-east. For the rest of the year the sunrise time and position fluctuates between these two extremes passing due east around March 21st and September 21st (the Spring and Autumn equinoxes).

The following picture may help in understanding the concept of how the sun changes its arc of travel throughout the year. It's based on my WH Smith protractor!



Note how the suns arc for June starts and ends in the northern section of the site.

The clip art sun is at around 9.30am for June 21st. Its azimuth is around about 120 degrees (see the arrow).

You can obtain sun related data from the Internet or from within existing documents which you might own.

For instance if you have a copy of **BS8206: Part 2: 1992** take a look at page 30. The diagram on this page shows the sun paths for London for each month of the year. It shows the period when the sun is visible in the sky from sunrise to sunset. Now follow the path for June 22 and note the point on the 360 degree protractor where it appears. It will show a time just before 4am and a position of around 50 degrees azimuth (read from the outer scale). That means that if you were standing on a nice flat area of landscape on June 21st and looking directly eastwards (an azimuth of 90 degrees) the sun will be rising slightly to your left in the northern sky (as 45 degrees azimuth equals north-east).

Alternatively, take a look at the **'Availability of Sunshine'** document produced by the BRE. Look on the inside back cover (page 27). Pick out the June column for the 21st and note the sunrise time and its azimuth value. These read as 3.42am and 49 degrees. Compare these with the BS8206 data above.

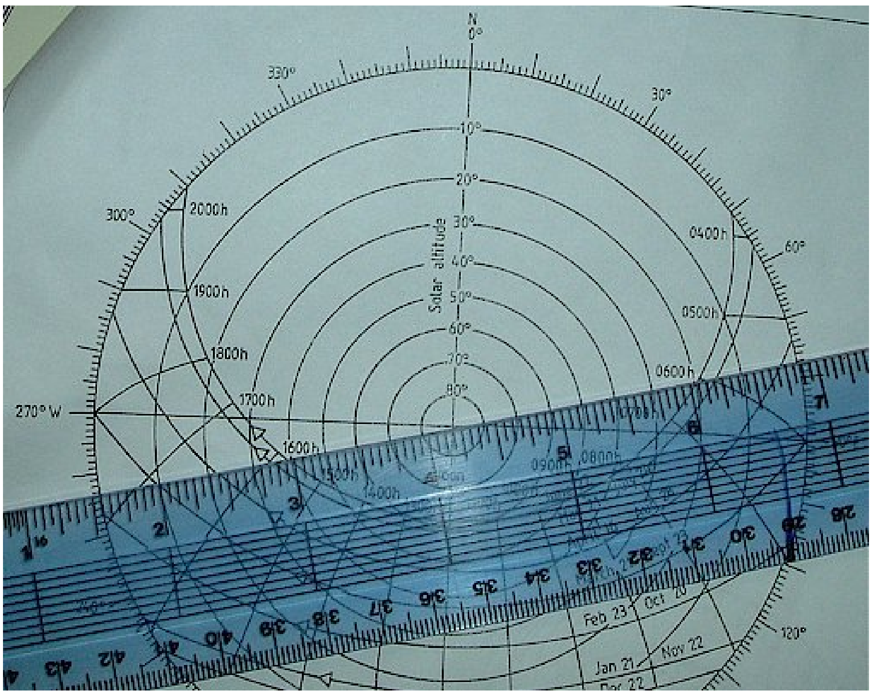
So, you may be asking, what has all this gobbledygook got to do with shadows? And the answer is of course, that any shadow will be mirroring the light source (the sun) and be moving in relation to it. The shadow will always be opposite the sun. So if the sun rises in the north-east the shadow will start in the south-west. If the sun is positioned due east the shadow will appear due west. As the sun moves from east to west in the southern sky so the shadow will move from west to east in the north of the site.

Does the Arbor-Shadow boomerang shape begin to make sense?

Part of it must be in the south if the sun is in the north; of course, the parts of the day when the sun is in the northern sky (very early morning and very late evening) are not really important to us for use in shadow analysis but maybe it is still useful to know how it all works.

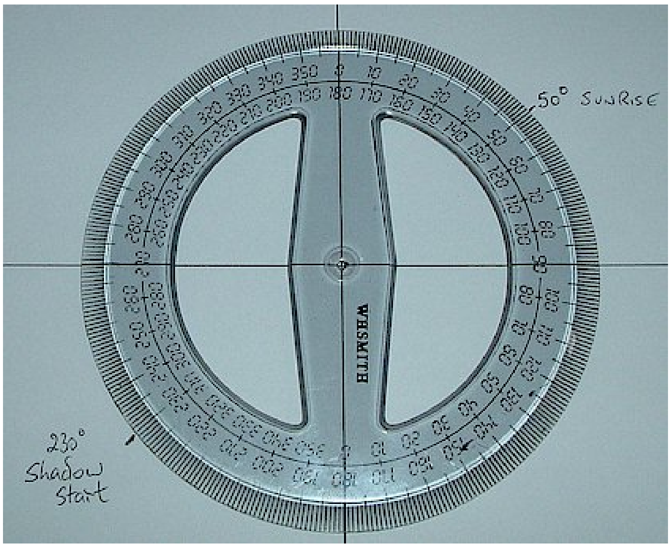
The following sequence of pictures will hopefully explain the start of the 'boomerang' shape in full. To do this I will use the data available on the BS8206 sunpath diagram and will plot the resulting shadow.
By using a ruler to line-up the centre of the chart with a time-line on a suns path line I can read off the azimuth angle from the outer edge.

In the picture below, I am reading the value for June 22nd at 6am. The azimuth angle is around 77 degrees.

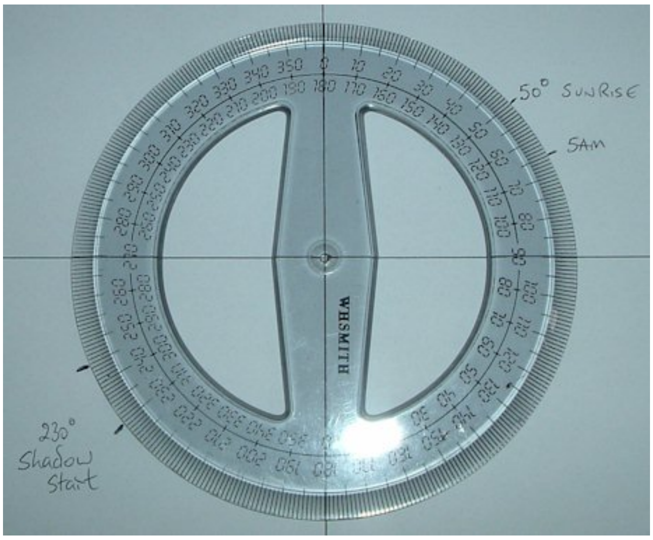


To keep things simple we will work in GMT and I will draw the plot onto paper and use a 360 degree protractor to represent my horizon. Imagine that I am standing in the centre of the protractor!

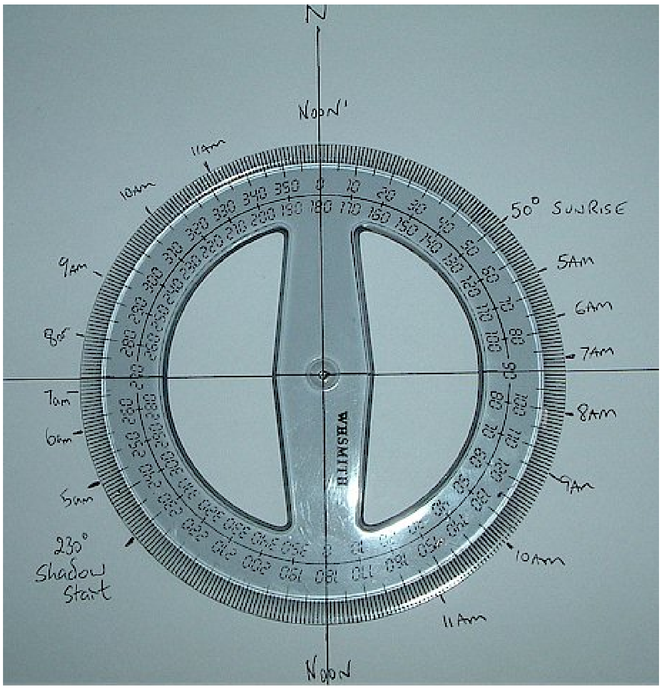
The first picture shows sunrise for June 21st, it is around 50 degrees azimuth. My shadow would be opposite the sun at 230 degrees azimuth (in reality the shadow would probably not be visible as it merges with a host of other shadows and the landscape would also not be perfectly flat).



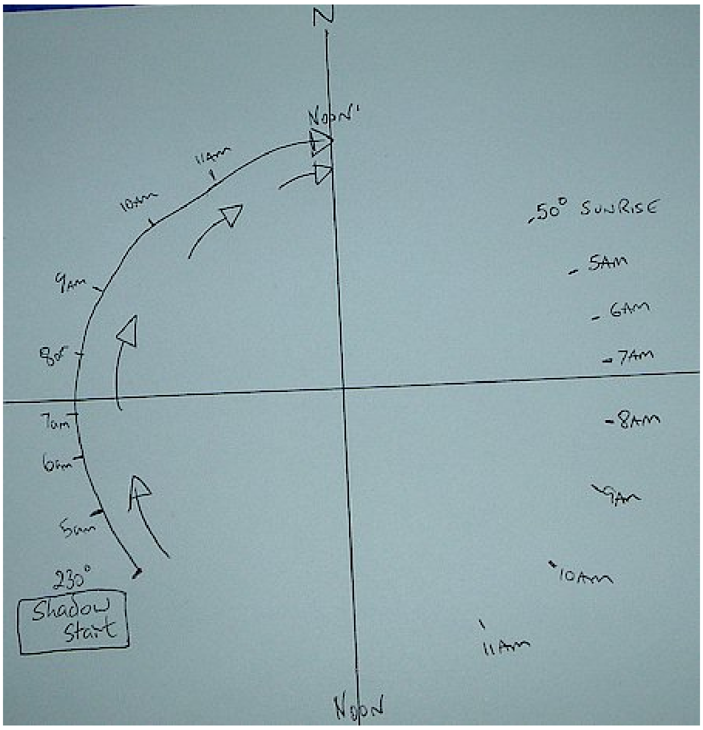
My next reading is for 5am which gives an azimuth of around 65 degrees. The suns azimuth (its position in the sky measured from due north) is moving southwards towards due east. My shadow is moving too.



If I carry the procedure further I can plot the suns azimuth for all its visible hours. The next picture stops at Noon because I think you get the idea.



If I remove the protractor and crudely join the shadow position together, it shows the beginning of a trace line (half a boomerang).



The above description illustrates shadow position but **not** shadow length. Shadow length is determined by the suns height in the sky or its altitude.

These are the two important factors, sun azimuth and sun altitude.

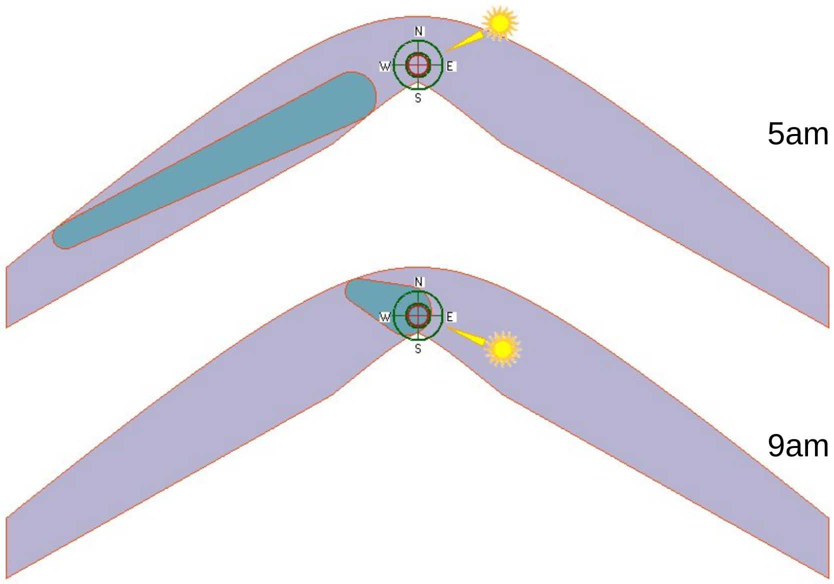
Azimuth tells us the position of the shadow, Altitude tells us how long it will be.

The higher the suns position the shorter the shadow. Shadows will be very long around sunset and sunrise. During the middle of the day they are very short. Subsequently, the width of the boomerang shape will be very long during the start and end times but narrow during mid-day.

The next picture shows an Arbor-Shadow display of an individual shadow plotted over the larger day shadow trace.

The top image is for around 5am and the lower is for 9am (**note the position of the yellow sun icon at 5am and 9am and how it relates to my protractor drawings**). The image also shows the differences in shadow length.

The ‘boomerang’ is complete! Its ends are cut off at a distance of 100m from the tree but would actually go on infinitely.



Note also that if the trace were to be only shown for the hours 9am-9pm you would get **a smaller reversed ‘boomerang’ shape** as only the middle part of the trace would be shown.

Part of the problem of misinterpreting the shadow graphics may relate to APN 5 *“Shaded by Trees?”*. This document was produced for arboriculturists by the AAIS.

The first problem with this document is figure 3. This shows a shadow position in relation to noon, 2pm, 6pm, 10am and 6am. Now I understand this diagram is not intended to be precise as it’s a sketch drawing which illustrates approximate shadow positions. But it can, I believe, give rise to misunderstanding. The main problem I have with this diagram is that it shows the shadow as being always in the northern section of a site. Worse still, is that it shows the shadow for 6am and 6pm as also being in the north where this is not possible for our latitudes in the UK (go back to the BS8206 sun path diagram again and look at the lines for 0600h and 1800h). During these times the sun is in the northern sky so the shadow will always be in the southern sky.

The second problem I have is the method the document uses to calculate the azimuth (or bearing) angle of the sun. **It is Wrong!**

Appendix C suggests that the suns azimuth can be calculated by using the described formulae. I don't wish to break any copyright by copying the information here but in simple terms their method is based upon using 15 degrees of sun movement to represent 1 hour of time. This, at first glance, makes sense as the earth takes 24 hours to rotate 360 degrees so 360/24=15 degrees per hour.

But the suns apparent movement in our sky does not follow this rate of 15 degrees per hour because of several factors such as the fact that the earth is tilted and located at different distances from the sun throughout the year. Also the earth's elliptical plane of movement fluctuates in relation to the suns plane. And we are located on the northern hemisphere of the earth so as the earth rotates, the moment and position of the sun as it appears over the horizon will be changing every day (again BS8206 confirms this).

In its example APN 5 gives a sun bearing of 210 degrees for 2pm. If you go back to the BS8206 sun path diagram and place a ruler between the center of the diagram and 210 degrees you will find the only point where the ruler intersects the 1400h line (2pm) is somewhere between Jan and Feb (or Oct and Nov) for the return sun path. It does it for 2 moments of time in the year. But the example in APN5 appendix C basically states this for all times of the year. The truth is that at 2pm the azimuth will vary between 205-225 degrees and not be static at 210 degrees as APN 5 states.