Tree Shadows: Part 3

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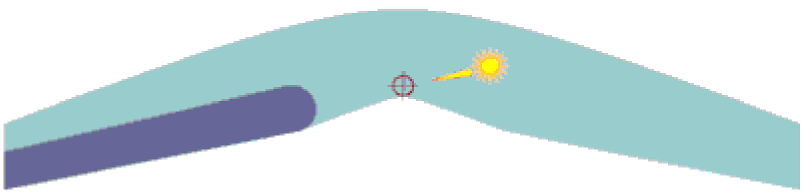
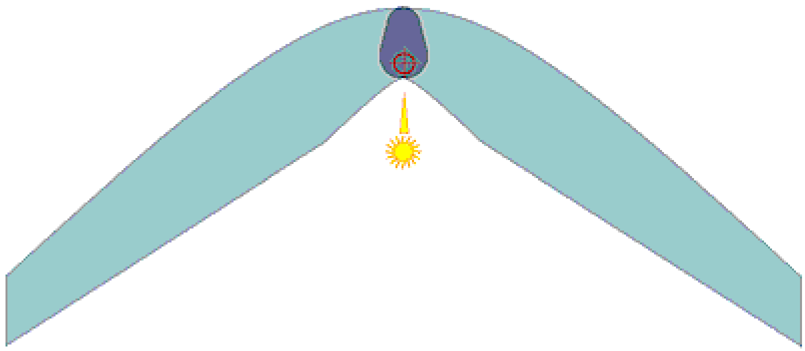
- **Shadow Movement**

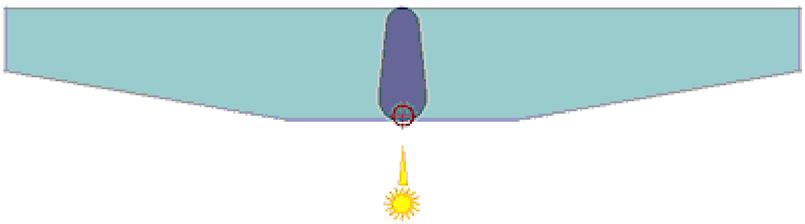
If the motion of a trees shadow for a whole day were recorded and displayed as a trace, then they can display an interesting pattern. As the sun rises in the east and falls in the west so the shadows are longest at these times and shortest for the middle of the day. The following Gif animation (for August 21st) illustrates the sun rising in the east, moving westward and then setting (imagine looking down over the tree which is marked with the red circle & cross). The shadow responds to the suns movement and also changes its length in relation to the suns altitude. The sun is highest at noon, when it is due south. The sun is constantly changing its position within the sky in these two ways, its **altitude** (height in the sky) and **azimuth** (lateral position). When the sun is close to sunrise & sunset so the its altitude is very small, subsequently the shadow length is becoming long but also changing its length at a higher rate (you can see this process in the animation). The suns position after solar noon mirrors its position before solar noon but the resulting shadow wont necessarily mirror itself in the same way if the tree is not symmetrical (this depends upon its crown shape).



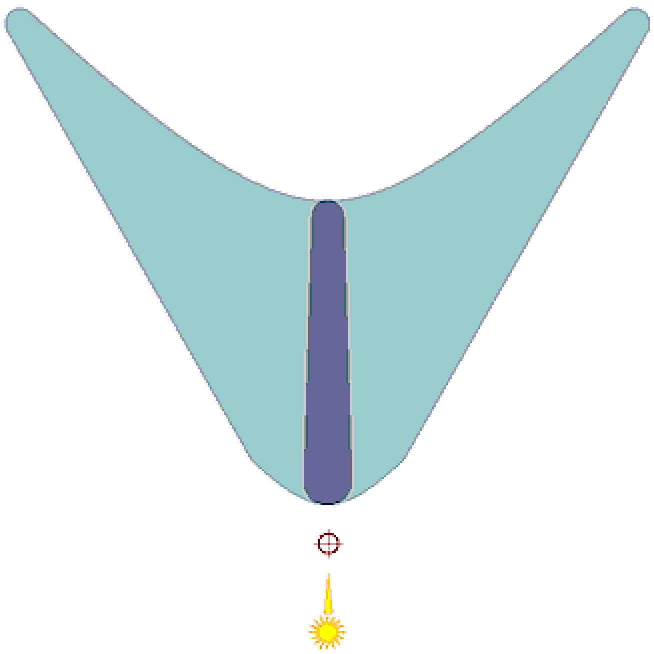
For the northern hemisphere, during June 21st (longest period of daylight hours) the sun actually rises in the north east and sets in the north west so the resulting day trace looks something like the following (the eastern and western edges have been clipped at a 100 meter distance). Its actual current shadow is superimposed over the day trace and is pointing due north.



During September & March a typical trace looks like the following.

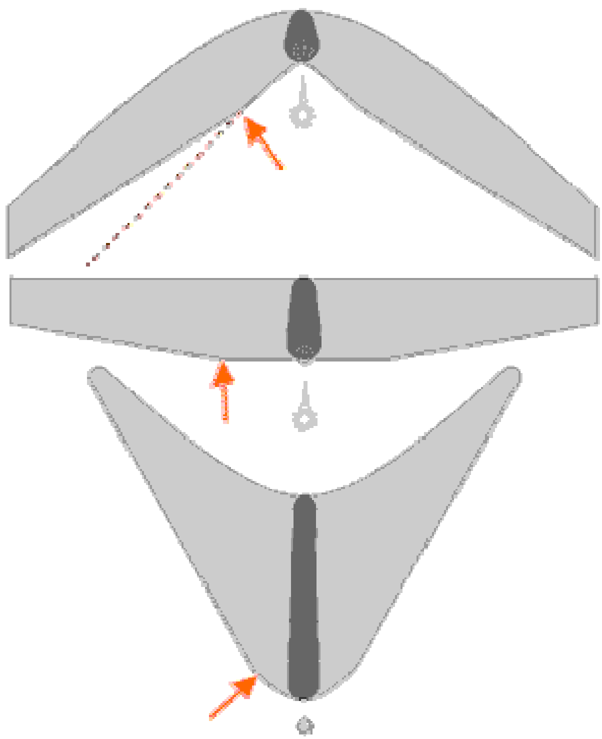


While for December 21st (shortest day) the day shadow extents for the same tree look similar to the following. The suns altitude is lower throughout the day for this time of the year so the shadows are longer.



If I were to animate the sequence for all months of a year the day trace shadows appear to 'flap' like a bird!

You may have noticed a slight irregularity in each trace shape. A 'sharp corner' can be found on each of the above images (I have marked the positions of these with a red arrow on the following image). The irregularity is due to the plotting program (Arbor-Shadow) only processing shadows for altitudes higher than 6 degrees. This is purely a processing problem where the plotting of the shadows below these altitudes requires a vast increase in processing time. At these low altitudes the sun is hovering very close to the horizon and producing shadows which are very long (a typical tree shadow could be over 200m long! They are also changing their length very quickly in relation to time. I have marked a red dotted line to show the extent of shadow which would be displayed for these lowest altitudes.



Such low altitudes are not always considered important in shadow calculation as the sun is often obscured by buildings and landscape and the shadows will merge with those produced by fencing, hedges and small obstacles such as sheds etc.

To give an idea of how the low sun altitudes can change shadow length take a look at the following table. These are typical shadow lengths calculated for a tree of 20m height.

Altitude of the Sun (degrees)	Shadow length
62 (typical for June 21st at Noon in UK)	10.6m
10	113m
5	228m
4	286m
3	381m
2	572m
1	1,146m (over 1km)
0.5	2,298m (over 2km)