Tree Shadows: Part 2

By Chris Skellern

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- **Shadow Length & Direction**

  As the Sun appears to move across the sky from east to west so all shadows produced by it will move from west to east. For the northern latitudes (Europe, USA, etc) the sun will almost always be in the southern sky and the shadows will be biased to the north (except for certain times & days). The lateral position of the sun in the sky is called its azimuth. This is measured in degrees from north or south. The azimuth for a given hour will change from day to day as the suns declination changes.

  Additionally, the length of a shadow is determined by the suns altitude (height above the horizon) and since its altitude is constantly changing throughout the course of a day, so too, will the generated shadow lengths. The shadow will be shortest at solar noon and longest just before the sun dips below the horizon (or just after the sun rises).

  One important point to mention here is the advice given within Appendix C of APN5 *Shaded by Trees.* published by the AAIS. Essentially, they suggest you simply multiply the hour offset (from noon) by 15 degrees to obtain this position (this is **hour angle calculation** and is **not** an observors angle). The term 'azimuth' isn't mentioned once (although interestingly they actually calculate the azimuth [but call it a bearing] for the sunrise & sunset positions within Appendix D). The reason for its omission is probably an attempt to simplify the subject as azimuth calculation is quite complicated. But the problem with using their suggested method is that the calculated bearings for some hours can be up to 20 degrees out from true azimuth, which, in my opinion, makes their advice quite unusable.

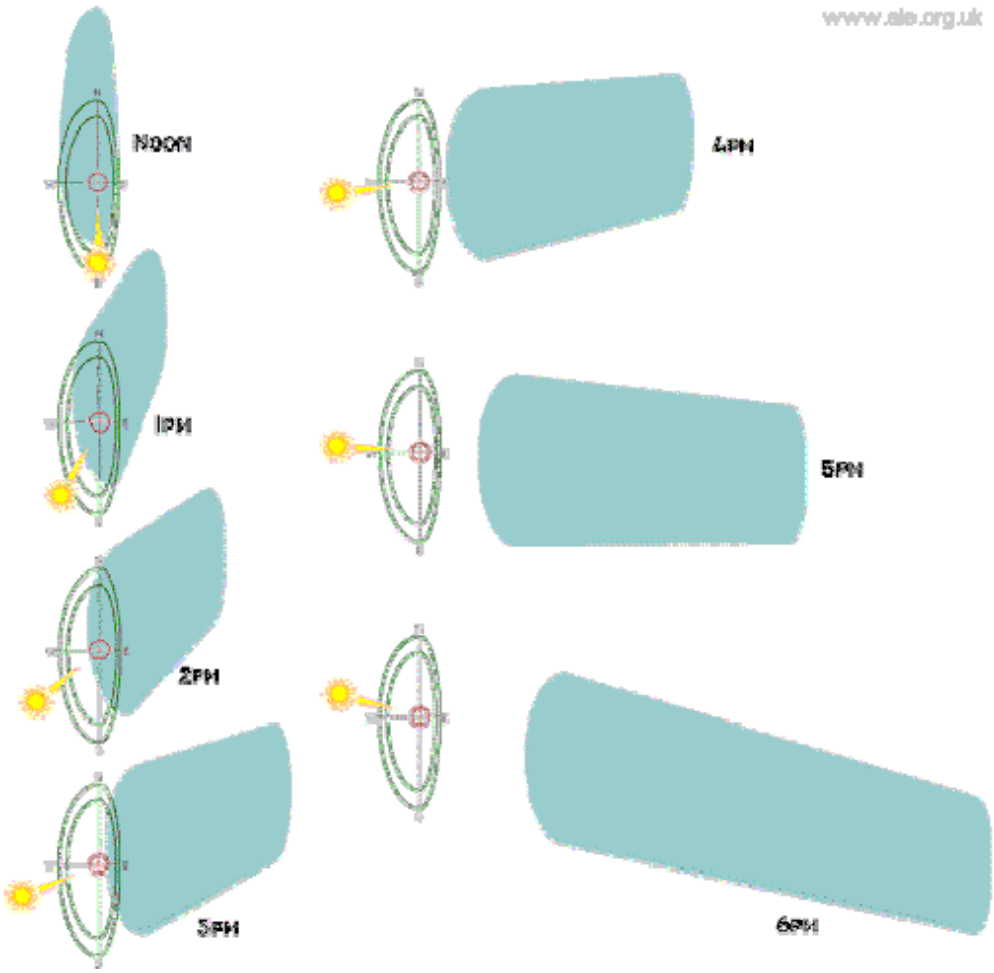
- **Shadow Shape**

  The shape of a tree crown will influence the size of the shadow. The following images attempt to illustrate this point. The pictures show the tree in a plan view (so you are looking down vertically over the tree). The red circle marks the trees stem centre and its canopy is represented by the two green circles (the smaller one represents the upper crown dimensions). In this example the canopy shape is distorted with around 8m of spread north, 9m south, 4m west

and 2m east. The month is June and the tree is about 19m tall with a 3m clear stem.

At solar noon the shadow points due north and is shortest (because the sun has reached its highest point in the sky). At this time the shadow is narrow as the sun is acting upon the narrowest part of the canopy. As the sun moves westward so the shadow changes shape and grows in length. At 3-5pm the width of the shadow is very large as the sun acts upon the broadest part of the tree. They are also getting very long. The gap between the start of the shadow and the tree represents the clear stem of the tree (as the sun descends in height so its rays travel beneath the canopy; the actual stem shadow isn't processed).

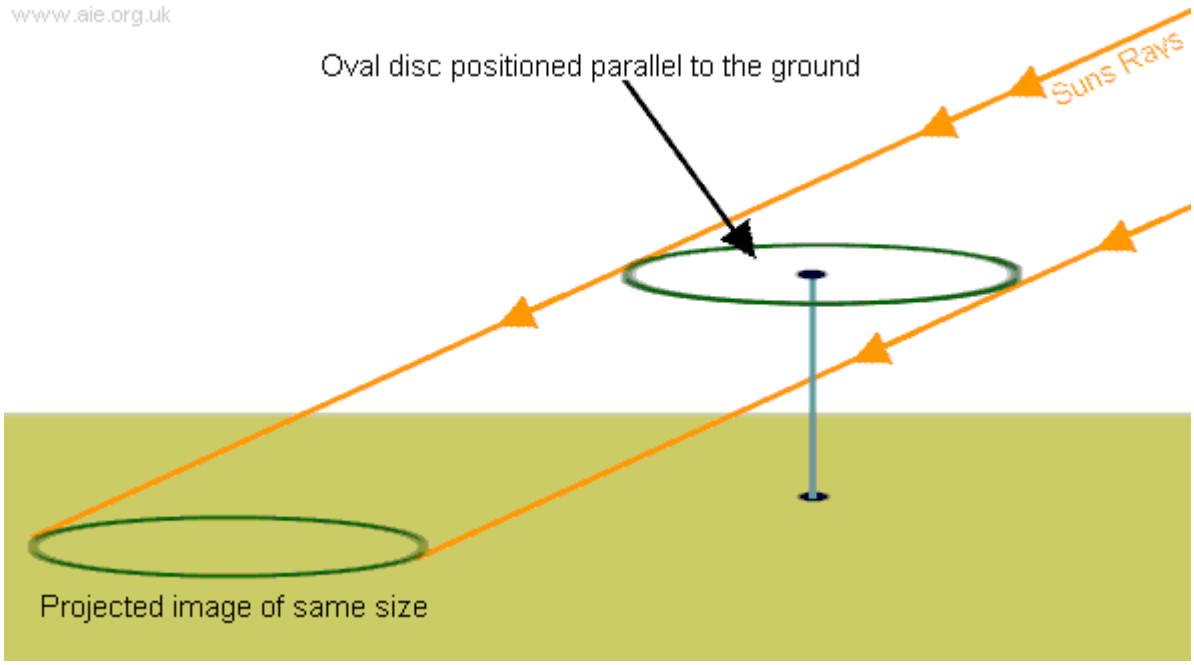
This is an extreme case used to illustrate how shape can be important, most trees would have a more regular shape.



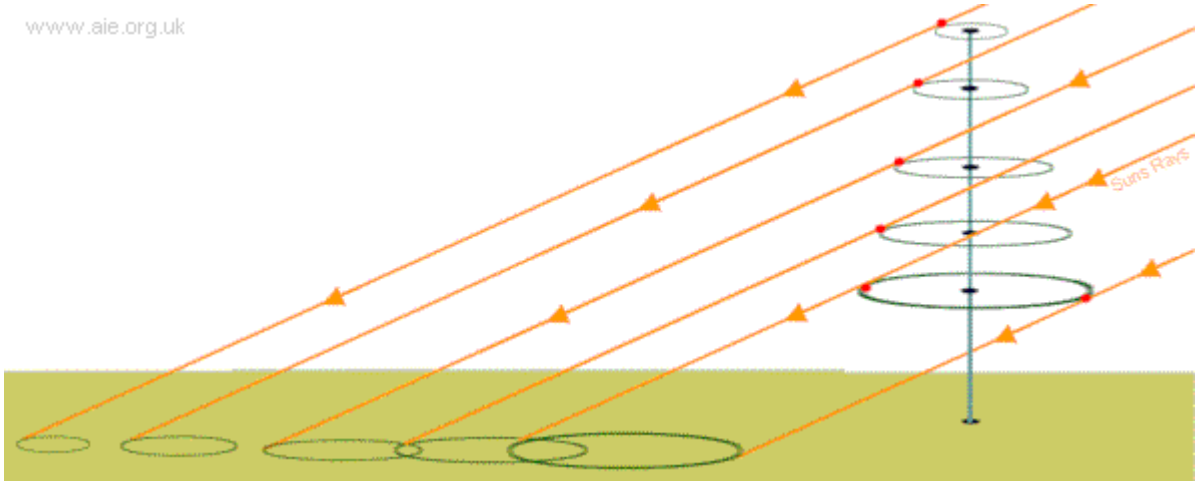
If the crown shape was distorted along the east-west axis then the above situation would be reversed where a narrow shadow would occur at dawn & dusk and a broad one would exist at noon.

- **Shadow Plotting**

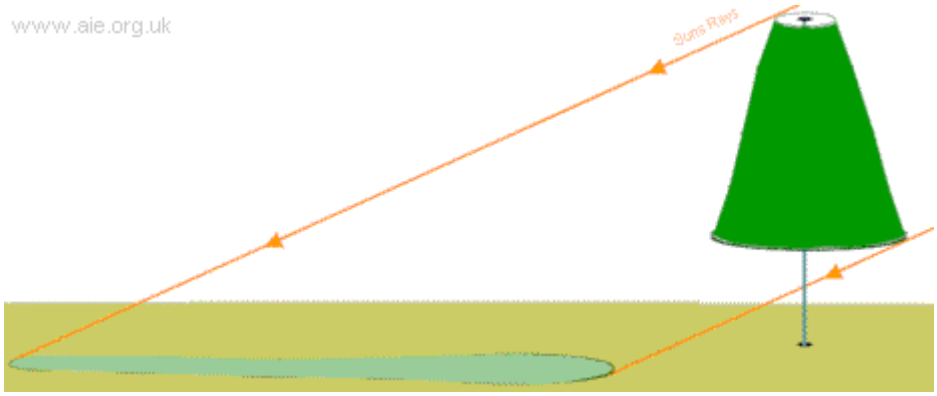
  A simple tree canopy is based upon 4 dimensions being measured from a tree centre in the direction of north, south, east and west. Assuming the tree is standing on level ground and the plane of the canopy lies parallel to the ground then each point around the perimeter of the tree canopy will be of equal height but at a different distance from the tree centre. Since light travels in straight lines and the rays of sunlight which strike the earth are considered to be parallel to each other (due to the size of the sun), it follows that an exact 'copy' or shadow of the canopy shape will appear on the ground (see following image).



Imagine this projected disc as being the base of a trees crown. If another disc was defined at a taller height, so it represented another 'slice' through the trees crown then this can also have its shadow projected onto the ground, but would be slightly further away from the tree (and probably be of a smaller diameter in relation to a narrowing tree crown). If the process were continued right to the top of the tree then I would have an irregular representation of the trees shadow on the ground.



If the distance of each 'slice' step was small then I would see an accurate representation of the trees shadow.



However, as you can see, a number of assumptions are made. First the trees is assumed to be straight and vertical. The ground is assumed to be flat and at right angles to the tree. And the crown outline wont look like a lampshade (as depicted here)!

Although some of these restraints can be overcome such as allowing for a leaning tree and a sloping crown, other factors such as a true crown shape would be impossible to cater for within a program. This is due to the infinite possibilities in actual shape and branch layout, even between trees of the same species and habit.