MEGALITHIC SCIENCE: ANCIENT OR MODERN?

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Introduction

"There is no fact in history which is not a judgment, no event which is not an inference. There is nothing whatever outside the historian's experience" (Oakeshott, 1933,100). This statement is never more evident than when considering the many 'scientific' theories relating to the Stone Rings of the late Neolithic and early Bronze Ages. These theories are simply a sign of our times; the reflection of modern scientific motivation and aspiration in the mirror of the past!

In recent years Megalithic Sites in general, and Stonehenge in particular, have been the centre of much controversy. Hawkins (1963), Hoyle (1966), and Colton and Martin (1966) have all examined the possibility that Stonehenge was an eclipse predictor; Newham has proposed a large number of 'significant' astronomical alignments. However, the outstanding name in the field of Megalithic Science is undoubtedly Professor Alexander Thom who has developed a complete scientific and technological culture from his observations of the Megalithic sites in Britain, Ireland, and France (Thom, 1967). He claims the existence of sophisticated astronomical measurement, and a calendar; but his most controversial proposal is the discovery of the Megalithic Yard which he insists remained constant to within 0.003 feet of 2.72 feet during the whole period of construction, well over a thousand years. The Professor goes further by using this unit of measurement to produce complex geometrical constructions for many non-elliptical sites - he calls them egg-shaped rings and flattened circles. The author (Angell, 1976) has given a simpler alternative method (the 'Polygonal' method) for constructing the same shapes, and there are many, many more 'scientific' interpretations of these sites.

The sport of theorising on the purpose and construction of Megalithic sites is by no means a modern phenomenon, many non-scientific cultures had their own non-scientific myths - concerning the Devil, King Arthur or the Druids. Mention of these 'stone temples' was made by scholars in Ancient Greece and Rome; more recently antiquaries like John Aubrey (1626-97) and William Stukeley (1687-1765) spent a lifetime under the fascination of these Stones and their legends. Indirectly, it is thanks to Stonehenge, via Inigo Jones's mistaken geometrical interpretation, that we have Piccadilly Circus today.

Not to be outdone, modern 'alternative science' places a high regard on Stonehenge, classifying it in importance alongside the Pyramids, Atlantis and Flying Saucers.

Jacquetta Hawkes was right when she summed up this fascination for theorising about the Megalithic Era by saying "Every age has the Stonehenge it deserves - or desires"!

Naturally there is no written evidence to support these aforementioned theories; no a-priori justification exists concerning the validity of any of them. 'Scientific' theories may appear to fit the facts but it must be appreciated that a 'fit' is firmly fixed in the context of twentieth century knowledge. Such theories were derived from a simple plausible idea being extended by the weight of our own scientific culture, which undoubtedly would be totally alien to the Britons of the last century let alone five millenia ago.

To demonstrate just how modern experience may be reflected in a Stone Ring theory, this article will derive such a theory, describing each step of its derivation from the initial elementary idea (using computer and mathematical terminology to accentuate its twentieth century foundations), thus illustrating the author's interests in computing and geometry as well as the possibility that this new theory could have been used in the construction of Stone Rings. It is obvious that without these interests the theory would never have been evolved, however, it is important to keep in mind that this theory must not be rejected because of the way it is presented. It fits the facts as well as any other theory mentioned, and it is proposed as a serious candidate for Ring construction. The mode of presentation is intended to ensure that the reader is aware of the limitations of any interpretation of Megalithic, or for that matter any other Archaeological remains. The acceptance of a theory is merely a concensus of opinion, it is not a certificate of authenticity!

Theory

One of the more evident features of the large circles and individual standing stones is the shadows thrown by them. We therefore set about producing a theory relevant to Stone Rings which uses shadows.

It is obvious to those human beings who see rather than just look, that not only does the length and direction of a shadow from a given object vary during the day (the sundial principle), but also when a direction is fixed, then the length of the shadow cast by an upright object in that direction will change, day by day, throughout they year. Fig. 1 is a typical example of daily shadow movement on horizontal ground at different times of the year. To give an idea of the scale involved it shows the path of the shadow of the apex of a pyramid (and assumes that we can plot these points even inside the body of the pyramid). Thus a point fixed in relation to a rod or standing stone, together with the knowledge of whether the shadow is increasing or decreasing at that time of year, uniquely defines one of the two days in the year when the shadow touches that point. This observation could account for the many standing stones in Britain; we will go further by using this fact to develop a means of generating the egg-shaped rings and flattened circles proposed by Thom.

We may assume that the observations are made at latitude λ in a direction with azimuth α (North = 0° or 360°, East = 90°, South = 180° etc.). After fixing a small rod of unit length in horizontal ground (less than a metre or the overall dimension of the site would be enormous), we measure the length of its shadow each day in direction α. Naturally since the sun is not a point object in the sky, the shadow has inexact length - we assume that the umbra is measured and ignore the penumbra. If the sun at the time of measurement has declination δ, then the true angular altitude of the centre of the sun σ (ignoring refraction) is given by the formula:-

$$\sin \delta = \sin \lambda \sin \sigma + \cos \lambda \cos \sigma \cos \alpha.$$

For each δ this is readily solved for σ, which may then be adjusted for the angular width of the sun and for refraction, whence the length of the shadow is $\cot \sigma$.

In order to study the variation of shadow length during the year we use the following model of the sun's declination.

$$\sin \delta = \sin 23.906^\circ \sin \phi$$

where $\phi = \theta + 0.0362^\circ \sin(\theta - 218.067^\circ)$

and $0 \le \theta \le 360^\circ$. $\theta = 0^\circ$ on March 21st and varies by $\frac{360^\circ}{365}$ per day.

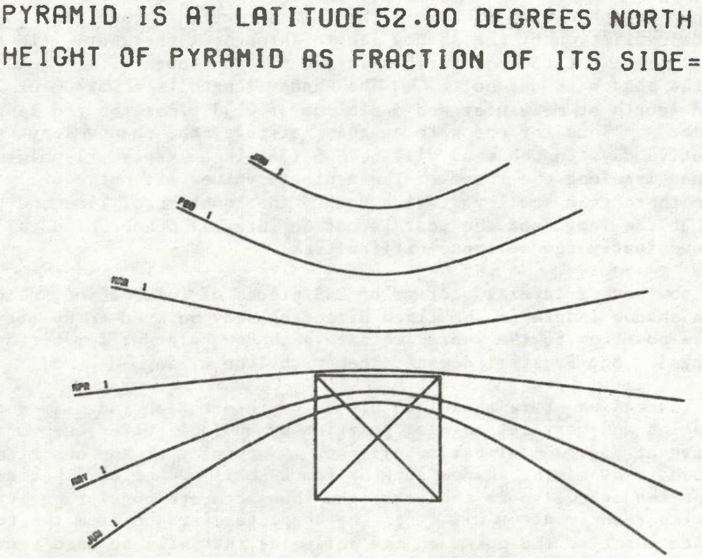

Figure 1.

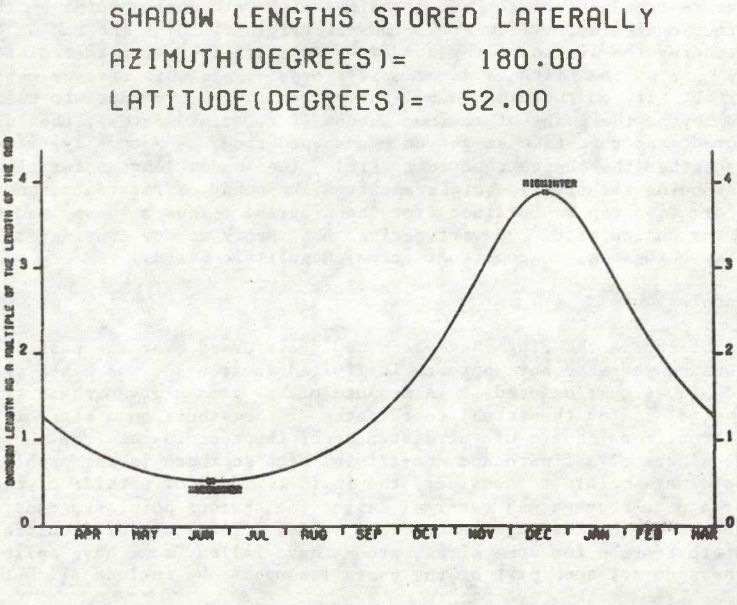

Figure 2.

If we imagine following the sun around the earth at the fixed latitude λ such that the shadow is always in the same direction α then Fig. 2 shows a typical variation of the shadow length throughout the year. In the example we are at latitude 52°North with the sun due south (i.e.α =180°) and hence the shadow is due north. The shadow length is a maxium of 3.88 times the rod length at midwinter and a minimum of 0.53 times the rod length at midsummer. Thus for one site on this latitude, the shadow lengths for consecutive days in the year will be 365 (366 in a leap year) points placed contiguously along the curve. The ordinate values are not equally spaced because there is a small variation due to the Equation of Time and to the fact that the length of the year is not an integral number of days; but we may conveniently ignore these difficulties.

We now have a lateral storage of 365 pieces of information, which when given a shadow length in the fixed direction, may be used to specify its relative position in the year - we have a shadow calendar for birthdays or deathdays! But it still doesn't look much like a ring.

If instead we store these 365 pieces of information radially about another fixed point and vary its angular position by 360/365° after each measurement we arrive at Fig. 3 - almost an ellipse. Naturally at any one site we would only wish to store the shadow lengths for a small number of 'special' days (perhaps ten or twelve in the year) and then accurate angular positioning is not so important - after all it is the absolute distance from the central data reference point to the point on the perimeter that will be used year after year to check if a special day has arrived. Note there are two ways of setting out the data, clockwise or anticlockwise; in what follows we arbitrarily chose anticlockwise.

The figure is still not satisfactory for data storage and retrieval since at the top of the diagram the information for half the year is squashed on to about a sixth of the perimeter. A simple way of distributing the months more sensibly would be to change the origin of measurement - after all there is no absolute reason for measuring the shadow from the base of the rod. We could measure from any point; but for simplicity we choose a point on the chosen directional line. If we take the new origin south of the rod we are in fact extending the length of the shadow by some arbitrary constant distance (d units say) and so the distance $d + \cot\sigma$ is stored. In this case we obtain a flattened circle! If, on the other hand, the origin is taken d units to the north of the rod, beyond the point of maximum shadow (i.e. at midwinter), then $d - \cot\sigma$ is stored, and this time we get an egg-shaped ring. Naturally, if d gets very large then the shapes tend to a circle, the shadow lengths for all days in the year being relatively equidistant from the point of reference, and no useful information can be obtained from the diagram. Thus a 'happy medium' is necessary in the choice of d. Having derived the theory we now consider the possibility of it being used to construct actual Megalithic Sites.

Examples

Of course the rings have been badly disturbed over the past four or five thousand years so any approach is limited in accuracy and hence statistical techniques must be used. A measure of how good a given shape (with parameters λ, α, d) is for the actual coordinates of the stones on a site, is taken to be the root mean square of the distances of the coordinates from the shape. The stones are of a finite and non-trivial size so there is the problem of what coordinate points to consider, the inside, middle or outside of the stones. For a data storage and retrieval device the obvious points to consider are the centres of the inside edges of each stone. There are difficulties of interpretation for some sites, stones have fallen, some have split in two, and others do not seem part of the overall shape. We include all but the most

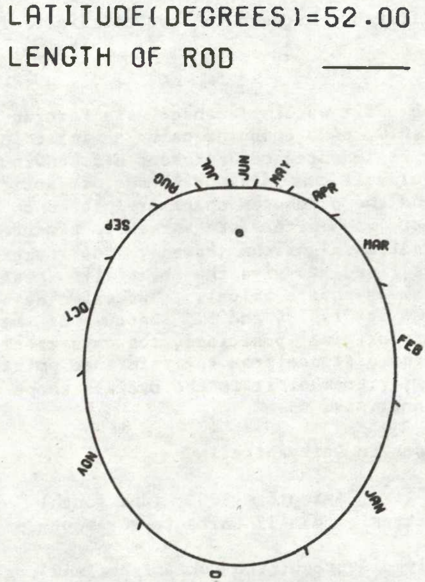

Figure 3.

Shadow lengths stored radially.

blatant 'odd' stones since we are making a statistical interpretation of the sites and we do not want subjective results! This does mean, however, that dubious results will be obtained for some stones.

To make a fit there are four more parameters to be considered:-

(a) the relative positions of the coordinate origin and the data base reference point (two values)

(b) the angular difference between the two coordinate frames

(c) their relative scales.

The method of obtaining a fit was implemented as a Fortran IV program on the University of London C.D.C. 6400 computer using an Imlac interactive graphics terminal. The author is indebted to Professor H.J.Godwin and Jonathan McDowell for their invaluable comments during the production of this program. Both the coordinates and the prechosen shape are placed on the screen and the above-mentioned four parameters are varied to produce a reasonable fit. Then the Powell minimisation algorithm (Powell, 1964) takes over, varying all six parameters (λ stays fixed) to give the 'best' fit (best in the sense of minimising the root mean square value). Two examples of the result of this technique are given in Figs. 4 and 5. Because of the certain movement of the stones from their original positions, the days specified in the diagrams are calculated not on the distance from the reference point but their angular position relative to it; remember it is the overall shape which is the principal consideration of this analysis.

Fig. 4 is of Barbrook in Derbyshire.

Latitude = 53° 16.6′ Azimuth = 180° (due south)
Height of rod = 0.66 metres d = 12 units to the south of the rod.

This site has been badly disturbed, the Duke of Rutland's gamekeeper dug a robbing trench through it - to no avail! For a description of this site and many more in Britain the reader is recommended to read Burl (1976) for an excellent survey of the 'state of the art'. Barbrook is described by Thom (1967,66) to be a flattened circle and as is readily seen in Fig. 4, a comparable outline is produced.

Fig. 5 is of Kenmare, County Kerry, Eire - an egg-shaped ring.

Latitude = 51°51′ Azimuth = 215°
Height of rod = 0.42 metres d = 16 units to the north of the rod.

The plan for this site was supplied by John Barber: the inner edge 'centres' are marked with a '+' and a straightedge approximation to each stone outline is also given.

Conclusion

This theory was developed with no a-priori information - simply an observation of the behaviour of shadows at Megalithic sites. At each step in the development, new ideas based on the author's experience in computing and mathematics were introduced to make it consistent with observed facts - which is exactly the case for every other theory proposed for these Rings. The Shadow Calendar Method gives fits which are just as good as those of Thom, or of the author's alternative Polygonal Method. It requires very little sophistication (no Megalithic Yard - all measures are absolute), only reasonably accurate measurement and the patient observation of shadow lengths.

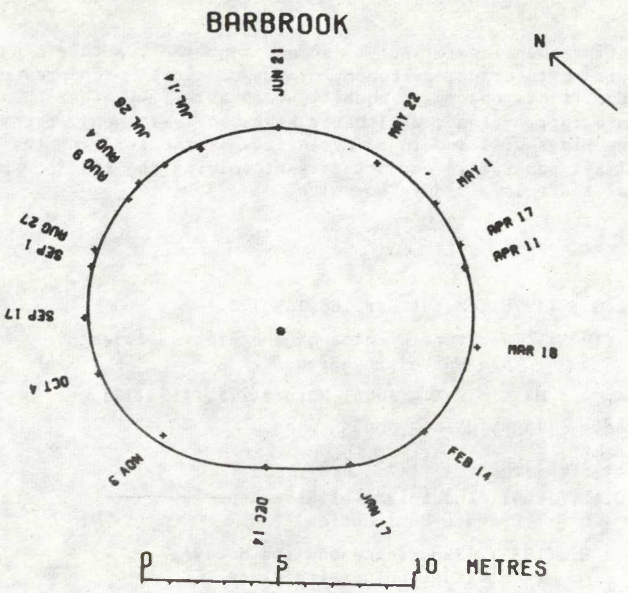

Figure 4.

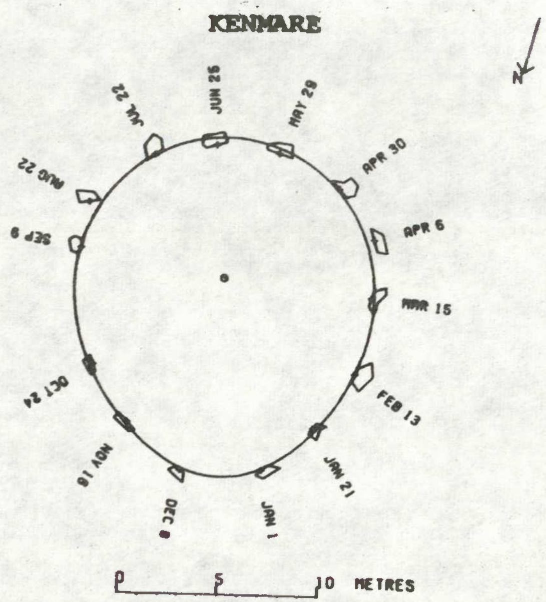

Figure 5.

All existing theories reflect to some extent their author's particular interest be it engineering, astronomy or mathematics. The present author therefore submits his theory as equally acceptable. Whether these hypotheses are fact or fancy will never be known. The only certainty is that Stone Rings will remain as mysterious as the smile on the Sphinx, and we shall all persist in our attempts at solving the riddle - always assuming that there is a riddle to solve!

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