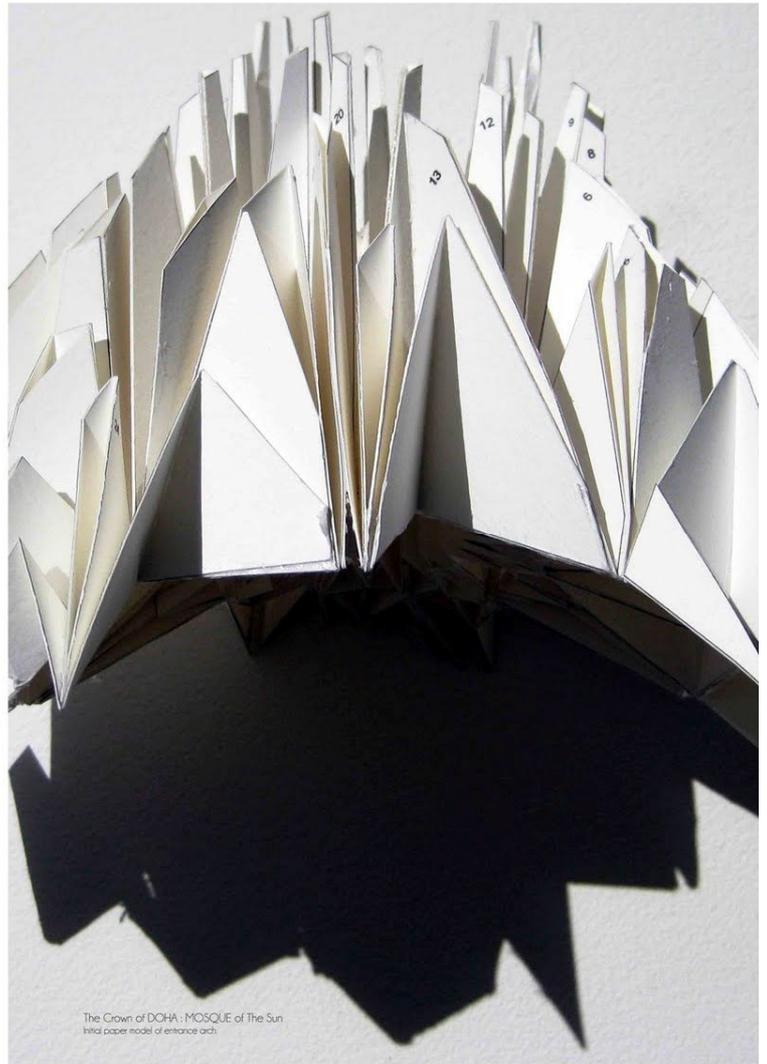
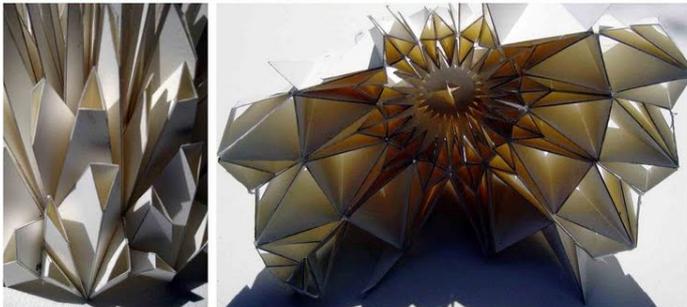


# The British Sundial Society

## BULLETIN

BSS Bulletin 24(iii)



The Crown of DOHA : MOSQUE of The Sun  
Initial paper model of entrance arch

September 2012



VOLUME 24(iii)  
September 2012

*General DIRECTIONS for Placing an Horizontal SUN-DIAL truly North and South, and for Setting CLOCKS and WATCHES by the same.* By B. MARTIN, Fleet-Street.

THE THEORY of SUN DIALS and CLOCKS has been largely treated of in our INSTITUTES of *Mathematical PHILOSOPHY*; but we find there is much wanting besides, a practical Method of *fixing the one*, and of *regulating the other*; which therefore we shall here supply. The Methods of fixing an *Horizontal SUN-DIAL* are many, but some of them too difficult, and others too expensive for common Use; we shall therefore mention only the three following, which we think will be sufficient for any *ingenious Mechanic*.

**METHOD I.** Let the Plane of the Pedestal on which the Dial is to be fixed, be made truly horizontal by a *Level*; then from a Point near the middle Part describe a Circle, and in that Point, or Center, fix a Wire as perfectly upright as you possibly can; and of such a Height, that it's Shadow at Noon may fall within the Circle. Then will the End of the Shadow cross the Circle in the Forenoon, and again in the Afternoon; mark those two Points in the Circle, and divide the Distance between them into two equal Parts by a third Point; and through this Point and the Center of the Circle, let a strait Line be drawn, which shall be the true *Meridian Line*, or that upon which the XII o'Clock Line of the Dial is to be nicely fixed; and the Dial will always go true.

**METHOD II.** The Plane of the Pedestal being truly levelled, as above, let a *Variation-Compass* be applied with it's strait Side against a Pin fixed in any Part near the Center, and moved about, till the Needle points to 20 Degrees *West of the North Point* (for that is the present *Variation of the Needle*), and then a Line being drawn along by the Side of the Box, will be the *Meridian Line* required.

**METHOD III.** Let your *Watch* be set by a Regulator to the *true Mean Time*, then place the Dial on the Top of the Pedestal, and move it above 'till the Time shewn by the Dial is so many Minutes faster or slower than the Watch as is required by the EQUATION-TABLE above for that Day.

Your Dial being thus truly fixed, will be always a sufficient Regulator for your *Watch* or *Clock* by the Assistance of the TABLE of the EQUATION of TIME. For the Reader must know, that because the SUN does not move in the EQUATOR, which is the only Circle whose Motion can measure *equal Time*; and also because its *annual Orbit* is not a CIRCLE, but an ELLIP-SIS, therefore the Time shewn by the DIAL cannot (on both these accounts) be *equal Time*, such as is that of a CLOCK or WATCH, but will constantly differ from them, excepting *four Days in the whole Year*, in which they will shew the same Time.

It has therefore been the Business of ASTRONOMERS to make a Computation of this *Difference of Time* between a *Dial* and *Clock* for every Day in the Year, which makes the *Table of Numbers for equating Time* in a *Watch* or *Clock*, whenever they become faulty, or do not shew *equal Time*; for while the Clock or Watch shews *equal Time*, or goes true, there will always be the same Difference between them and the Sun-Dial, as is expressed by the Numbers in the Table for any particular Day.

Hence the Equation-Table always supplies the Place of a Sun-Dial, or you see the Time both by the Clock and Dial on any Day, as truly as if the Clock and Dial were both in your View. As we divide the natural Day, or Space of Time between two Noons, into twenty-four Parts

or Hours, so the Days and Hours shewn by the *Dial*, will always be *unequal*, as those shewn by the *Clock* or *Watch* are ever *equal* to each other; which Property renders those Instruments of such universal and important Use in all the Concerns of Life.

To regulate *Watches* and *Clocks* by an EQUATION-TABLE will be to very little Purpose, unless they are good Work; and go well; which you may know by the following Method. Let a Telescope (of any sort be firmly fixed with a perpendicular Wire in the Focus of its Eye-glass; and then observe, on a clear Night, the Hour, Minute, and Second by the Watch when any noted Star comes to the Wire; let the Telescope remain unmoved 'till the next Night, and then observe the Minute and Second when the same Star touches the Wire again. If this Interval of Time be *twenty-three Hours, fifty-six Minutes, three Seconds*, your Watch goes exactly true at that Time. And if this Experiment be tried for several Nights successively, you will find if it continues to go true, and, of Course, if it be good Work.

Your Watch or Clock being known to be good, may be rectified to the Mean or equal Time by the Equation-Table, thus: Suppose you would set the Watch right on *January* the 1st, then you see in the Table, that on that Day, *Watches are before (or faster) than the Sun-Dial* by four Minutes, eight Seconds; therefore so much must the Index of the Watch or Clock be moved forward, or beyond the Time shewn by the Dial; and it will be right.

Again, *May* the 1st, *Watches are 3' 8'' slower than the Sun*; and so much must the Index of the Watch be placed short of the Time shewn by the Dial that Day. And the Watch being good, and once set right, will always keep its proper Distance from the Dial, and will agree or coincide with it, but four Days in the Year, *viz. APRIL 15, JUNE 16, AUGUST 31, and DECEMBER 24.*

On the other Hand, by the Watch or Clock well rectified, you always know the Time by the Sun (or Dial) by the Equation in the Table for the given Day. Thus, on *January* the 1st, the Time by the Dial is 4' 8'' less than the Time shewn by the Watch; and on *May* the 1st, the Time of the Dial is before that of the Watch, by 3' 8''.

The Greatest Equation, or Difference between the Time of the Dial and a Watch, is on *November* the 3d, when it amounts to no less than the 16' 6'' by which the Dial exceeds the Clock; whereas the Clock can never be more than 14' 42'' before the Dial, which happens on *February* 10.

The Time of the Day for setting the Watch will be better the nearer it is to Noon; and, indeed, it is at Noon, or XII o'Clock only, when you can set it precisely true, for at all other Times before or after, the Shadow of the Gnomon or Stile cannot point out the true Solar Moment of Time for two Reasons, *viz.* (1.) The Sun by Refraction of the Air is always too high, and therefore the Shadow will in the *Forenoon* be a little too fast; and in the *Afternoon*, a little too slow, on that Account. (2.) The Sun not being a *Point*, but subtending an Angle of *half a Degree*, will occasion the same Errors as the Refraction, which will therefore be doubled. But these Errors decrease with the Time from *Noon*, and the Shadow at XII is not affected by either; and of Course, the Moment of NOON is the only Time to set the Watch exactly true.

(Price Six Pence.)

*Instructions for setting up a horizontal sundial, as issued by the London mathematical instrument maker Benjamin Martin in a leaflet of 1768. An Equation of Time table for that year was also included. The language may sound rather dated but the methods proposed remain true today.*

© The Trustees of the British Museum.

**Front cover:** *The Crown of Doha: Mosque of the Sun—design details of an architectural study for a solar dome. See page 41 for the full story. Illustration from Sara Shafiee and Ben Cowd.*

**Back cover:** *The new Angel with Sundial at Talaton church, Devon, made by Harriet James. See the New Dials feature on page 28 for more details. Photo: H. James.*

# BULLETIN

## OF THE BRITISH SUNDIAL SOCIETY

ISDN 0958-4315

VOLUME 24(iii) - September 2012

### CONTENTS

1. Editorial
2. A Standing Stone and its Possible Astronomical Alignment—Using seasonal shadow and light displays in the Neolithic - *Daniel Brown*
6. Reader's Letter - *Drinkwater*
7. Check-in at Noon—A noon dial with analemma at an airport check-in desk - *Douglas Bateman*
8. The Stereographic Projection and Quadrant by Henry Sutton - *Michael Lowne and John Davis*
15. Postcard Potpourri 23—Churchill, Somerset - *Peter Ransom*
15. Gnomon Supporter - *Mike Cowham*
16. In the Footsteps of Thomas Ross. Part 2: The sundials at Craigiehall - *Dennis Cowan*
18. BSS Group photograph—Cheltenham, 2012
19. Cathedral Mass Dials - *Tony Wood*
20. The Planispheric Nocturnal - *Mike Cowham*
21. The Clock and the Sundial - *JD*
22. Lost Bonar Dial Resurfaces (Briefly!) - *John Davis*
23. A Dutch Manuscript Showing Polyhedral Dials - *Heilke van der Wijk and John Davis*
26. New Dials - *Brown, James*
28. Upton Manor Farm, Cambs - *JD*
29. The Tyttenhanger Sundial - *Geoffrey Lane*
32. The Old Meeting House, Norwich - *JD*
33. The Sundials of Gerald Laing - *Dennis Cowan*
34. Obituary—Peter Hingley (1951-2012)
35. Decorative Dials - *Tony Wood*
36. A Medieval Equinoctial Dial Excavated at St James's Priory, Bristol - *John Davis and Cai Mason*
40. Holbein's Cylinder Dial - *JD*
41. Mosque of the Sun II: Crown of Doha - *Sara Shafiei and Ben Cowd*
43. Early 19<sup>th</sup>-century English Drawings of Greek Dials - *John Davis and Jérôme Bonnin*
45. Exhibition of Sundials, North Oxford - *Douglas Bateman*
46. An Equatorial Sundial with EOT Adjustment: Update - *Roger Bunce*

### EDITORIAL

Readers of this issue might notice that the Editor's byline is attached to rather too many of the articles. The reason for this is that, for the first time in a number of issues, I was rather short of material and so either had to reduce the page count or to generate extra material. It is surprising how quickly the *Bulletin* uses up the stock of reserve, timeless, pieces. Our regular contributors, thankfully, continue to provide the core of every issue but I really do encourage other members to contribute something—I need articles from 1/8-page fillers (just a picture and a caption) through simple reports of a dial you have made or seen on your travels, in a museum or up for

sale, to multi-page, full-blown research studies. The scope of sundialling is so wide that everyone ought to be able to find something of interest to share with us.

A few issues ago, I said that I hoped we would be able to have more articles on polyhedral dials. I am pleased to meet that promise this time. Amongst the articles you will find, in the centrespread, the drawing for a dial which doesn't, as far as we know, exist. As a challenge to members, please try to visualise, in any manner you like (drawings, sketches, models) what the dial would look like. We may even find a small prize for the best solution!

# A STANDING STONE AND ITS POSSIBLE ASTRONOMICAL ALIGNMENT

## Using Seasonal Shadow and Light Displays in the Neolithic

DANIEL BROWN

Sundials and gnomons pointing out dates and times are a beautiful reminder of how we understand the movement of the Sun and use it to structure day and year. They also encapsulate the basic astronomical knowledge and concepts of the individuals and therefore their societies which have built them. At the heart of every sundial lies the recognition that the daily and seasonal change of light and shadow is repeated over and over again, in the past, present and into the distant future. Such knowledge was developed well before any written documents existed during times when observing did not mean measuring but rather watching and embracing the findings into a far deeper ritualistic religious framework. A 4,000 year old monolith located at Gardom's Edge with its striking orientation and in the midst of a landscape rich in other monuments is presented as a possible example of such astronomical knowledge and how it might have been applied to create a deeper meaning for this monument.

Within the Peak District National Park there are many ancient monuments ranging from the Neolithic, through to Roman and more modern times. Gardom's Edge close to Baslow is a special example of how in only a square kilometre you can experience the entire impact humans have had on the landscape. The gritstone scarp of Gardom's Edge consists of a medium high plateau overlooking the River Derwent. The area is littered with many rocks and overgrown with heather, bracken and partly birch trees. But it allows beautiful vistas towards the West and part of Chatsworth estate. The easiest approach in the sometimes quite boggy ground is from the free car park at the Robin Hood Inn as outlined in Fig. 1. Walking towards Baslow along the main road there is a foot path that can be taken to slowly walk higher past old braided hollow ways, cairns, and a medieval hermit's hovel. After having passed through an old dry stone wall gate the path forks and the right path along the dry stone wall will take you onto the plateau. After following the wall for a while you will cross the tumbled remains of another wall and a gate will be to the right. Entering, one is now only metres away from the monolith. Detailed descriptions of walks on site can be found in Harris<sup>1</sup> or Johnstone<sup>2</sup>.

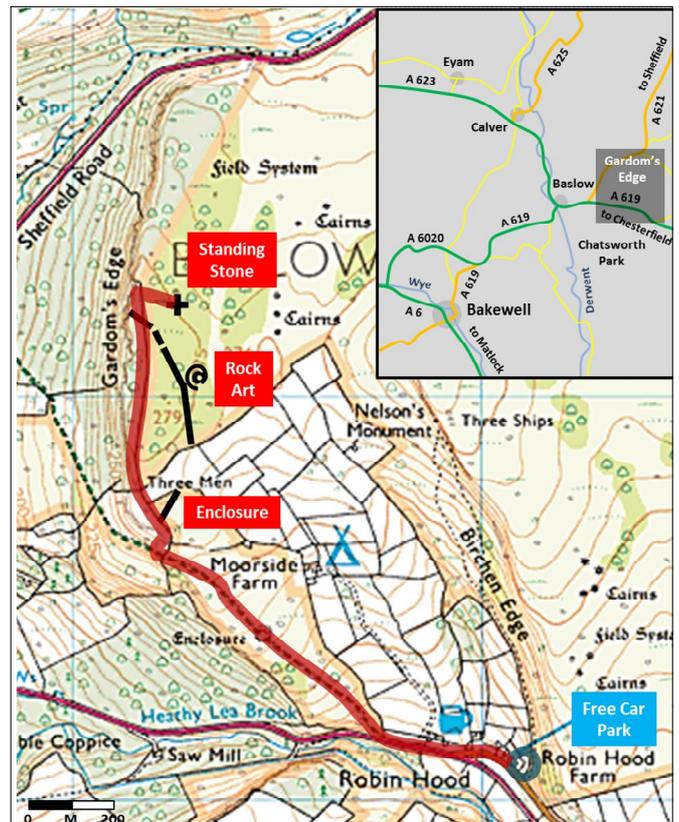


Fig. 1. This OS-map illustrates the location of the standing stone at Gardom's Edge. The free car park and various relevant ancient sites are labelled, including the easiest access route in red. The inset gives a larger overview of the region.

The area surrounding the monolith contains several Neolithic monuments that are proposed to be contemporary, including an enclosure of 100 m × 500 m size with walls 5–10 m wide and up to 1.5 m high (which will have been crossed twice while approaching the site) and *in-situ* rock art on a solidly grounded boulder 2 m × 1 m (located only 200 m further from the monolith). More difficult to spot are some Bronze Age round houses and field systems. A more in-depth overview of the site has been given by Barnatt.<sup>3</sup> These examples illustrate how humans have inhabited and farmed this region as well as given it a deeper ritual or religious meaning as expressed for example in the enclosure.

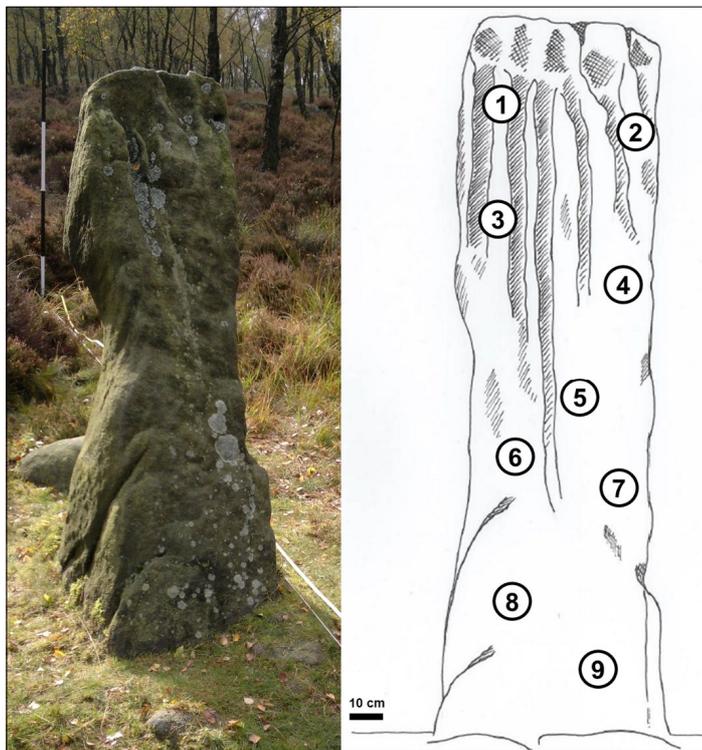


Fig. 2. A contemporary image of the standing stone (left) at midday on 13 October with the north-facing side in shadow. Note the presence of possible packing stones at the base. The sketch of the north-facing side (right) shows the erosion features as well as the nine locations used for the survey of the gradient and orientation.

Even though the entire landscape is littered with rocks the monolith is outstanding in its triangular shape and height of 2m illustrated in Fig. 3. It is also located a mere 50m north-east of one of the two entrances of the enclosure. It is made from a similar gritstone as the bedrock and the surrounding boulders but it is more angular than the others. It has suffered severe weathering leading to deep localised erosion. At its base several smaller stones can be made out (see Fig. 2) as well as a slight local increase in the ground level, both leading to the possible interpretation of packing stones and therefore an intentional erection of this stone. Such standing stones are rare in the Peak District as they tend to have been removed to be used in buildings over the millennia. There are no other such examples at Gardom's Edge or other adjacent moors, making this an ideal opportunity to study such a monolith in its original setting.

A detailed erosion study was carried out for the most affected north-facing side. The systematic mapping of weathering features indicates that the stone has been at its

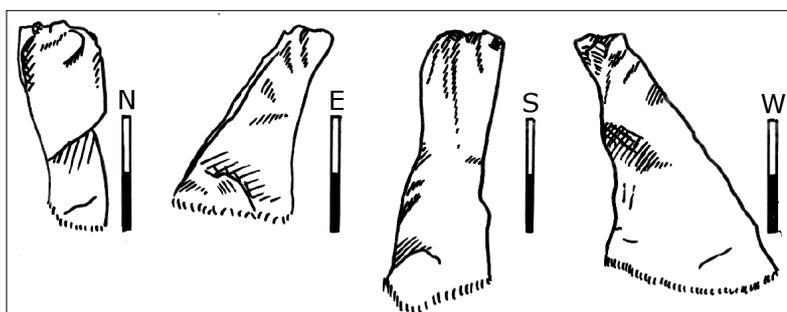


Fig. 3. The four sketches show the profile of the monolith when looking N, E, S, and W. A metre scale is given for comparison. Note the rather unusual angular or triangular shape of the stone.

current orientation for a significant period. The features are consistent with erosional processes at this orientation and have also occurred in Neolithic stone circles consisting of sandstone (see Duddo stones NT931437 described by Younger and Stunell<sup>4</sup>).

Ignoring the impact of localised erosion, the stone has one side which would have been quite smooth. The orientation and gradient were surveyed using nine different locations on this side that were mostly untouched by erosion, as seen in Fig. 2. This north-facing side is orientated so that it slopes up towards the South, its strike perpendicular to the gradient was measured to be  $(92.0 \pm 2.1)^\circ$  from geographic North and the overall gradient was  $(58.3 \pm 2.9)^\circ$ . Already, using only a tape measure to assess the steepness of the slope and a magnetic compass, it is possible to confirm the measurements on site. Otherwise, the stone appears to be upright only with a marginal tilt of  $(4 \pm 4)^\circ$  to the West.

These surveys were followed up by a high-resolution three-dimension survey of the surface structure of the stone. Together with the previously surveyed orientation and a rendered model of the monolith, a realistic illumination of the standing stone could be modelled including the correct ecliptic obliquity for the proposed erection time of 2000 BC ( $23.95^\circ$ ).<sup>5</sup> The overall rendered model is shown in Fig. 4 for 2 June, 1pm local time with shadows showing the realistic modelling of the erosion of the stone. The insets illustrate the north-facing side looking up the slope

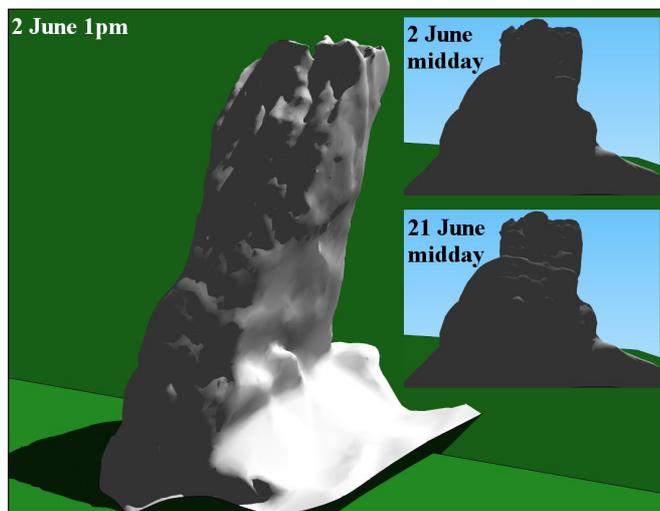


Fig. 4. The rendered three-dimensional model of the standing stone as illuminated 2000 BC on 2 June 1pm illustrates the realistic erosion features. The top inset shows the first illumination of the north-facing side at midday and the bottom inset shows the illumination of the north-facing side at mid-summer midday. Both insets are viewing the north-facing side looking up the slope.

allowing assessment of the impact of erosion as well as limiting cases for the illumination during local midday: the first shadowless day for the north-facing side 2 June (19 days or 2.7 weeks from mid-summer); and mid-summer with the side illuminated by the Sun. The mid-summer case visualises how the light falling onto the north-facing side passes not only through the runnel features created by erosion towards the right and the left of that side, but also passes over all of the top ridge. This modelling went hand-in-hand with a still on-going project to gather contemporary images of the illumination of the monolith.

Additionally to the work directly related to the stone, the base of the stone was also analysed. The entire site is listed and we only undertook non-invasive studies that allowed us to map the locations of any visible stones around the base of the monolith as well as measure the difference in ground elevation to a precision of 1 cm. This work revealed a possible higher density of rock and boulders at the north-west base of the stone that could be linked to an increased presence of packing stones.

It is intriguing to note that the highest altitude the Sun will reach (due South) during the year for this geographic location and at the time of erection of the Stone would be  $60.7^\circ$ . This would allow the north-facing side to be illuminated at local midday during mid-summer. Furthermore, the tilt is along the East-West axis and would not permit any light to fall onto the north-facing side during the winter-half of the year. In contrast to typical sundials, it is of no interest where the shadow of the monolith or its end is located on the ground or any other structure. Treating the monolith as a gnomon or the slanted edges of the north-facing side as styles is misleading and incorrect. (Note the sloping up towards the South.) We are only analysing the illumination of the stone. In the next section a concept for a seasonal sundial will be developed allowing for seasonally relevant light and shadow casting to occur. It is in no way intended to be able to measure dates but rather illustrate the seasonally varying path of the Sun.

The principle of a seasonal sundial is modelled in Fig. 5 where three panels illustrate the apparent passage of the Sun over a wedge-shaped installation with one tilted plane extended in grey. The entire illumination is illustrated with a hypothetical celestial sphere for the winter solstice (a), summer half of the year (b), and summer solstice (c). The north-facing side will be illuminated if the Sun is above the grey plane. If the Sun's path which is parallel to the celestial equator falls below the plane of the north-facing side of the stone the line is solid and if it falls above the plane it is dashed. As can be seen in Fig. 5(b) the Sun can cross the plane up to two times at equal distances from the Sun's position at local midday, both marked here as points B and C. These points move closer together as the summer solstice approaches. If the plane has an obliquity regarding the horizon of less than  $90 - \varphi + \varepsilon$  (where  $\varphi$  is the geographic latitude and  $\varepsilon$  the obliquity of the ecliptic) points B and C will never merge and the north-facing side will never be

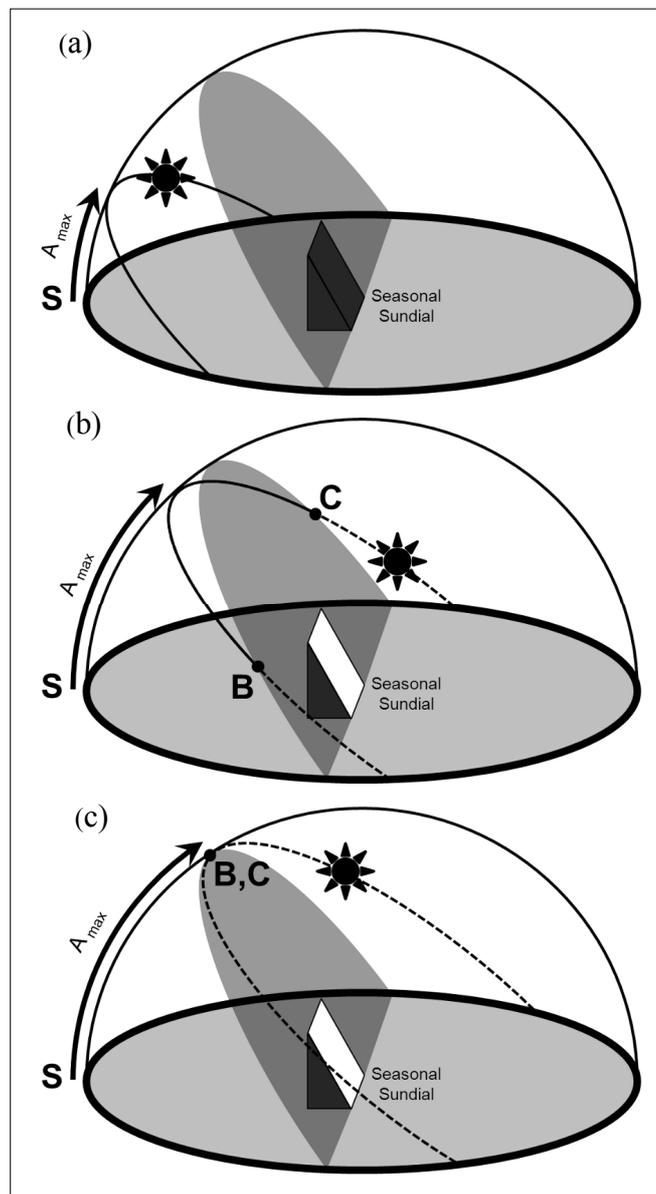


Fig. 5. The principle of a seasonal sundial is illustrated in panels a, b, and c. The apparent path of the Sun during the winter solstice (a), an arbitrary day in the summer half of the year (b), and the summer solstice (c) is shown by the black arc with the symbol of the Sun. If the Sun is below the plane shaded in grey defined by the north-facing side of the seasonal sundial, the arc is solid. If the Sun is above the plane the arc is dashed. The location at which the arc of the Sun intersect the plane is indicated by points B and C.

illuminated during local midday. If it is exactly  $90 - \varphi + \varepsilon$  the points will merge at local midday and the north-facing side will always be illuminated on the day of the summer solstice as illustrated in Fig. 5(c). To achieve such behaviour of the shadow, the flat side of the stone has to be orientated towards North, *i.e.* the plane intersects the horizon in an E-W direction. Given this behaviour, a seasonal sundial indicates the winter half of the year by having its north-facing side cast in permanent shadow. Only after the equinoxes will the north side become partly illuminated during the mornings and evenings. When the time of the summer solstice approaches the north-facing side will be illuminated during the entire day. The number of hours for

which it still remains in shadow is given in Fig. 6 and have been derived with the appropriate obliquity of the ecliptic. The hashed area indicates permanent illumination and the solid black area permanent shadow. The measured slope is indicated by the horizontal double line including a shaded area for the errors. The black point illustrates the result of the rendered model.

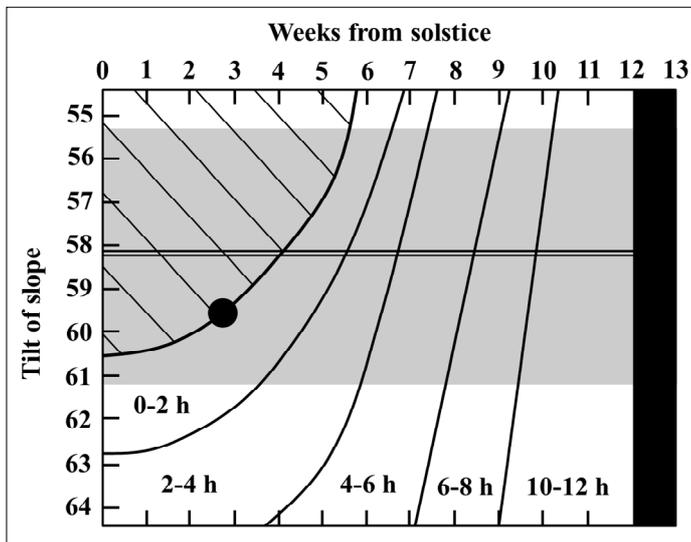


Fig. 6. This contour map of the tilt of the plane in degrees against weeks from solstice illustrates the number of hours the north-facing side of the stone remains in darkness around local midday. The shadow interval is binned into two-hour segments, the hashed area shows times when the north side is permanently illuminated and the black area illustrates times of permanent shadow. A geographic latitude and epoch for the obliquity are chosen according to the site and erection date. The surveyed dip of the north-facing side is marked by a horizontal double line and the error range is indicated by the shaded area. The first illumination of the north side in the rendered model is marked by a black point.

The general path of the Sun, including its varying rising and setting locations on the horizon during the year, was well known in pre-historic times. This knowledge is clearly applied in several well-known monuments across the world, including Stonehenge and other stone circles relevant for the context of the British Isles.<sup>6</sup> These monuments outline the typical knowledge and skills societies at the time of the erection of the Gardom's Edge monolith would have had, making its alignment achievable. However, the usage of shadows themselves to illustrate the passage of the Sun is not something so commonly encountered in the British Isles in this period. There are two sites which have been interpreted in a similar manner: Newgrange in Ireland<sup>7</sup> and some Clava Cairns in Scotland<sup>8</sup>. Both show surrounding standing stones casting a shadow onto the central burial monument during certain times that would have been of calendaric importance. But beyond that they also visualise the cyclic nature of time itself and use shadows to express eternity in a monument for the dead and living alike.

The existence of any form of calendar, megalithic or later iron-age, is highly debatable<sup>9</sup> and of no importance for the interpretation of the proposed astronomical alignment of the monolith. It is only able to highlight three of the four main dates during the year: equinoxes and summer solstice. Both equinoxes are also rather hypothetical in experience since their illumination effect on the stone would be only experienced during sunrise and sunset and strongly inhibited by the varying horizon and surrounding vegetation. Furthermore, determining the exact date of the summer solstices is impossible using such simple methods and was experienced in other manners. It is rather the inherent astronomical knowledge that had to be present in creating such seasonal illumination. Any other orientation could have been possible including pointing out the unmarked centre of the enclosure (azimuth  $(292 \pm 2)^\circ$ ), the rock art (azimuth  $(260 \pm 2)^\circ$ ) or a barrow known as the 'Three Men' (azimuth  $(282 \pm 2)^\circ$ ). However, these sites are all not directly observable from the standing stone. The only other location visible is the main entrance of the enclosure (azimuth  $(290 \pm 2)^\circ$ ). All of these orientations have been avoided. The finding presented here, especially the link of gradient and orientation of the slope, allows for the possibility that the standing stone at Gardom's Edge was astronomically aligned during the late Neolithic and early Bronze Age period. Therefore, this standing stone would have represented an ideal marker or social arena for seasonal gatherings for the otherwise dispersed small communities since it incorporates seasonal shadow casting within its design. Rather than including intricate carving as indications for the seasonal importance of this stone, a more natural message was incorporated into this marker. Such symbolic orientation can be compared to the alignment of mosques towards Mecca. Here the cause for seasons and life, the Sun itself, was included into the monument alignment encoding the cyclic nature of time and eternity through the delicate light and shadow play. It would have been the ideal location for ancient societies to learn more about what Francis Pryor<sup>10</sup> called the "lore of life" through the landscape itself.

## REFERENCES

1. R. Harris: *Walks in the Ancient Peak District*, Sigma Press (2010).
2. A. Johnstone: *The Prehistoric Peak*, lulu.com (2010)
3. J. Barnatt, B. Bevan & M. Edmonds: 'Gardom's Edge: a landscape through time', *Antiquity*, 76, 50-56 (2002).
4. P.L. Younger & J.M. Stunell: 'Karst and Pseudokarst: An Artificial Distinction', in A.G. Brown (ed): *Geomorphology and Groundwater*, New York, Wiley (1995).
5. The obliquity of the ecliptic in 2000 BC was larger than the current day value by about  $0.51^\circ$  or more than a solar diameter, as derived from A. Wittmann: 'The Obliquity of the Ecliptic', *Astronomy and Astrophysics*, 73, 129-131 (1979).
6. C. Ruggles: *Astronomy in Prehistoric Britain and Ireland*, Yale, London (1999).
7. F.T. Pendergast: 'Shadow Casting Phenomena at Newgrange', *Survey Ireland*, 9-18 (1991).
8. D. Trevarthen: 'Illuminating the Monuments: Observation and Speculation on the Structure and Function of the Cairns at

Balnuaran of Clava', *Cambridge Archaeological J.*, 10, 2, 295-315 (2001).

9. C. Ruggles: *Ancient astronomy – An Encyclopaedia of Cosmologies and Myth*, Santa Barbara, ABC Clío (2005).

10. F. Pryor: *The Making of the British Landscape*, Penguin Books, London (2010)

**Dr Daniel Brown** is a professional astronomer. He is working at the Nottingham Trent University and its on-site observatory, where he supports astronomy teaching and outreach work with the general public and schools. The main focus of his outreach work is based on archaeo-astronomy and the use of the outdoor classroom. He is a founding member of the 'Horizontastronomie im Ruhrgebiet e.V.', a German private initiative promoting astronomy outreach

based on an EU funded Science Park located within the Ruhr Area. He can be contacted at: [daniel.brown02@ntu.ac.uk](mailto:daniel.brown02@ntu.ac.uk).



## READER'S LETTER

### Hever Castle Dial

Having read the scholarly analyses and studied the photo of the modern replica, I would postulate the following scenario.

Skilled Italian sculptors have been 'replicating' ancient artefacts since at least the time of Michelangelo. Their main customer base was the stream of young men sent out from Northern Europe to acquire a gloss of classicism fitting them for a patrician role in their own countries in later life. An informed commentator has noted that what many of them actually acquired was a dose of syphilis which made them unfit for any purpose for the rest of their lives (but that is an aside).

Supposing one of these characters, having come across the workshop of such a replicator, and somehow transcending the language barrier, makes it clear that he would like a Roman sundial, but one suitable for his home latitude in the Shetland Isles, southern Norway or Sweden or northern Russia around St Petersburg. He does not understand the Roman method of timetelling but has a fair grasp of contemporary dialling requirements. The replicator understands: taking a genuine Sicillian dial as his model he produced a scaphe inclined at  $61^\circ$  to the horizontal. But the hour lines within the scaphe are still slavishly copied from the temporal hour lines of the original. By the time the dial is finished, the fickle patron has lost interest and it is never collected.

Another young man, from England this time, spots it and buys it – hence it gets to Hever. The original replicator never got as far as installing a gnomon – he just put a slot in what was to him the usual place. What is needed is a curved bendable and slideable gnomon which can be first adjusted and then fixed (a plate over the gnomon slot would readily do this). It wouldn't be clinically plain. A plausible

phoney Roman design would be a bird's beak. The point needs to stand where its shadow will track the two major day curves (summer solstice and Æquinox) with reasonable closeness: the winter solstice curve also if possible.

*Peter I. Drinkwater  
Shipston-on-Stour*

### Spalding Gentleman's Club, Lincs



Nicely painted, but what has happened to the delineation?!

## Beautifully Crafted Replicas of **PORTABLE DIALS** at Affordable Prices **ORIENTAL ASTROLABE**

Often known as "The World's First Personal Computer", the Astrolabe is one of the World's oldest scientific instruments providing a clear depiction of the heavens.

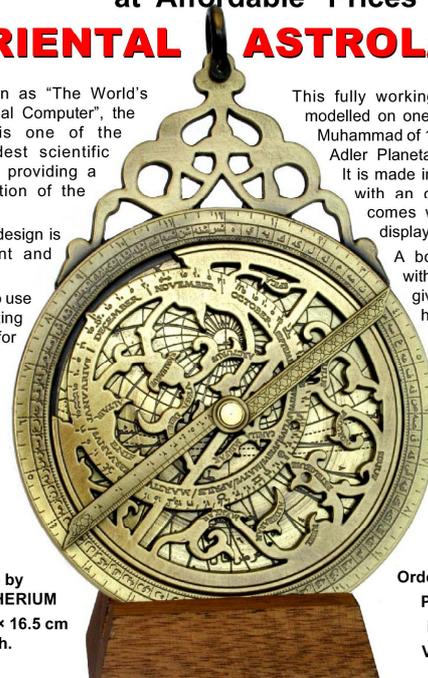
Its graceful design is both elegant and mysterious.

Learn how to use this fascinating instrument for yourself.

This fully working Astrolabe is modelled on one by Diya'al Din Muhammad of 1647, now in the Adler Planetarium, Chicago.

It is made in brass finished with an old patina and comes with a wooden display stand.

A booklet supplied with the instrument gives 22 pages of history and gives full operating instructions.



Made by  
**HEMISPHERIUM**  
12 cm dia x 16.5 cm  
high.

Order Code A-70  
Price £139  
including  
VAT at 20%

## GREEN WITCH

[www.green-witch.com](http://www.green-witch.com)

01767 677025

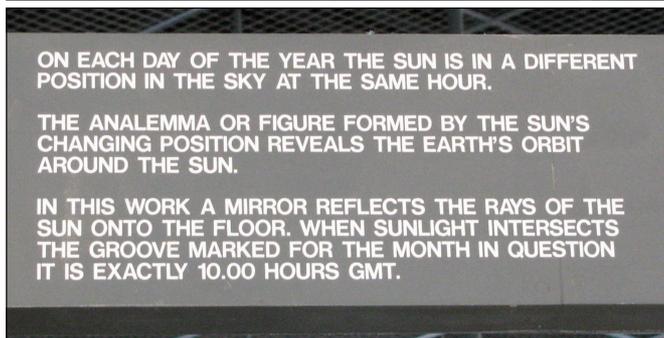
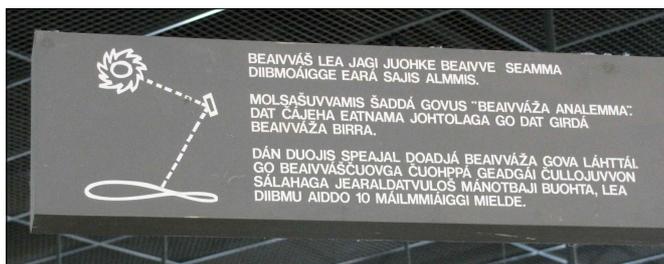
Greenwich House, 2 Bakers Court, Great Gransden,  
Sandy, Bedfordshire SG19 3PF

# CHECK-IN AT NOON

## A Noon Dial with Analemma at an Airport Check-In Desk

DOUGLAS BATEMAN

Whilst standing in the queue at the check-in desk at one of Finland's regional airports, Rovaniemi, latitude 63° 33' N, longitude 25° 50' E, my attention was drawn to an overhead banner with an intriguing symbol, as in Fig. 1. Amongst the 12 languages I found the English text, Fig. 2.



Figs. 1 and 2. A clue to something interesting, and the relevant text.



Figs. 3, & 4. The analemma set in the floor in line with check-in desk



Fig 5 (right). A slot in the ceiling reveals the angled mirror at roof level.



After the passengers were checked-in, all was revealed, see Figs 3 & 4. The months are indicated by small numbered plaques. The angled mirror in the roof space is shown in

Fig. 5, with the sun glinting in an hour after local noon. For Finland their time is 2 hours before Greenwich and the overhead text is making the assumption that passengers will be aware of the time zone difference. A truly unique location for such a dial.

The dial was designed by the highly acclaimed Finnish artist, Professor Emeritus Lauri Anttila, and incorporated into the airport extension in 2000. Details about the artist may be found on [www.amagallery.net/amaturku/anttila.htm](http://www.amagallery.net/amaturku/anttila.htm) with more photographs at [julkisetteokset.rovaniemi.fi/teokset/maan\\_kiertorata.htm](http://julkisetteokset.rovaniemi.fi/teokset/maan_kiertorata.htm).

[douglas.bateman@btinternet.com](mailto:douglas.bateman@btinternet.com)





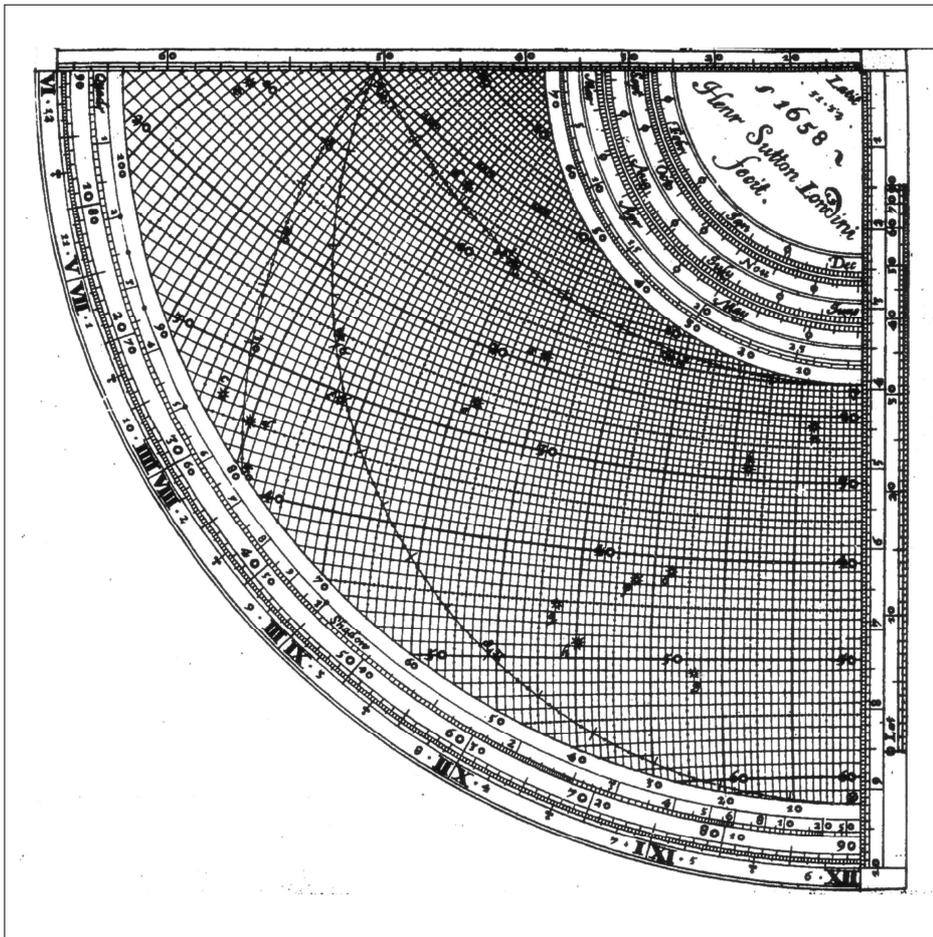


Fig. 2. The foreside of Sutton's small quadrant.

tropics of Cancer and Capricorn. As the two halves of the sky are symmetrical it is folded in half along the meridian. It is apparent that the projection cannot be fitted within the confines of a quadrant: that part of the sky shown shaded red which falls to the north of an arc passing between the east and west points of the horizon through the pole (the 6am–6pm line) is excluded. This defect is overcome by means of the 'reverted tail', that otherwise unused area towards the top of the projection shown in blue between the horizon line and the 6am – 6pm line. The use of this and other functions will be explained later. The cord with a plumb-bob to measure the altitude and a sliding bead to make settings would pass through a hole representing the pole at the intersection of the 6am–6pm line and the meridian at the apex of the projection.

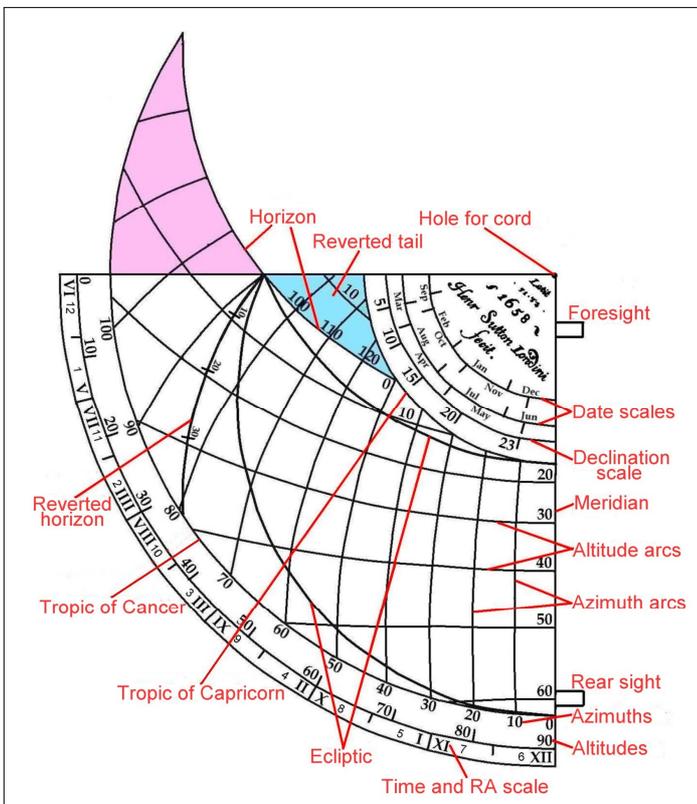


Fig. 3. Identification of scales.

Some features may not be obvious and Fig. 3 is a labelled much simplified diagram showing the full projection of the working area which, as the instrument is primarily intended for use with the sun, is limited to the region between the

Fig. 4 is an enlarged view of the date scale near the apex of the quadrant. It is in four arcs running from equinoxes to solstices and back, in intervals of one day. Below this is an arc of the declination of the sun from 0 to 23.5°. Laying the quadrant's cord through a date will show the declination: it is necessary for the user to supply the sense of this north or south of the celestial equator depending on the season of the year. Note the expansion of the scale near the solstices, due to the slow daily change of the sun's declination at those times.

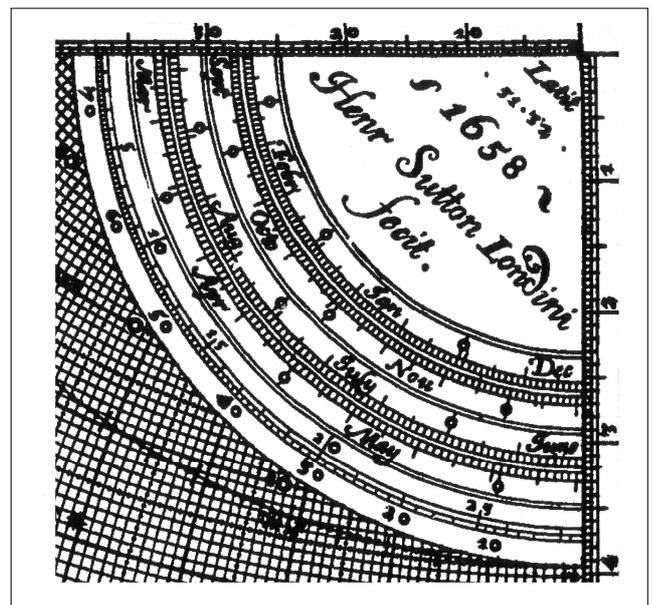


Fig. 4. Date and declination scales.

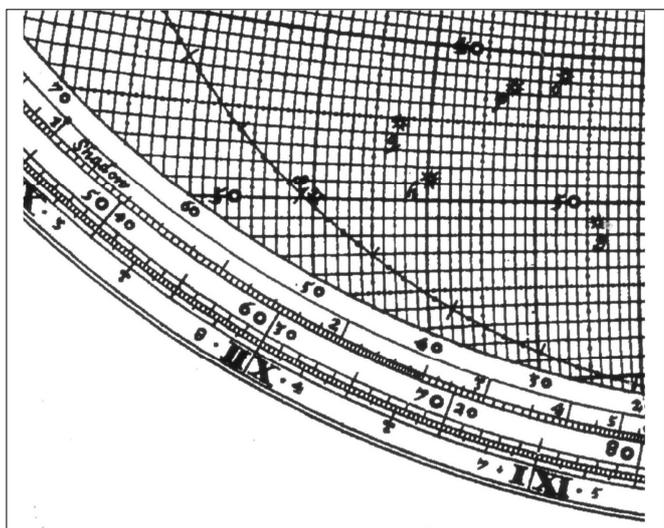


Fig. 5. Part of time and altitude scales.

Fig. 5 shows a part of the equally-spaced time and altitude scales along the limb of the quadrant. The altitude scale is divided to degrees and quarters and numbered in tens clockwise and anticlockwise. The time scale is divided to single minutes (equivalent to the quarter-degrees on the altitude scale) with hours numbered in Roman numerals I–VI clockwise and VII–XII anticlockwise. Smaller Arabic numerals adjacent to these will find the right ascension of the sun when the cord is placed through the date as described above. Part of an ecliptic arc is visible, with zodiacal sigils. Each sign is divided to 5° of longitude with small transverse lines, and to single degrees with dots.

The altitude and azimuth arcs are drawn for single degrees, with the tens thicker and the fives identified with dots placed centrally in the divisions. Altitude arcs meet the meridian orthogonally and are numbered in tens along the meridian and at intervals on the projection. They run from 15° to 62° on the meridian, the noon altitudes of the sun at the winter and summer solstices at latitude 51° 32'. Azi-

muth arcs start parallel to the meridian and become concave to it at increasing distances. They are numbered in tens between the projection and the shadow scale, and also between the projection and the declination scale.

Also shown is a part of the scale of 'quadrats' and 'shadows' which represents tangents of the altitude scale and is used to derive the vertical heights of terrestrial objects in a manner which has been described elsewhere.<sup>10</sup>

Scattered among the altitude and azimuth arcs are small multi-pointed star symbols, each plotted at the correct declination and right ascension as determined by the scales mentioned above. They are labelled according to a list of stars and their positions on the reverse of the quadrant, but the letters are difficult to read. Only those stars which lie between the tropics are plotted. Some symbols are visible on Fig. 5.

In his book, Collins also gives a full semicircle of the projection for the latitude of London (51° 32') and simplified quadrants for latitudes 0°, 13° (Barbados), 23° 31' (tropic of Cancer), 66° 29' (Arctic circle), 75° (Greenland) and 90°, providing a comparison of the appearance through a range of latitudes. The projection for latitude 13° is reproduced in Fig. 6 and that for 75° in Fig. 7. The shape and position of the pole-centred arcs (tropics and ecliptic) do not change but there are marked differences in the appearance of the zenith-centred arcs (altitude, azimuth and horizon). At 13° (Fig. 6) the zenith is within the projection and the altitude arcs for high altitudes are semicircles because the same altitude can be attained north or south of the zenith depending on the sun's declination. The azimuth arcs intersect at the zenith. As the summer sun rises and sets only a short distance north of the east and west points, the reverted tail (shown in blue) is very small. At 75° within the Arctic Circle the summer sun is above the horizon for up to 24 hours and the reverted tail spreads around the projection from 12 hours to 6 hours, as shown in blue on Fig. 7.

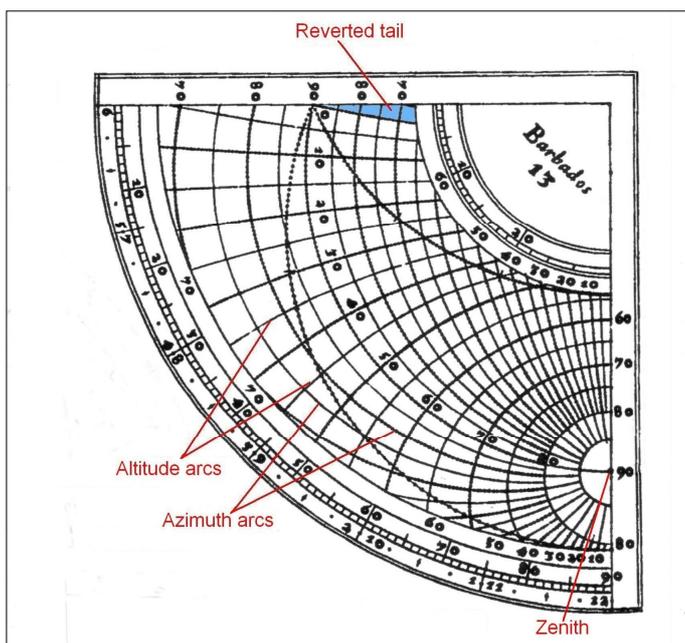


Fig. 6. Sutton's projection for latitude 13°.

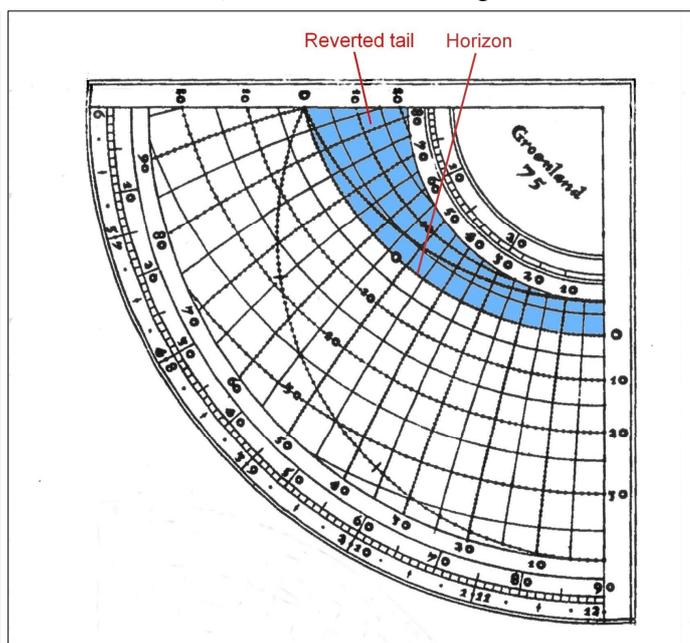
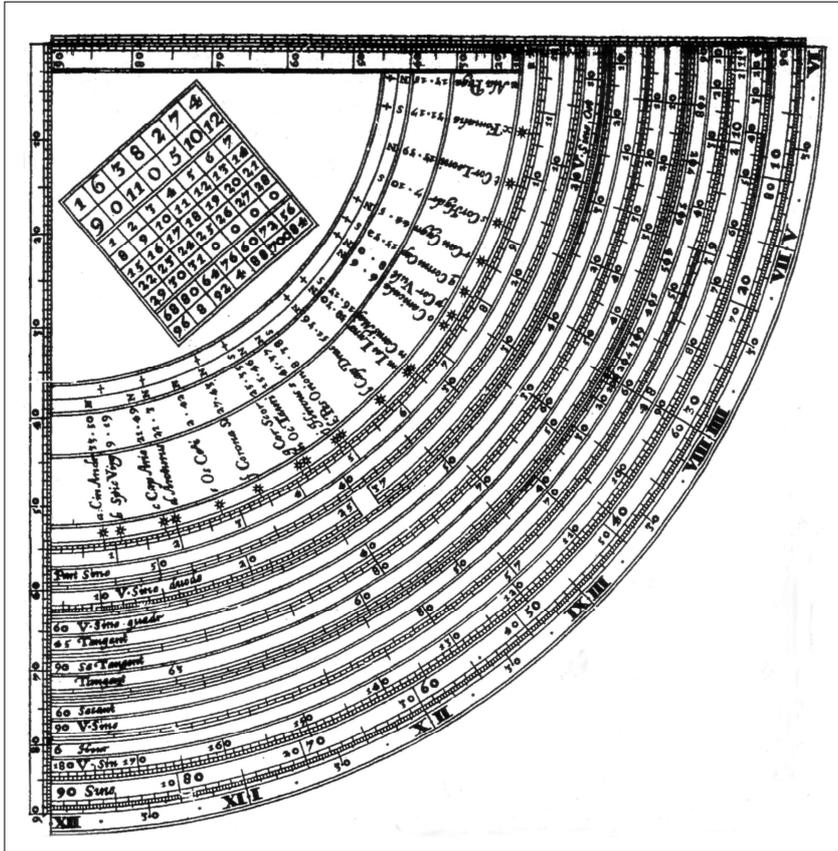


Fig. 7. Sutton's projection for latitude 75°.

Fig. 8. Reverse side of the small quadrant.



1	6	3	8	2	7	4
9	0	11	0	5	10	12
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	0	0	0	0
68	80	64	76	60	72	56
96	8	92	4	88	70	84

Fig. 9. The perpetual calendar.

The reverse side of the small quadrant is shown in Fig. 8. It has a simple perpetual calendar (Fig. 9) for the Julian calendar then in force in Britain. There are numerous trigonometric scales and a list of 21 stars with their declinations. The right ascensions of these can be found by pulling the cord through from the other side, laying it through the small star symbol by each entry and reading the RA on the adjacent scale of hours. This runs 0–12 hours: stars with RAs greater than 12 hours are identified by a ‘+’ symbol implying that 12 hours is to be added to the scale reading to derive the RA in the 24-hour system. (Note in passing that the Websters<sup>13</sup> were unaware of the meaning if this symbol.)

### Using the Quadrant

Collins allocates only thirteen pages to the use of the projection as it relates to the sun and a further nine to the star positions. This commences with instructions to use the perpetual calendar (Fig. 9), which is arranged in a block of 7 × 9 squares. The year is taken to start on March 1 so that January and February are part of the previous year and in a leap year February 29 is the last day of the year. The bottom two rows represent every fourth year from 1656 to 1708: intermediate years are found by stepping on one, two or three columns to the right. The column so found indicates the week-day upon which March 1 falls, counting from the left column as Sunday. In the top two rows the months are numbered 1–12 from March to the following February, and the dates given in the five centre rows are used to construct the calendar for a month. Dates in column 1 are those for the week-day found for March 1 and the rest of the calendar for March can be derived by stepping on the

daily difference from these. For subsequent months the column under the month number shows the dates of the same day and the calendar for that month can be derived.

An example may help to make the method clear:

- Required dates: 1695 October 14 and February 29.
- Column 6 is three years to right of that for 1692, so that the dates in the month columns are Fridays.
- October is month 8, found in the head of column 4, so October 11 is a Friday and October 14 is therefore Monday.
- In the same year month 12 for February is in the head of column 7, where February 28 is a Friday, so February 29 is Saturday and March 1 is therefore Sunday, confirmed by the day corresponding to the column for 1696.

The sun’s daily coordinates are found by setting the cord through the date: the right ascension from the reading on the limb hour scale, the declination from the scale next to the dates and the longitude in signs and degrees from the intersection with one or other of the ecliptic arcs. It is necessary for the user to supply the correct quadrant of RA or longitude and the sign of the declination depending on the season of the year. Values for these coordinates given by the date lines are for midday and were probably taken from a table calculated by Sutton and published by Collins.<sup>14</sup>

The sun’s altitude is measured by holding the instrument vertically and allowing the cord to hang freely when the sunlight is passed through the two apertures in the sights. The cord then indicates the altitude on the limb degree scale.

With the cord placed through the date the bead is set to the correct declination by setting it to the appropriate ecliptic arc: this is 'rectifying the bead'. Collins suggests using the declination to set the cord which might give improved accuracy but only if a table of daily declinations is available. Once set, the cord is turned so that the bead rests on the arc of the measured altitude of the sun; it then indicates the time on the limb hour scale and the azimuth by the position among the azimuth arcs.

As noted above, the quadrant will not directly show times earlier than 6am or later than 6pm in the summer months, requiring the use of the reverted tail. The need for this is shown by an inability to set the rectified bead to the measured altitude: the sun's altitude is less than that at 6am or 6pm. To use the tail, the bead is set to the winter ecliptic arc instead of the summer for the same date, thus setting it to a southern declination. The bead can then be placed on the altitude arc in the tail and the time read from the opposing hour scale, afternoon hours for a morning time and morning hours for an afternoon time.

Other uses include setting the rectified bead to the horizon to show the time and azimuth of sunrise and sunset. The reverted horizon can be used for either summer or winter dates. The bead is always rectified to the summer ecliptic, and placing the bead on the horizon indicates the time on the hour scale correctly for winter months but afternoon hours for sunrise and morning hours for sunset in summer. Figures on this arc give the sun's azimuth from the east or west points of the horizon, not from the south as with the main azimuth arcs.

The times of twilight can be found by using the antisolar point which is opposite to the sun, with reversed sign for the declination, at the same angle above the horizon as the required depression below it and twelve hours away in hour angle. The bead is rectified to the opposing ecliptic and placed on the altitude equivalent to the desired depression of the sun. The time is read from the afternoon hours for a morning time and morning hours for an afternoon time. This method is valid for all northern declinations but in winter months the antisolar point may lie to the north of the 6am–6pm line and it will be impossible to place the bead on the required depression as an altitude. In such a case the winter ecliptic is used to rectify the bead which is then placed on the depression in the reverted tail and the times read in the correct relation. Traditionally, a depression of 6° is taken as the beginning of morning or end of evening civil twilight, 12° for nautical twilight and 18° for astronomical twilight.

All these procedures can be used in reverse, for example to find the time and date on which the sun has certain values of altitude and azimuth, or to derive the date on which the sun will rise or set at a definite azimuth or time.

Using the star places given on the quadrant it is possible to find the time at night. To do this the altitude of an identified star is measured by sighting it through the holes in the

sights. The bead is placed on the appropriate star symbol on the projection which sets it to the declination of the star, and then turned to lie on the measured altitude. The 'star time' is read on the hour scale (morning hours if the star is east of the meridian and afternoon hours if west) and the time of night is found from the relation, working in 2×12-hour format:

$$\text{Solar time} = \text{star time} + \text{star's RA} - \text{sun's RA}$$

Collins recommends that instead of subtracting the sun's RA its complement to 12 hours should be added, thus avoiding the complication of a possible negative time. If the answer exceeds 12 hours, multiples of 12 are subtracted to give the time in the 2×12-hour system.

The sun's RA is found from the date and hour scales as mentioned above, and the star's RA either from the cord passed through the star symbol on the front or the reverse side of the quadrant.

### Delineating Sutton's Quadrant

Notation:

- $\alpha$  Right Ascension (RA).
- $\phi$  latitude.
- $\delta$  declination.
- $h$  hour angle.
- $a$  altitude.
- $A$  azimuth.
- $\varepsilon$  obliquity of the ecliptic (23.5° in 1658, 23.44° at the present time).
- $\lambda$  longitude of the sun.
- $x$  distance of a point orthogonally from the meridian, positive to the left and negative to the right.
- $y$  distance from the 6am–pole–6pm line, measured positive down from the centre and negative above.
- $R$  radius of the arc representing the celestial equator (not shown on Collins' drawing, but indicated by the distance from the centre to the intersection of the ecliptic arcs on the top line of the projection).

The graduations of the dates and declinations are obtained from the RA scale on the limb, from a table giving the sun's RA and declination for every day of the year. Such a table (calculated by Sutton for every noon in the year 1666) is given by Collins<sup>14</sup> and appears to have been used by Sutton on the quadrant so that the sun positions shown by the tick marks are those at the midday transit of the sun. Engraving them on the instrument would have been a rather tedious business!

The general formulae for finding the positions of the intersections of altitude and azimuth arcs are:

$$x = R \frac{\cos a \cdot \sin A}{1 - \sin \phi \cdot \sin a + \cos \phi \cdot \cos a \cdot \cos A}$$

$$y = R \frac{\cos \phi \cdot \sin a + \sin \phi \cdot \cos a \cdot \cos A}{1 - \sin \phi \cdot \sin a + \cos \phi \cdot \cos a \cdot \cos A}$$

The formulae for drawing the necessary arcs are:

Tropic of Cancer:  
 centre: pole                      radius =  $R \tan^{1/2}(90+\varepsilon)$

Tropic of Capricorn:  
 centre: pole                      radius =  $R \tan^{1/2}(90-\varepsilon)$

Ecliptic: summer months:  
 centre:  $y = R \tan \varepsilon$               radius =  $R/\cos \varepsilon$

Winter months:  
 centre:  $y = -R \tan \varepsilon$              radius =  $R/\cos \varepsilon$

Horizon:  
 centre:  $y = -R/\tan \varphi$             radius =  $R/\sin \varphi$

Reverted horizon:  
 centre:  $y = R/\tan \varphi$              radius =  $R/\sin \varphi$

Altitude arcs:  
 centre:  $y = -R \cos \varphi / (\sin \varphi - \sin a)$   
 radius =  $R \cos a / (\sin \varphi - \sin a)$  (Ignore negative value if  $a > \varphi$ )

Azimuth arcs:  
 centred on a line orthogonal to the meridian,  
 at  $y = R \tan \varphi$   
 centres on this line:  $x = -R/\cos \varphi \cdot \tan A$   
 radius =  $R/\cos \varphi \cdot \sin A$

The centres fall off the projection for  $A < 90^\circ$  and within it for  $A > 90^\circ$ . The centre for  $A = 90^\circ$  is on the meridian.

Azimuth points on reverted horizon, measured from east or west points:

line of centres:  $y = -R \tan \varphi$   
 centres:  $x = R \tan A / \cos \varphi$   
 radius:  $R/\cos \varphi \cdot \cos A$

The altitude arcs are concave to the pole for altitudes less than the latitude and convex to it if greater. If  $a = \varphi$  the arc becomes a straight line, as is shown by the formulae which result in infinite radius and  $y$  of centre. It is obvious that the long-radius altitude arcs (and also the azimuth arcs near the meridian) could not have been drawn from such distant centres and probably some mechanical device was used, capable of dealing with such a situation. Alternatively, the general  $x, y$  formulae could have been used and the plotted points joined with a smooth curve.

Solar longitudes on the ecliptic arcs can be plotted from the hour scale, taken as the sun's RA from the small Arabic numerals adjacent to the hour calibrations and converted from the longitude by the relation:

$$\cos \lambda = \cos a / \cos \delta$$

and plotted on the pre-drawn ecliptic arcs on a radius from the projection centre to the calculated RA. Alternatively the  $x, y$  positions can be calculated from:

longitude 0–90°

$$x = R \cos \lambda / (1 - \sin \varepsilon \cdot \sin \lambda)$$

$$y = R \cos \varepsilon \cdot \sin \lambda / (1 - \sin \varepsilon \cdot \sin \lambda)$$

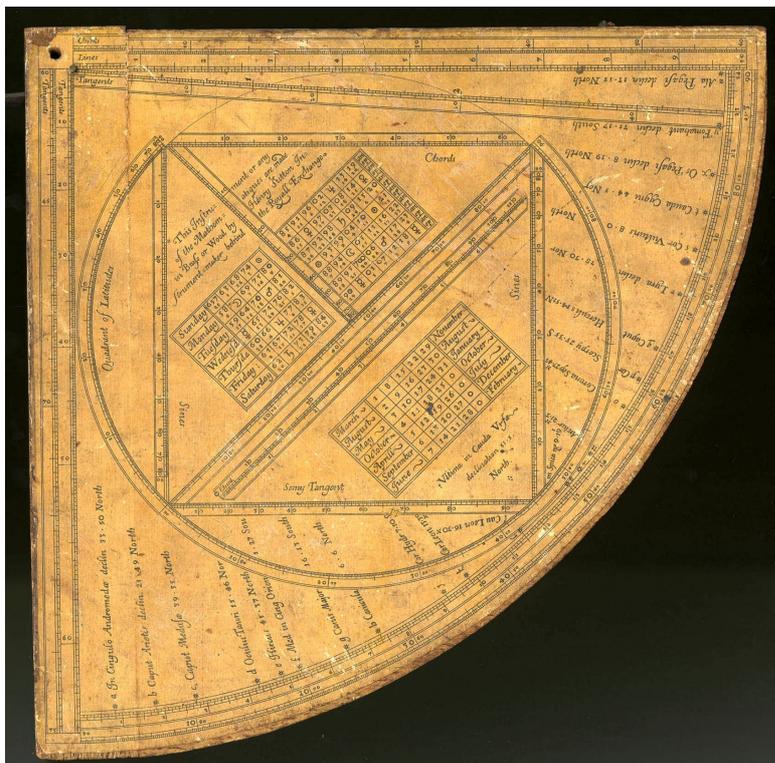
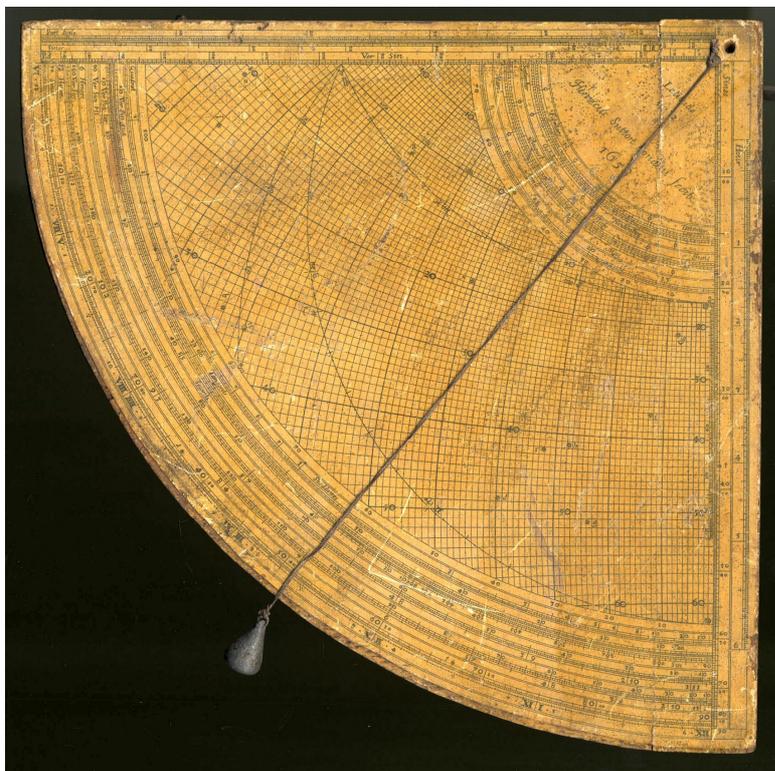


Fig. 10 (top). Foreside of the great quadrant.

Fig. 11. Reverse side.

Courtesy of the Oxford Museum of the History of Science, Inv. no. 25257.

longitude 180–270°

$$x = -R \cos \lambda / (1 - \sin \varepsilon \cdot \sin \lambda)$$

$$y = -R \cos \varepsilon \cdot \sin \lambda / (1 - \sin \varepsilon \cdot \sin \lambda)$$

As the projection is symmetrical about on the meridian it is only necessary to calculate for these longitude ranges; positions for 90–180° and 270–360° coincide with their complements to 180° or 540°.

## The ‘Great Equatorial Quadrant’

The final part of the book describes this instrument in detail, but unfortunately without an illustration, possibly because a direct print from the engraving made to print the paper versions of the instrument would have been too large to fit on a page. One quadrant matching the description is in the Oxford Museum of the History of Science, Inv. no. 25257, and is 11 inches (280 mm) across. Fig. 10 shows the foreside with the same projection as that of the small quadrant, but more trigonometric scales between this and the limb scales of altitude and time. The instrument still has a cord (possibly not original) and plumb-bob, but no bead and only one sight. The reverse side in Fig. 11 has many scales and 22 star positions (most of which are common to the small quadrant). There is a more detailed version of the perpetual calendar, with the weekday for March 1 given directly in the two upper tables for every year from 1657 to 1753. The weekday of February 29 is indicated by that day’s astrological symbol. The lower table shows the months directly and the dates in each month row are for the weekday of March 1 found in the upper tables.

## Biography

The lives of Sutton and Collins have been given in an earlier article.<sup>10</sup> Thomas Harvey is a more elusive character. E.G.R. Taylor has a short section on him<sup>15</sup> but this appears to be drawn solely from his mention in Collins’ book. She gives him as flourishing over the short period of 1657–63 as part of the group of amateur mathematicians which also included Michael Dary and Henry Bond.

## Conclusion

A few paper copies of the small quadrant are known, some of them pasted on to board to form a completed instrument. Brass instruments are rarer so it is not clear whether Mr Harvey ever got his desired brass quadrant! One brass example, by William Rayson and dated 1683, is in the Whipple Museum.<sup>16</sup> Another maker of printed paper instruments, John Prujean, also made a version of Sutton’s quadrant designed for the latitude of Oxford. It was part of a composite device which also included Gunter’s quadrant and the ‘horizontal instrument inverted’.<sup>17</sup> In his advertisement of 1701<sup>18</sup> Prujean described it as “Collins’s quadrant” so it seems Harvey was completely forgotten by then.

A list of some of the known Sutton’s quadrants is given in Appendix I. Although this list is by no means complete and many copies of the paper versions will have been lost over the years, it is clear that they were never anywhere near as popular a design as Gunter’s quadrant, of which there are many scores.

Of all forms of horary quadrant, it is possible that Sutton’s is the easiest to use, involving only one setting of the bead on the cord and reading the time on a scale uniformly divided to single minutes of time. However, in common with all altitude dials, small setting errors will cause dispropor-

tionate errors in the determined time, particularly near the meridian. The great quadrant would most likely have been too heavy and unwieldy to use without some support such as a pedestal.

## ACKNOWLEDGEMENTS

We thank the Oxford Museum for the History of Science (particularly Jim Bennett and Lucy Blaxland) for arranging the photographs of the great quadrant and for permission to publish them. The section by Morrison<sup>12</sup> on Sutton’s quadrant was helpful in resolving some design features.

## REFERENCES

1. C.M. Lowne: ‘The Design and Characteristics of the Double Horizontal Sundial’, *BSS Bull.*, 13(iv), 138-146 (2001).
2. J. Davis & M. Lowne: ‘The ‘Bacon’ Double Horizontal Dials’, *BSS Bull.*, 13(iv), 160-165 (2001).
3. J. Davis & M. Lowne: ‘The Henry Wynne Double Horizontal Dial at Staunton Harold’, *BSS Bull.*, 15(ii), 47-58 (2003).
4. J. Davis & M. Lowne: ‘Henry Wynne’s Double Horizontal Dials – update’, *BSS Bull.*, 18(i), 33-34 (2006).
5. J. Davis: ‘John Marke’s Horizontal Dials’, *BSS Bull.*, 20(iii), 117-118 (2008).
6. J. Davis & M. Lowne: *The Double Horizontal Sundial and associated instruments*, BSS Monograph 5, BSS, London (2009).
7. M. Lowne & J. Davis: ‘The Horizontal quadrant, Part 1’, *BSS Bull.*, 22(ii), 18-24 (2010).
8. M. Lowne & J. Davis: ‘The Horizontal quadrant, Part 2’, *BSS Bull.*, 22(iii), 10-15 (2010).
9. M. Lowne & J. Davis: ‘A Horizontal Quadrant of 1658 by Henry Sutton, Part 1’, *BSS Bull.*, 23(ii), 8-13 (2011).
10. M. Lowne & J. Davis: ‘A Horizontal Quadrant of 1658 by Henry Sutton, Part 2’, *BSS Bull.*, 23(iii), 45-48, (2011).
11. J. Collins: *The Sector on a Quadrant – or a treatise containing the description and use of four separate quadrants, two small ones and two great ones, each rendered many wayes, both general and particular. Each of them accommodated for dialling; for the resolving of all proportions instrumentally; and for the ready finding of the hour and azimuth universally in the equal limb. Of great use to seamen and practitioners in the mathematics.* Printed by J.M., London (1659).
12. J.E. Morrison: *The Astrolabe*, Janus, Rehoboth Beach (2007).
13. R. & M. Webster: *Western Astrolabes*, Adler Planetarium, Chicago (1998). A Sutton’s quadrant from the same printing plates as the one described in this article is described on pp. 134-5.
14. J. Collins: *The Description and Uses of a General Quadrant, with the Horizontal Projection upon it inverted*, J. Maycock, London (1658).
15. E.G.R. Taylor: *The Mathematical Practitioners of Tudor & Stuart England*, Cambridge University Press (1954). Harvey’s entry is #269.
16. D.J. Bryden: *Sundials and Related Instruments (catalogue 6)*, The Whipple Museum of the History of Science (1988). Inv. no. 0259.
17. An example of the composite quadrant is in the Newdigate Collection and is described in Ref. 6 as HQ-4.
18. D.J. Bryden: ‘Made in Oxford: John Prujean’s 1701 catalogue of mathematical instruments’, *Oxonienisia*, LVIII, 263-285 (1993).

For biographies and portraits of the authors, see *BSS Bull.* 23(ii).

## APPENDIX I

### Some Known Examples of Quadrants to the Harvey/Collins/Sutton Design

Date	Maker	Construction	Radius*	Latitude	Location/ reference	Comment
1658	Henry Sutton	Paper on board	117 mm (working)	51° 32'	Adler Planetarium W-256	Damaged by musket ball!
1658	Henry Sutton	Paper on wood	280 mm	51° 32'	Whipple Museum Wh-2754	
1683	William Rayson, Leicester	Brass	311 mm	52° 40' (Leicester)	Whipple Museum Wh-259	
1658	Henry Sutton	Paper on brass	113 mm	51° 32'	British Museum 88 12-1 277	
1658	Henry Sutton	Paper on wood	276 mm	51° 32'	NMM NAV-1042	Multiple projections, includes EoT scales
1738	Gabriel Stokes, Dublin	Brass (on stand)	310 mm (overall)	53° 20' (Dublin)	NMM NAV-1055	
1658	Henry Sutton	Paper on wood	276 mm	51° 32'	Oxford MHS 25257	'small quadrant'
1660/9	Henry Sutton	Brass	?	51° 32' ?	Oxford MHS 26116	
1658	Henry Sutton	Paper on wood	256 mm (working)	51° 32'	Private collection, England	Multiple projections
c. 1670	John Prujean	Paper on wood	220 mm (overall)	51° 45' (Oxford)	Newdigate Collection	

\* The radii have been taken from museum catalogues and it is not always apparent whether these measurements refer to the overall dimensions or the working radius.

### Postcard Potpourri 23 – Churchill, Somerset

Peter Ransom

This postcard shows the courtyard of Cottage Homes at Churchill, North Somerset (postcode BS25 5NE). I cannot find any reference to the dial in the *Register*, which is not surprising because there is a gate with a 'Private Residents Only' sign at the street entrance to the block of cottages that surround the dial. There is also a plaque saying 'Sidney Hill Cottage Homes'. This led me to the website [www.britishlistedbuildings.co.uk/en-33951-sidney-hill-cottage-homes-and-attached-ga](http://www.britishlistedbuildings.co.uk/en-33951-sidney-hill-cottage-homes-and-attached-ga) where, amongst other things, it mentions that these are Wesleyan Alms-houses, dated 1907. If you put the postcode into Google maps, then you can at least see an arial view of the houses surrounding the dial!

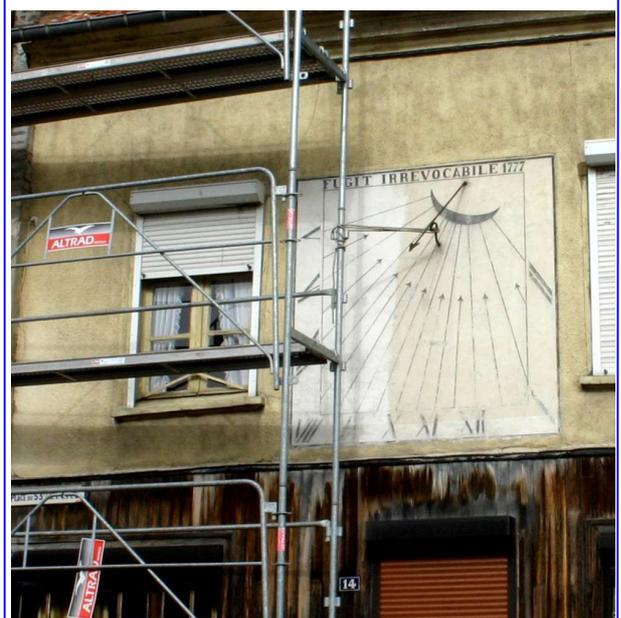
The postcard was sent in September 1929. It is hard to tell whether there are east and north dials, but it looks as though the west dial is there. The card was published by Harris, Post Office, Churchill.

[pransom@btinternet.com](mailto:pransom@btinternet.com)



VIEW OF COTTAGE HOMES, CHURCHILL, SHOWING SUNDIAL

### Gnomon Supporter



It seems doubtful that the gnomon of this sundial could provide much restraint to a scaffold tower! The unusual use for a sundial was spotted by Mike Cowham in Airanne, in the Somme, France. We hope it survived.

### Leap Seconds

Another leap second was added to UTC (Coordinated Universal Time) at the end of June 30, 2012, in order to keep it close to mean solar time. Thus our sundials, corrected for the Equation of Time, will continue to agree with Civil Time to a high level of accuracy for another couple of years or so.

# IN THE FOOTSTEPS OF THOMAS ROSS

## Part 2: The Sundials at Craigiehall

DENNIS COWAN

Craigiehall is a late 17<sup>th</sup>-century mansion house which is located some six miles west from the centre of Edinburgh and is currently used as the Headquarters of the British Army's 2<sup>nd</sup> Division. It has been in use by the military since the start of the 2<sup>nd</sup> World War when it was requisitioned by the Army and indeed Germany's surrender of its forces in Norway in 1945 was negotiated and signed there. It is rumoured that Rudolph Hess was there for a short while after his flight from Germany in 1941, but like Bonnie Prince Charlie before him, he is rumoured to have been everywhere! The mansion house is now used as the Officer's Mess.

There are two sundials at Craigiehall – a wonderful four metre high obelisk on the lawn in front of the Officer's Mess, and a horizontal dial to the rear. In the *Castellated and Domestic Architecture of Scotland*,<sup>1</sup> obelisk sundials are described as follows:

*“The constant parts of these dials are a square shaft, a bulged capital, and a tapering finial. Where the dial is of the normal type and unaltered, the shaft is divided on each side into five horizontal spaces by incised lines, thus presenting twenty compartments. These compartments are hollowed out with cup-shaped, heart-shaped, triangular, and other sinkings, which are generally lined so as to mark the hours, and were without doubt always meant to be so. The sharp edge of the figure casts the shadow, which is especially distinct in the angular shapes and at the top of the heart sinkings,*

*where there is often a certain amount of undercutting. Stone gnomons of various forms are frequently left in the cup-hollows, and metal stiles are to be found in all the dials. Occasionally some of the spaces are left blank, and on the north side initials, dates, and arms sometimes occur.*

*The capital is always bulged out so as to form an octagon in the centre, with an upright facet on each of the eight sides, having a dial on each. Above and below each facet over the four sides of the shaft are sloping facets, with a reclining dial or a proclining dial on each the former being those dials whose faces slope towards the sky, and the latter those whose faces slope towards the ground. The eight triangular pieces formed by the meeting of the square and octagon are cut out, and most effective shadows, from an artistic point of view, result from this arrangement, giving an air of dignity to the capital, which is wanting in the one instance (at Drummond Gardens) where this arrangement is departed from. The upright facets of the octagonal part have heart-shaped and cup-shaped sinkings, as in the shaft; but the proclining and reclining parts seldom have sinkings. Nor has the tapering finial, although usually covered with dials, ever any sinkings; like the shaft, this part is divided by horizontal incised lines, the number of spaces, for which there appears to have been no rule, varying according to the height of the finial.”*

Ross goes on to describe the obelisk dial at Craigiehall:

*“This dial [Fig. 1], which is one of the normal type, has undergone a considerable transformation. When the*

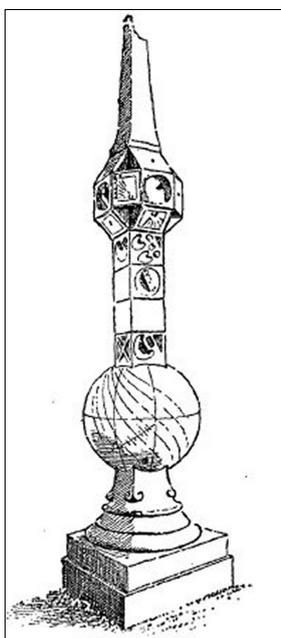


Fig. 1 (left). The obelisk dial at Craigiehall as drawn by Thomas Ross.

Fig. 2 (right). The obelisk dial now.



*mansion-house was rebuilt about the middle of last century by the Hon. Charles Hope Vere, second son of the first Earl of Hopetoun, the dial, which was probably broken, was set up on a new and most original base, consisting of a globe about 2 feet 2 inches in diameter, into which the shaft is fitted, burying the whole of one of the five spaces. The globe is supported on a rounded base, and the whole rests on a square plinth. The upper portion was also renewed, but not strictly after the old form, a slightly curved outline without division lines having been given to it. The whole of the renewed work is of white sandstone, while the original dial is of red sandstone. The height from the ground to top of globe measures about 4 feet 8 inches, thence to top of capital about 4 feet 5 inches, and the renewed top 2 feet 11 inches; total height is about 12 feet. The width of the base at the ground is 2 feet 2 inches. The dial stands in the park, and is protected from the cattle by an iron railing."*

Ross's hopes that the dial would be protected in its enclosure did not materialise as the sundial was discovered in pieces in 1965 within an enclosure of old railings to the south of the Officer's Mess.<sup>2</sup> It was subsequently restored by the Ancient Monuments Branch of the Ministry of Public Buildings and Works and re-erected at its present site on the lawn in front of the Officer's Mess – see Fig. 2.

As to its current condition, it appears to be still much the same as Ross saw it some 120 years ago. The only noticeable differences to me are that the lines on the globe are hardly legible now, but Ross may have enhanced them in his sketch, and the red sandstone parts may now be more worn. As in Ross's day, there are no gnomons remaining, but I counted stubs of some twenty-four, plus numerous cup hollows and geometric sinkings (Fig. 3), all of which functioned as sundials.

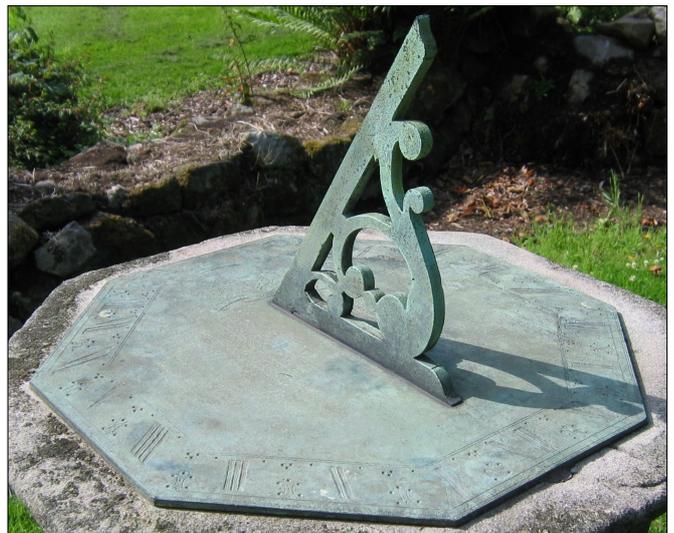


Fig. 3. Detail of the obelisk.

It was probably made in the late 17<sup>th</sup> century, but it is unique since its modification in the 18<sup>th</sup> century by the addition of the globe base. Obelisk sundials are few and far between, only twenty-six known complete examples exist in Scotland, and there are no other obelisk sundials quite like this one.



Figs 4 & 5.  
The horizontal sundial with the dial by John England.



As previously said, the other sundial at Craigiehall is a horizontal dial (see Fig. 4) and is located behind the Officer's Mess, just to the side of the west lawn and in front of the tennis court. Its pedestal is of carved stone, about one metre high, with a brass octagonal dial plate as shown in Fig. 5. It can be dated fairly accurately, as an inscription on the dial plate reads "Made by England, Instrument Maker to Her Majesty Ann, Charing X London". Anne was on the throne from 1702 to 1714 so the sundial must be from that period.

This date is further confirmed in that John England was known to be a mathematical instrument maker working from Charing Cross between at least 1703 to 1708. A 10 inch astronomical ring dial, signed by him and dated 1703, is at Trinity College, Cambridge. He also made a number of

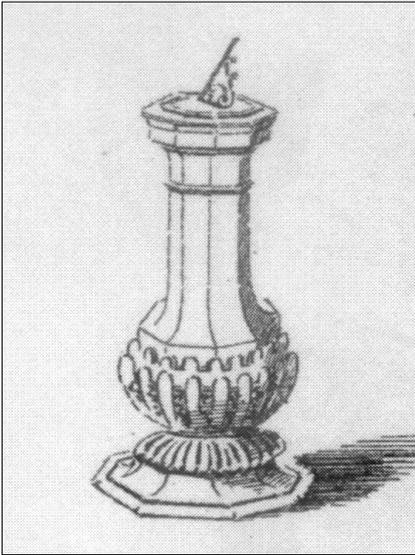


Fig. 6. Ross's drawing of the horizontal dial.

instruments for that College's observatory including a ring dial, a sector and an analemmatic dial, all now at the Whipple Museum.<sup>3</sup> Samuel Saunders<sup>4</sup> was at one time apprenticed to England.

The dial has now fading Roman numerals from 4am to 8pm, but more interestingly it also has an Equation of Time table, which dates it to after 1672. Unfortunately the table on the dial plate is now quite faint and is difficult to read, but if you look carefully, the months of the year can be seen at the top of each column of figures. The dial also includes the arms of the Marquis of Annandale quartered with those of his wife, Sophia Fairholm of Craigiehall, whom he married when she was only fourteen. It was this marriage that eventually resulted in Annandale taking ownership of the Craigie estate.

Ross says of this dial:

*"The horizontal dials at Craigiehall [Fig. 6] and Hoptoun are almost identical. The carved work on the pedestals was probably wrought by the same hand. On the*

*first-named is the inscription MADE BY ENGLAND, INSTRUMENT MAKER TO HER MAJESTY AT CHARING X, LONDON, with the arms of the Marquis of Annandale quartered with those of his wife, a Fairholm of Craigiehall."*

It can be seen that there is a difference of opinion regarding the word following 'Majesty' in the inscription, but the words are faint and either could be correct. However, it doesn't change the likely date of the sundial.

Ross mentions the dial at nearby Hoptoun, but does not provide a description, other than it was almost identical to the one at Craigiehall. Neither does he provide a sketch. Both of these mansions were built at the same time, both designed and overseen by the same architect, Sir William Bruce. According to contemporary reports, they suffered from the same problems that we have nowadays, in that tradesmen were often taken from one to work on the other and vice versa.

In July 2011, following a Defence Basing Review carried out by the Ministry of Defence, it was announced that Craigiehall would be closing in 2014/2015. Who knows what will happen to the mansion house and grounds, but more importantly from my point of view, what will happen to the sundials? Let's hope that access to these two wonderful sundials will be preserved in the future.

#### REFERENCES

1. D. MacGibbon and T. Ross: *The Castellated and Domestic Architecture of Scotland*, David Douglas, Edinburgh (1892).
2. There is some dispute regarding this date. Some sources say that it was discovered in pieces in 1972.
3. Jill Wilson: *Biographical Index of British Sundial Makers from the 7<sup>th</sup> century to 1920*. 2<sup>nd</sup> edition. BSS Monograph 2 (2007).
4. M. Lose: 'Samuel Saunders – a study of a London sundial maker' *BSS Bull.*, 24(i) and 24(ii), (March & June 2012).

For a portrait and CV of the author, see *Bulletin* 23(iv).

## Group Photo – BSS Cheltenham Conference 2012



Chris Lusby Taylor

# CATHEDRAL MASS DIALS

TONY WOOD

It is now a commonplace observation that mass dials are rare in larger towns and practically unknown on the ruins of abbeys and priories which came about on the Dissolution of the Monasteries in the early 16<sup>th</sup> century. Even the large surviving priory churches like Tewkesbury and Dunstable have no mass dials. Enquiries about Bath Abbey and possible dials there prompted:

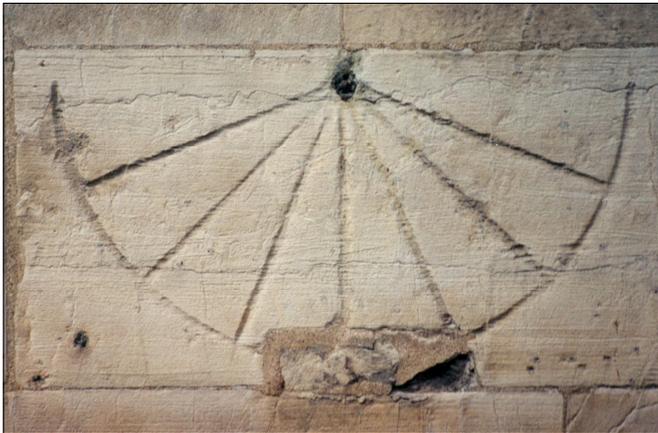
1) a visit, which revealed one isolated circle with no other marks; this was low down and ‘round the back’. The Abbey never did become a Cathedral and the local Bishop’s seat is at Wells, really only a small town but now a city of course.

2) the question: are there any mass dials on cathedrals? – the answer is ‘yes’, two so far and *both* in Yorkshire.

There is an excellent large mass dial on the south wall of York Minster (Fig. 1). Although repaired about the noon mark, its condition is suspiciously good: I wonder what stone the wall is made of.

The other is in Sheffield – an old church but a relatively new cathedral, Sheffield diocese being formed in the early 20<sup>th</sup> century. The mass dial is on the south wall all right but *inside*. Go through the front door, turn right and there it is, under a brass plate memorial (Fig. 2). Thanks are due to Dr Arnold Smith of the Cathedral Bell Ringing Team who not only pointed out this dial but also the much larger scientific dial high up, under the clock and now virtually hidden by the south chapel. It is practically invisible from the precincts in front of the Cathedral and one must stand well away to the south! Dr Smith took me up to the dial (Fig. 3) which is outside the luxurious ringing room (‘chamber’ sounds far too cold) above the chapel – ‘mind the gnomon’ – which hangs across the walkway (Fig. 4) and doesn’t look to have too long to go!

aowood@soft-data.net



Andrew James

Fig. 1. The mass dial on York Minster.



Fig. 2. The mass dial in Sheffield Cathedral.



Fig. 3. The vertical dial on the South Chapel of Sheffield Cathedral.



Fig. 4. The gnomon of the vertical dial, now without support.

# THE PLANISPHERIC NOCTURNAL

MIKE COWHAM

Many readers will be familiar with the nocturnal, an instrument for telling the time at night from the stars. It is generally used with the Pole Star (Polaris) sighted through its central hole and the long arm aligned with the 'Pointers' of the Great Bear (or Plough), or sometimes the bright star Kochab in the Little Bear. It is a great instrument and gives a fairly accurate reading of the time at night. As the position of the stars are not solar based, the Equation of Time does not need to be considered.

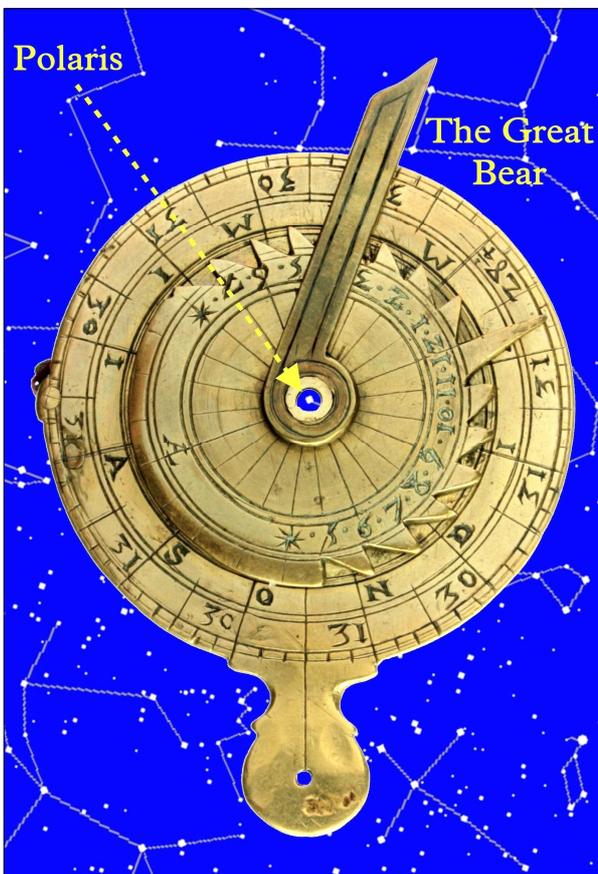


Fig. 1. How to use a nocturnal.

An alternative to this instrument is what is known as the 'planispheric nocturnal'. It is essentially similar in concept except that instead of using an arm to align with the appropriate stars, it just shows a picture of the heavens on a rotating plate. All that is necessary then is to align the plate with the actual stars, as seen. Admittedly, it is not quite so accurate as perfect alignment is more difficult, and it requires some light to see where the star disc is positioned, whereas the nocturnal proper can often be used in complete darkness. Some versions, like that shown in Fig. 1, can be used



Fig. 2. A planispheric nocturnal on the reverse of a quadrant by Nathanaell Heighmore, dated 1633.

by feeling the protrusions from each of the hours around the central disc, counting them from the longer 12 or midnight pointer.

The principal of the nocturnal is to tell the time from suitable circumpolar stars. During the course of the year, the

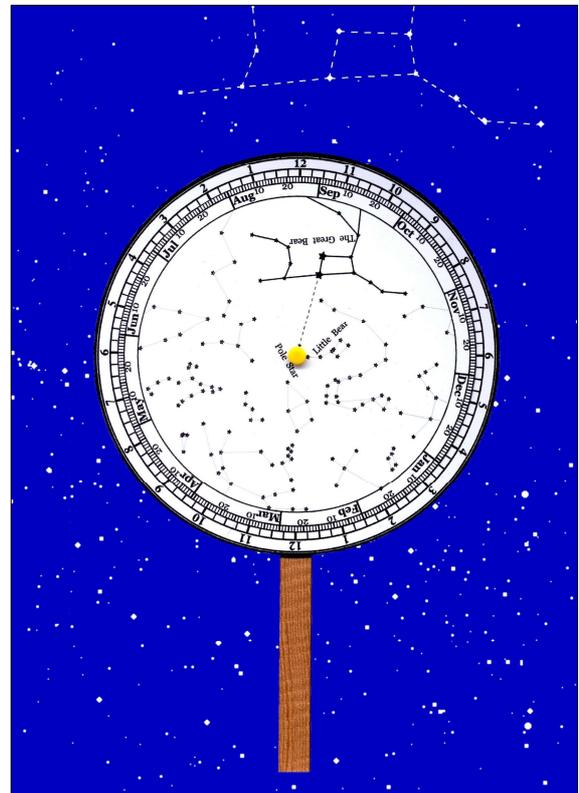


Fig. 3. A planispheric nocturnal being aligned with the stars at 11:30pm on 1 September.

Earth orbits the Sun doing one complete revolution with respect to the stars during this cycle. The stars above therefore appear to rotate once each day plus a further  $1/365\frac{1}{4}$  making 1.0027379 rotations each day. The nocturnal therefore needs to be set against a calendar scale to achieve its results.

The planispheric nocturnal may be found on several instruments, in particular on the reverse of some quadrants. The quadrant itself is usually an excellent timekeeper working from the altitude of the Sun, so the planispheric nocturnal may be used to give the time at night, making it a very useful instrument. It is often accompanied by a scale known as the De Rojas projection, also used for telling the time from the Sun. In the example shown by Nathanaell Heighmore it is quite difficult to see all of the star constellations but these would have been much clearer when it was first made.

In order to check out the ease of use of this projection, a model has been made and tested against the stars (Figs. 3 & 4). In practice it will usually give the time to within 15 minutes. It is not that easy to align precisely with the stars and will show any errors due to the handle not being held perfectly vertical. It would probably be easier to use if it had a hole in its centre, like the normal nocturnal, through which to view the Pole Star (Polaris).

To design the instrument, all that was necessary was to get a star chart with Polaris at its centre and to align this such that the 'pointers' of the Great Bear are directly above Polaris, towards the Zenith, on 7 September (the actual date, which varies very slightly depending on the Leap Year cycle, being when the pointer stars make their meridian transit at midnight). Once done, a calendar scale can be formed, each day equally spaced around the edge of the instrument.

To tell the time, align the rotatable disc to represent the sky and read off the time against the current date.

For convenience, the artwork for these discs is also accessible via the BSS website.

[mike@brownsover.orangehome.co.uk](mailto:mike@brownsover.orangehome.co.uk)

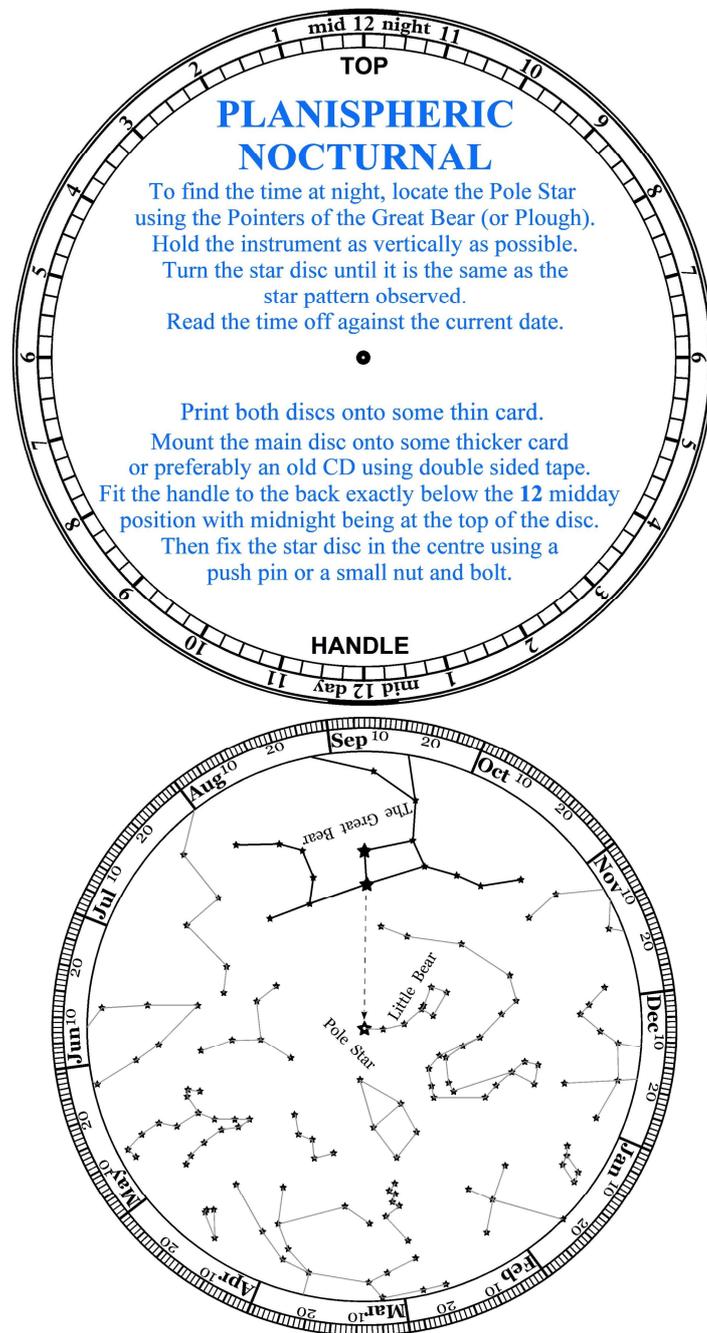


Fig. 4. Detail of nocturnal.

## The Clock and the Sundial

Images combining clocks and sundials are always a good reminder of how a clock is only a time indicator whereas the sundial is a time-finder. This one, showing a lantern clock, is particularly early. It is in pen and brown wash on vellum and is anonymous, though it is catalogued as "Netherlandish, later XVIc. In the style of engravings like those of Alaert Claesz or the Master 'S'".

The clock is rather well detailed but unfortunately the sundial cannot be clearly seen. The expression on the man's face is rather bemused—perhaps he is wondering why his expensive clock is so inaccurate. Perhaps if he had not set it up in a garden it would have performed better!

Courtesy of the Trustees of the British Museum, Reg no. 1946,0713.1067.

JD



## Lost Bonar Dial Resurfaces (Briefly!)

In his articles<sup>1,2</sup> on the slate equatorial dials of John Bonar (c. 1580 – after 1638), Gordon Taylor described one of the dials as made in 1634 for Loudon Castle, Scotland. He said that René Rohr had seen it in an antiques shop in Brussels in 1986 and then asked “where is it now?”.

The question was briefly answered recently when it appeared in the auction catalogue of the Kunsthaus Lempertz auction house<sup>3</sup> in Cologne, Germany, in a sale of ‘Decorative Arts’. It was described as “probably English” (!) with a provenance of being from an important German collection of art objects. It had an estimated price of 4000€ - 6000€ but, as it was only spotted a few days before the date of the auction, it was not possible to find a suitably well-heeled Scottish collector to bid for it. In the event, it seems that the dial was unsold and so it has now disappeared from view again.

The auction catalogue (and the photos) indicate that the dial was very precisely dated to 12 February 1634. It can be seen that there is a wealth of engraving on both sides of the dial. The dial is one of four similar ones known by the schoolmaster Bonar and despite the fact that the gnomon and the moon volvelle are both missing, it remains an important part of early Scottish dial-



ling. Although the actual dial is not available for inspection, the details of the photographs are sufficiently clear for more research to be possible, for example, into the heraldic device and the details of the inscriptions.

The similar Bonar dial from Wigtownshire, dated 22 September 1632, has previously been drawn and described in considerable detail.<sup>4</sup> Although this article did not understand the ‘establishment of the ports’ positioned against the compass directions, it did provide a full listing of the various Latin inscriptions. An earlier article<sup>5</sup> is referenced which describes the Kenmure Castle dial of 2 December 1623.

My thanks to Dr Ingrid Gilgenmann of Lempertz for details and photos.

### REFERENCES

1. G.E. Taylor: ‘The Dials of Bonar’, *BSS Bull.*, **91** (3), 13 (1991).
2. G.E. Taylor: ‘The Dials of Bonar’, *BSS Bull.*, **97** (3), 37 (1997).
3. [www.lempertz.com](http://www.lempertz.com). The sale was No. 994 on 10/11 May, 2012 and the sundial was Lot 880.
4. J. Graham Callander: ‘A Seventeenth-century sundial from Wigtownshire’, *Proc. Soc. Antiq. Scot.*, **44**, 169-180 (Jan 1910).
5. *Proc. Soc. Antiq. Scot.*, vol. xxiv, p. 222.

John Davis



# A DUTCH MANUSCRIPT SHOWING POLYHEDRAL DIALS

HEILKE VAN DER WIJK and JOHN DAVIS

One of us (HvdW) owns a rather mysterious Dutch manuscript which includes over 40 large drawings and calculations of sundials. Some of the drawings are for elaborate polyhedral dials which makes it a rare and important document which may shed some light on the origins of these unusual forms.

The manuscript can be dated by the fact that the paper has a French watermark which was used over the period 1670-75 and is relatively common in Holland in this period. This dating is confirmed by a contemporary inscription at the beginning of the manuscript stating that it was sold in a book auction in Nijmegen in 1690, having been the property of a certain Captain Paep (deceased) who was claimed to be the author of the drawings. Whether Paep was a naval or military captain is unknown (though the former is perhaps more likely to be associated with sundials). It can be noted in passing that 'Paep' was a nickname used by Dutch Protestants for Catholics.

The purpose of the manuscript is not clear. The figures are rather well drawn and hence do not look like the working drawings of a sundial maker. Rather, they may be a form of 'commonplace book' made by the owner as he collected information from a number of sources.

There is no overall title to the manuscript. There are three separately-numbered groups of drawings. At the beginning of the second group, of approximately 30 drawings, is a note that they concern cylindrical sundials made by Benjamin Braemers. An example opening is shown in Fig. 1.

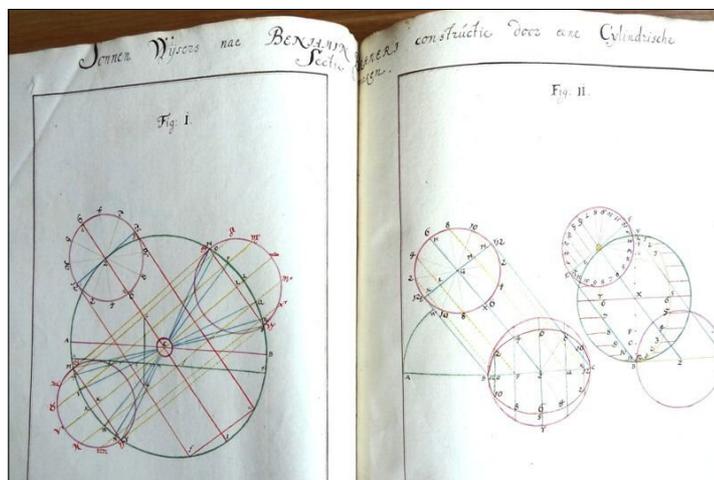


Fig. 1. Drawings of cylindrical sundial construction in the form of Benjamin Braemers.

Braemers (1588-1652) was a German mathematician who published several books and was the inventor of several mathematical instruments particularly for drawing in perspective, and a form of pantograph.<sup>1</sup> The drawings of the manuscript are similar to his published ones but do not appear to be exact copies.

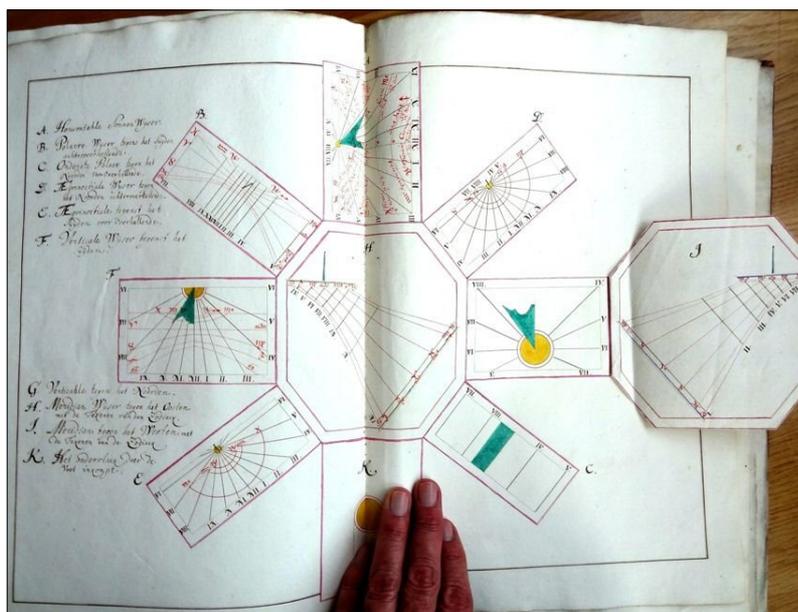
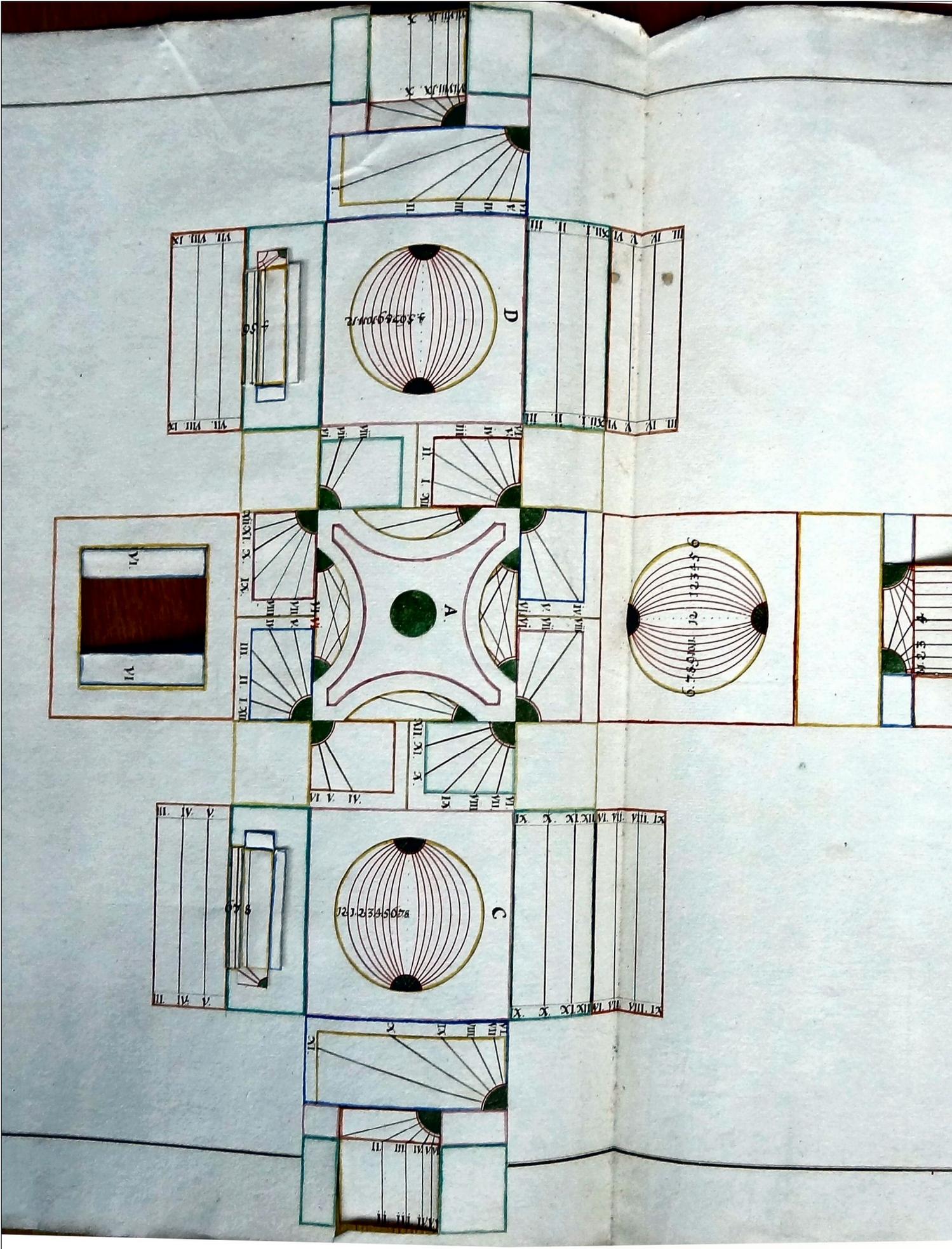


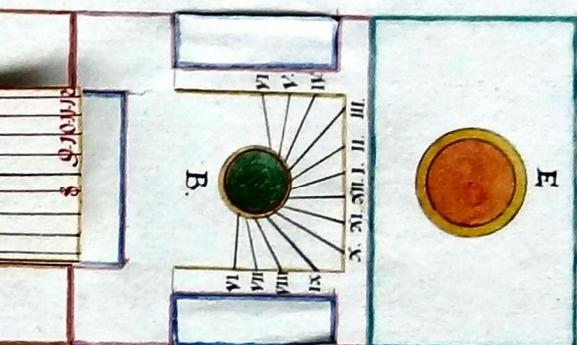
Fig. 2. Simple prismatic polyhedral dial.

An example of a relatively simple polyhedral dial from the third section of the manuscript is shown in Fig. 2. It is clear that if this shape was cut out and folded into a 3D structure it would produce a polyhedral dial of prismatic form with vertical dials for each of the cardinal compass points plus declining dials for NE, NW, SE and SW, together with a horizontal dial on the top surface. The largest, octagonal, faces are for the East and West dials which is perhaps unexpected. The authors have been unable to locate a real structure of this shape.

The real gem of the manuscript is shown in Fig. 3. This drawing for a complex dial consists of scaphe dials as well as planar ones, and also dials with thick rod gnomons. The Dutch key to the faces can be translated as:

- A: The equatorial sundials laying just against the north, drawn from different centres.
- B: Dial laying towards the south pole.
- C: Dial laying towards the East.
- D: Dial laying against the West.
- E: Is the foot or foundation on which the dial has been placed.





A. Syn. Egniochale. Somer  
 Myer's. waer tegen het  
 Noorden liggende, uyt di-  
 versen Conden getrokken.  
 B. Myer tegen den Jagers-  
 legende.  
 C. Myer tegen het Oosten.  
 D. Myer tegen het Westen.  
 E. De Doet, of het Tandenent  
 Over De Myer op gemackt  
 is.

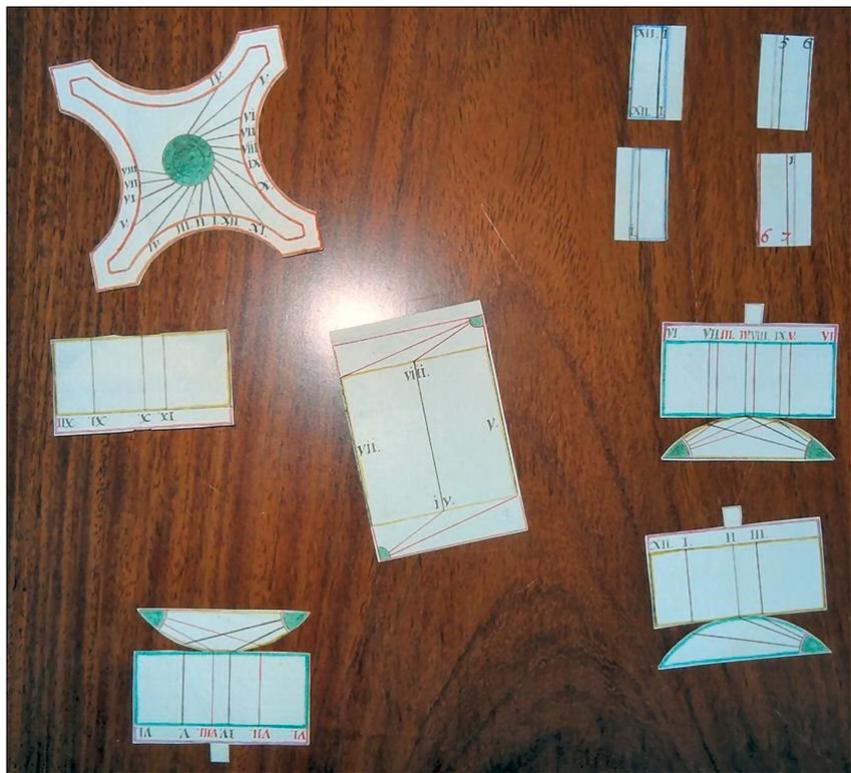


Fig. 4. Cut-out pieces associated with the manuscript.

Fig. 3. Complex 'lectern' polyhedral dial.

This drawing cannot simply be cut out and folded to make a solid structure (we have tried!). Clearly some earlier dial-list has also attempted a 3-D construction as a series of separate cut-out pieces, shown in Fig. 4, are associated with the manuscript, though it is not certain that they belong to this particular drawing. It is evident that the cross-shaped structure in the centre is the plan view of a shape which must be projected out of the plane of the drawing and that its edges then form a series of gnomons. Some of the smaller dial faces must be reclining or proclining and not attached directly to the main structure.

Thus, we issue a challenge to our readers to construct a model or isometric drawing(s) of what this dial would look like, accounting for all the faces. Origami experts and modellers, here is your chance to further gnomonic research! The overall form of the dial is expected to be very similar to Scottish 'lectern' dials, a term defined by Andrew Somerville in his catalogue of the dials of Scotland.<sup>2</sup> Of the dials of this type, the ones at Ruchlaw and Woodhouselee are two which seem most similar to the one drawn in the manuscript, particularly in terms of the equatorially-aligned cross structure on the top. Drawings of these taken from the work of Thomas Ross<sup>3</sup> are shown in Figs. 5 & 6 respectively, and form a guide to those taking up the challenge.

When discussing the origins of Scottish polyhedral dials, Somerville speculates about a possible Dutch connection

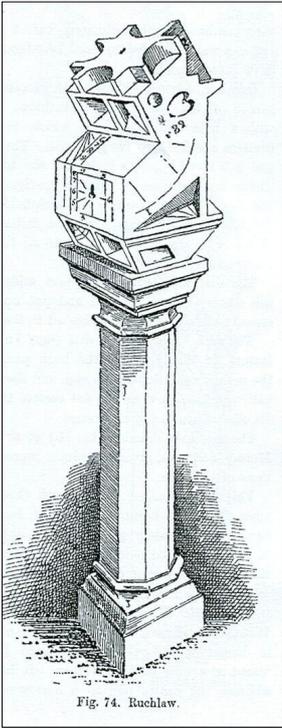


Fig. 74. Ruchlaw.

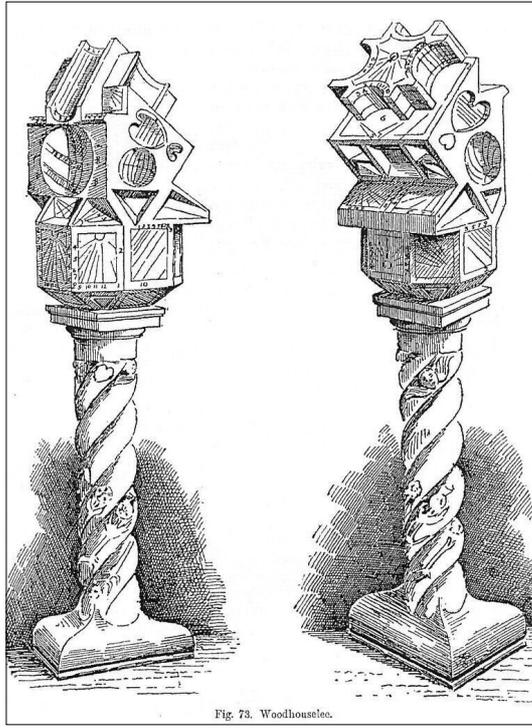


Fig. 78. Woodhouselee.



F. Maes

Fig. 5. The Ruchlaw lectern dial, 1663, now lost. After Ross.<sup>3</sup>  
 Fig. 6. The Woodhouselee lectern dial, now at the Royal Museum of Scotland. After Ross.<sup>3</sup>

Fig. 7. The lectern dial at the Huis van Loon, Amsterdam, dated 1578.

following the marriage of James VI to Anne of Denmark in 1589 and their exposure to the new Dutch style of architecture.<sup>4</sup> One remarkably early (1578) Dutch polyhedral sundial still exists at the Huis van Loon, Amsterdam – see Fig. 7. Whilst not exactly like the drawing in the manuscript it is much more in the Scottish style than the later polyhedral dials elsewhere on the Continent. Does the manuscript provide a missing link?

#### REFERENCES

1. [www-history.mcs.st-andrews.ac.uk/Biographies/Bramer.html](http://www-history.mcs.st-andrews.ac.uk/Biographies/Bramer.html)
2. A.R. Somerville: *The Ancient Sundials of Scotland*, Rogers Turner, London (1994). This is an extended reprint from *Proc. Soc. Antiq. Scot.*, 117, 233-264 (1987).
3. D. MacGibbon and T. Ross: *The Castellated and Domestic Architecture of Scotland*, David Douglas, Edinburgh (1892).
4. Ref. 2, pp. 249-51.

**Heilke van der Wijk** is a Dutch manuscript collector and can be contacted at [hiekewijk@planet.nl](mailto:hiekewijk@planet.nl).

## NEW DIALS

### Olympic Sundial

The story of the Olympic sundial was described in a talk at the 2012 BSS Cheltenham Conference. The problems of short timescales, a rather woolly design brief and the efforts to measure the likely shadowing by the surrounding ‘shrubbery’, which turned out to include at least one silver birch tree, were described, not to mention the necessity of using a solar-defined meridian line rather than the inaccurate one provided by the developer’s surveyor.

It is in the silver area of The Great British Garden, close to and to the northwest of the Olympic Stadium. It is 6 m in diameter. The components are polished 5 mm stainless steel (the closest approximation to silver) with etched detailing. The date scale is Welsh slate inset with stainless steel. ‘Bailey points’ are given as sunset and sunrise





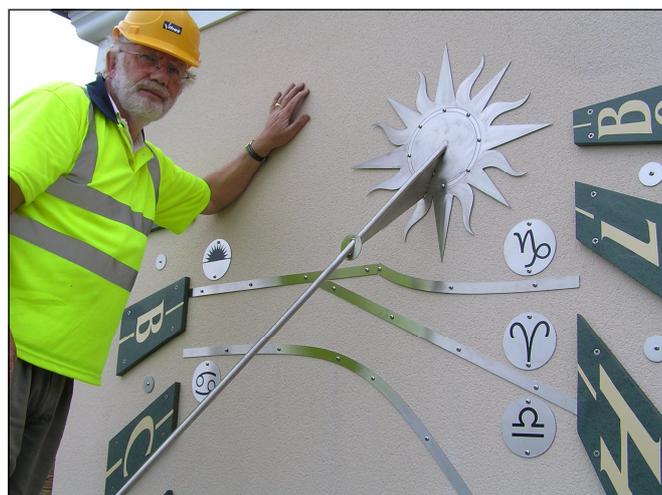
markers. Two instruction plates guide users on how to use the dial to tell the time and the position and time of sunrise and sunset. All the components are set in concrete. The dial was designed, delivered and aligned by David Brown with construction work by Willerby Landscapes.

David Brown  
[www.davidbrownsundials.com](http://www.davidbrownsundials.com)

### Sherbourne Girls School, Dorset

This dial is on the lift shaft of the school's new Science Centre building, hence their idea of using the first twelve elements of the periodic table in place of numerals. The chemists chose that. The physicists got their bit from the astronomical components (including the basic dial delineation) and the biologists suggested the use of the *fleur de lis* feature from their school badge. The 1.8 metre wide dial is made of green slate hour plates inset with cream-coloured resin. The lines on the plates indicate the hours and the edges the quarter hours. The stainless steel discs between the plates indicate half-hours. The stainless steel components have labels for sunrise, solstices (Cancer and Capricorn) and equinoxes (Aries and Libra). The noon cross and *fleur de lis*, as well as the sunburst, all have textured surfaces. A nodus disc is attached to the gnomon parallel to the plane of the dial so that it shows a circular shadow. There is a nearby EoT correction curve on a stainless steel plate with the names of the major donors listed as well as the designer and maker of the dial, David Brown Sundials. The dial was 'unveiled' on 6 July 2012.

David Brown  
[www.davidbrownsundials.com](http://www.davidbrownsundials.com)



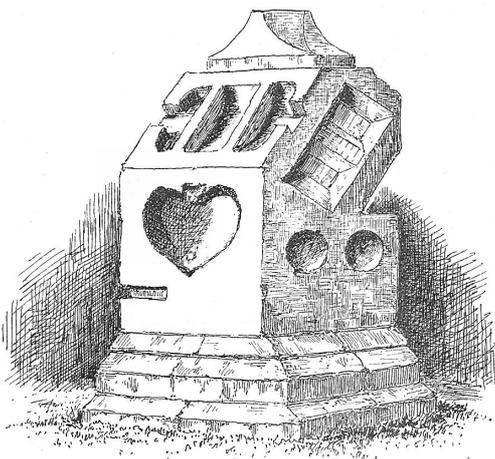
### Talaton, Devon – The Angel of the South West

The church of St James the Great, Talaton, is at 50° 47' 23" North, 3° 19' 28" West. The porch faces precisely due South – a tribute to the medieval surveyors who built the church. There are many fine sculptures on the church tower. However, the canopied niche over the door of the porch was empty before the angel and sundial were commissioned by Mrs Deborah Jarman in memory of her parents. Her father's family came from the village and had a farm behind the church in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. The idea of an angel standing in the niche holding a sundial was inspired by the one at Chartres Cathedral in France (see the front cover of the December 2011 *Bulletin*).

The angel and sundial were designed and made by Harriet James and carved in French limestone. An accompanying plaque inside the porch was carved in Delabole slate. The brass gnomon was made by Malcolm Stevenson of Lynchet Engineering of Market Lavington, Wiltshire. The shadow of the spherical nodus on the gnomon tracks a declination curve for St James' day on 25 July. For legibility, only the hour lines for 10am and 2pm are labelled with Roman numerals and noon is marked with a cross. The carved scallop shell at the origin of the hour lines is the symbol of St James.

There was a service of dedication for the sundial on 27 May 2012.

Harriet James  
enquiries@sunnydials.co.uk



### Upton Manor Farm, Cambs

This multiple scaphe dial is described by Mrs Gatty as being in the orchard of a former manor house near Peterborough, once the property of Thomas Dove, the Bishop of Peterborough (d.1630) and Queen Elizabeth's "Dove with the silver wings". The property has clearly gone downhill since.

Mrs Gatty says that "the whole block is 5 feet 10 inches in height" but the maximum dimension recorded in the Fixed Dial Register (SRN 2203) is 1040 mm. The *Register* says that it is of Ketton stone and has 29 individual dials. It was also described by Chris Daniel in one of his *Clocks* articles (14(5), p. 36, Oct 1991) where it is tentatively attributed to Edmund Gunter and said to have 30 dials. Although it was covered in lichen in Mrs Gatty's time it had been carefully drawn and described a century before when the numerals *etc.* were still visible. The reference is rather obscure but would be worth researching for more details as the original delineation is believed to have been complex and it has not been photographed since 1993.

JD

# THE TYTTENHANGER SUNDIAL

GEOFFREY LANE

The mid-seventeenth century was a time of mixed fortunes for English glass-painters. The civil war period saw the destruction of much old and new glass in churches. The restoration of the monarchy in 1660 offered fresh demands for armorial glass, but it was a long time before pictorial glass in churches again became at all widespread. One factor which helped to provide regular work for the trade was a fashion for glass sundials, which allowed their proud owners – on sunny days at least – to set their clocks and watches without having to step out of doors. A considerable number survive from this period, and more continue to turn up, thanks in good measure to members of the British Sundial Society.

One recent rediscovery is the Tyttenhanger sundial, made for the mansion of that name in Hertfordshire, some 15 miles north of central London. It was recorded in 1910 by the Royal Commission on Historic Monuments, but omitted from later works of reference such as Pevsner's *Buildings of England*. It was found in a north-facing window in 2010 by the BSS member Patrick Powers, who wrote: "The dial

itself is set as a centrepiece in some more flowery (and inappropriate) glass in a separate frame which is fixed, not just hung, on the inside of a Georgian window frame. The wooden bars of the Georgian window therefore obstruct the clear view through the dial. That dial frame is mounted (backwards) in such a way that the dial appears the wrong way round to anyone inside the chapel of the house (which is where the dial is) – I expect whoever set it there wanted the numerals to appear as they do on a clock" (see Fig. 1).

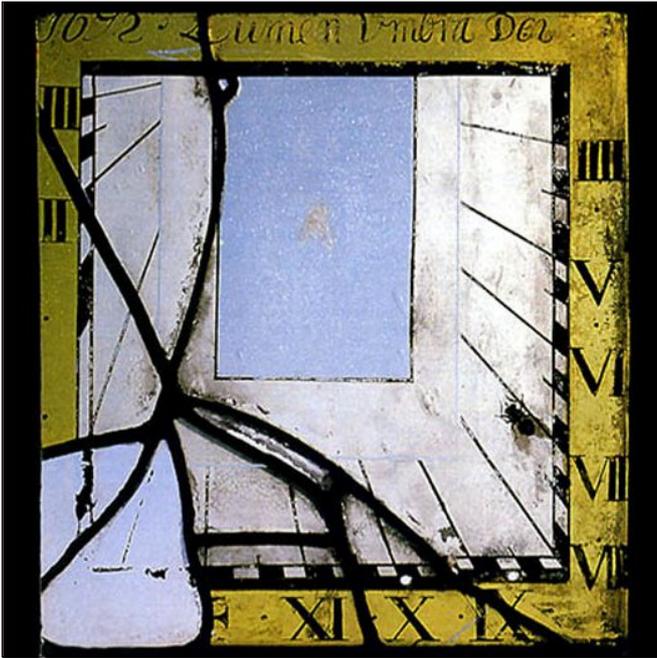
The first task is therefore to reverse the image and enhance it digitally, in order to show more of the detail hidden by the glazing bars (Fig. 2). This immediately clarifies the armorial device in the centre, and confirms that the sundial really does belong to the house. It displays the arms of Sir Henry Blount (1602-1682) – *Barry nebuly of eight or and sable* – impaling those of his wife, née Hester Wase –



Fig. 1. The Tyttenhanger sundial (photo courtesy Patrick Powers).



Fig. 2. The photo of Fig. 1 reversed and enhanced to reveal hidden detail.



Barry of six argent and gules. Lady Hester, joint heiress of Christopher Wase, had previously been married to Sir William Mainwaring, one of the Royalist victims of the Civil War. Mainwaring was killed in October 1645, during the siege of Chester, and his wealthy young widow soon caught the eye of Blount, who married her in 1647.

Unlike Mainwaring, Blount was a notorious survivor of the turmoil. A celebrated travel-writer in his youth, and a lawyer by training, he had been knighted in 1639, and fought for the King at Edgehill in 1642, but later switched to the Commonwealth side, and was even appointed by Cromwell in 1652 to serve on a commission to reform the criminal code. The deaths of his father and elder brother left Sir Henry in full control of Tyttenhanger, the family home and a former residence of the Abbots of St Albans, which he proceeded to demolish and rebuild around 1655. Pevsner dated the new house as c.1660.

The front of the house faces roughly 13 degrees W of due S, and Blount's glass sundial is designed for a declination of 13 or 14 degrees. Exactly when he commissioned it is not known, but its closest parallels seem to date from around 1670. It bears the Latin motto *Lumen Umbra Dei* (Light is the shadow of God) in a distinctive cursive hand. The same motto, in what appears to be the same hand, occurs on dials at two strikingly similar houses built soon after the Restoration of the monarchy in 1660: a rectangular dial dated 1672 at Tredegar House, near Newport, South Wales (Fig. 3), and a quarry (diamond-shaped) dial at Groombridge Place, East Sussex (Fig. 4) – one of a pair, its twin bearing the related motto *Umbra videt Umbra* (Fig. 5).



Fig. 6 (above). John Oliver's dials at Northill, Beds. (1664); the gnomon of the left dial has been replaced on the wrong side of the glass (photos courtesy Mike Cowham).

Left, top to bottom:

Fig. 3. The Tredegar sundial dated 1672 (photo courtesy Christopher Daniel).

Fig. 4. Motto on the Groombridge dial A, and

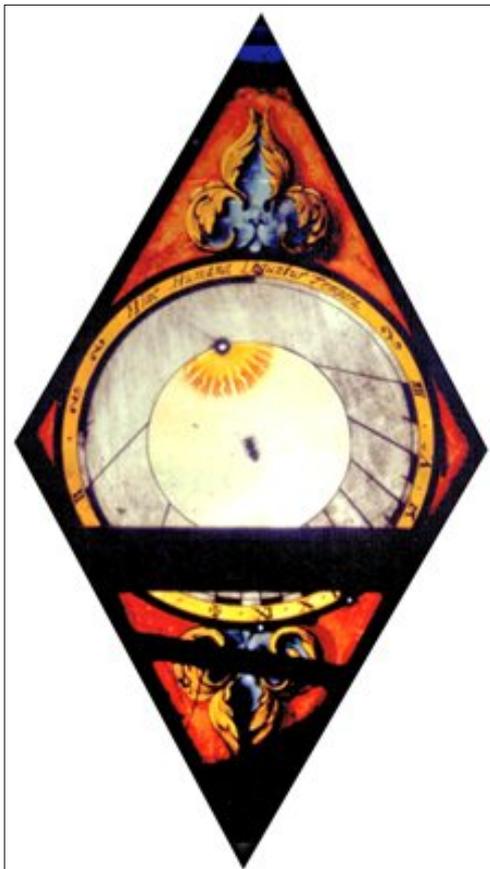
Fig. 5. Groombridge dial B; (photos © Andrew Rudebeck).

The Groombridge dials have been attributed to John Oliver, from their marked affinity to a pair at Northill, Beds., (Fig. 6) which date from 1664, when Oliver made a large armorial window for the church there. The dials were for the Rectory: the first, inscribed in Oliver's more formal hand, has his signature scratched in the matt (Fig. 7). But the second, perhaps intended for the Rector's wife, has an inscription in an informal hand similar to that at Tyttenhanger. Unfortunately the two mottoes have scarcely a letter in common, but at least they show that Oliver was happy to vary his scripts.



Fig. 7. Signature: "John Oliver fecit" in matt of Northill A (photo courtesy Mike Cowham)

Two other dials with similar motto-scripts are the Chicksands dial and the privately-owned *Non sine lumine* dial, a direct west dial with a linear scale rather than a clock face (Figs 8 & 9). If all the above are by John Oliver most may well come from a period of upheaval in his personal life. Oliver's home and workshop, at the junction of Great Trinity Lane and Little Trinity Lane, burned down in the Great Fire of 1666; it was more than a year before his plot was surveyed and he could begin to rebuild. Early in 1668 he joined the small team of City Surveyors, working alongside Robert Hooke and Peter Mills – which led in turn to his



Figs. 8 & 9. The Chicksands (left) and *Non sine lumine* (right) dials – both from John Carmichael's website (see author's note at the end of the article).



appointments in the winter of 1675/6 as a member of Wren's teams rebuilding the churches and St Paul's Cathedral. Despite all this Oliver seems to have kept up at least his small work during these years. His fellow-surveyor, Robert Hooke, recorded in his diary that he called on Oliver in December 1673, and "saw him paint glasse".

Both the Tredegar and Tyttenhall dials have also at various times been attributed to Henry Gyles, apparently on grounds of their general appearance. However this does not seem to be supported by a detailed comparison with his Nun Appleton dial, which also dates from 1670 (Fig. 10).

As is almost always the case with glass sundials, the hour-numbers are painted in black on a chapter-ring stained yellow. Inside this ring the hour-lines are painted on a matt surface (usually white or greyish) designed to show up the shadow of the gnomon, a brass rod mounted on the outer side of the panel. But at Nun Appleton, and in all the other dials most reliably attributed to him, Gyles consistently marked his half-hours with a line and a finial painted on the chapter-ring itself, whereas Oliver and other London makers usually painted a dot at this point and a shorter line on the inner matt field – as can be seen in all the other examples illustrated above. Gyles also used a markedly different handwriting, full of scrolling flourishes. In any case, Gyles was near the start of his career in 1670, and his reputation is unlikely to have spread this far. Blount had no cause to seek out a relative unknown in distant York, when his old London haunts were within walking distance of at least two established glass-dial-makers, John Oliver in the City and Richard Dutton (son-in-law of Baptist Sutton) in Holborn. Philip Packer, who built Groombridge, was

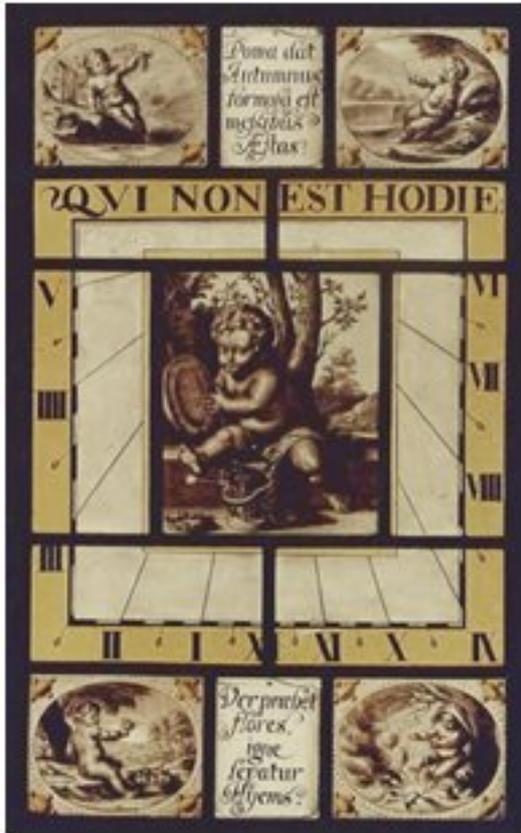


Fig. 10. Nun Appleton dial by Henry Gyles (1670), (York Glaziers' Trust, following conservation).

another London lawyer, and may have known Oliver through Christopher Wren. Even William Morgan, settled

in south Wales, would probably have found it easier to shop in London than York.

**Author's Note:** My thanks to Patrick Powers and John Davis for their help in preparing this article. Tyttenhanger and the two other Restoration-style houses featured in this article are described in the relevant volumes of Pevsner's *Buildings of England*; each house also has its own website. Regrettably there is as yet no comprehensive book on stained glass sundials, but nearly all the surviving examples can be studied on John Carmichael's excellent website *Stained Glass Sundials from around the World* at [http://advanceassociates.com/Sundials/Stained\\_Glass/sundials\\_Archive.html](http://advanceassociates.com/Sundials/Stained_Glass/sundials_Archive.html). The site has links to numerous articles on related topics. Mike Cowham (ed): *Sundials of the British Isles* (2005) also includes a valuable chapter on glass dials.

**Editor's Note:** The story of how the existence of the Tyttenhanger dial was (re)discovered by Ian Butson and Chris Daniel, and how Patrick Powers, as a local taxpayer, managed to gain access to view it, was reported in *The Recorder* Issue 8, Exeter (April 2010).

**Geoffrey Lane** is a retired BBC journalist who specialises in English stained glass of the 16<sup>th</sup>–18<sup>th</sup> centuries –



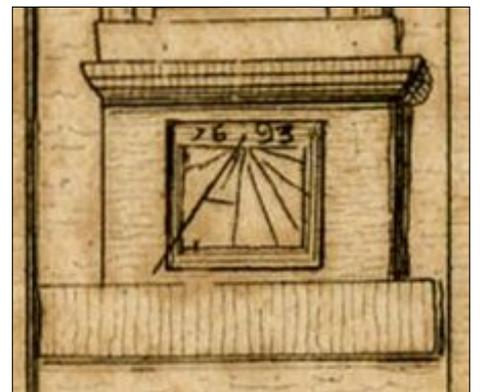
the somewhat neglected period between the Reformation and the Victorian Gothic revival – concentrating particularly on the work of London-based makers. He was pleasantly surprised to discover that their output included many sundials: he has written about them in the *Bulletin*. He can be contacted at [geoffrey.lane1@btinternet.com](mailto:geoffrey.lane1@btinternet.com).

## The Old Meeting House, Norwich

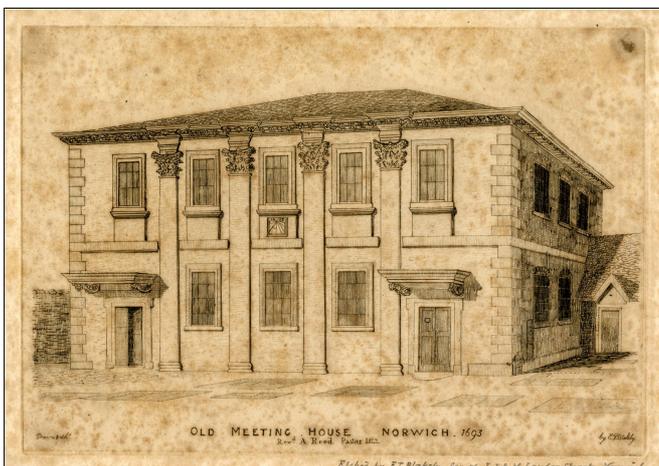
This 1842 etching of the Old Meeting House, Norwich, was printed and etched by the draughtsman Edward Theobald Blakeley. Blakeley's family is known to have attended the chapel in the building around the time the etching was made.

It is in the print collections of the British Museum and, as can be seen, features a vertical sundial which gives the original date (1693) of the building. It is one of the oldest non-conformist places of worship in the country.

Researching the building quickly revealed that it still exists today, in the Colegate area of the city, looking much the same as it does in the engraving. Its SRN of 6471 shows that it has been recorded only relatively recently (by Ian Butson). The dial has been refurbished and regilded but is probably still the same one. Note the unusual shape of the hour-lines. Image courtesy of the Trustees of the British Museum.



JD



# THE SUNDIALS OF GERALD LAING

DENNIS COWAN

Gerald Laing was a pop artist of some repute, in the mould, according to some, of Andy Warhol. He was born in 1936 in Newcastle-upon-Tyne and spent a great part of the 1960s living and working in New York. Like Roy Lichtenstein and Robert Indiana, with whom he worked after moving to America, he helped to define the 1960s with popular images that symbolised the icons of the era, be they automobiles—a particular favourite of his—or film stars. The famous image of Brigitte Bardot with her face encircled by a target ring is one of Laing's works.

His work is exhibited in public and private collections around the world, including the Tate, the V&A, the National Portrait Gallery and the National Gallery in London; the Museum of Modern Art and the Whitney Museum, New York, and the Smithsonian Institution.

In 1969 he left New York for the Scottish Highlands where he bought and restored the crumbling Kinkell Castle near Inverness. He abandoned painting and turned his hand to sculpture, setting up his own bronze foundry at Kinkell. One of his works, depicting four rugby players in a line-out, stands outside Twickenham, the home of English rugby. He returned to painting only fairly recently and these works include Victoria Beckham, Amy Winehouse and Kate Moss.

However, he is hardly known at all for his sundials, being responsible for at least four. He cast a bronze Scottish obelisk sundial at his foundry at Kinkell (SRN 1175, Fig. 1) for Dunphail House in Morayshire and was known to have been in correspondence with, and may have met Dr Andrew Somerville on this subject early in 1990. Photographs and copies of correspondence between the two are in the collection of the Royal Commission on the Ancient and Historical Monuments of Scotland. It is possible that this sundial was never installed at Dunphail, as Gerald Laing's website appears to indicate that it is at Kinkell,<sup>1</sup> unless of course, he made another one for himself!



Fig. 1. Kinkell obelisk.

The shaft has four square panels on each side with cup hollows (scaphe dials), hearts and vertical dials showing Babylonian, Planetary and Italian hours. The central boss has an octagonal band complete with four cup hollows with declination lines on the south face. The finial has four panels on each side giving the time in New York, Chicago, Hong Kong and Tokio.

Laing produced a very similar obelisk sundial in 2000 for the Wormsley Cricket Ground on the Getty estate in Buckinghamshire (SRN 6044, Fig. 2). This obelisk is in Portland limestone with bronze gnomons and shows the time at various cricket locations around the world including Delhi, Sydney, Barbados and Johannesburg. This dial was described in the Somerville Lecture at the BSS Annual Conference at Oxford in 2004.

He also produced a huge 37ft high market cross in 2001 which stands in Falcon Square in the centre of Inverness (SRN 7098, Fig. 3). It was unveiled by Prince Andrew and is a popular meeting place for people, young and old. It is made from the finest Clashach sandstone and is topped by a bronze Scottish unicorn. Four bronze flying peregrine falcons (sculpted by Leonie Gibbs) said to be in various stages of attack on a pigeon, are positioned around the upper reaches of the obelisk.



Fig. 2. Wormsley Cricket Ground.

Kevin Karney



Fig. 3. Falcon Square, Inverness.

Four cup hollows, robustly designed by Emma Lavender, are located around the base at the cardinal points. They show BST with declination lines marked by their zodiac symbols and include a graphical representation of the equation of time (Fig. 4). The gnomons have been designed to be particularly vandal proof. It was ‘Dial of the Month’ on the BSS website in June 2011.

In 1991 he produced ‘Axis Mundi’, a six metre high obelisk of polished black granite surmounted by the five wise virgins in bronze for Standard Life’s offices in Canonmills in Edinburgh (SRN 2074, Fig. 5). It includes three cup hol-



Fig. 5. ‘Axis Mundi’ at Canonmills, Edinburgh.

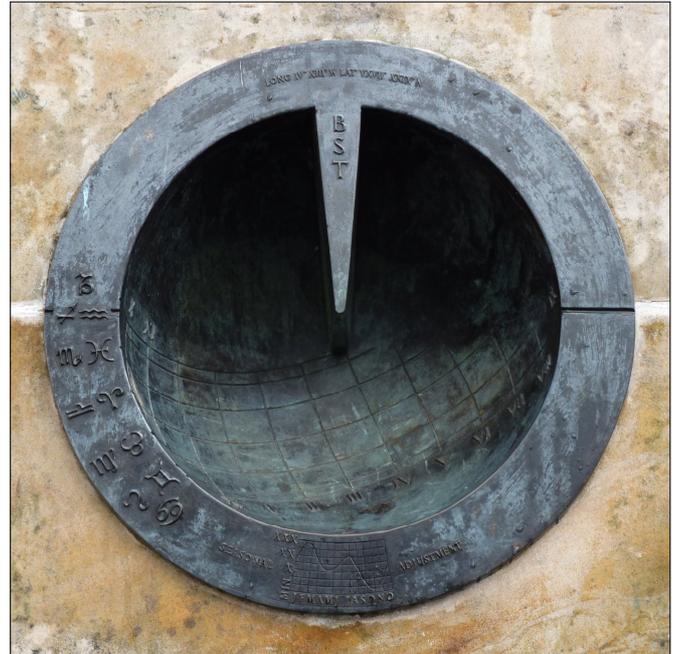


Fig. 4. The West scaphe dial at Inverness.

lows in cast bronze mounted at eye level on the east, south and west faces. The south dial has a 150 mm pin gnomon whilst the east and west dials each have a peripheral notch. The south dial, like the market cross at Inverness, has a graphical representation of the equation of time. The dials include hour lines, equinox and tropic lines. The gnomonics are by George Higgs.

Unfortunately, Standard Life’s offices here have been sold for development and the obelisk has been removed to storage. A spokesman for Standard Life confirmed that they have no current plans for its redeployment elsewhere.

Gerald Laing died in November 2011 aged 75.

#### ACKNOWLEDGEMENT

Many thanks to John Foad for providing details of the dials from the *BSS Register*.

#### REFERENCE

1. Gerald Laing’s website: [www.geraldlaing.com/index.php/work/publicsculpture\\_artwork/the\\_kinkell\\_sundial/](http://www.geraldlaing.com/index.php/work/publicsculpture_artwork/the_kinkell_sundial/)

### Peter Hingley (1951-2012)

It is with much sadness that we learned of the death in June of our member Peter Hingley.

Peter was the RAS Librarian at Burlington Arcade and was quietly influential when the BSS became affiliated to the RAS. He recently hosted the visit of BSS members to the RAS Library and was knowledgeable and helpful when members were looking for antiquarian publications on astronomy and gnomonics. His presence will be missed whenever the Council hold their meetings in London.

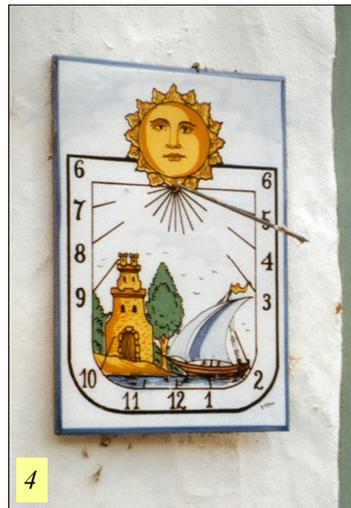
# DECORATIVE DIALS

TONY WOOD

The Society is greatly concerned with dials for telling the time. ‘What else?’ you might well ask. Every now and again one comes across a dial which is intended as decoration, or more seriously, as ornament.

Someone, somewhere, produced the two examples shown here (Figs. 1 & 2) and sold them to a ‘landscape gardener’ as eye-catching pieces. They have no numerals or delineation but have a super large gnomon and they are ornamental-only artefacts. The first is from Rosemary Verey’s famous garden at Barnsley in Gloucestershire and the second almost identical one is at Ablington Manor four miles away. So far these are the only two recorded but many must have been sold.

‘Decorative by default’ might be the description of the very well known dial at Hampton Court. It is a large bronze dial plate with a distinctive gnomon but the plate is blank (Fig. 5). The dial matches another (fully delineated) on the terrace overlooking the Privy Garden and is an unfinished replica of a Thomas Tompion double horizontal (SRN 2119). The other dial is also a replica of a Tompion dial, the two originals being kept indoors for security reasons. Apparently funds ran out and so we have an expensive ‘non-dial’ in our decorative dials selection. Neither replica



Another class of ‘decorative’ dials occasionally appears with people bringing back colourful tile dials from Spain, Majorca and the Mediterranean hinterland – jolly souvenirs of holidays in sunnier climes. Their chance of being accurate when perched on a British wall is remote as the gnomon is far off in latitude and centering; nevertheless they make a colourful addition to the environment and provide a nice dilemma for us magpie recorders. Fig. 3 shows one of my own tile dials from Minorca, bought for £3.50. So far in the Register we have examples from Anglesey (Fig. 4), Gloucestershire and Kent.

is registered but both are referred to in the entries for the original dials – there you go, I suppose.

The final picture (Fig. 6) shows a right mystery item which turned up whilst ferreting around an ‘architectural salvage’ establishment. It looks well made but doesn’t seem to be like any known dial; perhaps out there someone can recognise what appears to be a purely decorative ‘dial’ – let us know!

**Acknowledgements:** Mr R Cooper; Ablington Manor; Winchcombe Reclamation, Winchcombe, Gloucs.

# A MEDIEVAL EQUINOCTIAL DIAL EXCAVATED AT ST JAMES'S PRIORY, BRISTOL

JOHN DAVIS and CAI MASON

There is a distinct lack of medieval 'scientific' sundials in England (defined here as dials with polar-aligned gnomons delineated to indicate equal hours). However, recent archaeological investigations at St James's Priory in Bristol have uncovered a fragment of stone which has been identified as part of an equinoctial (or equatorial) dial for the local latitude and showing equal hours in the summer half of the year, labelled with Arabic numerals of medieval form.

## St James's Priory

St James's Priory is located in what is now central Bristol, just south of the bus station.<sup>1</sup> It was founded in 1129 as a Benedictine cell of Tewkesbury Abbey. During the medieval period the nave was used as a parish church. The surviving west (parish) end of the church originally comprised

a nave and two narrow aisles. The church retains many of its original Norman features; these include arcades in the nave with circular piers, and an un-restored wheel light and arcading on the west frontage. The cloisters (a small part of which survive towards the rear of 'Church House') and a southern extension to the south aisle (extant) were probably both built in the 14<sup>th</sup> century. A tower on the south side of the church was added in 1374.

When the priory was dissolved in 1540 during Henry VIII's dissolution of the monasteries, the nave was retained for use by the parish (now St James's Church, Grade I Listed), while some buildings of the priory complex, including Church House, were converted into dwellings. Further modifications were carried out in each of the following centuries, as is shown in Fig. 1 which colour-codes the different phases. The arrow on the top-left of the plan shows the direction of view in Fig. 3.

The south aisle was heavily modified in 1698. Millerd's map of 1673 (Fig. 2) shows a large porch on the south side of the church; this porch was demolished in 1802, to be replaced by the present structure. In 1864 a major renovation programme was undertaken. This work included demolishing some parts of Church House (the surviving part of the building is a Grade II\* listed structure), and replacing the medieval north aisle with a new, wider aisle. The central arcade of the new aisle follows the line of the old north wall.

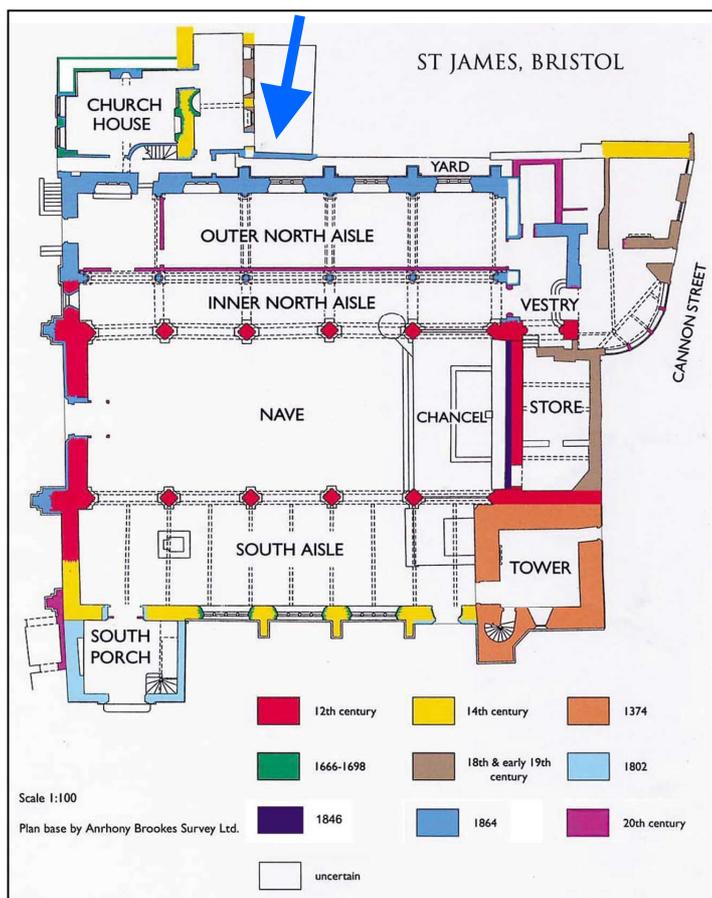


Fig. 1. Plan of St. James's Priory church showing various building phases (colour-coded). The blue arrow at top-left shows the direction of view in the photograph of Fig. 3. Drawing courtesy of St James Priory.

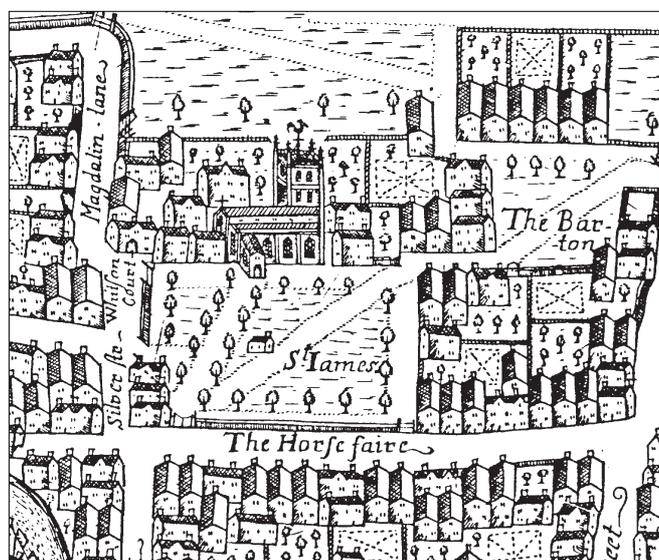


Fig. 2. Section of Millerd's map of 1673 showing the Priory from the south.



*Fig. 3. The opening on the Victorian N wall in which the dial was found as rubble infill. The arcades on the right side of the picture are the remains of the medieval cloister (incorporated into the later Church House).*

Worship at St James's Church ceased in 1984 and it has been open for quiet contemplation since the 1990s. The St James Priory Project has recently renovated the church.

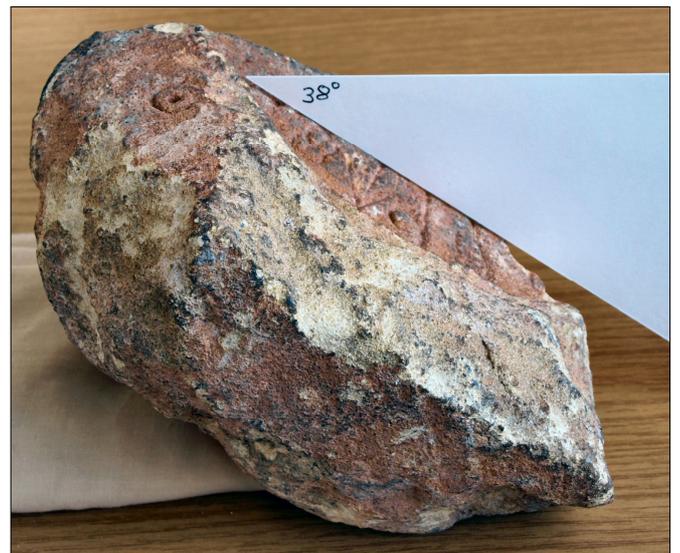
#### **The Excavation of the Dial**

As part of the St James Priory Project, Bristol and Region Archaeological Services (BaRAS) undertook an archaeological watching brief of the site over the period 2008–11 on behalf of the Project and its architects, as required by the planning consent for a major redevelopment.<sup>2</sup> One aspect of the work was to open a set of three apertures underneath windows in the 1864 north wall of the outer north aisle (see the plan of Fig. 1 and the photograph of Fig. 3). This revealed that the interior of the wall incorporated several re-used fragments of worked stone which probably originated from demolished parts of the priory. All of the fragments were carved in Bath stone (oolitic limestone) which is distinct from the largely sandstone Victorian wall, and included window mullions, other mouldings and a fragment which was later identified as part of a sundial. Considerably less than 5% of the interior of the wall was exposed so the finding of the dial was extremely lucky.

#### **The Dial**

The fragment of the sundial can be seen in Figs 4, 5 and 6. It is quite small, approximately 160 × 115 × 90 mm, and in the form of part of a rough cube with the face chamfered-off at an angle of around 38°.

With only part of the dial extant, some thought is needed to be able to visualise its original appearance. To be used as



*Fig. 4. Photographs of the sundial fragment. Top: front view. Bottom: side view with fragment resting on the worked bottom face and a with cardboard template.*

an equinoctial (equatorial) dial, the angled block needs to be set on a horizontal surface such that the angled face is at the co-latitude for the location. Bristol is at 51° 27.5' N so that the face of an equinoctial dial is at 38.5° to the horizontal. With the block oriented like this, the '6' line lies horizontally and represents 6pm.

A speculative reconstruction of what the complete dial may have looked like is shown in Fig. 7. In this picture, the flat, worked surfaces of the fragment, other than the circular face, are located at the base, the top, the left-hand side and the rear; all other surfaces are broken.

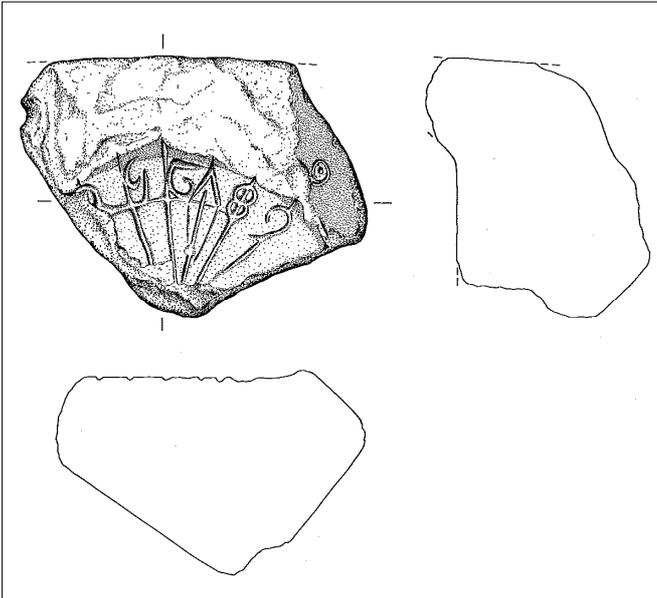


Fig. 5. Drawing of the sundial fragment. © BaRAS, drawn by Ann Linge.

A circular area of about 150 mm diameter has been slightly recessed in the chamfered plane and forms the dial face. This area shows traces of a reddish colouration. A set of radial lines is clearly engraved in the face and these are equi-spaced at 15° intervals as is shown by Fig. 6, taken with a transparent template over the dial. The centre of the circle is unfortunately missing but its approximate position can be estimated from the template and the accuracy of the delineation seen. The lines are numbered clockwise 4, 5, 6, 7, 8 and 9 although part of the figure '4' is missing. Note that there is no line for '10' although Fig. 5a shows that at least part of the numeral '10' would have been visible on the fragment if it had been part of the original design. The form of the numerals is medieval and is discussed further below. Additional engraving takes the form of a small circle with a central dot on the upper worked

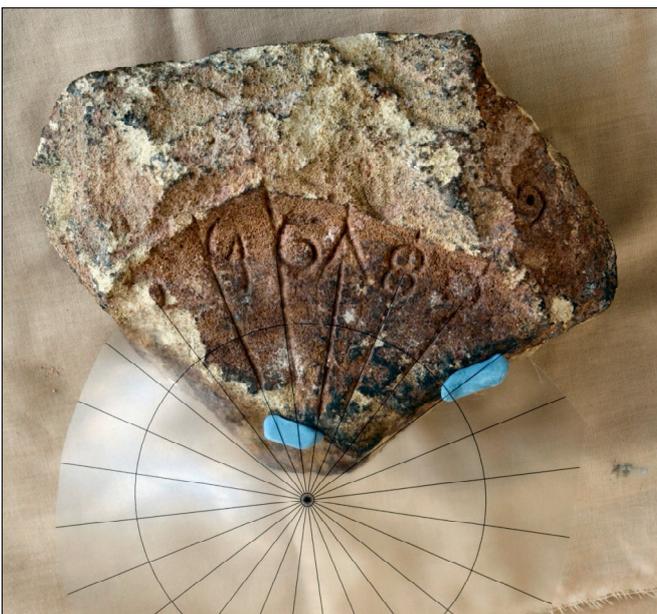


Fig. 6. Photo of dial face with a transparent equi-angular template attached.



Fig. 7. Artist's impression (by Jackie Jones) of what the dial may originally have looked like.

face adjacent to the '9', and two almost-radial lines lightly cut approximately midway between the 6 & 7 and the 7 & 8.

On the grounds of symmetry, the drawing of Fig. 7 has speculated that there was a second dot-and-circle in line with the 3am mark. These dots are not features known on other dials but would have been aligned in the E-W direction and thus may have been related to the direction of the equinoctial sunrise and sunset directions.

The red colouration of the dial face and some other surfaces is most likely to be the result of long exposure to weathering, though it is just possible that the dial face was painted. Broken surfaces of the fragment, presumed to have been broken just before being encapsulated in the wall, have a rather lighter off-white colour.

The dial depicted in Fig. 7 would only have operated in the summer half of the year when the sun's declination is positive. Presumably, a second 'winter' dial would also have been required but there is no evidence to allow a speculative design – it could have been a separate structure or somehow built into the same stone, as on the much later Scottish sundials. In fact, the dial would have operated for rather less than half the year as the recessed dial face would have made it difficult to see the gnomon shadow on the actual face until the declination was several degrees above the equator. Note, though, that the hour-lines seem to continue up the inside rim of the face to minimise this limitation.

The dial is imagined in Fig. 7 as standing on some form of pedestal with the chamfered surface facing north. It is possible, though unlikely, that the dial was attached to a south-facing wall but if this were the case the wall itself would have restricted the period when the dial could operate to times when the sun's azimuth was within 90° of South. Another possible location would have been on a south-facing buttress.

## Dating the St James Dial

The dial fragment is not explicitly dated and so its age can only be estimated from other clues, particularly the context of its discovery and the style of the engraving. The rubble in which it was found is clearly of a medieval nature and so its identification as coming from demolished parts of the Priory date it securely to before the dissolution, i.e. pre-1540. But it is the form of the numerals which provides more detailed evidence. The use of Arabic numerals in Europe only became widespread after Leonard of Pisa ('Fibonacci', c.1170–c.1250) wrote *Liber Abaci* in 1202 (re-published in 1228) and even then their use tended to be restricted to technical writings. The individual numeral forms evolved dramatically over the following centuries and did not take on a fully 'modern' appearance until the early 16<sup>th</sup> century.<sup>3</sup> The numerals which persisted for the longest with non-modern forms were 4, 5 and 7. In addition, the shapes of the '6' and '9', which tended to have a generally recognisable modern form, were stylistically different in that they originally had sweeping horizontal tails.

The numerals 4, 5 & 7 on the St James dial have forms which compare quite closely with those found on the 'Norfolk horologium' described recently<sup>4</sup> and also to be found in the manuscript of Robert Stikford<sup>5</sup> and the *Kalendarum* of Nicholas of Lynn,<sup>6</sup> the latter being dated to 1386. These particular forms remained in use for over a century and so the St James dial is most likely to date from the late-14<sup>th</sup> or the 15<sup>th</sup> century.

The choice of Arabic rather than Roman numerals for the dial is in itself significant. It took a long time for the Arabic system to become standard in England – merchants in the Elizabethan period often still compiled their accounts (with some difficulty!) using Roman numerals. The use of Arabic numerals in the medieval period implies an educationally-advanced, and probably scientific, designer. Church sundials from the 16<sup>th</sup> century, designed for use by the common populace, normally used Roman numerals. So it appears that the St James dial was made for, or by, someone familiar with the latest manuscripts on mathematics and astronomy and was intended to be read by similarly-educated people.

## Early Scientific Dials in England

The earliest reliably-datable 'scientific' dial in Britain is the stone polyhedral originally made by Nicholas Kratzer for Iron Acton. This dial is coincidentally also now in Bristol and was made quite soon after Kratzer first came to England in 1518.<sup>7</sup> It features Arabic numerals although it is wrongly delineated. Kratzer brought his knowledge of dial-making, derived from 'old manuscripts' he copied in a Bavarian monastery, with him. It is sometimes thought that scientific dials were unknown in England before Kratzer but, whilst he can be credited with popularising dials here, they were definitely known before this – both manuscripts<sup>8</sup> and excavated instruments provide the evidence.<sup>9</sup>

## The Introduction of Equinoctial Dials to Europe

Small brass equinoctial dials exist as part of pocket compendia found both in England and continental Europe throughout the 15<sup>th</sup> century. The basic components of these compendia (a magnetic compass, a folding equatorial ring held at the co-latitude by an extended gnomon and a lid featuring a primitive nocturnal) are unchanging but variations in the sophistication of construction and size, together with their metallurgy, points to their having been made by numerous centres.<sup>10</sup> This is quite different from the concentration of manufacture of the later ivory diptych dials in Nuremberg. However, monumental stone examples of this class of sundial from medieval Europe were unknown until the St James Priory find.

According to the eminent astronomer and historian of astronomy Ernst Zinner (1886–1970),<sup>11</sup> the first explicit mention of an equatorial dial in Europe is due to the astronomer Nicholaus de Heybech, writing in Erfurt in 1431.<sup>12</sup> Zinner refers to this in one of his early notebooks<sup>13</sup> where he derives his information from a manuscript MS 683 at the working monastery of Klosterneuburg, near Vienna. The reference to equinoctial dials appears at the end of a fairly standard description of an equal-hour wall sundial and so is not the first definition of a polar-pointing style. A full analysis of the manuscript, which is not explicitly dated nor signed by Heybech, is ongoing.<sup>14</sup>

Equinoctial dials are thought to have been known in classical antiquity but were very rare. Schaldach has described a two-sided marble equatorial dial, originally from Amphiareion near Athens, which he dates to between 350 and 320 BC.<sup>15</sup> Another possible example is the dial depicted in the Roman mosaic of the villa at Brading, Isle of Wight, though it is also possible that this rather unclear image actually shows some form of hemicyclium.<sup>16</sup> It never became popular, though, and appears to have been unknown in the early medieval period in Europe.

In Britain, there is a small corpus (less than 10) of unattached slate or stone dials which have 15° markings, sometimes with Roman numerals, which are usually interpreted as either horizontal mass dials with vertical rod gnomons or the more common vertical mass dial.<sup>17</sup> The best-known examples are from Crowan, Cornwall, and Nendrum, Ireland. Although these could perhaps represent equatorial dials, the fact that they are single sided (despite being on relatively thin slabs) and have hour lines for a full 360° makes it unlikely that they were ever intended to have been placed at the co-latitude angle with polar-aligned gnomons and thus the interpretation as sophisticated mass dials remains the most likely.

It is perhaps significant that St James Priory followed the Benedictine order. The 'Rule of St Benedict' meant that timekeeping was particularly important to their establishments. St Alban's Abbey, home of the late 14<sup>th</sup> century monk Robert Stikford who wrote on advanced equal hour sundials without using a polar gnomon, was also Benedictine.<sup>18</sup>

## Conclusions

The St James's Priory sundial is a major find and means that Bristol now has the two oldest 'scientific' dials in Britain. Its survival and discovery were remarkably fortuitous. Although it is not possible to date it exactly, it reinforces the growing awareness that equinoctial dials were a key early step in the development of scientific dials in early 15<sup>th</sup> century Europe. It is frustrating to wonder what other potential finds remain as infill rubble in the priory walls!

## ACKNOWLEDGEMENTS

We are grateful to BaRAS for permission to quote extensively from their report (ref. 2) and to Ann Linge for preparing Figs 2 and 5. Jackie Jones kindly made the artist's impression of Fig. 7. Susan Jotcham (St James Priory) is thanked for Fig. 1. Tony Wood and Graham Aldred (BSS) helped in identifying the fragment as a dial.

## REFERENCES & NOTES

1. The site of St James Priory is in central Bristol (BS1 2LU, NGR ST 58895 73470), and is bounded by St James Parade to the south, Cannon Street to the east, Whitson Street to the west and Bristol Bus Station to the north.
2. For a full report of all the excavations on the site, see Cai Mason: *Archaeological Watching Brief & Building Recording during alterations at St James Church, Bristol for St James Priory Project*. BaRAS Report No. 2112/2011, BHER No. 24820 (Sept 2011).
3. For a range of numeral shapes found in manuscripts from the 12<sup>th</sup> to the 16<sup>th</sup> centuries, see for example Adriano Cappelli: *Lexicon Abbreviaturarum...*, Hoelpli, Milan (1899) pp. 380-385. Also available as a modern facsimile.
4. J. Davis: 'A Portable Horologium', *BSS Bull.*, 24(i), 18-22 (Mar 2012).
5. J. Davis: 'Robert Stikford's De Umbris Versis et Extensis', *BSS Bull.*, 23(iv), 24-28 (Dec 2011).
6. S. Eisner (Ed.): *The Kalendarium of Nicholas of Lynn*, Scolar Press, London (1980). An illuminated page of the *Kalendarium* is on the British Library website.
7. For Kratzer, see J.D. North: 'Nicolaus Kratzer - The King's Astronomer', in E. Hilfstein et al. (eds), *Science and History. Studies in Honour of Edward Rosen*, Studia Copernicana, 16 (1978), 205-34. The Iron Acton dial is currently on display in the Bristol Museum & Art Gallery.
8. J. Davis: 'A Very Early Description of a Horizontal Dial in English', *BSS Bull.*, 24(ii), 24-28 (June 2012).
9. One possible scientific vertical dial in the form of a ceramic tile is from St Augustine's Priory, Canterbury, SRN 5891.
10. An example is shown in an illustrated manuscript c. 1450 (a French translation of Henry Suso's *Horologium Sapientiae*, now in the Bibliothèque Royale de Belgique, MS. Bruxelles, B.R.IV, f. 13v). Another illustration is the famous etching by Urs Graf, c. 1507, 'Man with a sundial'. A discussion of the various known examples in England and Europe was presented by J. Davis, 'Excavated Sundials', presented at the 2012 BSS Conference, Cheltenham (t.b.p.).
11. E. Zinner: *Deutsche und Niederländische astronomische instrumente des 11-18 Jahrhunderts*, Beck'sche Verlagbuchhandlung, Munich, (1956).
12. For an early description of Nicholaus Heybech (there are many variant spellings) see Lynn Thorndike: 'Nicholaus de Heybech of Erfurt', *Isis*, 39, pp.59-60 (1948). There is some online information on him at <http://naa.net/ain/personen/show.asp?ID=79>.

13. Ernst Zinner: *Verzeichnis der astronomischen Handschriften des deutschen Kulturgebietes*, C.H. Beck, Munich, (1925).
14. We are extremely grateful to Ronald Salzer, University of Vienna, for obtaining images of MS Klosterneuburg 683. The reference to an "annulus" is on f. 96r, lines 27-32.
15. K. Schaldach: 'The arachne of Amphaireion and the origin of gnomonics in Greece', *J. Hist. Astron.*, xxxv, 435-445 (2004).
16. For a picture of the Brading mosaic dial, see J. Bonnin: 'Symbolic Meanings of Sundials in Antiquity: Introduced by an explanation of ancient timekeepers', *BSS Bull.*, 23(i), 6-10 (Mar 2012).
17. A.O. Wood & F. O'Carroll: 'A Celtic quartet', *BSS Bull.*, 20(ii), 84-87 (Jun 2008).
18. See ref. 5.

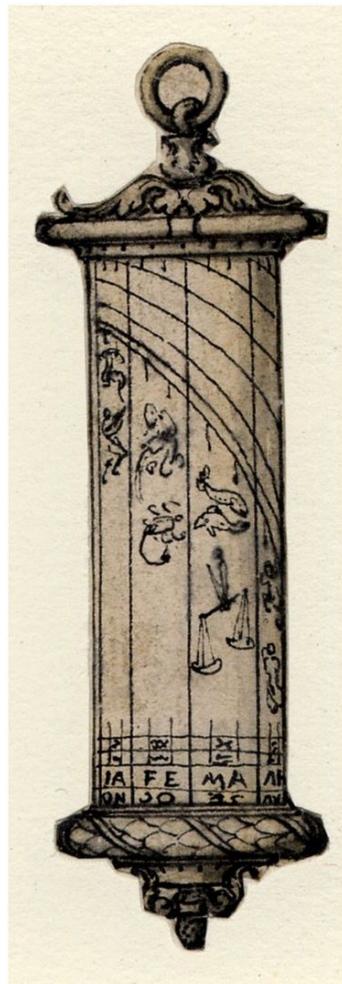
**Cai Mason** is a professional archaeologist with 10 years



experience. He is currently employed by Bristol and Region Archaeological Services and can be contacted at [Cai.Mason@bristol.gov.uk](mailto:Cai.Mason@bristol.gov.uk).

For a biography and portrait of **John Davis**, see *BSS Bull.* 23(ii).

## Holbein's Cylinder Dial



There are many depictions of cylinder (or shepherd's) dials from the Roman period onward. What makes this one special is that it was drawn by Hans Holbein the Younger, between 1532 and 1543. Holbein was Henry VIII's court painter and a friend and countryman of the king's horologist Nicholas Kratzer, so it is possible, even probable, that the image is of a real dial which Kratzer had made or was planning to make. The image is from Holbein's *Jewellery Book*. (Other examples of Holbein/Kratzer collaborations are the famous painting *The Ambassadors* and the Sir Anthony Denny clocksalt (see *BSS Bull.*, 21(iii) p. 45.)

Curiously, this image has been cut out around the dial's outline, as though it was destined to be used as part of a larger composite drawing. Another interesting feature is that the months Se, Oc, No at the bottom of the cylinder are written right-to-left, to show the direction the scale is running.

Image courtesy of the Trustees of the British Museum. Reg no. SL,5308.148

JD

# MOSQUE OF THE SUN II: CROWN OF DOHA

SARA SHAFIEI and BEN COWD

The requirement for Muslims to face Mecca when they pray is well-known, as is the fact that the times of prayer are calculated from the height of the sun. One result of this was the importance that the Islamic world placed on astronomy, and particularly sundials, in the medieval period – a time when European sundials were very crude by comparison. A professional *muqquat* (astronomer and timekeeper) was employed at the mosque to construct and read the complex sundials which were produced over several centuries before 1400. Islamic architecture has also been an important part of the religion and the domes of mosques remain structural and aesthetic gems for the whole world.

As academic architects, we decided to take these themes as the basis for a research project, providing a design for a modern mosque which emphasised our relationship with the sky as well as the ground. The original project, in 2010,

was for a new dome for the Mosque of the Sun in Esfahan, Iran. [As an aside, it is worth noticing that Esfahan – with various spellings – is a placename which is often found on English ‘geographical’ dials of the 18<sup>th</sup> century.]

The concept of the dome was to align accurately with the sun at prayer-time throughout the year. Other apertures align with key celestial events throughout the year. Fig. 1 shows some of the early design drawings. A concept model of the structure, constructed out of sheets of etched brass, was made (Fig. 2) and exhibited at the Royal Academy of Arts Summer Exhibition in 2010. Its popularity led to a second iteration of the design, now titled ‘Mosque of the Sun II: Crown of Doha’ which has been produced for the 2012 Summer Exhibition at the Royal Academy of Arts. The intended location of the design is Doha, Qatar.

The dome (or crown) of the mosque is designed to allow light to enter the interior of the prayer room at noon and

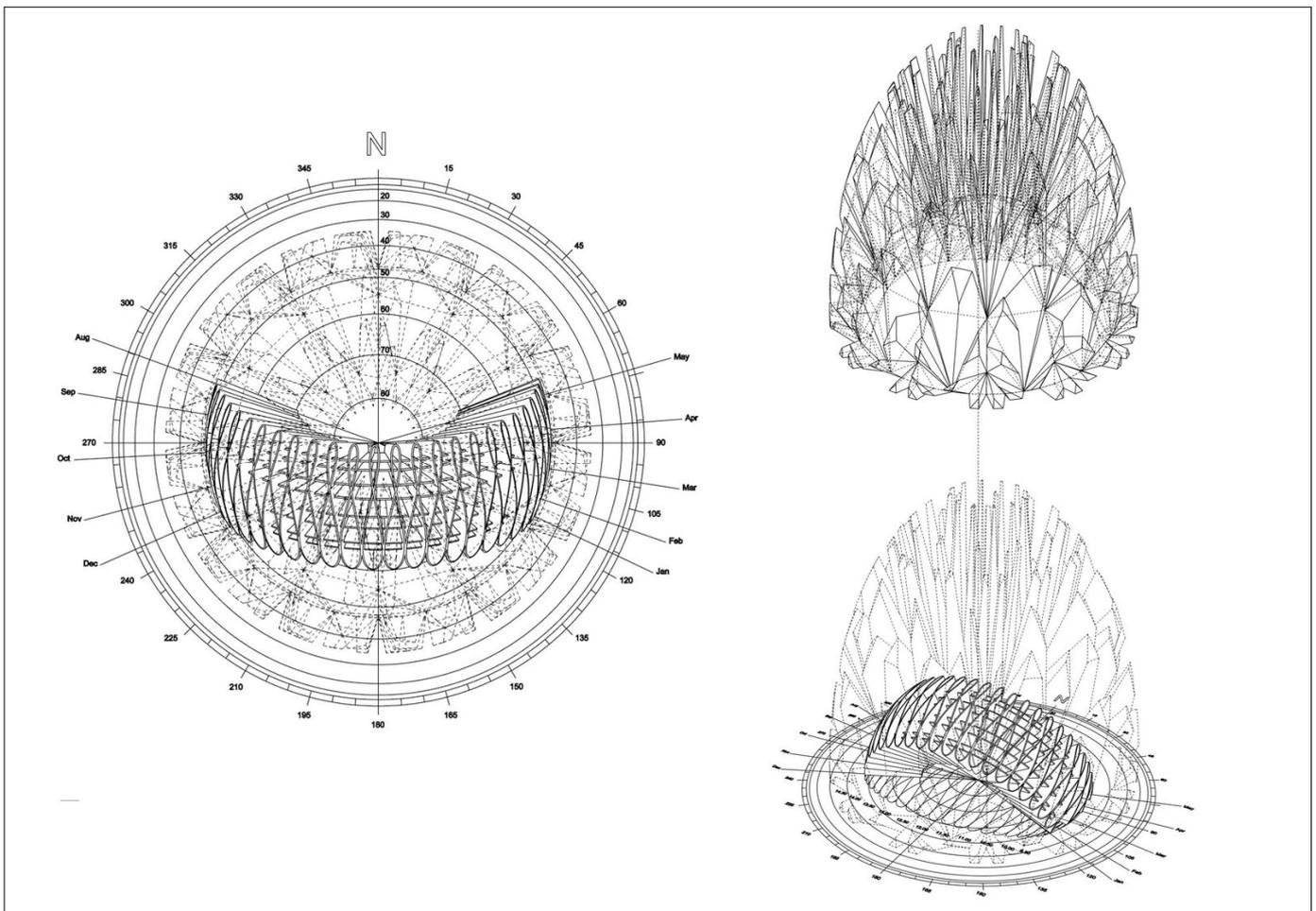


Fig. 1. Original concept design drawings for the Mosque of the Sun in Esfahan.

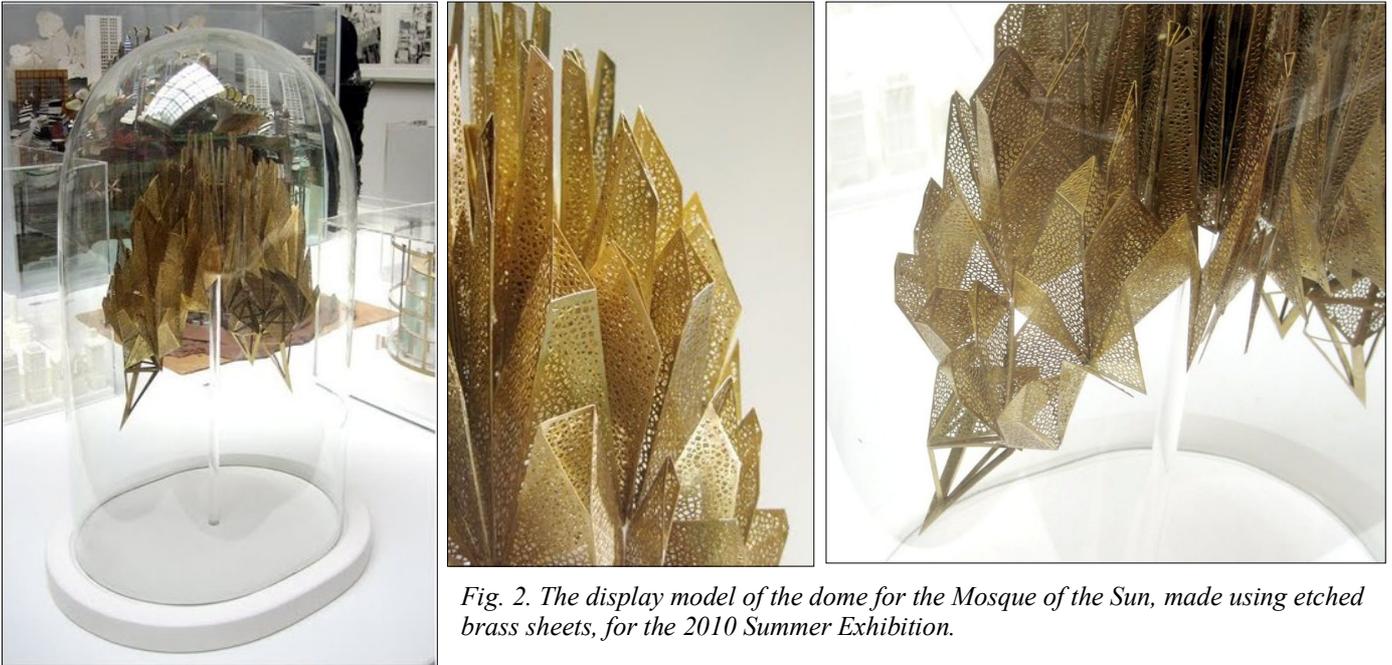


Fig. 2. The display model of the dome for the Mosque of the Sun, made using etched brass sheets, for the 2010 Summer Exhibition.

mid-afternoon when a shaft of light will enter the building signalling prayer. Where the shadow falls on the floor of the mosque is reflected in the pattern on the floor, which can be read as a clock and calendar. At sun-rise and sun-set, two large apertures open at the sides of the mosque, illuminating the interior and allowing worshippers to experience the event in the main prayer hall.

The form and position of apertures in the dome have been developed using Eco-tech analysis (environmental simulation software) and Rhino (Nurbs modelling software). These digital models are then 3D printed from resin to test and study in reality.

The prayer room is square in plan and points directly at Mecca (south-west) whilst the dome is orientated to the south to follow the path of the sun. This shift in geometry has a significant impact on the appearance and form of the mosque.



Fig. 3. Artistic impression of the Mosque of the Sun II.

The surrounding landscape that provides shelter during the hottest periods of the year and contains the service spaces for the mosque, is also informed by the position of the sun to each aperture—aligning buildings, planting and axis with specific months, solstices and equinox. The plan of the building can be read and experienced as a map of prayer time, and in its relation to the sun’s position in the sky.

Echoing the notion of an oasis sheltered within the sand and influenced by the landscape of Qatar, it is intended that the primary materials for construction would be concrete, stone, marble and brass. An artist’s impression of the structure is shown in Fig. 3 and some of the design drawings are in Fig. 4. A new ‘rapid prototype’ model,

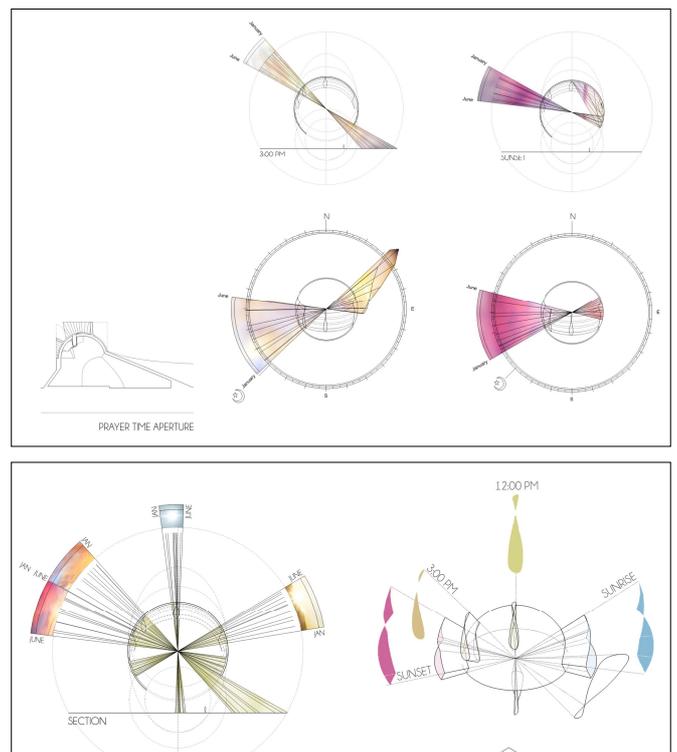


Fig. 4. Design drawings for the Crown of Doha.

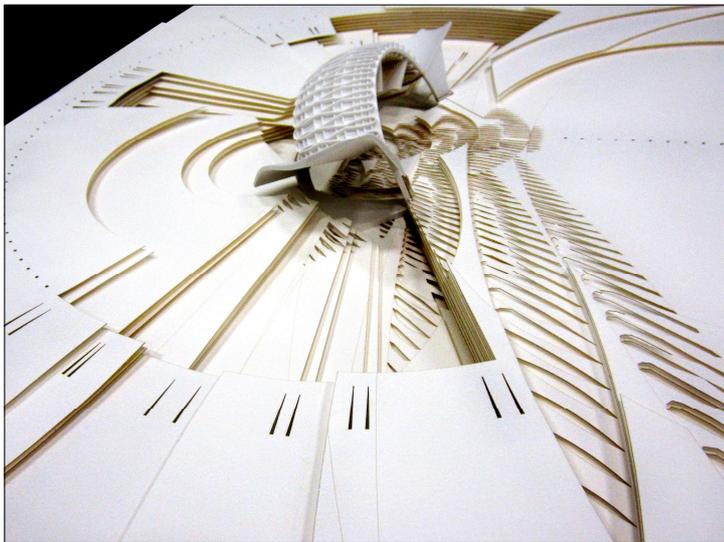


Fig. 5. The 'rapid prototype' model of the Crown of Doha for the 2012 Summer Exhibition.

using paper and etched brass, has been created for this year's Summer Exhibition and is shown in Fig. 5.

We are continuing to develop the concepts in these models and are looking forward to a full-size implementation.

**Sara Shafiei** and **Ben Cowd** are both Lecturers in Architecture (at UCL and the Leicester School of Architecture, respectively). Their studio specialises in digital design, fabrication and Islamic design, patterns and geometry. Their interest in Islamic architecture and craft has led the studio to work, teach and lecture extensively in the Middle East, and South Africa. They formed the Saraben-studio ([www.saraben-studio.com](http://www.saraben-studio.com)) in 2007. The practice includes teaching, research and experimental design.

## EARLY 19<sup>TH</sup> CENTURY ENGLISH DRAWINGS OF GREEK DIALS

JOHN DAVIS and JÉRÔME BONNIN

Charles Robert Cockerell (1788–1863) was a painter/draughtsman and architect, and one of a group of artists and architects to excavate the Temple of Apollo at Bassae in 1811–1812. He later became Professor of Architecture at the Royal Academy. The journals of his travels were published by his son who, like his grandfather, went by the name of Samuel Pepys Cockerell.<sup>1</sup>

Cockerell made many sketches on his travels. These were later used by a Miss Hutton to produce an article<sup>2</sup> and, possibly, a catalogue which is now lost. She annotated the drawings for the catalogue and they were then donated by Samuel to the British Museum in 1908. A full biography has also been written.<sup>3</sup> Of particular significance to us are two images, made in Greece, of sundials which may have been newly excavated.

The first of the drawings, dated to 1810, (Fig. 1) is in graphite on blue paper (as are the majority of the drawings) and is on the back of another drawing believed to be a distant view of the island of Ceos, now with the modern name Kea.<sup>4</sup> The dial is a classical conical one and stands on 'lion legs', quite similar to the sundial at Hever Castle which appeared in the *Bulletin* recently.<sup>5</sup> The actual dial, however, is quite different. In J. Bonnin's database of Greek & Roman dials, 31 conical dials possess lion legs but none of them exactly matches Cockerell's drawing. Two of the dials recorded in Sharon Gibbs' definitive book on the subject,<sup>6</sup> numbers 1028G from Pompeii and 3085 from Velletri, are similar but sufficiently different not to be the one depicted. The database also records another dial, originally from Delos but now lost, which might be a match, although the dimensions do not seem to fit. Another alternative is that it represents an otherwise unrecorded

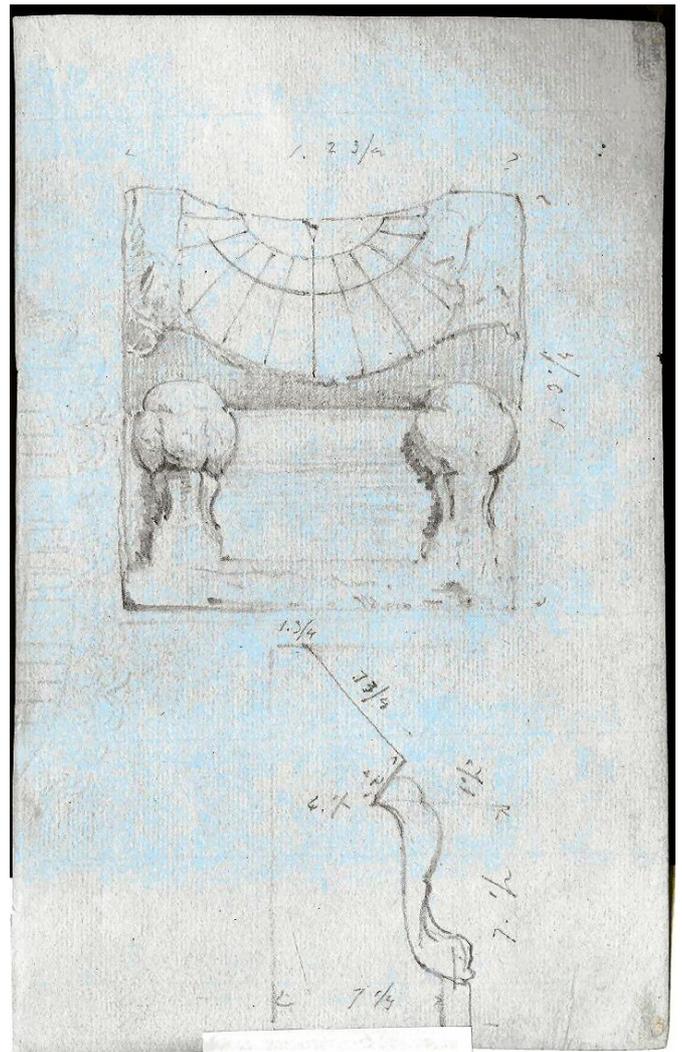


Fig. 1. Cockerell's drawing of an unknown dial. Courtesy of the Trustees of the British Museum.

dial—enquiries are being thanks to the French School in Athens at the Kia (Ceos) Museum, where the curator told us that fragments of sundial(s) were stored. Cockerell is known to have visited Delos – see below – which is, like Ceos, one of the Cyclades Islands and is also a location renowned for Greek sundials, with 27 examples known. The mystery continues!

The second of Cockerell’s drawings (Fig. 2)<sup>7</sup> shows an unusual form of Greek dial, a planar, vertical dial which is east-facing. The drawing matches well with Gibbs’ 5010, from Delos. The inscription on the drawing reads “Dial found at Delos [?] a foot”. It is unclear to what the “a foot” refers: Gibbs gives the diameter as “20 English inches”.<sup>8</sup> Cockerell wrote about his experiences and describes what might be the finding of this dial (our emphasis):<sup>9</sup>

“...From Tinos we sailed across to Great Delos (Rhenea), slept in a hut, and next day went on to Little Delos. Here there was nothing to sleep in but the sail of the boat, and nothing to eat at all. Everything on the island had been bought up by an English frigate a few days before. We were obliged to send across to Great Delos for a kid, which was

killed and roasted by us in the Temple of Apollo. I spent my time sketching and measuring everything I could see in the way of architectural remains, and copying every inscription. I had to work hard, but without house or food we could not stop where we were, and in the evening we sailed to Mycone. Next day I went back to Delos, and after much consideration resolved to try to dig there. I had to sleep in the open air, for the company of the diggers in the hut was too much for me. First I made out the columns of the temple and drew a restoration plan. Then we went on digging, but discovered next to nothing – a beautiful fragment of a hand, a dial, some glass, copper, lead, &c., and vast masses of marble chips, as though it had once been a marble-mason’s shop. At last it seemed to promise so little that I gave it up and went back to Mycone; but on the 28th, not liking to be beaten, I went back alone to have a last look. But I could discover no indications to make further digging hopeful, so I came away...”

The dial soon found its way to the ‘cabinet des antiques’ in Paris, brought by the French architect Antoine-François Mauduit in 1814. Indeed, another drawing of it was published dated 28 August 1815.<sup>10</sup> It later went missing but a report of 1938<sup>11</sup> mentions it as being in the Louvre. In fact, it passed to the Louvre in 1929, as the museum told us. It has been described recently<sup>12</sup> but further study is planned for September.

Only one other dial of this type is known, Gibbs 5024 from Grottaferrata, which features both east and west faces. It is unclear whether the dial depicted by Cockerell was unfinished or always intended as a single-sided device.

It thus seems that these two sketches record the finding of two important dials from antiquity.

#### ACKNOWLEDGEMENTS

The permission of the Trustees of the British Museum to publish these pictures is gratefully acknowledged.

#### REFERENCES

1. Samuel Pepys Cockerell (Ed.): *Travels in southern Europe and the Levant, 1810-1817. The journal of C. R. Cockerell RA*, London (1903, reprinted 1999).
2. C.A. Hutton: ‘A Collection of Sketches by C. R. Cockerell, RA’, *JHS* 29, 53-59 (1909).
3. David Watkin: *The Life and Work of C. R. Cockerell*, London (1974).
4. British Museum Reg. No. 2012,5001.195.
5. D. Brown: ‘The Scaphe Sundial at Hever Castle, Kent’, *BSS Bull.*, 24(i), 43-48 (March 2012).
6. S.L. Gibbs: *Greek and Roman Sundials*, Yale University Press (1976).
7. British Museum Reg. No. 2012,5001.168.
8. Gibbs (ref. 6) p.354.
9. Cockerell (ref. 1) pp.43-44.
10. F. Peter: *Di un Antico Orologio Solare*, Rome, (1815).
11. W. Deonna: *Le Mobilier Délien. Exploration archéologique de Délos* 18, p. 188, Paris (1938).
12. M. Hamiaux: *Les sculptures grecques, II, La Période hellénistique*, Paris (1998). The dial is now Louvre Inv. no. 1580, Ma 4833.

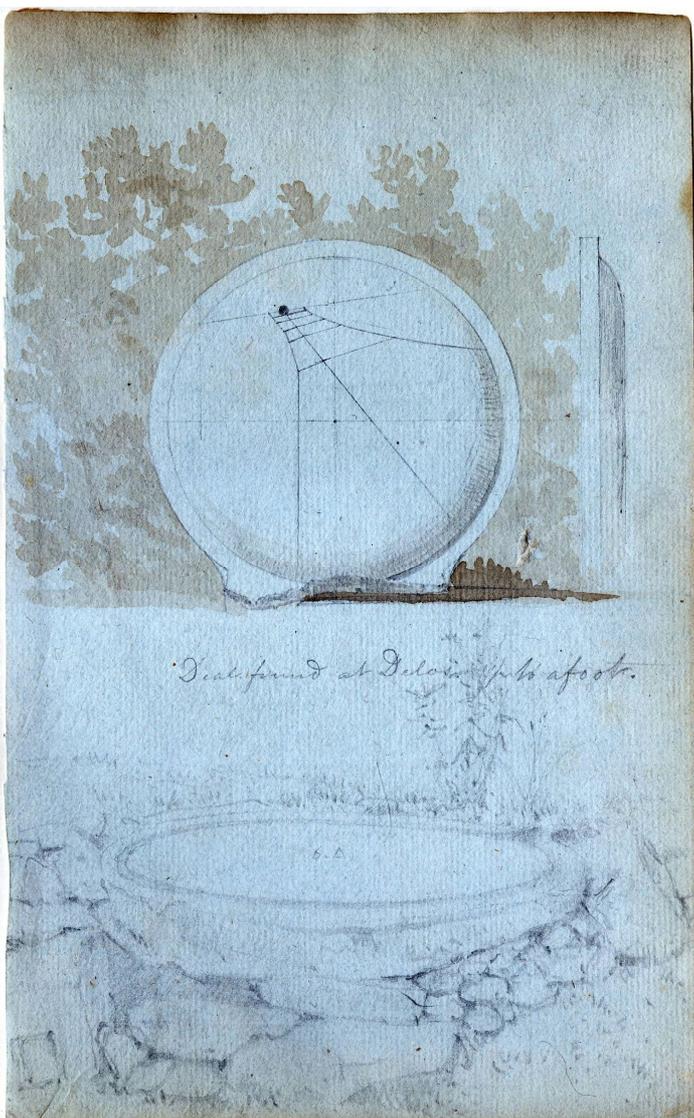


Fig. 2. Cockerell’s drawing of a dial at Delos. Courtesy of the Trustees of the British Museum.

# EXHIBITION OF SUNDIALS, NORTH OXFORD

## DOUGLAS BATEMAN

In a suburb of Oxford called Summertown there is a small public library and in the rear of the library is a plot of land that was restored in 2000 to be an attractive garden with benches, water feature and lawns. This garden, with its own website at [www.turrillsculpturegarden.org.uk](http://www.turrillsculpturegarden.org.uk), regularly holds sculpture and similar exhibitions. This particular exhibition runs from 2 June until 29 September 2012. The garden gives an attrac-

tive setting for dials by some of our well known members showing a total of 11 dials.

The exhibition came about when Garden's sculptor coordinator, Katherine Shock, met Joanna Migdal at the annual Art in Action event. Joanna is one of our leading artistic and sculptural dial makers, and recommended that contact be made with our Chairman, Frank King, who in turn suggested that Chris Lusby Taylor take the lead with recommending potential contributors.



*The large bronze dial (left) by David Harber dedicated to one of his mathematician ancestors, John Blgrave (1561 – 1611).*

*The bright stainless steel dial is an example of Harber's popular armillary spheres.*



*An intriguing 'Undial' by Chris Lusby Taylor that does not tell the time at all, but is a simple altitude instrument that marks the months from the altitude of the sun.*



*A dial of a modern sculptural form, also by Chris Lusby Taylor, that is entitled 'From Sunrise to Sunset'. It shows Babylonian hours and the spherical gnomon is considered to be unique.*

[More pictures on page 48](#)

# AN EQUATORIAL SUNDIAL WITH EOT ADJUSTMENT: UPDATE

ROGER BUNCE

**M**y original article on an equatorial sundial, fitted with an EoT cam, was published in the *Bulletin* in 2009.<sup>1</sup> The design was subsequently published on the Model Engineering Website, together with all the drawings needed to make the sundial. When the Editor of MEWS said he planned to republish the original design, it seemed a good opportunity to update both MEWS and *Bulletin* readers on recent developments. The engineering drawings will also be made available on the BSS website.

In February, 2012, the Austrian Sundial Society contacted me and said that they were planning to install a version of the sundial in the grounds of Schwarzenau Chateau, Lower Austria. Naturally, I was pleased, but concerned that in its present form it was not suitable for public use. In fact, as I said in my original article, the design was only intended as a concept model. So, here is the Mk.2 version, which includes the following improvements:

- Better weather protection
- Increased strength
- Improved vandal resistance.

Of course, it is impossible to totally guarantee against the ravages of both weather and man, without encasing in 'bullet-proof glass', so Mk.2 remains a compromise.

Figure 1 shows outside views of the revised sundial. In the descriptions of the changes that follow, the paragraph numbering refers to numbers on the revised general arrangement drawing (Fig. 2). The drawings show the sundial set to the latitude of Schwarzenau, but it is a simple matter of tilting the dial to suit other latitudes. This, and other aspects of adjusting the sundial, is fully described in the original article. I suggest that stainless steel is considered for most of the parts for improved corrosive resistance and to give it 'the modern look'.

1. Dial. The thickness is increased from 1.5 to 3mm for increased strength. Letters and numbers are engraved, and the upper surface bead-blasted to give a satin finish for good shadow contrast.

2. Winter Dial. Here, I suggest a major change: I have shown the Winter Dial fixed; it also acts as the Dial Support. The reason for this is to improve strength and vandal resistance. Furthermore, the earliest sunrise and latest sunset during the winter in Schwarzenau are 6:34am and 6:50pm. A fixed winter dial can allow coverage of, for example, 6:30am – 6:30pm (12hr apart). In other words,

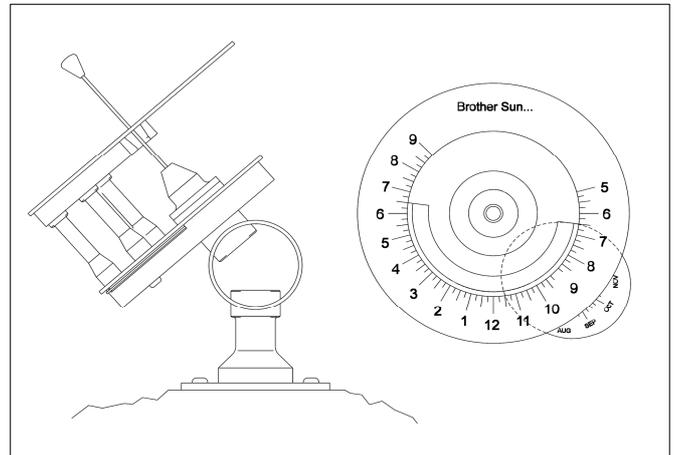


Fig. 1. Outside views of the Mk.2 sundial.

there is only a small part of winter daylight hours when it cannot be used. Also, the sun is weak and is only just above the horizon at the early and late hours, so the shadow will be indistinct. The same argument holds true for other parts of northern Europe including England. The Winter Dial is shown welded to the Dial for strength and the welds are hidden in the four slots cut into the Winter Dial (I did not want to have fixing screws on the top surface of the Dial). The original design, with the moveable Winter Dial, can of course still be used, but it is probably more suitable for use in a private garden, or where public access is restricted.

3. Pillar Plate. The thickness is increased from 1.5 – 3 mm for increased strength and rigidity.

4. Slotted Plate. The segment angle is increased. This provides coverage of the mechanism from 'inquisitive fingers' (particularly the two springs)!

5. Ring. The thickness is increased from 1.5 – 3 mm for increased strength and rigidity.

6. Cap. The diameter is increased from 24mm to 30mm. This is because of limitations in the sizes of 'security' grub screws available (M5 × 8 mm long).

7. Skirt. This is the second major change to the design. I have provided the mechanism with a 'Skirt' to give better weather protection and to guard against 'inquisitive fingers'. It does not cover the mechanism completely but, like an umbrella, it might be sufficient. However, the Skirt could include a cover plate if necessary. The Skirt is made from a bent strip of stainless steel, with five fixing tabs welded on (7a), and is screwed to the Pillar Plate. The join

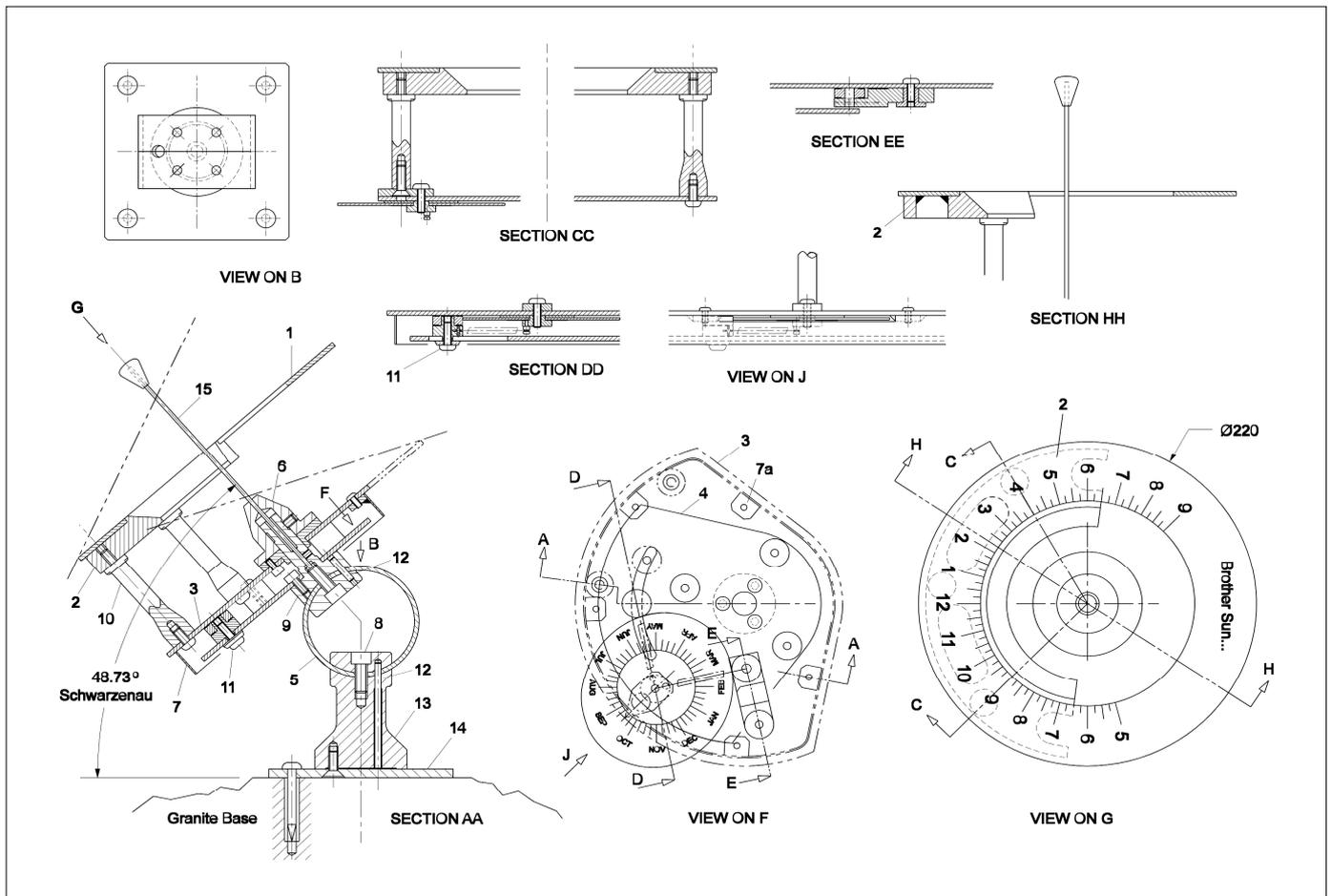


Fig. 2. General arrangement drawing of the Mk.2 sundial.

could be sealed on the inside with a fillet of silicone sealant. Alternatively, it could be welded to the Pillar Plate. However, I am not sure if it should be tack welded or continuously welded (I would be concerned about distortion).

8. The size of the two main fixing screws is increased from 6 to 8 mm for strength.

9. Radius Boss and Pivot Shaft. These two parts are combined and machined from solid for strength and concentricity.

10. Support Columns. Machined from solid for increased strength.

11. Adjusting Screw. This was originally a specially made thumbscrew and is now replaced with an off-the-shelf stainless steel security screw (Fastenright Ltd, Wolverhampton). In fact, all the screws used for the revised design are security screws. The screw is used to make the initial longitudinal adjustment and, thereafter, used just twice a year for 'summer and winter time' settings. To allow the public to do that would be inviting disaster – the sundial would never indicate the right time!

12. The latitude angle of Schwarzenau,  $48.73^\circ$ , is secured with location dowels. These are probably not essential, but are intended to prevent slipping due to rough handling!

13. Base Pillar. The diameter is increased for extra rigidity and in order to incorporate the location dowel.

14. Base Plate. This is increased in thickness from 3 to 6 mm, again for increased strength and vandal resistance.

15. Gnomon. The original gnomon was made from Nitinol (Memry GmbH., Germany). The use of this material is essential if the sundial is to be used by the general public. With the design shown, it is 'impossible' to permanently bend the Nitinol gnomon. Incidentally, it is also extremely hard and impossible to saw with a high-speed steel saw blade! Needless to say, the protective knob must be fixed on well with 'super glue' and the gnomon fixed tightly to the sundial!

Finally, in accordance with the Austrian Sundial Society's intentions, I have shown the sundial mounted on a granite boulder – at least that won't go missing!

#### REFERENCE

1. R. Bunce: 'An Equatorial Sundial with EoT Adjustment', *BSS Bull.*, 21(ii), 24-30 (June 2009).



**Roger Bunce** is a Chartered Mechanical Engineer. After retiring from The University of Birmingham he studied Horology at Birmingham City University, specializing in clocks. His interest in sundials began at about the same time. Combining these two interests led naturally to this project – a sundial that indicates clock time. He lives near Birmingham and can be contacted at [roger@bunce888.fsnet.co.uk](mailto:roger@bunce888.fsnet.co.uk)



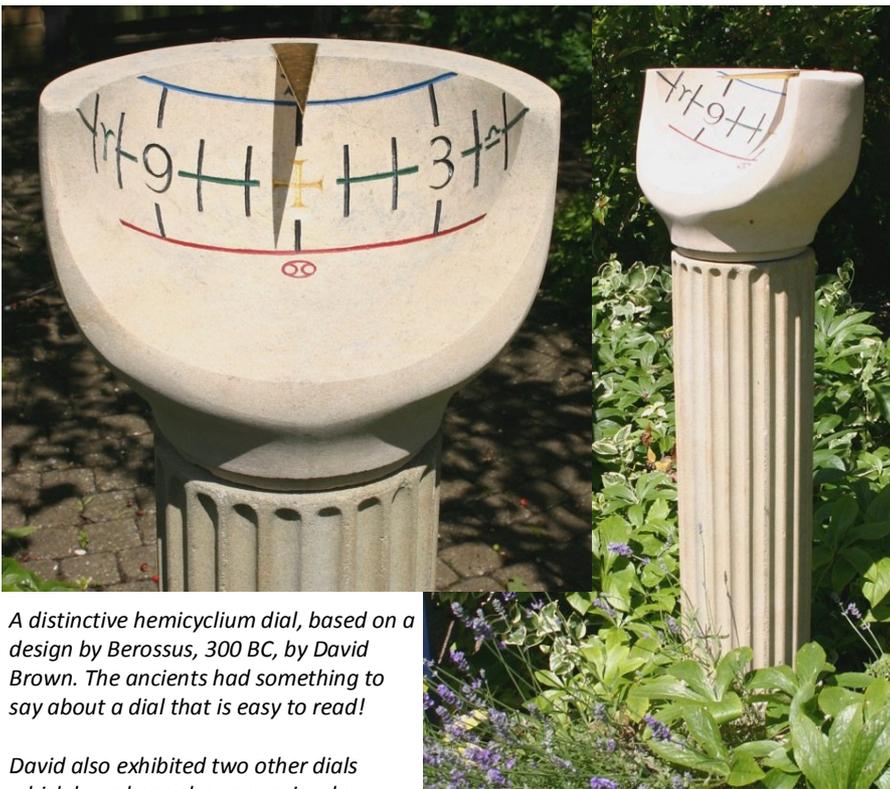
## Oxford Sundial Exhibition (continued from page 45)



*Alistair Hunter is well known for the emphasis on precision, particularly with noon dials, and extensive use of stainless steel for the dial plates. The reflectivity of the steel would suggest that it is not a good material to take a shadow, but with a matt surface treatment, it can be nearly as good a white card.*



*A cube dial on a pillar by Harriet James, drawing inspiration from Bewcastle Cross, ancient jewellery and numerals from different cultures.*



*A distinctive hemicyclium dial, based on a design by Berossus, 300 BC, by David Brown. The ancients had something to say about a dial that is easy to read!*

*David also exhibited two other dials which have been shown previously:*

*A slim noon dial with analemma. On the reverse is some elegant lettering with a quote from Dylan Thomas "All the sun long".*

*A scaphe dial that is a replica of a dial at Hever Castle, Kent, from a specification by David Brown, and sculpted by a fellow craftsman, Tim O'Regan, Somerset. This dial featured in an article in Bulletin, 24(i), March 2012, and also on the rear cover of the June issue.*



*Although Ben Jones can execute dials with straight edges and strong geometric forms, the beauty of this dial speaks for itself.*

# HONORARY OFFICIALS OF THE BRITISH SUNDIAL SOCIETY

*Patron:* The Hon. Sir Mark Lennox-Boyd

*President:* Mr Christopher St J H Daniel

*Vice-Presidents:* Mr David A Young & Mr Frederick W Sawyer III

## COUNCIL MEMBERS

Dr Frank King 12 Victoria St CAMBRIDGE CB1 1JP	(Chairman & Restoration) Tel: 07766 756 997 Frank.King@cl.cam.ac.uk	Mr Chris H K Williams c/o The Editor	(Secretary) Tel: 01233 712550 chkwilliams@googlemail.com
Mr John Foad Greenfields Crumps Lane ULCOMBE Kent, ME17 1EX	(Registrar) Tel: 01622 858853 Register.BSS@keme.co.uk	Mr Graham Stapleton 50 Woodberry Avenue NORTH HARROW Middlesex HA2 6AX	(Treasurer) Tel: 020 8863 3281 manaeus2000@yahoo.co.uk
Ms Jackie Jones 51 Upper Lewes Rd BRIGHTON East Sussex, BN2 3FH	(Membership Secretary) Tel: 01273 673511 jackie@waitrose.com	Mr Chris Lusby Taylor 32 Turnpike Rd NEWBURY Berks, RG14 2NB	(Conference Organiser) Tel: 01635 33270 clusbytaylor@gmail.com
Mr David Brown Gibbs Orchard, Sutton Rd SOMERTON Somerset, TA11 6QP	(2014 Anniversary Coordination) Tel: 01458 274841 David@davidbrownsundials.com		

## SPECIALISTS

Dr John Davis Orchard View, Tye Lane FLOWTON Suffolk, IP8 4LD	(Editor) Tel: 01473 658646 john.davis51@btopenworld.com	Mr Mike Cowham PO Box 970 Haslingfield CAMBRIDGE, CB23 1FL	(Advertising & Safari) Tel: 01223 262684 ads@brownsover.orangehome.co.uk
Mr A O (Tony) Wood 5 Leacey Court CHURCHDOWN Gloucester, GL3 1LA	(Mass Dials) Tel: 01452 712953 aowood@soft-data.net	Miss R Jill Wilson Hart Croft 14 Pear Tree Close CHIPPING CAMPDEN Gloucs., GL55 6DB	(Biographical Projects) Tel: 01386 841007 hart.croft@gmail.com
Mr Dariusz (Darek) Oczki ul. Konski Jar 4/88 WARSAW Poland	(Webmaster) Tel: +48 512 259 629 dharani@o2.pl	Mrs Elspeth Hill 4 The Village Stonegate Nr WADHURST East Sussex, TN5 7EN	(Sales) Tel: 01580 201720 Elspeth@ehill80.fsnet.co.uk
Mr J Mike Shaw 3 Millwood Higher Bebington WIRRAL, CH63 8RQ	(Newsletter Editor) Tel: 0151 608 8610 jmikeshaw@ntlworld.com	Mr David Pawley 8 Rosemary Terrace Enborne Place NEWBURY Berks., RG14 6BB	(Newbury Meeting Organiser) Tel: 01635 33519 info@towertime.co.uk
Mr Nick Orders 14 Gordon Rd Burton Joyce NOTTINGHAM NG14 5GN	(Librarian) Tel: 0115 9314313 nick@nickorders.orangehome.co.uk	Mr Ian R Butson 60 Churnwood Rd Parsons Heath COLCHESTER Essex, CO4 3EY	(Photographic Competition) Tel: 01206 860 724 ian@tipsdial.orangehome.co.uk

The British Sundial Society  
c/o The Royal Astronomical Society  
Burlington House  
Piccadilly  
London, W1J 0BQ

The Society's website is at [www.sundialsoc.org.uk](http://www.sundialsoc.org.uk)  
The British Sundial Society is Registered Charity No. 1032530

