

The British Sundial Society

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CONTENTS

1. Editorial
2. An Oxford Sundial Mystery – *Frank H. King*
9. New Dials (1)
10. A Craftsman’s Hand Helped Skirlaugh Sundial to Live On – *Margaret Ribchester*
11. Three Danish Sundials – *David Hawker*
13. Dialling Tales: The Day That I Said “No” – *Christopher Daniel*
14. Sundials in the Desert Lands of Central Australia – *Marg Folkard & John Ward*
17. Promoting the Society – *Doug Bateman & Jackie Jones*
17. Postcard Potpourri 31. Marsden Park, Nelson – *Peter Ransom*
18. A Seventeenth-century Halachic Horizontal Sundial by Robert Jole – *Maciej Lose*
23. Holiday Pictures
24. The Eaton Hall Sundial Pillar. A moving story of deviant orientation – *J. Mike Shaw*
28. New Dials (2)
29. Book Review – *Lester*
30. A Calendar Dial for Installation on the Moon – *Allan Mills*
33. A Vari-purpose Vertical Sundial – *John Moir*
34. BSS 25th Anniversary Conference, Greenwich, 25-27 April, 2014 – *Jim Holland*
39. Manchester Railway Dial – *JD*
40. Unexpected Aspects of Anniversaries, or: Early sundials, widely travelled – *Helmut Sonderegger*
45. BSS 25th Anniversary Photographic Competition, 2013-14 – *Ian Butson*
48. New Dials (3)

EDITORIAL

The Most Enjoyed Article award for 2013, won by Dennis Cowan, was announced last time and has now been duly presented. It is nice to see the sundial in Dennis’s own garden, one which Thomas Ross was not able to describe, I suggest. There is no article from Dennis in this issue (I’m still using up the backlog of articles held over from the June ‘special issue’) but, never fear, further instalments of Scottish dials are to hand and will continue in the next issue.

This time, as well as items from the Conference in Greenwich, we continue with articles from overseas members which are always good for widening our appreciation of dialling (even when one of the articles is about a London dial-maker!)



AN OXFORD SUNDIAL MYSTERY

FRANK H. KING

In March 2014, I was asked to give a talk in Oxford's Convocation House to the Friends of the Bodleian Library. My brief was to talk about sundials in general and about the two painted glass sundials in the windows of Convocation House in particular. In investigating these sundials I stumbled on some unexpected puzzles.

the Schools Quadrangle there is a sundial which is highlighted by a red circle in Fig. 1. This has been described by Anthony Capon⁴ who points out that the dial seems curiously placed until one realises that, in 1675, there were tenements and gardens in front of the south range. Placed where it is, the sundial would have been visible to those approaching via Schools Street which ran to the west of these tenements.

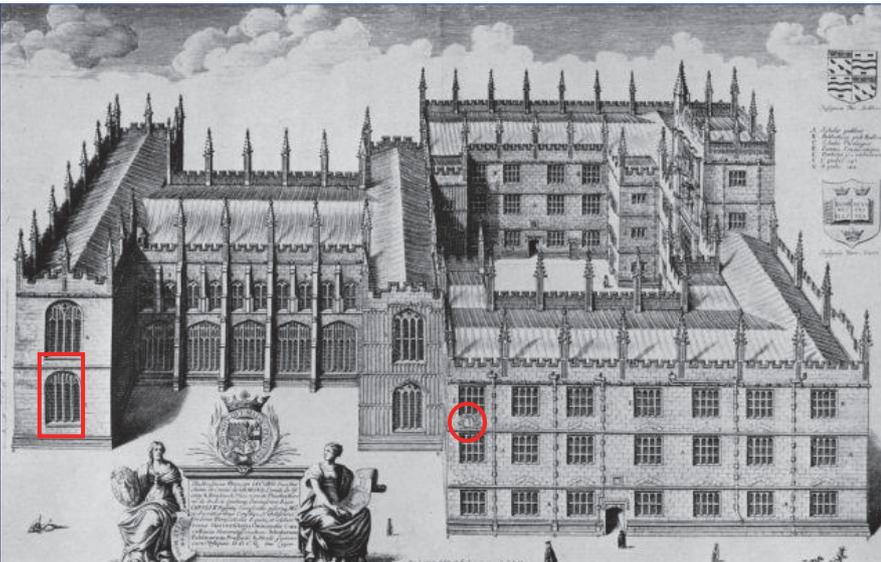


Fig. 1. David Loggan's 1675 engraving of the Old Bodleian Library looking roughly north. The open red rectangle highlights the south window of Convocation House. There is an almost identical window out of sight on the west side of Convocation House. The circle highlights a sundial that has now vanished.

The Old Bodleian Library is a generic term that refers to the collection of buildings shown in David Loggan's engraving of 1675¹ which is reproduced in Fig. 1. An excellent description of the buildings and their conservation, past and present, is given in *The Old Bodleian Library Conservation Plan*.² A comprehensive bibliography is included.

The buildings were constructed between 1426 and 1640³ and, at first glance, they look very much the same today; an H-shaped complex to the west abuts the Schools Quadrangle to the east. Catte Street runs alongside the east range of the Schools Quadrangle.

Bodleian Libraries lay on conducted tours for visitors who pay at the ticket office which is situated at the Great Gate on Catte Street. The noted Tower of the Five Orders rises above the gate. A tour will take you along the cross-bar of the H. This is the magnificent Divinity School which leads into the west upright of the H whose ground floor is Convocation House.

Loggan's engravings are well known for their attention to detail, and high up the south elevation of the south range of

Fig. 2. Loggan detail of the south range sundial.

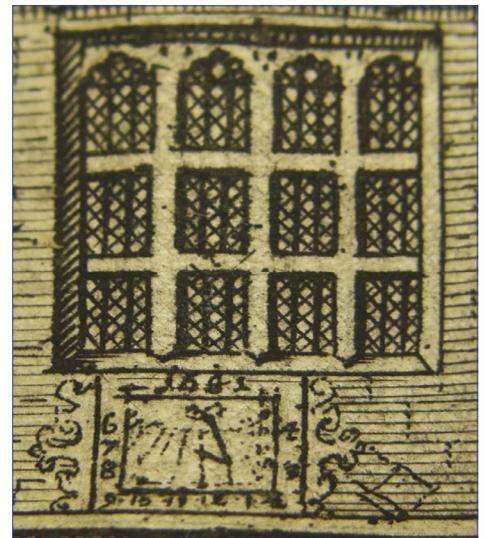


Fig. 2 shows a close-up of the sundial. It is possible to read the date, 1641, and to note that the hour numbers run from 6 to 11 before noon and from 1 to 4 after noon. This suggests that the wall declines a little to the east of due south which is indeed the case. The gnomon could, perhaps, have been drawn more convincingly!

Sadly, there is no sign of the south range sundial today. Capon provides evidence that this dial was still present in 1752 but had disappeared by 1814.

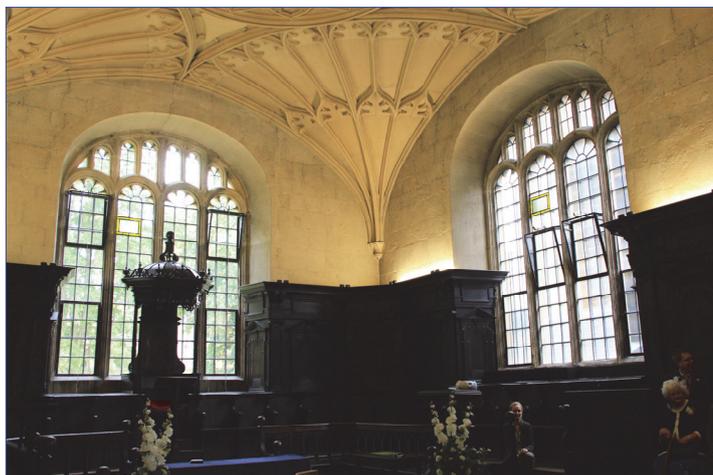


Fig. 3. Inside Convocation House, the south-west corner.

Convocation House

The usual entry into Convocation House is via the door at the west end of the Divinity School. Fig. 3 shows the view to the left immediately on entry.⁵ There are two large windows with a vaulted ceiling above and much splendid panelling below.

The window on the left faces roughly south and the window on the right faces roughly west. The south window is partly obscured by an ornate *baldacchino* or canopy that stands over the Chancellor's throne. In each window there are three stone mullions separating four leaded lights. In each case, in the second light from the left, there is a pale yellow rectangular outline that frames a seemingly featureless pane of glass. On close inspection, these outlines turn out to incorporate hour numbers. They are the chapter rings of two painted glass sundials. In both cases the gnomons are now missing.

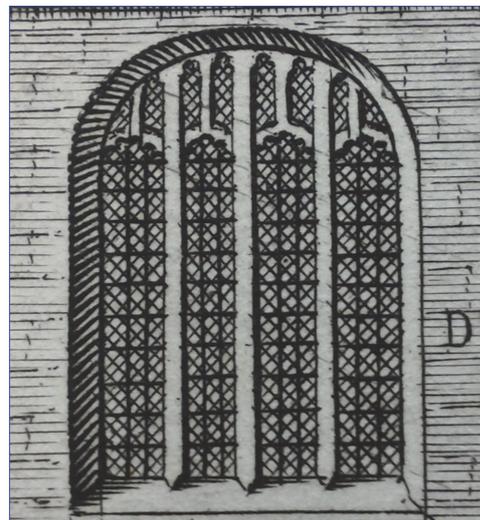
Before looking at these sundials more closely, it seems worth pondering how long they have been in the windows. The building was constructed over the years 1634 to 1640⁶ and it is tempting to suppose that the sundials were part of the original fixtures and fittings.

A difficulty with this supposition is that these windows do not seem to have been designed with the sundials in mind. It would have made more aesthetic sense for each window to have four mullions and five lights so the sundials could be central. As it is, the sundials appear to be something of an afterthought. Certainly the massive vaulting was an afterthought. It was added in 1758–59⁷ and the disruption of the building works would surely have resulted in the windows needing remedial attention. Perhaps the sundials were added then?

Study of the British Sundial Society's *Register of Fixed Dials*⁸ yields some interesting statistics. Of the 33 surviving pre-1900 glass sundials listed, 29 are 17th-century. These 29 include the two in Convocation House where the dates are shown as '16xx'. No supporting evidence is provided.

The heavy bias to the 17th century is one consequence of the Puritan Revolution that dominated that century. There was mass destruction of stained glass in churches and those who

Fig. 4. Loggan detail of the south window of Convocation House.



were skilled in the art of making stained glass had to find patrons outside the church. There were many commissions for armorial glass and somewhat fewer for glass sundials.

We may wryly reflect that Convocation House served as the House of Lords at the time of the Oxford Parliament during the Civil War (1642 to 1651) and that these two sundials might be an indirect consequence of that war and its aftermath.

This is all speculation. More useful progress may be made by considering 17th-century glazing technology and here Loggan's engraving is instructive...

The Original Windows

Fig. 4 shows a close-up of the south window highlighted by the red square in Fig. 1. The stonework appears almost exactly as it is today, with three mullions. There is no sign of the south dial, which supports the suggestion that both sundials were an afterthought. The figure nicely illustrates the glazing details. The diagonal lines that form criss-cross patterns represent so-called comes,⁹ strips of lead with H-shaped cross-sections into which diamond-shaped panes of glass, known as quarries, were fitted. These are standard leaded lights of a design that is still available today.

In addition to the diagonal lines there are, in each of the four main lights, two strong vertical lines and 10 strong horizontal lines. These represent impressive wrought-iron *ferramenta bars*¹⁰ which are keyed securely into the mullions. The vertical bars are known as stanchions and these run through eyes in the horizontal bars which are known as saddle-bars. Their purpose is not to deter intruders but to provide mechanical strength.

Although 17th-century builders did not follow modern engineering codes, they were well aware that a window could be blown in by a strong gust of wind. The relatively fragile leaded lights formed inner layers which were fastened to the ferramenta bars by copper-wire ties.

Today the windows still have leaded lights but the panes of glass are rectangular and, in size, exactly match the interstices of the ferramenta bars. This way, very much more light enters Convocation House than when it was first built.

By studying Fig. 3, it is easy to verify that there are two stanchions and 10 saddle-bars in each of the main lights. The stonework of the windows has probably been replaced at least once over the years but the ferramenta bars may well be original.

The exterior view in Fig. 10¹¹ shows the bars in the vicinity of the sundial in the south window. Where the bars intersect, one can just about see copper-wire ties. The present leaded lights are securely held against the ancient ironwork. A section of a stanchion has been cut out to prevent an unwanted shadow falling on the dial. There are no remnants of a gnomon and no sign of any fixing points for it.

It is possible that Loggan overlooked the sundial in the south window but this seems unlikely. Loggan or an assistant certainly counted the saddle-bars and would surely have noticed that a section of a stanchion was missing. It is too much to expect that the dial would have been shown in great detail but one would expect to see an interruption in the diagonal criss-cross pattern.

The Dates of the Sundials

The statistics favour the 17th century for these two dials. It seems likely that they do not date from the time of the original construction of Convocation House, and the absence of the south dial from Loggan's drawing suggests that they were not installed until after 1675.

Only two 18th-century glass sundials are recorded in the BSS *Register* and these are dated 1733 and 1734.¹² If the Convocation House dials date from after the installation of the vaulting in 1759 they would be very much statistical outliers.

In the 2003 edition of her book *Oxford Sundials*,¹³ Margaret Stanier does not give a date. She writes, "The authorities of the Bodleian Library can provide no information about the origin of these dials or the date when they were inserted here."

The earliest reference that has come to light is in the 1900 edition of *The Book of Sun-Dials*¹⁴ by Mrs Alfred Gatty, where one reads, "The west window of the Convocation House at Oxford has a dial showing the afternoon hours." Intriguingly, that is all. There is no mention of the sundial in the south window.

In his monumental work *Early Science in Oxford*,¹⁵ published in 1923, Robert Gunther, founder and first Director of the Oxford Museum of the History of Science, writes, "The only window dial in Oxford is in the west window of the Convocation House..." He does give a brief description but, like Mrs Gatty, he makes no mention of the sundial in the south window.

It seems unlikely that two sundial enthusiasts should have spotted the dial in the west window and not noticed the dial in the south window. One suggestion¹⁴ is that the dial in the south window was placed there after 1923 but, in appearance, these dials seem very much a pair. It is hard to believe that one dates from centuries before the other.

A light-hearted explanation is that both Mrs Gatty and Robert Gunther did spot the dial in the south window but they were so shocked by what they saw that they couldn't bring themselves to write about it. Although this explanation is not to be taken too seriously, it leads to a more plausible conjecture so it is worth pursuing briefly. Let us examine the unmentionable sundial in the south window



Fig. 5. The south dial.

The South Window Sundial

Fig. 5 shows a medium-shot of the sundial. This was taken by the late Andrew Somerville (first Chairman of the British Sundial Society) probably in the 1980s.¹⁶

The dial is shown next to the finial at the top of the Chancellor's *baldacchino*. A few features can now be discerned in the central pane of glass and there are hints of hour numbers in the chapter ring.

Fig. 6 shows a close-up taken in 2013.¹⁷ This clearly shows a half-sun feature and a badly decayed dragonfly, a common way of alluding to time flying. The hour numbers in the two narrow side panes are not too difficult to read but those in the two panes at the bottom of the dial are much less legible.

The left-hand pane at the bottom has been repaired twice, once with a wide came (near the centre of the pane) and



Fig. 6. Close-up of the south dial.

once with a narrower came that slopes diagonally. These two repairs can be seen from the outside in Fig. 10. There is also a repair in the right-hand pane but this is much less visible in Fig. 10. This may be an *in situ* repair with bitumen being applied to the inside to seal a leak.

The terms stained glass and painted glass are used loosely and differently by different writers. A good introduction to the subject of decorative glass is given in a website¹⁸ hosted by Norwich Heritage Projects. John Carmichael¹⁹ has written a step-by-step guide to making a stained glass sundial. He is one of the few living makers of such dials.

The central pane is almost certainly clear glass that has been given a translucent coating with decorative details added on top, probably using vitreous enamel. Although enamel is not paint, the term 'painted glass' is commonly used to describe the result. The coating has to be just right. If it is too opaque, you cannot see the shadow of the gnomon through it. If it is too clear you see the gnomon itself but not its shadow.

It is tempting to suppose that the six yellow panes of glass are coloured all the way through in the manner of pot metal glass²⁰ in medieval windows but this glass became unobtainable in the 17th century. An alternative method of producing yellow glass is to apply a silver salt (normally silver nitrate) to clear glass and then fire the glass in a kiln.²¹ The stained surface was usually arranged to be on the outside face of the window. A close inspection is required to confirm that this alternative approach was used.

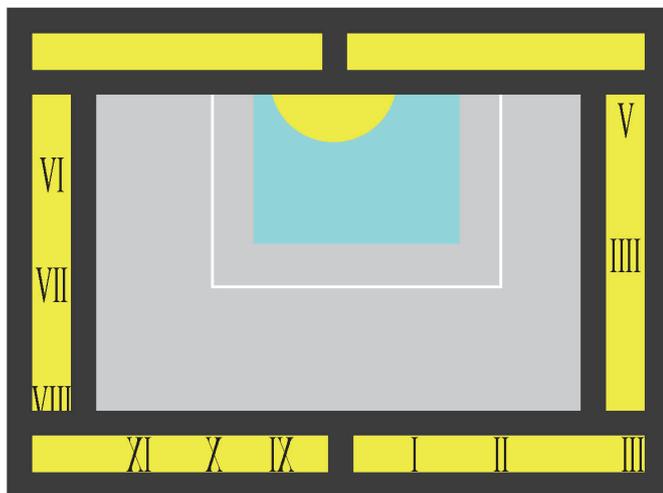


Fig. 7. Computer model of the south dial.

Fig. 7 shows an interpretation of the dial that is useful for discussion purposes. The seven panes of glass and the network of comes are shown. The proportions of the panes of glass and the came width closely match those in the photograph in Fig. 6. The aspect ratio may not be quite right and only very rough measurements were made on site. The model assumes that the dial is 438 mm wide and 340 mm high.

In the model, the came width is 17 mm which is very likely to be more than that used for the quarries depicted by Log-

gan. The actual came width may be $\frac{5}{8}$ -inch, a commercially available width which is appropriate for the much larger rectangular panes of glass in the windows today. It seems that these same wide comes have been used within the dial. This may increase the strength but it does not improve the appearance. Susan McCarthy, of Aura Visions, advises that $\frac{3}{8}$ -inch is the most likely width of the comes in the original window.²²

The repairs are not shown in Fig. 7 and there is no indication of the ferramenta bars that can be glimpsed through the clear panes of glass adjoining the sundial. The dragonfly has been omitted but the half-sun is shown in a blue sky. A photograph by Billett Potter of Oxford, in Margaret Stanier's book,²³ shows the sky much bluer than it is today.

To aid readability, the Roman numerals in Fig. 7 are much narrower than those in Fig. 6 where the final I of VIII and the final I of III are hidden under the faces of comes. This cannot have been the designer's intention and is supporting evidence that the width of the original comes was not as great as that of the current comes.

Apart from being artificially narrow, the Roman numerals match those in Fig. 6 both in order and in position. In particular, the hour numbers XI, X and IX in Fig. 7 have been copied as they are in Fig. 6. It is accepted that they are hard to read in Fig. 6 but the order there is as in Fig. 7. Noon is more implicit than explicit in Fig. 6 and if there ever were a mark for noon, it is hidden under the face of the central came. No sign is shown in Fig. 7.

Ignoring, for the moment, the strange ordering of XI, X and IX, the dial in Fig. 7 is, mathematically, much as that in Fig. 2. In both cases, there are six hour numbers before noon but, in Fig. 2, there are four after noon whereas there are five after noon in Fig. 7.

Without undertaking any gnomonic calculations, it is clear that the design in Fig. 7 is for a dial that declines a few degrees to the East of due South. As it happens, if you press your nose to the glass and face straight out you will be facing about 13° East of due South. BUT...

*The dial does not face out; it faces in.
This dial is the wrong way round!*

No wonder Mrs Gatty and Robert Gunther chose not to write about it. Even those with only a rudimentary understanding of how sundials work know that the sun is low in the eastern half of the sky in the early morning; that is, on the left. Accordingly, the shadow of the now-missing gnomon would be on the right, at some stage aligning with the V. Then, as the sun gets higher and moves round, the shadow will run through the times V, IIII, III, II, I and so on.

It is inconceivable that this sundial was in this window like this when it was first installed. The curious behaviour of the shadow would be obvious to everyone present on the first sunny occasion that there was a gathering in the room. The dial would have quickly been ridiculed.

Alas, without a gnomon, the alignment error in the dial seems to have escaped attention. There is no record that Andrew Somerville commented on it and the error is not noted in Margaret Stanier's book or in the BSS Register.²⁴ I was tempted to sub-title my talk:

*In Oxford, they arrange for time to run backwards;
no one seems to have noticed.*

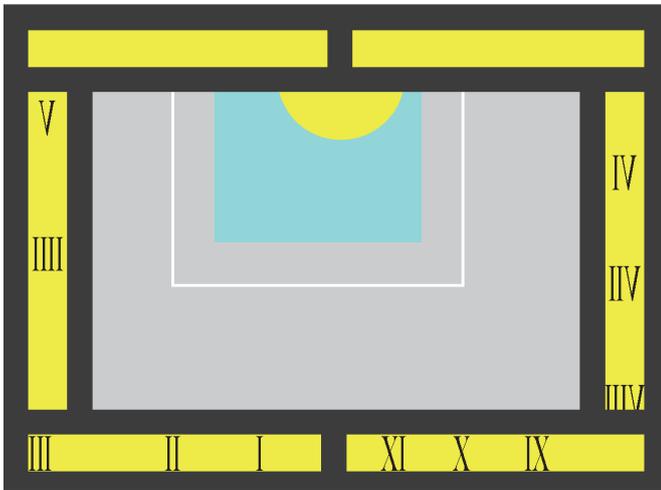


Fig. 8. The computer model reversed.

Fig. 8 is the mirror image of Fig. 7 and it is immediately clear that reversing the dial introduces a new problem. The early morning hours, 6, 7, and 8, are now shown as IV, IIV and IIIIV. More subtly, the fat strokes of all the Vs are on the right of the character rather than on the left. The two side panes were facing the right way all along and now need reversing again.

Subject to these additional changes, Fig. 8 is now substantially how the dial should appear when viewed from the inside. The hour numbers correctly go round clockwise and IX, X and XI are in the right order. There is no mistake in that pane of glass.

Fig. 9 shows the side panes reversed again. A gnomon and hour lines appropriate for a window that declines 13° east of south have been added too. The gnomon would, of course, be on the outside of the window and the line shown in Fig. 9 is more a diagrammatic indication of the alignment of the sub-style than a representation of the gnomon itself.

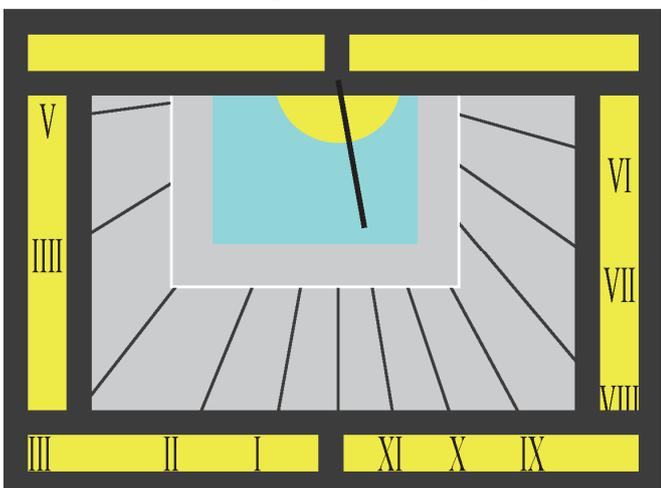


Fig. 9. The side panes reversed again.

The designer almost certainly intended the root of the gnomon to be at the centre of the half-sun. In Fig. 9, priority has been given to ensuring that the hour lines fit reasonably well with the hour numbers in the photograph. In consequence, the placement of the root of the gnomon is off-centre.

In the absence of a high-quality square-on photograph or reliable measurements, the angular positions of the hour numbers cannot be reliably estimated so it has not yet been possible to reconstruct the dial to high precision.

One might question whether the dial had hour lines. The high-resolution original version of the photograph in Fig. 6 shows very faint traces of hour lines. A close inspection should reveal firmer evidence and may even show half-hour lines. There are certainly hour lines and half-hour lines in the dial in the west window (see Fig. 11).

The likely use of comes that are different from those used originally and the use of additional comes to effect repairs may mean that the panes of glass are not quite in their original relative positions. This may account for the lack of a clear centre-line. The strip of came that lies where XII should be is slightly to the left of the strip of came that is roughly central at the top. The XII came has been displaced slightly because of the two repairs in the pane on which IX, X and XI are painted.

Given all these caveats, it makes little sense to comment on how well the hour numbers align with the hour lines. That said, there is no evidence that there were any significant errors in the original design.

It seems reasonable to suppose that the south dial has been repaired a number of times and that, at each repair, it would have had to be removed from the window. (We may overlook the *in situ* application of bitumen.) It would also have been removed at any major refurbishment of the stonework of the window.

As a conjecture, one may suppose that the dial was removed at some time in the 19th century, before Mrs Gatty, and it was decided that it was in too poor a state to be worth repairing. The panes of glass were placed somewhere safe and then forgotten.

At some time in the 20th century, after Robert Gunther, the panes were rediscovered. Someone realised what they were and decided that this was an interesting jig-saw puzzle. The panes were placed together as in Fig. 6 and a leaded-light specialist was called in to fit the panes into comes and to install the dial in the window as it is today.

Conservation and Restoration

A disastrous consequence of (much of) the dial facing outwards rather than inwards is that the painted surfaces of three of the panes of glass are exposed to wind, rain and weather. These surfaces should be on the inside to protect them from the elements.



Fig. 10. Exterior view of the south dial.

The two panes of yellow glass at the top are not painted but, assuming they are yellow stained, it would be usual for the stained surface to be on the outside. Since there is no painting on these panes, it does not matter which way round they are.

The panes of yellow glass at the sides have their painted surfaces facing inwards so the hour numbers have not degraded too badly. The two panes of yellow glass at the bottom have their painted surfaces facing outwards which perhaps explains why the hour numbers on these panes are so much less legible than those on the side panes. The large central pane is the only pane in the dial that is not yellow. It almost certainly has its painted surface, with all the major decorative features of the dial, facing outwards.

Fig. 10 shows the south dial from the outside. As with all stained glass or painted glass, decorative details are almost impossible to make out when viewed from outside. One mainly sees reflections, though the half-sun is just visible. It is not easy to interpret all the features in Fig. 10, but it looks as though a pane of clear glass has been placed over the central pane of the dial. It is held in place by an extra strip of lead at the top of the central pane.

This outer layer of glass may be a misguided attempt to protect the painted surface of the large central pane. The clear pane is now cracked and it seems to have water trapped beneath it. When the wind blows, the clear pane will surely slap against the painted pane which can only accelerate the degrading of the latter. This possibly explains why there is now almost no sign of hour lines, little evidence of blue sky, and why the dragonfly is so decayed. The clear pane should be removed as soon as possible.

The only good news is that the apparent cracks in the central pane that can be seen in Fig. 7 are actually cracks in the outer layer of glass. There is a good chance that the decorated central pane is free of cracks.

The inference from Fig. 9 is that the root of the gnomon should be close to the point where the central vertical strip of came in Fig. 10 intersects the horizontal run of came along the top of the central pane.

According to Carmichael,²⁵ gnomons were traditionally attached by drilling a hole in the glass and bolting the gnomon to the glass through the hole. This is hardly sound engineering and the glass was easily smashed. This approach cannot be recommended! In the case of the south dial, the right place for the hole would have been through the came at the top of the half-sun rather than through the glass but this approach is only marginally better than drilling through the glass.

Carmichael's high-tech solution is to attach a neodymium magnet to the root of the gnomon. This engages with a steel plate that is treated almost as a quarry in that it is held in place by comes. This would require a major change to the design of the south dial and would not be appropriate.

Seen in elevation, the line of the gnomon crosses the saddle-bar below the dial close to the west side of an eye, at a distance of about 207 mm from the plane of the dial. It should be possible to design a suitable bracket, one end of which would be attached to the saddle-bar and would be shaped to allow for the side of the eye. The other end would hold a light-weight gnomon at the proper orientation.

The bracket would have to be approved by conservationists and other interested parties. The gnomon would not run all the way to its root and would thereby be kept well clear of the glass. There are many sources of advice on the conservation and restoration of stained glass and painted glass. The website of *Corpus Vitrearum Medii Aevi*²⁶ offers some internationally agreed guidelines²⁷ that have the support of English Heritage.

The starting point is to prepare a Conservation Plan that the interested parties can agree on. These will probably include local planners, conservation bodies and English Heritage. The Conservation Plan documents the state of the glass and its historical importance, and describes the measures that are to be taken. These may include the following steps:²⁸

1. Discard the clear pane of glass that covers the central pane.
2. Remove the dial from the window.
3. Separate the panes from the comes. This will require agreement that the wide comes in the dials are not original.
4. Carefully clean each pane of glass.
5. Use the appropriate glass adhesive to join cracked pieces together.
6. Make good the losses by over-painting with non-firing conservation-standard glass paint. This is a reversible process. Current standard practice is to make good losses but not to correct any original mistakes. If an hour number is badly placed, it stays badly placed!
7. Reassemble the repaired and restored panes using, if possible, comes of the size originally employed. Ensure that all the panes are the right way round!
8. Design an arrangement to support a gnomon so that it cannot damage the glass.

9. Replace the restored dial in the window; check that it is the right way round.

It is not clear how the hour numbers were originally applied to the yellow panes of glass. Assuming that vitreous enamel was used, this involved firing the pane of glass in a kiln. In elaborate cases, an individual pane may be returned to the kiln several times. In restoration work, conservation-standard paints are used and these do not require firing, indeed old glass is never re-fired.²⁹



Fig. 11. Close-up of the west dial.

The West Dial

Fig. 11 shows the sundial in the west window which declines about 77° west of due south. It has much in common with the dial in the south window. Both dials have six panes of yellow glass surrounding a large central pane in which there is an inner rectangle set off by a narrow drawn line. The yellow panes have sustained even more repairs than those in the south dial and the central pane is cracked. All the panes are the right way round!

Just to the left of the hour number II there appears to be a bald patch in the yellow pane. This is possible confirmation that the yellow panes are not coloured all the way through.

Gunther writes:³⁰ "It is a beautiful little example of the art of glass painting, showing the afternoon hours II to VIII in a yellow border, round paintings of a yellow brimstone butterfly, a rose, and some flying insect resembling a gnat." Gunther is wrong about the range of hours shown. They start at hour I although that is admittedly difficult to see. The flying insect seems to have vanished.

As is appropriate for a window that faces not far off due west, only afternoon hour numbers are shown. Some hour lines and, indeed, half-hour lines, are discernible and these radiate from a point that is a long way off the top right-hand corner of Fig. 11 so it would not be appropriate to have a half-sun in this design.

Fig. 12 shows a computer model of the west dial. The butterfly and the rose and the half-hour lines have been omitted. A gnomon, or indication of the alignment of the sub-style, has been added. Fig. 12 may usefully be compared

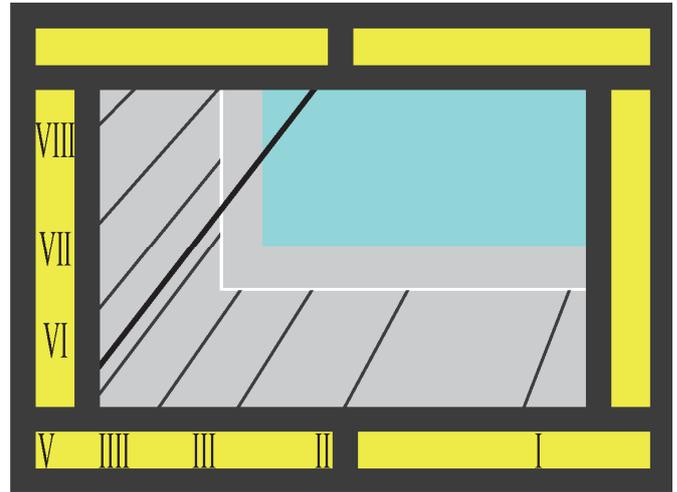


Fig. 12. Computer model of the west dial.

with the computer model in Fig. 9. Stylistically, there is much in common and the gnomonic differences are entirely a consequence of the different directions faced by the dials. As with the computer model of the south dial, the hour numbers and the hour lines do not tie up as well as one might hope. It is unfortunate that the panes that have had the greatest number of repairs are those with hour numbers.

Conservation and restoration should be almost as for the south dial but the gnomon will be a little more challenging to support. Seen in elevation, the line of the gnomon runs into the stonework of the neighbouring mullion before it reaches the saddle-bar below the dial. Fortunately, the root of the gnomon is some distance higher than the saddle-bar above the dial and the line of the gnomon crosses this saddle-bar about 79 mm from the plane of the dial. This is sufficient clearance for a bracket which could support another light-weight gnomon.

Conclusions

The majority of painted glass sundials that have survived in Britain date from the 17th century with a few dating from the 18th century. The two sundials in the windows of Convocation House have a 17th-century appearance but that is hardly firm evidence for their date. They are constructed in the same way and have so many similarities that it is plausible that they are by the same hand.

It seems most unlikely that one dates from after 1923 though it is entirely possible that the dial in the south window was removed for a period of several decades. That would explain why neither Mrs Gatty nor Robert Gunther referred to it.

The gnomonic evidence strongly suggests that these dials were custom made for Convocation House and were not originally somewhere else. Loggan's engraving and the design of the windows suggests that the dials were an afterthought. It is possible that they were installed at the time of the major refurbishment in the 1750s when the vaulted ceiling was added but the statistics suggest that that would be very late.

Both dials need conservation and restoration and the dial in the south window needs especially urgent attention because three of its panes have their painted surfaces facing outwards.

It would be good if the dials could be given new gnomons.

ACKNOWLEDGEMENTS

Many thanks are due to the BSS Registrar, John Foad, for supplying the photograph by Andrew Somerville and various other photographs, and to John Davis for supplying copies of two pages of Robert Gunther's *Early Science in Oxford*. Particular thanks are also due to my brother, David King, for undertaking much preliminary research on the history of the buildings that constitute the Old Bodleian Library and for taking many photographs. Finally, special thanks are due to Susan McCarthy of Aura Visions for providing many insights into the mysteries of glass conservation and restoration.

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14. Mrs Alfred Gatty: *The Book of Sun-Dials*, George Bell and Sons (1900), fourth edition, p. 130.
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30. Ref. 15.

For a CV and portrait of the author, see *BSS Bull.*, 23(iii), September 2011. He can be contacted at fhk1@cam.ac.uk

NEW DIALS (1)

Newry Analemmatic

The analemmatic sundial remains a popular form of adornment for public spaces as it is (almost!) vandal proof and ought not to attract the attention of the extreme Health and Safety brigade. It certainly adds interest to a blank area of paving,



This one is in Hill Street, Newry, Northern Ireland and was professionally installed in 2013 with granite setts inlaid to the pavement. The design is from *Modern Sun-clocks*, characterised by the twin rings of hour numerals for 'GMT' and 'BST', using a clever date scale to accommodate the two different sized ellipses. It is good to see a town centre layout receiving plenty of sun.

Info courtesy of Douglas Hunt.

A CRAFTSMAN'S HAND HELPED SKIRLAUGH SUNDIAL TO LIVE ON

MARGARET RIBCHESTER

The stories behind most of our sundials are lost in the fathomless mists of the time they measure; but I was fortunate enough recently to come across a personal account of the partial restoration of a vertical stone dial which must stand as a testimony to the quiet dedication and committed work of one Yorkshireman.



The church which bears this dial is St Augustine's Parish Church in Skirlaugh, East Yorkshire, home to the Local Ecumenical Partnership of the Church of England and Methodist congregations in the village. It's a stunning building of Grade 1 listing which has been described as being "the most perfect example of early Perpendicular architecture in any English parish church". Built between 1401 and 1405, it is more than likely to have been created by the stonemasons who worked on York Minster.

The vertical sundial over its south porch was recorded, according to the Register, as SRN 2975 by Jane Walker in 1995, but there was no image for BSS records. So, fresh from the harmonies and joys of the nearby Beverley Early Music Festival, I drove eastwards to find and photograph it.

The sheer size and impact of this church is quite breathtaking at first sight. On closer inspection the age of its stonework is apparent and explains why a section of the dial has been restored by a careful hand.

"Whose hand?" enquired the vigilant John Foad on my submission of a brief report and photos, subtly following this up with a flattering remark about the background stories I sometimes find. Thus spurred into further efforts, I delved more deeply and was lucky enough to discover one of the most interesting, and moving, stories behind a dial and its church that I have come across. I quote more or less verbatim the reply I received from my contact at Skirlaugh:

"The sundial was repaired by Edward Brown, who lived next door to us until his death ten years ago.

"Edward came to live locally in the late 1970s. He was a director of a large company in Hull but was made redundant when he was in his mid-fifties. Being unable to secure another job, he turned his attention to St Augustine's Church.

"Although he wasn't a Christian, he recognised the beauty of the building and noted that it was in need of repair. So, with the blessing of the vicar and the diocesan architect, he went on a six-month stonemasonry course in London, which he funded himself, and on his return he embarked on a comprehensive restoration on which he worked for 40 hours each week for ten years, from 1981 to 1991.

"He found out where the original stone for the church had come from and bought a second-hand car in which to transport stone from the quarry near Doncaster which had been its source. He bought his own stonemasonry tools and had a large shed built in his garden in which he worked.



“He cleaned and pointed the entire fabric of the building, both externally and internally. Eroded stonework was replaced, and as well as restoring the most worn part of the sundial he carved and installed the crosses over the east gable and the porch.

“When this monumental task was completed he turned his attention to overhauling the heating system, installing new radiators, removing the old platforms on which the pews stood and laying a new floor. He received no remuneration for any of this work. A truly magnificent effort. A plaque was placed in the porch to record our gratitude.

“Despite all our efforts over two years, even with the written support of the great and the good of our church and county, we were not successful when we nominated

him for an honour. This was a huge disappointment, but we had the pleasure of presenting him with a portfolio of letters which were fulsome in their praise for him.”

I am submitting this account to the BSS with the permission of Edward’s widow, Gillian, and with thanks to my correspondent, Cliff. Such a story deserves to be more widely known and although the circulation of our magazine is not large I believe there will be respect among its readership for such restoration work by a craftsman with a love for the material on which he worked. He must have been a worthy descendant of those long-ago stonemasons who brought this church into being.

Margaret Ribchester *marginrib@yahoo.co.uk*

THREE DANISH SUNDIALS

DAVID HAWKER

Denmark is quite well endowed with sundials, but for your interest I am showing three of those that I have seen and photographed there over the last few years. We frequently visit Denmark as I worked in Helsingør way back in the mid ’60s (so long ago) and still have friends there who we see regularly. The article in the December 2013 *Bulletin* by Barrie Singleton on helical sundials reminded me of the first dial and I thought it might be interesting to describe three quite different sundials.

A Helical Sundial

I saw this sundial (Fig. 1) last year when I visited the Danish Queen Margrethe’s Summer Palace at Fredensborg in North Zealand. It shows the time to be about four o’clock, (five o’clock Summer time) which we can confirm as we were supposed to have left the garden by then and got shut in. Unfortunately the queen wasn’t in residence so afternoon tea was off! The dial is located in the north east corner of a large vegetable garden down the centre of which runs a beautiful arched rose walk that leads to a stunning modern Orangery.

The helix seems to be made of painted steel and the latitude is not adjustable. The hours are indicated by dots, similar to the helical sundial described by John Davis in his article on helical dials in the December 2012 *Bulletin*. Although it wasn’t the equinox when I saw this dial (it was July), the shadow is almost perpendicular to the edge of the helix. Could the angle of the shadow across the plate be reduced with a ‘tighter’ helix? This helix looks more tightly wound than the one in the article mentioned above.

A dial of identical design to this one, apart from its size, can be found in the centre of the maze at Egeskov Castle on Funen. This is considerably larger than the Fredensborg



Fig. 1. Helical sundial Fredensborg Palace, Denmark.

dial – being 11 m high with a 4 m long helix – making it a prominent centrepiece for the maze. A little investigation determined that the Egeskov Castle dial is by the famous Danish scientist, artist and author Piet Hein (1905–1996), and was installed in 1989. There is no doubt that the Fre-

densborg Castle dial is also by Piet Hein as the Piet Hein website mentions that these were made in three sizes, 1.8 m, 4 m and 11 m.

A Vertical Declining Dial of Some Age

The second dial (Figs 2 and 3) is in Helsingør itself. Helsingør (Elsinore, with Kronborg castle where Shakespeare set Hamlet) is a very old town with streets of wonderful old buildings. It was a very busy port and still has a very busy ferry service crossing the Øresund between Helsingør and Helsingborg in Sweden. The buildings by the harbour were at one time mostly associated with shipping.

The sundial faces the harbour and is a vertical declining dial with what appears to be the date of 1655 just left of centre at the top of the dial. The adjacent building is dated at 1642. Most of the buildings along that stretch of Strandgade are from the same era.



Fig 2 & 3. Sundial at Helsingør, Denmark, showing the declining design.

The building faces around 37° east and the hour lines and gnomon location seem to reflect this declination. I can't suggest an origin for the unusual gnomon design unless it is a symbol of a Guild or society. The dial is very high up on the wall and, if it has not been moved, must have been quite difficult to read. The lines, numerals and decorations are carved in relief.

A Canonical Dial

I saw this sundial (Figs 4 and 5) when we were doing a tour of northern Jutland a few years ago. It is on the wall of a beautiful church over on the North West coast of Jutland called Vestervig Kirke. The brochure that I brought home with me from the church describes it as having been originally built as a cloister church for the Augustinian order around the year 1200 and then radically rebuilt in the Gothic style in the period 1400–1525. With the Danish reformation in 1536, the church became the parish church of Vestervig.



Figs 4 & 5. Canonical dial, Vestervig church, Jutland, Denmark.

The sundial was found with the rebuilding of the church in 1917 and has been dated to the time of the original construction and is therefore considered to be one of the oldest 'church' sundials in northern Europe. The location on the wall is, of course, not its original position.

This is a canonical dial and an unequal hours dial. It can be seen that the dial has the letters T, S and N and the Danish brochure (translated) explains these as "Tertia (the third hour)" shown as 8am, "Sexta (the sixth hour)" shown as 11am and "Nona (the ninth hour)" shown as 2pm, giving these as "the times for the Augustinians to assemble for daily prayers". There is also a small cross at the noon point. Referring to various sundial books, the times, as we know them, terce, sext and none are given as 9am, midday and 3pm respectively; one hour later than the times shown by the Danish dial. Are there any other canonical dials that actually indicate terce, sext and none against the hour lines I wonder?

For a CV and portrait of the author, see *Bull.*, 25(iv), Dec 2013. He can be contacted at david@hawkerdials.co.uk

DIALLING TALES: THE DAY THAT I SAID “NO”

CHRISTOPHER DANIEL

Almost every sundial designer or maker has a story to tell about an incident experienced during one or more of their commissions...

One day, early in the year 1980, when I was in my office in the National Maritime Museum, I received a telephone call enquiring as to whether I would instruct someone, who was in the process of making a horizontal garden sundial, on how to calculate the hour-lines and delineate the dial-plate. Naturally, I wanted to know a little bit more about the background to this request and added that it might be easier, saving time and effort, if I were to delineate the dial myself. This was met by some concern by the caller, as the sundial was evidently being constructed as a surprise birthday presentation for a *very* important person and the matter was strictly confidential. No doubt, the caller was anxious as to my discretion; but I couldn't resist the temptation to ask if this VIP was more important than Her Majesty the Queen, who had unveiled my vertical sculptured sundial on the building of the Marine Society – my second major sundial commission – the previous year. This question seemed to reassure the person concerned and brought the answer that the sundial was to be a gift from the VC & GC Association to Queen Elizabeth, the Queen Mother, to celebrate her 80th birthday on 4 August 1980.

Looking back, I presume that the caller was telephoning on behalf of the VC & GC Association; but the result was that I was introduced to Brian Asquith, a noted silversmith and sculptor of Youlgreave in Derbyshire, who had been commissioned to construct the dial. Brian had designed and made an elegant pedestal for the instrument, as well as the gnomon. All that remained was the delineation of the dial-plate itself. Nevertheless, I produced a simple dial-plate design as well as the required delineation of the hour-scale, which I duly sent to Mr Asquith. At some stage, I went up to Youlgreave to meet him and to discuss the proposed commission, which he had almost finished. In due course, in August 1980, the sundial was presented to Her Majesty, who evidently had it in mind to have it installed in the Doll's House garden at the Royal Lodge in Windsor.



One day, in the spring of the following year, I received a telephone call, asking me if I could be present at the Royal Lodge on the forthcoming Friday to supervise the sundial's installation. This was to be carried out by Brian Asquith and the Royal Lodge gardener. However, the day in question was not particularly convenient for me, so I said “No – but I could manage the following Friday”, which arrangement was agreed. Accordingly, on a sunny morning, I drove down to Windsor, parked in the car park and made my way to the Doll's House garden, walking through the magnificent, mountainous displays of beautiful azaleas.

I had not expected to meet anyone on site other than those already mentioned; but, as the sundial was being moved into position, Her Majesty the Queen Mother suddenly appeared, accompanied by four corgi dogs. She was not escorted by a detective, any personal bodyguard, or member of her staff, and was wearing country clothes and short wellington boots. Evidently, she wanted to see the installation of the sundial and to know that it was in the right place. However, once she was satisfied that all was going well, she was quite happy to stop and chat. She thanked me for taking the trouble to come to Windsor to set the dial up and asked questions about my work. I told her about my ‘Dolphin’ dial at Greenwich and she expressed an interest in seeing a picture of the dial. At one point, she warned me not to stroke particular Corgis, since some of them were not averse to snapping at strangers!

On my journey back to Greenwich, I recalled how warm, friendly and charming Her Majesty had been, and I marvelled at the fact that I had been left completely alone with her; but it also dawned on me that the Queen Mother must have been responsible for requesting me to come to the Royal Lodge at Windsor the previous Friday...and I had said “No!” Had I disobeyed a royal command? I reflected that it was just as well that this was the 20th rather than the 16th century, as I might not have lived to tell the tale!

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SUNDIALS IN THE DESERT LANDS OF CENTRAL AUSTRALIA

MARG FOLKARD & JOHN WARD

Broken Hill is a mining town in the Australian desert, located at Latitude $31^{\circ}58'$ S and Longitude $141^{\circ}29'$ E. A famous Australian artist known as Pro Hart lived there for all of his 77 years. Kevin Charles Hart was born in Broken Hill on 30 May, 1928. Later in his life he came to be called 'Pro' which was short for Professor because inquisitive children thought that this fellow was "a bit of a know it all". The name 'Pro' stuck.

Many years ago he asked us to make a sundial for his place at Broken Hill. Broken Hill has very dry, hot air, vivid colours and a natural brightness of light which enveloped Pro for all of his life. Early in his life he worked underground as a miner and at the end of a shift emerging into the very bright sunshine, he felt like an ant emerging from the ground. Eventually, he decided to quit mining and become an artist of the outback. His paintings with stick figures are sometimes compared in style to that of L.S. Lowry from Salford in England. Pro's creative imagination moved him to explore myriad mediums including sculpture, etchings, silkscreens and giclées. He worked with oils, acrylics, layered chiaroscuro, glazing and alla prima. His work can be found across the world in the private collections of Queen Elizabeth, Prince Philip, Lyndon Johnson, and many other Kings and Queens.

Pro met Raylee June Tonkin in 1958 when she was 19 and he was 30. By then he had been down in the mines for nine years and stayed down for another ten. He painted most days and worked tirelessly after his day labouring in the richest silver, lead and zinc mine (the lode) ever found on Earth.



Fig. 1. Raylee Hart with Pro's sundial.



Fig. 2. Pro Hart's armillary sphere sundial on its pudding dish pedestal.



Fig. 3. The Equation of Time plaque.

He wanted an unusual sundial as you can see from Figs 1–4. Pro was particularly fond of his miners' dish which we renamed the 'pudding basin'. At his request we attached the bronze armillary sphere sundial securely to the dish. In addition, to remind him of his ant-like days underground in the mine, we cast a large (400mm) solid bronze ant and attached it to the side of his pudding dish. When we last saw the dial in August 2013 the large ant had been moved next door to the safety of the three storey Broken Hill art gallery.

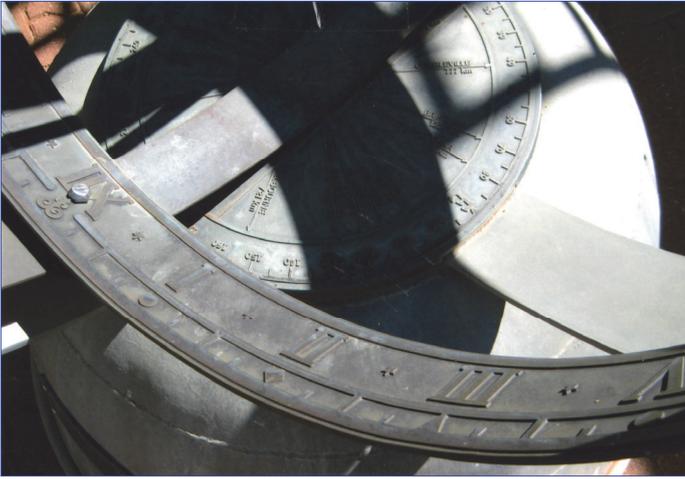


Fig. 4. The director plate as part of the sundial.



Fig. 5. The ant is 400 mm long.

The way we created the large ant is quite involved. When you poison ants, they curl up and die. We wanted a proud ant on our sundial. To achieve this, we placed some ants on a saucer containing honey. They stood up proudly. We gently floated the saucer in a dish of liquid nitrogen at -190°C which gradually immobilised the ants without them curling up! We then placed the ants in a vacuum chamber and coated them with a thin conducting layer of aluminium. Next we placed the metallised ants inside an electron microscope and scanned them in three dimensions with an electron



Fig. 6. A delicate sundial in Pro Hart's back yard.

beam. The result was a first class photographic print which we enlarged about 70 times to get the detail required. Finally we made a wood pattern from the enlarged print and had two castings made, one in bronze for the Pro Hart Dial and one in aluminium for our garden as a nice memory. The things you do for sundials!

To add yet more character to this very heavy sundial, Pro drew figures of ants on four flat pieces of Masonite. We converted these planar drawings into three dimensional patterns and cast them in bronze,¹ then rolled them to suit the curvature of the horizontal 'U' section horizon ring and finally attached the four 'ant plates' to the horizon ring as shown in Fig. 2.

Pro was delighted with the completed sundial. When the time came to pay us for our labours, he promptly paid then commented "You should have charged me twice as much and I would have happily paid". So we learn!

In the backyard of his private house there is another sundial made of bronze and lightly etched or hand engraved. The gnomon is paper thin by our standards; about 3 mm or 1/8" thick and has to be supported by two horizontal plates. Definitely not made by us and its origin is unknown.

Finally, and reasonably near by Australian standards (about 1000 km by road) there is another sundial in the desert lands, located at Marree (Latitude $29^{\circ}39'S$ and Longitude $133^{\circ}01'E$). In the 19th century, Marree was an important town through which passed both the Ghan line, as the railway line was known, and the camel routes which had been vital for opening up central Australia. This sundial represents a camel and was constructed using wooden sleepers from the famed Central Australian Railway. It was conceived by the people of Marree, who include descendants of the Afghan cameleers, and built in July 2011 under the guidance of travelling artists Siv Grava and John Turpie in time for the inaugural Marree Australian Camel Cup. It was part of the Serpent Project under which 13 South Australian towns used art themes to revive links forged through the old camel routes.



Fig. 7. The completed Camel sundial.

Fig. 10. Overall view of 'The Living Desert' sculptures.



The Living Desert Sundial

The Broken Hill City Council wanted to develop a reserve on the outskirts of the city which was totally surrounded by the desert. The reserve had to be natural, beautiful, attractive and hopefully it would become a Mecca for artists, scientists and visitors from around the World. A magnificent hill called Sundown was chosen and subsequently became known as 'The Living Desert'.

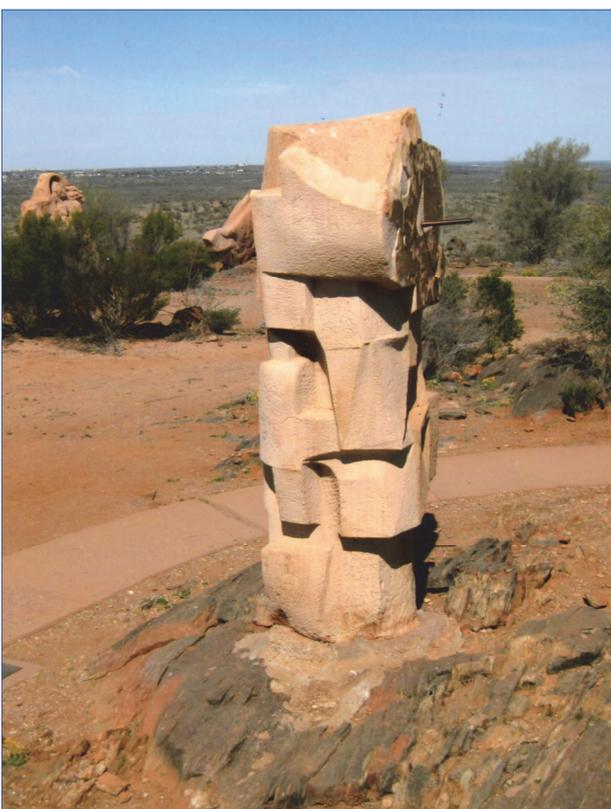
The council donated 53 tonnes of hard sandstone obtained from a nearby quarry. It was then divided into 12 separate sections and each section had one flat surface cut on it so that it would stand up horizontally or vertically. The rest of the stone was left in its raw state.

The council had invited some famous sculptors from around the world to come along, live in the desert and get carving. A symposium was held and the chosen artists were invited to carve and create whatever they thought was suitable for this superb location in the middle of the desert. This large, roughly circular array of huge stones became known as 'The Broken Hill Sculptures'.

One of these incredible creations sculpted by Valerian Jikiya from Rustiva in Georgia, became a sundial! Its artistic name was 'Angels of Sun and Moon'.

During the symposium, Valerian several times worked all night under a full moon to determine the planes and shadows of his sculpture. He described his work as a "device to measure time and light." In the artist's interpretation, the eastern face reflects the moon and the western side faces the sun. The shadows move continuously across the rock and thus the appearance of the sculpture changes from season to season.

The sundial shadow falls in the triangle each year at the same time that Valerian was working on the rock.



Figs 8 & 9. The 'Angels of the Sun and Moon' sundial.



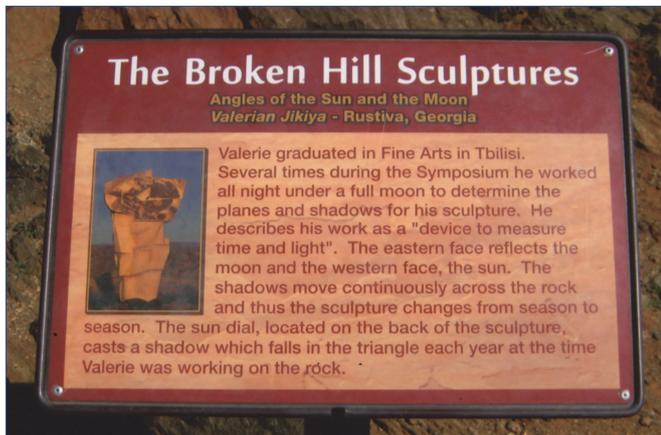


Fig. 10. The plaque accompanying 'The Angels of the Sun and Moon' sundial.

It has effectively become both a lunar dial and a sundial. Next time you are in Australia make sure you visit this astounding sculptural creation in the middle of the desert. We would be delighted to prepare a gnomonic itinerary for

our fellow BSS members to include the most interesting sundials which we know of, both here in South Australia and the rest of this island continent.

ACKNOWLEDGEMENT

Thanks to John's 15 year old granddaughter Kaitlin Ward for scanning the photographs and formatting the article in Margaret's absence. Young people are so good at computing!

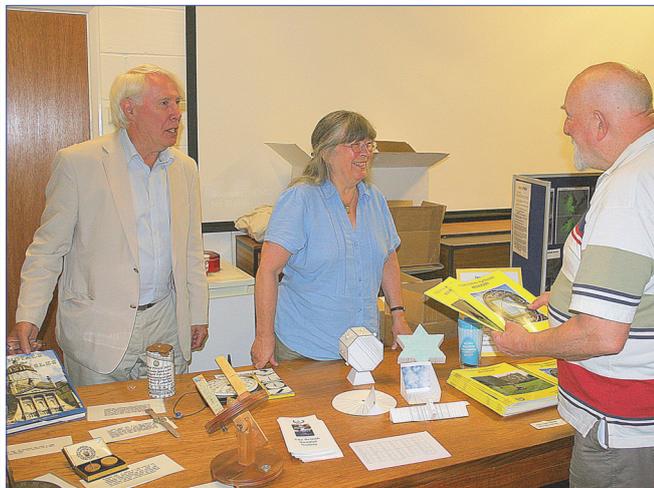
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Promoting the Society

In July, the south-east astronomy societies gathered for their annual meeting at the Chichester Planetarium. The planetarium has a traditional 'dumb-bell' cluster of projectors to show the stars, planets, constellations, and seasonal phenomena. It can also go backwards and forwards in time, and demonstrate the tricky concept of nutation. What is satisfying is that it does not



have any gimmicks as do modern 'entertainment' planetariums that owe more to Star Wars than astronomy. The planetarium is also remarkable for having a disconcertingly accurate wax-work model of Sir Patrick Moore to greet you at the door. Not surprising considering that he was a resident of Sussex, and a great encourager of astronomy. By a series of sundial connections, Jackie Jones was asked to come along and promote the Sundial Society. (See the March 2014 issue, A New Analemmatic Dial in Brighton by Jackie Jones.) Similar connections caused Doug Bateman to be an invited speaker to talk about the Greenwich time ball, more or less the same talk that he gave at the April conference, and he was able to bring dials and books to supplement Jackie's display. Promoting the Society in this way is important, and helpful if members can look out for opportunities. Photo credit to Tony Questa.

Doug Bateman & Jackie Jones

**Postcard Potpourri 31
 Marsden Park, Nelson**

Peter Ransom

This is a magnificent polyhedral dial in the shape of an icosahedron (20 faces). This postcard has a stamp with postmark dated 1912 and the *Fixed Dial Register* dates the dial as 1841. It is one of the first dials recorded by the BSS (SRN 0003) when it was recorded by Gordon Taylor, who consulted on its restoration in 1979.

The colour postcard was printed by Carrs Printers (Sales) Ltd., Barnoldswick, but as it has not been used the date is unknown.

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A SEVENTEENTH-CENTURY HALACHIC HORIZONTAL SUNDIAL BY ROBERT JOLE

MACIEJ LOSE

A recently discovered 17th-century horizontal sundial by London maker Robert Jole¹ is unusual in a couple of ways. It is the first dial recorded by this noteworthy maker, who so far is known only for manufacturing early calculating devices such as abacus beads and versions of Napier's bones, as well gauging rods and arithmetical compendia.² The dial, although substantially weathered, reveals on close inspection the fine engraving of its furniture: solar declination arcs, hour-lines of the Jewish time system (also referred to as seasonal or Biblical) and precisely graduated astronomical time chapter ring. The ring – a standard feature – in this particular case is the most unusual part of the dial due to its odd sequence of hour numerals (Fig. 1) which places VI on the noon line and XII–XII on the east-west line.

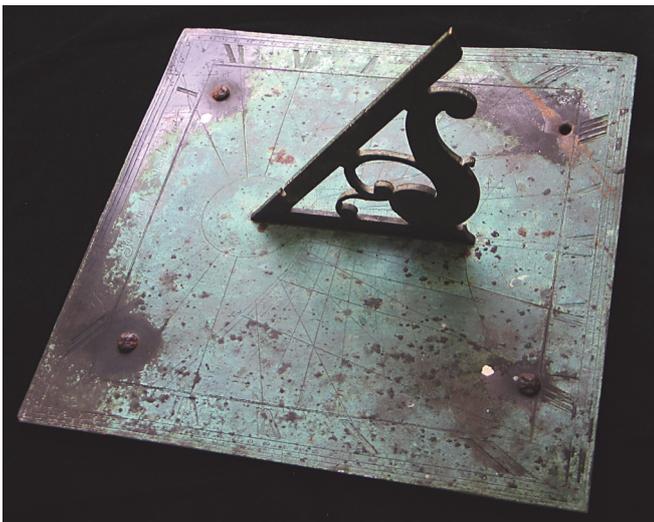


Fig. 1. General view of the horizontal sundial by Robert Jole. Notice the unusual sequence of hour numerals.



Fig. 2. Approximate locations of Robert Jole's premises on the 1746 Map of London by John Rocque:¹⁸ (a) Sign of the Crown, over against Durham Yard, the Strand; (b) Sign of the Globe, against the Feathers Tavern near Fleet-Bridge, (c) att ye Crowne Nere ye new Exchange fecit.

Robert Jole, Mathematical Instrument Maker

Robert Jole was apprenticed to Hilkiah Bedford of the Stationers' Company on 1 June 1656 and made free in that Company on 6 June 1664. He was admitted as a brother in the Clockmakers' Company on 24 February 1667, among nineteen instrument makers, and was active there until 1702. He took apprentices³ among whom were his son Thomas and John England – the latter became instrument maker to Queen Anne. Jole's recorded premises were at: *the Sign of the Crown, over against Durham Yard, the Strand; the Sign of the Globe, against the Feathers Tavern near Fleet-Bridge* and *att ye Crowne Nere ye new Exchange*. All these locations were in an area favoured by London scientific instrument makers of that time. His third location – near New Exchange – was possibly optimal for the trade of abacuses and calculating devices (Fig. 2).

Both Jole's master Hilkiah Bedford and his most distinguished apprentice John England were prominent sundial makers,⁴ known for manufacturing a variety of gnomonic instruments including standard horizontal dials, complex double horizontals and analemmatic dials, universal ring dials and quadrants. Thus it seems highly surprising that the dial discussed here is the only instrument of a gnomonic nature found to be signed by Robert Jole. Its existence suggests that there must have been other examples – some possibly filling the gap in the tree of knowledge and craft of rare double horizontals, for which both Bedford and England are recorded.⁵

Robert Jole's main area of interest must have been arithmetic. He is best known for construction of an arithmetical compendium around 1670, a calculating instrument devised

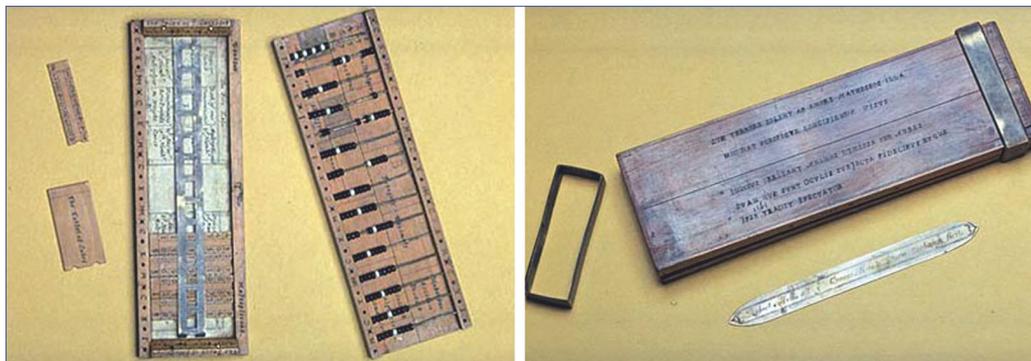


Fig. 3. The arithmetical compendium of Charles Cotterell made by Robert Jole. The brass tool is signed: Robert Jole att ye Crowne Nere ye new Exchange fecit. The New Exchange building was opened in 1669, in the place of the original destroyed by the 1666 Great Fire. Photo courtesy: National Museums Scotland.

in 1667 by Sir Charles Cotterell (1615–1701).⁶ This was a combination of Napier’s rods with a bead abacus, used to avoid writing down the partial products of multiplication using the rods. The compendium is regarded by historians of science as an early ancestor to computers and its inventor and maker as pioneers of modern computing. A complete instrument with case is preserved in the collection of the National Museums Scotland (Fig. 3).⁷ By 1680, Robert Jole published a book popularizing its use: *Arithmetick by inspection. Or, So easy a way, to learn and use that art, that even those who can neither write nor read, have been thereby taught all the general parts of it*. Reissue and popularization of this work could be of great benefit to modern society, which largely lost skills of basic practical mathematics!

Other preserved instruments include an incomplete and unsigned lower part of the compendium, with Napier’s bones only, which is in the collection of the Oxford MHS.⁸ Another instrument was auctioned at Sotheby’s in 1969.⁹

Description of the Dial

The square dial measures 31.5 × 31.6 cm (12.4 inches) and is made of brass plate of varying thickness (1.7–1.2 mm), thinning towards its corners (Fig. 4). To prevent deflection of the plate in the process of hammering the gnomon tenons, an additional rectangular brass plate was added underneath the dial (Fig. 5). Both the relatively thin plate (given the size of the dial) and the attachment of gnomon indicate the substantial value of brass in the period, and show cost optimization practices used by instrument makers.



Fig. 4. Side view of the sundial. The dial plate is of uneven thickness, thinning towards the edges on all sides, suggesting that it had been cut by the maker from a relatively small sheet of brass. The gnomon’s scrollwork design follows a pattern typical for mid-17th-century London makers. Notice the nodus, formed by a U-shaped incision in the shadow-casting edge of the gnomon.



Fig. 5. Back side of the dial with the gnomon tenons hammered against an additional brass plate in order to minimize deflection of the thin sundial plate.

The measured angle of the gnomon is about 51.4°. Its elegantly shaped scrolled supporter follows the characteristic form commonly used by London sundial makers in the second half of the 17th century (Fig. 4). Similar designs are present on dials signed by Hilkiah Bedford, John England, John Marke as well as many unsigned dials of that period. The nodus of the gnomon is in the form of rounded, U-shaped incision in the lower part of its shadow-casting edge.

The external time chapter ring on the dial is precisely graduated to one minute intervals and labelled every 10-minutes (Figs 1 & 6). Circular punches were used for numerals ‘0’ and ‘6’. Subsequent rings have divisions for 5, 10, 30 and 15 minutes. Half-hour intervals are marked with small, elegantly engraved fleur-de-lys in the outer chapter ring and a dot-hollow culminated line in the inner one. Quarter-hour intervals are marked with a reversed ‘T’ which is typical for early- to mid-17th-century London makers including Elias Allen (Fig. 6). Full hours are described with Roman numerals in the most unusual sequence, counting from sunrise: X–XII (6am)–VI (noon)–XII (6pm)–II.

The maker’s signature is engraved in an expressive cursive hand along the southern edge of the dial: “Robert Jole in the Strande fecit” (Fig. 6). The address given on the dial probably refers to the same location as one of those mentioned previously: The sign of the Crown, over against Durham Yard, the Strand.

The central part of the dial is occupied by a dense grid of lines: for astronomical hours, Jewish hours (2 to 10) and hyperbolic arcs of solar declination – for the solstices and for whole numbers of daylight hours. Both Jewish hours



Fig. 6. Detail of the engraving of the dial and maker's signature. Notice the reversed 'T' marker for 15-minute divisions of the inner time chapter ring. This type of marker was used predominantly by London makers in the first half of the 17th century.

and these arcs are labelled with Roman numerals, differentiated in size and with the indications of Jewish hours sized larger. Lines for the equinoxes and arcs of the solstices are further marked with corresponding zodiac sigils. Jewish hour lines are dotted to improve legibility against the grid – in a similar manner as major time and declination arcs of stereographic grid on double horizontal sundials.

The combination of Jewish hours and declination arcs for the number of the daylight hours through the year is unique among English dials. Only two early 17th-century horizontal dials by Isaack Symmes are known, described previously in the *Bulletin*,¹⁰ though these have the declination arcs selected for each sign of the zodiac, not for hours of daylight.

Though unusual for England, it has to be stressed that this set of gnomonic information was not unusual on continental dials, being common on more complex portable Nuremberg diptych dials¹¹ and many horizontal and vertical dials.¹² This might suggest that Jole's client had been accustomed to use of one of those continental instruments.

Analysis of the Dial

The results of the analysis of the dial's hour and half-hour angles indicate that the designed latitude must have been somewhere between 51° 30' and 51° 50'. The lowest average error of measured versus calculated hour angles is for the latitude 51° 40' and amounts 0.09°, with the standard deviation of slightly below 0.08°. Figure 7 shows that the most substantial, but still very low, calibration error was for the evening hours. It has to be noted that the measurements taken may be to some extent impaired by the deformation of the dial-plate as well as scanning and digitalization inaccuracies of the tracing paper template.

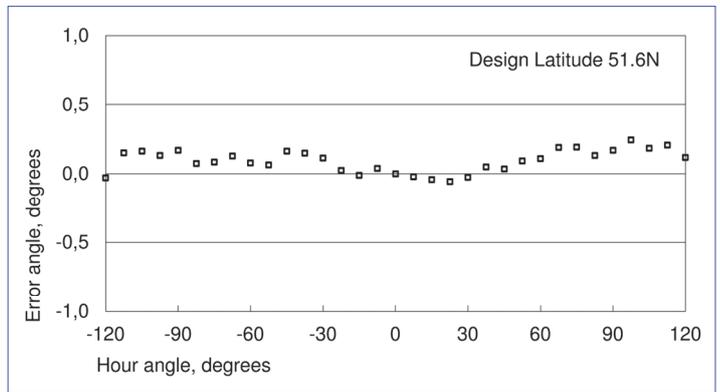


Fig 7. Analysis of the hour and half-hour angles of the dial which gives the best match, that is a minimal average error and standard deviation, for the latitude of 51.65° N. However, the extreme values of the time-scale on the dial – standing for sunrise and sunset on the summer solstice, as well the measured gnomon angle, suggest that the design latitude must have been slightly lower – most likely 51.50° N.

The time scale on the dial starts at 13 minutes before X hour (corresponding to 3:47am) and concludes after II hour (8:13pm), which matches perfectly with sunrise and sunset times on the summer solstice at the latitude of 51° 30' 13". With the gnomon angled at 51.4° ±0.2° it implies that the design latitude was rather closer to the southern border of the range derived from analysis of hour-lines – most likely London. The time-scale calibrated to one minute and the precise delineation certainly gave very good time telling accuracy overall as compared to other 17th century dials.

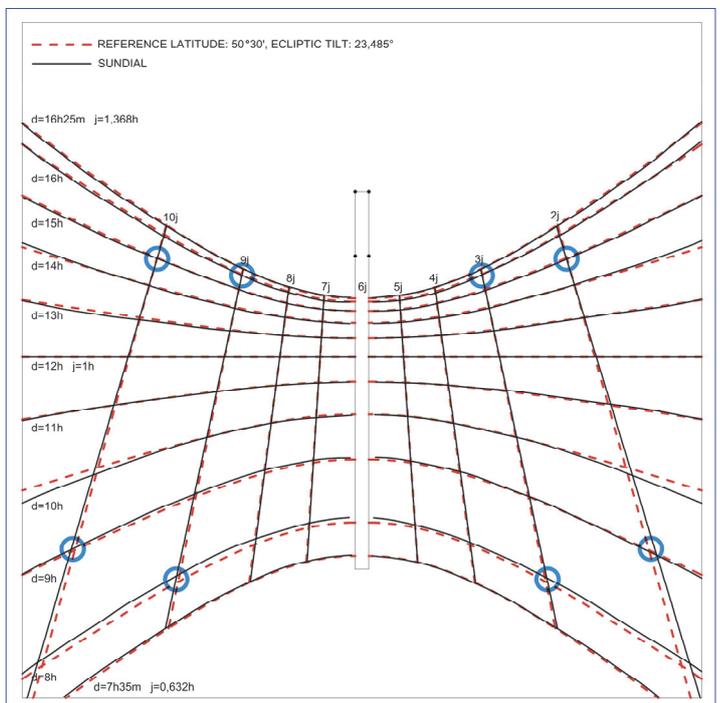


Fig. 8. Comparison of calculated declination arcs and Jewish hour-lines for a reference latitude of 50° 30' N (red dashed lines) with actual lines on the sundial. Blue circles correspond to points (beside the equinox line) where the astronomical and Jewish hour-lines, as well as the hyperbolic arcs of whole numbers of daylight hours, should meet. Compare with Fig. 9 where these correspond to intersections marked with circles.

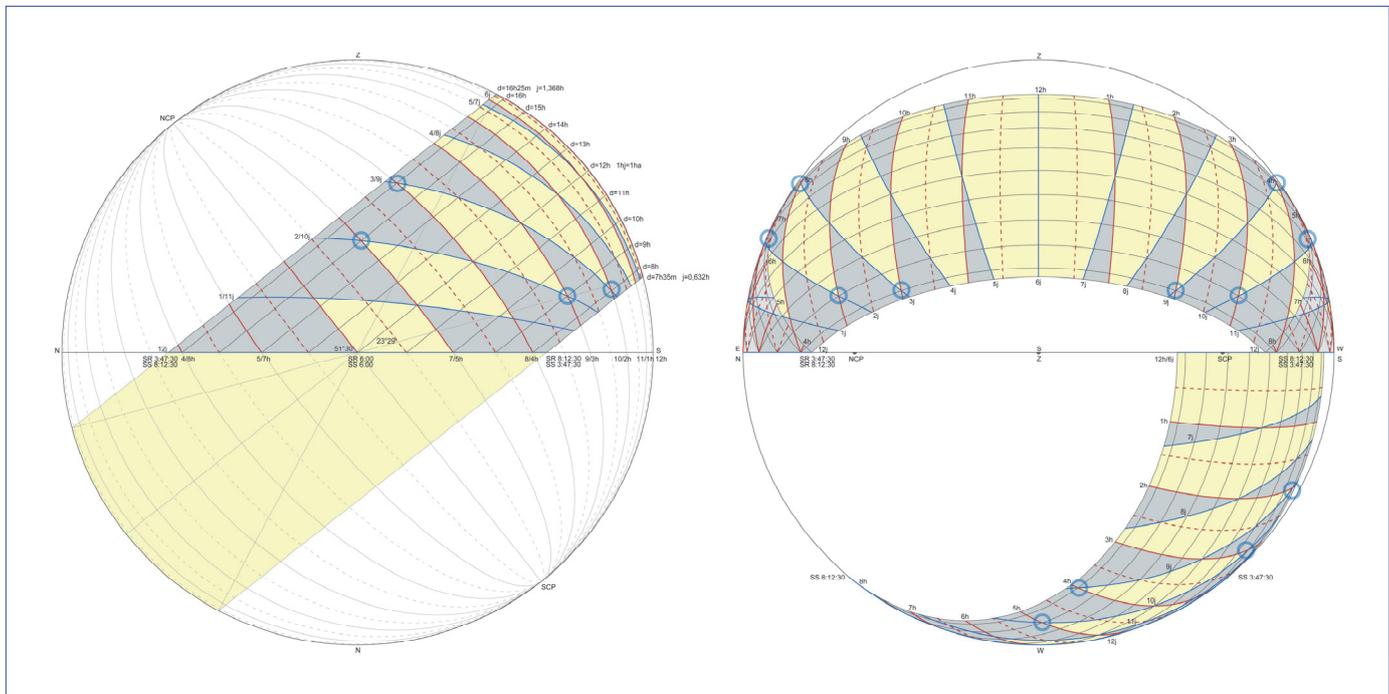


Fig. 9. Side and top projections of the celestial sphere, representing the relationships between astronomical (red) and Jewish hours (blue), drawn for the latitude of 51.50° and obliquity of the ecliptic of 23.485° . The Sun's paths are drawn for the solstices and days with whole numbers of daylight hours, corresponding to the declination arcs engraved on the sundial. Notice the changing time intervals (grey) between corresponding astronomical and Jewish hours, which grow towards the solstices and daily towards sunrise/sunset. The numbering of the astronomical hours on the sundial's main chapter ring according to the Jewish system (as on the equinoctial days) was helpful in determining these differences in the most straightforward way.

Actually, many dials manufactured in the 18th century and later do not meet this level of precision.

In order to verify the quality of the delineation of declination arcs and that of the Jewish hour-lines, they were copied onto transparent foil and scanned. The reference drawing was prepared using traditional graphical methods in CAD software. This time-consuming, yet enjoyable and rewarding exercise produced azimuth and altitude angles for every 30-minute interval for each declination arc. This was then used to prepare a reference layout (Fig. 8) for the dial and for projections of the celestial sphere that demonstrate the relationship between the astronomical and Jewish time measuring systems (Fig. 9).

The reference latitude was set at $51^\circ 30'$ and obliquity of the ecliptic at the contemporary value of 23.485° . The superimposed grids are shown in Fig. 8, with the actual dial delineation in black and the reference shown with red, dashed lines.

Both grids match surprisingly well. The only delineation errors are those of the peripheral curvature of the hyperbola for the day-length of 10 hours ($d = 10h$) and an obvious displacement of the curve for a day-length of 8 hours. Another very interesting error is in the delineation of the Jewish hour-lines. At the equinoxes, Jewish hourlines obviously cross with all astronomical hours (Fig. 9), but also in other parts of the year there are specific occasions when they are crossed on the dial by both astronomical hour-lines and declination curves for a certain number of daylight

hours. Consider a day of the year with 15 hours of daylight and hours 7am or 5pm (I and XI on the dial). A single Jewish hour on that day lasts 15/12h or 1.25 of an astronomical hour, thus with the sun rising at 4:30am, 7am corresponds to the second Jewish hour of that day, and 5pm, being twelve and a half hours after sunrise, to the tenth Jewish hour. These points are marked in the Figs 8 & 9 with blue circles.

Jewish hour-lines were drawn last and as a result the maker had to struggle to adjust them slightly to the precisely-drawn astronomical hours and hyperbolic grid, which already had some delineation errors. If the sequence of operations was different, Jole would easily have noticed that the curve for the day with 8-daylight hours should have been shifted southwards to coincide with the crossing of the VIII (2pm) and 9th Jewish hour-lines!

Despite the above, one must admit that the hyperbolic grid is delineated with high precision – unmatched by the dials of Isaack Symmes some seven decades earlier and thoroughly examined in an earlier *Bulletin*.¹⁰ Also, many dials of the later centuries failed to reach Jole's standard of delineation. Its quality reflects the individual character of the maker as well as developments that took place in 17th century London dialling – improved craftsmanship that naturally followed scholarly studies and many publications on practical gnomonics.

Interestingly, Jole's precision was likely learnt from his master Hilkiah Bedford, who was a Quaker and meticulous

maker. Bedford's reputation reflects the fact that, despite holding formally a secondary position as a 'Brother' in the Clockmaker's Company, only a year after his admission to the Guild he acquired the post as a frontrunner of the control group (holding a standard brass measuring stick) that conducted regular raids on the premises of makers and sellers in order to control standards, upholding the precision and quality of the instruments as well as collecting unpaid dues for the Guild.¹⁴ All inappropriate instruments were confiscated or defaced. In the records of the Company, we find that even Jole himself had two defective rules seized – though in his own defence he affirmed that those were made by other makers: William Elmes or Joseph Wells!¹⁵

Halachic Sundial

The rarity of English dials with Jewish hours indicates that its furniture was not simply a pattern copied from other sundials, as could have been with continental dials of the period. Rather, it was a custom-made instrument, responding to the individual needs and requirements of a specific Jewish client. This is further supported by the main (astronomical time) chapter ring which has hour numerals uniquely labelled in a way that matches the Jewish time system on the equinoxes – the two days of the year on which the two hour systems coincide.

Halacha, the collective body of Jewish religious laws based on the Torah, regulates the rhythm of daytime prayers according to the system of unequal (Jewish) hours – where the length of an hour is dependent on the season.¹⁶ The halachic day consists of 12 hours of daylight and 12 hours of nighttime, with noon always at the end of 6th hour of the day. At the latitude of London, the length of the Jewish hour across the year varies from 38 minutes at the winter solstice to 1h 22 minutes at the summer solstice. The course of the traditional Jewish day is thus inconsistent with the one ruled by astronomical timing, and thus the times of prayers in Halacha change daily when given in astronomical time (Table 1).

<i>Shema</i>	until 3 rd hour
<i>Prayer</i>	until 4 th hour
<i>Earliest Minchah</i>	6½ hour onwards
<i>Minchah Ketana</i>	9½ hour onwards
<i>Plag HaMinchah</i>	10¾ hour

Table 1. Jewish day prayer times according to Halacha¹⁶.

This must have been of great importance to European Jews, coexisting for centuries in communities with different time traditions, and is reflected in the furniture of many preserved continental dials, having both (or more) time scales.

In England though, as a result of the Edict of Expulsion issued by King Edward I in 1290, there were no Jewish communities for centuries, apart from a small London group of Sephardic Jews recorded in 1656. It was the period of Oliver Cromwell and then the Royal restoration when

restrictions were loosened and Jews were unofficially allowed to immigrate, attracted by peace and growing trade opportunities. Despite some remaining legal restrictions, the influx of continental Jews grew from 1660 onwards as a result of many wars, hostilities, rumours and persecutions directed against them in continental Europe. By 1667, the London community had grown to at least 500.¹⁷ It is likely that the dial could have been owned by one of these early Jewish London merchants or by another member of the community.

The basic information on Jewish time was read from the shadow of the nodus, indicating Jewish hours with additional information on the number of daylight hours given by the astronomical time scale. This secondary information allowed the user to intuitively grasp approximate relationship between the Jewish and astronomical time scales, based on his practice and experience of living in a society with two time systems. It is to be noted that on continental diptych dials Jewish hours were usually similarly represented in conjunction with arcs numbered with daylight hours.

The outer time chapter ring would normally give precise information on actual astronomical time, but here the peculiar labelling of hours means that it had some other function. It seems that arithmetic, Robert Jole's predominant interest, could be the clue in understanding it. Indeed, we can interpret it as a tool for the quick and precise calculation of current time difference between systems, given in astronomical time, with reference to the noon hour (which was common for both systems).

To obtain this difference one first recorded a Jewish hour indicated by the nodus, then looked at a chapter ring to check the time interval between hour number – the same as the Jewish one – on the chapter ring and the time indication by the shadow.

For the third Jewish hour at summer solstice, marking first moment for Shema Prayer, the gnomon shadow indicated IV (actually 10am). The difference between these values gives 1, an offset of an hour between the corresponding Jewish and astronomical hours. In other words Jewish time at that moment is slow by an hour to the corresponding astronomical hour (being 10am).

At sunrise that day – the end of the 12th Jewish hour of the night and the beginning of the first hour of the day, the gnomon shadow indicates IX hour and 47 minutes (3:37am) giving a 2h 13min interval between the shadow and the XII hour on the dial, the largest time difference between the systems for a given latitude. At the moment marking earliest Minchah prayer at 6½ Jewish hour, the shadow edge points VI and 41 minutes (12:41pm) giving after subtraction an 11 minute interval, by which the Jewish system is against noon slower to the astronomical one.

Of course this could well be done without numbering astronomical hours in this odd way, but then the operation would not be as straightforward and calculating mistakes could be made as a result of comparison to a wrongly-chosen hour. It

is possible that the dial was also used to prepare some time-tables for the local needs of the Jewish society.

Conclusion

Before modernity, different timescales ruled European societies and sometimes more than one was cultivated by ethnic groups or religious communities. This at one time was a characteristic feature of our continent. Groups who interacted with other cultures and those engaged in trade learnt from childhood how to function in multiple time systems, in a similar way as modern children learn and operate languages in bi- or multilingual families. This part of our heritage was erased from the cultures by standardization of time. Preserved sundials are artifacts that document this fantastic picture of coexisting time systems and transmit this knowledge of the past into our times. This also exemplifies the idea that any progress and development, while opening new perspectives, brutally closes some chapters of culture – deeply redefining human notions of time and space in this case.

Robert Jole's sundial exemplifies the way in which early societies of London Jews coped with the task of sharing time requirements of their own culture and religion with the demands of the outside society that functioned according to astronomical time... and what smart dialling methods they employed thanks to skilled instrument maker Robert Jole.

NOTES and REFERENCES

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3. Other known apprentices include: James Brickhill, Lionel Wyth and Samuel Davis (source: Jeremy Lancelotte Evans: 'Clockmakers' Company Masters and their Apprentices', transcribed from Atkins' list of 1931, www.clockmakers.org/wp-content/uploads/2012/04/CCMASTERSFINAL.pdf)
4. Biographical entries for Hilkiyah Bedford and John England in: J. Wilson: *Biographical Index of British Sundial Makers*, BSS Monograph No. 2, (2007), pp. 15–16, 68–69. For more on Bedford see note 14; on England: J. Davis: 'Sundials at Trinity College Cambridge', *BSS Bull.*, 16(i), 7–13 (March 2004).
5. J. Davis & M. Lowne: *The Double Horizontal Dial*, BSS Monograph No. 5, British Sundial Society, (2009), p.136.
6. A complete description, background and uses of the instrument can be read in: D.J. Bryden: 'A Didactic Introduction to Arithmetic, Sir Charles Cotterell's 'Instrument for Arithmetic' of 1667' in *History of Education 2* (1973), pp 5–18, 41–2; online version available from: <http://www.tandfonline.com>.
7. National Museums Scotland, online ID: 000-100-102-717-C. The brass tool that forms a part of the set is signed: *Robert Jole att ye Crowne Nere ye new Exchange fecit*.
8. Museum of the History of Science, Oxford, inventory number 34501.
9. Webster Signature Database record on Robert Jole; see <http://historydb.adlerplanetarium.org/signatures/>
10. M. Lowne & J. Davis: 'Lines of declination and two seventeenth century dials', *BSS Bull.*, 19(iii), pp. 128–134 (September 2007). Jewish hour-lines are also represented on two English quadrants by Humphrey Cole, from the late 16th century, described in: D. Vaughan: 'A very artificial workman: the altitude sundials of Humphrey Cole', in *Making Instruments Count*, 191–200, Anderson, Bennett & Ryan (Eds), Variorum (1993).
11. P. Gouk: *The Ivory Sundials of Nuremberg 1500-1700*, Whipple Museum of the History of Science, Cambridge (1988).
12. Portable Flemish horizontal dials of Jacques De Succa, some French slate multiple dial instruments, many German wall dials, to mention just a few different groups.
13. Assuming the Sun as a geometric point, no refraction effects and contemporary value of the obliquity of the ecliptic ca. 23,485°, as most likely Jole did.
14. B. Loomes: 'Hilkiyah Bedford and a Charles II sundial', series of articles: *Collecting Antique Clocks*, www.brianloomes.com/collecting/bedfordsundial/.
15. S.E. Atkins & W.H. Overall: *Some account of the Worshipful Company of Clockmakers of the city of London*, London, (1881); open access: California Digital Library.
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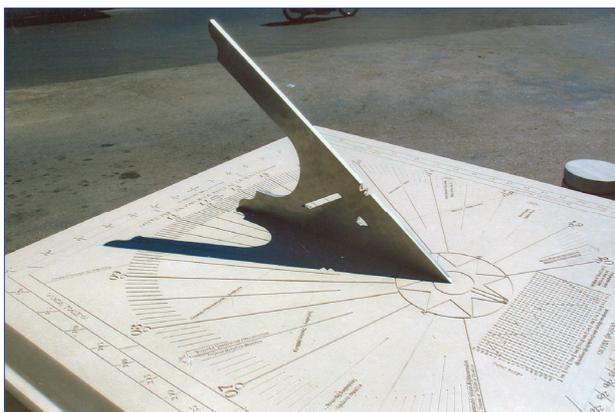
For a portrait and CV of Maciek Lose, see *BSS Bull.*, 24(i), p.7, March 2012. He can be contacted at mlose@interia.pl

Holiday Pictures

This dial is almost English in style but the low gnomon angle and Greek lettering point to its more southerly location.

It's actually in the town of Rethymnon on Crete, with a plaque giving its exact location as 35° 22' 0.87" N; 24° 28' 47.6" E. The gnomon has a W-nodus and an interesting slot whose purpose is not explained. The gentleman in the picture was a true local and was actually checking his watch by the dial!

JD



Edmund Knight

THE EATON HALL SUNDIAL PILLAR

A moving story of deviant orientation

J. MIKE SHAW

Eaton Hall, a few miles south of Chester, is the home of Gerald Cavendish Grosvenor, the 6th Duke of Westminster. It is part of an estate that extends to about 11,500 acres. The Duke allows the gardens of the Hall to be opened to the public about three times each year with the proceeds going to various charities.

Even though I live within a few miles of the Hall, I had never visited the estate until last year when we decided to take some visiting friends. On arrival, I immediately accosted a passing gardener and asked if there were any sundials within the grounds and was disappointed to be informed that there were none. We wandered through the kitchen garden and the formal gardens and eventually found a quiet, picturesque spot to stop and have the picnic that we had brought. We had hardly finished when a large black cloud appeared, then there was a loud rumble of thunder, the heavens opened and we endured a good half an hour of torrential downpour. By the time it had stopped, we were all pretty wet and decided it was time to leave. As we were wending our way towards the exit, someone pointed and said, “Isn’t that a sundial over there?” And so there was.



Fig. 1. The sundial pillar.

Sited in the middle of what was described as “the wild flower meadow” was a square, tapering stone pillar on a cruciform base topped with what appeared to be an urn complete with sundials on the east, south and west facing sides and an equation of time plate on the fourth (Fig. 1).

The position of the gnomons on the dials indicated that they were designed for a pillar declining slightly to the west of south. The equation of time chart was engraved “2 degrees 52 minutes west” which is correct for the longitude of the location. Just as we were about to leave, the sun came out briefly and “... just a minute – the pillar is the wrong way round!” Yes, the south-facing dial was facing north, the east-facing dial was facing west and the west was facing east. I felt a letter coming on.

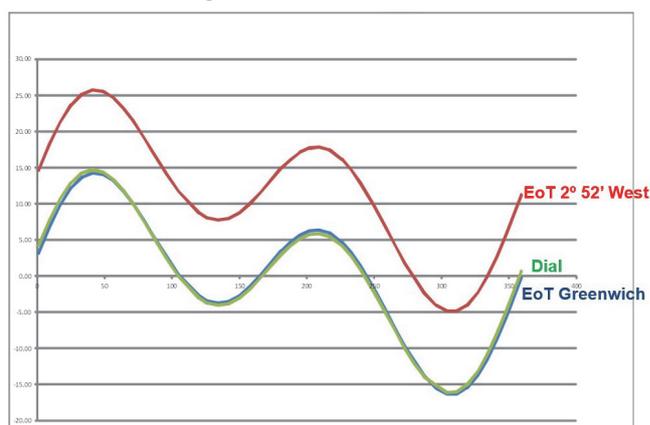


Fig. 2. Equation of Time graph.

The next day, I plotted out the figures given on the Equation of Time chart (Fig. 2). They agreed well with this year’s equation of time for Greenwich and I confidently predicted that the dials were post 1752 as they were clearly using the Gregorian calendar but pre 1880, as the plate showed local mean time rather than Greenwich mean time, which was introduced during that year. How wrong can you be!

A couple of days later, I was talking about the dials to a friend of mine who happens to be a local historian, and the following day he sent me a sketch of the dial that he had found in the archive library of the Royal Institute of British Architects (RIBA).¹ It was clearly the same pillar and had some handwritten notes on it. I contacted the RIBA and managed to get a copy of the sketch (Fig. 3) and was able to decipher the writing. It said:

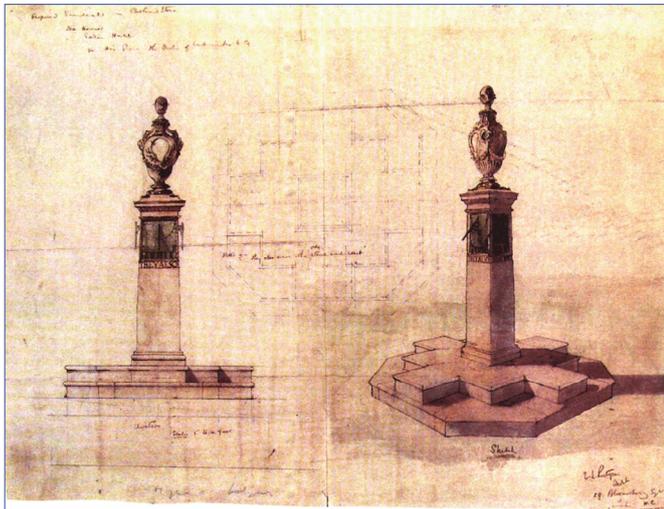


Fig. 3. Lutyens' original sketch.

*Proposed sundial in Portland Stone, Tea House, Eaton Hall.
For his Grace the Duke of Westminster KG.
Motto? They also serve who only stand and wait.*

The sketch was signed in the bottom right hand corner:

*E.L. Lutyens, Architect, 29 Bloomsbury Square,
London WC 10. 11. 98*

Edwin Landseer Lutyens was, of course, one of the leading architects of the time.

The drawing appears to be identical to the pillar except for the motto, which now reads "Horas Non Numero Nisi Serenas". The sundials themselves are also slightly different from the drawing in that the sketch shows them as being direct dials with Roman numerals.

A footnote attached to the drawing revealed that the stonework was by Farmer and Brindley. This company was active between 1821 and 1929 and were a firm of architectural sculptors and ornamentalists based in London.² An advertisement for the firm reads as follows:

*Farmer and Brindley, Sculptors and Carvers;
Contractors for every description of Marble Work;
Proprietors of the Ancient Quarries in Greece and
Egypt of Porphyry, Cipollino, Verde and Rosso;
Statuary of the Parthenon of Athens; Largest
Assortment of Stock in the Kingdom. 63 Westminster
Bridge Rd., London, S.E.*

Farmer and Brindley were one of the leading architectural sculptors of the day. Their list of commissions is impressive.³

- Architectural carving for the Albert Memorial in London, 1863–1875, for Sir George Gilbert Scott.
- Figures of Science and Fine Arts for the Holborn Viaduct, London, 1863–1869.
- Carving for the University of Glasgow, 1864–1870, also for Scott.
- 35 seven-foot figures of British monarchs for the Bradford City Hall, 1873.
- The Bishop's throne, Chester Cathedral, 1876.
- Twelve exterior statues for the 1877 Manchester Town Hall, for Alfred Waterhouse.

- Carvings for the Natural History Museum

Clearly the Duke was using the leading people of the day for this project – so who did he get to make the sundials?

I contacted John Foad, the BSS Registrar. Surely a trio of historically important dials within the grounds of a stately home must be in the Fixed Dial Register when we have been recording dials for 25 years. John said that they weren't in the Register, but he had seen a reference to them in *Landscape Gardeners at Eaton Park, Chester*, by Ian C. Laurie.⁴ This has a copy of the Lutyens sketch, together with the words:

The Dutch Garden, Eaton Park, Chester: sundial design drawings as executed by Lutyens, 1898. The sun dial has now been moved to the gardens of Ecclestone Lodge within the park.

The tea house mentioned in the sketch is part of the Dutch gardens within the grounds of Eaton Hall. For a single item of architecture in the Dutch garden, there is only one place that it could be situated, right in the middle, on the spot now occupied by a fountain and statue of Mercury (Fig. 4). This seemed odd, as that would require the sundials to decline 12° towards the east.



Fig. 4. The Dutch Garden.

Next I went to the Liverpool Central Reference Library and found a further reference to the dials in Pevsner's *The Buildings of England*⁵ which records the following:

Eaton Lodge: In the garden, a sundial by Lutyens, originally in the Dutch tea garden.

So now I had references to the dials in four different places:

- Post 1889 – The Dutch garden (declining 12° east)
- Pre 1971 – Eaton Lodge (location unknown)
- Pre 1985 – Ecclestone Lodge (declining 12° east)
- Post 1985 – Wild Flower Garden (declining 8.5° west)

The declinations were determined from Google earth. I was left with a number of conundrums:

- In its original location in the Dutch Tea Garden, the dials should decline 12° east but in its current location the dials decline 8.5° west which is correct (or would be if the pillar was the other way round).

- When the pillar was moved to its current location (post 1985), did they have new dials made and if so, by whom, and what did they do with the old ones?
- As it was erected post 1898, why is the Equation of Time chart showing local mean time and not Greenwich mean time?

In my letter to the Grosvenor Estate, I asked if I could return to have a further, more detailed, examination of the dials. My request was refused, so I returned to Eaton Hall on a subsequent open day and managed to speak with Eileen Simpson, one of the archivists, and also with Jan Lomas, the head gardener. I managed to determine the location of Eaton Lodge. It was very close to Eccleston Lodge and was originally built as a gamekeeper's cottage, but was later extended and used as the estate's Dower House. The Dower House declines the same way as the main hall and formal gardens, 8.5° towards the west.

I was also able to have a much closer examination of the dials. On each of the three dials I found a tiny maker's mark. It was very difficult to read, but I managed to borrow an eye glass from a gardener (ironically, from the one who had previously told me that there weren't any sundials within the gardens). Each dial had the inscription:

F.Barker and Son *Scientific Instrument Maker*
12 Clerkenwell Road, London EC.

The Equation of Time chart had no maker's mark, and the decorative border had a different design. I wondered if it was by a different maker.

I tried to contact Jill Wilson, the member of the BSS who keeps a record of the biographical details of sundial makers, but she was on holiday at the time. So I did a bit of digging myself and came across a 537-page book by Paul Crespel giving a comprehensive history of Francis Barker and Son together with copies of various catalogues of their instruments.⁶



Fig. 5. Francis Barker.

Francis Barker himself (Fig. 5) was apprenticed at the age of eight and learned the arts of both compass and sundial manufacture. He went on to found his own business in 1848 and ran it until his death in 1875 when the business was taken over by his son and subsequently other members of his family. Although the company name continued, there were no members of the Barker family involved in the business after 1938.

F. Barker & Son were well known makers of both compasses and sundials. They mainly manufactured unsigned sundials for retailers who then put their own marks on the dials. For example, apart from Pilkington and Gibbs' heliochronometers, they were the sole supplier of sundials to Negretti & Zambra.

I managed to track down the author, Paul Crespel who is retired and now lives on the shores of one of the Italian lakes. We had a lengthy telephone conversation, and he gave me an additional piece of information that was not in his book. The maker's mark was changed in 1907 when they dropped the 'EC' at the end following the word 'London'. This dates the dials on the pillar to between 1898 and 1907, a clear indication that the dials present today are the originals.

In their 1907 catalogue, they also show an Equation of Time (EoT) chart which is very similar in style to the one on the pillar and there is an explanation of how the owner should add the longitude correction to the figure given on the chart. So, as late as 1907, they were not including a longitude correction. The wording in the catalogue is also very similar to that on the pillar chart. I concluded that the EoT chart on the pillar is also an original by F. Barker and Son. I suspect that EoT charts were made by an apprentice to build up stock when business was slack, all to the same design, but leaving a space for the longitude to be added later when the location became known.

F. Barker & Son liked to determine the declination of the site themselves. In their catalogue, there is a paragraph that states:

Before constructing a vertical dial it is necessary for the maker to know the declination or true aspect of the wall, expressed in degrees, in addition to the latitude of the place. These figures must be absolutely correct for the whole accuracy of the dial depends upon the figure given. The makers prefer to ascertain the declination themselves, for they alone then hold themselves responsible for the dial to show the correct solar time.

These were professional dial makers and installers – they would not have got the pillar declination wrong.

I managed, via another friend who happens to be chairman of the Wirral Post Card Club, to find an old post card showing the dial (Fig. 6). The card was produced in the early 1900s and bears a postmark dated December 1918. In this picture, the dial is clearly not in any of the locations previously mentioned. It is actually shown as being on the edge of the lake directly in line with the front of the Hall.



Fig. 6. The sundial by the lake – 1918.

The Hall at the time was the so-called Waterhouse Hall which was present on site from 1870 until 1961. There was a wide pathway in terraces which went down from the front of the Hall right down to the shore of the lake. In that position it would be correctly orientated at 8.5° towards the west.

I now had five possible locations for the dials:

- The Dutch Garden (12° east)
- Eccleston Lodge (12° east)
- The Lake (8.5° west)
- Eaton Lodge (8.5° west)
- Wild flower meadow (8.5° west)

I informed the Estate of my findings to date and was kindly invited back to the estate and given access to various relevant archives by Louise Martin and Eileen Simpson, the archivists. We were, together, able to piece together the history of the sundial pillar.

When the Waterhouse Hall was demolished between the years 1961 and 1963, the family lived elsewhere until the new hall was completed in 1972. During this intervening period, not only was the new Hall under construction, but there was also major reconstruction work carried out on the layout of the gardens. This required the removal of much of the garden ornamentation.

We discovered an archive document, dated 1968 which detailed the location of the removed items: “The Whereabouts of Statues, Vases etc. Removed from Eaton Gardens”. One of the items listed states: “1 Very fine Sun Dial from the centre of the balustrade by the Lake. To Eaton Lodge”.

So finally, we had a definitive record that the sundial pillar has been located in three of the five possible locations:

- By the lake
- At Eaton Lodge
- Within the Wild Flower Meadow

At that time, 1968, Eaton Lodge was being used as the Dower House, occupied by Anne, the fourth wife of the second Duke. The Duke married Anne Sullivan in 1947, who was 37 years his junior. They attended the coronation

together in June 1953 but the Duke died the following month. Anne then occupied the Dower House for the next 50 years until her death on 31 July 2003. A further Estate record shows that the pillar was moved from Eaton Lodge to its current location in 2004, the following year.

At this point, I was still concerned that I had not been able to find any other photos of the dial in position, despite it apparently being there for about 70 years. So I went back to the Wirral Post Card Club, informed them of my findings to date and made an appeal for any further evidence that they might have.



Fig. 7. The Waterhouse Hall – 1930.

One of their members found for me another post card dated in the 1930s showing the sundial pillar in place, by the lake balustrade directly in front of the Waterhouse Hall (Fig. 7). There are very few early post cards of Eaton Hall because it was not open to the public. However, in the 1930s, the Duke invited Walter Scott, a leading post card publisher, to the Estate and he produced, for the Duke, albums containing post card sets that the Duke presented, as gifts, to his guests. We have definitive records that show that the sundial pillar was by the lake from the early 1900s until 1968, at Eaton Lodge until 2004 and in the wild flower meadow until the present.

I conclude that the books are wrong – the sundial pillar was never in the Dutch Garden which declines towards the east. Authors have taken the wording from the Lutyens sketch and presumed that it was originally installed there. I also suspect that when Laurie stated that it was located at Eccleston Lodge, he should have said near to the Lodge when it was in the grounds of the nearby Eaton Lodge.

The 1st Duke had the sundial pillar designed by Lutyens in 1898, but he died in 1899, probably before the Farmer and

Brindley stonework was delivered to the site. The 2nd Duke then decided to have it installed in the centre of the balustrade by the lake and it was there that F. Barker & Son determined its declination.

The design by Lutyens, stonework by Farmer & Brindley and dials by Barker & Son were all undertaken by the leading exponents of the day and are, therefore, of historical importance.

Sadly, despite my best efforts, the pillar remains incorrectly orientated.

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ACKNOWLEDGEMENTS

Original Lutyens sundial pillar sketch reproduced with the permission of the Royal Institute of British Architects Library Drawings Collection. Photo of Francis Barker and quotes from 'The Story of Francis Barker & Son, Compass and Scientific Instrument Makers' by Paul Crespel included with kind permission of the author. Two post card reproductions were reproduced courtesy of the Wirral Post Card Club.

J. Mike Shaw is a retired Industrial Chemist who got hooked on sundials in 1995 after reading Chris Daniel's Shire book. He has attended every conference since then and has been the editor of the BSS Newsletter since 2002. Outside of the BSS he is secretary of his local Rotary Club and is an ambassador for the ShelterBox charity. He can be contacted at jmikeshaw@ntlworld.com.

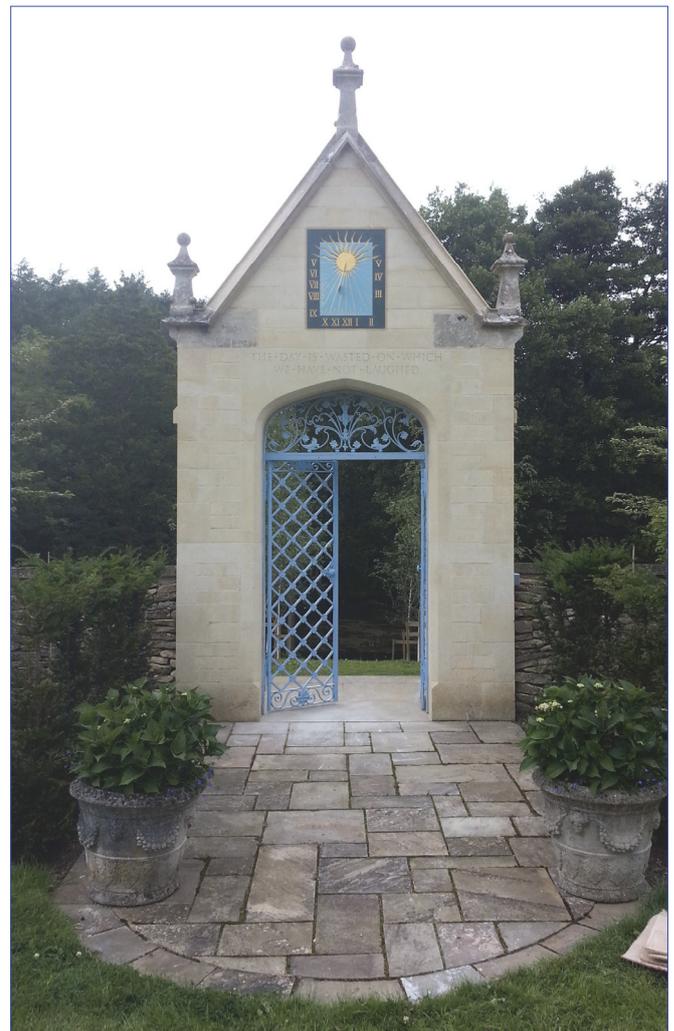


NEW DIALS (2)

Gateway Sundial

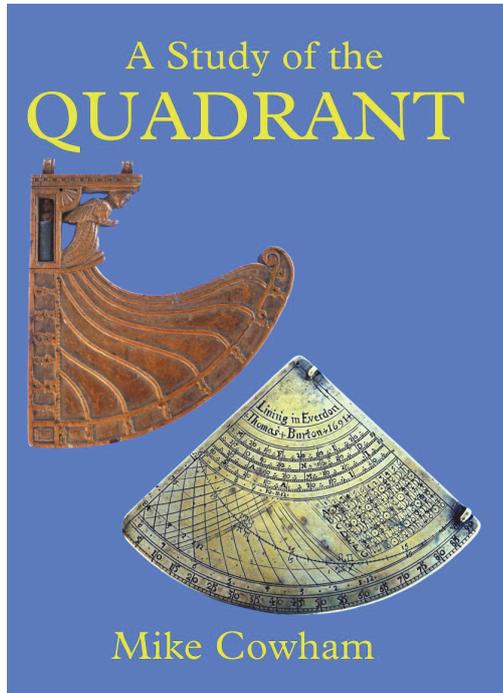
This vertical declining dial in Gloucestershire is based on one on a 17th-century manor house elsewhere in the county. The gateway, designed for the client by the architect Toby Falconer of John Falconer Associates, had an alignment of 17° 59' E of due south, as taken from the alignment of other buildings on site viewed on an OS map (with due allowance for grid north) and checked with GoogleEarth. It was designed and made in the workshop of Judith Verity from green Westmoreland slate with incised lines and numerals gilded with 23½ carat gold. The light blue region, designed to produce a good contrast for the shadow, is an enamel paint and the gnomon is from 3 mm brass plate.

www.judithverity.com



BOOK REVIEW

A Study of the Quadrant by Mike Cowham. ISBN 978-0-9551155-5-4. A4 soft covers. vi + 66pp. 68 colour photographs plus 71 diagrams. CD-ROM. Cambridge 2014. Obtainable from BSS Sales, price £12 + p&p.



Any diallist who regards the quadrant as just another altitude dial will find this monograph a revelation. We learn that there are many types of quadrant, most of which can tell us the time in equal or unequal hours though timekeeping may not always be their main function. Other designs have been developed for the purpose of setting out hour-angle dials while another variety is concerned with the solution of trigonometrical problems. The author does not claim to have covered the subject exhaustively, to have described every design of quadrant, or even worked out all the possible functions of some of them. He believes that there may be other types yet to be discovered and hopes that his work will enable them to be brought to light.

Nevertheless, he has described almost 50 different quadrants, many of them from private collections. His explanations of their construction and use are a model of clarity. Sometimes these are necessarily very long as for example those which explain some of the uses of the Panorganon. There is no ambiguity and the reader, taking the directions stage by stage, should be able to reach the end without confusion. It is hard to imagine better wording for these descriptions than that used by the author.

There are photographs of the quadrants described, and though these are of good quality they can only display the

present appearance of a quadrant which has become discoloured or damaged during the centuries since it was made. They are interesting to look at but not always easy to decipher. To remedy this, the author has provided clear diagrams which show the details of the scales and other lines much more plainly and make the written descriptions even easier to follow.

The versatility of quadrants is surprising though not all the things they can do are of direct interest to diallists even though they may still be fascinated by them. We may not be very concerned about measuring the height of a building, or determining our latitude and there are better ways of finding sines and tangents than by using a quadrant. This still leaves plenty of material for anyone interested in gnomonics. Apart from telling us the solar time, in equal or unequal hours, quadrants can determine the Sun's azimuth and times of sunrise and sunset. Though it is possible to design hour-angle dials using certain types of quadrant, the method described by Samuel Foster using the instrument he devised makes one think that there must be easier ways. Some quadrants incorporate a nocturnal (a planispheric one which is likely to be even less accurate than the usual variety), while others provide tables which inform us about the lunar cycle.

For those who are daunted by the often complex operations associated with quadrants there is still much in this monograph which will be of interest. The history and dating of the instruments, the huge variety of incidental information they incorporate, and the appendages they accrue are just a few of these. Apart from the frequently occurring shadow square there are perpetual calendars, devices for finding Easter, conversion tables between the Zodiac and the Calendar (Julian or Gregorian) and astrology creeps in from time to time. Scattered through the text there are interesting details about the inventors of the instruments, the errors they sometimes made and references to books they wrote.

The CD-ROM which is to be found inside the back cover has 48 quadrant diagrams in both TIFF and JPEG formats which can be printed out on card enabling the reader to create his chosen instrument. Two pages are devoted to practical advice about their construction.

'A Study of the Quadrant' is a work of painstaking thoroughness characteristic of its author. Those who have read any of his previous books and monographs would not expect otherwise and will need little persuasion to add this one to their libraries. To the few who have not I would highly recommend it.

John Lester

A CALENDAR DIAL FOR INSTALLATION ON THE MOON

ALLAN MILLS

The sundial in its various forms has a long history on Earth, but there is no reason why appropriate versions should not be used on other celestial bodies illuminated by the Sun. Several *moon dials* are known, but these are all installed in terrestrial locations and intended to give an approximate indication of the time at night when viewed by the light of a nearly-full Moon.

There has been considerable talk (mostly by politicians) of the possibility of establishing a manned base on the Moon, and it appears quite likely that such an undertaking will be attempted before the halfway point of the present century. Whether it is scientifically justifiable is another matter, for the capability of remotely controlled devices is increasing all the time, and these do not have to be returned to Earth when their mission has been completed. A manned mission to Mars is more justifiable, but only after the possible occurrence of indigenous microbial life at depth in the Martian regolith has been thoroughly investigated by sterilised remotely-controlled roving vehicles. Man always introduces his own bacteria wherever he goes! An example is the report of *Streptococcus mitis* (a common and harmless skin organism) cultured from spores within foam packing in Surveyor 3, which therefore appear to have survived for nearly three years under lunar conditions.¹

A Dial on the Moon

A Martian sundial has already been taken to that planet mounted upon a roving vehicle.² There is no reason why the design of a dial for the Moon should not be undertaken as an intellectual exercise, and it would seem preferable to envisage it as a fixed installation on the lunar surface. Indeed – as will be seen – such a study can draw attention to matters that have previously been overlooked. An initial requirement for any such undertaking is a comprehensive study of the relevant characteristics of the lunar orbit.

The Appearance of the Moon from Earth

The Moon is the only natural satellite of the Earth, and its motion has been studied for centuries. However, it is much the smallest body in the trio Sun-Earth-Moon, and as such is subject to perturbations that seriously disturb its long-term regularity in orbit. It rotates in synchronous lock with the Earth (probably due to an Earth-facing bulge in the lunar mantle) so always presents the same face to terrestrial observers. We are therefore unable to see the far side, and tend to refer to it as the dark side of the Moon. This is incorrect: it is in brilliant sunlight for half of every month. Also, the Moon does rotate on its axis with respect to the Sun and stars – see Fig. 1.

Phases of the Moon and Earth

As it moves with the Earth around the Sun, the varying direction of solar illumination gives rise to the phases of the Moon characterised as new, waxing, full and waning crescents. (Fig. 1). Viewed from the Moon, the Earth would present the complementary phase, but as its rotation is not in synchronous lock with the Moon the appearance of the continents and oceans within the illuminated portion (be it crescent, gibbous, etc.) will vary perceptibly from hour to hour. The synchronous lock will, however, cause the Earth to appear approximately fixed in the lunar sky above a point on the horizon at a given Earth-facing site, but the Sun and stars will slowly drift past it.

The full Earth viewed from the Moon would appear to subtend about 1.8° , $3.7\times$ the apparent diameter of the Sun (0.5°). Therefore, although it could at times obscure the latter to give a total eclipse, it could never produce the ‘all round’ view of the solar corona that we enjoy. Moving away from concentricity would expose a portion of the corona, but the Earth’s atmosphere would slightly blur the hard, sharp edge that the Moon presents to terrestrial observers.

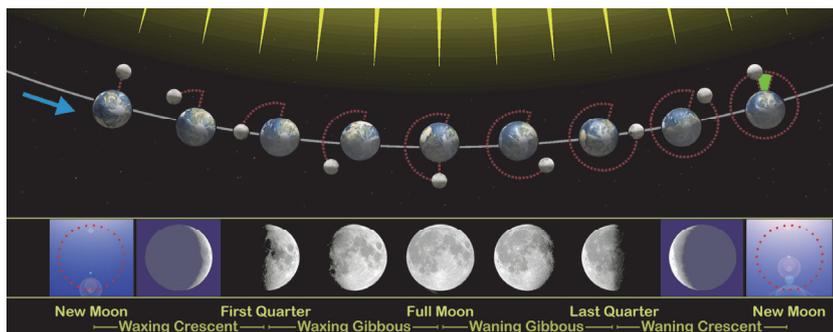


Fig. 1. Phases of the Moon (courtesy of Wikipedia). The phase of the Earth when viewed from the Moon is the opposite, being 180° away.

In the past, our calendars commonly attempted to utilise the varying appearance of the Moon to subdivide the year (the orbital period of the Earth around the Sun from a given fixed point such as the Winter Solstice) into shorter and more convenient ‘moonths’ by taking note of the period between successive New Moons. Unfortunately, the incommensurability of the various orbital periods has always led to trouble. The ‘day’ is the period originally from noon to noon, but now defined as midnight to midnight to avoid an awkward change in day-name. Normally divided into 24 equal hours, it is essentially fixed over human timescales. Using this unit, the orbital year is approximately $365\frac{1}{4}$ days, and the lunar month averages about $29\frac{1}{2}$ days. ‘Leap years’ are required for our calendar to cope with these inequalities. The ‘week’ – originally a convenient market interval – is now defined as 7 days, running sequentially from Sunday midnight to the next Sunday midnight. Unlike date-numbers, this day-name sequence is always maintained.

In practice, we nowadays accept the date and month as marked out in official publications and diaries, and rarely look at the Moon at all! I am sure that both calendar and ‘clock time’ on a lunar station would in practice be controlled from Earth.

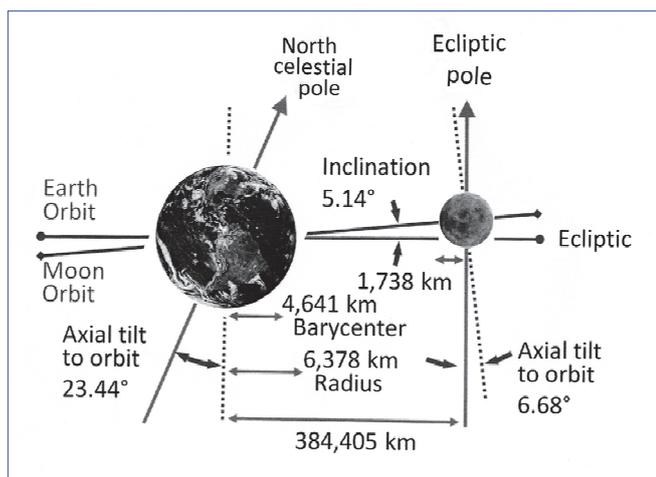


Fig. 2. Orbital characteristics of the Moon (courtesy of Wikipedia).

Orbital Characteristics of the Moon³

These are shown in Fig. 2. All are means, and the variations about the mean can be considerable.

The sidereal rotation period of the Moon is that with respect to the stars, and is 27.3 days. However, with respect to observers on the Earth/Moon system, the Earth will have moved a little further around its orbit, and more time will be required to ‘catch up’. This ‘synodic period’ is 29.5 days, and constitutes our nominal month.

Setting a Terrestrial Dial

The gnomon of a terrestrial sundial must be set parallel to the rotation axis of the Earth, and so point at the appropriate celestial pole. The usual method of achieving this is first to determine the meridian by the ‘Indian circle’ method, utilis-

ing a set of circles drawn around a vertical post.⁴ The altitude of the celestial pole is then set by means of the relationship:

$$\text{Altitude of the pole} = \text{Latitude of the observer}$$

The latitude of a site is nowadays normally available to anyone in the developed world by reference to a map, so a cardboard template cut to this angle is simply set with its base along the meridian.

The distances involved are so great that this axis is virtually co-axial with the Earth’s spin axis, and so the Sun appears to turn about it in the course of the day.

Setting a Lunar Dial

The same principle applies to a dial on any other rotating celestial body. Fig. 1 illustrates the fact that the Moon orbits close to the ecliptic plane, with the poles of its axis therefore close to the ecliptic poles. (The latter are at 90° to the plane of the ecliptic.) This behaviour is quantified in Fig. 2, where it is shown that:

- Earth and Moon really rotate about their centre of mass or *barycentre*. However, as this falls well within the mantle of the Earth, it is usual to say that the Moon orbits the Earth.
- The inclination of the Moon’s spin axis to the ecliptic is actually 1.6°. This would indicate that the poles of this axis are displaced 1.6° from the ecliptic poles. However, they precess about the latter in a period of 18.6 years,⁵ so any listing of exact celestial coordinates would have to include the date. I have not succeeded in locating any such tabulation, so it would appear best to initially attempt to set the gnomon of the hypothetical lunar dial upon the appropriate ecliptic pole, and then perhaps refine it by trial-and-error. I would be content if the time indicated by a lunar dial never departed by more than 2 hours from the time transmitted from Earth.

Setting a Lunar Dial on the Northern Ecliptic Pole

During the lunar day, by the ‘Indian circle’ method

On the Moon, the much slower apparent motion of the Sun would necessitate days rather than hours between observations of the shadow on the circle, so there would perhaps be a case for correcting these for the Sun’s small change in declination.⁶ A variation in position of the meridian due to the 18.6 year precessional period should be apparent after a year or two. The co-ordinates of the lunar base would necessarily be known to a high degree of precision to allow space navigation, so cutting an altitude template should present no difficulty. However, the co-ordinate system on which these figures are based must be checked, and if necessary transformed to ecliptic co-ordinates.

During the lunar night

The ecliptic poles fall on a circle $23\frac{1}{2}^\circ$ distant from the celestial poles. The co-ordinates of the northern ecliptic

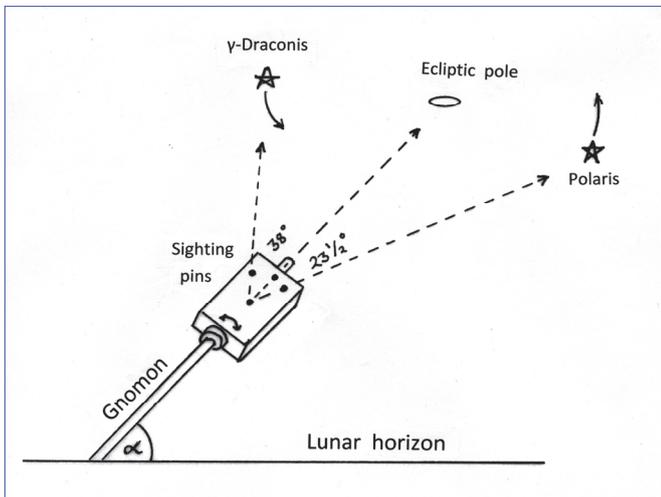


Fig. 3. Orientation of the gnomon of a sundial installed on the Moon. Angle α represents the altitude of the ecliptic pole at the given site.

pole are RA 18h 0m and Dec +66.5°, and a star map will show it falling close to an imaginary line joining Polaris with the star γ -Draconis. It should therefore be possible to approximately set a gnomon at an angle to suit the chosen landing site by the use of a simple gauge block, pivoting on a rod driven into the regolith at such an angle that Polaris and γ -Draconis remain visible across the pin-sights on the appropriately turned block as they rotate about the ecliptic pole during the course of a month (Fig. 3). The gnomon of the dial would be arranged parallel to this rod.

The Sun will move across the lunar sky, and round the above gnomon, in one half of the lunar synodic period of 29½ days. A convenient approximation (used on many lunar dials on Earth) is 15 days. It will then fall below the lunar horizon for the next 15 days, leaving the bright Earth, in phase, in the starlit sky. This would be the best time to adjust the gnomon of the lunar dial.

In view of its greater surface area and albedo, I think it would be possible to see the shadow of a gnomon upon a scale drawn on a white surface, but as Earth hardly moves this does not provide a means of time-telling during the long lunar night.

A Possible Site for a Manned Lunar Station and Dial

To design a lunar dial we must know its intended site of installation in terms of lunar latitude and longitude. Assuming it would be close to a manned lunar station, the necessity of line-of-sight radio communication between Earth and Moon means a closely-defined site on the Earth-facing hemisphere of the Moon. (There is no ionosphere on the Moon, and communication with astronauts venturing over the horizon would also have to be via Earth or orbiting lunar satellites.) Psychologically, it would also appear important to have the Earth visible, at varying phase, whenever possible.

A fairly smooth surface surveyed on previous missions would be best for a controlled descent, and the site of the

Apollo 17 landing at 20.2° N, 30.8° E in the Taurus-Littrow Valley might well be considered. This was the final landing in the Apollo series, occurring on 11 December 1972. However, it must be noted that the given lunar latitude and longitude coordinates are based on the system used on Earth, and the North pole is not the ecliptic pole.

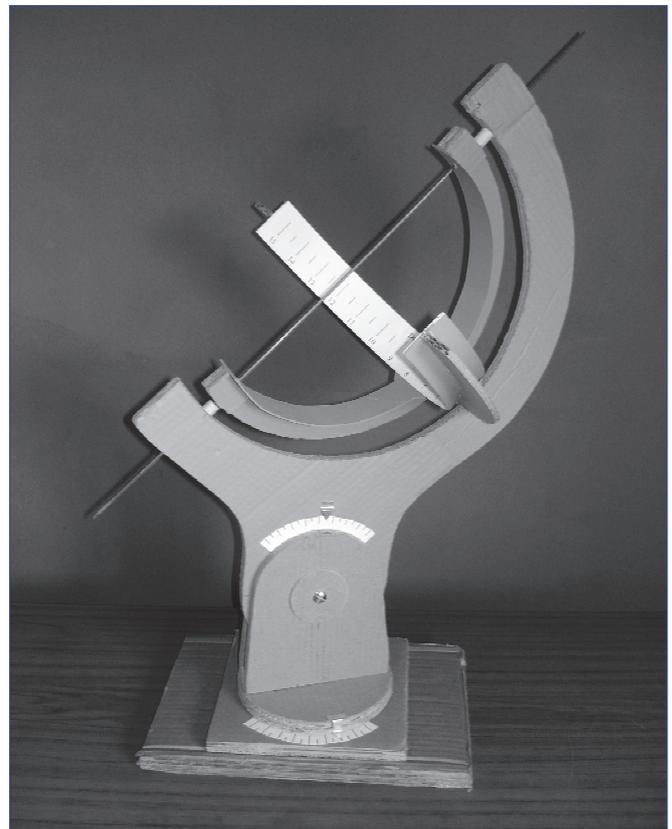


Fig. 4. A calendar dial proposed for installation on the Moon.

Design of a Lunar Dial

We have seen that the Sun will appear to rotate around the gnomon from horizon to horizon (180°) in approximately 15 days, equivalent to 12° per day. A convenient scale of 1° equal to 0.1 inches gives the day as represented by 1.2 inches: rather too small for hour markings. A calendar dial marking the days and half-days would be more practical. The range of 15 days would occupy a scale 18 inches long upon a semicircle 11.5 inches in diameter. This appears a reasonable size for both visibility through a spacesuit helmet and construction from thick cardboard, with a supporting structure cut from the type of 1- or 2-ply corrugated fibreboard used for large boxes. Any inhabited base on the Moon would presumably have to be supplied with dehydrated foodstuffs stored outside in lightweight boxes of this nature. The strength and stability of this board and its adhesive under the lunar 'freeze-drying' conditions would therefore need to be tested under long-term conditions, apart from any application as a constructional material. The cost per kilogram of carrying anything to the Moon would preclude taking any prefabricated dial, or sheets of constructional materials.

Dial Markings

A most important factor to be considered in any lunar excursion outside the habitable base would be the duration of sunlight before the Sun sets. It would therefore appear appropriate to calibrate the scale of the lunar dial in whole (terrestrial) days numbered 15–0, with the midpoint 7.5 marking the solar culmination. It might be labelled ‘Days of sunlight remaining’. This is a timescale with which evolution and experience has made us familiar.

It has been explained that a readily-adjustable dial appears essential, and this need is best met by some form of equatorial design. Figure 4 shows an instrument made from cardboard and corrugated fibreboard, with the scale suspended from the gnomon in such a way that it may be rotated to adjust the scale markings. There is no weather on the Moon, so this is not simply a prototype – it is tentatively put forward as representing a practical lunar calendar dial!

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ACKNOWLEDGEMENTS

I should like to thank the Editor and referees for their time, trouble and expertise in improving this paper.

For a portrait and CV of the author, see *Bulletin* 23(ii), June 2011. He can be contacted at allanmills1@hotmail.co.uk.

A VARI-PURPOSE VERTICAL SUNDIAL

JOHN MOIR

For many years, this elegant watering-can (Fig. 1) has hung from a peg on the south-facing (within 1°) wall of my London home, handy for the water tap and patio plants beneath it. Recently, something about the configuration of its long spout suggested to me that it might have gnomonic possibilities. Intrigued, I set about measuring the angle between the spout and base. Amazingly, this turned out to be within half a degree of the co-latitude of my house. All that was needed would be to replace the wall-peg with a cradle or clasp which would support the can in the required orientation for a sundial. It would then be a simple matter to return the can to its dialling duty after each watering session.

Finally, hour lines and numbers could be painted on the wall to complete the sundial (Fig. 2). The 6 o’clock hour lines have not been shown as around these times the merg-

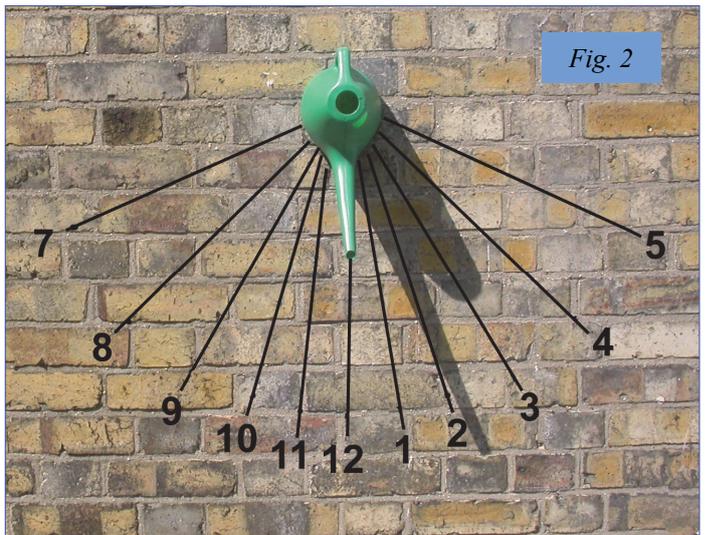


Fig. 2



Fig. 1

ing of the can’s body and spout shadows makes reading the time difficult.

In its sundial alignment, it will be noticed that the can now strongly resembles a nesting box, with the added unique feature of a drainage pipe. It may therefore be expected that sooner or later a passing house-sparrow may spot its nesting potential and move in. Should this happen, an alternative means of watering will have to be found until such time as the tenants’ offspring have fledged.

Having amused myself with this small project, I wonder if other readers have been involved with or come across any similar vari-purpose sundial.

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BSS 25th Anniversary Conference, Greenwich

25–27 April, 2014

Jim Holland

Keen anticipation for this milestone conference built upon the superb BSS conference last year in Edinburgh and the Newbury one day meeting in September, 2013. This historic city of Greenwich includes the Royal Observatory with its notable sundials in addition to horological treasures and the Time Ball. The meetings were held in King William Lecture Theatre in the University of Greenwich that occupies the Old Royal Naval College adjacent to the RGO grounds.



Friday 25 April

After the AGM formalities. Chris Lusby-Taylor chaired presentation of papers.

BSS Chairman Frank King: *Extreme Ring Dials or Diamonds are a Girl's Best Friend*

Frank took us from the humble construction of extreme ring dials made from the cylinders of F&M biscuit tins or a locomotive boiler to the other extreme of platinum ring dials with inlaid emeralds or diamonds that he was commissioned to design. These Arabian Nights fantasies were commissioned by the princess of an oil-producing state as gifts for her dinner guests. Elegantly designed and constructed, may we expect that one will some day be exhibited at the British Museum? It has an 'aperture gnomon' that serves as a cursor. Back at the other end of the scale, Frank concluded by showing how a playground could serve the same function as a ring dial.

At the coffee break, we viewed entries in the Cake Competition to vote on our favourite. Five cakes baked and ingen-



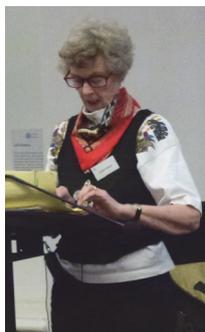
iously decorated as sundials were on display. Every one was a visual treat and tasty delight as well during the next

morning tea-time. A video of the ceremony will appear on the BSS website. The winner, announced at the Gala dinner was Ian Maddocks, with Tony Moss and David Brown joint second.

Jackie Holland: *North American Indian Sundials*

Jackie first pointed out that the title is

a myth. These Indians had no concept of hourly time nor even had a word for 'late', so they had no use for sundials. Her theme was the Pierre LeMaire pocket dials made in Paris mid 18th century for French Government explorers/missionaries/fur traders to use in North America. They were inscribed on the back with names of settlements, trading posts and Indian tribes with their approximate latitude locations. Only four LeMaire dials so inscribed are known, including one that Jackie examined at the Neville Museum in Green Bay, Wisconsin that was unearthed in 1902 near the Green Bay of Lake Michigan. The French sought fur pelts, especially beaver, to make fashionable hats for Europeans. In exchange the American Indians wanted anything made of metal: pots, pans, knives, guns, etc. Also desired were woven wool blankets that were much warmer than deer skins or their woven



mats of heavy grasses. The French left their names on many North American settlements that grew into such cities as Montreal, Quebec, Detroit, St. Louis, New Orleans, etc. More LeMaire pocket dials so inscribed are sought.



Woody Sullivan: *Four New Public Sundials in the USA*

It is fitting that a radio-astronomer is a skilled designer of sundials. Woody

showed four dials that he designed:

- on a Seattle school: it has blue hour lines on the red brick school wall. Stainless steel marker balls are placed at 08:30 and at 3:00 pm to show the start and end of the school day.
- another is a scaphe dial with a movable oculus at the Exploratorium Museum in San Francisco. He took inspiration from a similar dial made at Ephesus about 200 AD.
- another is a group of solar hour benches for San Francisco, showing time from 10 am to 3 pm, similar to an analemmatic dial layout.
- the fourth is the Jansky Very Large Array Radio Sundial in St Augustine, New Mexico. This is a large field of radio source discs that capture radio-frequencies from distant solar sources to find sidereal time. The radio-physics that are applied were developed by Sir Martin Ryle and Ron Bracewell. A large horizontal dial made using this information was named the Ron Bracewell Radio Sundial.

Kevin Karney: *Amazing Australian Sundials*



Surely Kevin was not amazed to find that "the dials all go backwards". He found that it is proper for a big brush country to have

bold, often very large and blocky dials. Many forgeries of British dials are found there. At the Questacon Tech Centre are found ingeniously contorted rods whose clearly focussed shadow will clearly show the Arabic numeral for that hour only.

Many dials are made with embossed numerals because some birds there leave droppings that erode and blur the engraving. The largest 'sundial' in the world is at Mount Gnomon Farm in Tasmania where the adjacent tall mountain casts predictable shadows.

Kevin concluded with Groucho Marx's observation that: "Time flies like an arrow, but fruit flies like a banana". Not recorded by Mrs Gatty but begging to be inscribed on a stained glass dial most suitable for a genetics laboratory?

Helmut Sonderegger: A Hartmann Dial Admired by Rheticus

[See the article on p. 40] Helmut reviewed the Ptolemeic view of astronomy, having the Earth



the centre of the known universe. A rich cast of characters in this Golden Age of Feldkirch included George Joachim who was taught by Martin Luther and Rheticus who studied at the Nürnberg Centre for Astronomy with Georg Hartmann. Hartmann created an ivory cross dial with exquisite carving that is now in the British Museum. Good copies of it have been made, one of which was held up by Frank King for us to view. Nicolaus Copernicus transformed astronomy in the early 1500s with his sun-centric theory that encouraged further development of astrolabes and sundials. Helmut also reviewed the horologes (sundials) that Nicolaus Kratzer devised for Henry VIII. Kratzer brought astrolabes and sundials to England about 1520 and served as lecturer in astronomy at Oxford and Wittenberg. He devised a clever column dial that read Babylonian hours on the east face, Italian hours on the west and another on the south face.

Martins Gills: What We Expect From Sundials – a Story from Latvia

The oldest Latvian dial known is from the 14th or 15th century but many dials in Latvia came from Germany. Although many dials in Latvia were destroyed in WWII, Martin showed several major dials



that were successfully pieced together. Martin has made many dials for public places in Latvia including one that shows both winter and summer time.

He also showed his lovely analemmatic or 'participation sundial' as translated from Latvian. The 'participant' stands on the correct date on a large equation of time to cast his shadow on the correct time. Martin's creative designs and energetic search for innovative dials worldwide suggest that we may hope to hear more from him.

Martin Jenkins: A Mystery Sundial by Girard and Barrère

This very interesting dial was purchased by Martin at the last Newbury meeting. It is adjustable for latitude, in both hemispheres. Martin set out to learn with Conan Doyle persistence about the designer, T.H. deLange and the supplier, Girard et Barrère Paris, that now makes educational aids but there is no record of them dealing in sundials. The manufacturer, while unknown, was probably Maison du Cadran Solaire of Carcassone, no long extant. Even Anthony Turner could not trace M. deLange or the presumed manufacturer. Best estimate is that it was made between 1930–50. Its best owner may be a peripatetic diallist who roams the world seeking his shadow. Martin?



Johan Wikander: *The Norwegian Mass Dials: Were They Painted?*

Johan Wikander: The Norwegian Mass Dials: Were They Painted?



Yes, some were, but Johan projected a more fascinating story of these dials with his transparencies. The Tingvoll vertical

dial was made ca.1200 for 62° 57' with an iron style. Pitch was rubbed into the lines to make them easier to read as they were placed as high as 20 m above ground! The Bergen vertical dial made

ca.1550 was similarly executed and its photograph projected. He showed the Trondheim pocket sundial on soapstone that has an underlined 'x' at the bottom of the dial that was used in Scandinavia in the middle ages to indicate the N-S direction. Perhaps Johan can speculate that mass dials could be scratched on ice in the frozen far North? As George Higgs once remarked, "I presume that such a dial would show only temporary hours?" (George made this comment at AGM #1 after Andrew Somerville projected a photograph of himself standing proudly by a pillar dial that he had made from compacted snow.)

Jackie Jones: A Reflecting Ceiling Dial



Jackie showed us photographs of the designing and careful drawing of the lines on the ceiling of a room in her home, a two-year labour of love. Well done!

Horniman Museum and Gardens; Sundial Trail



A true London mizzle brought out the brollies as we visited this lovely site with its twelve dials, many designed and/or constructed by BSS members. David Young organised the visit and gave an introductory talk in the conservatory (above). The dials are complemented by



carefully tended vegetation to foster greater appreciation for the entire setting. The classic glass conservatory features a vertical stained glass dial delineated by David Young. In the

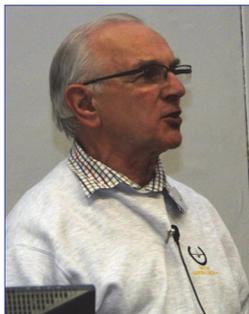


garden a horizontal dial has a filamentous butterfly wing serve as gnomon. Other delightful dials are a scaphe dial, a 'Tea-time dial' that is declining and shows only tea-time from 2:30 to 6:00pm, a Double Polar Horniman logo dial, a horizontal Spot-On dial by Piers Nicholson, an armillary octahedron constructed by Tony Moss, an equatorial dial by Silas Higgon, David Brown's Roman dial, the horizontal Horniman Dial and an attractive analemmatic dial. Inside the CUE Building library is a ceiling dial read by the reflected point of light on the ceiling where the hours are marked. Although there were no 'sunny hours' to show their function, the harmony of beautiful sundials and verdant foliage were much appreciated. The Horniman provided us with a pamphlet that is a superb guide to the features of its Sundial Trail and worth keeping.

Saturday 26 April

Mike Shaw: *Eaton Hall Sundials: a Moving Story*

[See article on p. 24]. The Duke of Westminster's estate in Cheshire is opened to charity visits three times a year. Mike thus visited the estate recently to inspect the tapering stone pillar dial (its face needs TLC) in the Wild Flower Garden. It was made some time between 1572-1880 (!) and has been sketched and pho-



tographed many times over the years. It was even featured on postcards 100 years ago, showing it placed by the river. It has been moved hither and yon on the estate, but when it was last moved about 1985 it was rotated 180 degrees! Mike noted this and offered to help realign it, but the Duchess declined to do so now, but 'when time and resources permit'. Pity. But the right time will never arrive by the dial as now oriented. Now, consider the motto originally planned for the dial: 'We also serve who only stand and wait'.

Geoff Parsons: *The Homan Helio-chronometer*

Geoff has broad experience with helio-chronometers that are 'mean-time sundials', giving the correct clock time by including the EoT in its reading. Homan devised an instrument similar to the P&G Sol

Horometer but with different marking arrangements intended to improve accuracy. He applied a different EoT correction with an analemma and the light slot of Homan. It has two screens on an equatorial dial face plane. Homan's design was sufficiently different that a patent was granted. Geoff brought a Homan for us to appreciate its elegant design.



Frank Evans: *The Trinity House Sundial, Newcastle; a Question*

Frank showed a painted dial made in honour of the Master Mariner, John Welford and dated 1721. The hour lines have been carelessly repainted over the years, as Frank showed by comparing photographs and diagrams from past years. Frank is consulting with the owners about repainting it with corrected hour lines. The dial is mounted on the Dog Bank Building on Broad Chair Road. Local lore ascribes that road name to a travelling judge's posterior physiognomy. Trinity Houses

were built near British seaports. Their master mariners had responsibility for maintaining local lights, training pilots to bring a ship into port and other maritime safety duties. Frank notes, perhaps with a touch of envy, that the master mariners, as Freeman of the City, have the right to graze their cows on the Town Moor.



David Payne: *Take 5: A Black Granite Cube Dial*

David's 'Take 5' theme is taken from a piece of jazz music that uses five

steps in making the music and that he used to make the dial. The block of black granite came from Tamil Nadu, India. Black granite has a very dense structure that defies bird droppings to stick to it, as well as being an attractive material for a dial. He used scanning and stencil application to lay out the design of its three faces. The stainless steel gnomon was cut by laser. The pedestal is a section of concrete pipe used commonly for drainage; indeed it was recovered from a ditch. The dial is the second one of a sundial trail of 15 dials that he is developing on the North Burlingham Walks in the Norfolk area. Notably, six churches in the area have scratch dials on them. We may hope to see more of his dial trail.

John Davis & Michael Lowne: *A Cambridge Astrolabe and a Kalendarium*

Subtitled 'East Anglian astronomy before the Black Death', this presentation linked a medieval astrolabe to one Walter Elveden, one of the founders of Gonville & Caius College, Cambridge and the writer of a very early 'Kalendarium' – a cross between a calendar, an almanac and an eclipse predictor. (The College also has a fine sundial on its cupola that was seen at our last Cambridge meeting.) The astrolabe, delineated for Norwich, had features which could be closely linked to building work being undertaken in the cloisters of Norwich Cathedral in 1320–23. The authors concluded "here is lot of information packed into one small brass instrument".

Martin Hogbin: *What is Time? – A Physicist's Perspective*

Martin thus challenged our perception of time: "we don't know or care". But time is central to physics and keeping time by the unstable rotation of the

earth requires adjustments along the way. This earliest way to note passage of time is now threatened. To eliminate leap seconds because computers do not like them would cause the time indicated by a sundial not to match exactly that given by International Atomic Time that the French advocate. Thus, time as calculated by Caesium-133 decay at nine billion/second just records seconds, independent of the earth's rotation. For now, Coordinated Universal Time (UTC) indicates time that is synchronised with the earth's rotation and adds leap seconds at irregular intervals as needed. And GMT now is used throughout the world. But the decision to keep leap seconds will be reconsidered by an international committee in 2015.



the US in 1883. Daylight savings time was first proposed in the US in 1909 and adopted in Britain in 1916. BBC pips were introduced in 1924 and the speaking clock in 1936 that continues now. But radio controlled clocks and watches have now become the best ready source of the correct time for the public.

Chris Daniel: *Sundials in Greenwich*

Chris presented the history of the Przykowski noon mark mean time dial that he detailed with an error correction for its reconstruction in 2012. He published a history of this dial, first made of wood and installed at the RGO in 1968 [*BSS Bull.*, 22(iv) 26-30, Dec 2010]. This is fascinating to read. In brief, the dial deteriorated to such a bad state that it was removed in 1991. Now reconstructed to its correct configuration as delineated by Chris and brilliantly executed in slate by Ben Jones, the dial is resplendent back in its original location on the south wall of the Observatory [*BSS Bull.*, 24(iv) 47-48, Dec 2012]. Ben Jones's description of the hair-raising anxieties of handling that large plate of fragile slate, both during his work on it and its installation, is unforgettable.

The exquisite Dolphin Dial that Chris designed for the Queen's Silver Jubilee commemoration in 1977 now has pride of place



in a lovely garden on the south side of the Observatory adjacent to Flamsteed House. It was modelled by sculptor Edwin Russell. There were also 25 miniature reproductions of it made soon thereafter under supervision by Mr Russell. More relevant information about Edwin Russell's dials is in Doug Bateman's article in *BSS Bull.*, 25(iv), 32-33, Dec 2013.

Another dial designed by Chris is sited by a pond at the northeast corner of the Observatory grounds. It is a large bronze 'double horizontal' [but not to Oughtred's design!] with a nine foot gnomon that indicates both local apparent time and the azimuth of the sun. I have enjoyed visiting it many times, often watching happy children cavorting on it. Chris has designed notable public dials for many sites in Britain, such as the ones that grace the Church of St Margaret, Westminster, overlooking Westminster Abbey.

For parting synapse-busters, Martin left us with the following to ponder (leaving us with more questions than answers):

- Time slows down when we move.
- Time runs at different speed at different heights.
- Time takes longer going around the world in one direction than the other.

David Le-Conte: *It's About Time: The Adoption of GMT in the 19th Century*

David reviewed the history of developing a uniform time system, forced by the railways' need for it to avoid train collisions and to set timetables for the traveller. He cited amusing examples of local town councils regulating time by their sundials that would be almost always different from Greenwich time and the legal cases that finally required GMT use throughout Great Britain. Milestones in development of improved time keeping included the Longitude Prize offered in 1714, the first 1:00pm Greenwich Time Ball drop in 1833, the appointment of innovative Astronomers Royal Pond and Airy, and the first electronic transmission of exact (Greenwich) time in Britain in 1852. Also credited for improving public knowledge of correct time were the Belvilles, mother and daughter, who daily carried accurate Greenwich time to London subscribers from 1892 into the 1930s. GMT became legal time in Britain in 1880 and in



Woody Sullivan: *An Analemma on Mars*

Woody described the Mars Rovers sent there years ago. Of the two that arrived only 'Opportunity' is still working in the harsh climate of temperature variations from zero to 100 C. Its Pancam calibration target/MarsDial carries the motto: "Two worlds, one sun". The sundial is the backup for the timepieces on board. But Mars is even more wobbly than Earth, having a variation of 'tilt' up to 20° that challenges sundial accuracy. Its analemma is a single lobe (not bi-lobed as for Earth) and shows adding or subtracting up to 50 minutes depending upon solar longitude. Mars may change its rotation as time moves on, to the point of showing a bi-lobar analemma. Perhaps we shall need to send up another dial to keep proper time for the Martians.

Kevin Karney: *The Genius of Ptolemy*

Claudius Ptolemy (ca. 90–168 AD) was a controversial Greek astronomer who lived his whole life in Alexandria as a Roman citizen. A polymath who was extraordinarily knowledgeable for his time, he mistakenly defended the geocentric theory based on the earth-centred system described by Aristotle. Despite Aristarchos's (ca. 400 BC) proposal that the sun is the centre of our universe, Ptolemy's justification for his belief was accepted until 1500 years later when Copernicus presented his correct heliocentric theory. Ptolemy's influence was so long lasting for at least two reasons: his surviving clear and compelling presentation of his 'proofs' and theorems and that there were no instruments accurate enough to prove him wrong. His 13 books of the *Almagest* (the Greek title translates to 'The Mathematical Compilation') were masterpieces of clarity and definitude. The *Almagest* shares with Euclid's 'Elements' the glory of being the scientific text longest in use. He observed the inequality of solar days so important to us diallists, deduced the EoT, established the concept of mean time and the eccentricity effect, could predict when eclipses would occur and presented details of the motions of the visible planets that were not far off the mark. Later astronomers and physicists found many faults in Ptolemy's logic and findings. Yet Ptolemy amassed a large body of observations leading to deductions that are accepted today. He was indeed a genius for his time and long thereafter. Now Kevin, was Ptolemy aware of the role of fruit flies in telling time?

Doug Bateman:
*The Greenwich
Time Ball*

Doug presented his work to preserve and restore this historic instrument. The concept of an 'Instantaneous Signal' was first proposed in 1818 by Captain (later Vice-Admiral) Wauchope. Why was the 1 pm time chosen for the ball drop? "Because the Captain himself decided". The first time-ball was made by Maudslays of Lambeth in 1833. Doug has published the details of the many repairs and reconstructions in his well documented three part article in *Antiquarian Horology*, vol 34, June, September and December 2013. I have read it with great interest.

The present time ball was designed by Alfred Hardcastle, constructed in 1904 and restored in 1989. The ball is now set to drop precisely at 1PM by a radiocontrolled clock with millisecond accuracy and observed by ships in the Thames to set their chronometers.

Doug also presented his own design of a vertical declining mean-time noon dial for the DERA. He also described the noon dial now gracing the south wall of the Observatory that was designed by Przykowski. It was reconstructed in 2012 with additional detail work by Christopher Daniel. Slate work and letter cutting were done by Ben Jones who supervised the delicate task of remounting it on the wall [see above!].

Doug's presentation concluded just in time for us to witness from the lecture hall windows that the time-ball did drop at 1 pm.

**The Andrew Somerville Memorial
Lecture**

Rory McEvoy, The Curator of Horology at the RGO: *Supplying Time to the Royal Observatory in the Age of Enlightenment*

Rory reviewed the history of improving mechanisms for keeping time. Galileo made seminal discoveries, including his assertion that the sun, not Earth, is the centre of our universe as initially proposed by Copernicus. This alienated the Pope and the Jesuits, leading to his lifetime of house arrest after trial by the Holy Office. He used the telescope to find the four largest satellites ('moons') of Jupiter and the regularity of their transit to use for counting the passage of time. He also discovered the pendulum and that it swings in the same time what-



ever its weight, confirmed by many other observers. This finding, among many others, led to the development of pendulum clocks.

Thus in 1657 Christiaan Huygens FRS (who formulated the wave theory of light) developed the first pendulum escapement to keep more accurate time. He noted that the pendulum swings more slowly at the equator.

The Royal Observatory was founded to develop better navigation for the Royal Navy. The first Astronomer Royal, John Flamsteed FRS, appointed in 1675 was important to development of this function. He used a new method of determining star positions that greatly improved accuracy. He also collaborated, quite reluctantly, with Isaac Newton who needed Flamsteed's help in determining the moon's orbit but never received it. Flamsteed also noted the sighting of Uranus.

George Graham FRS worked on the magnetism of compass needles and also invented many valuable astronomical instruments such as the great mural quadrant at RGO. He also loaned £200 to George Harrison to help start him working on marine timekeeping. His work with assistants Shelton and Sisson on the effect of temperature variations on pendulum escapement accuracy led to improvements in pendulum design.

Edmond Halley FRS sought the effect of magnetic variation among many other scientific investigations. He worked with John Flamsteed and succeeded him as Astronomer Royal in 1720. John Harrison discussed his plans for improved timekeeping at sea with Halley and also with George Graham, who supported him in negotiations with the Board of Longitude.

Neville Maskelyne, the fifth Astronomer Royal, had discovered that lunar distance could be used to determine longitude by ships at sea. So enamoured was he of his laborious and lengthy method that he suppressed the superior results of Harrison's H4 timepiece.

Despite Maskelyne's obstructions, Harrison finally was awarded the Longitude Prize by Act of Parliament, overriding the Board of Longitude that was influenced by Maskelyne. Nonetheless, in part because Maskelyne's useful lunar distance method of determining longitude was calculated at the RGO, as well as many other valuable findings that he made there, the Greenwich meridian was ultimately adopted internationally as the Prime Meridian in 1884.

As a result of all these and subsequent investigations, Greenwich time can now be received by wireless in one's home as broadcast from Paris!



*Above: Jim and Jackie Holland et al.
Below: international dialling with Frans
Maes (Belgium) and Martins Gills (Latvia) in
deep conversation.*



Saturday evening brought the Gala Dinner in the Council Chamber, Queen Anne Building. This lovely formal setting was a fitting site for a celebratory dinner. This was followed by a number of award presentations and one of our entertaining auctions in which one couple were seen bidding against each other and a number of 'priceless' items went abroad. A copy of Gatty was knocked down for a bargain £65, perhaps because the contents are now available online. The total

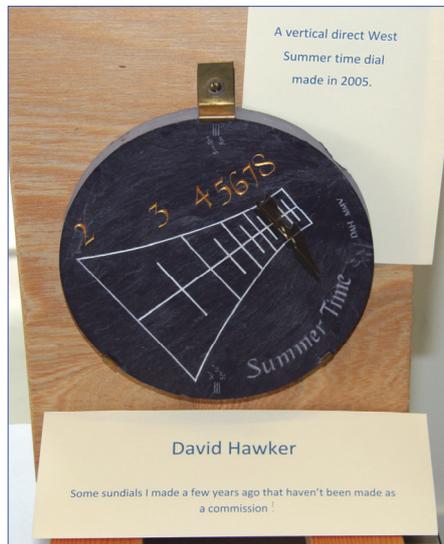


contribution to Society funds on the night was £454.50, with Gift Aid still to add.

Sunday 27 April
 'Guided Tour of The RGO'

Those who arrived early got the guided tour with Chris Daniel and others. The rest of us puffed up the hill a little later with friends to wander through the Observatory on our own, which was very rewarding. The collection of historic clocks and scientific instruments, a close-up view of the Time Ball, interesting exhibits and of course the superb noon-mark dial of Przyrkowski and the magnificent Dolphin Sundial were of special interest. Occasional bright sunshine allowed photographers to record the shadows of the dolphins' tails that ingeniously show mean time. Some of us lingered in the beautiful garden where the dolphins now have a dramatic home. And the RGO gift shop offers memorable souvenirs.

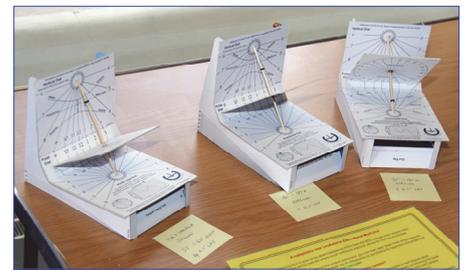
Back down the hill, the National Maritime Museum exhibits showed fasci-



nating displays of Britain's naval history, navigation instruments, astrolabes and sundials.

Then it was time to bid adieu to our many old and new friends in the BSS and plan to meet again at Newbury and the next BSS AGM.

Pictures from Jim Holland, Tony Moss and John Davis



Dials from David Hawker (left), Tony Moss (above) and David Brown (below)



MANCHESTER RAILWAY DIAL

The rather large horizontal dial in the photograph is, we believe, the one described by Roger Bowling in his article 'Liverpool Road Railway Station, Manchester', *BSS Bull.*, 20(iii), 121–22 (Sept 2008).

The photograph was spotted by member Nick Orders in the journal of the Bahamas Locomotive Society (a class of engine, rather than the location of the railway!) and we are grateful to Pete Skellon of the BLS for this copy and permission to publish. The original print, which is now part of the Ingrow Loco Archive of the Society, carries a stamp for Fox Photos Ltd of 31 Bridge Street, Manchester. The caption on the back is partly missing but mentions the "departure of trains ... being inspected by 1936". The uniforms would seem to date from that period so it seems likely that this is when the dial was being taken out of use and handed to the Goods Manager for safe-keeping. The fact that a photographer was present indicates that the occasion was specially staged, rather than three workmen just happening to be inspecting a dial.

The connection between dialling and steam locomotives, like that with campanology, continues to be a strong one.

JD



UNEXPECTED ASPECTS OF ANNIVERSARIES or: Early sundials, widely travelled

HELMUT SONDEREGGER

This year my hometown, Feldkirch in Germany, celebrates the 500th anniversary of Rheticus. He was the man who published the first report on Copernicus's new heliocentric view of the world. Subsequently, he helped Copernicus complete his manuscript for publication and arranged its printing in Nürnberg. When I planned my attendance at the BSS Conference 2014 at Greenwich, I asked myself if there could be any connections between the 25th BSS anniversary and the 500th anniversary of Rheticus' birth. And now in fact, I have found a really interesting story!

Feldkirch 500 Years Ago

Feldkirch, a small district capital of about 30,000 people, is situated in the very west of Austria close to Switzerland and Liechtenstein. Five hundred years ago it was a prospering town of about 1500 inhabitants. In April 1514 Georg

Iserin was appointed town physician and all of his family were accepted as citizens of Feldkirch. Georg, a man with widespread interests, owned a considerable number of books and a collection of alchemical and medical instruments. Over the years, superstitious people suspected this extraordinary man of being a sorcerer in league with sources of darkness.

A few weeks before his appointment as town physician, on 16 Feb 1514, his only son Georg Joachim was born. When the son was 14 his father was accused of betraying his patients and, additionally, of being a swindler and kleptomaniac. He was sentenced to death and subsequently beheaded by the sword. His name Iserin was officially erased by so-called 'damnatio memoriae'. His wife and children changed their name to the mother's surname. As she was well off, her son Georg Joachim could continue to study at the famous Latin school in Zürich. At the age of 18 he enrolled at the university of Wittenberg for mathematics and astronomy. From that time onwards he called himself Georgius Joachimus Rheticus – in memory of the region he was from. Feldkirch after all, had been part of the Roman province Rhaetia.

By the age of 22, Rheticus was appointed by his patron Philipp Melanchthon as lecturer for mathematics and astronomy at the university of Wittenberg. Fig. 1 shows the first page of notes by Nicolaus Gugler of Rheticus' lecture on the 'Tractatus de Sphaera' by Johannes de Sacrobosco (1195 – c. 1256). Sacrobosco wrote this booklet around 1230 at the university in Paris, where he lectured on the old geocentric view of the world by Ptolemy (c. 90 – c. 168). According to this idea, the Earth was considered the centre of the entire universe. Thus, the Earth – at rest itself – was orbited by the moon, the Sun, by all known planets (Mercury, Venus, Mars, Jupiter, Saturn) and by all the stars beyond. Even in Rheticus's time, lectures on this Ptolemaic system were the commonly accepted introduction to astronomy in all West- and Middle-European universities. But scholars knew that calculations of the planets' motions showed rather inaccurate results within this system. For a long time some scholars reported that a canon named Copernicus far away in the East of Prussia had found a new and hopefully better method of calculating the movements of the planets.

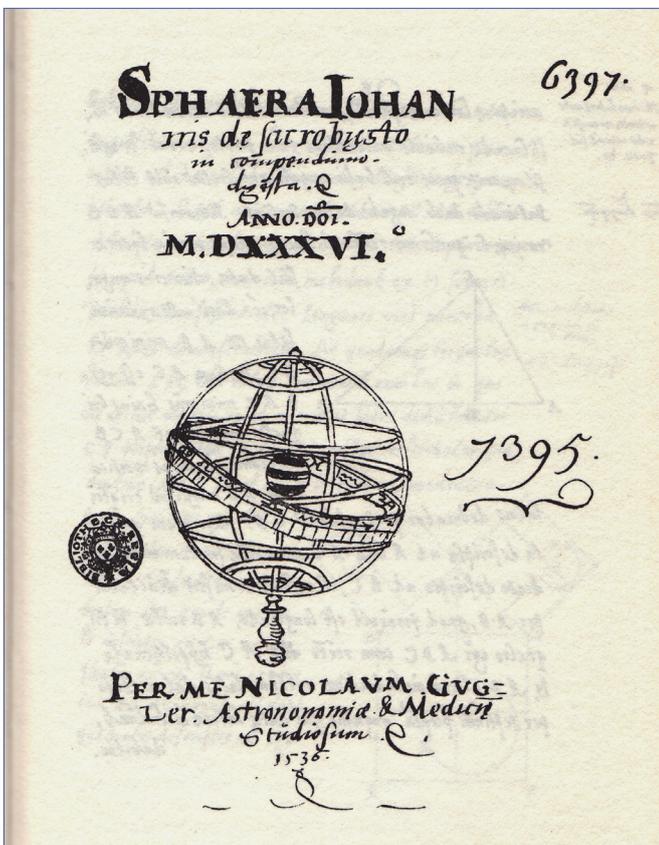


Fig. 1. Notes by Nicolaus Gugler of Rheticus' lecture on Sacrobosco's 'Sphaera'. Gugler copied the armillary sphere with the geocentric Ptolemaic system from Sacrobosco's book. After Burmeister.¹⁰



Fig. 2. Frombork Cathedral. The roof on the left of the tower is where Copernicus lived during his time in Frombork. Photo by the author.

A Landmark Journey

Like others, Rheticus had heard of Copernicus's ideas and he decided to study them at first hand. In the year 1539 he was given leave from the university to undertake the long and exhausting journey to Copernicus in Frauenburg in distant East Prussia (now Frombork in Poland: see Fig. 2). On his arrival in Frombork, the 25-year-old Lutheran scholar Rheticus found a friendly welcome by the 66-year-old Catholic dignitary Copernicus. Soon they were good friends and the elderly man was a helpful tutor to his young guest and only student. He committed his manuscript on the new heliocentric theory to him and they both discussed all of its details and problems. Both worked so hard that Rheticus was able to produce his famous 'Narratio prima' within a few weeks. In this 'First account' he formulated the substance of Copernicus's revolutionary idea: the Earth was no longer the rotation centre of all objects in the sky but the Sun now took this role. Both of them were convinced that the Earth (together with its moon) moves around the Sun like all the other planets. What appeared to be the daily orbit of the Sun and the stars around the Earth is only the result of the additional Earth rotation around its own axis.

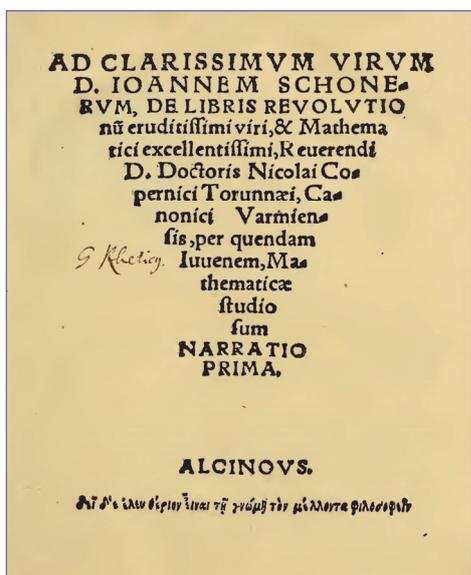


Fig. 3. Title page of 'Narratio prima' (1540). After Rosenfeld & Zeller¹ or Open Library (<https://openlibrary.org/books/OL25326748M/>).

With Copernicus's approval, Rheticus published his *Narratio prima* in 1540 (see Fig. 3). It was the first ever printed and published report on the new Copernican heliocentric system. It caused a sensation in the scientific world and became the spark for the so-called 'Copernican Revolution'. Dibner writes, "The scale of change which Copernicus proposed and which is universally accepted today did more violence to the accepted thinking of man than any other product of thought, including the doctrines of evolution or of relativity."¹

After the huge success of Rheticus's *Narratio prima* and the encouragement Copernicus received from many of his friends, the old man agreed to publish his own manuscript, and so with support from Rheticus, the manuscript was made ready for print. Later, Rheticus organized the printing of Copernicus's life work '*De revolutionibus orbium*' in Nürnberg. The book was completed in 1543. A copy of it was brought to Copernicus on the day of his death.

Rheticus's Interest in Sundials

As far as we know, Rheticus did not show much interest in astronomical instruments or sundials before he made his long journey to Copernicus. He mainly concerned himself with mathematical and theoretical aspects of astronomy. However, just a short time after his arrival in Prussia, he mentioned two astronomical instruments in his *Narratio prima*! He had seen them in the residence of Copernicus's friend Bishop Tiedemann Giese during his first weeks in Prussia.

The first instrument was an armillary sphere for observing the equinoxes. It enabled astronomers to measure the exact length of the (tropical) year. This was essential for the improvement of the Julian Calendar, in use at that time. For decades or even for centuries adjustments of it had been proposed.

The second instrument was even more fascinating: 'The bishop ordered a gnomon [sundial] from England. It was proper for a noble bishop and I [Rheticus] saw it with great pleasure because it had been made by a very good artist and an expert in mathematics too.'² In a later letter of the bishop, we learn that he had ordered this stone gnomon from a famous mathematician in London constructed specifically

for the latitude of Königsberg.³ Moreover, he writes that this stone sundial showed coloured lines. So the question arises, who could have been the constructor and mathematician in the early 16th century in London?

It seems obvious to suppose that Nicolas Kratzer was the constructor because he was in England at that time. Zinner⁴ is quite certain about this because he was the only famous mathematician in London who also constructed stone sundials at that time.



Fig. 4. Nicholas Kratzer (1487–1550). Painting after Hans Holbein the Younger. WikiCommons, from the original in the Louvre, Paris (copy in National Portrait Gallery, London).

Nicholas Kratzer and Sundials

Fig. 4 shows the very famous portrait of Nicholas Kratzer at work on a sundial. It was painted by Hans Holbein the Younger in the year 1528. At that time, Kratzer and Holbein were both at the court of Henry VIII. Nowadays, the original painting is displayed in the Louvre, Paris, and a very fine copy of it can be seen in the National Portrait Gallery, London.

Nicholas Kratzer (1487–1550) was a Bavarian mathematician, astronomer and horologer. The first time he came to England was in 1517/18. Before this journey he spent some time in the Carthusian monastery of Mauerbach near Vienna to study and copy astronomical and gnomonic treatises. Much of the material can be still found in Kratzer's manuscript '*De horologiis*' in the Bodleian Library.⁵

Kratzer writes in this manuscript, 'In the year 1520, I, Nicolas Kratzer, born a Bavarian of Munich, a servant of King

Henry VIII, at his command lectured at Oxford'.⁶ Amongst other topics, his lectures covered *De Sphaera* by Sacrobosco⁷ and the construction of the astrolabe. Furthermore, 'While there I set up a column or cylinder before the church of the Blessed Virgin with the help of the mason William Eyst, the king's servant.' In addition, he cites verses by Ludovicus Vivès, his contemporary at Corpus Christi College at Oxford. Vivès' Latin text explains the hour lines with their different colours. Here, two examples in Gunther's translation:

'On the East: The hours [old German or Babylonian hours] are marked by green lines, which the numbers point out, beginning with the birth of the day.'

'On the West: The dark blue lines [the Italian hours] show how many hours of time the sun hath fulfilled since he hid himself beneath the waters.'

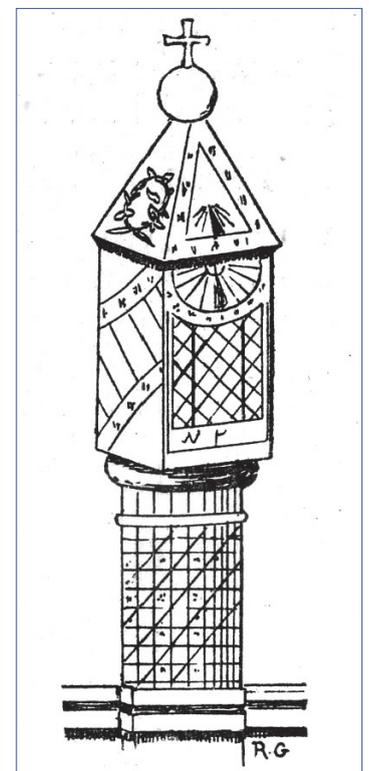


Fig. 5. Kratzer's dial at St. Mary's Church, Oxford. Sketch by Gunther,⁶ after Loggan's '*Oxonia illustrata*', 1675.

The only known engraving of this dial is found in Loggan's print *Oxonia illustrata* (1675), which appeared about 50 years later than Vivès' verses. Fig. 5 is an enlarged detail from Loggan's print as shown by Gunther. It can be seen that the hour lines of the West sundial in this engraving do not match Vivès' description, given above.

North⁸ hints at further inconsistencies and errors in Kratzer's manuscript. He says "Kratzer never approached the apex of either art or the mathematics of his day. If he established any tradition it related to craft and rationale of instrument-making". He was "more craftsman, perhaps, than scholar, ...with well-developed mercantile instincts."

In a similar vein, Peter Drinkwater writes, "Kratzer triumphed, not through genius or creativity, but through having learned what others had discovered and invented, and by being the first to apply that learning in England."⁹



Fig. 6. Kratzer's polyhedral dial for Cardinal Wolsey.
 Courtesy of the Museum of the History of Science, Oxford.

Traces of Kratzer's Sundials

Kratzer left only a few traces of his work. Nowadays, only one complete and functional sundial by Kratzer is preserved. It is the beautiful portable polyhedral sundial for Cardinal Wolsey, which is now in the Oxford Museum of the History of Science and can be seen in Fig. 6.

The dial in the churchyard of St Mary's Church mentioned above was removed in 1744. Loggan's sketch of it in some aspects resembles Turnbull's 'Pelican Sundial' at the quadrangle of Corpus Christi College in Oxford.¹¹

Another polyhedral sundial by Kratzer stood in the Corpus Christi College Garden. Again, nothing but a sketch of it by Robert Hegge has survived.

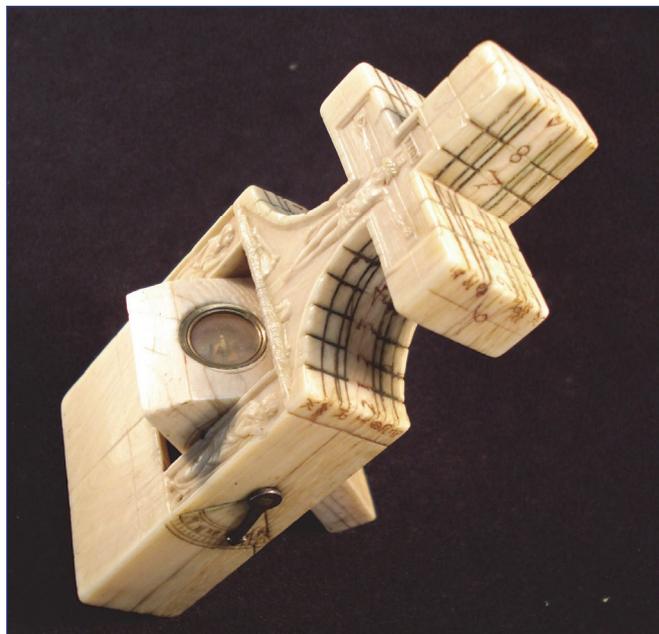


Fig. 7. Ivory cross sundial by G. Hartmann (1541).
 Courtesy of the Trustees of the British Museum, London.

Even worse, we have no idea of what the stone sundial which was ordered from Nicholas Kratzer by Bishop Tiedemann Giese looked like as this widely-travelled dial is now lost. It has, however, left another link to London. That is to say, the letter that Bishop Giese wrote to Duke Albrecht of Prussia in 1543, which reveals that Giese sent this stone gnomon to Duke Albrecht in return for a marvellous present that Giese had received from him. It was a most precious ivory cross sundial, constructed and manufactured 1541 by the famous sundial-maker Georg Hartmann (1489–1564) in Nürnberg. This dial can still be seen in the British Museum in London (see Fig. 7).

In letters from the Duke to Georg Hartmann, we learn that the Duke repeatedly ordered valuable sundials from Georg Hartmann. He in turn not only sent his sundials but also informed the Duke on the tide of all political events in Nürnberg. This was of special interest for him because

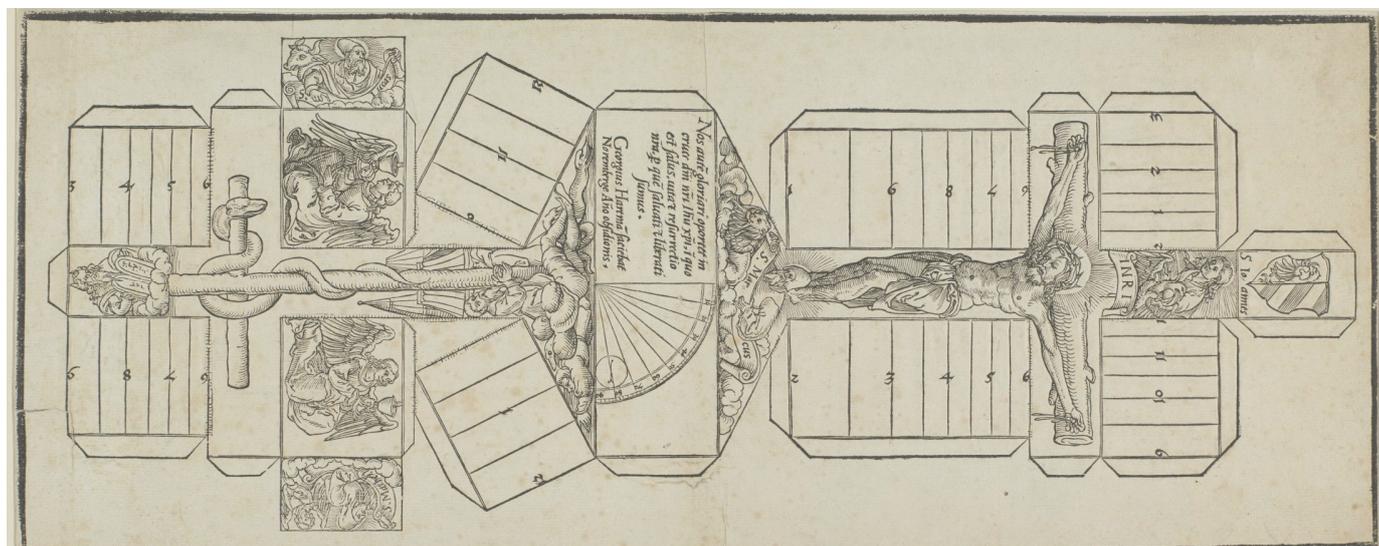


Fig. 8. Hartmann's print of the paper cut-out sundial. Image by the author, courtesy of Germanisches Nationalmuseum, Nürnberg.



Fig. 9: Paper cut-out sundial by Georg Hartmann, Nürnberg. The dial shows 2:30 pm. Image by the author.

Nürnberg was the place of the ‘Imperial Reichstag’ at that time. These were the general assemblies of the Imperial Estates of the Holy Roman Empire and hence the meeting point of many prominent political and clerical dignitaries.

The Earliest Cruciform Sundial?

In 2004, devotees of paper woodcuts found a very early cut-out sheet for a cruciform sundial in the Germanisches Nationalmuseum (GNM) in Nürnberg (see Fig. 8). It is thought to be the earliest paper cut-out sheet ever created. Georg Hartmann constructed and printed it. Experts interpret the words ‘anno obsidionis’ on it as a clue to its year of construction. They say it must be 1529, which was the year of the first Turkish siege of Vienna.

During Hartmann’s lifetime, Nürnberg itself had never been besieged, however, in the early 16th century the siege of Vienna was considered to be a huge danger for all Christian countries in Europe.

If this cut-out sheet is assembled one gets a polyhedral cruciform sundial with eight polar sundial planes (Fig. 9). Moreover, experts find Hartmann’s cut-out sheet a very clever and compact construction which can also be glued together by people without any experience in paper cut-outs.

If we consider the iconography of this dial, we realize it is very similar to the ivory cross dial. Somehow this paper

cut-out dial looks like a preliminary exercise for the ivory sundial cross from 1541. This leads to the assumption the paper cut-out cruciform sundial could be the earliest cruciform polyhedral sundial. The author has failed to find an earlier one. Thus, any interested diallist can make his own original version of the earliest cruciform polyhedral sundial – and for very little money.

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Helmut Sonderegger was born in 1937 and lives in Feldkirch, Austria. During his career as a teacher of mathematics and physics, he became interested in many aspects of sundials. On his webpage <http://www.helson.at>, he offers free sundial software for Windows systems where about 20 different sundial types can be constructed, printed and saved for further editing. Also, additional calculations and tables of sun positions are included.



Some People have SatNavs....

Seen in a BMW parked in Eynsham, Oxfordshire, by Dennis Stukenbroeker.



BSS 25th ANNIVERSARY PHOTOGRAPHIC COMPETITION, 2013–14

IAN BUTSON

Generally, the Photo Competition is now run every two years, with the previous one being held in 2012–13. Although the competition had been run last year, it was also suggested by a number of the members that a special photographic competition might be held in 2013–14, to commemorate the 25th anniversary of the Society. This was readily agreed, but instead of being marked by a panel of selected judges as in the earlier competitions, the results would be determined by a vote from participating members at the annual conference held at Greenwich in April 2014.

In addition to the formal voting process used in recent years, a Conference Vote had also been conducted which proved popular among the members. On this occasion it was felt that a Conference Vote only would be the ideal method by which to mark the entrants to the competition.

As at the previous conferences, delegates at this conference were given the opportunity to consider the photographs, and by means of a simple vote to indicate their favoured choice for first, second or third places in the competition. Three points were allocated for the first choice, two points for the second and one point for the third choice of those voting. The entry receiving the most points would then be declared the winner of the Conference Vote. Ballot papers had been prepared previously and made available close to the photographs on display. A ballot box had also been provided and all those attending the conference were encouraged to make their choices and enter their votes.

Forty-two voting forms were submitted with votes being cast on 28 of the 35 photos on display, with the results shown below

First (44 pts)	<i>Chicago Sunset</i>	(Mike Shaw)
Second (29 pts)	<i>I counted minutes all day long.</i> <i>Am resting now, with the full moon rising</i>	(Rainer Jacob)
Third (22 pts)	<i>Frozen in Time</i>	(Mike Shaw)
The next seven photographs which made up the Top Ten entrants were identified in the order of points scored, having received from 17 points down to 9 respectively as:		
	<i>Ambushed</i>	John Lester
	<i>Good Morning Sunshine</i>	Jackie Jones
	<i>Cat with Attitude, Dials with Latitude</i>	Mike Shaw
	<i>NOTICE This Sundial is about to close for the day. Normal service will resume tomorrow, weather permitting</i>	David Levitt
	<i>Gateway to Time</i>	Ian Butson
	<i>The End of Time</i>	Jackie Jones
	<i>Sorry! Two's company, but three's a crowd</i>	Mike Cowham

} (Equal 7th place)

After the results had been announced, the chairman presented Mike Shaw with the first and third place prizes of a Butterfield style universal dial with compass, and a small replica pillar dial, as well as certificates to celebrate his success.

Because Rainer Jacob, an overseas member, was not attending the conference, his prize for gaining second place of a magnetic compass dial and certificate were later posted to him in South Africa.

Congratulations to all those who achieved winning results in this anniversary photographic competition, and thanks to those who also took part in the voting.



CHICAGO SUNSET

First Place
Mike Shaw



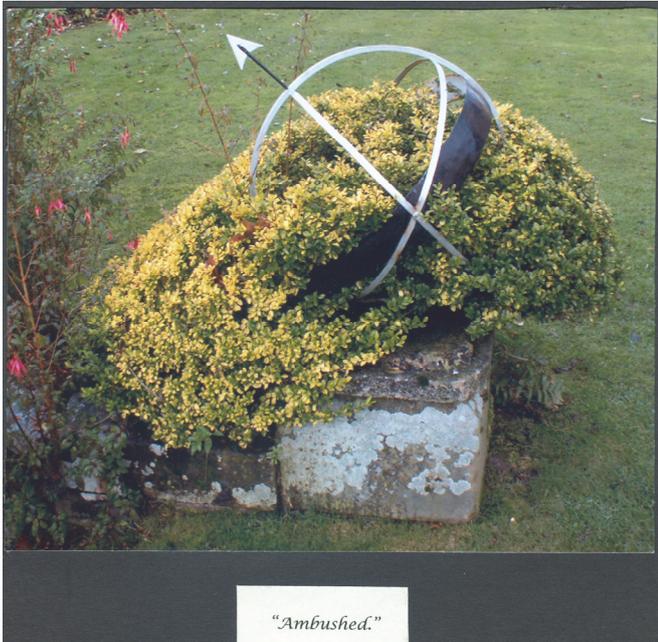
I counted minutes all day long. Am resting now, with the full moon rising

Second Place
Rainer Jacob

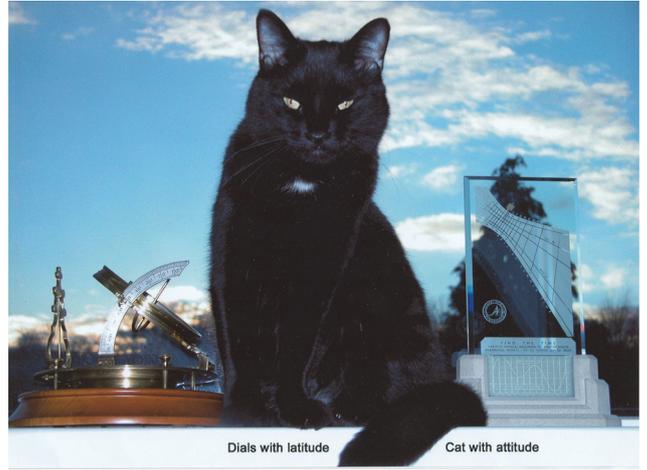
Third Place
Mike Shaw



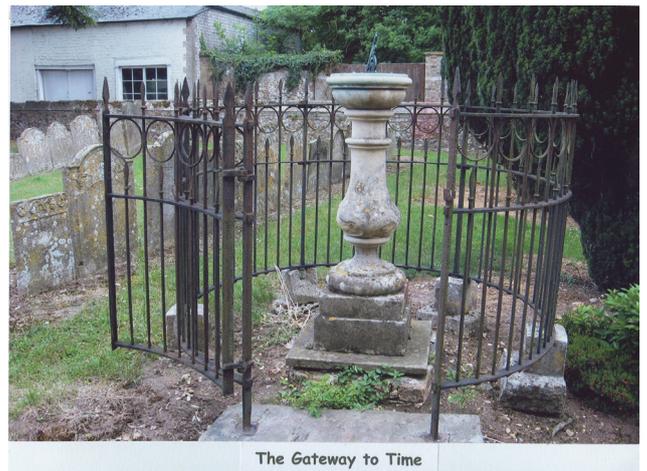
FROZEN IN TIME



"Ambushed."



Dials with latitude Cat with attitude



The Gateway to Time



NOTICE

This sundial is about to close for the day.
Normal service will be resumed tomorrow, weather permitting.

These are the other entries in the 'Top Ten'.



The End of Time



Good Morning Sunshine



"Sorry! Two's Company but Three's a Crowd"

EDITOR'S CHOICE



Make time for the REALLY important things in life

Two Photographic Competition entries from Margaret Ribchester—although unplaced, they get my vote! They are good demonstrations that all gnomons point to the celestial pole.

The picture above is of SRN 0167 at the Waterton Park Hotel, near Wakefield. That on the right is at Slaley Hall, Hexham in Northumberland (SRN 3545).



OK, if you say it's ten past ten, it's ten past ten ...

NEW DIALS (3)

Bath Armillary

This large armillary sphere in the centre of Bath was unveiled on 13 July this year and is a memorial to Admiral Arthur Phillip, Commander of the First Fleet and the founder of modern Australia. It is the result of years of campaigning by the Britain-Australia Society. The 1.2 metre diameter bronze sphere was made by David Harber Ltd and the stone pedestal is from deep quarried Bath stone worked by Somerset stone carver Nigel Fenwick. The internal globe is rotatable and tracks the historic path of the eleven ships of the First Fleet. At the top, there is a compass rose and a topograph indicating the distances, in nautical miles, to key points on the eight-month journey to found New South Wales in 1787. It shows the time in Bath and in Sydney, Australia. There are engravings on the dial and the base giving a list of Phillip's achievements and some of his memorable quotations. The plinth is 2.5 metres in diameter in a form resembling a quayside bollard with



hand-carved anchor chain and subtle carvings in aboriginal style around the edge, reflecting Phillip's requirements that settlers should live amicably with the Aborigines and that there would never be any slavery in the country.

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