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EDITORIAL

As forecast in the March editorial, this June issue includes a report of the Oxford Conference and the Minutes of the AGM. This year there was only one competition, the cake competition, which was notable for having only a single entry. This entry was in the form of nine astonishingly realistic mass dials which also looked very mouth watering – see the picture on page 43.

Conference talks can often lead to *Bulletin* articles and this issue includes a scholarly article by John Davis on the Navicula, a most intriguing article by John Wilson on the Newstead Abbey sundial and some colourful pictures by John Lester of numerous 'Fundials' that he has made over the years. All three articles directly relate to talks given by their authors at recent conferences.

This issue also includes the latest article in Dennis Cowan's popular Thomas Ross series. These articles are a very rich resource and, indeed, a single photograph in Part 15 formed the basis of my talk on Double-Vertical Sundials.

Sadly, this issue includes the obituary of Allan Mills who was frequently a speaker at our conferences and who was also a prolific contributor to the Bulletin.

We are entering the sunniest time of the year and no doubt many of you will be out with your cameras. If you are recording a sundial for the Registrar, please always ensure that you take a side view of the gnomon for the Society's records. Such views are crucial should the gnomon ever go astray. The side view shown is of the gnomon of SRN 1527, the only known 'double vertical' sundial; note the W-shaped nodus that is easily missed.

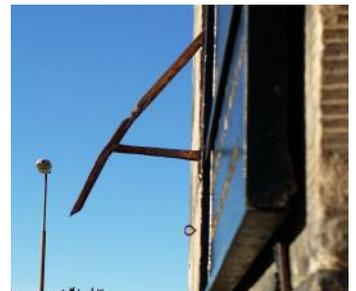


Photo: Christine Northeast

Frank King

THE BRIGHTON i360 – A GIANT GNOMONIC POSSIBILITY

FRANK H. KING

Brighton's latest tourist attraction is the spectacular British Airways i360 tower. This is shown in Fig. 1 where the view looks northwards to the South Downs. The shore line in the foreground runs roughly west to east. The base of the i360 lies on the axis of Regency Square, the green area that lies immediately inland of the tower. The same axis is shared by the ruins of the West Pier and the i360 is sometimes described as a vertical pier.

Visitors ride in a doughnut-shaped pod which, in the figure, is near the top of the tower. At night, and when people are disembarking, the pod rests in a circular recess at the bottom of the tower.

With its uniform circular cross-section and uninterrupted views to the south, the i360 tower is almost begging to be used as a gnomon. Sundial enthusiasts may sense, in the

i360 and Regency Square in Brighton, an echo of the obelisk of Horologium Augusti in Campus Martius in Ancient Rome.¹

A new body, the i360 Sundial Society,² has been established in Brighton to exploit the tower gnomonically. This article is a personal interpretation of some of the Society's proposals and, inevitably, some details reflect the thoughts of the author rather than those of the Society. A principal goal is to provide an exhibit that illustrates the development of the measurement of time and, to that end, the Society intends to place dial markings round the base of the tower, in Regency Square and in neighbouring streets.

The Shadow from the Air

From inside the pod, there are spectacular views and, if the sun is shining, any sundial enthusiast will be struck by the



*Fig. 1. The British Airways i360 tower in Brighton. The open green area behind the tower is Regency Square.
Photo: © Evening Standard, by permission.*



Fig. 2. The shadow of the i360 tower and the pod.

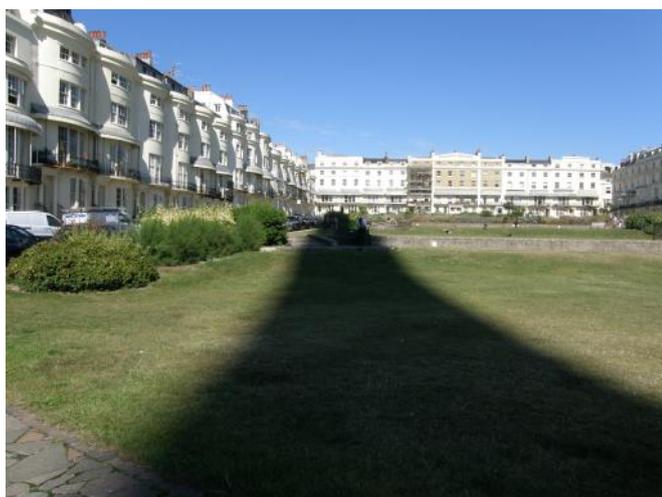


Fig. 3. The shadow of the i360 falling in Regency Square on 7 September 2016.

impressive shadow (Fig. 2). From this viewpoint the shadow should appear as a straight line but the pod's curved windows introduce a little distortion. It is easy to identify the shadow of the pod which would invite consideration as a nodus if it didn't move up and down the tower!

The shadow of a vertical gnomon falling on a vertical plane will itself be vertical. In the foreground of Fig. 2, the shadow falls on the south front of the Hilton Brighton Metropole Hotel and it is instructive to stand on the opposite side of the road and observe this element of the shadow as it slowly travels eastwards.

For a few minutes each day, hotel guests with sea-front rooms will experience a low-grade eclipse of the sun! Long-term guests will notice that, as the year progresses from summer towards autumn, the time of the eclipse gets later and later in the day until, some time in October, the sun sets before the shadow reaches their rooms.

The Shadow from the Ground

The shadow is no less seductive when seen from ground level (Fig. 3). Around the time of the winter solstice, the shadow enters the square about 10:30 GMT and leaves

about 15:30 GMT (not long before sunset). During these five hours, the vertical element of the shadow sweeps across the fronts of the buildings on the west, north and east sides of the square.

Around the summer solstice, the shadow's visit is much briefer, roughly two and a half hours, and the shadow is so short that only the buildings in the south-west and south-east corners of the square will experience the low-grade eclipse. The photograph in Fig. 3 was taken on 7 September, a few minutes after local solar noon, when the shadow was much longer than at the summer solstice but was still not quite long enough to reach the north side of the square. By serendipity, a few minutes after taking this photograph, the author came across John Kapp, Secretary of the i360 Sundial Society, who was making observations at the end of the shadow.

Using the i360 as the Gnomon of an Azimuthal Sundial

The temptation to exploit the shadow for gnomonic purposes is irresistible but there is an overriding constraint: the i360 tower is not polar oriented but vertical. The direction of its shadow indicates the azimuth or bearing of the sun and this means that it can be used as the gnomon of an azimuthal sundial. Such sundials take a variety of forms but a favourite with many diallists is the stereographic projection associated with the vertical gnomon of a double horizontal sundial. A very embryonic example, delineated for the position of the i360 in Brighton (50.8214° N, 0.1509° W), is shown in Fig. 4.

In principle, this is a possible scheme for the i360. Imagine that the little ring above the north pointer is the cross-section of the base of the i360 and the associated dial markings are marked out on specially prepared level ground in the neighbourhood of the tower. Three long circular arcs are labelled WINTER SOLSTICE TIMES, EQUINOCTIAL TIMES and SUMMER SOLSTICE TIMES. The short circular arcs are hour lines; these are labelled with times.

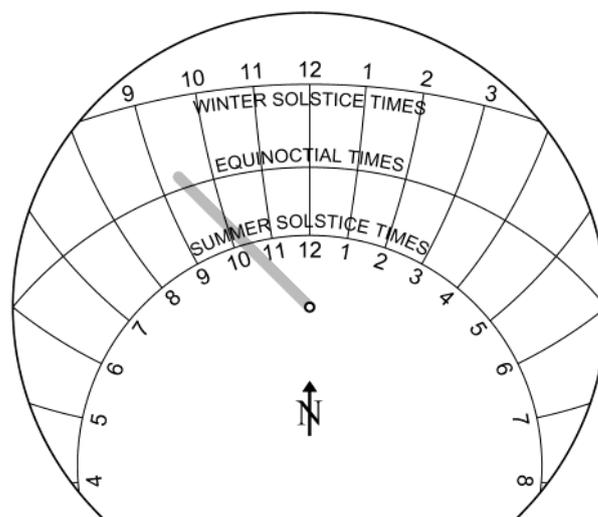


Fig. 4. An azimuthal sundial employing a stereographic projection.

To illustrate how to determine the time, suppose that on the day of the summer solstice you chance upon the i360 when the shadow is as shown in Fig. 4. You note where the centreline of the shadow crosses the SUMMER SOLSTICE TIMES arc; it is somewhere between the 10 am and 11 am hour lines and, by interpolation, the time is about 10:20. This is local solar time rather than GMT or BST.

If it were the day of an equinox then you would note where the centreline of the shadow intersects the EQUINOCTIAL TIMES arc and deduce that the time is about 09:30, almost an hour earlier. The shadow would be a good deal longer than at the summer solstice and it would be much longer still at the winter solstice. There would be no danger of the shadow not reaching the WINTER SOLSTICE TIMES arc at that time of year.

It is customary to mark in numerous intermediate long circular arcs for different times of year and numerous intermediate short arcs for half-hours and quarter-hours. One could certainly design a full-scale version of Fig. 4 for the i360 but there is a serious practical difficulty. Brighton is built-up and hilly, and Regency Square rises quite steeply as you advance away from the sea front. It is inconceivable that the local authorities would permit all the demolition and earth-moving that would be required to level the ground!

The design in Fig. 4 has to be adapted to suit the local circumstances...

Using Regency Square as Part of a Dial Plate

Fig. 5 is a sketch map of Regency Square and its immediate neighbourhood. This map should be compared with the photograph in Fig. 1. The viewpoint is no longer over the sea but is looking directly down the i360 tower! The square is actually a large rectangle (about 70 × 160 metres) with minor roads along the three built-up sides and a wide road, King's Road, along the sea front to the south. Fig. 5 shows these roads and some associated pavements and little else. The i360 is on the south side of King's Road.

The map is drawn so that the axis of the square runs straight up and down the page. The i360 lies on this axis but, as the direction of the north pointer makes clear, this axis is offset from true north-south; the offset is about 15°. Fortunately, this will not present any problems.

Fig. 5 should also be compared with Fig. 4. The shadow of the i360 is again shown at a particular time on a particular day. Moreover, it is again the day of the summer solstice but you do not use the green Summer Solstice Arc to tell the time. Instead you have to note where the shadow crosses the blue line. This is actually a run of kerbing marking the south margin of Regency Square. There are no intersecting hour lines but it is proposed to mark this run of kerbing with times of day (again local solar time). In Fig. 5, the marks are shown as blue dots at 15-minute intervals. In reality, there could be much finer sub-divisions.

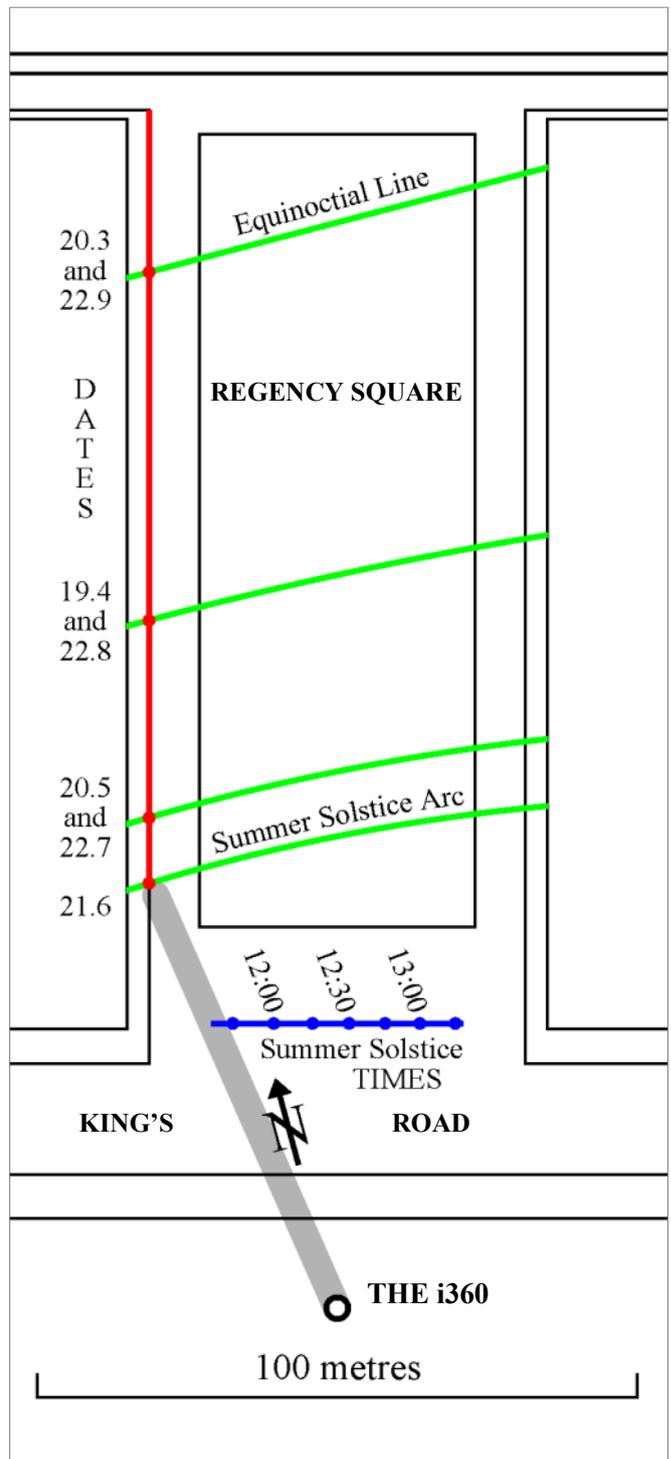


Fig. 5. Outline map of Regency Square showing an example of the shadow of the i360.

As shown, the blue dots mark a run of less than two hours which is much less than the run covered by the SUMMER SOLSTICE TIMES arc in Fig. 4 which is over 16 hours. This deficiency is easily attended to; the afternoon times could be continued along the kerb of King's Road to the east of Regency Square and, likewise, morning times could be marked along King's Road to the west. In this way, the dial markings will be extended well beyond the confines of Regency Square itself.

Time Paths

The run of kerbing marked in blue, taken together with its morning and afternoon extensions, plays the role of the SUMMER SOLSTICE TIMES arc in Fig. 4. These runs of kerbing can be regarded as elements of a highly unusual chapter ring with the time marks corresponding to the tick marks that one finds in conventional sundials. There seem to be no widely accepted terms to distinguish the elements of chapter rings that are crossed by time lines from other elements that are crossed, say, by constant-declination curves. Accordingly, for the purposes of this project, the term 'time path' will be used.

In Fig. 4, we can regard the three long circular arcs as time paths and, in the first instance, it is proposed to have just three corresponding time paths for the i360 dial. For example, the low stone wall that runs across the middle of Fig. 3 could serve as part of the time path for the equinoxes. One can see in that figure that in early September the shadow extends beyond this wall; it is even longer at an equinox.

Consideration of the equinoctial time path illustrates why the marked times have to be local solar time rather than GMT or BST. At the vernal equinox, the equation of time is about $-7\frac{1}{2}$ minutes whereas, at the autumnal equinox, it is about $+7\frac{1}{2}$ minutes. If the blue dots were marked for GMT or BST at the vernal equinox they would be about 15 minutes in error at the autumnal equinox.

Any time path will be marked out for a particular solar declination. In general, each declination occurs twice a year and the equation of time may be very different on the two occasions. The two extreme values of the solar declination occur on the summer and winter solstices and, since these declinations occur only once each, the two associated time paths *could* be marked with GMT or BST times. For consistency, though, it seems prudent to mark all time paths with local solar time, and to provide explanatory information about converting to GMT or BST.

From Fig. 2 it is clear that, for much of a typical day, the shadow crosses roads, walls and rooftops. In theory, any well-defined line or edge in the built-environment is a candidate time path provided that, for at least part of the year, the shadow of the i360 falls on it. As a fortuitous example, around the winter solstice, the shadow falls on a car park which is several blocks to the north of Regency Square.

A time path also needs to be readily accessible to the public though there is nothing to stop residents of Regency Square marking elements of private time paths in their bedrooms if they wish!

Constant-Declination Curves

The four green arcs in Fig. 5 are idealised constant-declination curves and must be treated with caution. Each such curve marks the path followed by the shadow of some

fixed point, a nodus, during the course of a day. The declination is assumed to have some specific constant value throughout the day and the path is assumed to run along level ground.

Using the top of the i360 tower as a nodus presents numerous challenges. One problem is that the top is not a point; it is an open ring that is best treated as a circular disc. Only half the shadow of this disc features in the end of the shadow on the ground. Accordingly, the tip of the shadow in Fig. 5 is shown as a semi-circle. It is hard to estimate its centre but the tip of this shadow can be identified with acceptable precision. This tip marks one point on the most southerly green curve.

Including cladding, the diameter of the i360 is 4.5 metres and, ignoring fuzz, this is the width of the shadow and the diameter of the semi-circle. On a plane surface, the path traced by the *centre* of the semi-circle is a hyperbola, but the path traced by the *tip*, another 2.25 metres further out, is a very slightly distorted hyperbola.

When calculating constant-declination curves a key parameter is the nodus height. The published height of the i360 is 162 metres but, relative to the point on the ground marked by the tip of the shadow in Fig. 5, the height of the top of the tower is 145 metres. The published height is that of the top of the tower above the Admiralty chart datum. The point on the ground marked by the tip of the shadow is about 17 metres above this datum. We are a little way up the sloping west pavement of Regency Square.

The green arc through the tip of the shadow in Fig. 5 is calculated using the solar declination at the summer solstice and a constant nodus height of 145 metres. This arc doesn't take into account variations in nodus height as the path crosses the grassed area of the square and it would be a gross approximation to reality if it were extended across roof-tops.

It would require extensive surveying to calculate the path traced by the tip of the shadow of the i360 at a given solar declination but, subject to planning and other permissions, the i360 Sundial Society proposes, eventually, to mark such lines across the lawns of Regency Square simply by making repeated observations.

Date Paths

The red line in Fig. 5 is a run of kerbing on the edge of the pavement on the west side of the square. This line is a 'date path'. The red dots on this line mark dates rather than times of day and, instead of noting where the shadow as a whole intersects this line, the user notes where the *tip* of the shadow crosses the line.³ On the day of the summer solstice the tip crosses at the red dot marked 21.6 (the i360 Society's way of representing 21 June).

At the summer solstice, the solar declination is at its maximum so the 21.6 red dot marks the most southerly point at which the tip of the shadow can cross this run of

kerbing. Accordingly, the red line does not extend any further south. Three other red dots are marked on the red line for three other declinations. Each of these dots corresponds to two dates, one for when the declination is increasing and one for when it is decreasing.

The positions of the four red dots have been determined by observation rather than by calculation and, from each, one can determine the height of the i360 and deem that to be the appropriate nodus height when drawing the associated green constant-declination curve in Fig. 5. As drawn, these curves are of little value; they would be correct only if they ran along cartographic contours.

In Fig. 5, the red dots are shown at roughly monthly intervals. In practice, on this single date path, there could be dots at daily intervals from March until October but they would be very close together for a week or so either side of the summer solstice.

Observing the Tip of the Shadow on Date Paths

An obvious difficulty that concerns any large sundial is deciding just which part of the penumbral region of the shadow to use. A useful approach when observing the tip of the shadow of the i360 is to walk along the approximate centreline of the shadow, away from the tower towards the tip, until the shadow of your head *just* starts to appear. This will be much sharper than the shadow of the tip of the tower and using the position of the tip of your own shadow leads to a more precise observation.

The tip of the i360 shadow moves quite quickly and, when using the date path marked in Fig. 5, the observer is best advised to watch the tip of the shadow as it runs down the front of some building onto the pavement and then closely track the tip as it crosses the pavement. This gives sufficient time to be confident of the position of the tip when it reaches the kerb.

For this reason, it is better to place the red dots in Fig. 5 on the kerb edge of the pavement than on the inside edge of the pavement. On the pavement on the east side of Regency Square this consideration is less important. One can readily observe the tip of the shadow crossing the road and then crossing the pavement so it would not be a problem to have the dots along the inside edge of the pavement.

Time Paths and Date Paths – A Precedent

There is nothing particularly novel about using time paths and date paths that have no special mathematical significance as they do in the stereographic projection. Fig. 6 shows a fanciful use of time paths and date paths on an azimuthal sundial devised by Mike Cowham.⁴

The distorted circles are time paths. The innermost time path, bordering the green central area, is the time path for the summer solstice. The times are not marked by dots but by the inner ends of the distorted radial lines. Times are marked from 4 am to 8 pm but the time paths are continued through the night. Seven time paths for seven different

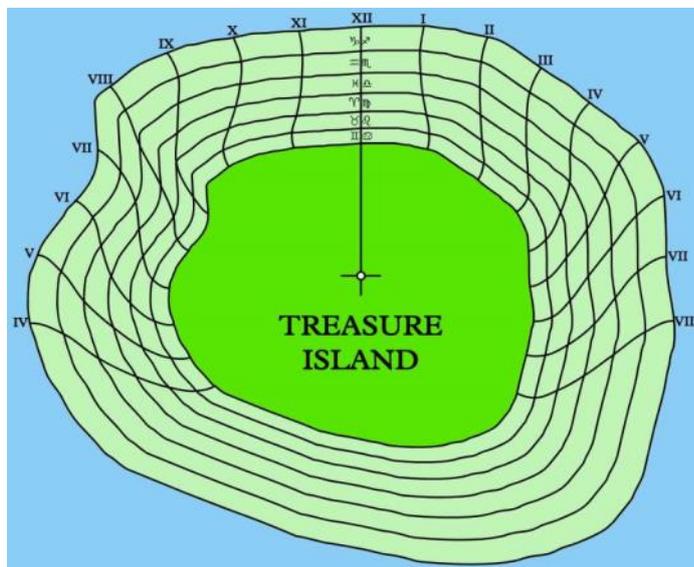


Fig. 6. *Treasure Island, a fanciful design for an azimuthal sundial by Mike Cowham.*⁴

declinations are shown in Fig. 6; this contrasts with the three time paths initially proposed for the i360.

Note that each distorted radial line relates to a specific time. Such a line therefore corresponds more to the hour lines in the stereographic projection of Fig. 4 than to a date path like the red line in Fig. 5. No times will be associated with any of the dots on the red lines.

Observing the Shadow on Time Paths

When using the stereographic projection of Fig. 4, it was explained that the observer should note where the *centreline* of the shadow crosses the relevant date path. The shadow of the i360 is 4.5 metres across and it is difficult to determine the centreline with any precision. It turns out to be easier to use the *edge* of the shadow. You look along the shadow towards the tip but shuffle sideways *to the right* until you can just see the shadow of your outstretched right hand. You then walk forwards or backwards until the shadow of your hand falls on the time path that is applicable to the day of the observation.

This explains why the north pointer in Fig. 5 doesn't point at the 12:00 blue dot. At this time the *centreline* of the shadow aligns with the north pointer but it is the *leading edge* of the shadow that intersects the 12:00 dot. Note that one uses the leading edge of the shadow whatever the time of day.

An Alternative Method of Observation

Contrary to the remarks just made, there is a way of determining the position of the centreline of the shadow with some measure of precision but it is too dangerous to recommend for public use. Provided you are not too far from the tower, and exercise considerable care, you can stand near the centre of the shadow and look straight at the sun. Fig. 7 shows how the sun appears when standing on the shadow's centreline about 130 metres from the tower.



Fig. 7. A photograph taken from a position on the centre of the shadow looking directly into the sun. The tower is about 130 metres from the camera and subtends an angle of about 2° .

The angular diameter of the solar disc appears to exceed the angular diameter of the tower but this is not really the case. At 130 metres, the angular diameter of the tower is about 2° or roughly four times the angular diameter of the solar disc. The brightness on either side of the tower is the result of the scattering of sunlight by high-altitude clouds.

If you move even slightly to one side, the brightness on that side will greatly outweigh the brightness on the other side. This is therefore a precise way of determining the centre of the shadow but it is hazardous. At the north end of Regency Square the angular diameter of the i360 tower is only just over twice that of the sun and the scattered sunlight is becoming dangerously bright. It would be most unwise to recommend this approach. It is safer to make observations by studying the edge of the shadow and that is how the time marks will be positioned.

Marking Times and Dates

The blue and red lines and dots in Fig. 5 do not reflect an intention to paint blue and red lines and dots on the pavements round Regency Square. Instead, the i360 Sundial Society proposes to mark times and dates with bricks, each $200 \times 100 \times 50$ mm in size. The bricks would be home-made, from sand and cement, and the numbers would be chromium plated brass such as are sold for house numbering.

Fig. 8 shows some of these bricks. Three time bricks are shown (11:59, 12:00 and 12:01); these are separated by

unmarked bricks used as spacers. The bricks are spaced as they would be on the blue line in Fig. 5.

Ten date-path marks are shown. One may imagine these being placed alongside the kerb marked in red in Fig. 5. In the days leading up to the summer solstice the bricks are to be viewed from the north, in the direction of travel of the sun. This is why the bricks marked 9.6, 10.6, 11.6, 12.6 and 14.6 are upside down. On the day of the summer solstice and the days that follow, the bricks are to be viewed from the south. The relevant bricks in Fig. 8 are marked 21.6, 28.6, 30.6, 1.7 and 2.7.

The solar declination is changing so slowly at the summer solstice that if the instant of the solstice were at 12:00 then 24 hours later the displacement in the position of the tip of the shadow would be little more than 10 mm. This explains why there are missing dates!

Project Funding

The costs involved in making the bricks shown in Fig. 8 suggest a rough figure of £60 per brick laid. This would include the materials and labour in making the bricks and the work involved in transporting them to and laying them in the pavements and paths.

The i360 Sundial Society is proposing that the sundial should be a large-scale project planned and built by the community and led by Brighton's Trust for Developing Communities.⁵ A request has been made to the Council for 0.5% of i360 sales from 2018. It is estimated that this would bring in £40,000 a year which equates to funding nearly 700 bricks per year.

Conclusions

The Secretary of the i360 Sundial Society, John Kapp, reports that this project has been received enthusiastically by many people who have been approached, including councillors, planning officers, community leaders and the



Fig. 8. A selection of bricks for marking times (three examples are shown) and dates (ten examples are shown). Photo: John Kapp.

designer of the i360, David Marks. The Society is confident that the project will go ahead when the funding stream arrives in 2018.

Anyone who is interested in this project would be most welcome to join the i360 Sundial Society and play a role in the detailed design of the time paths and date paths and also help prepare material to appear on information boards and leaflets. It is hoped that one day, there will be guides who would give explanations to visitors and to school children. There is considerable scope for school projects.

ACKNOWLEDGEMENTS

The author is most grateful to John Kapp of the i360 Sundial Society for providing detailed information about the proposals. The Society in turn would like to acknowledge the considerable help and advice that it has received from Jackie Jones and David Brown, trustees of the British Sundial Society.

REFERENCES and NOTES

1. Frans W. Maes: 'The sundial of Emperor Augustus: Rise and decline of a hypothesis', *NASS Compendium*, 12(3), 13–27 (2005). This article provides a scholarly summary of different 20th-century interpretations of the sundial and includes an extensive bibliography.
2. Further information about the i360 Sundial Society can be found at their website <https://i360sundial.org.uk>
3. The current thinking of the i360 Sundial Society is not to use the tip of the shadow of the tower but, instead, to use the leading shoulder, where the semi-circle meets the straight line of the leading edge of the shadow. The Society are confident that observations made in this way can be precise.
4. M. Cowham: 'Horizontal azimuth dials', *BSS Bulletin*, 27(iv), p.30 (December 2015).
5. The Trust for Developing Communities delivers youth work across Brighton. See: <http://brightonandhoveyouthcollective.org.uk/city/brighton/trust-for-developing-communities>

For a portrait and CV of **Frank King**, see *Bulletin* 23(iii), September 2011. He can be contacted at fhk1@cam.ac.uk

HOLIDAY PICTURES

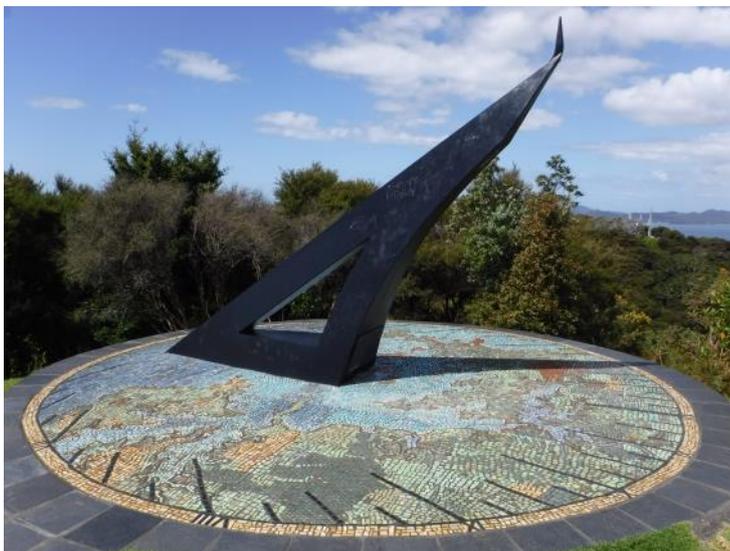
This photograph of a sundial on Flagstaff Hill, Russell, in North Island, New Zealand, was sent to David Payne by his friend Charles Bartram.

It is situated at 35° 15' 20" S, 174° 07' 15" E and overlooks the beautiful Bay of Islands.

The colourful dial plate is a mosaic designed and assembled by Margaret and Peter Coup of Kaikohe in 1990; it depicts the Bay of Islands.

On the underside of the gnomon is a plaque, shown below, indicating that the dial commemorates the centenary of the New Zealand Institute of Surveyors (1888–1988). It bears an Equation of Time table with the instructions:

TO CONVERT SUNDIAL TIME TO NEW ZEALAND STANDARD TIME
 NEW ZEALAND DAYLIGHT SAVING SUMMER TIME ADD 1 HOUR
 AT ALL TIMES ADD:



The sundial is a few metres from the summit of Flagstaff Hill (also called Te Maiki), a place of great significance in New Zealand's history. The Union Jack was flown there by the British for the first time in 1840, but the flagstaff was chopped down by a local Maori chief Hone Heke or one of his allies four times during 1844 and 1845 as a symbolic gesture against British rule.¹

Can any reader supply further details of this dial? The hour lines and subdivisions do not seem to be marked out from two centres; there is no sign of a noon gap.

REFERENCE

1. [https://en.wikipedia.org/wiki/Flagstaff_Hill_\(New_Zealand\)](https://en.wikipedia.org/wiki/Flagstaff_Hill_(New_Zealand))

READER'S LETTER

Location of the Hastings Sundial – Discovered

In the December 2016 issue of the *BSS Bulletin*, I requested help in identifying the location of the Hastings town sundial that had been worked on by my five times great-grandfather, Joseph Wakeham Carswell.¹ Since that article was published, my wife Ruth and I have done further research in Hastings and on-line – and it is pleasing to report that the location has come to light.

A problem with early property transactions is that the property is described by those around it, rather than by a specific address, and this can make precise location difficult. The following transaction is described in this way:

*“Lease for a year 25 December 1782: Robert Manser of Hastings, cordwainer, to John Gibson of Hastings, gent a shop or building and the toft whereon the same was standing near the Stone Beach in Hastings All Saints (E: premises of Edward Capell of Hastings deceased; W: the Sun Dial; S: a tanhouse theretofore of John Sarjeant)”*²

Fortunately, the premises of Edward Capell deceased are well known: in 1760 he acquired the site of an old cottage and stables occupied by Benjamin Carswell until 1757, and built a grand house, East Cliff House, which still stands today, being used by Webbe's restaurant (Fig. 1). So from east to west we have East Cliff House, the Manser/Gibson property, then the sundial. Today, All Saints Street has been extended to run immediately to the west of East Cliff House, but in the 18th century it stopped at the town wall. It appears the Manser/Gibson property will have been demolished in the extension process.

Further confirmation of the location comes from Charlotte Osborne's *Stranger's Guide and Directory to Hastings and St. Leonards*,³ which includes the following passage:

“... at the foot of All Saints Street, adjoining East-cliff house, was an Arched Gateway, with a flight of stone steps leading down into the harbour. Under the wall where Pleasant Row now stands, was the 'Martin's Nest', a place of shelter for old fishermen. ... The plate of the Sun Dial at the 'Look-out' on the East Hill, was taken from one formerly standing nearly opposite the 'Martin's Nest'.”

J. Mainwaring Baines indicates that there were cottages on Pleasant Row from at least 1724,⁴ so the sundial must have been in front of those cottages, the spot today where the flagpole and sculpture for the Winkle Club now stand (Fig. 2). There is a net shed on the other side of Rock-a-Nore Road, roughly where John Serjeant's tan-house would have been, but the sea itself was much closer than it is now. It also would appear that the dial was a plate, presumably of metal, a material that Joseph Carswell was comfortable with, rather than wood or stone.

The 'Look-out' on the East Hill was, and still is, at the top of Tamarisk Steps leading from Rock-a-Nore Road (just east of East Cliff House) to Tackleway. It was where the



Fig. 1. Looking north towards the site of the dial. Behind the net shed is Rock-a-Nore Road, with Webbe's Restaurant (formerly East Cliff House) on the right.



Fig. 2. Winkle Club sculpture and flagpole beside Rock-a-Nore Road, with All Saints Street and Webbe's Restaurant behind.

wives looked out to sea waiting to see if their men were coming in safely from fishing. It seems likely the original dial was moved there when the new stone dial was erected at the end of the Parade in 1851.

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2. East Sussex Record Office SAS/B 16.
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Bob Wilcock

IN THE FOOTSTEPS OF THOMAS ROSS

Part 19: Some Sundials of East Lothian

DENNIS COWAN

The region of East Lothian is on Scotland's east coast and borders Edinburgh and Midlothian to the west with the Scottish Borders to the south, and has coastlines on the Firth of Forth and the North Sea. It has more hours of sunshine than any other region of Scotland – perfect for sundials!

In volume 5 of *The Castellated and Domestic Architecture of Scotland*,¹ Thomas Ross mentions a number of dials in this area and six of them will be covered in this article.

Dunglass Collegiate Church is situated in the very south-east corner of East Lothian just off the main A1 road. The age of the church is unclear but it was known to be in existence in 1421. An Act of the Scottish Parliament in 1563 abolished Mass and the church's days as a Roman Catholic chapel were over.

It was used as a parish church until the 18th century when it was sold to a farmer. The building was desecrated at some point thereafter when the east window was 'modified' to make an opening to allow the church to be used as a barn (Fig. 1). In 1807 some dignity was restored when Sir John Hall bought Dunglass; the family later used the south transept as a burial aisle. The church is now in the care of Historic Environment Scotland, so no more 'modifications'.

There is a rather unusual structure within the grounds of the church and Ross describes it thus:

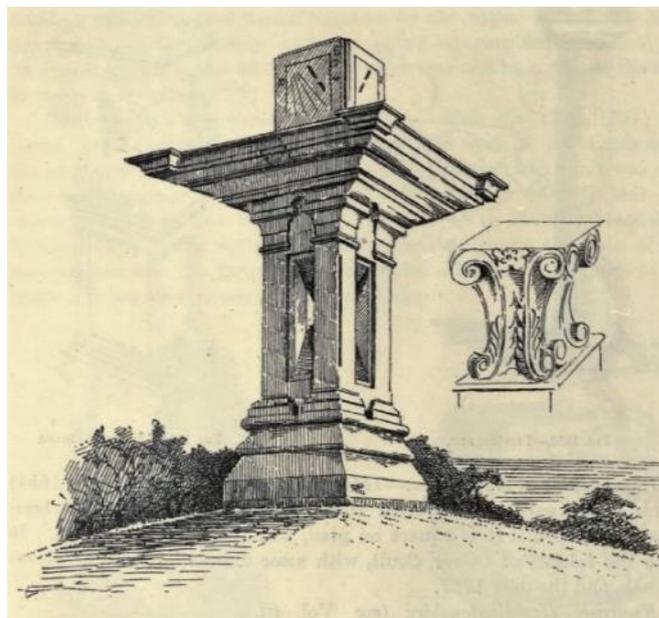


Fig. 2. Ross's sketch of the Dunglass dial, also showing the loose stone.

"This dial [Fig. 2] stands on the summit of a circular artificial mound about fifty yards south-west from the ruined Collegiate Church of Dunglass. It is square on plan, and has very much the appearance of being a fountain, with what seems to be a broad projecting square. The dials



Fig. 1. Dunglass Collegiate Church, showing the 'modification'.



Fig. 3. East face of the Dunglass dial.



Fig. 4. West face of the Dunglass dial.

The main difference today, apart from the general deterioration of the dial faces (Figs 3 and 4), is that the loose stone mentioned by Ross and shown in Fig. 2 is now been fitted to the top of the cubic dial stone. As Ross suggests, it was probably part of the original structure and it does not look to be out of place in its current position (Fig. 5). However, the possibility that the structure served some other purpose originally cannot be ignored, as it seems perhaps unlikely that the whole structure was designed as a sundial.

Further west, Fountainhall near Pencaitland dates from the 17th century and is a typical Scottish Laird's house of the period, although it underwent several phases of extension in the next hundred years or so (Fig. 6). Ross describes two dials at Fountainhall, and of the first he says:

"This charming old mansion has a dial [Fig. 7] on the south-west corner. Fountainhall is a seventeenth century building, and the supporting stone seems to be part of the



Fig. 5. The Dunglass dial today.

are on the top of the seeming basin, the upper surface of which is flat; they measure about 15 inches square by about 2 feet high; but it is doubtful if this part of the structure is in its original condition. There are various loose stones, moulded and carved, lying about, one of which is here shown [in Fig. 2], and it seems probable that these are connected with the dial. The height from the ground to top of basin is about 6 feet 2 inches, and across the basin the measurement is 5 feet 1 inch; the width across the pedestal is about 20 inches."



Fig. 6. Fountainhall mansion house with the large cantilevered dial on the corner.

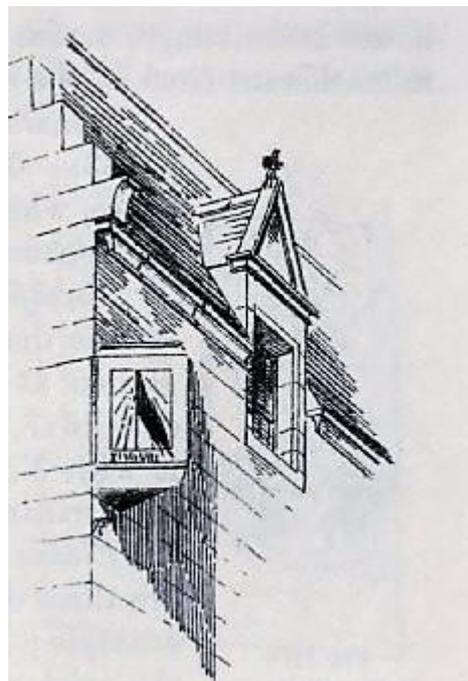


Fig. 7. Ross's drawing of the Fountainhall dial.



Fig. 8. Close-up of the Fountainhall dial.

original structure, but the dial itself is evidently of later workmanship, and is believed to have been put up by Sir Andrew Lauder about the end of last century. The dial faces due south, and is accurate as a timekeeper.”

Today the dial, which has Roman numerals, is in rather poor condition with its face badly flaking (Fig. 8). As Ross says, it does not appear to be original and it may have been a replacement dial. Ross identifies another dial at Fountainhall as follows:

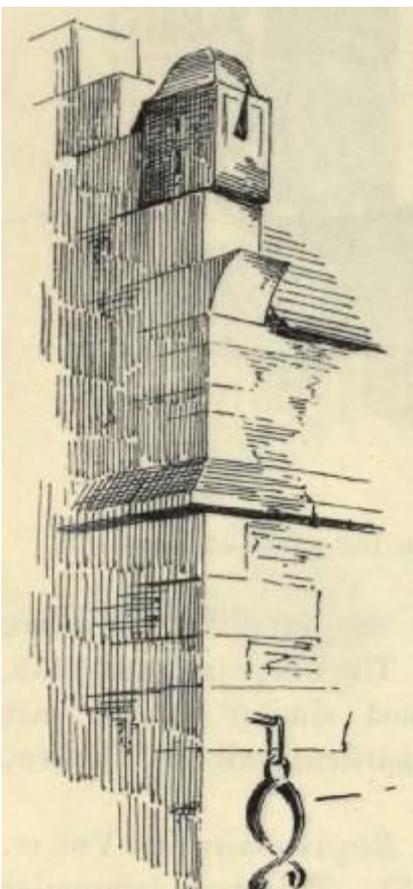


Fig. 9. Ross's sketch of the other Fountainhall dial, also showing the 'jougs'.

“This singular juxtaposition of a dial and ‘jougs’² [Fig. 9] is to be found on a pigeon-house at Fountainhall. The old mansion-house was the residence of Lord Fountainhall (Sir John Lauder), and the tradition that he held occasional public courts of justice here is not lessened by the presence of the ‘jougs’ on one of his pigeon-houses. Only one gnomon of the dial remains entire; the stone faces have scaled off, and it is altogether in a neglected state; while the pigeon-house itself has been allowed to fall into total ruin. This and another pigeon-house stand about fifty yards south of the mansion-house, the ancient approach to which passed through between them, so that the ‘jougs’ and dials were in full view of all visitors.”

Given Ross’s description it is not surprising that this dial is now missing. The current owners, who have owned the house for only a short time, have no knowledge of it. The remains of a pigeon house are still in place but whether it is the one that had the sundial and jougs, or the other one mentioned by Ross, is not clear.

Less than three miles away lies the village of Ormiston, the location of a sundial recorded by Ross but about which he says only that:

“This simple dial [Fig. 10], supported on a moulded bracket, is placed below the eaves of a two-storied house in the village. It bears the date 1736.”

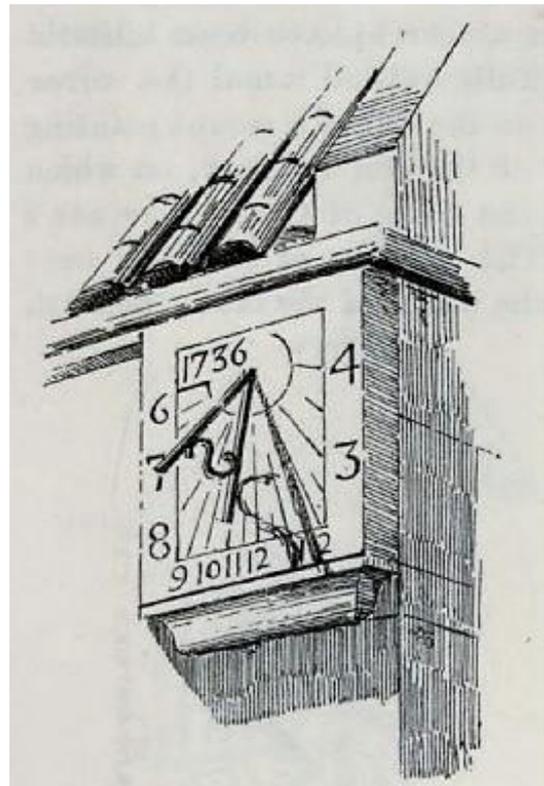


Fig. 10. Ross's sketch of the Ormiston dial.

This sundial today has been replaced by a modern dial (Fig. 11) which appears at first glance to be a faithful copy, particularly regarding the differing sizes of the numerals. However, a closer examination shows that 5pm has been added, the gnomon is positioned too low down and the hour lines do not all radiate from a single point (Fig. 12). I think

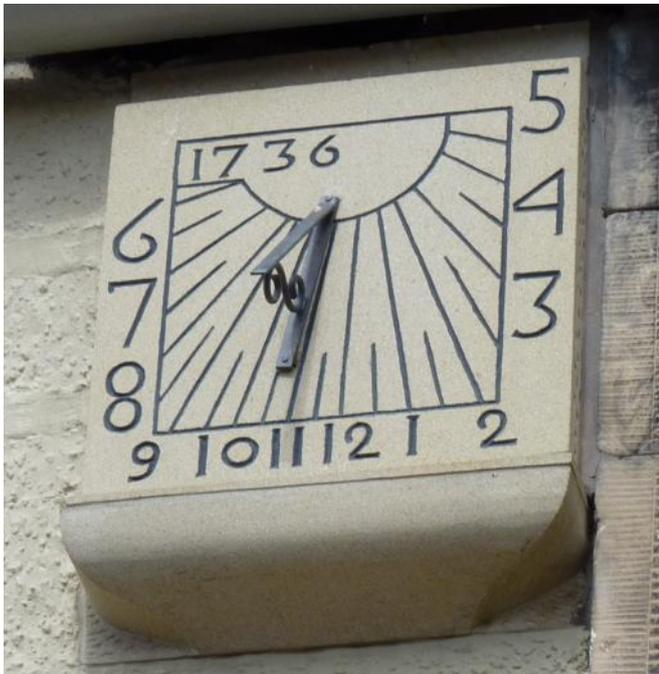


Fig. 11. The modern replacement of the Ormiston dial.

that it was John Allen who originally pointed out the hour line anomaly to me. Unfortunately I have been unable to find out what happened to the original dial.

Ross comments on another dial, at the nearby Ormiston Manse, by saying:

“The dial here [Fig. 13] stands on the top of the garden wall, but, as appears from an inscription on it, DEDICAT TO THIS CHAPEL BE THE (PARISHIONERS?), it is obviously not in its original position, but probably stood on one of the corners of the old church of Ormiston, to which it was

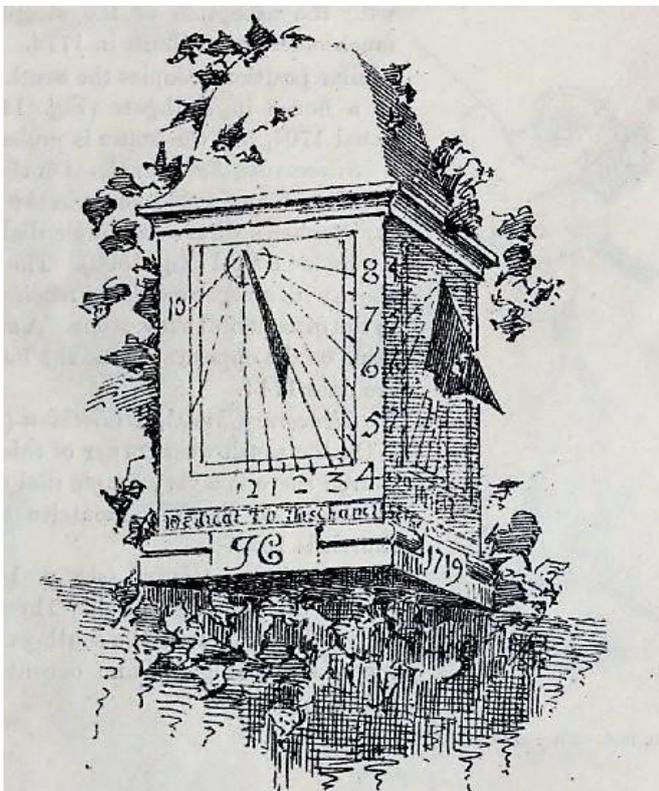


Fig. 13. Ross's sketch of the Ormiston Manse dial.

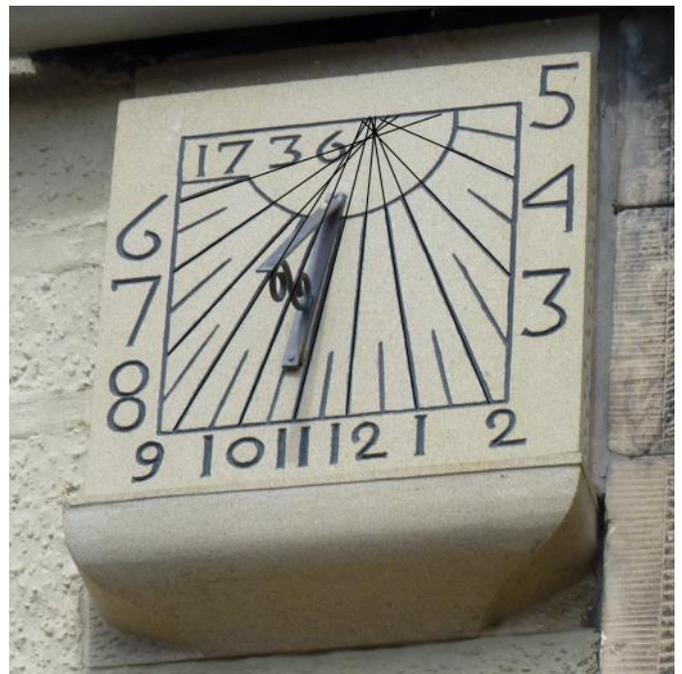


Fig. 12. The Ormiston dial with the hour lines extended.

gifted. The reading of the end of the inscription is very obscure. We have suggested the ‘parishioners,’ but are not at all confident of this, especially as it also contains beneath the initials J.C., probably some member of the Cockburn family, who would not likely place his private initials on a public gift. It further bears the date 1719.”

The manse has been a private house for many years and unfortunately the sundial has disappeared.

The village of Garvald is situated virtually in the centre of East Lothian, and nearby is Nunraw Abbey Tower (Fig. 14) which until recently was the home of the Cistercian monks in Scotland (or at least used by them as a guest house). There is a multi-faceted sundial in the grounds and Ross comments that:

“This dial [Fig. 15] stands in the grounds of Nunraw House, and Mr. Walter Wingate Grey of Nunraw, in sending a photograph, writes: ‘The small dials include dials for Cairo, Ispahan, Jerusalem, Mount Sinai, Jamaica, etc., and also Savannah, Philadelphia, etc., which shows that it cannot be more than a hundred years old; also on



Fig. 14. Nunraw Abbey Tower. Photo copyright Renata Edge and licensed for re-use under Creative Commons Licence.

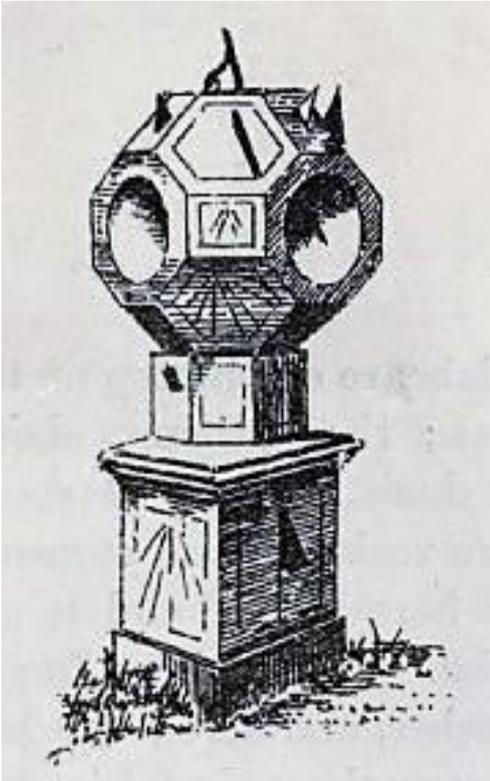


Fig. 15.
Nunraw dial
by Ross.

one of the sides of the pillar there is a system of figures for making an equation of time.' The upper, or faceted, part has the usual dials, hollowed and plain."

Ross's correspondent probably wasn't far out on his estimation of the age of this dial. Although Savannah was involved in the American War of Independence in the late 18th century, it was probably its appearance as a prominent seaport in the early 19th century that earned it a place on this dial, so that would put its age at around 80–90 years at the time of the original writings.

This dial has three sections and at the time of my visit (in 2009) the dial was lying on the ground in two parts (Fig. 16). The upper faceted part, which has 25 dials, is lying on its own and is in reasonable condition other than some missing and broken gnomons and some lichen growth. It has large vertical scaphe dials on the cardinal points and also has vertical, proclining and reclining dials as well as a horizontal dial on top.



Fig. 16. The two separated parts of the Nunraw dial.



Fig. 17. The east and south-east faces of the octagonal stone with JERUSALEM marked on the south-east face.



Fig. 18. The south-facing dial of the cube.

The other two parts (a cube and an octagon) are still connected in one piece as can be seen in Fig. 16. The octagon has dials on all eight vertical faces and the east and south-east faces are shown in Fig. 17. There is an inscription on the west face of the cube but it is badly flaked and hard to read. This is at odds with Ross's sketch of the west face which appears to show a dial face wrongly delineated. The south face on the other hand has a dial which, although faint (Fig. 18), can be easily read. This is the only dial on the cube, where the north face is blank and the east face contains the equation of time mentioned above.

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1. D. MacGibbon and T. Ross: *The Castellated and Domestic Architecture of Scotland*, David Douglas, Edinburgh (1892).
2. Common at one time in Scotland, a set of joughs was an iron collar normally attached by a chain to a wall. The collar was placed round the offender's neck and fastened by a padlock. Time spent in the joughs was intended to publicly shame the offender. Source: <https://en.wikipedia.org/wiki/Joughs>

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THE NAVICULA

Made in Medieval East Anglia?

JOHN DAVIS

This article is based on the presentation made at the 2017 BSS Conference in Oxford.

The navicula is an extremely rare and interesting portable altitude dial dating originally from the late Middle Ages: see Fig. 1 for an example. As well as several articles, a whole book has been published dedicated to the subject.¹ There are only five extant medieval examples from that period in the world, all currently in museums, together with reliable written evidence of one further example. There was a revival of interest in the navicula in the 16th century following the publication of a description in a book by Oronce Finé² and several examples of his somewhat simplified geometry³ also exist (sometimes called ‘ship-shaped dials’ to distinguish them from the medieval originals⁴) in museums – an example is shown in Fig. 2 – though they will not be considered further here.

The existing medieval examples are now in the National Maritime Museum, Greenwich,⁵ the Oxford Museum of the History of Science,⁶ the Musée d’Histoire des Sciences,

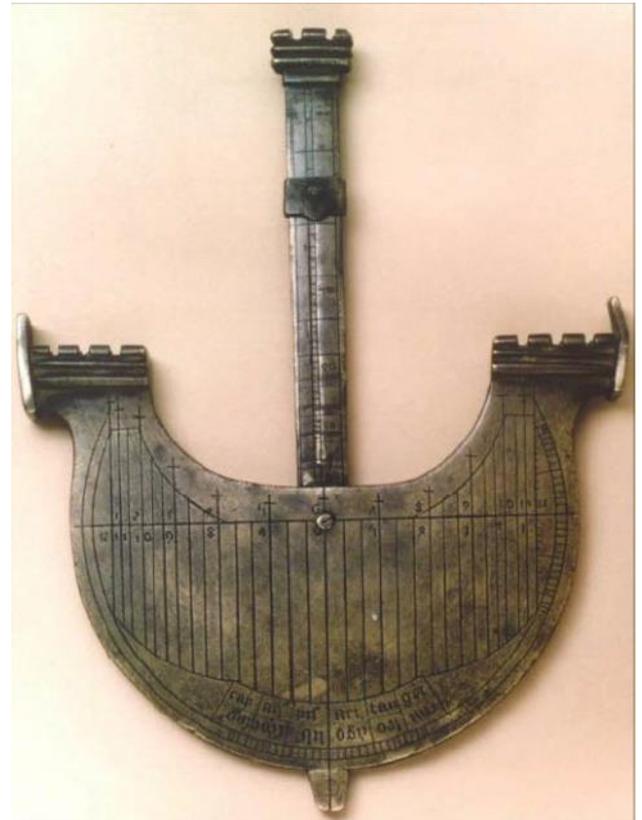


Fig. 1. Photograph of the medieval navicula now in Geneva. Photo courtesy Musée d’Histoire des Sciences, Geneva.

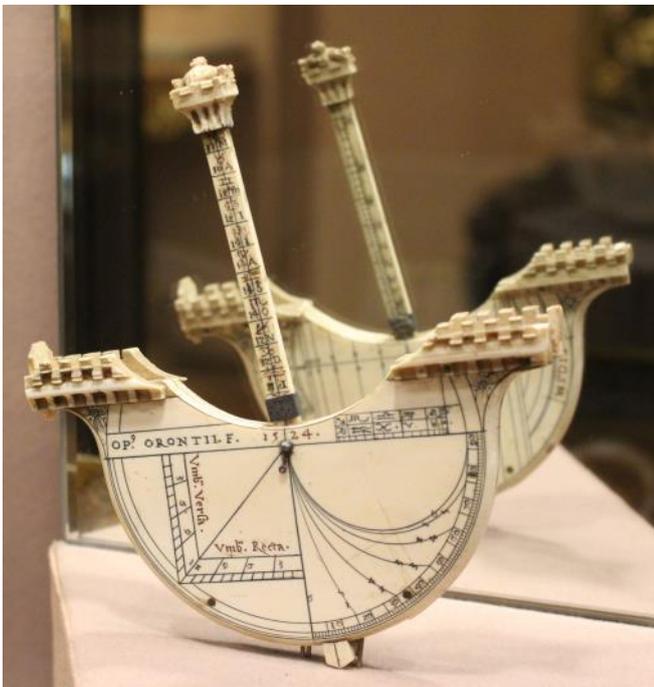


Fig. 2. Photograph (in front of a mirror) of the later ‘ship-shaped dial’ by Oronce Finé and dated 1524, in Museo Poldi Pezzoli, Milan (inv. no. 4277). This example, unusually, is in ivory. Photograph courtesy of Darek Oczi.

Geneva,⁷ and the Museo Galileo (previously the Istituto e Museo di Storia della Scienza), Florence.⁸ A detailed engraving of a fifth navicula was published in a letter to the *Gentleman’s Magazine* in 1786 although the whereabouts of the actual dial are now unknown.⁹ During the research for this article, a further medieval navicula was found by a metal detectorist and it currently resides for analysis with the National Museums Scotland so it will be referred to as the ‘Edinburgh’ navicula, though it was excavated elsewhere. The sizes and basic features of the medieval naviculae are shown in Table 1. Although all of these examples were found in Britain they were originally attributed to Germany by Lewis Evans and Robert Gunther, possibly because the design geometry is similar to that underlying the Regiomontanus dial and to the Organum Ptolomei.¹⁰ The dial now in Florence is of quite a different style from the other five: it was at one time in the Medici

	Mast overall	Mast pivot to 60° latitude line	Sight–sight o’ all	12–12	Hour Divisions
Oxford	93.8	42	82.6	52.4	½
Greenwich	110	49	89	51	½
<i>Gentleman’s Magazine*</i>	158	51	128	55	⅓
Geneva	162	73	120	83	⅓
Edinburgh	132	71	107	75	⅓
Florence	171	78	92	80	⅓

* taken from the full-size printed drawing, assumed 1:1.

Table 1. A list of the known medieval navigulae with their key dimensions (mm) and time divisions.

collection.¹¹ Although it may possibly be English-made, it will be considered separately from the other five which are all stylistically very similar. It is now generally accepted that the navigula is uniquely English, partly because the list of latitudes engraved on some of them are all for English towns and cities and partly because all the manuscript descriptions of their design and use have English roots: no navigulae have been excavated outside England. Until now, no-one has tried to narrow down the location of their origin but I wish to suggest here that they are quite likely to have come from medieval East Anglia, possibly from an as-yet unidentified workshop in Norwich or Bury St Edmunds.

There is almost no information on the actual making of any scientific instruments in the Latin West during the Middle Ages until the emergence of the Parisian workshop of Jean Fusoris at the very end of the fourteenth century and early fifteenth.¹² The existence of a small number of well-made instruments, particularly astrolabes and quadrants, from the previous century shows that some centres of expertise must have existed in England, quite probably located in universities and monasteries. Individual scholars, such as the ‘Oxford calculators’ at Merton College, seem to have made their own individual (and rather idiosyncratic) instruments in the mid-fourteenth century. At about the same time, there was a centre at St Alban’s Abbey which was possibly a spin-off of the workshop that produced Richard of Wallingford’s celebrated astronomical clock¹³ and which was supplying simple quadrants.¹⁴ But the source(s) of the great Sloane astrolabe¹⁵ and the much smaller one known as ‘Caius B’,¹⁶ both in the 1320s, are yet to be identified.

Operation and Design of the Navigula

The navigula is a surprisingly sophisticated altitude dial considering its early invention date, thought to be in the late-14th or early-15th century. John Whethamstede (ca. 1400–1465), an Abbott of St Alban’s Abbey, credited its invention to a Benedictine monk called Peter of Muchelney.¹⁷ It is ‘universal’, i.e. for latitudes between the tropic of Cancer and the Arctic circle, and shows equal hours which had become the standard form of timekeeping only relatively recently. Although David King makes much of the fact that the principles it uses were available in 9th-century Baghdad,¹⁸ in its navigula form it does seem to be a

uniquely English development and was in use around half a century before the more widely-known Regiomontanus dial in Germany which was based on the same principles but using a strictly practical rectilinear shape.

Making a navigula involves drawing four separate non-linear scales.¹⁹ Firstly, the positions of the parallel hour-lines must be set out. Then, the positions of the slider on the mast from which the plumb-bob is suspended must be calculated for the range of latitudes required. Next, the arc on the ‘keel’ with the zodiac dates which determines the tilt of the mast is drawn, with the equinoxes in the centre. Finally, a different date scale is required on the side of the hull (invariably the right, or stern side) to allow the correct setting of the time-indicating bead on the plumb-line. To aid conversion of the civil date to the sun’s position in the zodiac, a table giving the dates of its entry into each sign is usually provided. Not all the navigulae are correctly delineated and it seems that even Oronce Finé made some ‘approximations’.

The Five/Six Navigulae

The only one of the group of similar medieval navigulae with an unequivocally East Anglian origin is the instrument now in the National Maritime Museum (NMM, Greenwich, Fig. 3) which was excavated by a metal detectorist in 1989 at the remains of Sibton Abbey, near Yoxford in the north of Suffolk (Fig. 4). Sibton Abbey was founded ca. 1150 as the only Cistercian abbey in East Anglia, twinned with Warden Abbey in Bedfordshire. It was one of the main houses under the control of the Bishop of Norwich and it grew rich through dealings in the wool trade. There would have been many monks and merchants travelling to Sibton from Norwich and King’s Lynn (a Hanseatic port) and beyond so it is not difficult to see one of them losing their portable dial.

The navigula in the Oxford Museum of the History of Science (Fig. 5) was originally part of the museum’s founding Lewis Evans collection. Examination of Evans’ handwritten inventory card shows the revealing footnote “Given to me by Mr Reve, curator of the Norwich Museum 1898”. ‘Mr Reve’ can be identified as James Reeve who was indeed a long-standing curator and benefactor at the museum.²⁰ His personal collecting interest was in the



Fig. 3. The navicula found at Sibton Abbey, now in the NMM, Greenwich. Photographs by the author, with thanks to the National Maritime Museum.

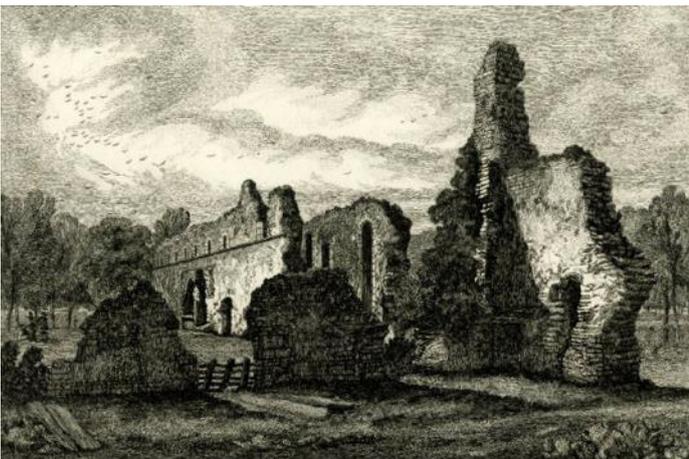


Fig. 4. The remains of Sibton Abbey, in an 1827 etching by Henry Davy (above) and photographed in 2014 (below).

painters of the Norwich School (he sold his collection to the British Museum) but he would have been a natural recipient of ‘curiosities’ brought in by local residents and he had a very wide range of connections at all levels of society. Though there is no guarantee that the navicula was local,



Fig. 5. The Oxford navicula. Courtesy of the Oxford Museum of the History of Science, inv. no. 54358.

the chances are high that it had not travelled far. Its condition suggests that it was probably found by excavation. This navicula was the first one to come to modern attention: David King calls it “crudely-made” and “a crude imitation of better instruments from 14th-century England” but he is wrong – it is just smaller than some of the others and has been buried for a long time.²¹

It was initially less easy to find an East Anglian link for the navicula in the Musée d’Histoire des Sciences, Geneva (called the Geneva navicula in the rest of this paper). It is rather larger than the Oxford and NMM examples (the overall height of its mast is 162 mm) but it is in almost pristine condition and it shares most of their stylistic features. The Geneva museum purchased it in 1993 from the dealers Trevor Philip & Sons who had recently bought it at a Sotheby’s auction for £36,000.²² There, it had been consigned by the descendants of a John Wilson who had owned it in the 18th century. John Wilson (1719–83) lived at Broomfield Hall near Sheffield and he was a prolific collector of early manuscripts and books, particularly on the history of the region around the Hall, as well as of other ‘curiosities’.²³ Sheffield is a long way from East Anglia so it was difficult to see how the dial could have got there as there were no national sales of antique scientific instruments, or indeed other curiosities, at that time. Of course, it could have been lost or given away by a traveller but it initially seemed just as likely that it had local origins. However, looking deeper into Wilson’s development as a minor collector produced a very significant fact: his mother’s brother was the Rev. Cox Macro, DD, a well-known antiquarian and important collector of manuscripts and many other antiquities and very likely the role-model for Wilson. Cox Macro (1683–1767) lived at Little Haugh Hall in the parish of Norton, seven miles east of Bury St Edmunds in Suffolk (Fig. 6). He was educated at Christ’s College, Cambridge, was a chaplain to the King and a J.P.²⁴ Wilson actually catalogued Cox Macro’s collection shortly before his death in 1767²⁵ but unfortunately the navicula is not listed amongst the items, which range from paintings through manuscripts to items such as a “bull pizle” and an Indian tomahawk! It is, though, quite possible that Macro had already passed the navicula to Wilson who clearly kept it separate from his own collection, as evidenced by the fact that it remained in the family after his death even though most of his collection was auctioned off. Evidence of Munro’s interest in scientific items is shown by the fact that he once owned a codex originally from the abbey of Bury St Edmunds in the 14th century. It is now in the Cambridge University Library²⁶ and amongst its separate manuscripts are a copy of the



Fig. 6. Little Haugh Hall in Suffolk, painted by the Dutch painter Peter Tillemans (1686–1734), the home of the Rev. Dr Cox Macro, who was a possible 17th-century owner of the Geneva navicula. Courtesy of the Norwich Castle and Museum (Patterson Collection).

pseudo-Massahala treatise on the astrolabe and several astronomical tracts by Robert Grosseteste.

The navicula illustrated in the *Gentleman’s Magazine* (Fig. 7) was drawn by the correspondent “W.B.” from Colchester, in Essex just south of the Suffolk border. All efforts to identify W.B. have so far failed. In his letter, he says that the engravings are accurate enough to allow a replica to be made though they carry no scale. There are no clues to how this navicula was obtained: the drawings show no imperfections or damage which may indicate that it has not been found by excavation though the artist may have decided to show a ‘perfect’ representation. Although the engravings show it to have a style extremely similar to the extant examples, some small features have slight variations and thus indicate that they are of a different example which is now lost – there remains a possibility that it will one day re-appear.

The Edinburgh navicula (Fig. 8) is still undergoing conservation but it can be seen to follow the style and layout of the Geneva instrument quite closely.

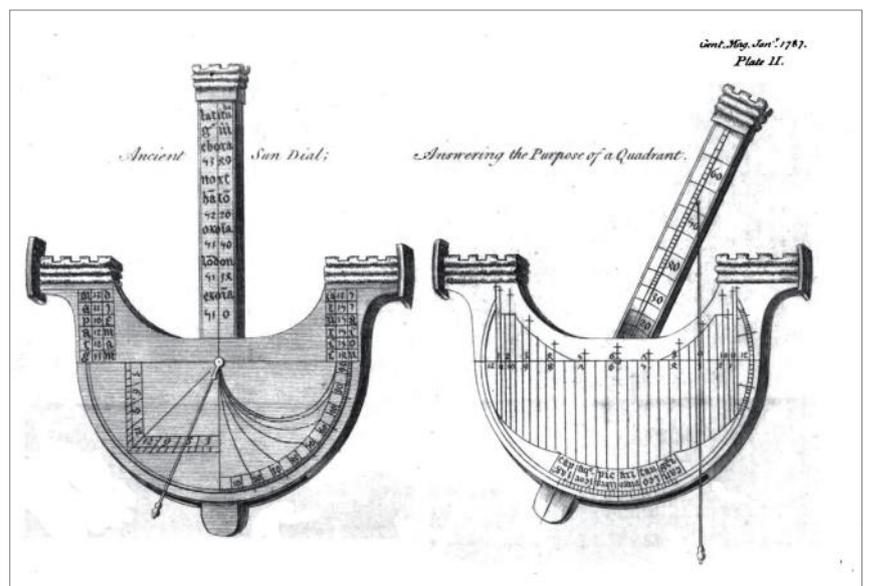
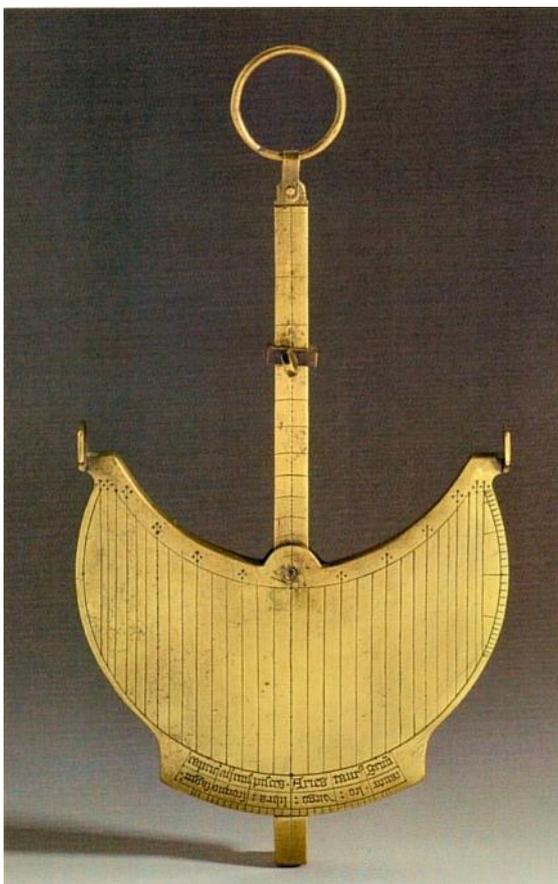


Fig. 7. The *Gentleman’s Magazine* navicula drawing.



Fig. 8. The Edinburgh navicula. Photos courtesy of Tacye Phillipson, National Museums Scotland.



*Fig. 9.
The Florence
navicula (front
and back).
Photos courtesy of
the Istituto e Museo
di Storia della
Scienza.*



The Florence navicula (Fig. 9) can be seen to have a completely different style from the others although the general principles, form and construction are the same. It is of high quality but it is unfinished in that the scales are unnumbered. The engraving is very neatly done, in the Gothic style and suggesting, perhaps, that it was a high-value gift from an Englishman to an Italian merchant. Its design is less obviously ship-shaped, being a more formal and practical layout.

Style, Construction and Metallurgy

The construction of these quite small instruments is rather more sophisticated than might be appreciated at first sight. The engraved cheeks which make up the 'hull' are cut from hammered copper-alloy sheet of just over 1 mm thickness (rather variable). They are held in alignment with a pair of slightly thicker spacers by several flush alloy rivets, leaving a gap within which the 'mast' can swing. This riveting has, in all cases, been performed with considerable skill and the

'heads' of the rivets are not always easy to see, only an occasional difference in colour giving their positions away. The engraving is continuous over the rivets and hence was performed after assembly. The use of rivets was standard practice in the Middle Ages and short lengths of copper-alloy wire suitable for use as rivets have been recovered in archaeological excavations of London workshops of the 14th century.²⁷

The mast is made from a strip of the same alloy as the hull with two small trapezoidal pieces attached at the bottom, again by a rivet, to form the 'keel' which carries the fiducial marker for the declination scale. The top of the mast is capped on the complete examples (the NMM one is an exception) with a castellated piece formed from the same three-stripe shape which is also used for the 'fore-castle' and 'stern-castle'. This strip is likely to have been made as a single casting and cut and folded to shape afterwards. In modern mass-production, a piece like this would be formed by extrusion or continuous casting but in the medieval period it was probably made in a relatively short clay mould. The castellation may have been included in the pattern but it is more likely to have been made by filing at a later stage. Some of the naviculae also use the same three-stripe strip to make the slider on the mast as well, although some sliders are either missing (*Gentleman's Magazine*) or a replacement (Geneva).

The pieces for the stern-castle and fore-castle are also riveted onto the hull with the heads of the rivets being carefully spaced and filed to match the strips in the surface. The actual sights – a pair of small holes in each sight, spaced to avoid the obstruction of the mast – are small pieces of alloy plate with a slight curvature. This curve seems to be intentional rather than damage and is presumed to be for aesthetic/architectural reasons rather than practical ones.

The size of the rivets varies with the overall size of the navicula, being 3.4 mm diameter (average) for the Geneva instrument and 2.6 mm for the NMM one. Thus, there was clearly no standard off-the-shelf rivet available to the maker. Indeed, it is likely that the (spade?) bit used to drill the holes for the rivets had a short life and needed to be re-sharpened regularly.

The use of rivets to hold parts of a scientific instrument together looks to be a particularly English trait at this period and can be compared to the construction of contemporary astrolabes. Here, the limb may be either integral with the mater (i.e., cast in a single piece) or soldered on, or riveted. Some English astrolabes, particularly of the 'Chaucerian' design with Y-shaped rete details, favour the integral construction as do most contemporary Continental and Islamic instruments. 'Gothic' English astrolabes with quatrefoil retes, on the other hand, are mainly of riveted construction. The ability to fit these rivets points to a workshop or workshops where this skill could be learned and it is particularly appropriate

for a small-scale enterprise lacking the large foundry and machining facilities needed to cast and turn an integral limb/mater design. The skills of making riveted constructions could readily be applied to naviculae, and also quadrants etc., as well as astrolabes.

The small size of the numerals and lettering on the navicula would require another set of skills. The basic lines of the design could be scratch-engraved with a sharp point, needing abilities mainly in geometry for their laying-out. The wielding of a burin for the lettering may have required a separate artisan – accounting, perhaps, for the fact that the Florence navicula is generally unfinished, lacking the labelling. The form of the numerals and letters, though clearly medieval, shows some variation in form between the instruments, leading Eagleton²⁸ to declare that they cannot have been made in the same workshop. This is not necessarily the case, though.

The metallurgy of three of the medieval naviculae has been investigated by X-ray fluorescence; the Oxford and Greenwich examples by the author using a portable analyser and the example in Geneva in 1995 by an SEM-based system with the results kindly conveyed by Stéphane Fischer.²⁹ (An analysis of the Edinburgh navicula is planned for the future.) A summary of the results is shown in Table 2, which also includes for comparison the components of a roughly contemporary compendium found on the Thames foreshore and now in the British Museum (Fig. 10). It should be borne in mind that the surface-sensitive measurements had to be made through the surface patination and thus will not be an accurate representation of the bulk alloy: in particular, 'dezincification' will mean that the reported zinc concentrations of the Oxford and Greenwich examples are likely to be several percent too low.

Although the compositions of the majority of the instruments is best described as 'latten' (a quaternary alloy of copper, zinc, tin and lead) there is significant variation in the amounts of the alloying elements and it cannot be stated that all were made from the same basic stock, as might be hoped for if they were made at the same time in the same workshop. The main sheet components (mast and hull) are the most important to consider and here it can be seen that the Oxford navicula has a composition which could be classed as a brass – it has a composition which is very close to the four slightly earlier Richard II quadrants which have been analysed previously.³⁰ This rather high-quality material has sometimes been thought of as being Continental (owing to the absence of tin) and might initially suggest that this instrument was made at a different location to the others. The case of the British Museum compendium (Fig. 10; found in the river Thames at Isleworth) proves that this is not necessarily the case as this one instrument has two of its major components (compass and equatorial dial) made of latten but its third, the nocturnal which serves as a lid, is made of brass. Clearly,

Navicula	Part	Cu	Zn	Sn	Pb	Ag	Ni	Fe	As	Others/Comments
Greenwich	Hull	82.0	8.5	5.9	1.9			1.1		
	Mast	78.7	8.3	4.9	6.5		0.1	0.8		
	Castles	72.2	7.5	7.0	11.7			1.1		
Oxford	Hull	76.8	21.1	0.07	0.3	0.37	0.18	1.1	0.6	Sb 0.03
	Mast	79.7	19.4	0.08	0.4	0.12	0.55	0.5		Sb 0.03
	Castles	78.4	16.2	3.0	0.6	0.10	0.10	1.0	0.2	
Geneva	Hull	80.4	13.2	4.8	1.6	tr.				Sb (tr.)
	Mast	82.7	12.0	4.3	1.0	tr.				
	Castles	86.3	8.2	4.5	1.0	tr.				
	Spacer	70.5	11.0	9.5	9.0					
Whipple #0731 (1620)	Hull (front)	65.6	33.3	0.1	0.3	0.09	0.05	0.31	0.13	
	Hull (back)	72.2	24.7	1.8	1.1		0.27	0.26		different from front
	Mast	71.5	24.7	2.0	1.2		0.38	0.26	0.07	same as hull back
	Castles	not measured								
Brit Museum Compendium 1853,0618.1	Compass base	84.9	9.2	3.9	0.4			0.2		
	Equatorial dial	86.2	8.7	3.9	0.3			0.2		
	Nocturnal/lid	77.8	21.0		0.1		0.1	0.7		

Table 2. Alloy compositions of three of the medieval naviculae and one later 'ship-shaped dial', together with a contemporary compendium, as measured by XRF. Values in wt%, rounded to one decimal place. The Greenwich and BM instruments were measured by the author using an InnovX portable analyser; the Whipple and Oxford naviculae were measured with a Niton analyser with higher sensitivity and the Geneva instrument was measured by its owners in an SEM EDAX system with a smaller spot size but lower sensitivity. Note that the measurements were obtained on unprepared surfaces and hence are subject to an unknown amount of patination. tr. = trace. Blank cells = not detected.

both materials were available in a single workshop. Perhaps the brass (Cu:Zn) was chosen for the lid on account of its preferred golden colour.

The castellated castles are generally more heavily leaded than the other components and this suggests that they were castings, probably made in continuous strips with the 'three-stripe' shape which could then be filed to form the



Fig. 10. The British Museum compendium (1853,0618.1), contemporary with the naviculae. Photo by the author, with thanks to the Trustees of the British Museum.

castellations or folded and silver-soldered to make the mast fittings. Similarly, the shaped spacers which separate the two sides of the hull and create the space for the mast to pivot also appear to be specially cast.

Origins of the Ship-Shape

Part of the charm of the navicula is exactly that it is shaped like a ship: the Regiomontanus dial, which uses very similar geometric and gnomonic principles, is a much more utilitarian rectangular shape. This was clearly a conscious design choice as the name is original, appearing in early manuscripts, and not just as a modern description. It is the Latin diminutive of the term *navis*.³¹ The shape is based on the 'cog', a single-masted trading vessel which was common around English shores in the 14th and 15th centuries. There were also river-going cogs, distinguished by their lack of a crow's nest. An example of a sea-going cog is seen in Fig. 11 from the Luttrell Psalter, and representations can be found on coins of the period, such as that shown in Fig. 12. Perhaps more significantly, the shape also appears as graffiti on the walls of medieval churches, particularly those in Norfolk.³²

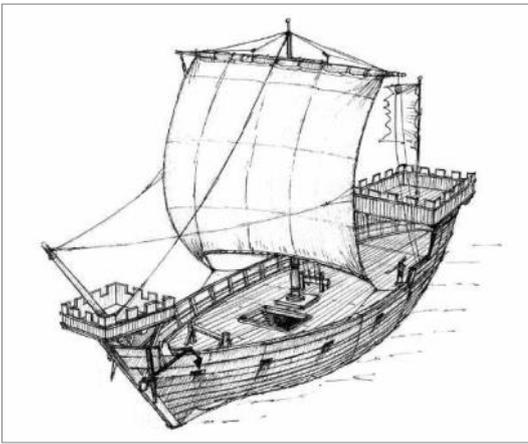


Fig. 11. A drawing of a ‘cog’ (Wikimedia Commons) and a representation found in the Luttrell Psalter (British Library Additional MS 42130, f. 161v, first quarter 15th century). Note the anchor emanating from amidships – not good nautical practice but a nice representation of the plumb-bob on a navicula!

One of the examples of ship graffiti in Fig. 13 has been selected for its location on the walls of St Nicholas’ church at Blakeney, on the north Norfolk coast. The greater part of the church dates from the 15th century, when Blakeney was a seaport of some importance (it features on the contemporary Gough map). It could well be merely coincidence, but it is worth pointing out that the oldest signed and dated European scientific instrument is an astrolabe in the British Museum which carries the inscription “Blakene me fecit Anno doⁱ 1342”, suggesting that its maker came from Blakeney.³³

Other images of ‘cogs’ from the medieval period abound, including one which features on the seal of the great port of Dunwich, on the north Suffolk coast, which still features as the sign of the local Ship Inn.

The concentration of naviculae in East Anglia does not, of course, prove that they were invented or made there. However, it does add to the circumstantial evidence that suggests that it could be so.

ACKNOWLEDGEMENTS

Tim Pestell (Norwich Museums), Tacye Phillipson (National Museums Scotland), Anthony Turner (Paris), Lucy Blaxland and Silke Ackermann (Oxford Museum of the History of Science), Louise Devoy (National Maritime Museum), Stéphane Fischer (Musée d’Histoire des



Fig. 12. A gold noble from the reign of Edward III featuring a ship.

Sciences, Geneva), Giorgio Strano and Anna Giatti (Istituto e Museo di Storia della Scienza), Josh Nall (Whipple Museum, Cambridge), Darek Oczki (Poland), Matthew Champion (Norfolk Medieval Graffiti Survey) and Oliver Cooke (British Museum) are all thanked for their help.

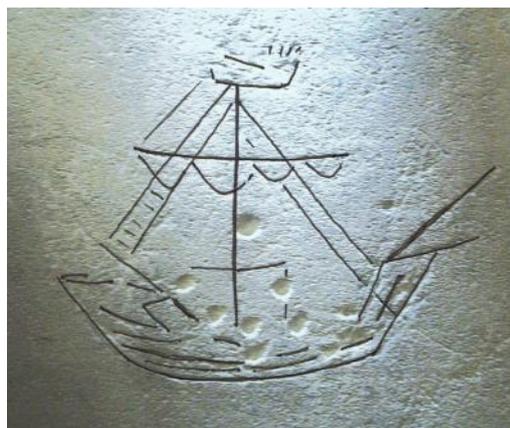
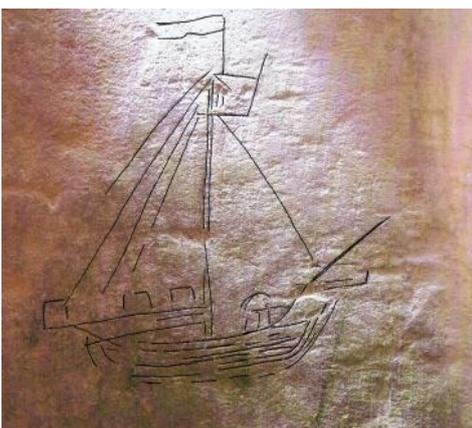


Fig. 13. Ship graffiti on the inside of Norfolk churches. Left: Cley next the Sea. Right: Blakeney. Photos courtesy of Matthew Champion.

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19. See Eagleton, note 1 for details.
20. I am grateful to Dr Tim Pestell, current curator at Norwich Museum, for this information. For an extended biography of James Reeve (1833–1920), see the Norwich Museum website at http://www.museums.norfolk.gov.uk/Visit_Us/Norwich_Castle/Past_Exhibitions/2005/Cotman_in_the_British_Museum/Online_Exhibition_Catalogue/James_Reeve/NCC081534
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31. The dial was called the *navicula de Venetii* (little ship of Venice) by Derek de Solla Price in his article 'The Little Ship of Venice – a Middle English Instrument Tract', *J. History of Medicine*, 400–7 (October 1960) as it is called that in the manuscript version he was editing and that name has since gained wide acceptance. However, in the vast majority (13 out of 16) of manuscripts it is simply called the *navicula* (or *navis*), suggesting that an English origin of the boat is just as likely, so that name is used in this article.
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33. The 'Blakene astrolabe' is British Museum 1853, 1104.1 and can be seen at www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=54861&partId=1

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NEWLY REPORTED DIALS, 2016

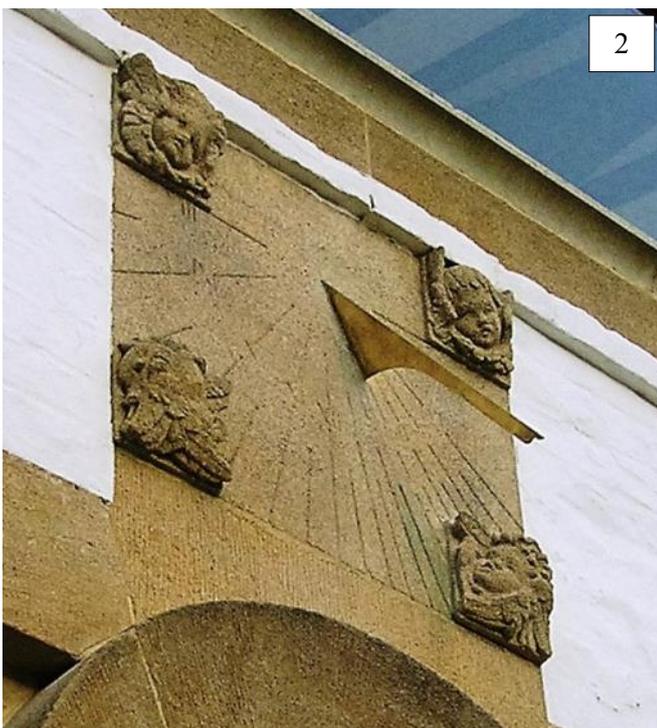
JOHN FOAD

The year 2016 did not see a bumper crop of reports from members. Maybe we all had enough on our minds with Brexit here and Trump over there! Whatever the reason, the Register grew by only 47 newly reported dials. As usual, however, there were some quality finds among them, with dials from each of the last five centuries. A selection is shown here.

1. A recent analemmatic dial, in a more attractive setting than some. I trust the undulating site was allowed for in the layout! It has hour markers in the form of circular wooden stools, with carved numerals for 6 am to 9 pm in winter (GMT and with a frosty surround), and 7 am to 10 pm for



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summer (BST, with a flaming sun surround). SRN 7885. Clearburn Natural Play and Picnic Area, New Lanark, Strathclyde, ML11 9DB, Open.

2. The house was built in 1938 by Robert Lutyens; his father, Sir Edwin, who died in 1944, may well have designed this simple vertical dial. It never had a gnomon until 2016, when David Brown designed and fitted the one seen here. SRN 7886. Somewhere in Surrey, Private.

3. 'Green Hedges' was once the home of Enid Blyton, and a miniature copy of the house now stands in the model village of Bekonscot, with a matching tiny copy of the dial which once adorned the south wall. The real-life dial, made by Francis Barker in 1913 and shown here, is now also displayed at Bekonscot, where it is mounted on a pedestal which reflects the architectural features of its original location. SRN 7887. Bekonscot Model Village, Warwick Road, Beaconsfield, Buckinghamshire, HP9 2PL, Restricted.

4. A fine domed dial plate inscribed 'Evans, Maker, Carmarthen'. The gnomon went missing only four years ago. SRN 7897. Laugharne Castle, Dyfed, SA33 4FA, Restricted.



4

Photo courtesy Abigail (www.abigailsworld.co.uk).

5. A plain octagonal 19th-century dial with a filigree gnomon. SRN 7914. Cringletie House Hotel, Eddleston, Peebles, Borders, EH45 8PL, Private.

6. This simple but well preserved diptych dial of 1689 is mounted at first-floor level on the corner of the house, directly above the pavement. The east face has Arabic numerals. SRN 7916. Sundial Café, Main Street, Limekilns, Fife, KY11 3HN, Open.

7. A beautifully located dial with a pierced sun gnomon. It is a memorial made by R. Drew of Auchterarder in 1992, to replace an earlier one of 1900. SRN 7917. St Conan's Kirk, Lochawe, Strathclyde, PA33 1AL, Open.

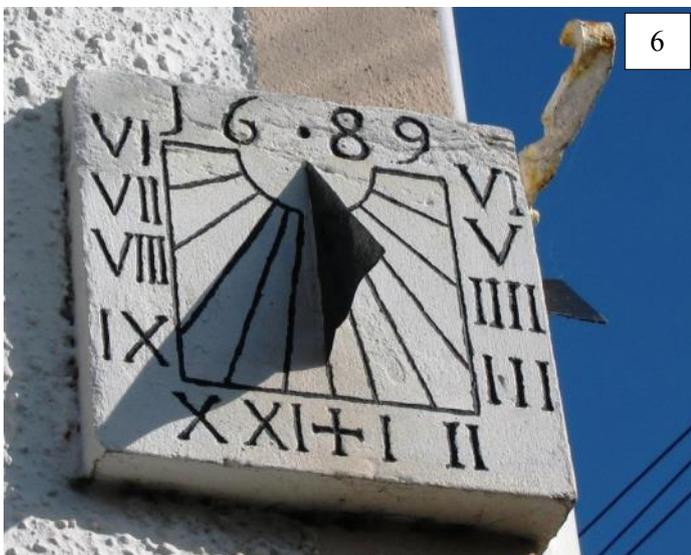
8. A tall ornately decorated 17th-century baluster sundial with a small circular vertical dial on each of the cardinal point faces. It bears numerous mottoes including "Tak tent o time ere time be tint" and "As a shadow so doth life pass". SRN 7918. Saughton Park, Edinburgh, EH11 2RZ, Open.



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9. Little is known about this massive and fine pillar dial, and more information would be very welcome. SRN 7919. Cuerden Valley Park, Shady Lane, Bamber Bridge, Lancashire, PR5 6AZ, Restricted.



10

10. This dial by Dollond is situated high on the south-facing wall of a block of apartments on the north side of Knightsbridge, near the junction with Old Brompton Road. It can be seen (with difficulty) from the pavement outside. The maker's name is at the bottom right-hand corner. Sadly, the gnomon is now bent as can be seen. The 6 pm hour numeral would seem to be an ill-judged afterthought, presumably not original. SRN 7928. Wellington Court, 116 Knightsbridge, London SW1X 7PL, Visible (just!).



11

11. Oswald Partridge Milne built this house in 1910, and he probably designed the dial as well. The plate appears to be embossed lead sheet. The delineation implies a small declination to the east, but the gnomon lies vertically along the noon line. Milne's one-time employer, Edwin Lutyens, would not have approved. SRN 7938. Huntercombe Hall, Bradley Road, Nuffield, Oxfordshire, RG9 5SE, Restricted.

12. The gnomon here is a vertical limestone monolith, and hour stones are laid out in an arc around it. The tip of the monolith acts as the nodus of a conceptual style stretching



12

down to a point at the south, where I trust the hour lines converge. Accordingly, the time is read by the shadow of the tip of the gnomon. Not many dials are designed in this way. Strangely, the latitude and longitude displayed on an accompanying tablet point to a location in the middle of the Irish Sea, halfway between Blackpool and the Isle of Man! SRN 7949. Sparrow Park, Warton, Lancashire, LA5 9NW, Open.

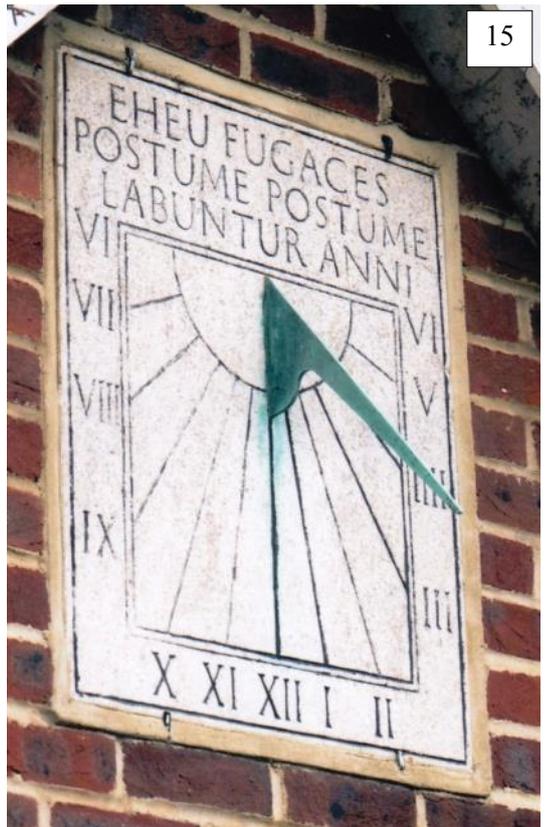
13. The date of 1731 is displayed in the pediment of this substantial dial. The carved figure in the centre is now unclear, but may represent a smiling face with flowing locks. SRN 7951. Baysgarth House Museum, Caistor Road, Barton upon Humber, Lincolnshire, DN18 6AH, Open.

14. This dial was saved from 'The Railway' public house in Pitsea, when the pub was demolished in 2013 (see SRN 4977). It was cleaned and relocated to its present position in 2016. SRN 7953. Wat Tyler Country Park, Pitsea Hall Lane, Pitsea, Essex, SS16 4UH, Restricted.

15. The property here is very close to Piggotts, the past workshops and community of the sculptor and designer Eric Gill. The dial may well have been made at the Piggotts



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13

workshops, probably not by Gill himself but perhaps by one of his apprentices. It is delineated for direct south but the wall on which it is mounted faces approximately 25 degrees east of south. SRN 7954. Little Piggotts, Piggotts Hill, North Dean, Buckinghamshire, HP14 4NF, Private.

registrar@sundialsoc.org.uk

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THROWING LIGHT ON A SUNDIAL AT NEWSTEAD ABBEY

JOHN WILSON

This article formed the basis of a presentation made at the 2016 BSS Conference in Liverpool.

Newstead Abbey in Nottinghamshire has a long history as a private house¹ and was owned by several prominent families. The most famous of these is the Byron family, who owned Newstead for 263 years until 1818 when the sixth Lord Byron, the poet, sold the property to his friend Colonel Thomas Wildman. The Wildman family owned the Abbey until 1860 when it was purchased by William Frederick Webb, who made many alterations and improvements to the house.

William Frederick (1829–99) was the son of Frederick Webb and his wife Mary Sheils. Frederick, who had been in the Army, died in 1846 when William Frederick was just seventeen, leaving the latter a very wealthy young man. William Frederick entered the Army after education at Eton but did not stay long, although it is known that he served in



Fig. 1. Marble capital from the Temple of Venus with sundial.



Fig. 2. Dial plate of the sundial in the Newstead Abbey Cloister.

the Crimea at some point.² He resigned his commission as a captain in the 17th Lancers to go to South Africa, where he became a close friend of the explorer David Livingstone.³ Livingstone is known to have visited the Webbs at Newstead Abbey. William Frederick's younger brother Augustus, also a captain in the 17th Lancers, died in November 1854 of wounds received at the Charge of the Light Brigade. He is commemorated by a plaque in Newstead Abbey.⁴

There is, in the Cloister of Newstead Abbey, an unusual sundial consisting of a marble pillar with a dial plate of the mid-19th century (Fig. 1). This dial is not in the 2015 BSS Register. It once stood in the Fernery,⁵ then was apparently transferred to a position in the American garden,⁶ but at some point was brought into the Cloister. The dial bears an inscription:

*This Piece of Marble
The Capital of one of the smaller Columns
of the "Temple of Venus" at the
Piraeus, Athens
Presented to Mrs F. Webb
by Captain. F.W.Gore 3rd Reg^t October 1856*

The dial plate is of a copper alloy, with a simple gnomon (Fig. 2). It is inscribed with hour lines and a compass rose, and a maker's mark 'Osmond Sarum'. The dial is 330 mm

in diameter and the thickness is 3 mm as far as I can ascertain.

The questions that come to mind are:

- who was Captain Gore?
- who made the sundial, and where?
- what was Captain Gore's connection to Mrs Webb?

Captain Gore

Captain Frederick William Gore (1825–1909) had been commissioned into the 3rd Foot (the 'Bufs') in 1846 and saw service in many war theatres, including the Crimean War. His unit was moved to Piraeus in November 1854 and stayed there until March 1855.⁷ After a spell in Malta and further service in the Crimea, Captain Gore returned to England in 1856. Presumably it was during the stay at Piraeus that Captain Gore 'acquired' the capital from a column of the Temple of Venus. After a distinguished military career, Gore retired in 1867. The following year he married Millicent, daughter of Major Robert Miller Mundy, RA, who was Lt Governor of Grenada.

Osmond Sarum

To my knowledge, there is no sundial maker by the name of Osmond known in Salisbury. However, a search of *Kelly's Directory* of Wiltshire for 1867 revealed two Osmonds in Salisbury (Sarum) at that time: Osmond, William, and Son, stone masons and sculptors, St John Street and Osmond, Thomas, boot and shoe maker, of St Ann Street. (The latter can of course be discounted.)

William Osmond (1793–1875) was appointed Mason to Salisbury Cathedral in about 1818, and worked in that capacity for many years.⁸ In addition to restoration work on the cathedral itself, he supplied many monuments for the cathedral and other churches. He was a close friend of the influential Gothic revival architect A.W.N. Pugin. It is quite conceivable that Captain Gore asked Osmond to obtain a suitably engraved sundial and then mount it on the Greek pillar brought from Piraeus, so that he could present it to Mrs Webb.

The Salisbury Connection

There is a connection with Salisbury in that Frederick and Mary Webb lived in Wiltshire for many years, in the village of Hamptworth.⁹ There is a memorial plaque to Frederick Webb in Salisbury Cathedral, made by Osmond¹⁰ which states:

“Sacred to the memory of Frederick Webb esq of Westwick county of Durham and Hamptworth in this county. Youngest son of the late Sir John Webb Baronet; who departed this life at Brighton on the 4th of February 1846 aged 56 years.

“Also of his youngest son Augustus Frederick Cavendish Webb esq, Captain 17th Lancers who died at Scutari on the 6th of Nov 1854 aged 22 years from wounds received in the brilliant Light Cavalry charge at Balaklava on the 25th of October 1854.”

After Mary's death on 28 August 1860, the entire east window in the Church of St Andrew at Landford in Wiltshire was installed and dedicated to her memory.¹¹ This

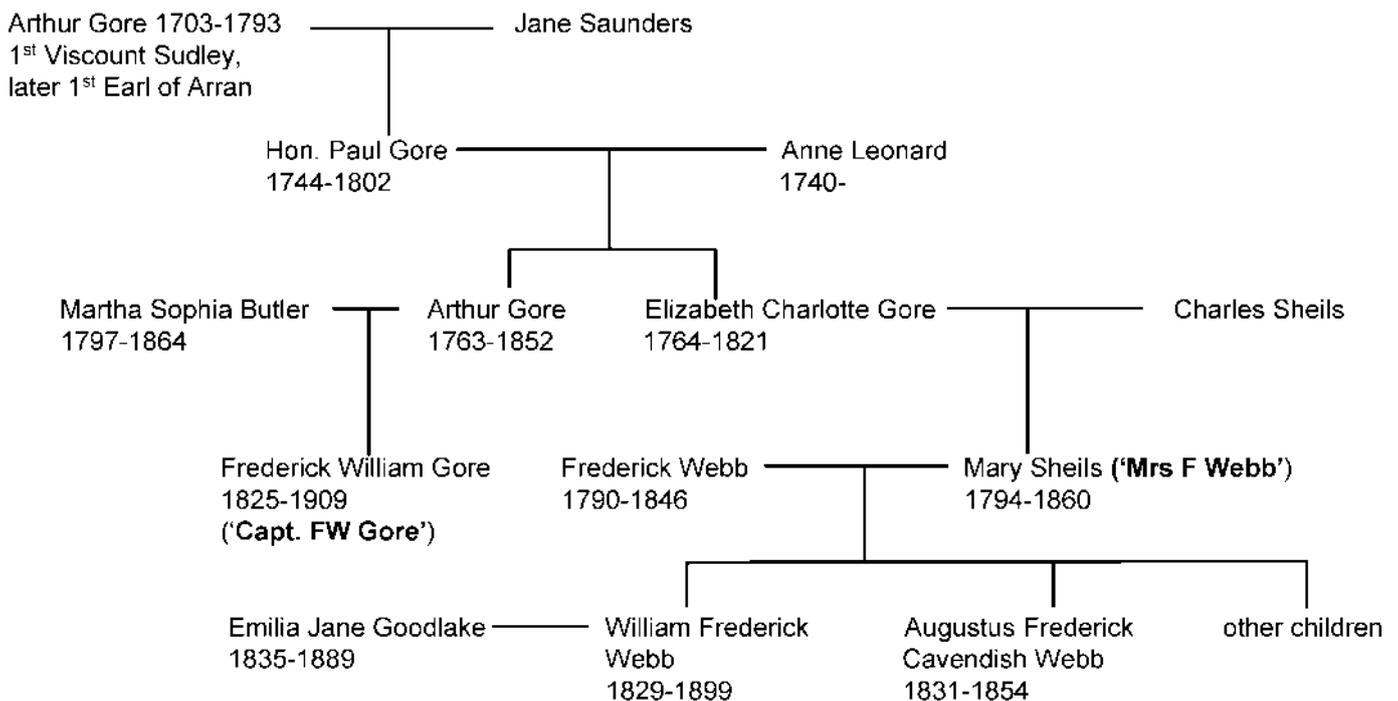


Fig. 3. Webb-Gore family tree.

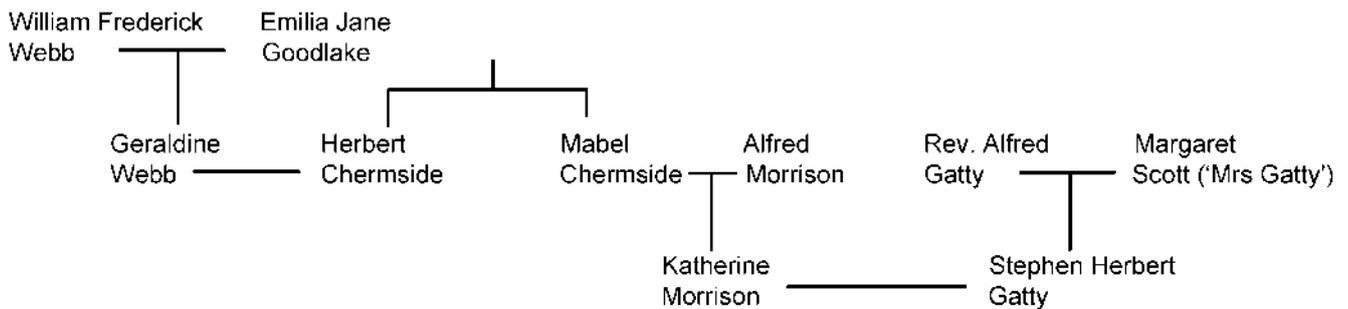


Fig. 4. Gatty connection family tree.

would indicate that she had worshipped there on a regular basis for some time.

The Gore–Webb Connection

So why did Captain Gore present the mounted sundial to Mrs Webb? Recently, a set of papers of the Webb family was donated to the Nottinghamshire Archives. A preliminary search of the archive revealed two documents of interest:

- a letter from Elizabeth Gore, dated 22 April 1916, to her friend Mrs Fraser (a descendant of the Webbs), asking about the ‘rumoured’ relationship between their two families.
- a list of ‘notes from a Bible’ giving names of members of the Webb family and their dates of birth.

An Internet search revealed the family tree shown as Fig. 3.

Captain Gore was therefore a cousin of Mrs Webb, as can be seen from the family tree. It is entirely possible that on his return from the Crimea, he gave the gift of the mounted sundial to his cousin Mary, in memory both of her husband Frederick who had pre-deceased her and of her younger son Augustus who had died at Scutari. Mary died in 1860, the year that William Frederick Webb purchased Newstead Abbey, so she would probably never have lived there. However, no doubt her son would have thought it important to bring the sundial, with its family connections, to Newstead.

The Gatty Connection

BSS members may be familiar with the very fine church of St Mary’s, at Ecclesfield in Yorkshire. There is a connection between the Reverend Alfred Gatty (Rector of Ecclesfield for 64 years) and his wife Margaret (the ‘Mrs Gatty’ who compiled *The Book of Sun-Dials*), and the Webb/Gore family. The Gattys’ son Stephen Herbert Gatty married Katherine, daughter of Mabel Chermside and her husband Alfred Morrison (see Fig. 4). Mabel was the sister of Herbert Chermside who had married Geraldine Webb, the daughter of William Frederick Webb.¹²

ACKNOWLEDGEMENTS

I would like to thank Haidee Jackson, Curator of Newstead Abbey, for helpful discussions and permission to photograph the sundial. This article is based on one originally published in the *Newsletter of the Thoroton Society of Nottinghamshire*, and is reproduced here by kind permission of the Editor of the *Newsletter*.

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John Wilson is a retired pharmacist with interests in local history, church history, meteorology and sundials.



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A REPLACEMENT ARMILLARY DIAL FOR CHRISTCHURCH PARK, IPSWICH

JOHN DAVIS

The armillary sphere in Christchurch Park, Ipswich was first recorded by the BSS (SRN 2535) in 1994. It was in a sorry state, still attached to its stone pedestal but lying on its side and very rusty. Its origins are unknown but when the gardener James Mann installed it in his newly-created Lower Arboretum in the 1920s he described it as “very old”. It may originally have belonged to the Fonnereau family who owned Christchurch Mansion before it became a public park. Postcards from the 1930s show it splendidly displayed in a paved area of the Arboretum (Fig. 1), though slightly later pictures show that it had been moved to the front of the Wolsey Art Gallery in the park (Fig. 2).

The plight of the sundial was brought to the attention of the Friends of Christchurch Park in 2015 and they determined to restore and reinstall it.



Fig. 1. Postcard from the 1930s showing the original dial in the Lower Arboretum.



Fig. 2. The original dial outside the old Wolsey Memorial Art Gallery.



Fig. 3. The remains of the sundial and its pedestal in August 2015. Photo: David Miller.

The actual iron armillary sundial (Fig. 3) was not worth saving and has been replaced by a new one in bronze, made by Robert Foster Sundials (Telford) as a custom version of one of his standard designs. The main section of the limestone pedestal was reasonably sound and, with a new section grafted in and a new top and stone ball made by Ray Templeton of Suffolk Masonry Services, was erected on a new set of octagonal steps. These were sited a short distance from the arboretum which has now grown rather tall and does not allow much sun to reach the original site. It was determined that the sides of the square-sectioned pedestal had originally faced the cardinal directions and, although not strictly necessary, it was decided to repeat this. As a result, a meridian line had to be established at a few degrees to the path running alongside. A note



Fig. 4. The new dial. Photo: David Miller.



Fig. 5. The official tape-cutting by the Ipswich Mayor in January 2017. Photo: David Miller.

explaining the reason for this offset is incorporated into the text of the large and colourful (and hopefully graffiti-proof) display board nearby.

The restored sundial (Fig. 4) has been dedicated to Dr John Blatchly MBE who had recently died. John was for many years the Headmaster of Ipswich School – founded sometime before 1399 – which has its current site alongside the Park. (The school shares its coat of arms and motto – *Semper Eadem*, Always The Same – with Elizabeth I. It would not go amiss on a sundial!) He was a great supporter of many activities in Ipswich and his

regular articles in the local newspaper were known on occasion to mention the great selection of sundials in the town.

Setting out the meridian line in late November 2016 and then aligning the dial on the pedestal a few weeks later both benefitted from wall-to-wall sunshine which was very much needed with the low winter sun. Amazingly, we had another crystal-clear day on 5 January 2017 for the official ‘unveiling’ and dedication of the dial by the Ipswich Mayor, the local MP, relatives of John Blatchly and a good crowd from the Friends of Christchurch Park (Fig. 5). Sunny Suffolk lives up to its name again!

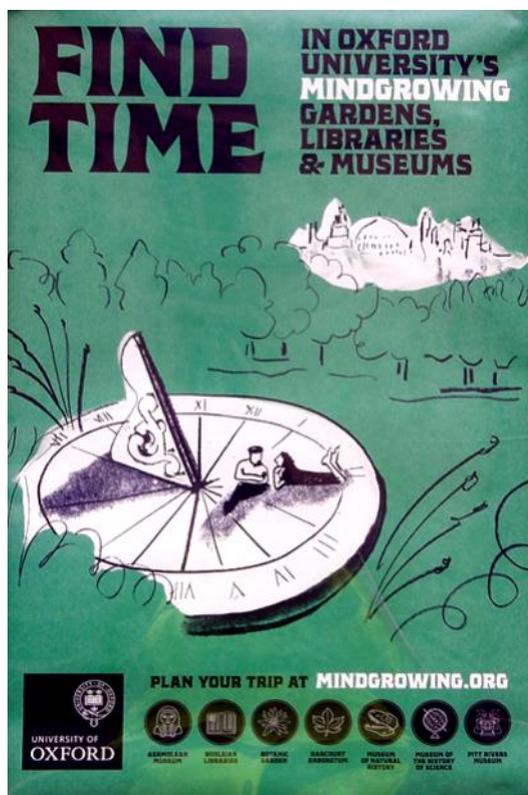
ACKNOWLEDGEMENT

Thanks are due to David Miller (Chairman of the Friends of Christchurch Park) for involving me in the project and for supplying the photographs in this article.

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A Curious Oxford Sundial

Many delegates to the Oxford Conference noticed this poster. Amongst other places, the poster advertised the Oxford Museum of the History of Science. One can understand the merit of incorporating a drawing of a sundial, but the poster designer ought to have checked what a sundial looks like. Delegates from Cambridge largely kept their thoughts to themselves.



FHK

TWO INTERESTING SLATE DIALS

MIKE COWHAM

Slate can be an ideal canvas for the sundial artist and the result is often more than just a simple dial.

Two attractive dials on slate are described below. Another such dial was shown in my ‘Dial Dealings 2014’ article in the March 2015 *BSS Bulletin*.¹ I also published an article, ‘An Unusual Slate Sundial’ in the June 2010 *Bulletin*.²

A Dial by Robert Connell

This is an unusually shaped nine-sided dial by Robert Connell, dated 1815 (Fig. 1). It is fairly large, being 59.5 cm (23.4”) long and 54.4 cm (21.4”) across. Unfortunately, its single gnomon is now missing. The slate surface itself is covered in scales and decoration with hardly any space being left. It is signed (Fig. 2) just below its centre. Note the statement that “This was finished with care most fervent by”, and then he has not left sufficient room for his name!

Below this statement are the tables shown in Fig. 3, with the caption above: “A Perpetual Almanack”.

At the top of this table are four columns with the words “Leap” written vertically between them.



Fig. 1. A nine-sided slate horizontal dial by Robert Connell, dated 1815.



Fig. 2. Signature of Robert Connell engraved on the dial.



Fig. 3. Perpetual Almanack tables engraved upon the dial.

A Perpetual Almanack

		Leap		1700	Leap		1800	Leap		1900	Leap		2000										
				2100			2200			2300			2400										
				2500			2600			2700			2800										
				2900			3000			3100			3200										
				3300			3400			3500			3600										
				3700			3800			3900			4000										
	6	17	23	28	34	45	D	C	F	E	A	G	B	A	51	56	62	73	79	84	90		
1	7	12	18	20	35	40	46	C	B	E	D	G	F	A	G	57	63	68	74	85	91	96	
	2	13	19	24	30	41	47	B	A	D	C	F	E	G	F	52	58	69	75	80	86	97	
	3	8	14	25	31	36	42	A	G	C	B	E	D	F	E	53	59	64	70	81	87	92	98
	9	15	29	26	37	43	48	G	F	B	A	D	C	E	D	54	65	71	76	82	93	99	
	4	10	21	27	32	38	49	F	E	A	G	C	B	D	C	55	60	66	77	83	88	94	
5	11	16	22	33	39	44	50	E	D	G	F	B	A	C	B	61	67	72	78	89	95	00	
			Jan	May	Aug	Feb	Jun	Sep	Apr														
			Oct			Mar	Nov	Dec	July														
		G	<i>Mo</i>	<i>Tu</i>	<i>We</i>	<i>Th</i>	<i>Fr</i>	<i>Sa</i>	<i>Su</i>														
		F	<i>Tu</i>	<i>We</i>	<i>Th</i>	<i>Fr</i>	<i>Sa</i>	<i>Su</i>	<i>Mo</i>														
		E	<i>We</i>	<i>Th</i>	<i>Fr</i>	<i>Sa</i>	<i>Su</i>	<i>Mo</i>	<i>Tu</i>														
		D	<i>Th</i>	<i>Fr</i>	<i>Sa</i>	<i>Su</i>	<i>Mo</i>	<i>Tu</i>	<i>We</i>														
		C	<i>Fr</i>	<i>Sa</i>	<i>Su</i>	<i>Mo</i>	<i>Tu</i>	<i>We</i>	<i>Th</i>														
		B	<i>Sa</i>	<i>Su</i>	<i>Mo</i>	<i>Tu</i>	<i>We</i>	<i>Th</i>	<i>Fr</i>														
		A	<i>Su</i>	<i>Mo</i>	<i>Tu</i>	<i>We</i>	<i>Th</i>	<i>Fr</i>	<i>Sa</i>														

Fig. 4. 'Perpetual Almanack' tables as found on the dial. The 00 century date did not appear on the original but has now been added.

The columns list 24 century dates from 1700 through to the year 4000.

Having tried the system out I have found that by using these tables it is quite quick and simple to determine the day of the week for any date during the period covered. (Obviously it would not apply to the old Julian calendar that was in force in Britain and its colonies until 1752.) In order to explain the use of these tables I have taken a sample date of 23 April 2016. (For ease of use, a copy of these tables has been made; see Fig. 4.) Firstly, find 2000 which is at the top of the right-hand column. Then look for 16 in the smaller characters that are placed either side of the capital letters. It is at the bottom of the third column on the left side. Find where the columns for 2000 and 16 cross. This gives us a letter B. Now go to the lower section and look along line B to see where it crosses the month of April. This gives us a Friday, which is the first day of April. To save doing any mathematics, transfer to the "Days" chart, lower right and go across from 1 to 22, this top line of dates all being a Friday. Then go down to 23 which must then be a Saturday. As 2016 is a leap year, if we had been looking for a day in the first two months, then instead of picking the letter B we would need to pick the C from the column to its left labelled "Leap". Note that the dial of Connell's did not have the century year inscribed. This has now been added on the chart as 00.

Check your own birth date and day. As a test you may also wish to confirm that Queen Elizabeth's Coronation on 2 June 1953 fell on a Tuesday.

The dial has four hour rings (Fig. 5), the outer one for local use of the dial, here a place in Northern Ireland. This is shown by the "Latitude 55° 5'" and "Longitude 7° 21'"

placing it just to the north of the town of Londonderry. (This location is approximately 30 minutes behind Greenwich.) The next inner ring is "1.H. Earlier" with 17 places engraved around its outside, beginning with Leghorn, or Livorno (10° 20' E). Then inside that the next ring is "4H. 31½ M. Later", this time with nine places engraved around it, starting with Philadelphia (75° 18' W). Note that this longitude with that of the dial being deducted



Fig. 5. Detail of the various scales upon the dial.

from it will show the difference of 4 hours and 31.8 minutes. The innermost ring is “2.H. 51.M. Earlier” also with nine places around it, beginning with Jerusalem (35° 13' E). This scale too is at the correct figure for Jerusalem.

Between the main hour ring and the subsidiary ones is “The Equation of time, Watch faster than the sun” with the corrections being shown for the dates of 1, 8, 16 and 24 for each month.

Also, around the centre, which is decorated with a 32-point star pattern, are listed the 32 points of the compass.

A Dial by Richard Melville

This dial (Fig. 6) is of a more usual square design using eight subsidiary dials with individual gnomons to indicate the times of various parts of the World. It is a 42 cm (16.5") square slate dial made by Richard Melville of Glasgow in 1848 presumably for “P. J.” of Stirling (Fig. 7). Its latitude is given as 56° 8' N (Stirling). The longitude of Stirling is 3° 55' W, making it 15.6 minutes later than Greenwich.

At the sides of the subsidiary dial at the top centre is a small motto:

*Tempus Fugit
Memento Aeternitatis*

and at the bottom:

*As onward moves this shade
Our precious time does fade*

Melville himself was originally from Ulster, moving later to Glasgow. He is known for several dials of this nature. He subsequently moved on to work in Liverpool, London and finally in Dublin.³

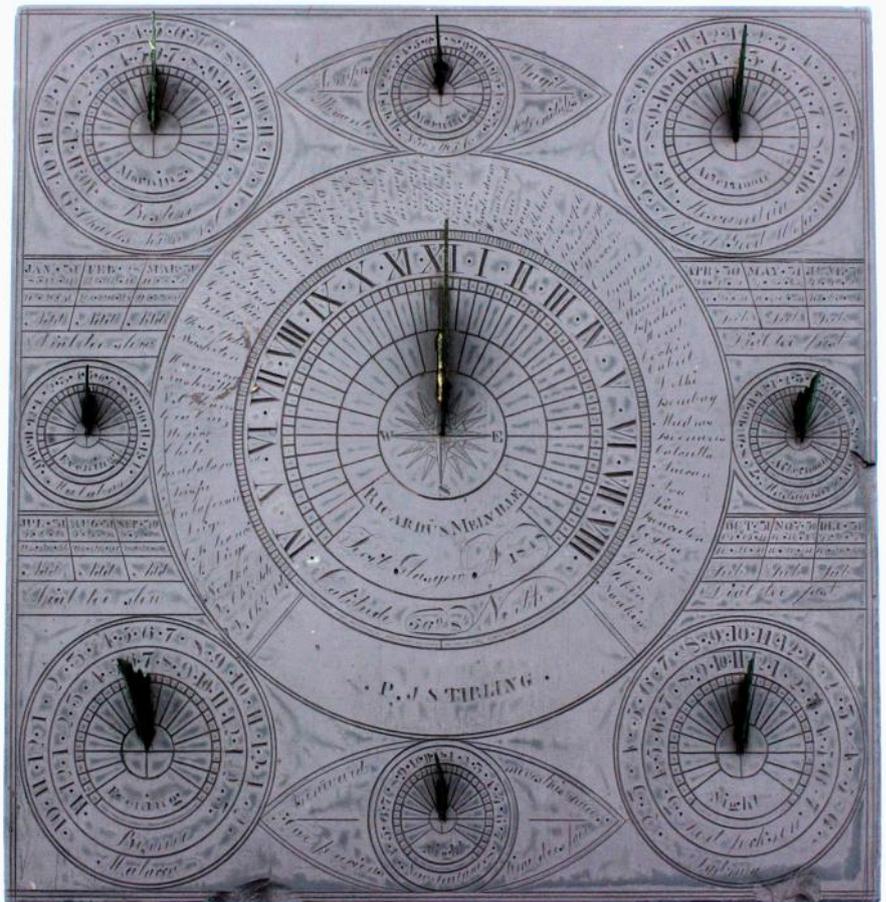


Fig. 6. Slate dial by Richard Melville with nine gnomons, dated 1848.

The main central dial has 70 places listed radially around the chapter ring to show the time when it is noon at each. These stretch from “Nankin” (118° 55' E) to “Qⁿ. Ch^s. S^d.” (Queen Charlotte’s Sound, 128° W) with typically four places listed for each hour.

Around the edge of the dial are eight subsidiary dials with direct scales for reading the time at a total of 12 places (see,



Fig. 7. Signature of Ricardus Melville on the dial.

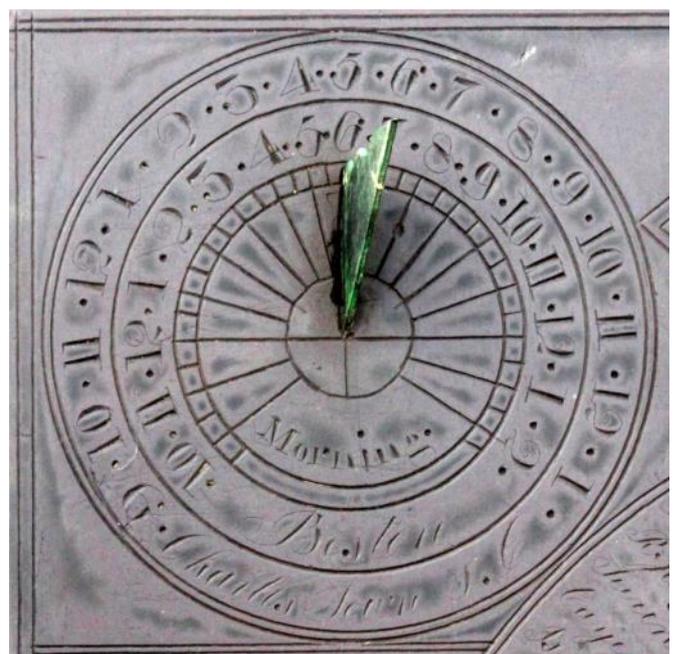


Fig. 8. Subsidiary dial for Boston and Charles Town S.C.

for example, Fig. 8). These are as follows. The time shown is for when it is noon at Stirling.

- Boston (71° W) 6 am
- Charles Town S.C. (80° W) 5 am
- New York (74° W) 7 am
- Alexandria (29° 45' E) 2 pm
- Cape of Good Hope (18 30' E) 1 pm
- Malabar (75° 25' E) 5 pm
- Madagascar (46° E) 3 pm
- Bornio (114° 30' E) 7 pm
- Malacca (102° 12' E) 6 pm
- New Zealand (173° E) 12 pm
- Port Jackson (151° 12' E) 11 pm
- Sydney (151° 12' E) 10 pm

(The longitudes given here have been added for reference and often show up some small errors in the time scales, such as Port Jackson and Sydney, both in New South Wales, which have the same longitudes but are one hour apart!)

On both left and right are tables for the Equation of Time, with three figures being quoted for each month; these are for the dates of 11, 21 and 28, 30 or 31 (Fig. 9).

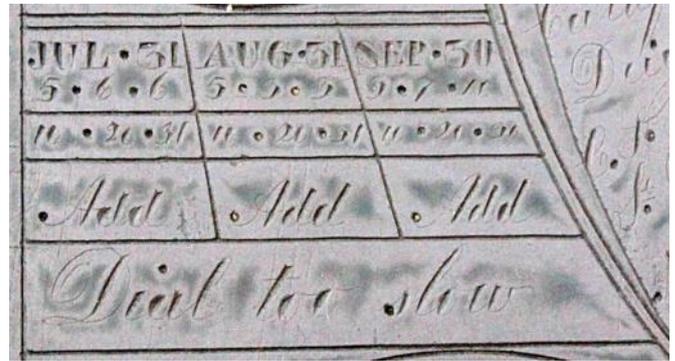


Fig. 9. One section of the Equation of Time table.

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Postcard Potpourri 39

Siófok, Hungary

Peter Ransom

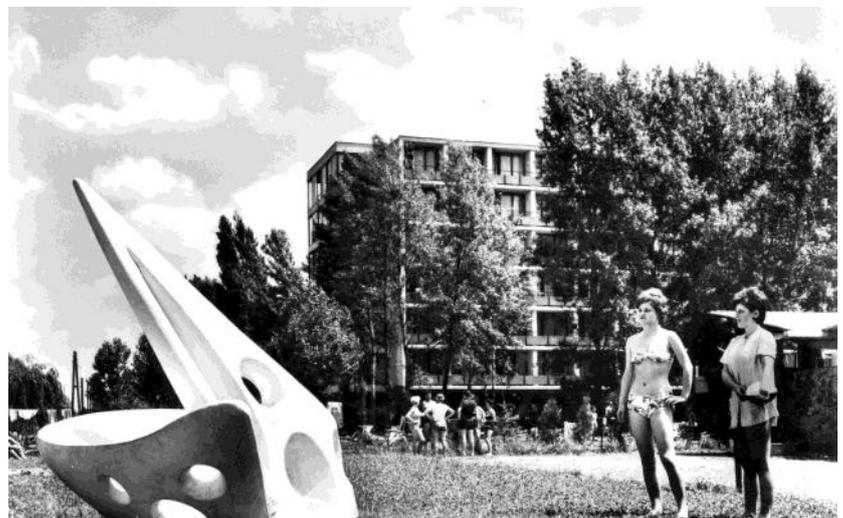
Adial from further afield this time. Siófok is a town on the shore of Lake Balaton in Hungary and the sundial shown here was made in 1962 by Barta Lajos. A website (in Hungarian) at https://www.kozterkep.hu/~2893/Napora_Siofok_1962.html mentions that the dial has disappeared but that it was one of the most progressive sculptures of the time in Hungary. The hotel in the background is the Hotel Balaton.

Barta's work had been temporarily interrupted by the Hungarian uprising at the end of 1956, but immediately afterwards he took it up again as an abstract sculptor.

From about 1959 onwards, he entered state competitions to enlarge his portfolio of work. Four of his models were accepted and were realised in 1961–2: in Budapest and Pécs as well as this dial in Siófok.

Nevertheless, he began to realise that abstract art was not recognised in Hungary at the time. Not even the purchase of his major works in 1963 by the Hungarian National Gallery (which had changed significantly after the uprising) meant anything.

In 1964 he experienced great difficulties in the realisation of the playground sculpture "Drei Pferdchen" (Three Little Horses) and so left Hungary for ever.



More information about Barta may be found (in German) at https://de.wikipedia.org/wiki/Lajos_Barta

The postcard is undated, but published by Képzőművészeti Alap Kiadóvállalata (translated as the Fine Arts Publishing Company), Budapest.

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ALLAN MILLS

Allan Alfred Mills, who died on 28 February 2017, was one of the earliest members of the BSS (membership number 008) and was always a strong contributor to the Society. He published around 43 articles in the *Bulletin* on a wide variety of dialling subjects, usually with a slightly off-beat theme. He is one of the few authors of a sundial article in the *Annals of Science* and even supervised a PhD student studying Egyptian dials.

Allan was born in 1933 in London to a father who was an engraver, giving him an interest in the practical side of dials and other scientific instruments as well as a wealth of connections to the manufacturing methods used for brass instruments going back to the late-nineteenth century.

After a brief evacuation during the Blitz, a scholarship took him to Nottingham University where he graduated in chemistry, followed by a doctorate in geology. This led to post-doc research at Oxford in radiometric dating of rocks and then to oceanographic research in Nova Scotia. He had married Pauline in 1960 and their first son was born in Canada. The family moved back to England in 1964 with Allan working at the Harwell nuclear research facility. They had two further sons (one adopted).

In 1969 the family moved to Leicester where Allan was a Lecturer in Planetary Science, also teaching physics, geology and astronomy. His private interests extended to the Turin Shroud, on which he published scientific papers, as well as scientific instruments and phenomena of all kinds. He was the second editor of our sister publication the *Bulletin of the Scientific Instrument Society* and published articles there until a few months before his death. He



always enjoyed making scientific models and had a home workshop where, working mainly in wood, he could produce working dials and other instruments which were used to illustrate his articles and lectures. These items included an astronomical clock built for the Rattray Lecture Theatre at the University of Leicester and a variety of reproduction Greek and Roman sundials for the Leicester Time Trail. He was very disappointed when arthritis forced him to give up this aspect of his life a few years ago.

Allan retired from teaching in 1999 but continued to search out obscure areas of science for investigation. These included the Will o' the Wisp, the Aeolian Harp and, for his final paper, the 'cracking' of knuckle joints, modelled by a hypodermic syringe full of water!

In 2016 prostate cancer spread to his lower spine and he spent his last few months in a nursing home. He was always a cheerful person and I remember many interesting conversations with him at various meetings which he usually attended accompanied by Pauline: his lectures were always a highlight of BSS conferences where his clear presentation style ensured that his varied audiences could all follow the story. He will be much missed by BSS members as well as by his surviving family.

Further details are at <http://memorialwebsites.legacy.com/drallanmills/homepage.aspx> and a video showing the manufacture of brass telescope tubes in which he appears is at <https://www.youtube.com/watch?v=r93q626KhQ&t=1660s>.

John Davis



Mike Shaw

A VERY PERSONAL SUNDIAL

ORTWIN FEUSTEL

This is the short story of the development of the sundial shown in Fig. 1, which was occasioned by the death of my wife.

Prologue

Death, as the most elementary experience in human life, raises many questions but ultimately compels us to accept the unavoidable. A sundial with additional personal date lines provides a memorial that is special for me: the symbolic traces of gnomonic shadows impress us about the transience of our existence.

Conception

Characteristics of the gravestone

The polished gravestone is of nearly-black Impala granite (from South Africa) and measures 800 × 550 × 40 mm. The typeface for the chiselled name is Times New Roman with a type size of 35 mm. The name is light-coloured (silvery) and positioned on the lower area of the stone. The stone's upper part is reserved for the mounting of the sundial (about 400 × 400 mm); there are three dead holes with a depth of 30 mm for cementing threaded rods (6 mm in diameter).

Declination of the gravestone

The normal line of the gravestone's front points more or less southwest. Finding out the exact direction a self-made shadow angle measuring instrument was used as shown in Fig. 2. This equipment is very helpful for calculating the required dial-plate declination based on the angle which the pin gnomon's shadow makes with the vertical through its base at a certain time.



Fig. 2. Equipment measuring the orientation of the gravestone.

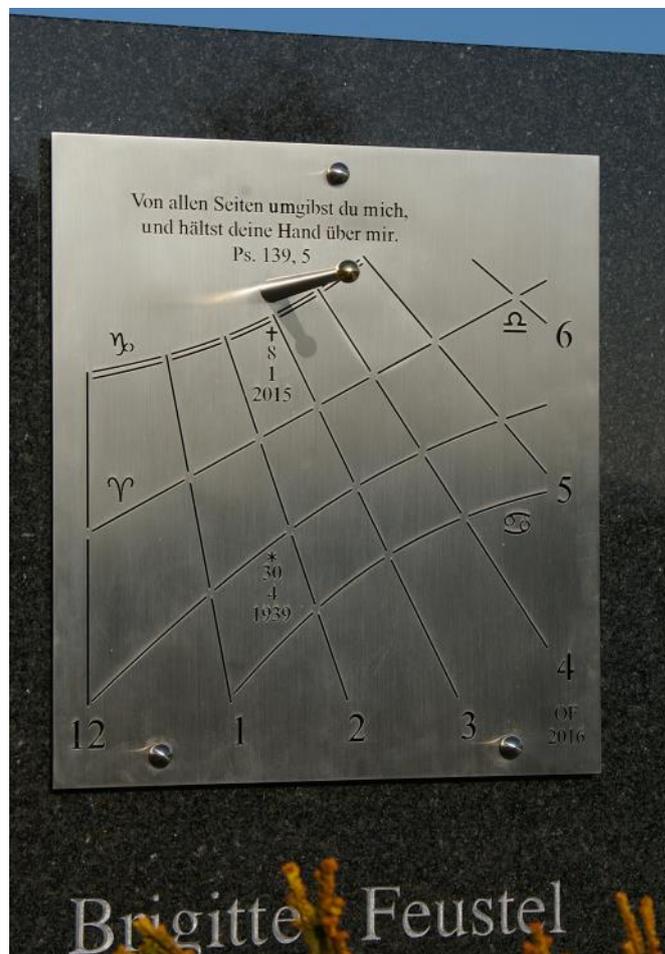


Fig. 1. The completed dial on my wife's gravestone.

Guidelines for the sundial

Hardware: The dial plate, pin gnomon and three spheres (15 mm diameter) for fastening consist of matt sandpapered stainless steel; delineation and lettering are laser cut, so that the dark shade of the gravestone shows it off to its advantage; three mounting holes with a diameter of 7 mm make it possible to adjust the dial; a gold-coated sphere (representing the sun) at the gnomon's tip serves as a nodus.

Delineation: The declination lines for the solstices and equinoxes are marked with their zodiacal signs; two additional declination lines indicate the days of birth and passing, each marked with its date and a symbol; the number and lettering of the hour lines (apparent local time) are in accordance with the alignment of the gravestone.

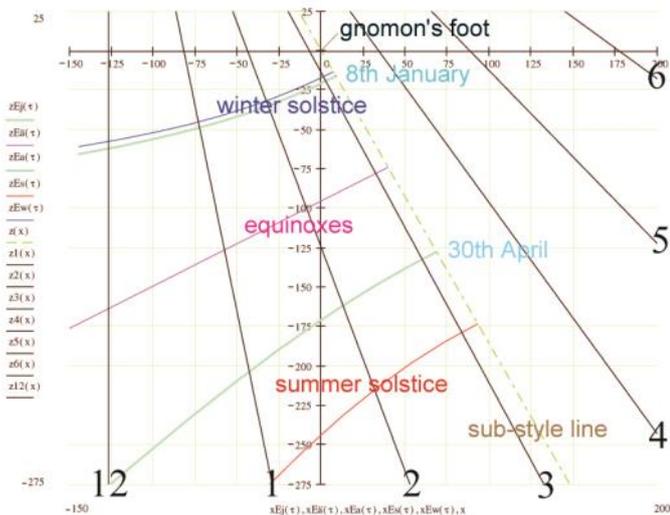


Fig. 3. Diagram of the dial's delineation; the parts of the declination lines not shown run symmetrically to the sub-style line.

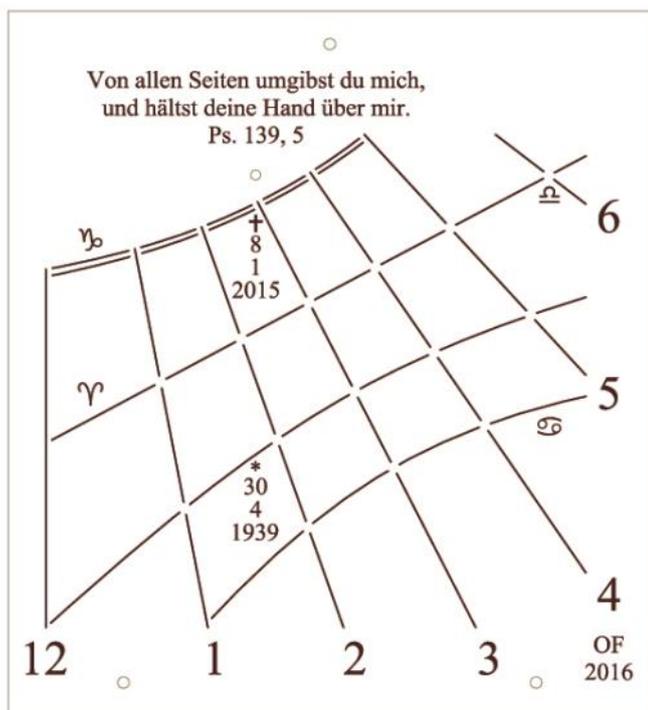


Fig. 4. Drawing of the dial plate as documentation for the production; the plate measures 430 × 390 mm.

Inscription: An appropriate quotation is placed above the pin gnomon.

Overall: All the lines (width of lines) and lettering (type sizes of Times New Roman) produce a harmonious appearance.

Draft

Measurement of the shadow angle

Fig. 2 explains the method of measurement: the radio clock documents date and time of day correlating with the current shadow angle. Ten measurements of the shadow angle on three days at different times yielded for the declination of

both the gravestone and the dial plate a calculated^{1,2,3} mean value of 40.25°.

Calculation of the dial's delineation

The arrangement (position, spreading) of the declination and hour lines on the dial face essentially determines its appearance. It was therefore necessary to find out the appropriate length of the pin gnomon. Fig. 3 shows the resultant diagram for the delineation; the solution by trial and error⁴ amounted to 150 mm for the height of the nodus (centre of the sphere) above the dial plate. The gnomon's sphere has a diameter of 15 mm.^{5,6}

Drawing of the dial plate

The drawing in Fig. 4 comes from a handful of dial-plate designs – based on the delineation in Fig. 3 – in which gnomon positions (origin of the delineation's coordinate system), lengths of declination and hour lines as well as type sizes and placement of the lettering were varied. The declination and hour lines are interrupted each at their crossings on account of the laser cutting. The centre of the quotation, gnomon's foot, symbol and date of the day of passing and symbol and date of the day of birth are arranged meaningfully along one line.

Manufacture

At the laser-cutting stage the laser beam cuts out all the material within a closed line (poly line). That means that the wide declination and hour lines as well as the characters in the drawing of Fig. 4 are needed simply in their contour lines. Furthermore, characters with inner and outer boundary lines have to complete in such a way that parts of the object cannot get lost (see Fig. 5). Fig. 6 shows the appropriate modified drawing of the dial face.

The serifs of Times New Roman with type sizes of 10 mm and 20 mm have very small radii within their poly lines so the dial plate was laser cut from sheet stainless steel only

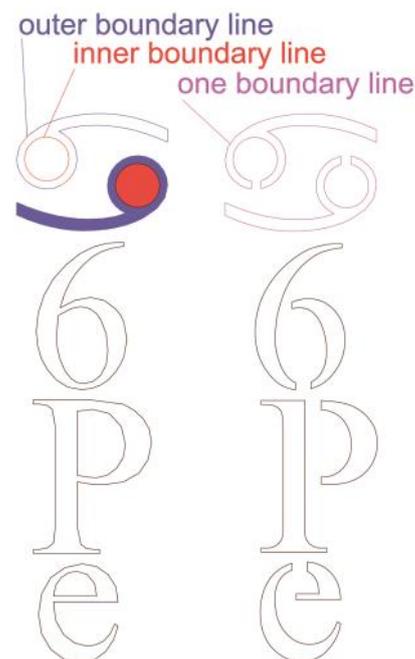


Fig. 5. Examples of characters modified for laser cutting.

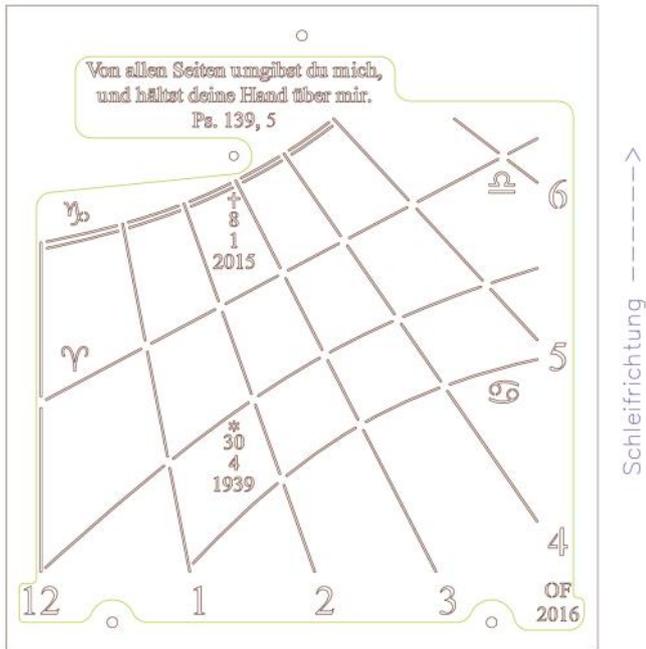


Fig. 6. Technical information for the production; the green line represents the frame on the rear face, the blue arrow indicates the direction for sanding the front face (see Fig. 7).

1 mm thick. Therefore, a ‘frame’ of 2 mm thickness – joined to the sheet – ensures the necessary solidity of the plate and the fastening of the pin gnomon (see Fig. 8).

Epilogue

About twelve hours before my wife drew her last breath some verses from Psalm 139 were of some consolation to her, especially verse 5: *Von allen Seiten umgibst du mich, und hältst deine Hand über mir*⁷ (You are all round me on every side, and you protect me with your power).⁸

Also the sun is all round us with its power!

Fig. 9 shows a close-up of these words from Psalm 139 as they appear on the dial.

ACKNOWLEDGEMENT

The author wishes to thank Dr Carlo Heller, Helios Sonnenuhren, Wiesbaden, that he accepted just like that special desires with regard to the dial’s realisation as well as for the excellent workmanship of the dial plate and the pin gnomon.

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Fig. 7. Sanding the dial’s front face. Photo: Carlo Heller.



Fig. 8. Detail of the rear of the dial.



Fig. 9. Close-up of the gold-coated sphere representing the sun with the inscription in the background.

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BSS ANNUAL CONFERENCE

Oxford, 21–23 April 2017

Jackie Jones and Jenny Brown

This year's Conference was held at the Jurys Inn Hotel on the north-west side of Oxford, just a short bus ride from the city centre; it was efficiently organised by Chris & Liz Williams, Doug Bateman and Bill Visick.



Our base for the Conference.

Friday 21 April

On the Friday morning, prior to the start of the conference proper, a few of us who had arrived earlier went to lay out an analemmatic dial in a school playground at Wroxton, a village near Banbury. This will be the topic of a future article when the school have (we hope) made the dial layout permanent. It continues the tradition of a pre-conference dial-making exercise following the one created on Crosby Beach near Liverpool last year.¹

After dinner, Chris Williams welcomed us all and this was followed, while we waited for our coffee, by [Kevin Karney](#) reading a poem – *Sundial Serenade*. In an RAF station in India in 1944, after the planes had left for Burma, Wing Commander Sindall and his men were hot and bored, so turned to writing poetry. It was printed in the *Journal of the Air Forces, Indian Edition* and, given various permissions being obtained, you will be able to read it in full in the September *Bulletin*.



Looking at some of the displays before dinner.



And then the programmed talks commenced....

[Ian Butson: Finding the Declination Angle of a Wall – some Thoughts and Ideas](#)

Ian referred to Mike Shaw's talk at the Newbury Day last September² and described a number of methods to establish the declination of a wall, illustrated by a range of assorted gadgets, some also on display. In an ideal situation, this would be based on measurements at the proposed dial's location taken at exactly local solar noon which is determined by the value of the Equation of Time, longitude correction and also summer time if applicable. But the sun does not always shine. Ian outlined six methods which could be used, maybe in combination for clarification, or in different situations.



1. Measurement using a magnetic compass. This will provide a general assessment of the declination, but there are a number of issues to consider, the main ones being: any nearby ironwork pulling the compass

needle and the fact that it will read magnetic north, not true north. The magnetic variation will need to be taken into account.

2. Viewing the building on Google Earth. The approximate declination of the building may be obtained by measuring the angle of an overlaid line on the building's image on-screen or the 'Where's the Path' website.
3. The meridian line method. After establishing the general declination of the wall, a more accurate measurement can be obtained by using a plumb line with two equally spaced lines either side of the main line to record the times of the sun's shadow at the azimuth. This value is given on the 'SunCalc' app. By taking three readings, they can be averaged to produce an overall azimuth value to determine the declination.
4. Adjustable rotating sundial method. This allows readings to be made up to 2 hours before or after local noon in 15 minute increments. The sundial is then rotated to indicate the exact EoT corrected time and the declination is then read from the attached protractor scale.
5. Measurement of the sun's azimuth angle. This method, based on trigonometric principles as described



The Cake Competition's winning entry. The only entry, in fact. Deliciously cheesy mass dials by Jackie Jones.

in Waugh,³ can be used at any time that the wall is in sunshine.

- Direct measurement of the sun's azimuth angle using a protractor. This method is based on an article by Ray Ashley.⁴ A circular disc, free to rotate, is fitted with a protractor and with two vertical pins along a datum line, the taller of the two being the gnomon. At the exact instant of local noon, the disc is rotated so that the shadow cast from the gnomon aligns with the smaller metal pin, and the declination is read off from the protractor scale against the datum line.

Saturday 22 April

The usual brief AGM was followed by the morning's presentations.

Frank King: *Two for the Price of One? Double Vertical Dials*

Frank first outlined his criteria for double horizontal dials

- There must be a horizontal (plane) dial plate
- There must be two gnomons which cast line shadows
- The gnomons must be fixed
- The gnomons must intersect

He noted that, for the purposes of this talk, there was no constraint on the orientation of the gnomons (though, implicitly, their shadows should be gnomonically interesting) and no requirement for a stereographic projection.

His criteria for a double vertical dial were identical except that 'horizontal' would be changed to 'vertical'.

Frank acknowledged that he had found only one double vertical sundial; this had featured in a September 2011 *Bulletin* article⁵ by Dennis Cowan but its unusual functionality had not been commented on.

This double vertical dial (SRN 1527) was made in 1735 by Archibald Handasyde and is now on the south-facing wall of Inveresk Church about five miles east of Edinburgh. The dial had been described in the 1880s by Thomas Ross.

Frank had examined photographs taken by Dennis Cowan and Christine Northeast and had made a mathematical model of the dial. This model was a close reconstruction of the original dial with the exception of the nodus.

Notwithstanding much study of the

photographs and Thomas Ross's sketch of the dial in the 1880s, it is unclear what the original nodus looked like. For his model, Frank settled on using an aperture nodus and accepted that this was most unlikely to have been the form of Handasyde's nodus.



The original dial and Frank's model incorporate an inner chapter ring with azimuth markings, and the appropriate shadow to use is not that of the principal gnomon but that of the supporting strut which serves as a secondary gnomon.

These are fixed gnomons that intersect and cast line shadows onto a vertical dial plate. This is indeed a double vertical sundial.

The azimuth markings run from E via S to W and Frank's model confirmed that the shadow of the secondary gnomon really would indicate the solar azimuth but only when the solar declination was zero. That said, he demonstrated that it was possible to use the azimuth scale at times of year well away from an equinox but the user would need to understand a nice geometrical construction to do this.

At this point, Frank upgraded his model. He lengthened both gnomons and gave the secondary gnomon a dip of 7.89°. With this adjustment, the inner chapter ring could be converted into a gnomon-driven unequal hours dial which works to

a very good approximation. Two articles in the September and December 2011 issues of the *Bulletin* explain this.^{6,7} The result is necessarily spot on at the end of the 6th hour, and the angle of dip ensures that it is very close to spot on at the end of the 3rd hour and at the end of the 9th hour.

He ran the model for the 12 60-minute daylight hours of an equinox and for the 12 40-minute daylight hours at a time of year when Inveresk has exactly 8 (common) hours of daylight.

Frank concluded that a modern double vertical sundial, with intersecting gnomons, possibly made of stainless steel tubing, could be constructed to this design. Moreover, provided the gnomon assembly was in the meridian plane, the sundial could decline to the west or east. It did not have to be due south-facing as the Handasyde dial is.

During questions, Frank noted that, although nearly 300 years had passed since Handasyde constructed his dial, no-one else seems to have made a double vertical sundial. Frank had, though, come across a very near miss, a dial with two gnomons which directly shows solar time and solar azimuth but the gnomons do not intersect. Who had made this dial? Well, he was sitting right in front of Frank. It was John Lester!

Fred Sawyer: *Two Seventeenth Century Eclipse Dials*

The forthcoming eclipse of the sun which will be seen across the USA from north-west to south-east in August prompted Fred to choose this particular topic for his Saturday talk. He showed us two dials made in the seventeenth century which each featured eclipses, one a lunar eclipse of 1617 and the other featuring eclipses of the sun and moon for the years 1645 through to 1651.

Fred first discussed the beautiful dial at Rouffach, known to BSS members who had been on the 2008 Sundial Safari to Alsace in 2008 and described by René R.J. Rohr in the *Bulletin* of October 1993.⁸

This dial was restored in 1997, thanks to Rohr's persistence and painstaking research which had enabled him to discover the positions of various stars and planets not visible on the dial



in its former poor state. He had thus been able to date the eclipse commemorated to 16 August 1617.

Rohr had been unable to identify the maker because all manuscripts associated with the Franciscan monastery at Rouffach had been lost in 1789 at the time of the French Revolution. Fred took up the challenge and made the case for Johann Ruderauf, an astronomer living and working in Rouffach at the time. He was a friend and correspondent of Johannes Kepler who had worked with Tycho Brahe and continued to develop and publish astronomical data and hypotheses until his death in 1630.

Ruderauf would have observed the lunar eclipse of 1617 in Rouffach anyway, but Fred went on to develop the idea that, in spite of the fact that Ruffach occupied low-lying land between a mountain to the west and a forest to the east, the astronomer might well have observed both the setting sun in the west and the already partly eclipsed moon in the east at the same time on that date – a selenelion! Ruderauf was physician to Archduke Leopold who resided in the castle of Isenburg when in the area, and from that high spot on the mountain, the geometrically impossible phenomenon would have been visible owing to atmospheric refraction.

Fred's other example was Athanasius Kircher's design for a polar eclipse dial which featured vertical sectors for the six years 1645–65, the winding vertical lines in the form of a dragon (traditional in 16th-century eclipse astronomy). The spaces between the declination lines are labelled with the appropriate signs of the zodiac. The eclipses are marked on the vertical 'dragon' throughout this period. Kircher, hugely prolific in all the scientific fields of his day, maintained that this dial would work as an almanac to predict future eclipses, reusable every 18 years, based on the Saros cycle. However,



John Lester introducing the Andrew Somerville Memorial Lecturer.



Waiting to go into Convocation House



as Fred reminded us, the Saros cycle (18 years, 11 days, 8.3 hours) does not encompass a whole number of days. The earth rotates an extra 8 hours (120 degrees) between one Saros cycle and the next. Therefore, the eclipse information on the '*Orologia relative alle eclissi di Sole e di Luna*' we were looking at could not be applied to any other Saros cycle.

Finally, Fred showed a slide of Bill Gottesman's instructions for making a sundial for a solar eclipse (website, May 2012, California). Watch out for this year's version for August!

The Andrew Somerville Memorial Lecture

Dr Allan Chapman: *Instruments, Almanacks and Astrologers; the Mathematical Arts in the Tudor and Stuart Age*

After coffee, Dr Allan Chapman captivated us all by the sheer brilliance of his survey. He began by linking the theme of his talk to the culture in which sundials and dialling flourished in the 16th century. Declaring his own commitment to practicalities and craftsmanship, he cited as the basis of Tudor culture:

- the development of printing
- the growth of vernacular languages
- craftsmen like Kratzer
- travel and discovery
- the acceptance that the Sun was central in the universe

During this period, the Bible and prayer books became available for people to read in their own languages. Gradually chapbooks, diaries and joke books became popular. Chaucer's *Treatise on the Astrolabe* was written in 1491; Kratzer was astronomer to Henry VIII. Many fine sundials were created at Oxford and Cambridge. America was discovered in 1492; ships were taking people to where they had never been before. They needed information that would pave the way for the

development of navigational instruments using mathematics and astronomy.

However, it would be a mistake to think there was a wholesale rational understanding behind all this creativity. For example, comets and meteors were regarded as portents heralding the end of the human race, the sky falling in and other disasters. Almanacs of all kinds would be read aloud by the parish clerk around the alehouse fire.

Moreover, astrology at this period was still very much in the scholarly tradition, closely linked with all branches of natural



philosophy, including astronomy and, of course, medicine. Learned men believed in astrology implicitly and many sundials included

astrological information. Dr Chapman reminded us of the four humours of classical medicine, closely related to the four seasons and the idea of the planet-emitting forces that worked on the humours. Diseases were caused by blockages, and treatments like purges and bloodletting were designed to eliminate the relevant blockage. When Robert Boyle arrived on the scene, medicine was still dominated by these ideas, but Boyle was critical. His interest in preparing practical remedies in his laboratory inclined him towards chemistry and he also was also drawn to mechanics as an explanation of the human body. These ideas became pivotal to his work, to that of his assistant Robert Hooke and to the scientific community in general. Precision instruments were developed and by 1720 all traces of the old way of thinking were gone. In that context, maybe the early fascination with sundials had gone, but they would thereafter continue as precision instruments, maintained by a passion for mathematics. And certainly, astrology was no longer central to scientific thought!

Frank King lecturing to an attentive audience in Convocation House.



Saturday afternoon

After lunch a coach took us into Oxford where we assembled at the fine statue of William Herbert, 3rd Earl of Pembroke and admired the Tower of the Five Orders and other buildings in the Old Schools Quadrangle. Frank King had arranged a visit to Convocation House, which is one of the historic buildings in the Bodleian Library complex and has two stained-glass sundials in its windows.

Frank King: *Convocation House and its Sundials*

Notwithstanding competition from sound engineers making a loud noise in the grounds of adjacent Exeter College, Frank explained that Convocation House had been built in the 1630s and that, in 1644, it had hosted the House of Lords during the period of the Oxford Parliament in the Civil War. Quite possibly, Charles I had addressed the House from roughly where Frank was speaking.

Oxford has a long history of hosting Parliament which is not too surprising when one notes that it was the *Provisions of Oxford*, written in 1258, that prompted England to establish its first Parliament. Later in the same year, Parliament was not only set up but met several times in several places including Oxford.

Frank noted that the adjacent Divinity School had had its stained-glass windows smashed in 1550 during a Visitation by the King's Commissioners (Edward VI) in the aftermath of the Reformation. This smashing of windows was repeated country-wide during the Puritan Revolution that followed the Civil War.

Those who lived by making stained-glass windows had to find new product lines. Many turned their attention to armorial glass and some started making stained-glass sundials. Two such late

17th-century dials (SRN 2282 and SRN 2283) were made for Convocation House. These sundials were the subject of an article in the September 2014 *Bulletin*.⁹ They were much photographed after the talk.

We concluded our visit by looking into the Divinity School where the glass is clearly ancient but it is clear. The original stained glass was never replaced.

Between the visit to Convocation House and the Gala Dinner we were free to renew or make the acquaintance of some of the beautiful sundials in the vicinity, or visit the History of Science Museum or other places of interest.

Sunday 23 April

Sarah Schechner: *Time in the Wilderness – European Pocket Sundials Used in Colonial America*

The first portable sundials brought to the Americas by European explorers and settlers were not made explicitly for use in those lands, but were adapted for the purpose. Sara's talk looked at a number of the sundial relics ploughed up on old battlefields or discovered in collections; they had links to remote forts, tribal lands, trading posts, sugar plantations



and colonial administrative seats. The dials found that date from the mid-seventeenth century have fixed and incorrect

latitudes; by the 18th century, they were more suited for the area. They were generally made of brass, occasionally in silver, although it could be that any made of wood did not last. There was little evidence that any were manufactured in the colonies and the style of dial chosen reflected their origin. The English preferred a compass dial,



In the conference hall.

while the French favoured a Butterfield style such as one found for 18–22° for Hispaniola (now Haiti). Pierre le Maire, one of the main manufacturers in Paris, was commissioned by the French Government to make dials for use in America. They were engraved on the back with a list of sites to be conquered or traded with; different spelling of place names reflected the tug of war between the powers wanting control of the land. Some dials had a cross on them which suggested use by missionaries. These dials shed light on the relationship of time to imperialism and the transmission of cartographic and ethnographic knowledge during the colonial period. They reflect the desire to impose discipline on a land which did not run on Western time.

Fred Sawyer: *Solar Decliners, or Sundials CLARAFied*

Fred discussed a variety of sundial he calls a 'Solar Decliner'. This is a portable vertical dial with peg gnomon; the dial is held in the sunlight and declined until the endpoint of the gnomon's shadow meets a predefined condition, generally touching the current date curve. The time is then read from the position of the shadow among the hour curves. Fred mentioned a few historical examples and then developed several new varieties, including a dial with parallel equi-spaced hour lines, a dial with equiangular hour lines meeting in a single point, and a dial with equi-spaced circular hour curves. He also demonstrated two techniques for indicating mean time on these dials, including a new method involving modifications to the day curves instead of to the hour lines.

Johan Anton Wikander: *A Carved Compass Rose in Norway and a Mass Dial*

A compass rose is carved on a rock weighing about 120 kg at 62° 10' north, on a peninsula into the North Sea at Stadt and is shown on a map dating from

1800. It is part of a fort which also has fire beacons for warning. The fairway is not protected and was therefore dangerous and open to attack from England in the war of 1807–14. The rose does not point true north, but 27° off; as it varies, it is now the same as it was in 1650.

At Silje Monastery, 7 miles north of the fort, a horizontal mass dial was uncovered during excavations in 1870. It is carved in slate and probably dates from the mid-15th century. Saint Silje was an Irish Princess in the late 900s who escaped from Ireland over the North Sea to Norway.

John Davis: *The Navicula – a medieval Portable Dial Originating in East Anglia?*

A navicula is a universal altitude dial designed to look like a ship with a tall central mast for the latitude scale and fore and aft castles for the sights. The keel is used for setting the date. It has equal hours on the front face and on the



back a shadow square and an unequal hour quadrant; there are two plumb-bobs, one with a sliding bead. They date from late 14th or

15th century England and are not found in Europe or the Islamic world. According to John Whethampstede, Abbot of St Albans Abbey (d. 1465) they were invented by a monk at Glastonbury Abbey. The word navicula comes from the Latin for small boat. They are constructed from two sheets of hammered brass with cast spacers and then riveted together; they are all very well made and considering that some have been in the ground, are in good condition.

There are six known medieval naviculae which date from pre-1500. One was found by a 'Mr Reeve', curator of Norwich Museum, who gave it to Lewis Evans who later donated his collection to the Oxford Museum of the History of Science. In 1989 another was excavated in Suffolk; this is now at The National Maritime Museum in Greenwich. The Geneva Museum's dial was originally

from the descendants of John Wilson (1719–93) of Broomfield Hall, Sheffield. Wilson was the nephew of the Rev. Dr Cox Macro (1683–1767) of Little Haugh Hall, near Bury St Edmunds, Suffolk who was an antiquarian and collector of some note. This one is in very good condition as it had been kept in a drawer. A drawing in *Gentleman's Magazine* from 1787 shows one that has not yet been found. The Museo Galileo in Florence has one that was once in the Medici collection; it is not known where it was made. The National Museum of Scotland, Edinburgh, has a recent find (2016) from an unknown location.

Drawings of this type of boat, a cog, were also found on coins from Edward III in 1340 to Henry VIII's reign: on medieval seals, pub signs and also similar-looking boat graffiti in medieval churches in Norfolk. They seem to originate from East Anglia.

[John's article 'The Navicula – Made in Medieval East Anglia?' appears on pages 15–22 of this issue of the *Bulletin*.]

John Lester: *Fundials*

John gave a fascinating and amusing account of making and selling wooden portable sundials and astrolabes to raise funds for the Astronomy Centre in Lancashire. His first interest was astronomy; after the Centre's original sheds were destroyed by wind, money was needed for a new one. John is an expert in working in wood and has a well-equipped workshop and became interested in sundials – it was something he could make and then sell to raise funds. The first were cylinder dials turned on a lathe which he wrote up for a woodworking magazine. He then went on to make nocturnals, horizontal dials, polar dials looking like a bow tie, bifilars and equatorials. There were a few little problems along the way such as the large bag of cheap compasses which didn't work; they turned out to be made of aluminium. The floating dials designed for use outside were not too successful in the wind as the gnomon acted as a sail and disoriented the dial. It was an amazing collection and the astronomy centre now has a new building. Two of John's pictures are shown on p.48.



Jenny Brown: *An Intriguing Job – How a Simple Request for a Gnomon led to a Magical Mystery Tour in Leafy Surrey*

Last April, David Brown received an email asking whether he could supply a gnomon by mail order. The attached photos showed an attractive square vertical sundial carved directly onto bare limestone set into an impressive façade of matching stonework and white-painted brick. The dial itself featured four putti carved in raised relief, one at each corner. There was indeed no gnomon and the hour lines and numerals were barely visible.

David's response indicated his willingness not only to supply and fit the gnomon but also to carry out restoration of the sundial by re-cutting the hour lines and numerals. He attached an itemised costing for all this work; but at this point, contact with the potential clients (possibly spooked by the price, or the deluge of sundial information David had included) fizzled out. Thereafter, although the order was eventually confirmed, the job proceeded by fits and starts, not without a few tricks on the Browns' part to keep the ball rolling, until finally the gnomon was fixed in place (by David) on 3 November 2016. This dial is now number SRN 7886 on the BSS Register.



The address supplied in the original email showed the property to be in super-affluent leafy Surrey and here too, persistence and luck paid off in shedding light on the house and its history, if not on the current (Russian) owners. The building, when the Browns visited (to take sun-sights in June and fix the dial in November) was indeed 'an architectural masterpiece, set in stunning gardens', built in 1938 by Robert Lutyens, son of Sir Edwin Lutyens. The client in 1938 was Woolf Barnato, legendary racing driver and one of the 'Bentley Boys'.

The Surrey County Record Office has photos showing the sundial with a gnomon in the 1940s. What actually happened to it is still a mystery. It may have been lost or damaged at the end of the 1990s when travellers were thought to have occasionally occupied the empty property in the years before its restoration and refurbishment. Further



Photo: Bill Visick

research will be undertaken on the fate of the gnomon and the original design of the sundial.

[A photograph of this dial may be seen on page 24 of this issue of the *Bulletin*.]

David Brown: *Sundials for Peru*

David Brown told us how a phone-call from Argentina led to two sundials and a cosmic weathervane for Peru. A farmer, Robin Begg, who is in charge of Ingleby Farms and Forests for South America wanted a sundial for a new development in NE Peru where table grapes and avocado pears were to be produced. A southern

hemisphere sundial near to the equator needed some thought, and inspiration was sought from both historical Peruvian structures (such as mirror stones, temple of the Sun and Machu Picchu's Intihuatana as well as more modern sundials close to the equator. A very large rubblestone gnomon with collimator tubes mounted high up on appropriately-inclined walls to give seasonal markers on reflective ground-level targets was considered, but dismissed as being inappropriate for the already-allocated site, so a more modest solution was required. This came in the form of a polar dial which had hour lines with EoT and longitude corrections built in. Much help had been obtained from Valentin Hristov who generously made his software readily available.

A separate motto in Spanish for each sundial was sourced from Benjamin Franklin (*Hide not your talents. They for use were made. What use is a sundial in*



the shade?) and from a Somerset sculptor Alan Dun who had designed and constructed a large cast iron sundial on the banks of the Kennet and Avon canal towpath in Bath (*Time is the waterway of all our days. We are dreamers on its banks*). The sundials were made in stainless steel by firms in Lyme Regis and Bristol and set on specially-constructed concrete plinths in their new locations.

Not forgetting the earlier inspirations from Peruvian history, Robin Begg steered David towards an additional structure which acts both as a weathervane in the form of the company's sprouting seedling logo and as a nodus for season marking. The weathervane has a large stainless steel flaming sunburst mounted horizontally atop a 6-metre pole with apertures for NSEW (in Spanish) to indicate wind directions on the ground. The sunburst also has a 15 cm diameter hole so that a circle of sunlight can fall throughout the year on each of a set of four polished stainless steel plates set along the meridian to mark local noon on the seasonal dates and when the sun is vertically overhead.

Geoff Parsons: *The Recent Discovery of Two Sundial Books*

Geoff talked about two books he has recently found. The first is a paperbound edition of Frank Cousins' *Sundials*. It is the printer's draft copy with many ink amendments; these were probably done by Cousins as they are corrections to the content.



Pictures were the wrong way round, references incorrect, images mistitled and page numbers out of order. The second book is *The Heliochronometer* published by the AiResearch Casting Company in California. It details how they made a copy of a Pilkington and Gibbs Heliochronometer from Liverpool and contains cam drawings and other plans.

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Speaker photos by Mike Shaw
Additional photos by Jackie Jones,
Frank King and Christine Northeast

MINUTES OF THE 28th BSS ANNUAL GENERAL MEETING

Oxford, 22 April 2017

The AGM was chaired by Frank King (Chairman) with Chris Williams (Secretary) and Graham Stapleton (Treasurer) in attendance.

1. Minutes of 2016 AGM

The minutes of the 27th AGM, held at Liverpool on 16 April 2016, were published in the June 2016 *Bulletin*. As no comments had been received by the Secretary, they were taken as read.

2. Receive 2016 annual statement of accounts and the 2016–17 trustees' annual report

Both documents were circulated to all members in the March 2017 *Bulletin*.

Voicing concern at the fall in membership, Ian Butson expressed the view that the membership could be expanded by the Society undertaking significant advertising – flyers aimed at other clubs and societies and in the press – and erecting a sundial in central London. The Chairman responded that the trustees were already considering advertising – digital advertising – and invited Ian to undertake a programme, to be agreed with the trustees and funded by the Society, of traditional advertising in his local area. Experience gained can then illuminate the most effective way

forward. A central London sundial cannot be meaningfully considered without much more detail.

In further discussion two ways were suggested to improve the opportunities members have to contribute ideas – additional meetings and the members' area of the website.

In closing the Chairman confirmed that the accounts and trustees' report had been received, and that the trustees would respond to all, and related, matters raised.

3. Election of a trustee

Jackie Jones and Frank King retired by rotation. Both were willing to continue to serve and offered themselves for re-election.

Jackie Jones and Frank King were both elected to the office of charity trustee.

4. Appoint examiner for 2017 annual statement of accounts

Independent Examiners Ltd was reappointed.

5. AOB

No other business was raised.

Secretary
3 May 2017

A Host of Fundials

Here are just two of the many delightful photographs that John Lester showed at the Oxford Conference (see page 46 for an account of his presentation).



HONORARY OFFICIALS OF THE BRITISH SUNDIAL SOCIETY

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