

The British Sundial Society

BULLETIN

BSS Bulletin 25(ii)

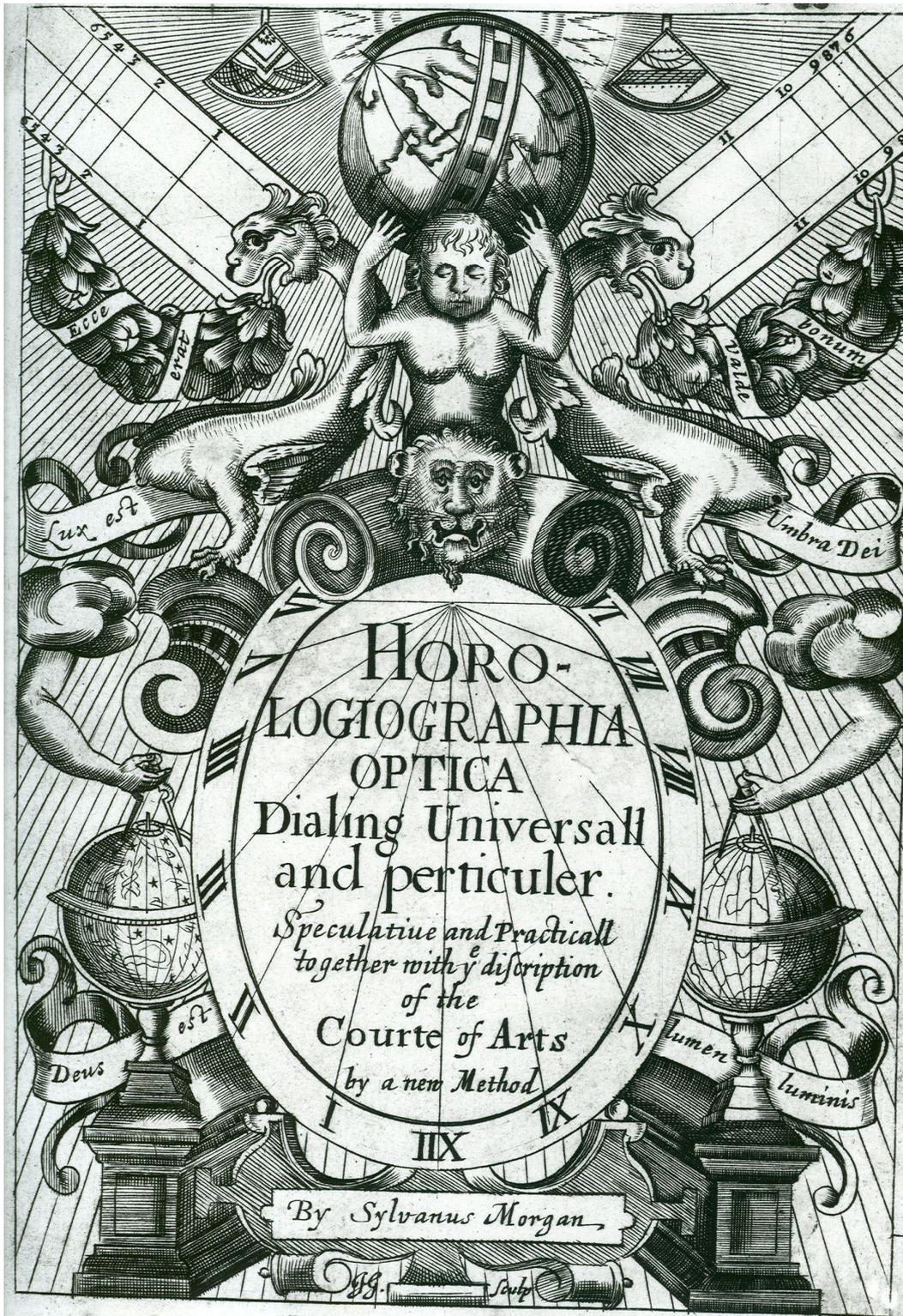


June 2013



VOLUME 25(ii)

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The title page of *Horologiographia Optica* ..., by Sylvanus Morgan (1620–1693), published in 1652. Morgan was born and lived in London at the peak of the development period for dialling in England (and the chaos of the Commonwealth period). He is mainly known as an heraldic arms-painter and also published several books on that topic. He was associated with William Leybourn which may be where his interest in dialling came from. Note the several dials and quadrants in the engraving. Image courtesy of Chris Daniel.

Front cover: A horizontal dial by Samuel Saunders of London, c. 1735, made for an English location at latitude of c. 52°. The dial, with a badly repaired gnomon, was put up for sale by several UK auction houses before being purchased by a private collector. The maker Samuel Saunders and his dialling instruments were the subject of articles published in the *BSS Bulletins* of March and June 2012, where the dial was labelled “HD2”. The story of the extensive restorations of the gnomon are on page 44 of this issue. Photo: Maciej Lose.

Back cover: The typically Scottish polyhedral dial at Holyrood House seen during the BSS Conference tour in Edinburgh. See page 52 for the full report. Photo: Dennis Cowan.

BULLETIN

OF THE BRITISH SUNDIAL SOCIETY

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EDITORIAL

Most Enjoyed Article Award 2012

I am delighted to announce that the winner of this award is Peter Kunath, for his article on the Henry Moore sundial '*Lost and Found. The long journey of an unusual sundial*' in the December issue, 24(iv). Peter is definitely to be congratulated, particularly as he is a non-native English speaker. Most of the votes for the competition were collected at the Edinburgh conference but some readers who didn't attend sent me their inputs beforehand.

A very close second behind Peter was Dennis Cowan for his series of articles '*In the Footsteps of Thomas Ross*'. Here, I took the votes for the various parts of the (ongoing) series together as this is the way some of the votes came in. Votes for some of Dennis's other articles, which also featured, were counted separately.

In third place was the '*Mosque of the Sun II: Crown of Doha*' by Sara Shafiei and Ben Cowd. This was rather an unusual article by non-member authors so it was pleasing to see it so well received.

It would be invidious for the authors to give a full listing but suffice to say that most of our regular writers featured, some more than once, and that a total of 31 different articles received at least one vote. The range of topics was very wide with historical dials and modern ones, constructional items, visit reports, and sun-compasses and others, all attracting some supporters.

One thing which was noticeable was the high level of interest in the shorter items, sometimes used as fillers between the 'blockbuster' articles. The average length of articles picked was 2.76 pages and none of them had any equations! One piece of only a quarter of a page got a vote! Whilst it would be very hard work to fill the *Bulletin* with articles like this, it is good to see that the effort of filling small spaces is worthwhile. And, never fear, we will continue to publish 'serious' articles which will stand the test of time, advance the understanding of gnomonics and enhance the standing and authority of the Society – as long, that is, as authors contribute them!

THE ARTS OF URANIA

PETER DRINKWATER

Urania, the muse of Astronomy, holds her place among the nine attendants of Apollo the Sun God; thus establishing her sphere of influence as a divinely inspired art, rather than a cold atheistical science. To those that gave her that position, astronomy had nothing to do with telescopes (radio or optical), but was rather about understanding the movements of the 'sun and the other stars' for the determinations of 'times and seasons', with their qualities in the determination of human affairs.

Geometry, the language of Astronomy, was not the 'invention' of Urania, but of her sister Thalia, the muse of Comedy who therefore presides over both the sublime and the ridiculous. One of her attributes is a shepherd's crook, providing a very plausible link between the two. It was not for nothing that Danté called his major work (which is replete with astronomical/astrological references) 'The Divine Comedy'.

Urania's own attributes, a celestial globe and a pair of dividers/compasses, indicate her mission to use that language (Geometry) to express those divine spherical motions on the mundane medium of a flat surface. To do this, only two instruments are requisite; a pair of dividers/compasses and a straight edge. The starting point is that the radius of any circle will divide the circumference of that circle (chordally) into 6 equal parts. Bisection then gives 12, then 24, divisions. Trisection and quinsection (passé the mere theorists, who get nowhere) can be readily accomplished by the skilful use of the dividers.

As far as I am aware there are only three natural (inherent) projections of the Sphære (I keep 'sphere' for the earthly or mundane): the **orthographic**, the **stereographic**, and the **gnomic**. Each of these has a point of projection and a plane of projection.

Fundamentally, there are two coordinates: the parallel circles of declination (including the 'day curves' of the Sun), and the radiating circles of the right ascension (including the solar hour lines). Think spherical spider's web. There is also the horizon line (cutting the Sphære in two) and the ecliptic (bearing the signs of the zodiac).

The Orthographic Projection

The orthographic projection is essentially the art of drawing things exactly as they appear, but entirely without perspective. It is God's eye view, projected without diminution from infinity. Its plane of projection is a surface at right angles to the infinite point from which it is projected. All

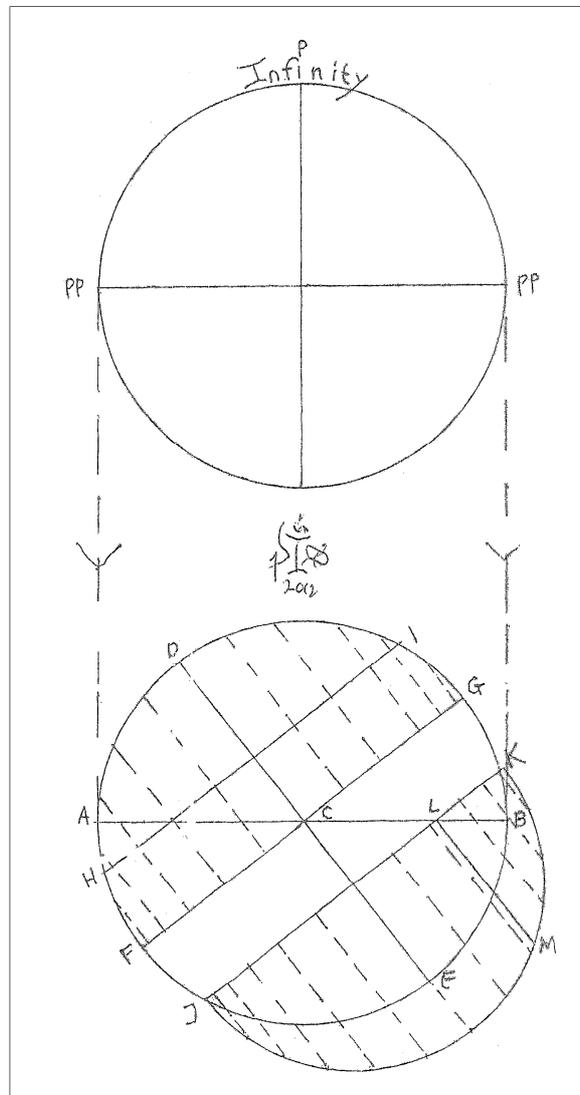


Fig. 1. The orthographic projection.

circles on this plane (or parallel to it), including the Sphære itself, appear as circles. All circles at right angles to this plane appear as straight lines. Any circle which forms a non-right angle to this plane appears as an ellipse. Ellipses need plotting and as such are studiously avoided.

Exemplification

See Fig. 1. A-B is the horizon. C is the centre of the Sphære. D-C-E is its axis. Angle DCA is the latitude of the place. F-C-G is the Æquator, at right angles to the axis. Set out the angle of the obliquity of the ecliptic ($23\frac{1}{2}^\circ$ is approximate) either way from points F and G to draw H-I and J-K, the tropics of Cancer and Capricorn. To divide the Æquator into the hours of right ascension: divide the semi-circle F-D-G into 12 equal parts and draw the lines parallel

to these points to the axis from these points of the Æquator. The latter will be correctly divided.

To divide the Tropics (or any other parallel) into the hours of right ascension: draw a semicircle on the base of that line. Divide that semicircle into 12 equal parts and project as before. That circle will be correctly divided. If you are a true classicist and wish to draw the temporal hours of antiquity, mark point L, where the parallel crosses the horizon, and draw L-M parallel to the axis. Divide the arc K-M into 6 equal parts (for a symmetrical 12) and project as before. L-K will be correctly divided.

That, very basically, is the orthographic projection. It is essential to the art of dialling. The Greeks, and the Romans that followed them, called it the Analemma; which (passé the meaning given in modern Greek and Latin dictionaries) means 'the King of diagrams'. The analemmatic sundial, with its plotted ellipse of hour points, springs directly from it, as does a Regiomontanus dial (and its derivatives) which determine time by the solar altitude.

The Stereographic Projection

The beauty of the stereographic projection is that it consists solely of perfect, if often eccentric, circles whose radii extend from nought to infinity. Those circles whose centres are at infinity are, to all intents and purposes, straight lines and are usually so-called (I do not so call them). These present no problem. The problem with this projection lies with those circles which have centres approaching infinity: these have vast radii, ultimately exceeding the capabilities of even a good-sized beam compass.

The centre of a stereographic projection can be anywhere: zenith, celestial pole, the pole of the ecliptic, the due East or West point of the horizon, *etc.*. The point of projection is 180° distant from this. The plane of projection cuts the Sphære in half at right angles to these points. Unlike the orthographic projection, the stereographic projection is not limited to its prime circle but extends outwards to a potential infinity; only the point of projection, lying as it does at infinity, is impossible to represent.

Exemplification

See Fig. 2. To draw a stereographic sphere which matches the forgoing orthographic one:

Draw a circle A-Z-B-P on centre C. Draw A-B for the horizon and, at right angles to it, Z-P for the zenith and nadir. Set out

the latitude from A to D and draw D-C-E for the axis of the Sphære. Draw F-C-G at right angles to this for the Æquator. Set out the obliquity of the ecliptic from G to I and K, and from F to H and J. Draw lines from G to H and J to mark L and M on the axis. Find centres along extensions of the axis from which arcs can be swept through J, M and K, and H, L and I to draw the tropics. All other circles of declination are drawn in the same way.

To draw the hour lines, divide the arc F-D into 6 equal parts (I have manifestly failed to do this correctly! This is because I used a protractor for speed and read it wrongly – bad idea! Never depart from basic first principles.) Draw lines from these points to mark a series of points along F-C. Transfer them, symetrically, to C-G. Find centres along extensions of F-C-G from which the arcs can be drawn through these points, and the poles, D and E. Alternatively,

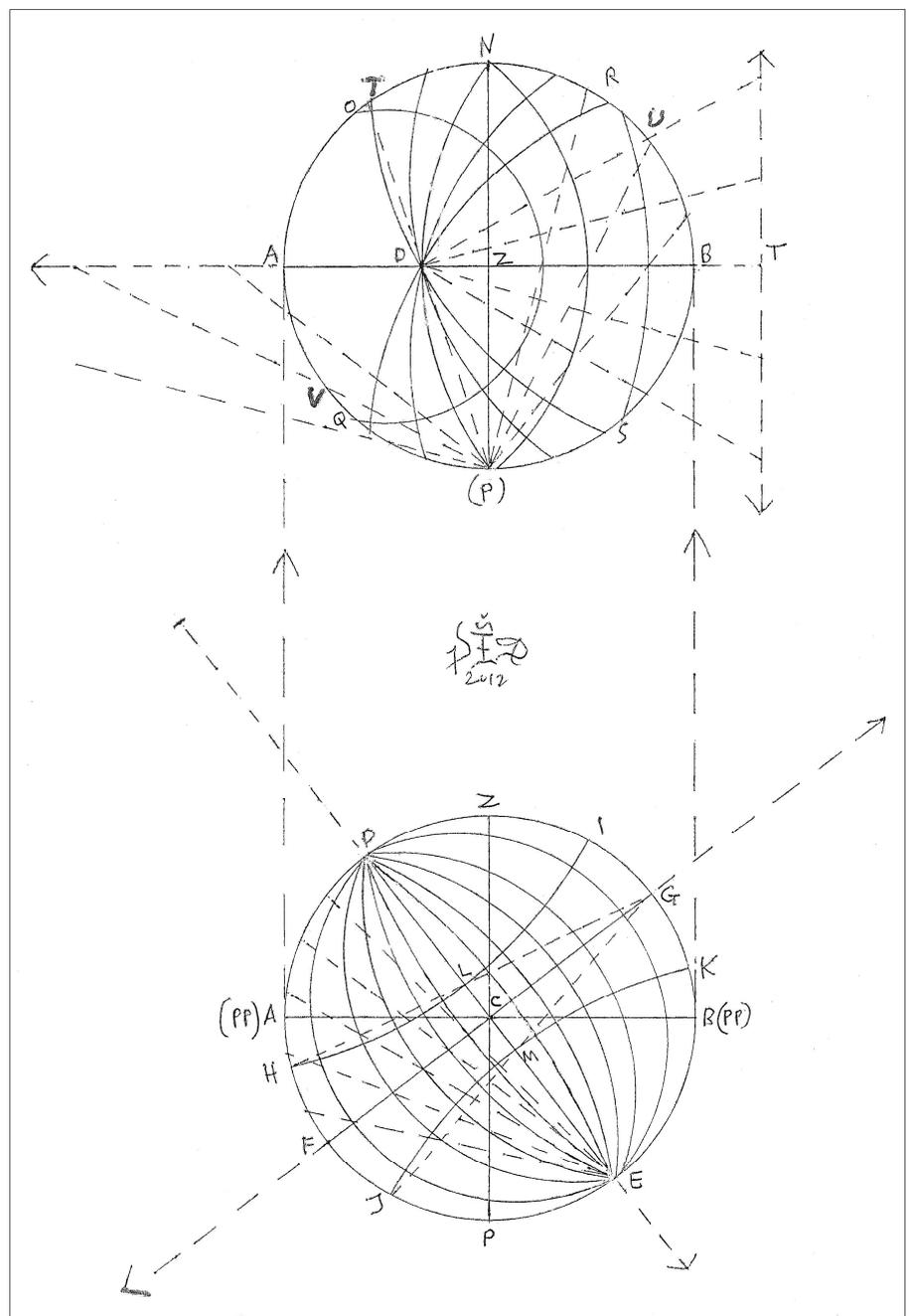


Fig. 2. The stereographic projection.

draw a circle centred on E and divide it into 24 hours. Draw projection lines through these points along an extension of F-C-G. Using these points as centres, sweep arcs through points D and E. Both methods are geometrically correct and the results should coincide exactly.

To draw a stereographic Sphære in the plane of the horizon (that is, PP-PP in the diagram we have just drawn): Draw A-N-B-(P) on centre Z, for the horizon. Draw A-Z-B for the North-South line; and, at right angles to this N-Z-(P) for the East-West line. Set out the latitude from A to T and draw the line T-(P) to determine point D, the North pole. Set out the latitude from N to determine point U, and from (P) to determine point V. Draw lines from (P) through these point to determine two points along A-Z-B (extended as required). Bisect the distance between these points. Using this point as a centre, draw N-P for the Æquator. Set out the obliquity of the ecliptic from U and V in both directions. Draw lines through all four points thus determined to determine points along A-Z-B (suitably extended). Bisect the distance between the two points thus determined which are nearest the pole D. Using the point thus determined as a centre, draw O-Q for the tropic of Cancer. Bisect the distance between the two points furthest from the pole D and, using the point thus determined as a centre, draw R-S for the tropic of Capricorn.

To mark the hour lines: find a centre along A-Z-B from which an arc can be swept linking P, D and N. This is the 6 hour line. Draw a line through that centre (point T) at right angles to A-Z-B. Set out intervals of 15° from point D to that line. Using these points as centres, sweep arcs through point D. These are the hour lines. I have only drawn some of them as the radii rapidly become alarming.

The stereographic principle of projecting from a point on one side of a circle to points on the other is most simply applied in the altitudinal ring dial. Its most sophisticated application is in the construction of the astrolabe. In this instrument, a fretwork map of the skies, with pointers for some of the bright stars and a graduated zodiac, projected from the South pole and centred on the North pole, extends beyond the limits of the Prime Circle, here the Æquator, to the tropic of Capricorn (or beyond). Under this turnable fretwork lie a series of interchangeable plates, all projected from the South pole and centred on the North, containing the azimuth and altitude circles (all drawn on the eccentric) for a variety of latitudes. Its main purpose is the prosaic one of determining the time by observations of the sun and stars.

The ancient Greeks certainly had the astrolabe but I know of no evidence that the Romans ever got their heads around it. It appears to have been transmitted to mediæval Europe either directly from the Greeks (an early Archbishop of Canterbury was a Greek and certain Greek practices, e.g. bearded priests, persisted in England for centuries) or through the medium of Islam via Spain.

The astrolabe was particularly valued in Islam as it gave a ready means of determining the exact times for calling prayers – particularly the early morning prayers which are called at daybreak. Astrology also valued the astrolabe, especially in determining house divisions.

Herman the Lame [Hermannus Contractus], composer of the *Salvé Regina* and the other seasonal Marian anthems, wrote a treatise on the astrolabe, as did the poet Chaucer, and the latter is still readily available – all editions of that poet's complete works contain it.

An astrolabe is difficult and expensive to make. Simplifications of the astrolabe projection to a quadrant form were developed by Profatius (a Spanish Jew) in the 1200s, and by Gunter (an Englishman) much later. These things are much cheaper and easier to make but more complicated and more difficult to use: they fall far short, in scope, of what the astrolabe can do. In dialling, the stereographic projection is employed in the 'double horizontal dial' and some have made great show of using stereography to draw ordinary plane sundials. But why do things the hard way when easier methods do a better job?!

The Gnomonic Projection

Do I need to explain the gnomonic projection to members of the British Sundial Society? See Fig. 3. It is essentially the projection of the Sphære from its centre to any flat plane (or other surface). It has this important quality: on any flat plane all circles which divide the Sphære in two (Great Circles) will appear as straight lines extending to infinity. Lesser circles come out as ellipses (closed), parabolæ or hyperbolæ (also extending to infinity).

Many people (including some supposed experts) do not realize that the famous Mercator projection of the Sphære/sphere is the gnomonic projection, made not onto a flat plane but onto a cylinder wrapped round the Æquator/Equator. With this projection, all parallels of latitude and lines of right ascension/longitude appear as straight lines. Compass bearings also appear as straight lines, and both poles are at infinity.

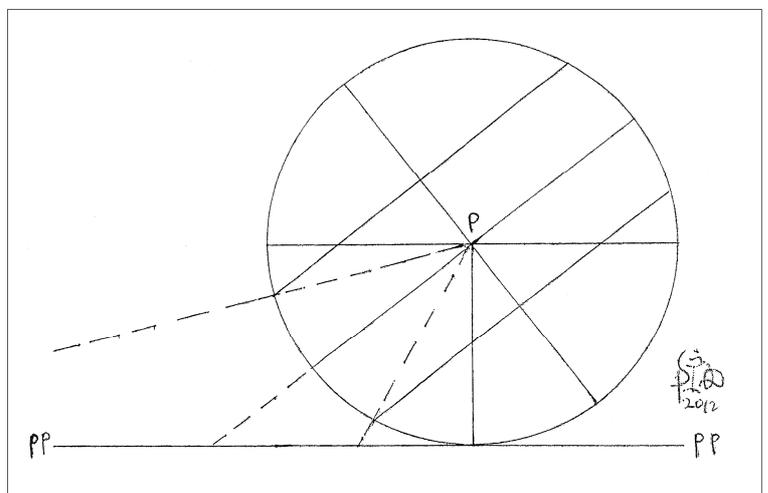


Fig. 3. The gnomonic projection.

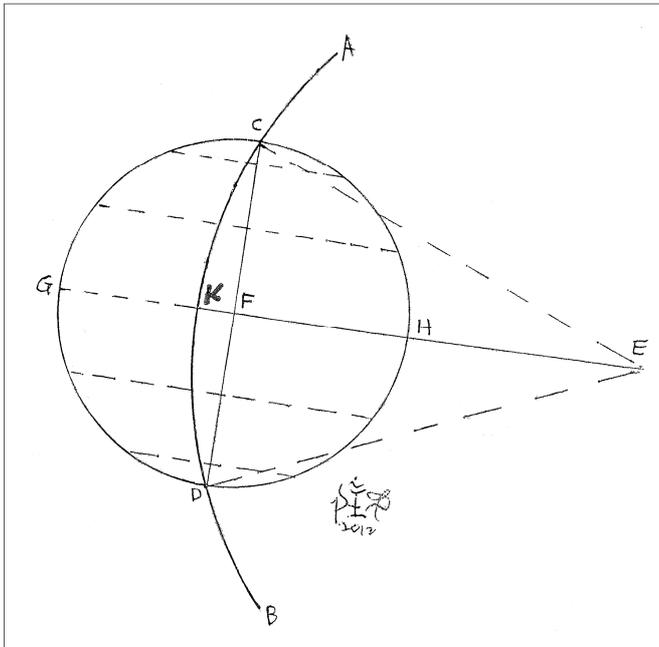


Fig. 4. Determining the angles of seasonal solar declination.

There are many little tricks to learn in the geometrical projections of the Sphære. The most easy and important concerns the determination of the seasonal solar day curves (solar declinations) – see Fig. 4.

A-B is an arc of your Prime Circle. K-E is the radius of your Æquator. Set out the obliquity of the ecliptic from K to C and D. Draw C-D to mark F. On F as a centre, draw the circle C-H-D-G. Divide it into 6 by natural geometry. Bisect each division to make 12. Connect opposing points by lines parallel to G-K-F-H-E. Where these lines cross arc C-K-D are the correct angles for the Sun's monthly declinations from centre E. You can sub-divide the small circle as finely as you like – it always 'works'.

Using the principles here enunciated anyone can draw the classic projections of the Sphære and might more readily come to grasp what the Arts of Urania are all about.

Author's address:

I Saw Cottage

56 Church St,

Shipston-on-Stour, CV36 4AS

MARTON CUM GRAFTON MASS DIAL FOUND AT LAST

ALAN COOK

South Leeds Archaeological Society (SLAS) are assisting the Local History Group at Marton cum Grafton village, near Boroughbridge, North Yorkshire, to discover the history of their village. Their work includes excavations at a Roman road close to the village and a detailed study of their church history. There was an old Norman church until its demolition in 1873 and a replacement Victorian church was built about a quarter of a mile closer to the village. Their work has been greatly helped by notes made by the vicar at that time, a man named as Reverend J.R. Lunn.¹ It is intriguing to speculate whether he was either personally known to Mrs Margaret Gatty who was writing *The Book of Sun-Dials* at just about that time or she had access to his notes. In her book she writes:

"FLOREAT ECCLESIA (may the Church flourish) This dial was given by Mr. W. Buck, minister herein anno 1697. This inscription is on a dial over the church porch at Kirby Malzeard, Yorks. Mr. Buck afterwards became vicar at Marton cum Grafton and he put up a dial bearing the same motto, with his initials and date 1700 on the chancel wall of that church. When the church was rebuilt in 1873, the dial was removed to its present position on the vestry chimney. It was dropped during removal and the iron gnomon was broken. The Reverend J.R. Lunn, then vicar, replaced it with a copper gnomon pierced with his initials and the Sunday Letter and Golden Number for the year of rebuilding. An older



Fig. 1. The vertical south dial, originally dating from 1700, now canted out and located on the vestry chimney. Photo courtesy Paul Boothroyd (SLAS).

stone dial, possibly of the twelfth century, was found in the old church, and has now been inserted in the wall inside the vestry with other old remains."

In 1995 I was an enthusiastic BSS Recorder for both scientific and mass dials and used Mrs Gatty's book to point me in the right direction when looking for sundials. Armed with the information given, I visited Marton cum Grafton



Fig. 2. The mass dial, recovered from an internal wall of the demolished church and now built into an interior wall of the vestry of the current church and partly hidden by the doorframe. Note the raking illumination from the right hand side. Photo courtesy Paul Boothroyd (SLAS).

and duly recorded the scientific dial on the vestry chimney (Fig. 1) but, even with the assistance of the then Church Warden who kindly let me have access to the vestry, I failed to find the mass dial.

The Local History Group have made a very detailed examination of the church fabric to locate other artefacts mentioned in Rev Lunn's notes and found the mass dial in the vestry wall (Fig. 2). Fortunately, they informed the BSS that they had found the dial and it has now been added to the *Mass Dial Register*. The dial is carved onto a single quite rough stone block. The gnomon hole is bored into the stone, although it is only a couple of centimetres from the top edge of the stone and mortar line. The hole still has the remains of an iron gnomon embedded in it, as detected with a magnet. There are eleven clear lines, thirteen centimetres long, radiating from the gnomon hole at fifteen degree angles. There is a well cut circle surrounding the dial but, although it extends up to the top of the stone, it may or may not have completed a full circle on a stone mounted above it, now lost. Unusually, there is no horizontal line but at least two of the lines extend about three centimetres beyond the circle.

The mass dial has been built into the stone aperture leading to the outside door of the vestry, *i.e.* at ninety degrees to the door. This door is locked, barred and hasn't been used for many years. It was originally used for access for either wood or coal fuel for the now-defunct church heating system located in the vestry. This doorway is screened, inside the vestry, by a heavy curtain but even with the curtain pulled back the mass dial is not easy to see and only becomes clear when a torch is shone on it at an oblique angle.

In the Rev Lunn's notes he records that the dial was found during the demolition of the Norman church. He writes:²

"In the coigning stones of the chancel were found built up a First-pointed³ piscina with a plain square basin,

and a sun-dial of probably the same period. This would of course been done when the chancel was repaired, or almost rebuilt, at a later date."

A potted history of the church at Marton cum Grafton is that there was very probably a Saxon church there at the time of the Norman Conquest but this was completely destroyed during the 'Harrying of the North' in 1087. Sometime during the following century a Norman-style church was built on the same site. This church was burnt and pillaged, along with the village, during a Scottish raid in 1318/9 (the 'Battle of Myton'). It is very probable that the piscina and mass dial were reused during the rebuilding following this event and built into a chancel wall and hidden by the quoin stones referred to in Lunn's notes. The church then suffered again at the time of the Dissolution of the Monasteries in 1540 and evidence has been found suggesting that the church was in a ruinous state until 1600. Again, in 1873 the old Norman church was in such a poor state of repair that it was decided to knock it down and start again.

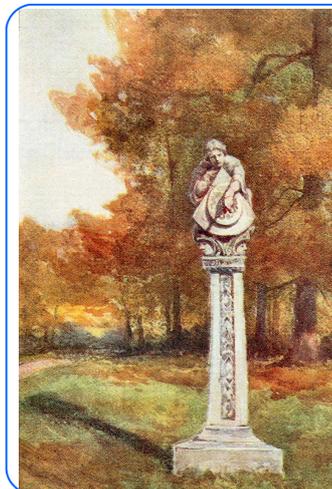
From this short history we can conclude that the mass dial could have been cut and in use from sometime in the late 1100s until 1318. After that date it would have been hidden from view inside a rebuilt wall. There is nothing to suggest that Lunn knew anything about it until they dismantled the old church in 1873.

Many thanks are due to Paul Boothroyd of the South Leeds Archaeological Society and Tony Hunt of the Marton cum Grafton Local History Group for finding this dial and for informing the BSS.

REFERENCES and NOTES

1. J.R. Lunn: 'Marton-cum-Grafton church, Yorkshire', *Proc. Yorkshire Architectural Soc.*, XV, Pt. 2, 224-241 (1879). Available online at www.martoncum-grafton-history.-com/lunns-report-on-the-demolition-of-the-old-church-at-marton-cum-grafton.-html
2. *ibid.*, p. 230.
3. The 'First-pointed [period]' is a Victorian term of architectural history referring to Early English Gothic architecture in the period 1180-1275.

9, St Nicholas Crescent,
Coptanhorpe, YO23 3UZ



A watercolour from Alfred Rawlins, used as the frontispiece of 'A Book of Sundials' published by T.N. Foulis in 1914.

Does anyone recognise the dial?

PLINY THE ELDER AND GNOMONICS

JOHN LESTER

One of the most industrious men of classical times was surely Pliny the Elder (Gaius Plinius Secundus, 23–79 AD). He came from a well to do family and pursued a varied career as a soldier, lawyer and ultimately adviser to the Emperor Titus. He met his death while commanding a fleet in the Bay of Naples during the eruption of Vesuvius which destroyed Pompeii. Going ashore to have a closer look, allegedly with a pillow over his head to protect him from flying stones, he was suffocated by the poisonous vapours from the volcano.

It is as a writer that he is best remembered and, though many of his works have been lost, his *Natural History* has survived. Comprising XXXVII Books, it is an encyclopaedia of everything which was known or believed at that time about the natural world. In order to write it Pliny consulted about 2,000 works by Roman, Greek and Egyptian writers so that little of the work is original. He claimed to have supplied his readers with 20,000 significant facts and Book I is a detailed table of contents of all the subsequent books giving the names of the authorities used for each book. Some of the information he provides is accurate and it can surprise us to find that certain facts were known so long ago. However, Pliny's credulity is such that he has sometimes uncritically accepted material that is obviously nonsense. Pliny the Younger (Gaius Plinius Caecilius Secundus) was the nephew and ward of Pliny the Elder and records in some detail his uncle's devotion to study. He required little sleep and used every spare moment to read or have books read to him, even during meals or while travelling.

Since little of his material is original it might be thought a waste of time to read his *Natural History*, but it is in fact a useful summary of what was known at that time and a guide to the authors from whom he has extracted information and to whom we also might wish to refer. Of most interest to diallists is Book II which, in CXIII sections, deals with cosmology, astronomy, meteorology and earthquakes. The author tells us that it contains 417 facts (*res*) narratives (*historiae*) and observations and the list of 44 authors consulted includes a subset of 13 who are specifically designated as writers on sundials (*gnomonico*). These are:

- Euclid.
- Coeranus the philosopher – nothing is known of him.
- Dicaearchus – all his works have been lost.
- Archimedes.
- Onesicritus – historian and geographer who wrote about the coast of India but was regarded, even in his own time, as unreliable.

- Eratosthenes – only scattered quotations from his works survive.
- Pytheas – an explorer who reached at least to the Shetland Isles and is sometimes claimed to be the first to describe the midnight sun and to associate tides with the Moon.
- Herodotus – a historian with a scientific curiosity.
- Aristotle.
- Ctesias – a Greek physician and historian of whose work on Persia only fragments remain.
- Artemidorus of Ephesus – geographer who wrote about the Mediterranean area but little of his work survives.
- Isidore of Charax - a first century BC geographer whose surviving works give distances between various locations.
- Theopompus - a Greek historian: two fragmentary books of his survive.

After some preliminaries, Book II, Section II states that the Earth is a perfect sphere and (III) that it rotates, though Pliny still clings to the idea of a geocentric universe (LXIX). Surprisingly accurate figures for the orbital periods of the superior planets are given (VI). It is not until Section LXXIV that we encounter any reference to gnomonics. Here we are told that sundials (*vasa horoscopica* – the use of the word *vasa*, suggesting hollow vessels, is interesting) cannot be used universally because the readings may vary at every 300 to 500 stades (of latitude – a stade being about 210 yards). Pliny amplifies this by comparing shadow and gnomon lengths at midday at an equinox: for Egypt the shadow is a little over half the gnomon length, in Rome it is one ninth shorter, at Ancona one thirty-fifth longer while in Venezia it is equal. Reference is then made (LXXV) to the Sun being overhead at Syene in midsummer and at other places at the same time. In Section LXXVII the length of daylight on the longest day at different latitudes is quoted; at Alexandria it is 14 equinoctial hours, in Italy 15 and in Britain 17. We are told (LXXVIII) that the science of gnomonics was discovered by Anaximenes of Miletus, the pupil of Anaximander, and that he first exhibited at Sparta the sundial (*horologium*) which was called the sciothericon. The various methods of reckoning the hours of the day are set out in Section LXXIX; the Babylonian hours being from sunrise to sunrise, Athenian hours between two sunsets, Umbrian midday to midday while the Roman priests, the Egyptians and Hipparchus counted from midnight to midnight. Pliny fails to describe the construction of sundials and embarks on a digression concerning the effect of intense sun on the Ethiopians before turning his attention to earthquakes.

Continued on page 27

WILLIAM CUNINGHAM'S 'COSMOGRAPHICAL GLASSE'

JOHN DAVIS

William Cuningham (Fig. 1, c.1531–1586) was a 'doctor in phylsicke' from Norwich who in 1559 published a book entitled *The Cosmographical Glasse*.¹ Although the subjects covered by the book were mainly geographical and navigational (as well as cosmographical), there are numerous items in it which are of interest to diallists. He also published a series of almanacs from 1558 to 1566 and, later in life, some medical tracts. Details of Cuningham's life can be found in the *Dictionary of National Biography*.

The Cosmographical Glasse is perhaps best-known for its fold-out topographical map of Norwich (Fig. 2), thought to be the first of its kind in the country. The map was drawn in 1558 when Norwich was past its zenith as England's second city but it still reflects its medieval nature with Castle, Cathedral and many churches all carefully depicted.² But it is the two figures in the foreground (one of which is thought to be Cuningham himself) which are of particular interest as the front of the table at which they are standing has a vertical dial on its front surface. The strange thing is that the dial, for modern equal hours, is clearly a direct south one whereas it is actually facing West: the map is drawn looking eastward over the City with the compass needle on the top of the table indicating North to the left. The dial drawing has its faults—the 6am–6pm line is missing and the

origin is misplaced—but its presence may indicate that there were many dials on the buildings of the City at that relatively early date. It has an interesting motto, *Præterit Tempus* (Time Passes) which strangely isn't in Mrs Gatty.³

The title page of the book (Fig. 3) is decorated in the usual way with fanciful illustrations of numerous historial and scientific figures. That for Hipparchus, famous for his early star catalogue and for describing the precession of the equinoxes, shows him taking a measurement with some form of horary quadrant. Something looks wrong about the image, though, and it is that the quadrant is being held the wrong way round so that the plumb-bob, which would hang from the apex of the quadrant, cannot possibly fall across the altitude scale. Perhaps Hipparchus has been blinded by looking directly at the sun, or there is some hidden message in the error! It would be interesting to know from what source the engraver, thought to

be the book's printer, John Day(e), was working.

The book is dedicated to Queen Elizabeth's favourite Sir Robert Dudley. In his dedication, Cuningham promises to produce a further seven books on topics which include "a new *Quadrat*, of no man euer published", "The *Astronomicall Ring*" and "Chronographia". It seems that these titles were never published which is a great pity as they would have given valuable information on the state of



Fig. 1. Portrait of William Cuningham, taken from 'The Cosmographical Glasse'. It shows him in the doctoral robes of Heidleberg Universtiy, from where he gained his MD in 1559.



Fig. 2. The topographical map of Norwich which features prominently in 'The Cosmographical Glasse'. Above: enlargement of the two men in the foreground (the one on the right is thought to be Cuningham) showing a vertical dial on the side of the table.

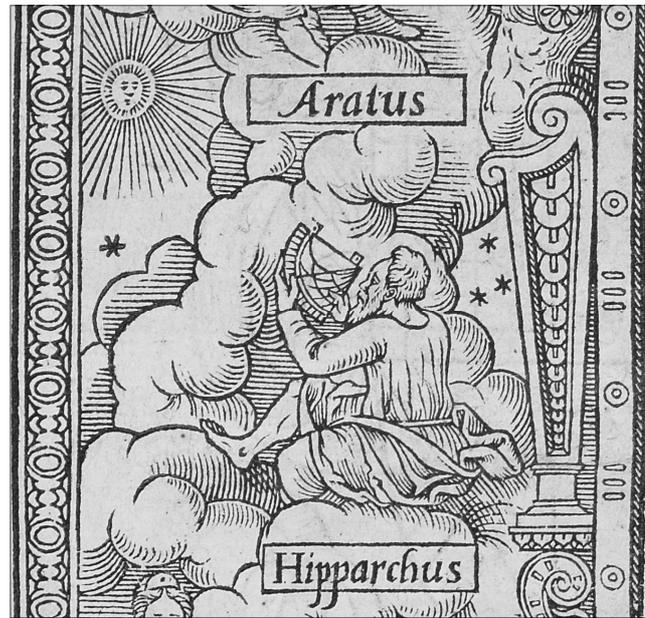
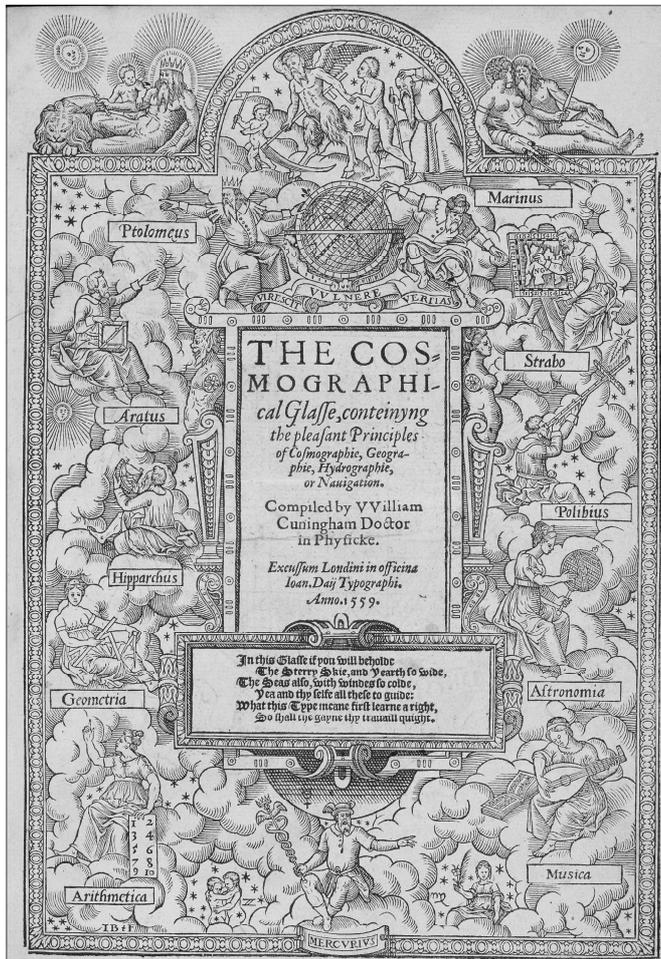


Fig. 3 (left and above). The title page of 'The Cosmographical Glasse' with the figure of Hipparchus holding a quadrant the wrong way round to look at the sun.



Fig. 4. Illuminated initial 'S' including a depiction of a vertical dial.

instrumentation and science at the time. With reference to the promised 'new Quadrat', recall that the remains of an enigmatic quadrant which combines medieval lettering with the design principles of Gunter's quadrant have been found close to Norwich.⁴ It is not possible to do anything other than speculate about any possible connection though the link between Norwich and timekeeping is again reinforced.

The first section of the book covers basic astronomy. As well as a table of the positions of a number of major stars (often shown on contemporary instruments) for the year of publication, it quotes a value of $23^{\circ} 28'$ for the obliquity of the ecliptic, giving Georg Peurbach as the source. There are also useful tables of solar data and shadow lengths.

The section on geography explains the principles of terrestrial latitude and longitude before giving values for numerous locations both in Britain and worldwide. These must be of significance to anyone studying early 'geographical' sundials. It should be noted, though, that the values of longitude quoted are relative to a meridian some $19^{\circ} 52'$ west of London. This is a location in the Canaries or "West Fortunate Ilandes", often taken by the ancient Greeks as the western limit of the known world. It would be replaced in 1584 by St Mary in the Azores, at around $25^{\circ} 40' W$, in Christopher Saxon's famous map. It would be good to locate some sundials using these unfamiliar values of longitude. Cuninghame states: "touchinge this my booke of Longitudes and Latitudes, I have for the chief places of Englande used bothe my frendes travailes, and also mine owne

observations", i.e. he was making instrumental measurements (with quoted resolutions, if not accuracies, of arcminutes) rather than relying on previously presented results. In fact, he actually states that he measured the "meridiane altitude of the sone by my Altrolabe" on 10 March 1557 at Norwich and used it to calculate a latitude of $52^{\circ} 10'$ (the actual value is $52^{\circ} 38'$).

The initial letter 'S' at the start of the third 'booke' includes a depiction of a vertical dial (Fig. 4). The design shows hour lines above the horizontal which can never receive a shadow but it does give an indication of the geometrical method by which delineation has been achieved.

Another useful source of 16th-century data is for the ‘climates’, the ancient method of specifying latitudes by dividing the globe into bands with similar periods of daylight at the summer solstice. As well as the seven classical climates used by the “olde Græcians”, together with their key place names, it extends the scheme to a total of 96 bands, from the Equator to the North pole.



Fig. 5. Illuminated initial ‘W’ formed by two overlapping ‘V’s.

The style and presentation of the book is worth commenting upon. Most of the material is presented in the form of a discussion between a teacher, *Philonicus*, and a student, *Spoudæus*, a similar form to that adopted by Galileo. It is printed in a pseudo-italic hand and with marginal notes of key points, similar to many printed bibles of the time and

later. And although it is in English, the printing often uses the symbols for missing letters when contracting words in the manner of a medieval manuscript. Also of interest is the compositor’s use of “VV” instead of ‘W’ in numerous places. An example is the initial letter of the fifth ‘booke’ (Fig. 5) with its two overlapping Vs which can be compared to the scratched signature on the excavated lead dial described in the December 2012 *Bulletin*.⁵

In all these regards, the author shows his close links to the past and gives an excellent feel for the science of the time.

REFERENCES and NOTES

1. VWilliam Cuningham: *The Cosmographical Glass – conteinyng the pleasant principles of cosmographie, geographie, hydrographie, or nauigation*. London (1559). A modern facsimile is available from Early English Books Online (EEBO).
2. Carole Rawcliffe and Richard Wilson (Eds): *Medieval Norwich*, Hambledon & London (2004).
3. The motto may have been taken from a passage in St Augustine’s ‘Confessions’, Book 11, reading *Cum ergo praeterit tempus, sentiri et metiri potest, cum autem praeterierit, quoniam non est, non potest* (When, therefore, time is passing, it can be perceived and measured; but when it has passed, it cannot, since it is not.)
4. J. Davis: ‘A Medieval Gunter’s Quadrant?’, *BSS Bull.*, 23(iii), 2–7 (Sept 2011).
5. J. Davis: ‘An Excavated Lead Sundial’, *BSS Bull.*, 24(iv), 18–20 (Dec 2012).

john.davis@btinternet.com

Postcard Potpourri 26 Château des Rochers-Sévigné, Vitré, France

Peter Ransom

Spot the error on this dial! (Answer at the end of this article.)

This postcard was posted in 1915 and features the large multi-faceted dial at the Château des Rochers-Sévigné. As well as the south facing dial there are polar, scaphe and equatorial dials, making a total of 20 dials according to one source. A more modern picture postcard can be found at http://michel.lalos.free.fr/cadrams_solaires/autres_depts/ille_et_vilaine/cs_pays_vitre.html#vitre where the base is different and the column on which the dial stands appears to have been broken and repaired at some point. Another picture found on the internet makes me think that the block is now off the pedestal, safely on the ground. The château was rebuilt in the early 16th century: between 1644 and 1690, Madame de Sévigné stayed here and refurbished the house.

The error: the gnomon on the south face has been replaced upside down. Congratulations if you spotted that before looking at the answer!

pransom@btinternet.com



Collection H. D.

VITRÉ — Château des Rochers-Sévigné - Les Jardins - Le Cadran Solaire

READERS' LETTERS

Trouble with Four

The picture in the March 2013 *Bulletin* of John Flamsteed's sketch for the construction of a horizontal dial has come under my 'examine your dials' observation. No doubt Flamsteed was a busy man and relied on engravers to create dials from his sketches.

A quick glance reveals 'IIII' and **two** 'IV's on the drawing. Until now I had thought that the appearance of both IIII and IV on one dial was unique to the 'well-known' design which incorporates a sweeping curved gnomon casting a shadow from its lower edge. (It may be well known but so far nobody has tracked down the maker; there must be a dozen examples in the *Register*; someone must know. See *The Recorder* 2012 issue). Flamsteed has IIII in the morning and IV in the afternoon with the reverse obtaining on the 'well known' design.

The second IV means six and follows the 'convention' of marking Roman numerals 'as you go round' as explained in John Lester's article in *Bulletin* 18(iii) (Sep 2006), looking at the Cornish dials of the Berrys. Flamsteed uses a conventional VI for 6am however, and the 'reversed Roman' numerals only appear in the upper left quadrant.

All supremely trivial but one wonders if various 'conventions' were in use by dial makers across the country or were just 'one man' usage.

Tony Wood
Gloucester

Supposed Threat to the Library

I was interested to read the Letter to the Editor in the March *Bulletin* with the rather contrived defence for the library. Nevertheless it is a serious issue to be set against the other activities of the Society, and counter arguments can be found. I will fill in some of the background and try to give a balanced view – for and against.

I am the person, so named at the last AGM, that raised the concern. I visit Bromley House quite often, and because of the 'discovery' of the meridian line (See '*A Meridian Dial in a Subscription Library, Nottingham*', *BSS Bull*, 11(ii), 55-61, Jun 1999) and the provision of a replica aperture and a solar noon chart, I am quite well known at the library. One of the regular staff volunteered, volunteered I might add, that no-one had looked at the sundial books in the last 10 years. It was this remark that prompted me to worry about the purpose of our collection, and 'suggested that an independent assessor should advise on its future' as recorded in the minutes in the June 2012 *Bulletin*.

The writers mention that the library features in the Objects of the Society in the constitution, with the phrase "establishing a reference library of relevant books and documents". However, the very existence of the library is entirely optional, as all the topics from clause *a* to *g* are qualified by the phrase "Such activities *may* include,

without limitation, the following..." (my italics). In other words, these activities are not mandatory and are at the discretion of the Society and without prejudice to any other activities that may arise. The writers have stressed the charitable benefit, but because the Charity Commission is not directly represented on our Council, it has no role in our management and it is for the Society to decide how best to create public benefit.

For the visits to the library, the writers point out that "the Council itself (including the complaining member) have until recently met at the library annually...". However, the writers omit to say that Council members were *obliged* to visit the library to hold Council meetings! Accessibility by the general public is not easy, for examples our website *mentions* the library, but goes on to say that a print version of the catalogue is available to members only, and must show formal personal ID to be checked against the current BSS membership list when visiting the library.

Examination of the *Bulletins* show that almost none refer to our books, and I quote the former librarian "Unfortunately the library receives few visits from BSS members because there is so much in the *Bulletins*, *Compendiums* and on the Internet that there is much less incentive to browse a book for information" (*Newsletter* No 60, June 2011). The cost of the library is quoted as £150 a year (*Newsletter* No 61, September 2011), and whilst this is not a huge sum, one of my concerns is that the money could well be spent elsewhere. Such questions will surely be asked by the current Council which is reviewing all our activities to examine what is most beneficial in terms of attracting and maintaining new members, together with outreach to schools, external advice, *etc*. If the library was to be closed, then disposing of the books will have to be handled carefully, but let us not put the cart before the horse.

To summarise, the best argument for retaining the library is to use the 'intellectual' approach as if we need the library to keep up with our national learned institutions. At a more mundane level, it is just a means of (expensively) storing the books that we own. The public benefit element can be discounted because the numbers involved are utterly insignificant compared with the major benefits we achieve elsewhere. If it comes to a vote, members need to consider what they *actually get out of the library*, and perhaps like me, now believe that the money could well be spent supporting other activities.

This topic clearly merits wider discussion and I have asked the Secretary whether he would be willing to receive and collate comments. He has agreed to this approach so, to avoid a protracted correspondence in the *Bulletin*, please send suggestions or alternative ideas to the Secretary. He will publish a summary in due course.

Doug Bateman
Crowthorne, Berks.

ROMEO AND JULIET – A PROPOSAL FOR A SHAKESPEAREAN-THEMED SUNDIAL

VALERY DMITRIEV and DOUGLAS BATEMAN

In March 2012 a design was suggested by Valery Dmitriev by email to Doug Bateman, who in turn contacted the BSS Council to enquire if the Society could support the design and construction of a dramatic silhouette dial (see Fig. 1). The dial could be set up in Stratford-upon-Avon, ideally within sight of the Royal Shakespeare Theatre.

BSS members Jill Wilson and Tony Wood visited Stratford to make contact with the local authority who may in turn contact the group looking after the 400th anniversary (in 2016) of Shakespeare's death, and they identified a suitable large open park just south of the Theatre that could take a large dial. Responses were favourable, but such a project would need a primary customer and a lot of effort to man-

age such a project, both for the administration and construction. The Council's opinion is such they, as a committee, could not manage such a project, but would support the concept.

The next step was to put the proposal (by DB) to a wider audience at the BSS meeting in Newbury in September, 2012, as reported in the December *Bulletin* (24(iv), pp.28–30). The presentation showed many of Valery's imaginative designs (many of which have already appeared in the *Bulletin*) and a photograph taken at the 2008 conference at Latimer, where Valery gave a talk about dials in St Petersburg and Russia. The presentation continued with versions of the proposed design for Stratford-upon-Avon and concluded with an animated video of the design, as prepared by Valery. Despite the interest, no-one stepped forward to manage the project. The purpose of this note, therefore, is to bring the proposal to a wider audience.

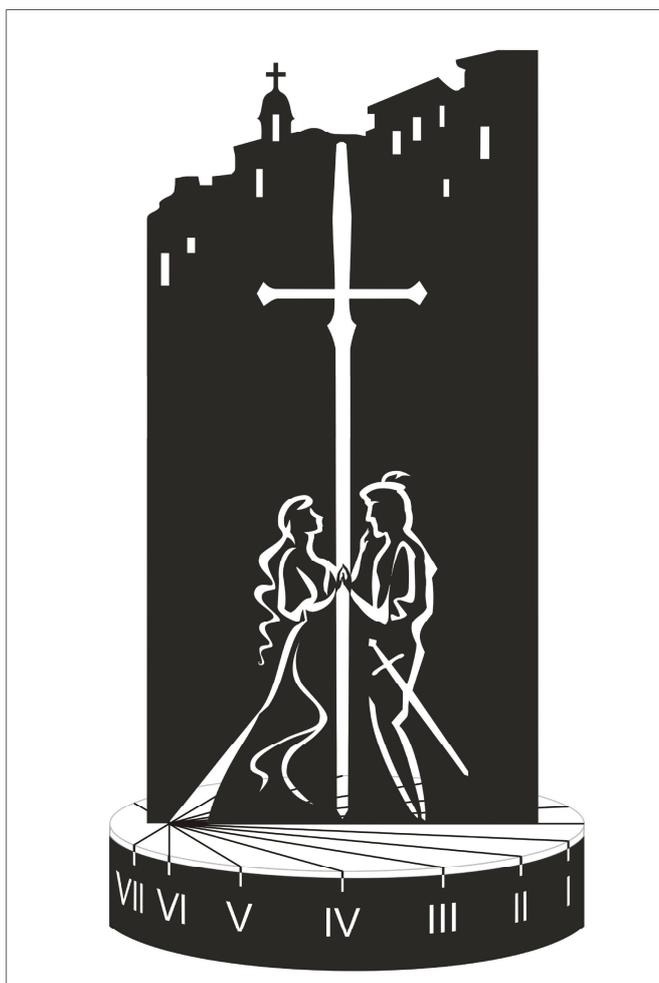


Fig. 1. The proposed dial made from a slab of steel. The dial could be 3.7 metres tall.

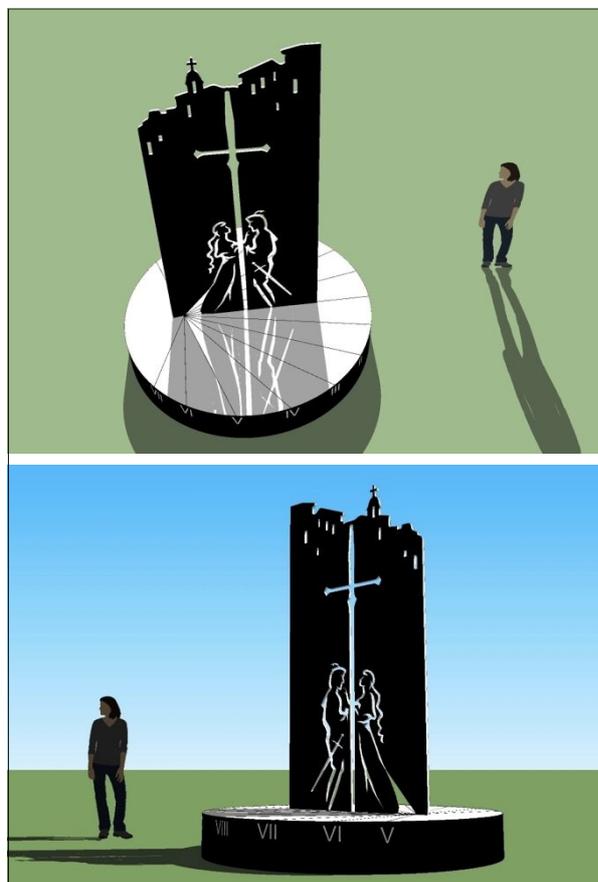


Fig. 2. Two perspective views of the proposed dial.

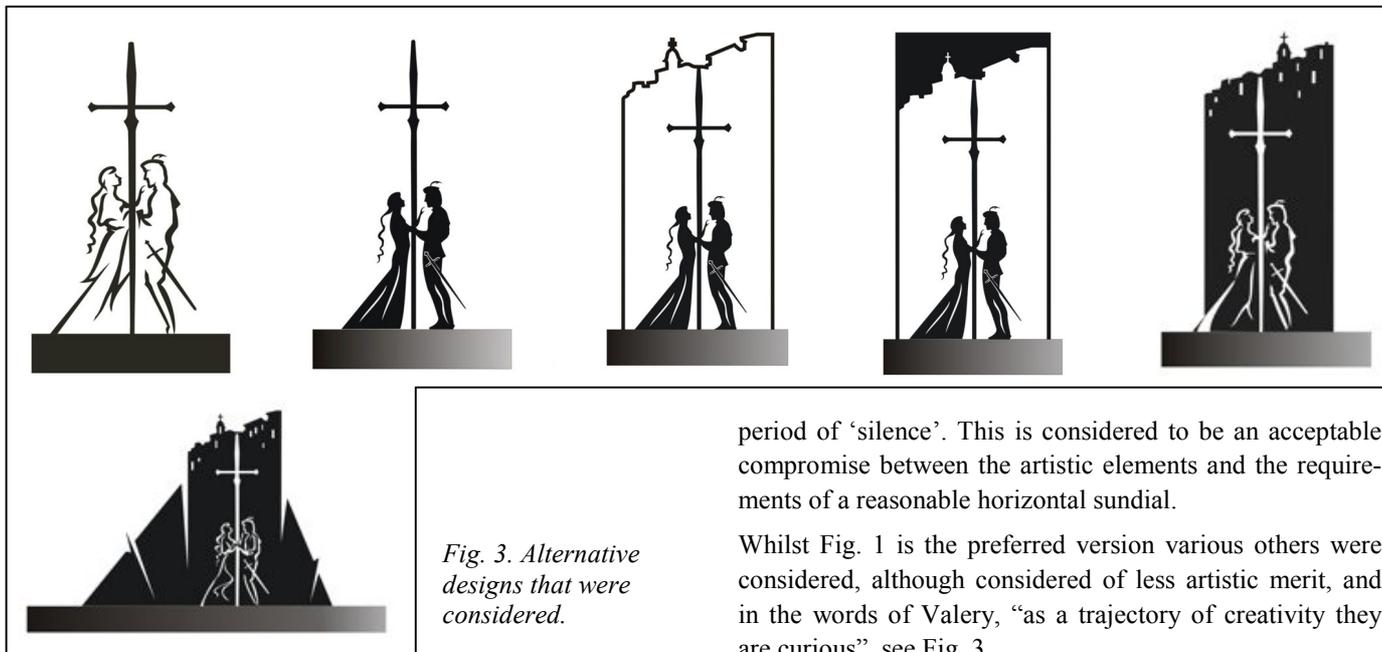


Fig. 3. Alternative designs that were considered.

The Artistic Concept

It is difficult to find people in the modern literate world for whom the heroes of tragedy of the great English playwright, William Shakespeare – Romeo and Juliet – would be unknown. It is hard to find the person who never experienced love or the pain of parting and bitterness of loss.

Whether it is possible to connect a symbol of light and eternal time – a sundial and a tragedy by William Shakespeare, the Romeo and Juliet project (Fig. 1) is an attempt to answer this question.

The artistic decision includes an outline of medieval Verona, the figures of Romeo and Juliet turned to each other, a cross-sword as a death symbol, and close palms enamoured, as a symbol of eternal love. The cross-sword divides the two parts of the city of Verona, such as the families Montague and Capulet, whereas the outlines of Romeo and Juliet with their palms symbolising a small heart, connect before the tragic separation.

The technical decisions are based on a horizontal type of sundial with an internal gnomon. The general height of a composition is 3.7 metres, including a vertical part 3.3 m. The pedestal-dial has height 0.4 m and diameter 2.0 m. The vertical part is a steel sheet with a thickness of 30 mm. The vertical planes are painted black with the edges white. The pedestal may be made from black and white coloured stone. Hour markings and numerals are as shown together with the quotation “For never was a story of more woe, than this of Juliet and her Romeo”.

The design is calculated for Stratford-upon-Avon with geographical co-ordinates: latitude 52° 11' 23" N, longitude 1° 42' 18" W. It displays of local solar time according to the tradition of the 16th–17th centuries.

Further illustrations of the project are given by 3D modelling with different views as shown in Fig. 2. One of the difficulties of the design is due to the thickness of the metal sheet so that around noon, for say 30–40 minutes, there is a

period of ‘silence’. This is considered to be an acceptable compromise between the artistic elements and the requirements of a reasonable horizontal sundial.

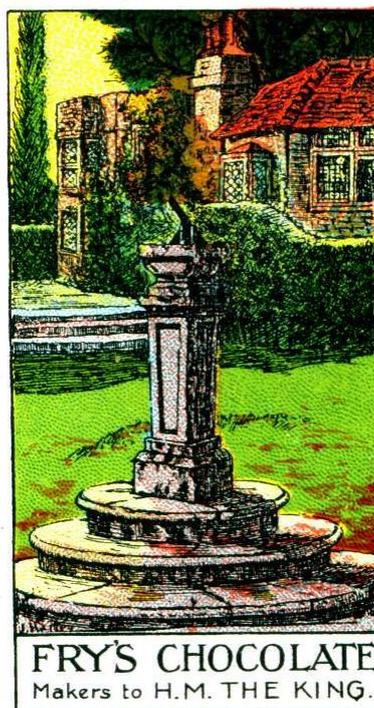
Whilst Fig. 1 is the preferred version various others were considered, although considered of less artistic merit, and in the words of Valery, “as a trajectory of creativity they are curious”, see Fig. 3.

It is further hoped that the youthfulness of the romantic theme will inspire some fellow feelings amongst the young and old who look at the dial.

Valery Dmitriev (Russia) wishes to acknowledge encouragement from Tony Wood and Jill Wilson (UK), Martins Gills (Latvia), and Andrej Evdokov (Russia).

And finally, “Dear readers of the *BSS Bulletin!* If Romeo and Juliet’s project is represented to you as interesting, if its purposes are clear for yours souls and hearts, support it, please.”

sundials_spb@mail.ru
douglas.bateman@btinternet.com



Fry's card of the dial said to be at Rockingham Castle

A NEW SUNDIAL FOR ST GEORGE'S CHAPEL, WINDSOR CASTLE

JOHN DAVIS and DAVID HARBER

Windsor Castle has a strong tradition for sundials. Currently on display is a magnificent 1680 horizontal dial by Henry Wynne. Originally, it was one of a pair but its partner, a double horizontal, is now at Clarence House.¹ There is also a fine 1723 vertical dial on the south wall of St George's Chapel, in the lower ward of the Castle.² Thus, when the Canons' Cloister to the north of the Chapel was undergoing a major restoration in 2012 it was natural for another sundial to be commissioned.



Fig. 1. A bronze dial designed and made by Charlotte Manley, a precursor to the St George's Chapel dial.

The idea for a sundial, its general concept and the preliminary design came from the Chapter Clerk, Charlotte Manley LVO, OBE. It was originally conceived as a horizontal sundial in bronze to stand on a custom-made stone pedestal. Charlotte had shown an interest in sundials earlier in her life, having designed and made a cast-bronze example for her parents' wedding anniversary some 18 years ago. The dial, seen in Fig. 1, shows an artist's palette and brush to reflect her late father's profession as an art restorer.

The concept for the Canons' Cloister dial had three key features.

- It would be bordered by the belt of the Garter Knights, on which would be the famous motto of the order, in medieval French: HONI SOIT QUI MAL Y PENSE. St George's Chapel is the spiritual home of the Garter Knights and heraldic brass-and-enamel nameplates for many of the past Knights are still to be seen on their stalls. The belt and motto feature prominently on the Henry Wynne dial and also form the badge of the Chapel.

- The delineation of the dial would not show the normal hours but instead would indicate the times of the principal daily services in the Chapel. As these times are specified in normal Civil Time, conversion to solar time would need some thought.

- The design of the gnomon was to be based on the heraldic 'hemp press' of the Bray family. Sir Reginald Bray (c. 1440–1503) was Henry VII's chief financial advisor who left a substantial legacy with which the Nave of St George's Chapel was completed. A 'hemp press' (or hemp-break or hemp-bray) is a manual tool for breaking and removing the outer shell of flax and hemp stalks as an early stage in the production of linen and rope. Thus it was used as an heraldic rebus by the Bray family and many versions of it can be seen in the internal stonework of the Chapel (see Fig. 2), as well as in the stained glass of the nave and transepts.³ The Bray connection continues to this day and as it was The Bray Fellowship that was funding the restoration work it was natural for this to be celebrated on the dial. As can be seen in Fig. 2, the handle of the press is ideally suited to be set at a suitable gnomon angle.

C. Manley



Fig. 2. Two examples of the 'hemp press' carved into the stonework of the Chapel.

The architects responsible for the restoration project, Martin Ashley Architects LLB, after consultation with Chris Daniel, asked the first author (JD) to survey the proposed site for the dial and to convert the outline design into a bronze horizontal dial. Charlotte's delineation, achieved by geometrical methods, and her paper model, proved a very good guide. But an initial look at a plan of the site raised concerns about its suitability for a sundial as it is a deep canyon, only 7 metres wide and surrounded by three-storey buildings. A visit to the site on a gloriously sunny August day confirmed the problem – with the addition of full-height scaffolding all around the cloister, only the sky directly overhead was visible and no sun was penetrating to ground level at midday, making a proper gnomonic survey virtually impossible.

A plot of the sky visibility was drawn up relying on the architect's plans (with a dubious unspecified arrow for

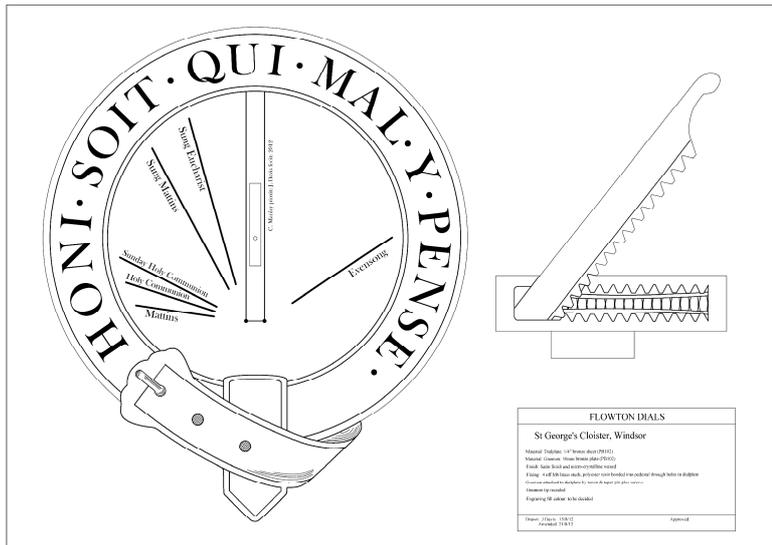


Fig. 3. The plans for the aborted horizontal sundial.

Before manufacture commenced, though, it was decided that perhaps permission could be granted to hang a vertical dial on the external 15th-century chimney breast set into the north wall after all, and that this would both improve the usefulness of the sundial and avoid problems with uncertain ground conditions and underground services that had been encountered within the cloister.

Thus a second survey of the site was undertaken, this time for a vertical dial. By now, the scaffolding had been taken down and, although it was rapidly approaching the autumn equinox, there was plenty of sun on the wall to allow its declination to be measured with a pin declinometer. This turned out to be

$9.5^{\circ} \pm 0.2^{\circ}$ E of due south, somewhat different to the 18° E extracted from the architects' plans! Using a simple sextant while standing on a ladder close to the proposed dial site, a series of readings of the elevations of the surrounding buildings allowed the skyline to be established. This is shown in Fig. 4, together with the sun's elevation and azimuth during the day at a key date. The calculations indicated that the dial would see sun for at least part of the day as long as the sun's declination was greater than about -5° , corresponding to dates from early March to early October.

north) which indicated that a horizontal sundial at a height of 1 metre in the centre of the cloister might see some sun for a couple of hours around noon for 5 months of the year. It was also reported that a vertical sundial, placed around 2 metres up on the northern wall of the cloister, would see considerably more sun. Nevertheless, plans for a horizontal sundial were drawn up (Fig. 3) and preparations made for its manufacture.

The times of the Services that were to be indicated by the dial are shown in Table 1. They are for Civil Time, *i.e.* GMT in winter (approx. dates) and BST in summer. Since the dial would never see the sun in the winter half of the year, it was a simple decision to choose BST for the dial's delineation. Longitude correction for Windsor's location $0^{\circ} 36' 26''$ W of Greenwich (2 mins 26 secs) was also simple. There remained the question of what to do about the Equation of Time. One possible solution would have been to take the mean (average) value over the period when the dial might see some sun: luckily, the range of the EoT is quite limited over this period. A different solution was adopted, using the median value (mid-point between the extremes) so that the maximum error that could ever be observed was minimised. An observer was not likely to note the errors over a number of days and take the average! The EoT value turned out to be just 1.5 minutes which would allow the dial to have zero error on 19 June.

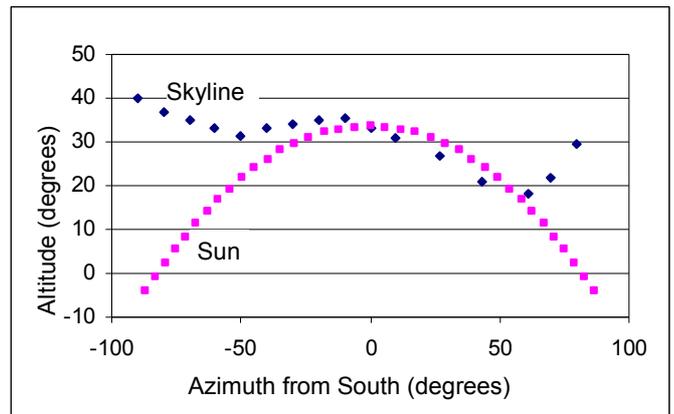


Fig. 4. Skyline plot from the proposed position of the vertical dial (blue diamonds). The red squares show the sun's position when its declination is -5° , representing the date when the dial becomes functional. The sun is visible above the skyline from just before noon to around 4pm.

Service	Time (BST)	Time (L.A.T.)
Mattins	7:30 am	6:26
Holy Communion	8:00 am	6:56
Sunday Holy Communion	8:30 am	7:26
Sung Mattins	10:45 am	9:41
Sung Eucharist	11:45 am	10:41
Evensong	5:15 pm	16:11

Table 1. The times of the Chapel Services indicated by the dial and their solar equivalents used for the dial design.

This was much more promising and so a full design for a vertical dial was made, following the original concept as closely as possible. One option which was introduced with this slightly-declining dial was to move the origin of the delineation a small amount to the East, allowing more space for the predominantly morning hour lines. Of course, the size of the dial was now increased dramatically, from a diameter of 280 mm for the horizontal dial to 880 mm for the vertical one. Since this required manufacture in a serious workshop, David Harber Ltd was recommended as the maker and the project was handed over to them.

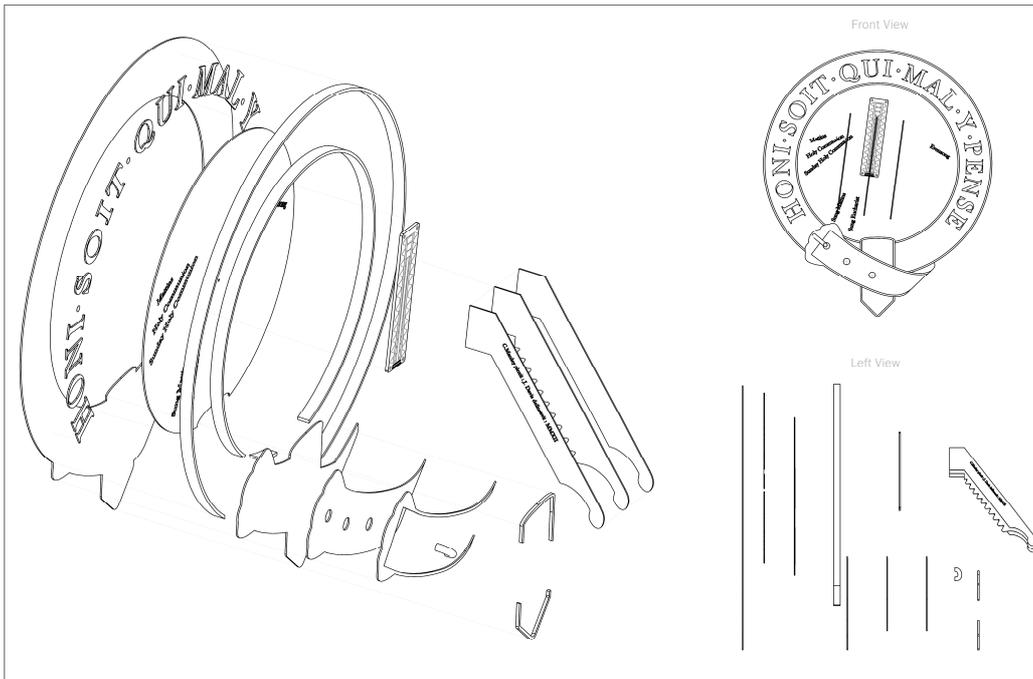
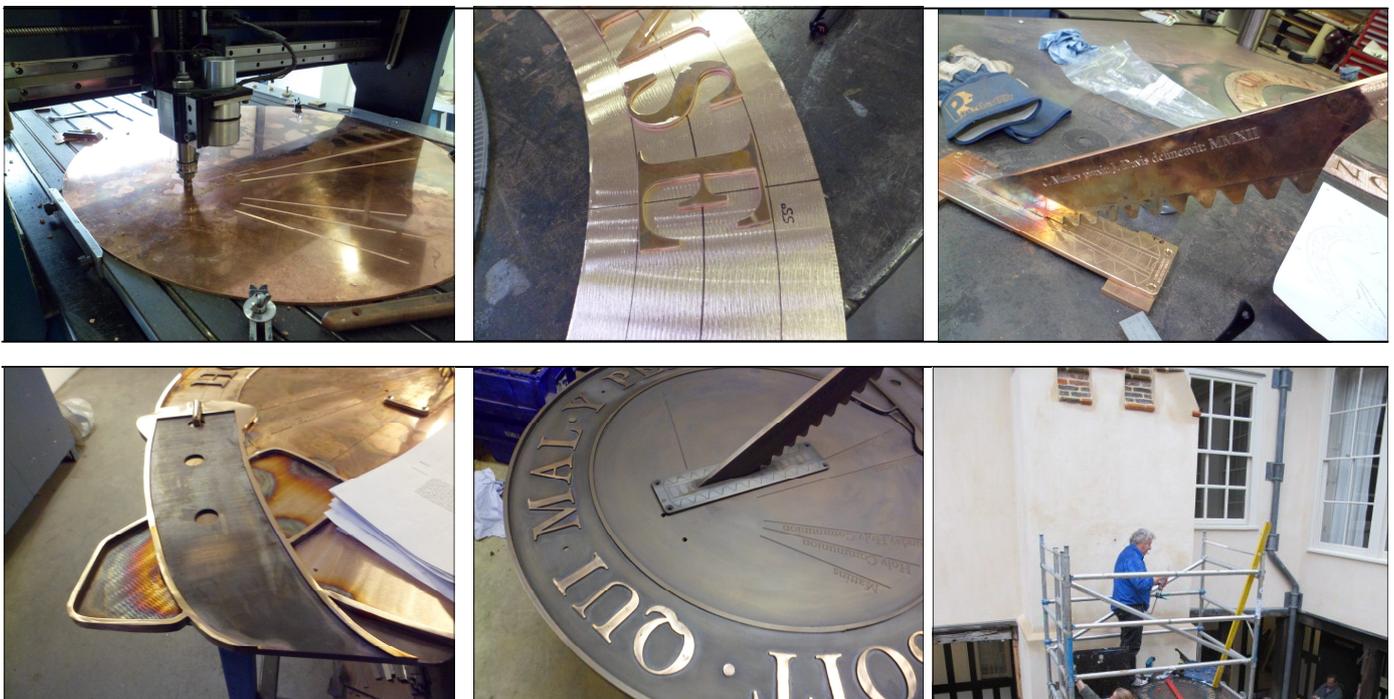


Fig. 5. Exploded view of the final design for the vertical dial as produced by David Harber Ltd.

Figs 6–11 (below). Left to right, top to bottom:

- CNC engraving the hour lines.*
- Positioning the motto.*
- Assembling the gnomon.*
- Details of the 'buckle'.*
- Gilded lettering and textured surface.*
- Preparing for installation.*

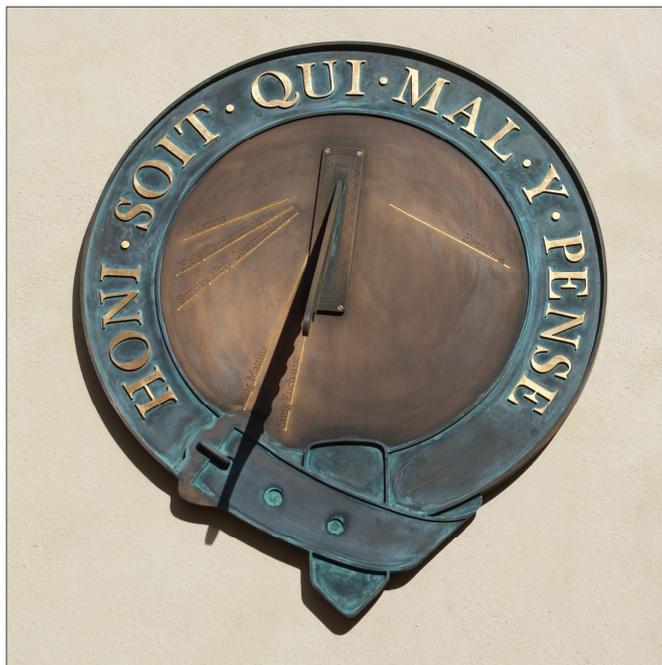


David Harber writes:

We were delighted to be asked to work on this project and were all agreed that this was one of our most favourite commissions of 2012.

The dial was fabricated from bronze and care was taken to introduce textures onto the surface of the dial to reference the garter fabric. Due to the overlapping nature of the garter belt, a great amount of time and effort were given to devising the components in order that they convey depth and layers to give an almost 3D visual effect (Fig. 5). Most of the pieces were cut using a waterjet process with the rest being hand forged and fabricated. The gnomon mathematics and hour lines had been precisely calculated by John Davis giving us the freedom to concentrate on the fabrication and aesthetics of the dial.

Due to the historic nature and fabric of the building we were at pains to minimise any damage to the original building and we elected to produce specialist 316 grade stainless steel marine grade inserts which were bonded onto the wall allowing the dial to be fixed with stainless steel studding. These fixings were hidden behind purpose-made bronze caps which doubled as the punctuation marks between the motto wording, allowing no visible means of fixing on the



Figs 12 &13.
The finished dial in its setting in the Canons' Cloister. Photos taken by Charlotte Manley at Easter (end-March) 2013, with the Sun's declination at about +4°. © The Dean & Canons of Windsor.

dial face. A 7 mm air gap was also left so as to minimise the risk of trapping dampness behind the dial.

The main motto was created from individual bronze letters arrayed on the garter belt and gilded with 23¾ carat gold leaf. This was then slightly distressed to remove some of the brash newness and exposing the red bole size. The time lines and wording were engraved and the gnomon was fabricated to reference the 'hemp press' of the Bray family and this was discretely engraved with "C. Manley pinxit: J. Davis delineavit: MMXII" on one side and "The Bray Fellowship" on the other side with "David Harber me fecit MMXII" below.

The finished dial was glass bead blasted, patinated and burnished giving a rich warm aged look. On the day of installation as luck would have it the heavens opened and a colleague and I were absolutely drenched and were musing on the drainage capacity of the small courtyard cloister. We were obviously unable to check the dial on the day but have subsequently confirmed that the layout and calibration of the dial were absolutely spot on.

We are thrilled with the final installation of the dial and hope it will enchant all those fortunate enough to happen upon it for centuries to come.

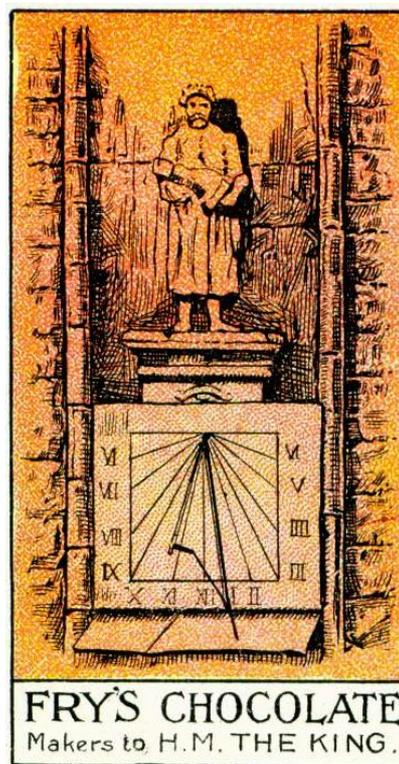
ACKNOWLEDGEMENTS

We are very pleased that Charlotte Manley conceived such an interesting dial and arranged for its inclusion in the Cloister restoration plan. Chris Daniel is thanked for his introductory recommendations. Eric Watts and Susan McDonough of Martin Ashley Architects LLP ensured the project progressed in an orderly manner. Rory Elliott, Robert Payne, Keeret Riat, Shawn Grantham, Andrew Eason & Karen Fry from David Harber are thanked for seeing the project through from drawing board to installation.

REFERENCES and NOTES

1. The Henry Wynne dial (SRN 6338) is on the northern terrace. It features on the front cover of the Sept 2011 *Bulletin*, 23(iii).
2. The vertical dial (SRN 7423) was shown in J. Foad: 'Nine Newly-reported Dials', *Bull.* 24(iv), p.26 (December 2012). The remains of an earlier vertical dial of the same aspect is some 20 yards to the west, partly obliterated by later building work.
3. See www.stgeorges-windsor.org for information about Sir Reginald Bray and the Canons' Cloister project.

john.davis@btinternet.com
Karen@davidharber.com



Fry's card no. 45 for Bolton Abbey, Yorkshire.

A GARDEN HELIOCHRONOMETER (A mean-time horizontal dial)

MARTIN HOGBIN

This article is based on a presentation that I made to the British Sundial Society at their 2012 Annual Conference in Cheltenham.

I am a physicist and since as long as I can remember I have been fascinated by sundials. I should also say that I am a newcomer to the art of sundial design and that I am not trying to teach the old hands of the BSS anything, rather I am trying to give readers an idea of the thought processes that led me to the sundial design described in this article. As the saying goes, ‘There is nothing new under the sun’.

Sundials look attractive and many gardens have them for this reason alone but I have also been interested by their function; using the accurate and reliable rotation of the Earth, they can tell us the time.

I soon found out that with many garden sundials you are lucky to get the time within half an hour. Many are badly set up and inaccurate or designed for other latitudes. Occasionally I would come across what seemed to be a properly designed and accurately made dial. However, I was disappointed to find out that, even then, the time could be out by up to a quarter of an hour. It seemed to me a sad waste of the engineering effort that had clearly been put into their design.

I thus came to learn about the, rather grandly titled, Equation of Time, the function that tells us how sundial (solar) time differs from clock (mean) time throughout the year. After some research, I discovered that the thing that I wanted was a heliochronometer, an instrument that measures the time accurately using the position of the sun in the sky. There are many designs of heliochronometer, many of them involving moving parts, which need to be adjusted carefully in order to determine the time. Others require the user to use tables and calculations to get the time.

I wanted to design a sundial that was accurate but looked like a normal garden sundial. After all, people seem to want sundials in their gardens even when they do not accurately tell the time. I wanted a design that was reasonably robust, easy to read, had no moving parts and did not require the any form of calculation or use of tables to get the time; in other words, a sundial that could be used and read just like a clock.

Concept

As I am sure many of you will know, if you plot the position of the sun (or its shadow) at the same clock time on

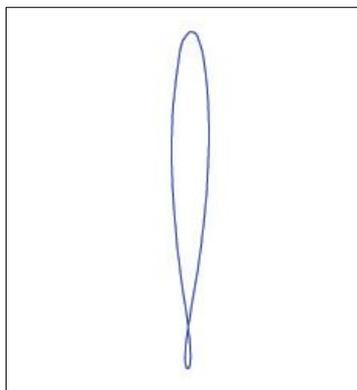


Fig. 1. A noon analemma projected onto a horizontal plane.

different days of the year you get a figure-of-eight shape known as an analemma. This shape can then be used to determine the exact instant of 12:00 o’clock by simply noting when the sun’s shadow crosses the analemma, although it is necessary to know which half of the analemma relates to the current date. Fig. 1 shows an analemma projected onto the horizontal plane, making the bottom loop (summer) much smaller than the top loop (winter).

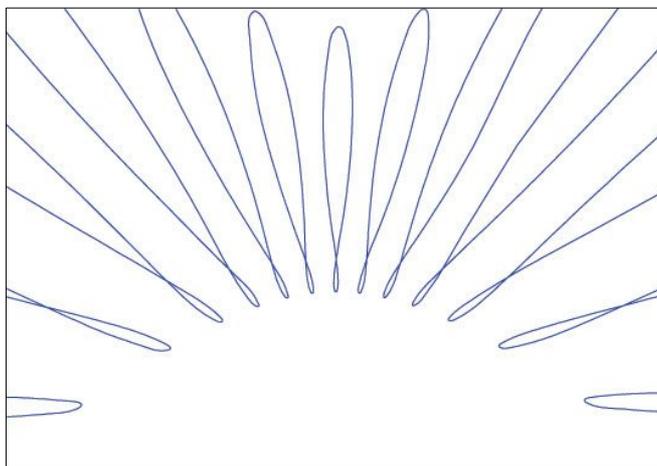


Fig. 2. Hour analemmas on a horizontal plane.

It is, of course, possible to draw an analemma for any hour (Fig. 2), and by doing this it is possible to make a sundial that will accurately tell you when each hour passes. In fact, this principle was used in the design of the sundial in Houston by John Carmichael shown in Fig. 3.

Two problems still remain, however, in producing a sundial that can tell you the time at any time of the day. First, it is necessary to know which part of the analemma applies on the day in question. Secondly, it is necessary to interpolate between the analemmas to get the time.

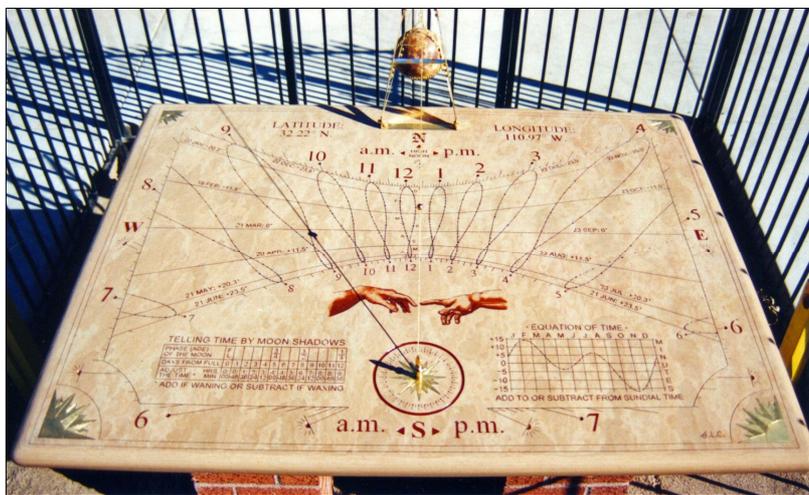


Fig. 3. Design by John Carmichael with full analemmas for each hour.

The problem of interpolation is reduced if analemmas are drawn every half hour, although it can be seen from Fig. 4 that that the analemmas now touch one another. To obtain a reasonable accuracy of interpolation it is necessary to draw analemmas at even closer intervals, say every ten minutes. Unfortunately, when this is done, the picture becomes hopelessly confusing, as shown in Fig. 5.

As shown in Fig. 6, each analemma consists of two parts, one which runs from the summer solstice to the winter solstice, and another which runs from the winter solstice to the summer solstice. This fact gave me the idea of just showing

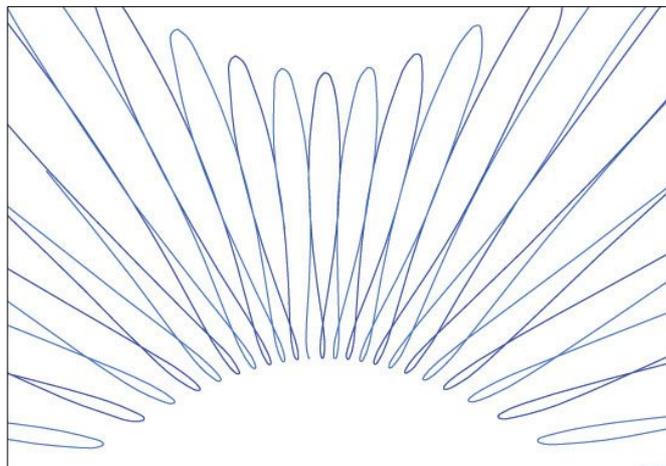


Fig. 4. Half-hour analemmas.

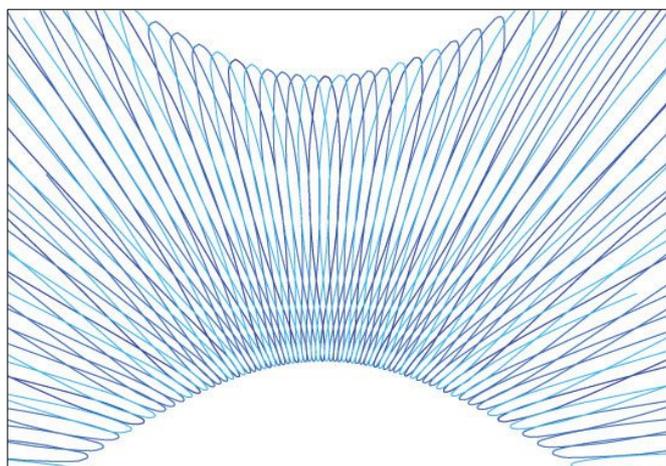
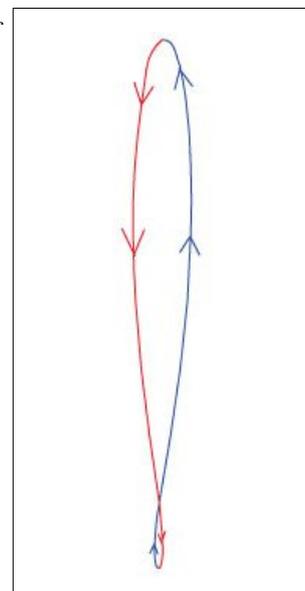


Fig. 5. Ten-minute analemmas.

Fig. 6. Two parts of an analemma.



half of each analemma at a time. It has the advantage that the analemmas no longer cross one another and it is no longer necessary to know which is the relevant part. Provided that the right half of the analemmas are shown for the time of year, it is now possible to read the time with reasonable accuracy by interpolating between the ten-minute lines.

Using this method (Fig. 7), two dial plates would be required, one covering the time from the summer solstice to the winter solstice ('Autumn') and the other covering the time from the winter solstice to the summer solstice ('Spring').

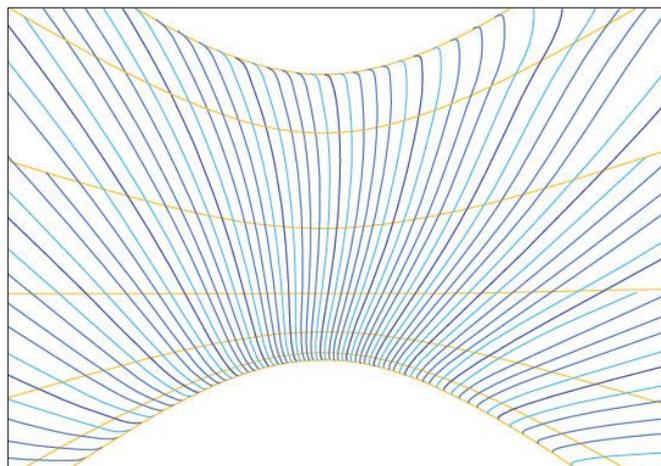


Fig. 7 'Autumn' analemmas.

This idea, then, of using two dial plates, each with half analemmas on them, was to become the basis of my design for a horizontal sundial. At the time I first had this idea, which I think was in the early 2000s, I could not find any references to other designs using changeable dial plates with half analemmas. Later, I found out about the famous Dolphin equatorial dial at Greenwich, designed by Chris Daniel and sculpted by Edwin Russell back in the 1970s. In some ways it was a good thing that I did not know about this dial as this enabled me to carry on in blissful ignorance, believing that I had discovered something new.



Fig. 10. The base plate.

Setup

One unexpected benefit of this dial was the ease with which it could be set up. A standard horizontal dial must be on a level surface and carefully orientated so that the noon line points due north, with an allowance for longitude, not a particularly simple process to perform accurately.

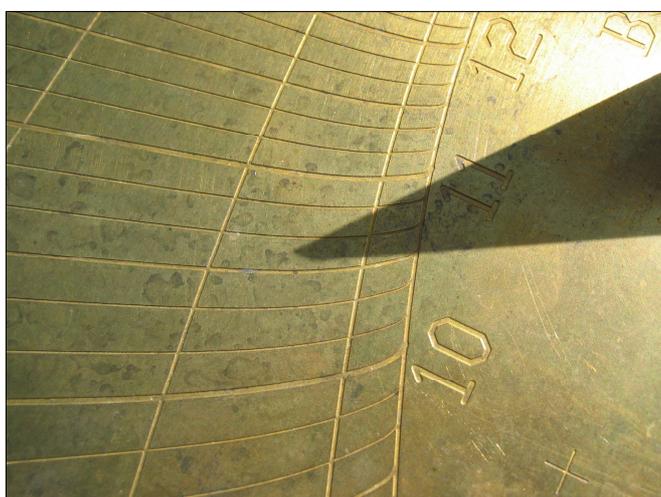
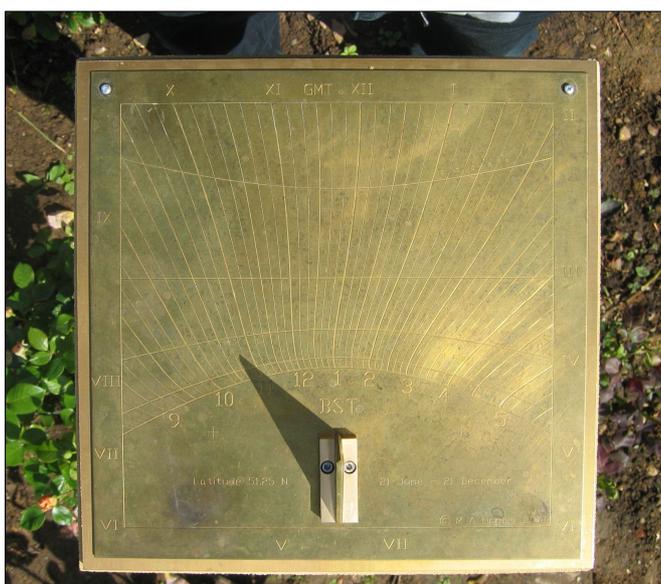


Fig. 11. The complete sundial shown from above.

Fig. 12. The time is read from the tip of the shadow.

When used in the location for which it was designed, this design, like the standard horizontal dial, requires a horizontal base but it is then simply rotated until it shows the correct time. To get the best out of the dial an accurate clock is required for this purpose. This simple method cannot be used for a standard dial, for which, in the worst case of the dial being set up at one extreme of the Equation of Time and read at the other, an error of half an hour would result.

Use

The completed dial was fixed to a standard pedestal and aligned as described above. The time is read directly from the tip of the shadow, interpolating between the ten-minute lines. In Fig. 12, the time is about 10:37.

As Figs 11 and 12 confirm, the dial achieved my objective of designing a sundial that looks similar to a standard garden horizontal dial, is easily read, and has no moving parts.

At the 2012 BSS Conference, it was suggested that the dial should be described as a horizontal mean-time dial. Whilst I do not argue with this description, I have called it a garden heliochronometer because it gives an accurate indication of the time by accounting for the Equation of Time, and it looks like a common garden sundial.



Fig. 13. The sundial on its pedestal.

Performance

Having designed and built the sundial and installed it on a plinth in my garden, I checked it at irregular intervals whenever the sun shone over a couple of years. For checking, I used my radio-controlled watch, which is accurate to the second and, rather appropriately, solar powered. The dial was usually correct to within a minute and was often within thirty seconds of the correct time.

Sources of error and limits to accuracy

In the few days about the summer solstice, when the equation of time changes rapidly and the sun is high in the sky, the accuracy was at its worst, sometimes being a couple of minutes out.

I used thicker lines on the plate to identify the hours and half-hours. This is a potential source of inaccuracy unless care is taken to use the centre of these lines as the basis for interpolation.



Fig. 14. Turning the dial plate every 6 months:

Top L: Tools required.

Top R: Removing the dial plate.

Bottom L: The gnomon removed.

Bottom R: The dial plate is turned over.

The question might be asked as to why the accuracy is limited to a minute. There are several reasons for this. Firstly, the finite size of the sun means that the shadows it casts have blurry edges – the penumbra. Some heliochronometer designs overcome this problem by have a focussing lens and using a fixed point on the sun's image to indicate the time but I wanted to keep the design simple. However, even with these refinements, it is difficult to tell the time to an accuracy of better than about 30 seconds. The position of the sun in the sky at a given time varies slightly from year to year.

Use in other locations

My dial was designed specifically for use in my own garden but I did give some thought as to what would be required to use the dial at other locations.

For small variations of longitude the well-known trick dial of rotating the dial in the horizontal plane until it shows the right time could be used. Although not mathematically correct, I suspect that the errors for this type of dial would be quite small for, say, the south-east of England. For different latitudes, I had the idea of tilting the dial but this may look a little odd. The best, but most expensive and complicated way would be to make a special dial plate for every location.

Maintenance

Twice a year, at each solstice, it is necessary to turn over the dial plate. The plate is then turned over and re-fixed (Fig. 14). The whole process takes about ten minutes. Two allen keys are required.

- The four screws holding the dial plate to the base are removed.
- The two screws securing the gnomon are removed and the dial plate is turned over.

- The gnomon and screws are then replaced. The markings on the two sides of the dial plate are sufficiently well aligned that no adjustment of the dial is required after this procedure.

The Future

As can be seen from the design, I am no artist: the design was produced from what is essentially an engineering point of view. The dial plate design looks reasonable but it would have benefited from some artistic talent.

The gnomon design provides great latitude for creativity since only one point of it, the point from which the time is read, must be fixed in space. The rest of the design could be a statue, with a raised finger, or a ship, for example, where the top of the mast is the reference point.

I would be interested in working with other sundial designers, artists, and sculptors to produce beautiful dials which actually tell you the time!

ACKNOWLEDGEMENTS

I would like to thank Patrick Powers for supporting me in my original presentation at Cheltenham and John Davis for his help and encouragement in writing up my presentation as an article for the *Bulletin*. I would like to thank my wife Jakkie for her help with data entry and proof-reading.

Martin Hogbin was born in 1949 and has a degree in physics from University College London. He worked for several years in industrial research and later in new product development. He now runs a business manufacturing high quality multiroom audio and video equipment. He has been interested in time, clocks, and sundials for as long as he can remember and is a member of London's Eccentric Club. He can be contacted at sundials@hogbin.org.



THE CROSS OR CRUCIFIX DIAL

MIKE COWHAM

Several dials are known that are in the form of a cross, either as a simple cross with equal length arms or in the shape of a crucifix. Generally, these dials are mounted in the equatorial plane with one of the legs pointing directly south. The shadow is formed by six different edges of the cross which fall onto six separate scales, each on a different face. Each of these dials formed are therefore polar dials.

Perhaps the best known of these dials is on a grave in the churchyard at Dyffryn Ardudwy in Gwynedd, North Wales (SRN0967)¹ commemorating the life of Ann Griffith in 1863 (Fig. 1). This dial is pictured in Fig. 2 on a card in the set of 'Old Sundials' issued by Wills's Cigarettes in 1928.

Cross dials are not particularly common and only a few are known. There are just 21 in the BSS *Register*. They are generally mounted on tombs or in cemeteries acting as a religious symbol as well as a sundial. This article describes three different ones that have been studied.



Fig. 1. The crucifix dial on the grave of Ann Griffith, dated 1863, at Dyffryn Ardudwy, North Wales.

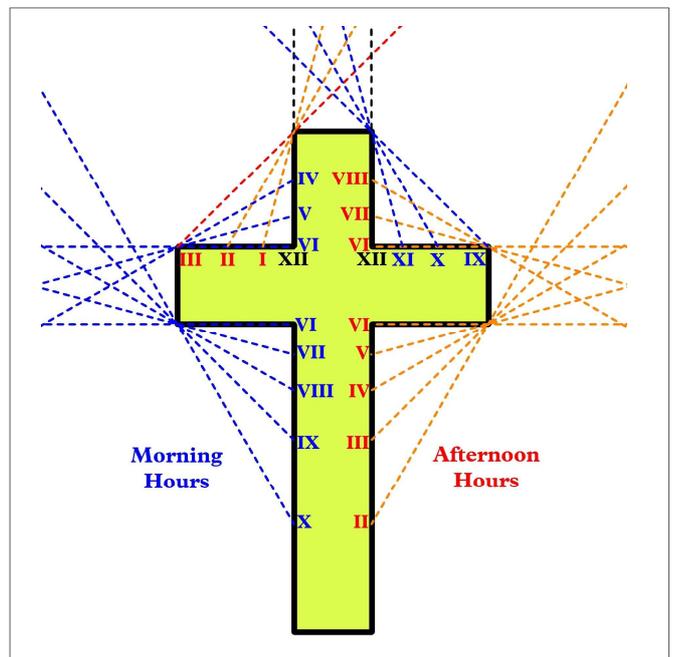


Fig. 3. Showing the calibration for each hour of the day.

The diagram in Fig. 3 shows how the six separate dials work, the Sun rays being shown for each daylight hour. This is basically the same as the cross dial illustrated by Leadbetter, shown in Fig. 4.²

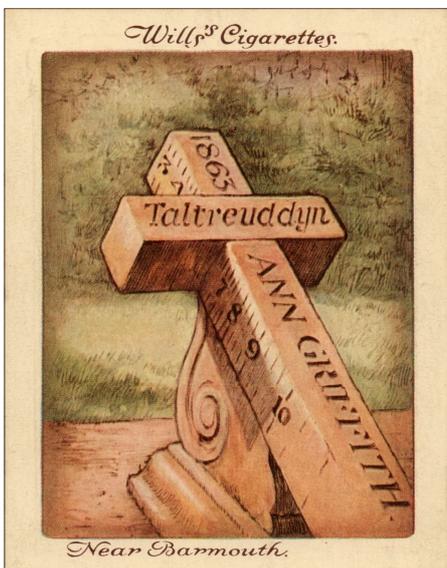


Fig. 2. The Dyffryn Ardudwy dial as featured on a Wills cigarette card of 1928.

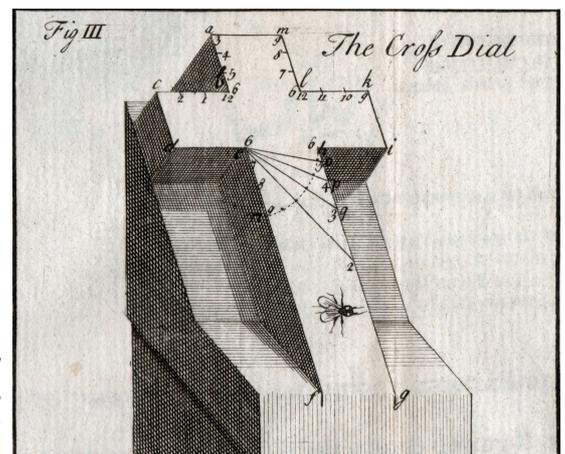


Fig. 4. The cross dial as illustrated by Leadbetter.²

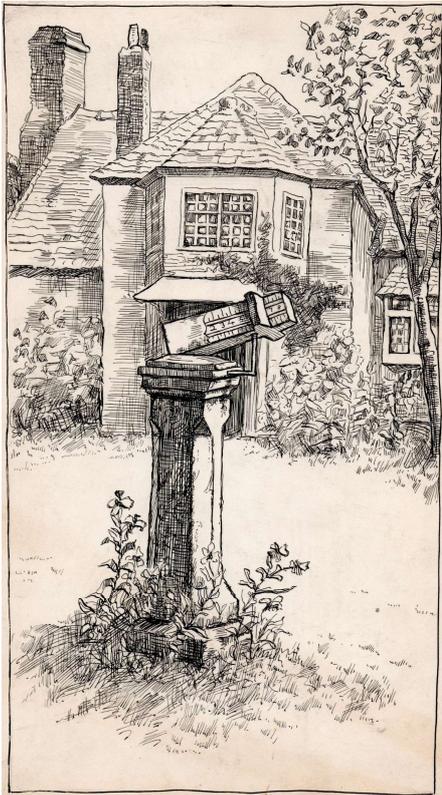
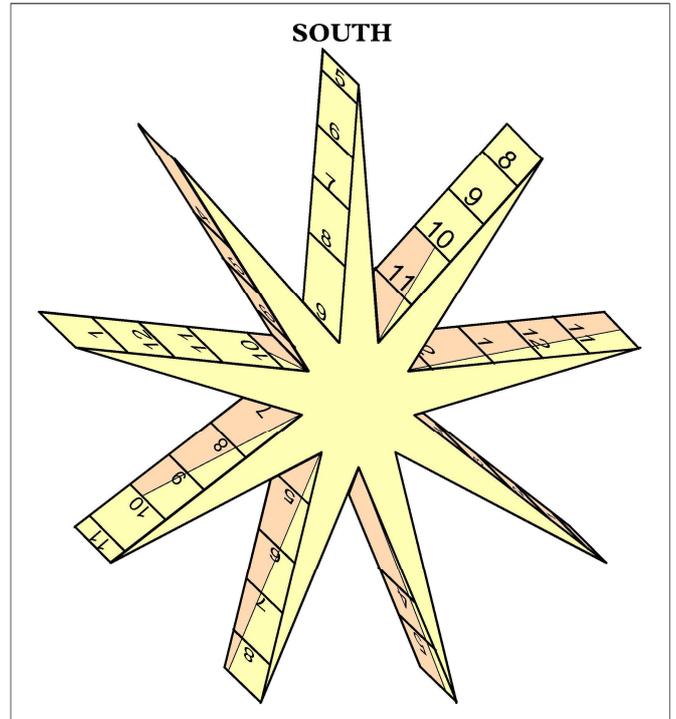


Fig. 5 (far left). Cross dial at Scotsraig, Fifeshire drawn by Miss Dorothy Hartley (scanned from her original drawing).

Fig. 6 (left). Detail of the cross dial in Fig. 5.

Fig. 8. A nine-pointed star dial at 10 am in Summer.



Other cross dials are shown by Henslow in his 'Ye Sundial Booke'.³ These are Scotsraig in Fifeshire (SRN0863), Shenstone Vicarage near Lichfield (SRN2768), one from 'An Old Curiosity Shop', Baslow in Derbyshire (SRN0487) and Port Sunlight. In his book the drawings were done in ink by Miss Dorothy Hartley, first appearing in his 'Verses for Sundials – Part 1' published ca. 1911 (Fig. 5).

Another important point is that in order for the shadow to fall on the faces of the dial throughout the year the cross has to be thick enough to take into account the $\pm 23\frac{1}{2}^\circ$ variation in the Sun's altitude, Fig. 9. This thickness needs to be a minimum of 0.435 times the distance between the

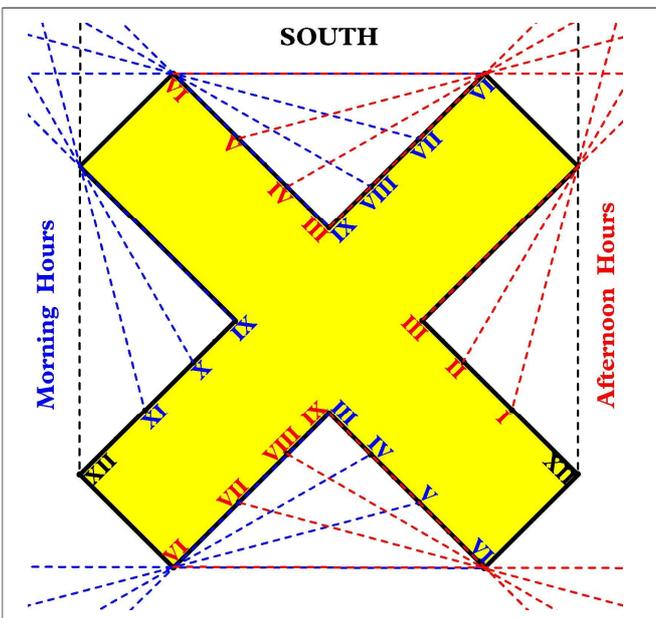


Fig. 7. A saltire cross dial (set at 45°).

Another possible version would have the cross set at a 45° angle as in Fig. 7. This way it would not have any religious significance. A cross or a star with virtually any number of arms, in any direction, set in the equatorial plane, would also make a workable dial such as the nine pointed star design in Fig. 8.

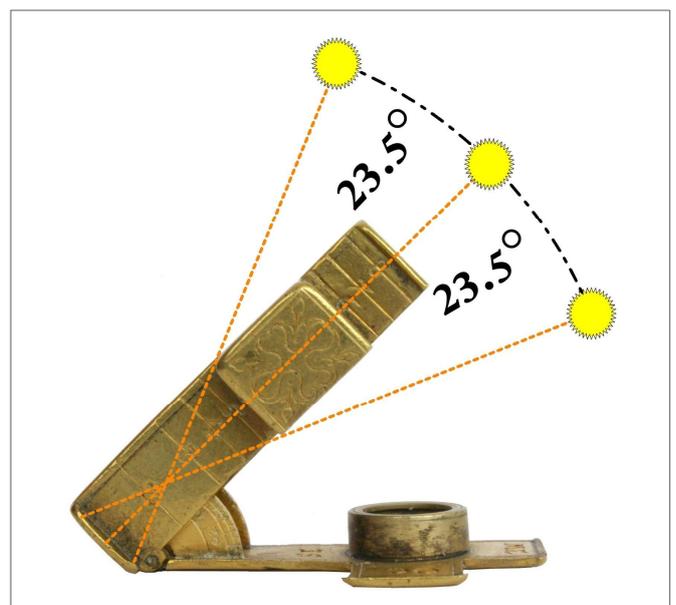


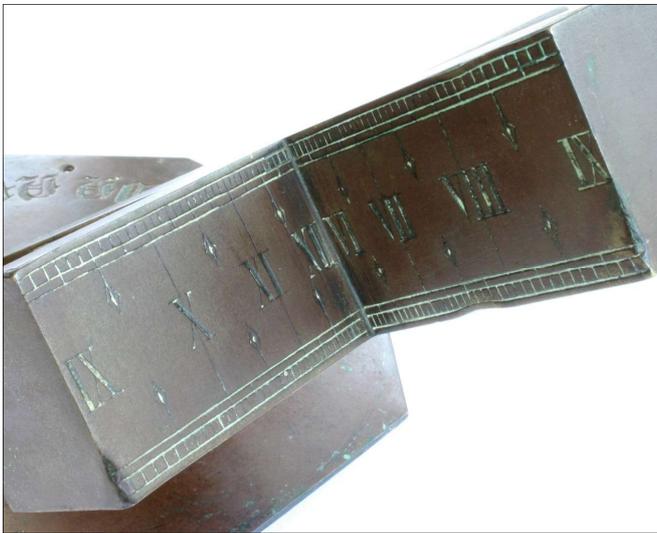
Fig. 9. Diagram showing how the thickness of the cross assembly is necessary to ensure that the shadow falls on each scale throughout the year.



*Figs 10–12.
Bronze crucifix
dial.*

*Below left: hour
calibration on
two of the dial
faces.*

*Right: Equation
of time inscribed
on the upper
surface.*



extremities of two arms of the cross but as a rough guide this should be about half the distance between the arms to allow space for the shadow to be clearly seen at the two solstices.

The delineation of these dials is therefore quite simple, with each hour line being at 15° from each other, with respect to the edge of each style.

The first dial studied, Figs. 10, 11 & 12, must have been made as a memorial and is made from bronze. It is hollow inside, so it has been fabricated by joining together several plates of metal. The assembly is then screwed onto an octagonal base plate at the required angle. This dial was made by:

L · CASELLA
Instrument Maker
TO THE ADMIRALTY
HATTON GARDEN · LONDON

They were active at 23 Hatton Garden, London between 1848 and 1860.⁴ On its upper surface is engraved the Equation of Time, now somewhat lost due to weathering and cleaning. A small plaque on the upper limb explains this to the user:

*Fig 13. Cross dial carved in stone, and
Fig 14. Two of the hour scales.*

FAST MEANS
 THAT THE CLOCK
 SHOULD BE FASTER
 THAN THE DIAL
 SLOW SLOWER

The hour calibrations on the six scales, are to each five minutes and are deeply incised, as is the inscription on the rather thin base plate that reads:

HORAS NON NUMERO NISI SERENAS

(I count the bright hours only).

The dial is 8" across the arms with the section of the cross 2" x 2". The 2" thickness is ideal being just under a half of the 4 1/4" between the tips of the arms.

The second dial, Figs 13 & 14, is again almost certainly originally from a gravestone. This time it has equal arms. It has beneath a single mounting hole showing that it was originally mounted at an angle, probably on a pillar. The hour scales are divided to quarter hours. Its size is 19" (482mm) square with a thickness of 4.8" (122mm). It weighs 46 kg. Although undated, from its style it probably belongs to the late Victorian period.

The last dial to be described, Figs 9 & 15, is a portable dial designed to be hung around the neck of the user, its suspension loop now missing. It is in brass, originally gilt and contains a small magnetic compass for correct alignment. Although similar to the other dials described it has small extensions to each style edge and the hours depicted on the lower vertical stem are extended by one. On its top face is an image of the Crucifixion and on its underside a Crucifix with a snake draped over it. Again the dial is undated but this one was probably made around 1650, possibly in Germany. Its size is just 36 mm long and 9.5 mm thick.

A similar dial is illustrated in 'The Book of Sun-Dials' by Eden & Lloyd of 1900 (Mrs. Gatty),⁵ Fig. 16.



Fig 15. Portable crucifix dial, c.1650.

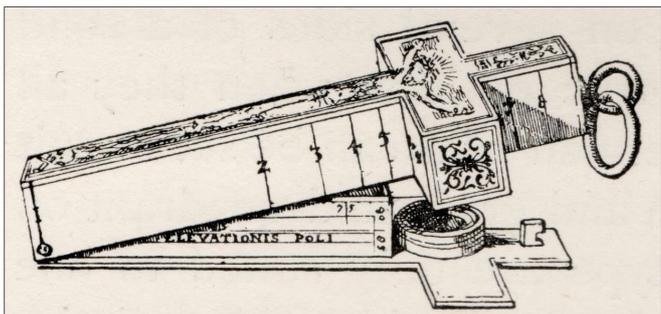


Fig 16. Crucifix dial illustrated by Eden & Lloyd.⁵

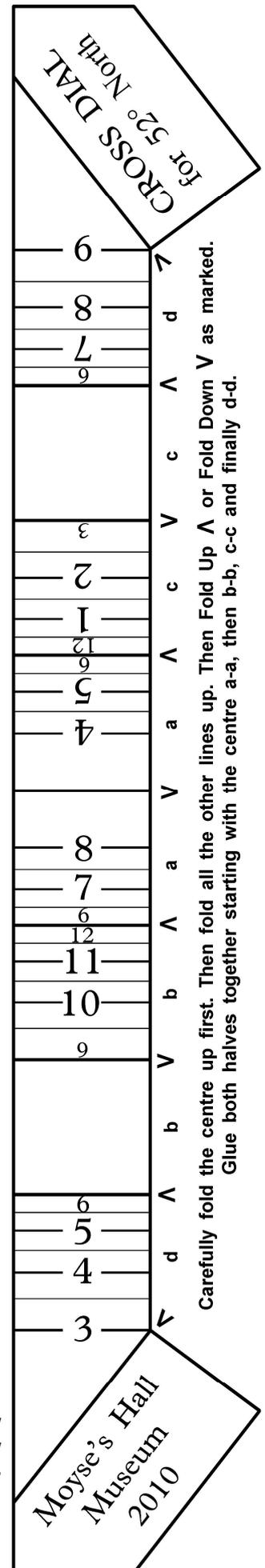


Fig. 18. The cross dial design for Moyses Hall Museum in Bury St. Edmunds, Suffolk.

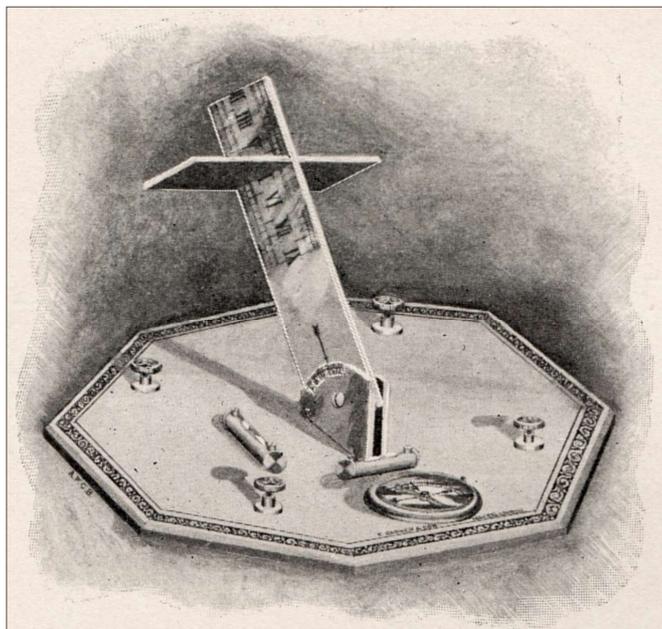


Fig 17. Cross dial by F. Barker & Son, London.

With all of these dials the cross is of an indeterminate width. This does not matter as the body width has no relevance to the function of dial itself. A perfectly useable dial may also be made with virtually no body thickness. Such a dial was made by F. Barker & Son, London as illustrated by Alice Morse Earl,⁶ Fig. 17. A dial of similar type was designed for children to produce at a local museum, Figs 18 & 19. The pattern, Fig. 18, was originally printed on card for the children to fold into a cross. Alternatively, the indi-



Fig 19. Cross dial made in card for children at a local museum, showing here the time as 9 am.

vidual sections may be pasted onto a suitable wooden cross framework.

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3. T. Geoffrey Henslow: *Ye Sundial Booke*. London (1914).
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5. Eden & Lloyd (Gatty): *The Book of Sun-Dials*, George Bell & Sons (1900).
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mike@brownsover.orangehome.co.uk

PLINY THE ELDER AND GNOMONICS (continued from page 7)

In Book VII, Section LX, agreements about various matters are detailed. One of these concerned the recording of sunrise, sunset and, later, noon by the consuls' apparitor. When "from the Senate house he saw the Sun between the Beaks (a speakers' platform in the Forum adorned by the beaks of ships) and the Greek lodging" noon was declared. When the Sun sloped from the Maenian Column to the Prison he announced the last hour. The section continues with the statement of Fabius Vestalis that the first sundial was erected 11 years before the war with Pyrrhus at the Temple of Quirinus. Fabius omitted any mention of the sundial's construction or its maker. According to Marcus Varro the first public sundial was set up on a column near the Beaks during the First Punic War. It was brought from Sicily thirty years later than the traditional date of the previously mentioned dial which was 264BC. The lines of the sundial did not agree with the hours but they used it for 99 years until Quintus Marcius Philippus placed a more carefully designed one next to it. Both were superseded by a water-clock showing equal hours which was housed in a roofed building.

In Book XXXVI, Section XV there is a detailed description of an obelisk brought from Egypt and set up in the Campus Martius in Rome. It was adapted by the Emperor Augustus to mark the Sun's noon shadow day by day (*singulis diebus*) by means of bronze rods set in the pavement. It was designed by Novius Facundus who "set on the pinnacle of the obelisk a golden ball at the top of which the shadow would be concentrated, for otherwise the shadow cast by the tip of the obelisk would have lacked definition". Pliny goes on to say that for the last thirty years the readings have been inaccurate and suggests that possible causes could be a change in the Sun's course, a movement of the Earth from its central position in the universe, the effects of earth tremors or subsidence of the shaft due to flooding of the Tiber. This obelisk survives in the Piazza di Monte Citorio.

The most easily accessible edition of the Natural History is that published in ten volumes by the Loeb Classical Library. In common with other works produced by Loeb it has an English translation on the recto page with the Latin original opposite so that cross referencing is made easy. The series includes other works by Greek and Latin authors which may be of interest to diallists (e.g. Vitruvius).



MINUTES OF THE 24TH BSS ANNUAL GENERAL MEETING

Edinburgh, 7 April 2013

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

1. Minutes of previous AGM

The minutes of the 23rd AGM, held at Cheltenham on 15 April 2012, had been published in the *Bulletin* of June 2012, were taken as read, and were approved.

2. Officer & Specialist Reports for 2012-13, and 2012 Accounts

The Reports and Accounts had been circulated with the Conference papers, and are shown below. These were received without comment.

Chairman – Frank King

We have had another very good year for our traditional programme of core activities: four splendid issues of the *Bulletin*, a most enjoyable main conference and bright sunshine for the Newbury meeting.

Securing our future has to be my prime responsibility and, in this, I am keen to involve the membership as a whole, seeking participation and welcoming feedback.

Discussion at the Cheltenham Forum resulted in Council giving priority to working on a new website and content. The work on this site is now at an advanced stage and there will be a demonstration at the Edinburgh Conference.

One feature of the new site is to include descriptions of a substantial number of British sundials. It is also proposed to put early *Bulletins* on line. The Scientific Instrument Society has shown the way. It is inescapable that our website is the most influential and cost effective vehicle for achieving our principal goal: educating the public in the science and art of gnomonics.

Increasingly, new members find us via the website and the better the site the more visits it gets and this leads to more education and more members. It therefore makes sense to share rather than hide a greater proportion of our knowledge base.

We can run our programme of events and make the investment in our future only through our volunteers. I would like again to thank all of them for their hard work over the year and mention by name only those who are standing down. Mike and Val Cowham have led their last safari and it seems as though theirs may be an almost impossible act to follow. John Foad is standing down from Council after seven years but, fortunately, he will be continuing as Registrar where his expertise is proving invaluable in assembling a collection of sundials for the website.

My role is possible only with the support of the membership, the many Specialists, and fellow Council members. I have been very fortunate on all counts.

Secretary – Chris Williams

Council: The 2012-13 Council welcomed a further two new members, resulting in a majority of Council being composed of new – post March 2011 – blood. The reorientation of Council priorities and rebalancing of its time allocation, begun in 2011–12, has been completed. Most of Council's quality time has been spent considering the Society's future. 'Dials' definitely outscored 'admin and regulation'. Council has also conducted its affairs with the views of, and the need to consult, the membership very much at the forefront of its mind.

Operations and regulation: The only matter of normal regular business worthy of comment pertains to maintenance of our website. We were beset by a cascade of unexpected events beyond our control. These were resolved during the summer. Since then the website has been maintained in a timely fashion to an improved standard.

The Society's future: Council has focused its attention on the new website, new additional content for our website, a review of grants policy, and the Society's 2014 silver anniversary. This is a challenging agenda, completion of which will also keep the 2013–14 Council fully occupied.

New website: Substantial progress has been made: it will be reported and demonstrated at Edinburgh. We have been most fortunate in a new volunteer coming forward, affording us a hitherto unavailable level of (internal) expertise.

New content for our website: In the final analysis any website is only as good as its content. We can rapidly make a magnificent improvement by deploying two (hitherto under-utilised) assets – our listings/recordings of dials and *Bulletins*. Together these represent the Society's cumulative achievement. Our constitutional *raison d'être* – 'to educate the public in the science and art of gnomonics' – dictates we share these with the public by putting them on line.

Project Bridol (British dials on line) is progressing well. Member's comments, feedback and participation have been overwhelmingly positive and supportive. A Bridol prototype demonstrated at Newbury was very well received. The call by the Registrar for editorial assistance has been good. Only one member has objected to his/her dial photos being used on line – enquiries continue to identify those involved. Bridol will be reported upon and demonstrated at Edinburgh. The opportunity will also then be taken to consult on putting our *Bulletins* on line.

Grants policy: As awarding grants involves the direct expenditure of member's money a consultation paper has been issued following Council's review. In the light of comments received the 2013–14 Council will progress matters.

Volunteers: The Society is entirely dependent on its volunteers. We are in the process of experiencing the progressive retirement of the stalwart cohort of recent years. Although new blood has come forward, we (currently) have to run to

stand still; and, the need for additional volunteers remains our most immediate need and binding constraint. There are specific Specialist vacancies (Publicity, Education, Safari and Archivist) as well as *ad hoc* tasks (e.g. new content for our website). If you believe you can help, or have ideas for the Society's future development, please contact me.

Matters arising from the 2012 AGM: There were two. Firstly, Council considered the proposal for a review of the Library. In the light of more immediate and pressing priorities, combined with the nature of polarised opinion within the membership and the volunteers available, it concluded it was for a future, rather than the 2012–13, Council to decide and discharge. Secondly, the situation regarding the circulation and availability of the 2011 Accounts was both unintended and unacceptable. The position going forward was confirmed by me in the March 2013 Newsletter.

Treasurer – Graham Stapleton

Once again I can report that our funds are in a comfortable state and the Society can meet its requirements. This needs to be emphasised because the 2012 Accounts – taken in isolation – show a loss and consequent reduction in total funds of £5,225.

When reading sets of accounts it is essential to distinguish between short-term effects and long-term trends. Any individual year's actual results are far less important than the underlying trend and financial situation. In several past years, I have given an account of how price movements and the timing of payments – particularly Conference – have distorted the picture, creating large variations in relation to the overall net change.

In the long-term, two considerations are particularly important. Firstly, our losses over recent years have been driven by the decline in subscription income. We have been losing members at a fairly steady rate, but with the long postponed adjustment to subscription rates and efforts to attract new members, income is rising. Even so, if you can encourage somebody to join, please do. Secondly, losses are one thing, the ability to finance them another. Fortunately we have had adequate reserves and, in recent years, these reserves have been significantly reduced to cover losses. Together, increased subscription income and remaining reserves are judged to be adequate to support the Society's present activities and plans.

Finally, a word of gratitude to those members who have already returned their new Gift Aid form. This is an important source of income, only possible with your help.

Membership – Jackie Jones

At present we have a membership of 380 of which 19 are non-paying and receive a complimentary copy of the *Bulletin*. These are mainly other societies with which we have an exchange of *Bulletin* agreement. Of these members, 264 are in the UK and 59 in the rest of Europe. There are 57 in the rest of the world; 35 in the U.S.A., 5 in Canada, 4 in Australia and others spread far to include South Africa, New Zealand, Brazil, Japan, Mexico, Israel and Bermuda.

Since the last conference we have welcomed 14 new members. Unfortunately, there have been a number leaving, mainly due to ill health and 10 have died. Last conference I reported a total membership of 420. We have an ageing membership and need to do more to encourage the newly-

retired to join us. We have recently started asking on the membership form if people would like to give their date of birth. This is optional; of the last 4 members, 3 are younger than I am. The fourth did not give a date.

Bulletin Editor – John Davis

We changed our printers (again!) during 2012 in the constant search for the best value in a cut-throat and ever-advancing field. So far, things are working out well. As usual, four issues of the *Bulletin* were produced and there is a steady stream of articles written by both our regular contributors and occasional authors, all of whom I thank. Although each 48-page issue has been filled, more contributions are always welcomed. Also to be thanked are the team of proofreaders who check through each issue and spot all sorts of mistakes that I have missed. This year, we have introduced an annual 'Most Enjoyed Article' award for which votes are needed from all readers (please!).

A second edition of the Bulletin Archive DVD has been issued, largely due to the work of Kevin Karney. It now contains all the published *Bulletins* up to March 2012 and is a tremendous resource.

One new title in our monograph series (no. 10), Mario Araldi's *De Cursu Solis*, was published right at the end of 2012. Several new titles are in the pipeline for 2013/4 with a publication schedule largely determined by the editor's work rate.

Registrar – John Foad

The *Fixed Dial Register* now has details of 6,946 British dials. 79% have one or more photographs, and this figure continues to grow as early prints and transparencies are recovered from the archives. We aim to put a large selection of our holding on the BSS website, an exercise that requires a fundamental overhaul of the way the information has been held for the last 20 years and more. With the assistance of a band of helpers, this work is progressing well, with 80% of the 'Open' dials now rewritten. Watch this space!

Apart from preparatory work for the new web release, it has been a quiet year. There has however been a steady flow of new reports of quality dials from all periods, and it is clear that the record of good pre-20th century British dials is far from complete.

Mass Dial Group – Tony Wood

The year has seen the installation of a new printer (very successful) and copies of the County booklets are now produced much more quickly.

Entry into the *Mass Dial Register* database has continued and Hampshire, Herefordshire and Northamptonshire have now been entered, printed and stored in the archive at the Borthwick Institute, York. (Thanks to Peter Ransom, Colin Lindsay and Richard & Catherine Botzum respectively for their contributions here). I will enquire to see if our Library is interested in holding copies of the County Registers also.

It is remarkable but discoveries of 'new' mass dials still occur with three in the first two months of 2013. Our friends of the NADFAS Church Recorders have kept us informed of the dials they find (including 'scientific' dials). Particular mention must go to Ian Butson for his surveys of Oxfordshire (completed) followed by parts of Lincolnshire which revealed that Bob Adams had concentrated on mass dials

BSS ACCOUNTS FOR YEAR

Statement of Financial Activities

	Notes	Unrestricted Funds £	Restricted Funds £	TOTAL 2012 £	TOTAL 2013 £
INCOMING RESOURCES					
Voluntary Income	2a	615	1,054	1,669	1,793
Investment Income	2b	501	0	501	407
Incoming Resources from Charitable Activities	2c	47,039	0	47,039	45,541
TOTAL INCOMING RESOURCES		48,155	1,054	49,209	47,741
RESOURCES EXPENDED					
Charitable Activities	3a	50,525	0	50,525	39,044
Administration Costs	3b	2,872	476	3,348	7,254
Governance Costs	3c	561	0	561	705
TOTAL RESOURCES EXPENDED		53,958	476	54,434	47,003
NET INCOMING/ (OUTGOING) RESOURCES		-5,803	578	-5,225	738
Total Funds Brought Forward		73,271	8,561	81,832	81,094
TOTAL FUNDS CARRIED FORWARD		67,468	9,139	76,607	81,832

The accounts presented in these two pages are extracts of the full 10-page Accounts document prepared by Independent Examiners Ltd. Any member may access the full report on the BSS website or by application to the Treasurer. That document gives a full explanation of the various Notes and also provides breakdowns of the detailed elements.

ENDING 31 DECEMBER 2012

Balance Sheet

	Notes	Unrestricted Funds £	Restricted Funds £	31-Dec-12 Total £	31-Dec-11 Total £
Fixed Assets					
Tangible assets		16,635	0	16,635	16,635
Current Assets					
Debtors	7	0	0	0	0
Cash at bank and in hand	6	51,394	9,139	60,533	65,758
Total Current Assets		51,394	9,139	60,533	65,758
Creditors: amounts falling due within one year	8	561	0	561	561
NET CURRENT ASSETS		50,833	9,139	59,972	65,197
NET ASSETS		67,468	9,139	76,607	81,832
Funds of the Charity					
General Funds		67,468	0	67,468	73,271
Restricted Funds	4	0	9,139	9,139	8,561
Total Funds		67,468	9,139	76,607	81,832

Trustees Responsibilities

The Charities Act 2011 require the trustees to prepare financial statements for each financial year which give a true and fair view of the state of affairs of the trust and of the surplus of the trust for that period. In preparing those financial statements the trustees are required to:

- Select suitable accounting policies and apply them consistently
- Make judgements and estimates that are reasonable and prudent
- Prepare financial statements on the going concern basis unless it is inappropriate to presume that the trust will continue in existence.
- State whether applicable accounting standards and statements of recommended practice have been followed, subject to any material departures disclosed and explained in the financial statements;

The trustees are responsible for keeping proper accounting records, which disclose with reasonable accuracy at any time the financial position of the trust. They are also responsible for safeguarding the assets of the trust and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

These accounts were approved by the Trustees and signed on their behalf on the 10th March 2013

Signed  Dr. F. King, Chairman.

Signed  G. Stapleton, Treasurer

almost to the exclusion of scientific dials. Also to Maureen Harmer for her comprehensive survey of Sussex, which is currently in hand.

Thanks to various members who were asked to follow up reports on our behalf. Non-member Dave Everest has also provided dials from Hertfordshire and other counties on a regular basis.

Archaeological finds have included a metal vertical mass dial and 'not a mass dial' on a piece of stonework from a Priory in Bristol.

Isolated enquiries from members of the public via the Internet have also cropped up and an interesting 're-carving' of a mass dial has surfaced which I hope to deal with in the near future.

Entry to the database continues with Oxfordshire – which will occupy quite a long time.

Finally, thanks to John Foad for help with the database and dealing with problems arising.

Restoration/Conservation – Frank King

The workload of the Restoration/Conservation Adviser is largely about attending to unsolicited enquiries sent in by people who have found the contact address via an Internet search.

Many enquiries are from people who have come across a sundial that has been hidden away for years and they simply seek some kind of description. Relatively few enquirers actually want advice about restoration or conservation.

In many cases, the dials are of low quality. Those by Pearson Page (of which there are plenty!) come in an intermediate category and there are a few which are of great interest. Most enquiries conclude after one or two e-mail messages each way. Once in a while I have sought guidance from true experts and here I especially wish to thank John Foad, John Davis and Mike Cowham for helping me out.

Those enquirers who seek advice about restoration and conservation are almost invariably concerned with a dial on a Church or Vicarage. They come in two categories: those who want advice and those who want funding.

As a body the Society is able to supply very high-quality advice on almost any aspect of restoration and conservation and indeed can give advice and support about fund-raising. A number of letters were written in support of applications for Heritage Lottery awards.

The Society has limited funds for making grants and a separate paper on this subject is to be discussed at the Edinburgh Conference.

One observation might be noted: for any project to be brought to a successful conclusion it is crucial that there should be some motivated individual (or group of individuals) on the spot determined to see the project through. Fortunately there are still such people around. They raise their own funds and seek support from the Society only on technical matters.

2014 Silver Jubilee – David Brown

2014 marks the 25th anniversary of the foundation of BSS. A clear motivation for a celebration, apart from sharing the joy of achievement, is to increase the public profile of the Society and thereby to increase membership numbers.

Suggestions of ways in which this milestone might be celebrated were sought from members last year. Council is grateful for the wide range of ideas offered – they were honed down by Council and floated at Newbury in September. With Council's approval I consulted with others (Ben Jones and Martin Jenkins) and that yielded further suggestions. These were taken again to Council in February 2013.

Council resolved that there should be an extended 3-day BSS conference in Greenwich. In addition:

- Oxford was our birth-place and a short gathering there was favoured by many.
- *Bulletin* – anniversary edition.
- New pamphlet/flyer for general publicity.
- Publicity material to be prepared for distribution to all members for onward communication to regional radio, TV and newspapers to publicise the birthday as well as the aims of the Society.
- Article for *Times Educational Supplement* in Spring 2014.
- Provide educational materials through the web site for schools related to National Curriculum demands, schools competition to find the most sundials.
- Develop contacts with youth groups such as scouts/guides/ to build-in sundial related activities to existing or new achievement badges.
- Printed wall calendar (in time for circulating before end of 2013).
- Competition for the best sundial-related YouTube video

...and a pot-pourri of further ideas including: schools sundial, birthday cake(s), car badge sticker, Kellogg's sponsorship with cut-out sundial developed by Tony Moss. We have enough ideas – now we need to put any or all into action. Please contact me if you would like to help make 2014 special.

3. Election of 2013-14 Officers

Frank King (Chairman), Chris Williams (Secretary), and Graham Stapleton (Treasurer) had been (re)nominated. All were elected by a show of hands.

4. Election of other 2013-14 Council Members

David Brown, Jackie Jones, and Chris Lusby Taylor had been (re)nominated. Bill Visick had also been nominated. All four were elected by a show of hands.

5. Appointment of Independent Scrutineer for 2013 Accounts

Independent Examiners Ltd was reappointed.

6. AOB

Chris Daniel indicated he had a few concerns over Council's Consultation Paper on Grants Policy. The Chairman responded with two comments. Firstly, the Paper is mainly a statement of the actual constraints encountered, and the actual practice that has emerged, in recent years by successive Councils. Secondly, the consultation process remains open and Council continues to welcome further specific comments to those already received.

Secretary
April 2013

IN THE FOOTSTEPS OF THOMAS ROSS

Part 5. The Fettes College Sundial

DENNIS COWAN

Fettes College is a leading independent boarding and day school in Edinburgh. It is often referred to as a Public School, but as the Public School Acts apply only to England and Wales, that is actually a false description. It is probably most widely known as the former school of ex-Prime Minister Tony Blair but also includes many luminaries amongst its former pupils including at least four winners of the Victoria Cross, Britain's highest award for gallantry.

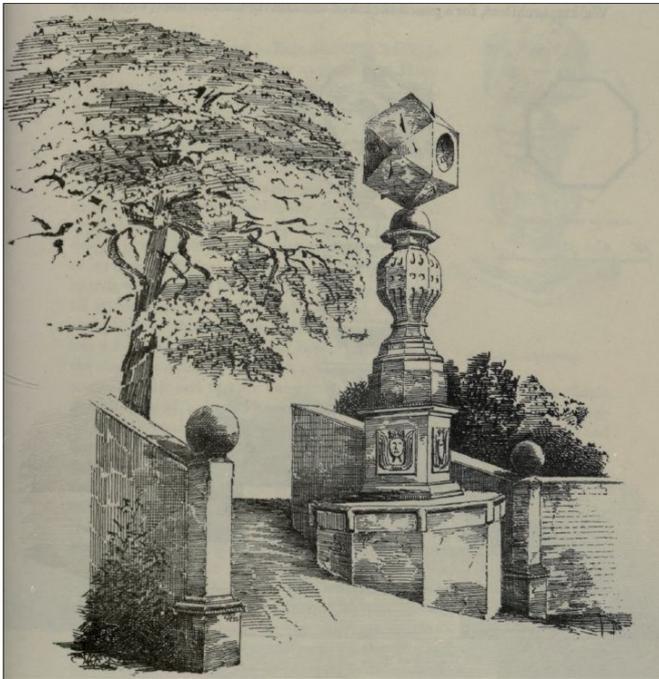


Fig. 1. Drawing of the Fettes College dial.
After MacGibbon & Ross.²

The school was designed by David Bryce and has been described as his Scottish Baronial / French Gothic masterpiece. It was built between 1864 and 1870 using funds bequeathed by Edinburgh Lord Provost and Merchant Sir William Fettes. I have to say that it is a magnificent looking building.

Within the grounds of the school, in the Sunken Garden adjacent to the Headmaster's house, is a multi-faceted sundial originally from Warriston House in Edinburgh. The sundial is 'A' Listed¹ and is described by Thomas Ross in volume 5 of *The Castellated and Domestic Architecture of Scotland*² of 1892 as follows:

"The dial here [Fig. 1] is probably all that remains of the old mansion-house of Warriston. It has had a stepped

base, but only a portion of it now remains; otherwise the dial is perfect. On the top of the remaining step there is a square pedestal ornamented with Oriental-looking heads, above which rises the moulded baluster for supporting the dial-stone, which rests on a point. Round the centre the dial-head is six-sided, with flat dials on its numerous faces, except on one side, where there is a cup-hollow. The height of the dial and baluster is 5 feet 3 inches, and the pedestal measures about 1 foot 10 inches above the steps."

It is unclear whether Ross was describing this dial when it was still in the grounds at Warriston House or at its next location at Inverleith House. Reputedly dating from 1642, it was moved from its original location at Warriston House to the terrace of Inverleith House (now in the grounds of the Royal Botanic Garden), just a short distance from Fettes. It was subsequently moved from there to the school in 1893, and placed as a central feature within the ornamental sunken garden adjacent to the Headmaster's house, where it remains to this day (Fig. 2).



Fig. 2. The dial in its current position.



Fig. 4 (above). Detail of one of the proclining faces, with a bent gnomon.

Fig. 3 (left). Detail of the scaphe dial on the vertical south face. Other bent gnomons can be seen.

2. D. MacGibbon and T. Ross: *The Castellated and Domestic Architecture of Scotland*, David Douglas, Edinburgh (1892).

For a portrait and CV of the author, see *Bulletin* 23(iv). He can be contacted at dennis.cowan@btinternet.com.

This polygonal sundial still looks as it did in the sketch of 1892. There are fourteen dials in total, including one cup hollow or scaphe dial (Fig. 3), but many of the gnomons are now either broken, bent or missing (Fig. 4). The visible numerals on all dials are Arabic in style and the cup hollow dial still has its hour lines visible. Two of the upper faces have some damage, but otherwise it is in reasonable condition. It is remarkable how it has managed to survive for so long perched only on a single point.

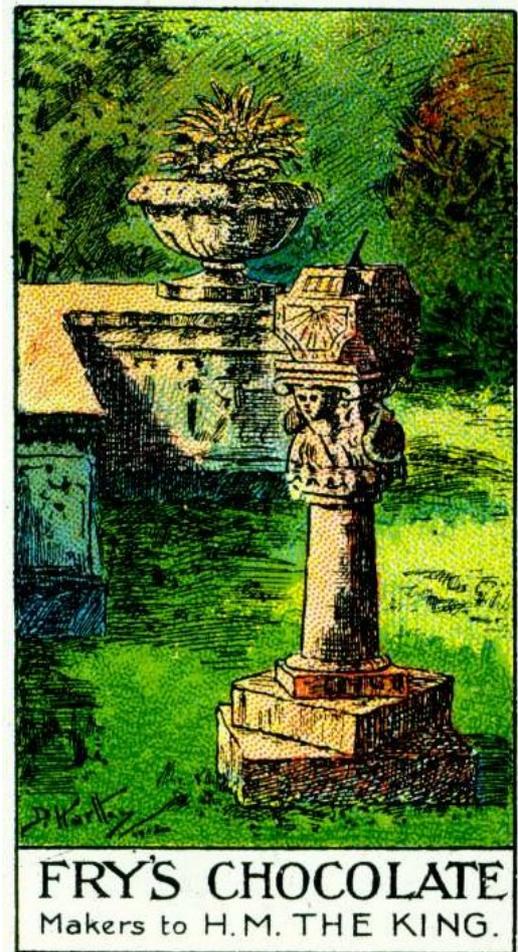
The moulded baluster which supports the dial still sits on the square pedestal with its Oriental-looking heads, as it did in Ross's day, with the remaining part of the stepped base underneath.

I wonder if any of the school's pupils ever dared to attempt to clamber over the sundial – probably not, considering its proximity to the Headmaster's house! On the off-chance, I contacted the Office of Tony Blair to see if he could recall the sundial and if he or his fellow pupils ever attempted any stunts on it. There was no response.

It is always very pleasing to be able to locate one of Ross's sundials when it is no longer in the location where he recorded it. It is difficult enough as he was not always specific regarding its location, and when they are moved to another location it is doubly so. They are not always easy to find, although this one, I'm pleased to say, has been reasonably well documented.

REFERENCES

1. In Scotland, an 'A' Listed structure is defined as "of national or international importance, either architectural or historic, or fine little-altered examples of some particular period, style or building type".



Fry's card showing the dial at Carberry, Scotland, number 43 in the series.

THE GLASSMOUNT SUNDIALS (and a Palimpsest Gnomon)

DENNIS COWAN

I first heard of Glassmount when investigating gardens to visit under the Scotland Gardens Scheme¹ as they are often a likely source of sundials. A little more investigation revealed that Dr Andrew Somerville² had listed a multi-faceted dial there, but other than noting that it was early 18th century and was a cube with mounded cap and base, there was no more information.

Glassmount itself is located inland in a fairly isolated spot somewhere between Kirkcaldy and Kinghorn in the county of Fife and is in a fairly elevated position. It has an intriguing densely planted walled garden with surrounding woodland. A Mackenzie and Moncur greenhouse and historical dovecot are complemented by newer structures including an atmospheric water feature/fish pond. Snowdrops and daffodils are followed by a mass of candelabra and cowslip primula, meconopsis and cardiocrinum giganteum. Hedges and topiary form backdrops for an abundance of bulbs, and clematis, rambling roses and perennials create interest through the summer into September. The gardens were featured in 'Country Living' and was the winner of The Times/Fetzer Back Gardens of the Year in 2008.

I made arrangements to visit and was delighted to be shown round personally by Irene Thomson, the owner. When she



Fig. 1. The cube dial at Glassmount.

heard that my main interest was in sundials, she escorted me to the dial identified by Somerville. It was located a short distance away from the house.

It was a cubic sundial on a cracked three-tier plinth with the eroded dial faces giving way to a stepped cap with scalloped carving, with the finial and all gnomons missing (see Fig. 1). There was a finial lying nearby but it was obviously not original to the dial. The three-tier plinth was tied up in wire to hold it together and all in all it was in a rather poor condition and was sitting on a rather wobbly and makeshift base.

She then showed me round her wonderful gardens and then almost as an afterthought she said "did you know that we have another sundial?" When I said "no" she said that it was on the end of the house. Right enough there was a vertical dial high on the south gable end of the house above the first floor bay window (Fig. 2), but she knew nothing about it at all. I could just make out the date of 1722 and after taking a few photos of it, I left after a little more chat.



Fig. 2. The southern gable with vertical dial.

Some time later I enlarged the photos on my computer and noticed that there were the remains of lettering on the gnomon. However, I didn't take much notice until I read John Davis's article in the *Bulletin* on 'A Palimpsest Gnomon'.³ That reminded me of the Glassmount vertical sundial and I had a look again at the lettering on the gnomon.

When I had originally looked at it (see Fig. 3), I couldn't think what the "PHY" meant and I thought that the "HOURS" must have been something to do with sundial



Fig. 3. The vertical dial and a close-up of the gnomon.

hours, but I couldn't figure it out. I sent the owner a copy of the photos, but unfortunately she could not shed any light on the gnomon's origins.

I am now of the opinion that the gnomon may have originally been a nameplate for a doctor's surgery or similar as the letters 'PHY' quite possibly stand for 'Physician' and 'HOURS' could well be part of 'Opening Hours' or 'Hours of Business'.

The two dials are probably contemporary with each other, but are earlier than the house which is 19th century. It is quite possible that the vertical dial had its gnomon replaced at the same time that it was mounted on the new house and a doctor's plaque was conveniently re-used for this purpose.

It can be seen from the detail photo, however, that it was not an expert who replaced the gnomon as it has been fitted somewhat too low down on the dial face, as its tip should be at the centre of the small circle on the 6am–6pm line. As

to the dial itself, there are hour lines for 5am and 7pm above the horizontal which of course can never see any shadow. The dial is clearly a direct south dial, but the house wall declines some 14 degrees to the east of south. This is probably another indication that the dial was previously mounted elsewhere. It possibly also confirms that the non-expert who fitted the gnomon may also have fitted the dial to the wall, as an expert would have taken the trouble to cant the dial so that it faced direct south.

REFERENCES and NOTES

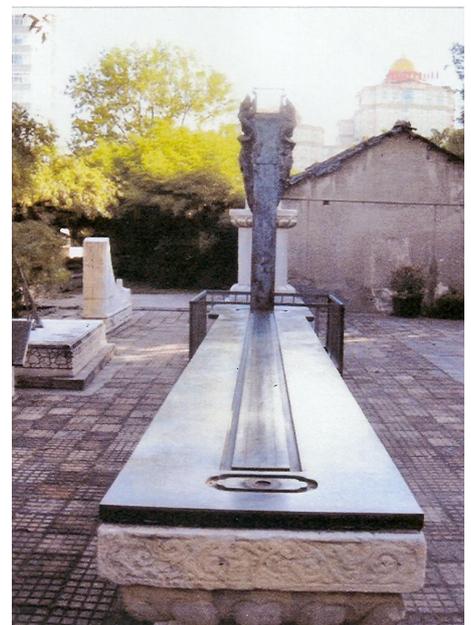
1. Scotlands Garden Scheme is a registered charity created in 1931 which raises funds for other deserving charities by facilitating the opening of gardens of horticultural interest of all sizes throughout Scotland to the public.
2. Andrew Somerville: *The Ancient Sundials of Scotland*, p. 3–D4, Rogers Turner Books, London (1994).
3. J. Davis: 'A Palimpsest Gnomon', *BSS Bull.*, 25(i), 28–29 (March 2013).

For a portrait and CV of the author, see *Bulletin* 23(iv). He can be contacted on dennis.cowan@btinternet.com.

BEIJING SUNDIALS

Our member Maurice Kenn, now residing in Australia, has provided us with some pictures of sundials in China taken by a friend of his. They are reproduced here as an enticement for others to visit and write-up the full history of dialling there.

The pictures here, in the Old Observatory of Beijing, show a 'gnomon' made in 1983 as a copy of one in the Purple Mountain Observatory of Nanking and originally made by the astronomer Guo Shoujing in the Ming Dynasty. It determines the instances of the solstices and the length of the tropical year. Note the similarities with the Gaocheng dial described by Allan Mills (*Bull.*, 24(ii) pp. 2–7, Jun 2012) and the water trough for checking that the scale is truly horizontal.



THE ASTRONOMICAL FUNCTION OF THE MARBLE ZODIAC IN THE FLORENCE BAPTISTRY

SIMONE BARTOLINI and MARCO PIEROZZI

ABSTRACT

The Zodiac in the San Giovanni Baptistry is one of the eight monumental sundials built in Florence, with scientific or celebrative purposes, between the 11th and 18th centuries. It is the oldest sundial, but also the most controversial one as far as its real function is concerned. With the re-discovered astronomical function of the Basilica of San Miniato Zodiac, two new hypotheses are proposed relevant to the Zodiac of the Baptistry. The first one considers the possibility that the marble Zodiac has always been in the place which it occupies today and that there was a mirror just below the cusp hole re-directing the Solstice light beam on the Sun onto the figure inlaid in the centre of the Zodiac. The other hypothesis assumes that the marble has been moved and, originally, it was in the vicinity of the base of the columns in front of the northern door, so that the Solstice light beam coming from the cusp hole hit the inlaid Cancer sign, similar to what happens with the ‘twin’ Zodiac of San Miniato.



Fig. 1. The Baptistry of San Giovanni in Florence, 5th century. (Photo by Stefano Barbolini.)

The study of the marble Zodiac of San Miniato, as presented in the previous paper (*Bull.* 25(i), March 2013) is incomplete without comparison with the earlier Zodiac which can be admired in the Baptistry of San Giovanni in Florence (Fig. 1).

The two Zodiacs almost seem as twins due to their many similarities: maybe they have been designed and subse-

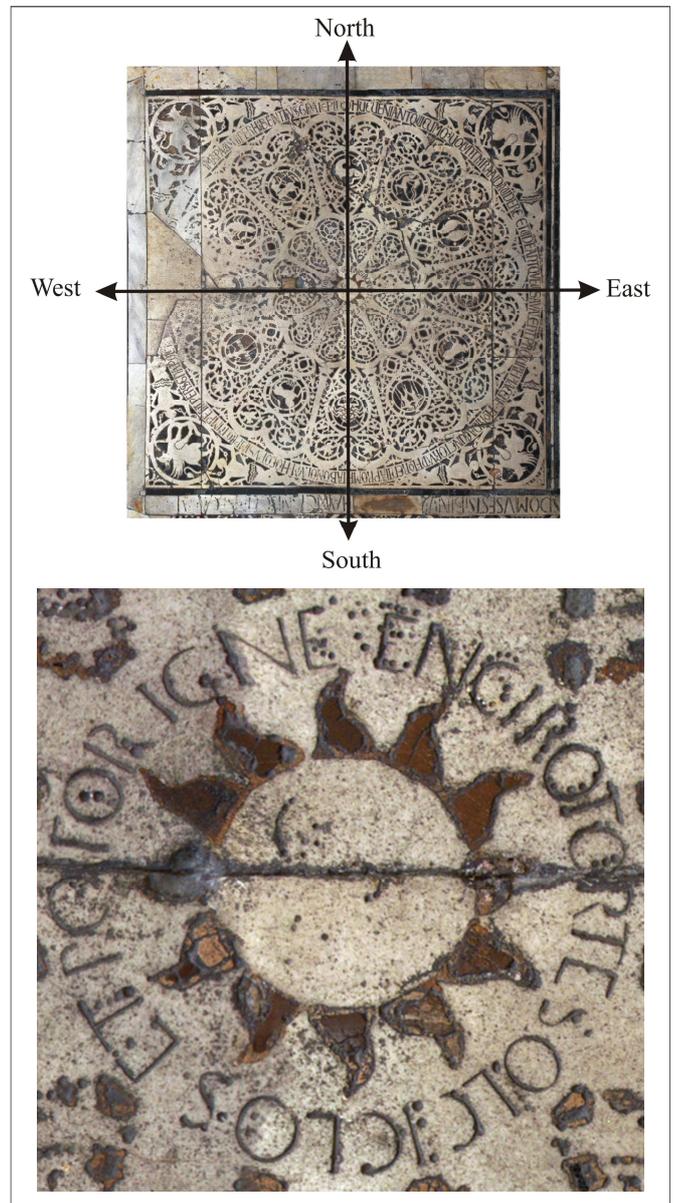


Fig. 2. The Sun sign of the Baptistry Zodiac, 10th century, polychrome inlaid marble, Baptistry of San Giovanni, Florence.

quently made the same artisan's workshop. In any case, the San Miniato Zodiac is not the copy of that in the Baptistry, which appears more refined with its inlays, in spite of its greater wear due to the foot-traffic of numerous Church functions.

At the centre of both the Zodiacs, the Sun is represented within a circle which, for the Baptistry, is described by a famous sentence (Fig. 2):

En giro torte sol ciclos et rotor igne

“I, the Sun, obliquely drive the celestial circles and I have been driven by fire”

It is a solar palindrome, *i.e.* a sentence which reads the same from left to right and *vice-versa*, which seems to recall the apparent motion of the Sun between the Winter and the Summer Solstices.

The Zodiac of the Baptistry is placed in alignment with the Paradise Door, the eastern door in front of the Duomo, oriented with the Aries and Libra signs in the East-West direction and with Capricorn and Cancer signs in the North-South direction. There is no certain information relevant to the period or the designer of the marble Zodiac: the sole hypothesis of a supposed authorship concerns Strozzi Strozzi, an astronomer and astrologist who lived between the 10th and the 11th centuries. This conjecture is due to Leonardo Ximenes: since the burial of Strozzi Strozzi coincides with the place of the zodiacal marble, one is driven to suppose that the Solstice marble is to be attributed to the astronomer who is buried there.¹



Fig. 3. The lantern closing the cusp hole of the Baptistry of San Giovanni in Florence.

Fig. 4. Interior of the dome of the Baptistry of San Giovanni in Florence.

Ximenes also makes reference to the text of Giovanni Villani who, in a paragraph of the *Cronica* (first half of the 14th century), writes:

“E troviamo per antiche ricordanze che la figura del sole intagliata nello ismalto, che dice: EN GIRO TORTE SOL CICLOS ET ROTOR IGNE fu fatta per astronomia; e quando il sole entra nel segno del Cancro, in sul mezzogiorno, in quel luogo luce per lo aperto di sopra ov'è il capannuccio”²

[And we find from ancient memories that the Sun figure, inlayed in the enamel, saying *EN GIRO TORTE SOL CICLOS ET ROTOR IGNE*, was made for astronomy; and when the Sun enters the Cancer sign, around midday, that place is illuminated from the opening in the lantern.]

As a matter of fact, the dome of the Baptistry was originally open, with a central hole through which the sunlight passed; but, according to Villani, the closing lantern of the dome was built in 1150 (Figs 3 and 4), so the Sun rays could no longer enter on 21st of June, to illuminate the inlayed Sun at the centre of the Zodiac.

In another edition (1729) of the Villani's *Cronica*, a sentence is reported which is slightly different: “...e quando il sole entra nel segno del Cancro, in sul mezzogiorno, in quello luce la spera di sopra ove è il capannuccio, et non per altro tempo dell'anno”. [... and when the Sun enters the sign of Cancer, around midday, on that sign the *spera*, up where is the lantern, is enlightened, and at no other time of the year ...] This sentence both clarifies and begs further questions, in fact it turns out to be more precise than the previous one because it says that the light beams entered only on the Summer solstice, but at the same time it is not clear what he was meant by the term “*spera*”. This term had several meanings and it could be used with reference to an opening, a sphere or to a mirror: those three different meanings drive us towards (considerably) different hypotheses.



Fig. 5. Totila destroys the town of Florence, with the painting of the Baptistry without the lantern, 1341–48.

After Giovanni Villani: *Croniche*, Biblioteca Apostolica Vaticana.

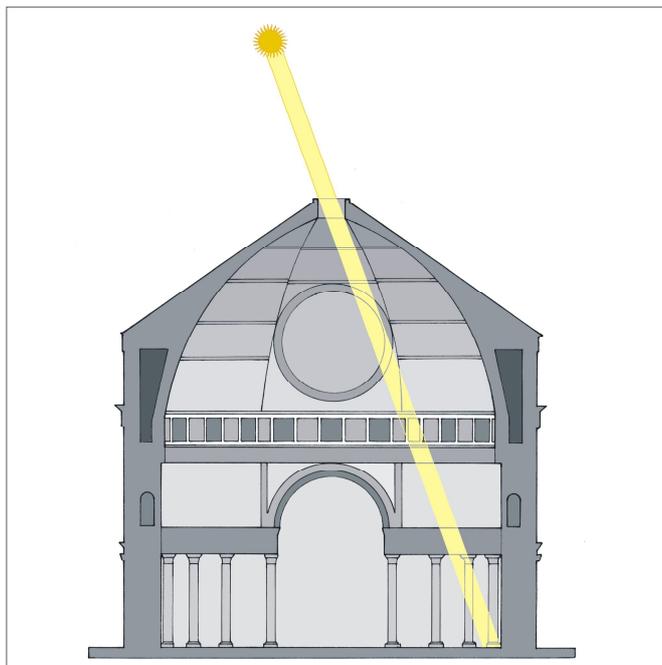


Fig. 6. Cross-section of the Baptistry with the Sun rays which illuminated the pavement before the construction of the lantern.



Fig. 7. The pavement in the interior of the Baptistry and the marble Zodiac in the direction of the Paradise Door, 10th – 13th century, inlaid polychrome marble, Baptistry of San Giovanni, Florence. (Photo: Stefano Barbolini.)

Considering the first meaning of opening, attributed to ‘spera’, as is confirmed by the figure reported in the Villani’s text (Fig. 5), at midday on the Summer solstice the Sun’s rays would fall near the Baptistry’s northern door (Fig. 6). If, instead, we attribute to the term ‘spera’ the meaning of sphere, as was hypothesized by Piero Degl’Innocenti,³ then we instead hypothesize the presence of a sphere at the centre of the cusp hole. Its use was very simple: when the sphere was illuminated by the sunlight, it projected its own shadow on the inlaid Sun at the centre of the Zodiac: that time was the Summer solstice day. As an astronomical instrument it would certainly not be precise, in fact the shadow produced by a sphere from a considerable height over the ground, about 34 metres, turns out to be rather indistinct.

At present, the marble Zodiac is on the pavement corridor which leads to the eastern door (Fig. 7): this position has

led to the hypothesis of a possible move of the marble Zodiac from its original position, which would have happened during the restoration works of the Baptistry carried out in 1351,⁴ or even in 1200 as reported in some documents.⁵

After some computations, using the height of the central hole and with the Sun elevation at midday on the Summer solstice, we have been led to hypothesize the precise position of the marble Zodiac, which should have been placed between the two columns in front of the northern door. Since the side of the square circumscribed to the zodiacal circle is 3.20 metres long, while the distance between the columns’ bases amounts to 2.80 metres, it turns out to be impossible for the marble Zodiac to be placed in this position.

If, instead, we assume the past existence of a plane mirror placed at the centre of the cusp hole, as was hypothesized by Filippo Camerota,⁶ that mirror could receive the Sun rays even with the presence of the lantern, and it could also have the same diameter as the Sun inlaid in the marble Zodiac in such a way that it would have reflected the Sun’s rays exactly to the centre of the Zodiac on the Summer solstice.

The Summer solstice anticipates the celebration of San Giovanni Battista, the Patron Saint of Florence, and in this case the visible manifestation of the astronomical event could be directly related to the imminent religious celebration of which the Florentines were very proud.

A further hypothesis could be suggested regarding the original position of the marble Zodiac, as an alternative to the one proposed by Degl’Innocenti.⁷ The inlaid sun has always been considered as the reference on the Zodiac, used as an indicator of the Summer solstice, but “*quel luogo*” [that place], as written in the Villani’s text, could (in the opinion of the first author (SB)) be referred to the inlaid Cancer sign, previously mentioned in the sentence

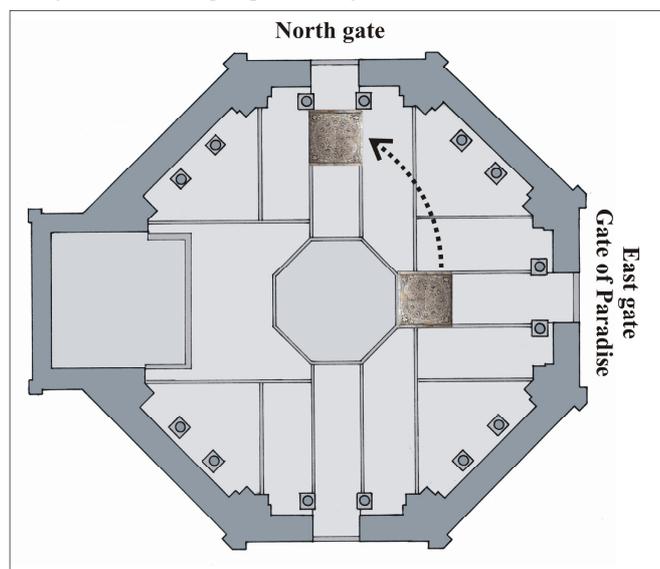


Fig. 8. Plan of the Baptistry with the position of the marble Zodiac in front of the eastern door and the eventual position in front of the northern door.

relevant to the constellation. Such an eventuality causes us to reconsider which was the original position of the marble Zodiac. In fact, if the shadow of the sphere of the light beam coming from the hole hit the Cancer sign, then the whole square of the marble Zodiac could be placed with a side along the base of the columns (Fig. 8): in this case the hypothesis of the displacement of the marble Zodiac is feasible. In order to verify this hypothesis, some measurements and computations have been carried out, which have proven such possibility.

The date of the marble Zodiac of the Baptistry of San Giovanni is uncertain; maybe it already existed at the beginning of the 11th century, as it was hypothesized by Leonardo Ximenes, or it is contemporary with the Zodiac of San Miniato.

Following both these hypotheses, first we have to determine the value of the obliquity of the Ecliptic relevant to the year 1000 and to the year 1200. The obliquity value can be computed using the following formula from modern astronomy:

$$\varepsilon = 23^\circ 26' 21.26'' - 46.84'' \cdot T$$

where T indicates the time (in centuries) starting from 1900. For the year 1000, $T = -9$, from which we get

$$\varepsilon = 23^\circ 33' 25''.$$

Alternatively, for the year 1200, $T = -7$, so we have

$$\varepsilon = 23^\circ 31' 45''.$$

Therefore, at the Summer solstice the Sun elevation at midday was:

$$\begin{aligned} \hat{H}_{\text{Sun}} &= 90^\circ - \Phi + \varepsilon \Rightarrow \hat{H}_{\text{Sun}} = 69^\circ 47' \text{ for the year 1000} \\ &\Rightarrow \hat{H}_{\text{Sun}} = 69^\circ 45' \text{ for the year 1200} \end{aligned}$$

where $\Phi = 43^\circ 46' 23''$ (the latitude of the Baptistry).

With this value and with the height of the hole $h = 33.13$ m (Fig. 9), we compute the distance PC from the vertical of the hole:

$$PC = \frac{h}{\tan(H_{\text{Sun}})}$$

giving 12.20 m for the year 1000 or 12.22 m for the year 1200.

Thus, computations show a difference of just 2 cm in the position of the illuminated disc, which is surely insignificant for an advanced hypothesis. So in the year 1000 or 1200 the cusp hole was producing a light disc, with a diameter of about 1.36 metres, which would have been at a distance of about 12.20–12.22 metres from the foot of the cusp hole (Fig. 9).

Assuming that the square side, in front of the Cancer sign, were ‘touching’ the column bases, we can simulate the position of the light disc with respect to the marble Zodiac and in relation to the sign of Cancer. In Fig. 10 one can check such simulation: the solstice Sun rays would illuminate the inlaid Cancer and the south side of the light disc would be tangential to the sign itself.

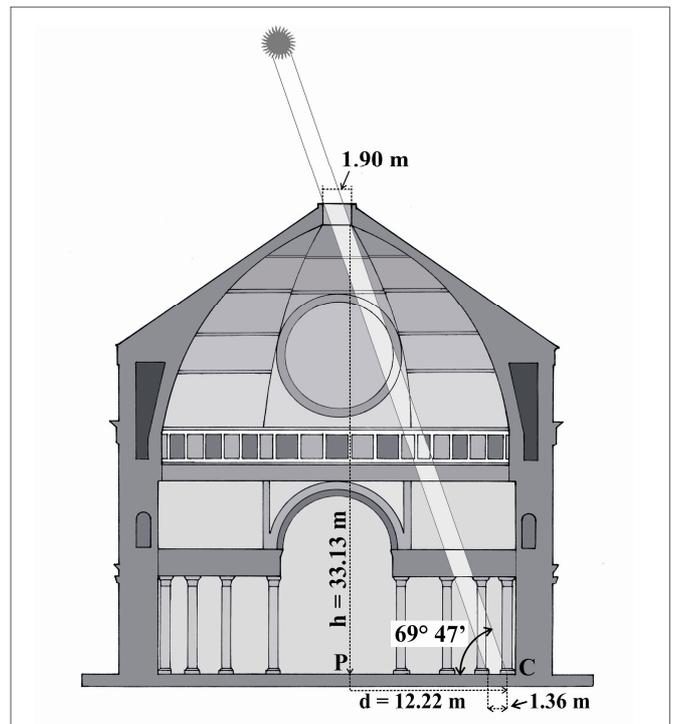


Fig. 9. Cross-section of the Baptistry of San Giovanni in Florence indicating the position of the light disc at midday on the Summer solstice in the year 1200.

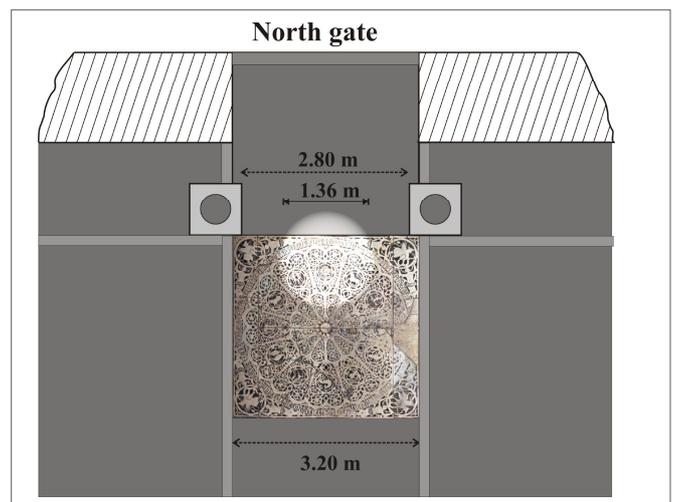


Fig. 10. The hypothetical position of the marble Zodiac in the Florentine Baptistry of San Giovanni with the simulation of the position of the light disc coming from the cusp hole, at midday of the Summer solstice in the year 1200.

In support of this last conjecture, the San Miniato Zodiac can help, as it turns out to be a precise astronomical reference for the Summer solstice, just through the illumination of the inlaid Cancer sign, “when the Sun enters the Cancer sign”, as written by Villani in the *Cronica*.

In conclusion, while the historians agree on the past existence of the opening on the top of the octagonal dome, there is no certainty regarding the astronomical function of the marble Zodiac. Based on the previous considerations, only two of the proposed hypotheses turn out to be possible, *i.e.*:

- the hypothesis which considers the possibility of the past existence of a mirror positioned near to the cusp hole, with the purpose of re-directing the Sunlight at midday on

the Summer solstice towards the inlaid sun, or the Cancer sign, so that the marble Zodiac would never have been moved;

- the hypothesis which assumes the possibility that the marble Zodiac was displaced, and originally it was placed with a square side adjacent to the bases of the columns in front of the northern door, with the Cancer sign in the northern direction. In this case, the Sun beam, or the sphere's shadow, would have hit the Cancer sign inlaid in the marble.

The first hypothesis, if it were confirmed by the discovery of some document reporting it, would move the invention of a great reflection, or catoptric, sundial by almost 700 years; the first known great sundial was realized in the first half of the 17th century, so it would be an important discovery to scientific history.

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 2. F. Villani, *Croniche di Giovanni, Matteo e Filippo Villani*, a cura di G. Aquilecchia, Torino 1979, I, LX.
 3. P. Degl'Innocenti: *Le origini del bel S. Giovanni: da tempio di Marte a Battistero di Firenze*, Firenze, CUSL 1994, p. 157.
 4. This date is reported in the text of L. Strozzi, *Vita di uomini illustri di casa Strozzi*, Salvatore Landi, Firenze 1892, p.5:
- "correndo l'anno 1351, disfacendosi il pavimento del nostro San Giovanni di Firenze, anticamente tempio di Marte, vi si trovò un monumento verso levante, di Strozzo grande astrologo, morto negli anni del Signore MXII, condottiero dell'esercito fiorentino, secondo il soprascritto della pietra". [in the year 1351, while removing the pavement of our San Giovanni in Firenze, formerly a temple dedicated to Mars, a monument was found, in the eastern direction, of the great astrologist Strozzo, who died in the years MXII, leader of the Florentine army.]
5. A cura di F. Camerota, *La linea del Sole – Le grandi meridiane fiorentine*, Firenze, IMSS – Edizioni della Meridiana 2007, p.17.
 6. F. Camerota, Lo specchio solare del Battistero, in S. Barbolini & G. Garofalo, *Le meridiane storiche fiorentine*, Firenze, Polistampa 2011, p.15.
 7. P. Degl'Innocenti: *Le origini del bel S. Giovanni: da tempio di Marte a Battistero di Firenze*, Firenze, CUSL 1994, p. 154.

*Simone Bartolini,
Italian Military Geographic Institute (Florence)
simo.bartolini@tiscali.it*

*Marco Pierozzi,
Italian Navy Hydrographic Institute (Genova)
pierozzi@teletu.it*

For portraits and CVs of the authors, see *Bulletin* 25(i).

Fry's Chocolates "Ancient Sundials" Cards

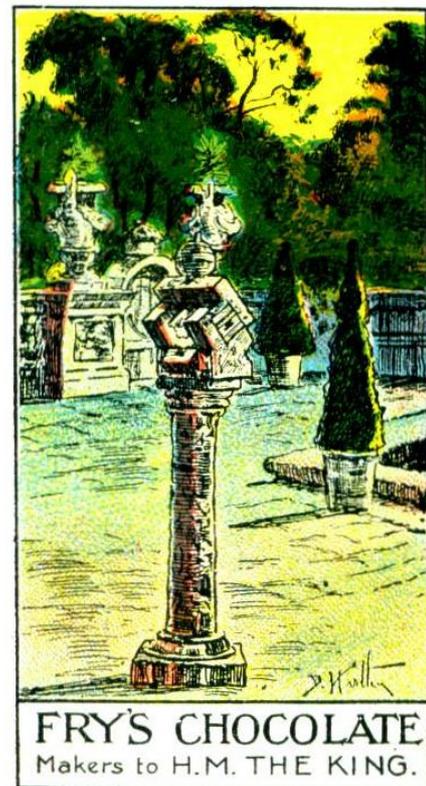
Dotted throughout this issue (and probably future ones!) are reproductions from a set of cards given away by Fry's Chocolates from 1924 to 1927. There were 50 cards in the series called "Ancient Sundials".

A similar set of cards, issued in the same period by Wills Cigarettes, is quite well known and examples were frequently used by the previous editor, Margaret Stanier, to fill gaps in the *Bulletin* layout. These Fry's cards have remained largely unknown and I am indebted to Ian Butson for bringing them to my attention. They are similar to the Wills series but have the advantage of being brightly (garishly?) coloured.

The artwork for the cards again comes from Miss Dorothy Hartley who provided the illustrations for, amongst other publications, Henslow's *Ye Sundial Booke*. She was quite a good observer of dials but they are often shown against totally fictitious backdrops, so beware if you go looking for any of the dials! Please let us know if you know the present location or condition of any of these dials.

As an aside, Ian Butson has been through *Ye Sundial Booke* and listed where many of the dials now are, whether they are recorded in the *Register* and where photographs can be found online. This is an invaluable piece of detective work but there are still dials to be identified and found.

John Davis



Fry's card no. 44 "Cheeseburn, Northumberland". It is clearly a Scottish obelisk type which found its way further south.

ERRATIC NUMERALS

TONY WOOD

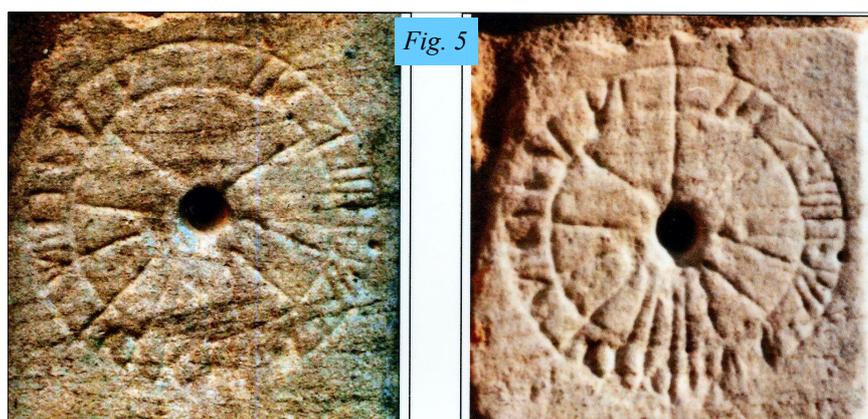
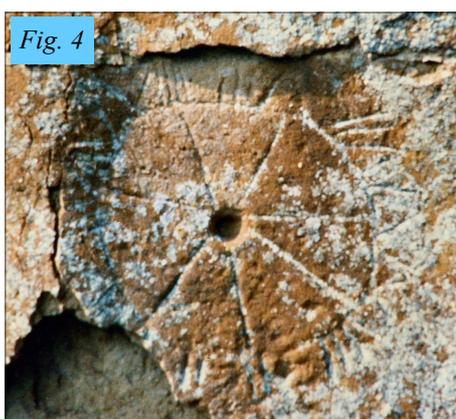
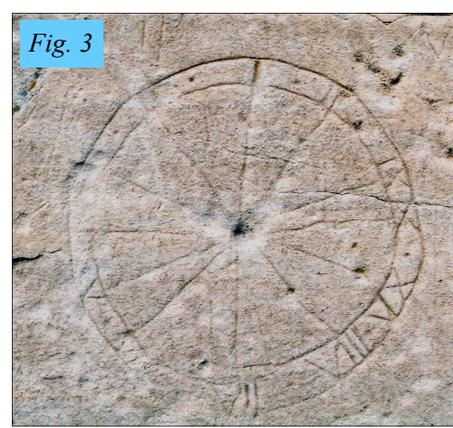
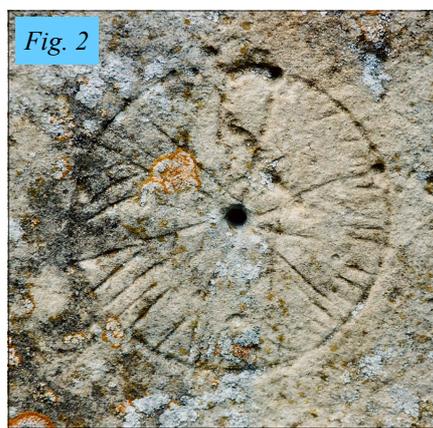
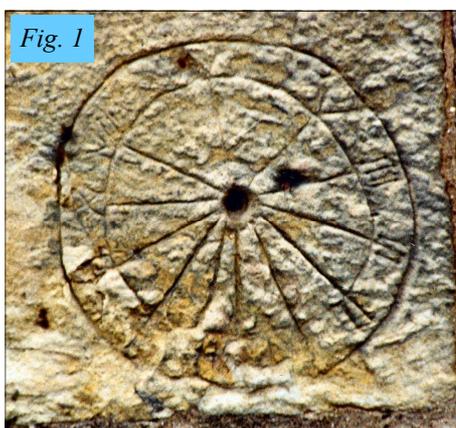
Amongst the mass dials that have been encountered are a certain number with numerals 'round the edge'. A recent Spanish document '*Relojes de Sol canónicos con numeración*'¹ would appear to cover similar dials but in fact there is a difference in that 'numerals' there are also represented by P, T, M, N and V as Prime, Terce, Meridies, Nones and Vespers. So far these have not appeared on any British dial although there are examples in France and Spain.

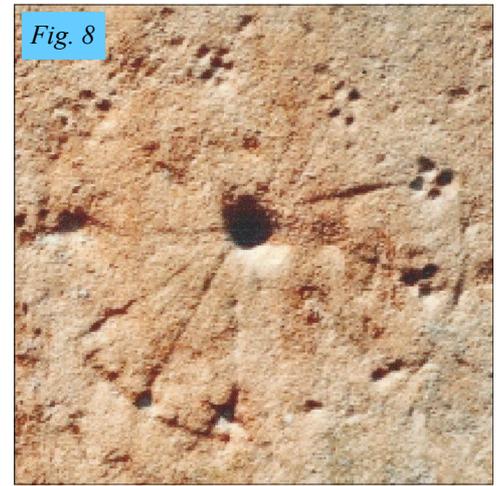
Usually, the numbers indicate a time that would be shown on a vertical dial and indeed such dials are usually regarded as late mass dials where knowledge of 'clock time' or an early inkling of scientific dials is known. In some cases the delineation also implies a knowledge of the scientific dials to come: the term 'transitional' is used and covers quite a few dials of 'in-between' status.

Occasionally, however, we have dials whose numerals are apparently random or not in accordance with sundial usage and so far they have defied interpretation. The term 'erratic numerals' is used to describe such numeration. The dating of such dials is difficult as no obvious 'scientific' influence is apparent and possible clock influence is only apparent in

two examples. The numbers rarely follow any logical sequence and give no meaningful time indication. Tentatively, they are dated as 'earlier' examples rather than later but essentially are a mystery. Currently the following examples have been noted:

1. St Andrew, BAINTON, E Yorkshire (Fig. 1)
II, III, IIII and V read from inside are clearly visible as are VIII and IX but their positioning doesn't accord with any known time indication and, as a vertical dial, lines above the horizontal would be non-operative anyway.
2. St Mary, BISHOPSTONE, nr Swindon, Wiltshire (Fig. 2)
Very roughly marked but with a definite III, IIII, V sequence in the upper right quadrant and X, XI in the lower right quadrant. It looks to be old and again a full circle couldn't be used if mounted vertically.
3. St James the Greater, ASLACKBY, Lincolnshire (Fig. 3)
Two crude circles with what appears to be the numerals I to XII read from outside. They occupy the full circle but some are eroded away. It is not usable as a vertical dial in any way and the irregular division by roughly drawn lines is another mystery.





4. St Ethelreda, HORLEY, Oxfordshire (Fig. 4)

Here is a very crudely engraved dial featuring a rough circle with external numbers, the V on the left read from inside. It is difficult to see a sundial usage being made from this layout.

5. St Peter, COGENHOE, Northamptonshire (Fig. 5)

The full circle is divided into very irregular sectors but numbers appear round the full circumference in a chapter ring and are apparently read from the inside. Again the apparent delineation above the horizontal makes it difficult to see any use as dial if mounted vertically.

6. Old Church, THE LEE, Buckinghamshire (Fig. 6)

Mounted alongside a more conventional mass dial this dial clearly shows the Roman numerals I to XII, read from inside and using IV, IIV, IIV and XI for 6 to 9 and IX, IIX for 11 and 12 (which look correct if viewed from outside). This convention of carving the numerals 'as you go round' persisted into the era of scientific dials and was explained in John Lester's 2006 *Bulletin* item.²

7. St Mary, NORTH LEIGH, Oxfordshire (Fig. 7)

Described as 'a curious dial fitted with a strange modern gnomon',³ the layout is similar to the preceding dial in having a full circle from I to XII with the numerals following the same convention. This is a much better carved dial however and has firm dots between the numbers. The gnomon referred to is placed at mid-radius vertically above the circle centre, is horizontal and casts no meaningful time-telling shadow.

8. St Andrew, BOOTHBY PAGNELL, Lincolnshire (Fig. 8)

This final example is perhaps a precursor to the ones above. Here the numeration is by dots; not unknown but relatively rare on mass dials.⁴ The dots start in the lower right quadrant with sequence 1,2,3,4,5 (not in 'quincunx' form) and 6; after which they become difficult to follow but there is a possible X cross at 'noon' which accords with mass dial (and later, sundial) practice but the upper quadrant layout and numeration show it would not function as any sort of dial.

In summary, the following points are noted. We have a small corpus of 'consistent' dials which apparently would not function satisfactorily in a way we would recognise – and for which we have no explanation. I have proposed the term 'erratic numerals' as an identifying name should further examples appear. Geographically, they would seem to be located in easterly or central parts of England, none being noted in the West Country or Deep South. Needless to say, details of any similar dial would be of interest to the Mass Dial Group and the known dials are currently incorporated into the *Mass Dial Register*.

ACKNOWLEDGEMENTS

Thanks to Ian Butson, Mike Cowham, David Scott, Colin Lindsay, Bob Adams and Andrew James.

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Tony Wood was born in Yorkshire and studied at Imperial College, London. After spending 16 years in the aircraft industry he turned to teaching mathematics. His interest in sundials was sparked by seeing the Borstal Hill dial in Whitstable and finding a mass dial at Westbury-on-Severn. He served on the BSS Council for 7 years and continues to look after the Mass Dial Group. He can be contacted on aowood@soft-data.net



TWO RESTORATIONS OF A SCROLLED GNOMON

MACIEJ LOSE

This article covers the story of two restorations – historical and recent – of a broken gnomon from an early-18th century horizontal sundial by Samuel Saunders, and is intended as a follow-up to the article on this London-based maker and his gnomonic instruments.¹

It is a sorrow to all sundial enthusiasts that gnomons are greatly susceptible to all kinds of damage. Unfortunately, past centuries didn't have a Tony Moss, who recently shared with us his expertise in the construction of everlasting gnomons.² As a result, we far too often encounter historical dials with bent, broken, displaced, lost or replaced gnomons. Thus it is rare to see a horizontal sundial with its original, but historically repaired gnomon: this was in a case of the Samuel Saunders dial (Fig. 1).

scrolled gnomon was broken into two pieces, with five breaking points – two on the scrolls and one on the style (Figs 2 and 3). It must have been subsequently detached from the dial and presumably flattened in the areas where it had been deformed along the fracture. The two parts of the gnomon were joined with six brass plates, placed on either side of the gnomon and tightly fitted by hammering a number of brass pegs through holes previously drilled through the gnomon (Figs 1 and 2).



Fig. 1. Historical repair of the gnomon. Six brass plates join the two broken parts of the gnomon with brass pegs, the heads of which are barely visible due to weathering. The first trapezoid plate is slightly set back from the shadow-casting edge of the style.

Historical Repair

The gnomons of English 18th-century horizontal dials are usually made of cast copper alloys of varied chemical composition, mostly with substantial amounts of zinc (*i.e.*, brasses). The specific composition of the dial or gnomon reflects the source materials available to the maker and technological processes applied.³ Copper-zinc alloys are in general strong materials, but with increasing zinc content the alloy becomes more fragile,⁴ and easily break when dynamic or shearing forces are applied.

The Saunders sundial was made around 1735 and rather early in its history the gnomon sustained damage – interestingly without any noticeable damage on the dial itself. The



Fig. 2. Extreme ecosystem which was revealed between scrolls after removal of the brass plates. Behind the dirt two fractures of the large scroll and one of the style are seen.

Fig. 3. Two broken components of the original gnomon after initial cleaning.

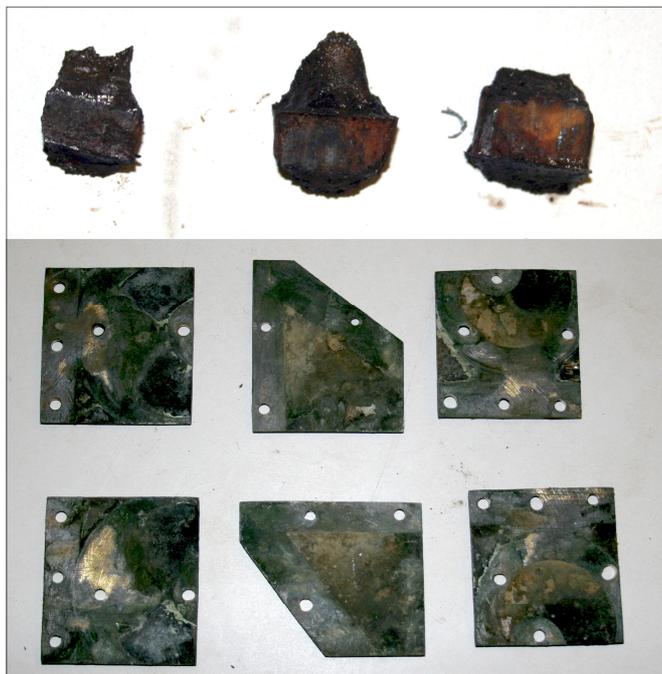


Fig. 4. Small remnants of the three corroded iron wedges (re)used by the historical restorer to lock the repaired gnomon to the dial. Seen below are the gnomon-facing sides of the six brass plates used for the historical repair.

This historical repair of the gnomon, despite its obvious visual awkwardness, brought back time-telling functionality to the sundial. The shadow-casting edges of the style were made straight again, and the gnomon was re-attached to the dial by the repairer with three iron wedges, fitted into gnomon tenons. Small remnants of those almost entirely corroded wedges, as well as the weathering products of the brass plates joining the broken gnomon (all seen in Fig. 4), suggest an early date for the repair.

It is worth noticing that the brass plates used to join the broken parts of the gnomon were slightly set back from the edges of the style, probably on purpose to minimize interference with the shadow. This, as well as the method of attachment and precise re-setting of the gnomon on the dial, indicates that the repair was made by a good craftsman, possibly a sundial maker.

We will never know why it was decided to repair the original broken gnomon – was it easier and more economical to re-use its two broken pieces rather than substitute it with a new, simple one? Or was it that the artistic merit of the original was appreciated and it was deemed worthwhile to preserve it, at least partially, given the limitations of the repairer’s workshop? All in all the original but broken gnomon was preserved behind the brass plates, creating an obligation for future generations to bring its attractive scrolls back to light.

Restoration Doctrines

In any restoration, options have to be carefully considered before any decisions and actions are made on the original fabric. Christopher Daniel, in his interesting article on the

theory and practice of sundial restoration,⁵ gives an accurate summary of some universal ethical and technical problems that should be addressed.

One can think of many approaches to the quite unusual situation of restoration of a historically repaired gnomon. In the most rigorous or pure doctrine one could argue that the historical repair – being part of the dial’s history and evidence of early restoration methods – should be preserved in all its extent and consequently no change to the dial should be made (‘conservation’). It could be argued though that a ‘restoration’ should be conducted, but in such a way that all the alternations are made clear and are visibly distinguished from the original fabric of the gnomon.⁶ Probably the most common conservation philosophy today would advise restoration of the historic form, preferably with least harm to the original fabric.

Each doctrine has its advantages and drawbacks. Of the above, the last option could be regarded as the most difficult to perform successfully, involving the risk of loss of the authenticity of an object if inappropriately performed.⁷

Surely each restoration case is different and unique, so one has to search for an individually adequate solution and find a proper balance, considering the limitations that come from the artifact itself, its cultural value, uniqueness, as well as the available restoration techniques and workmanship.

The author’s view was that the original intention of the maker of this sundial was to merge artistic and time-telling functions in one object. Thus, despite regaining its functionality with the historical repair, its aesthetic component was impaired and it should be restored.

The other objective was to limit the planned interventions and make them discreetly visible, in a way that would not affect the overall historical form of the sundial, and be distinguishable only to a trained eye. The beauty of historical objects, sundials in particular, also come from the different tales they can tell, and in author’s view searching for clues to uncover those complex stories brings more satisfaction than if they were given directly.

Modern Restoration

In the autumn of 2010, with some preliminary thoughts on restoration in mind, the sundial was examined by Mariusz Wierchowski and Marcin Sokolnicki, experts from the Metal Conservation Workshop of the National Museum in Wroclaw. They were rather afraid that removal of the brass plates would open a Pandora’s box, but the wish for an interesting and unusual restoration project prevailed and they agreed to assist. The first step of the restoration was to detach the gnomon from the dial and to remove the six brass plates of the historical repair. This was achieved by drilling through the brass pegs connecting the plates to the gnomon. When the plates were removed, the fracture of the gnomon was uncovered together with aged sediment that had aggregated between the scrolls (Fig. 2).

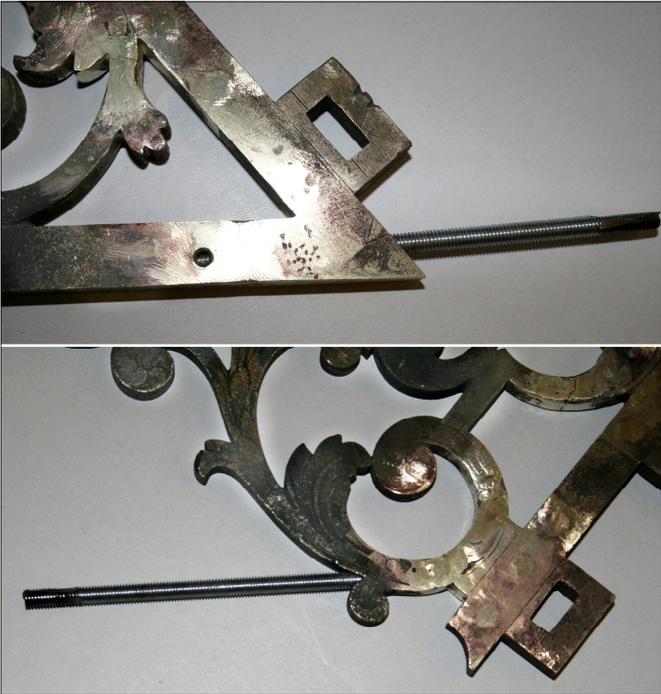


Fig. 5. Threaded stainless steel studs were fitted into the drilled style and smaller scroll to reinforce the gnomon and ensure its rigidity during later steps of the restoration.



Fig. 6. Initial and final stages of repair of the large scroll.

The two parts of the gnomon were cleaned and their match was checked. They fitted quite well; they were not bent and there was no need to flatten the parts.

It was decided that they should be brazed using a brass filler wire colour-matched to the gnomon and with a lower melting point. But beforehand, to ensure rigidity and retain

the proper geometry of the gnomon during brazing, as well as providing general reinforcement, both parts were mechanically joined. The gnomon style and smaller scroll were drilled through from the gnomon foot side and two threaded stainless steel studs were screwed in (Fig. 5).

The next step was brazing. As the heating process unavoidably involves removal of the original patina, it was limited to the area along the break. The operation seemed to be successful at first but, as the gnomon cooled, the internal stress in the metal caused fractures to reappear in the larger of the two broken scrolls. This was the unwanted consequence of the uneven heating.

Several unsuccessful brazing attempts caused some local deformation of the gnomon in the break area of the large scroll and as a last resort a more drastic solution had to be applied. Small portions of the problematic larger scroll were cut off in the area of its two fractures, and it was replaced with four little brass plates on both sides, attached with brass pegs. Fig. 6 shows how crude this looked originally, but subsequent surface filing and some polishing gave an acceptable appearance.

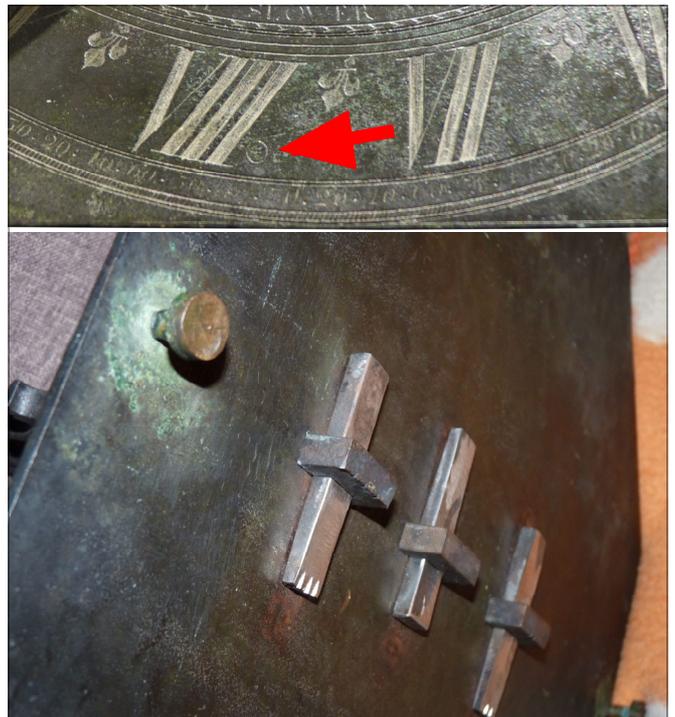


Fig. 7. Four brass pegs with one of the circular feet were originally used to fix the sundial into the mortar bed instead of typical screw-fixing to the pedestal through holes drilled in the dial. Outlines of the heads of these pegs are seen on the upper side of the dial and one is indicated with an arrow on the upper image. The restored gnomon was re-attached with steel wedges, bearing markings complementary to the ones present on the gnomon tenons.

Holes left in the gnomon after removal of the original pegs were filled with new short brass pegs, levelled and ground to the face of the gnomon. It is to be noted that four brass pegs of a similar nature, with additional circular feet, were originally installed by the maker of the sundial to its underside in order to bed it into the mortar on the pedestal. Three



Fig. 8. Restored gnomon after recreation of the engraving and chemically-induced patina.

of these preserved feet and the outlines of the pegs can be seen on the top surface of the dial in Fig. 7. The method applied by the restorers to fill in the holes in the gnomon thus repeated the one that had already been used by Saunders on the dial.

The next step of the restoration was to recreate the engraving to the sides of the scrolls, which had been partially or entirely lost in the areas of intervention, including numerous spots left by the new pegs. This was carried out manually with engraver's burin, based on the photographic documentation of the engraving done prior to the brazing work. Thanks to the experience of the restorers it was successful overall, but the quality of Saunders' engraving proved to be hard to match in some areas.

The last phase of the restoration was to apply a chemical patina to unify the look of the gnomon surface and bring back its aesthetic appeal (Figs 8 and 9). A small tent was built to cover the gnomon and it was left for several weeks together with a dish filled with a weak solution of acetic acid and a second dish of powdered chalk.

The restored gnomon was finally aligned and attached to the dial from the underside with three steel wedges, each marked to match the mark present on the edges of its tenon.

Conclusion

The restoration did not go smoothly – which had been anticipated – and the problems had to be overcome in a way that required more drastic methods than originally planned. Despite the difficulties the final result was better than had been initially expected. With the techniques used, long-term outdoor exposure of the dial is not advised. Therefore it can be concluded that the restoration brought back original sundial's form but as a side effect has partially impaired its function as a time-telling instrument intended to be kept outdoors – another conservation criteria that should have been initially considered, but was not foreseen!



Fig. 9. Sunlit sundial by Samuel Saunders after the second restoration.

Thus, largely unwittingly, we converted the dial into a museum artifact. Fortunately, in its new role it also has a number of educational and aesthetic purposes ...and of course one more story to tell.

ACKNOWLEDGEMENTS

First, I would like to express my gratitude to the unnamed original repairer of the gnomon, whose efforts allowed us to preserve it to our time. I also thank Mariusz Wierchowski and Marcin Sokolnicki from the National Museum in Wroclaw for their experimental restoration, which finally led to success. This report probably wouldn't have seen the light of day if it wasn't for the subtle pressure exerted John Davis and it wouldn't be understood without the help of Michał Goncerzewicz, who polished the translation.

REFERENCES and NOTES

1. M. Lose: 'Samuel Saunders. A Study of a London Sundial Maker – Parts I & II', *Bull BSS* 24(i), p. 2 (2012); *Bull BSS* 24(ii), p. 8 (2012). Part I includes a description of the Samuel Saunders horizontal sundial, referred to as "HD2"), which is therefore omitted here.
2. T. Moss: 'Secure fixings and fastenings for sundials', *Bull. BSS* 24(iv), p. 42 (2012).
3. J. Davis, T. M. Brown & I. Brightmer: 'Brass or Bronze', *Bull. BSS* 19(ii), p. 50 (2007).
4. S. Prowans: *Materialoznawstwo*, Warszawa-Poznań (1977).
5. C. Daniel: 'Conservation. The restoration of sundials, some necessary questions' *Bull. BSS* 98,2 p.26 (1998).
6. A good example of this restoration approach is the gnomon replacement of the 19th century sundial by Stephen Bithray in the Sam Waller Museum, which follows shape of the original but is made of glass. It can be viewed at: www.samwallermuseum.ca/feature/?id=7
7. An historically common practice to revive old sundials with faded, weathered detail was to re-engage them. Today's conservation doctrine would regard such practice as dissolution of the original character and authenticity of the dial.

For a portrait of the author, see *BSS Bulletin* 24(i), March 2012. He can be contacted at mlose@interia.pl.

A TRANS-ATLANTIC SUNDIAL FROM A HOLLANDAISE SOURCE

TONY MOSS

[This article is similar to one which appears in the *NASS Compendium* (and an online version¹). Normally, the *Bulletin* and *Compendium* editors avoid reproducing each others' articles as the two societies share a good number of members. In this case, though, it was jointly decided to publish on both sides of the Atlantic as the story of the dial belongs to both countries. Ed.]

This article is based on a PowerPoint presentation given to the BSS at the Edinburgh Conference in April 2013. The story of my involvement began at the NASS Burlington, Vermont Conference in 2010 when I spent some time with other NASS members at the home of Bill Gottesman. I always enjoy visits to the workshops of other dial makers and Bill was keen to show us what he does and the specialist items of equipment he uses. As a one-time maker of keyboard instruments, mechanical music has always been a parallel interest of mine so I was very intrigued by his Mason & Hamlin 'player' piano working from pierced paper rolls.



Fig. 2. Samuel Holland (1728–1802), Surveyor General to George IV.

but this was not the case. The dial, originally commissioned by one Samuel Holland for Dartmouth College in its location at Hanover in New Hampshire, was to be reproduced for Holland College on Prince Edward Island in Canada. The latter college takes its name from Samuel Holland (Fig. 2) who, in his capacity of Surveyor to King George III for the then-British lands of North America, had made the original survey of the island. Direct descendants of Samuel Holland still live there.

Retired or not, what dial maker could resist the temptation to make an accurate record of a large London-made dial of 1773 by Heath & Wing? Immediately we set to work with measuring tape, hastily-sourced talcum powder and my digital camera to record the finest details of the delineation, engraved text and the beautifully hand-engraved ornamental features (Fig. 3). Rich and Frank provided their own close-up images of the dial but stressed that they were strictly the copyright of Dartmouth College. Later on I was given permission to use these images for a one-off educational production.

Just how the above situation came about is a complex sequence of serendipity and chance. Holland College on Prince Edward Island in the Canadian Gulf of St. Lawrence is a modern educational establishment with a newly-completed Science & Technology development built around an area of lawns and footpaths. In the architect's first proposals there was to be a large central flower bed. Michael O'Grady, Vice President, envisioned something more interesting as a central focal point to bring students and staff together with an educational/social purpose. Quite what led him to imagining a sundial centrepiece I do not know but serendipitous chance gave rise to a remarkable



Fig. 1. Rich Kremer (left) and Frank Manasek with Dartmouth College's prized Heath & Wing sundial plate.

Towards the end of the visit two men arrived bringing a fine antique bronze dial plate devoid of its gnomon (Fig. 1). Prof Richard ('Rich') Kremer and Dr Frank Manasek were introduced as coming from Dartmouth College in New Hampshire. At first I thought they intended to display the dial at the NASS Conference but it soon became evident that their very short stay was to allow me to record any details necessary for a reproduction. As a recently *retired* commercial dial maker this was 'news to me' as I had no previous contact with this project. My first thoughts were that the copied sundial was for the owners of the original



Fig. 3. The original Dartmouth Heath & Wing dial plate, covered in talc to highlight the engraving. A reproduction gnomon is normally fitted to the dial.

Fig. 4 (below left). The signature on the dial.



Fig. 5. The Dartmouth dial without talc showing the inelegant scroll ends.



coincidence. On Googling for ‘Samuel Holland’ and ‘Sundial’ he was led to Dartmouth College where a sundial bearing Holland’s name is a much-prized item in the college’s museum collection.

Did this dial still exist and would permission be granted to make a suitable reproduction for the proposed Holland college centrepiece? Following consultation with Dartmouth authorities it was decided that a single version of the dial could be made but the question then arose, who could be found to make it? Holland College had previously consulted Geoff Lock of *Colonial Instruments* in Ohio about historic items in their collection. As his company name implies Geoff makes wonderfully accurate versions of surveying instruments *etc* from British colonial days. His products are true *replicas* which employ distressed lacquer work, patination and evidence suggesting years of use and handling. By a remarkable chance I had been in touch with

Geoff some years previously via Jim Morrison, a well-known authority on astrolabes in the USA. Geoff and I had compared notes and images on a mariners’ astrolabe he had in hand and one that I had recently completed. When asked by Holland College if he would attempt a hand-engraved replica of the Heath and Wing dial he wisely passed the task on to me. What took me six weeks by computer tracing and photo-etching would have taken him many months, if not years, by hand with a burin.

Before starting work on the dial it was agreed that I should retain an error made by the dial’s original creator in the compass rose *viz* the sequence E–ESE–SE–SSW. Oh Dear! I’d love to have been a ‘fly-on-the-wall’ when that blunder was discovered. Hand engraving of the dial is of the highest standard with the exception of the terminating scrolls on the chapter ring and the equation of time which are not even symmetrically executed or located. These inelegant items (Figs 4 and 5) appear to be by a different hand which I suggested might have been that of an apprentice learning his craft. My request to substitute neater alternatives was accepted.

At this stage, I was glad that a length of metric rule had been incorporated in my photographs as there were many concentric and eccentric circles to be laid out in Adobe *Illustrator* on my iMac. Revised delineation for the latitude of Holland College at 46° 41' N was essential as Dartmouth College is almost 5° apart in latitude at 41° 47' N. An especially challenging task was the layout of a part-circular

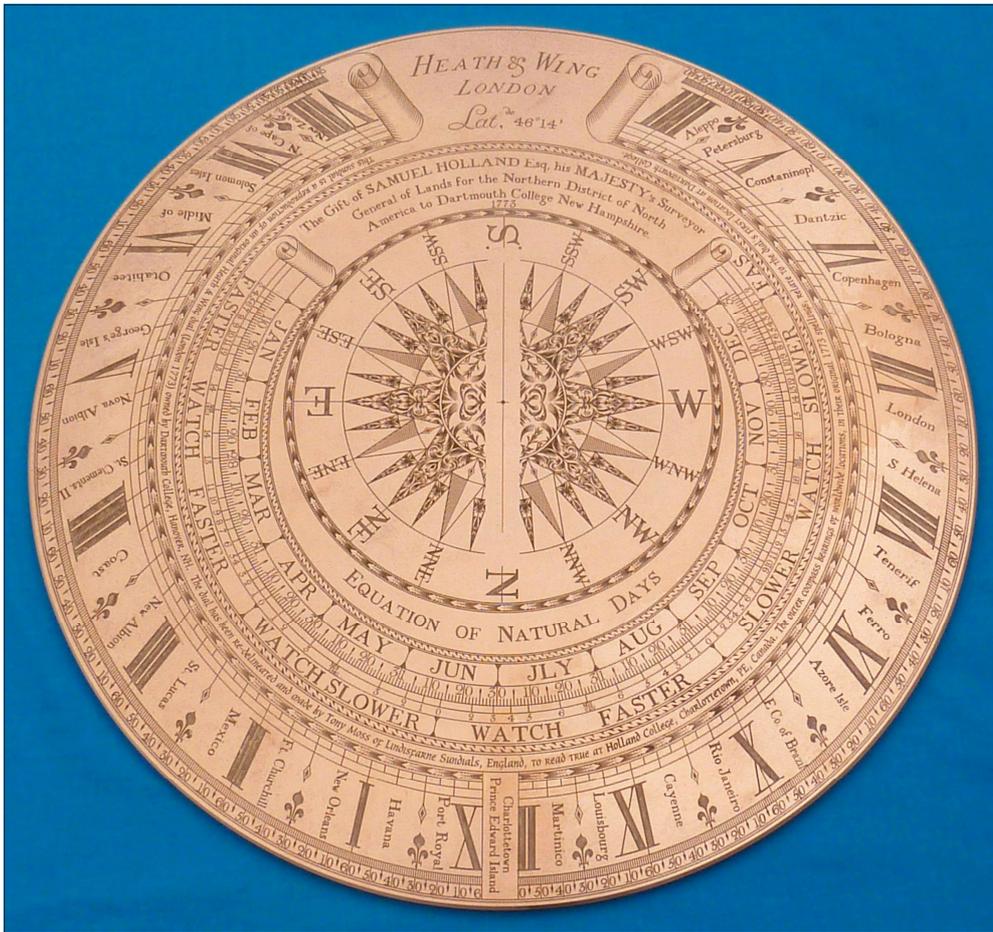


Fig. 6. The Holland College dial plate, as etched. The inscription, copied from the original, reads:

“The Gift of SAMUEL HOLLAND Esq. his MAJESTY’s Surveyor General of Lands for the Northern District of North America to Dartmouth College New Hampshire”

Note the intentional error of the ‘SSW’ on the eastern side of the compass rose and the improved scrolls.

equation of time scale covering 244° but the *Illustrator* facility to draw ‘stars’ with unlimited points and an inner radius of zero solved the problem. Division into 365 days was easy but the offsets for the EoT and its numerals took many careful hours. Skewed roman numerals and fleur-de-lis for the half hours were straightforward in *Illustrator*, although not quick, but the skewed minute numerals at the outer edge were a lengthy and painstaking task. My aim in such cases is to simulate the irregularities of hand engraving as closely as possible or the finished result looks *mechanical*. With repeated items such as ornamental bands of *feathering* I alternate several elements each of which differs slightly.

Perhaps the most daunting task was reproduction of the lengthy hand-engraved inscriptions. Any attempt to use standard computer fonts would look woodenly anachronistic but the prospect of hand tracing each letter by hand/mouse was not to be considered. *Your Fonts* to the rescue! This service can be found on the internet² and begins with two downloaded A4 grids. Each grid square is for an upper/lower case letter, numeral or symbol: there is even one for your signature. Traced examples of the original Heath & Wing lettering were placed in their relevant grid square and emailed to *Your Fonts*. Within minutes a TrueType font sample was emailed to me and, after an online payment of £10, this was loaded into my iMac and I was *typing* in Heath & Wing text. As an interesting spin-off I can now ‘type’ in my own handwriting.

The elegant compass rose has eight main *petals* in two different sets of four, alternating at 45° intervals (see Fig. 6). Thanks to Adobe *Illustrator* only one side of each petal was hand-traced with the mouse before ‘flipping’ to complete it. A series of 90° rotations, *grouping* then further rotations and the compass rose, which took the original hand engraver many days/weeks of exacting work, was completed in a day or two. In line with the tradition at that time, the dial is surrounded by equivalent times of solar noon at various local and exotic locations in the quaint spellings of the day. These were reproduced without any alteration to suit the new dial’s location so I hope no traveller sets his watch en-route for *Tenorif*, *Ferro*, *Dantzic* or *Nova Albion* based on these indicated times. In a narrow concentric band the only modern addition to the dial inscriptions reads:

“This sundial is a reproduction of an original Heath & Wing dial (London 1773) owned by Dartmouth College, Hanover, NH. The dial has been re-delineated and made by Tony Moss, Lindisfarne Sundials, England, to read true at Holland College, Charlottetown, PE, Canada. The outer compass bearings of worldwide locations, in their original 1773 spellings, relate to the dial’s first location at Dartmouth College.”

In addition the noon gap is inscribed “*Charlottetown Prince Edward Island*”.

The dial plate was photo-etched 0.5mm deep onto a 445mm diameter plate of 6mm PB102 phosphor bronze by a process I have described several times in print and on YouTube.³



Fig. 7. The completed dial, before shipping.

Fig. 8 (below). The dial fitted on its brick and granite pedestal, being opened by Michael O'Grady, George Dalton (in period costume, a direct descendant of Samuel Holland) and Rich Kremer.



Fig. 9. The dial in its setting in front of the newly-completed Science & Technology building at Holland College, Prince Edward Island, Canada.



The gnomon was water-jet cut from a 16mm thick slab of PB102 before fine milling and hand finishing to profile with an extra-long tenon protruding through the plate and deep into the pedestal masonry for security. Taper pins of stainless steel and PB102 on the underside of the plate were used to secure the gnomon. The PB102 items were a back-up against any possibility of galvanic corrosion.⁴ Six securing bolts were threaded from the underside of the plate near to the rim. Their rounded tips were set flush with the upper surface and intended to visually dissuade would-be thieves from a fruitless attempt at removal.⁵

The completed dial (Fig. 7) was despatched by a major international courier but, due to muddled paperwork (theirs), it was lost en-route to the USA. Sent back to the UK, it then crossed the Atlantic for a third time before finally arriving weeks late but in time for a simple inauguration (Fig. 8). Fig. 9 shows the dial in its permanent location. Some weeks later I was informed that the sundial had been selected for a *Charlottetown Annual Heritage Award*. While the local press announcement listed all its Canadian *history* the source of the reproduced instrument got no mention.

REFERENCES and NOTES

1. For a version of the story on the NASS website, see <http://www.sundials.org/index.php/features/205>.
2. www.yourfonts.com.
3. For videos of photo-etching see www.youtube.com/watch?v=ML37yRmAsOA and www.youtube.com/watch?v=PAW0q6i7aqq.
4. For galvanic corrosion, see http://en.wikipedia.org/wiki/Galvanic_corrosion.
5. For images of the dial retention and packaging, see Tony Moss: 'Secure Fixings and fastenings for sundials', *BSS Bull.*, 24(iv), 42-45 (Dec 2012), Figs 15 & 16.

For a portrait and short biography of Tony Moss, see *Bulletin* 24(iv), Dec 2012. He can be contacted at lindisun189@gmail.com.

BSS Conference, Edinburgh, 5–7 April 2013

Alastair Hunter

Friday 5 April

Following the coldest March for fifty years and a week of April which was little warmer, when people had left home with snow falling, it was a relief to see blue skies and sunshine in Edinburgh at least for some parts of the weekend. But all this was forgotten as warmth and comfort and attention to detail quickly became the binding threads that made this year's meeting at the University of Edinburgh's conference campus so enjoyable. From the bulging conference packs, colour coded for everything from topics to visits to menu choices, to squadrons of waiters serving dinner so precisely they might have learned their skills from synchro swimming at the international pool next door, the whole event ran smoothly like clockwork. Chris Lusby Taylor was the sundial master who had set the clocks—many congratulations were offered to him.

After Dinner Session: Makers on their new sundials

BSS Chairman Frank King, on the dot of 8pm, stood up to say greetings and welcome with grace and humour—we were now convened. Chris took over as Chair for the opening session on 'Makers and their new sundials', and everyone relaxed happily in their seats around the dinner tables.

David Brown: 'Making a slate sundial'. David spoke of the essential spark of inspiration and the tremendous amount of toil and sweat that goes into a new sundial in slate. He described a presentation dial for a colleague's retirement. Not only was this to be an octagonal dial with references to the life's work of the recipient but it would be engraved with lettering on the edges as well as on the slate's top surface. No wonder there was sweat! David said little of his own



acquired experience and skill though his description of all the stages of sawing, coating, wetting, grinding, scribing, gouging, lettering and finally installing made that very clear. And, he explained, dark slate does show a sharp shadow!

Tim Chalk: 'Sculptural sundials in modern materials'. Tim took us quietly by the hand and led us into his own world of representing art and understanding. His work as a sculptor draws inspiration from place and time, finds imagery in poetry and writings, and makes use of many different modern materials. Tim finds that sundials are unusual and exciting—he can sculpt with sunlight, shape with shadows and juxtapose ideas of time as order or chaos. His work appears in a Caithness museum, and at the birthplace of Robert Burns. Not only has he found the public can accept the idea of sundials more easily than some sculpture, but he has innovated. His equatorial dial becomes see-through with glass and will tilt for latitude. Corten steel on rocky flint drew a gasp of admiration.



Alastair Hunter: 'It takes a little time'. Alastair gains terrific knowledge from BSS, he said, which he uses in new designs for his sundials. Very often he reads something that will spark off an idea and then he tries to turn it into what will work and can be made. He believes he's on his way into a sundials business but learning where is best for exhibiting the dials and which designs are most appealing to the public just takes a little time. He has created a new universal sundial using the ancient equinoctial ring and the



once popular portable horizontal instrument. It looks attractive and goes on show this summer.

Martin Jenkins: 'A Cooke-type heliochronometer'. Martin described a remarkable type of heliochronometer which he has re-created in his own workshop. The original was patented by



William Ernest Cooke, government astronomer in New South Wales, Australia, and astronomy professor at Sydney University. It won a Gold Medal at the

British Empire exhibition of 1924. Not only does the instrument have a mechanism for indicating mean time, but it reads out on a clock dial face with hour and minute hands. Martin has completed Mk II of his own instrument after 300 hours of work—Mk III with a second hand is contemplated, and Mk IV might become a wristwatch!

Fred Sawyer: 'Projected refraction sundials with ambigram'. Fred Sawyer capped the conference evening with such a novel development that Isaac Newton's light rays combined with Dan Brown's script flips, were only two of the essential elements in making it happen. This was hour and declination lines meet refraction and projection then curl up small and creep along sideways. Reading a motto inside out and upside down (an ambigram), considerations from a younger Sawyer family member on Horace's Latin (*Carpe Diem*), two words



split so only one is visible unless the sun shines—all have gone into this new creation. And there's more than one, he's created others!

Saturday 6 April

Kevin Karney: 'Competition! The place in history of sundials in context with other timekeepers'.

We needed to be awake for this one: "Competition!" Kevin Karney swept us through three thousand years of man's puzzling over the wonderful question, "What is time?" If only we knew: there is time divided into moments, time passing, the tick of time, when it will be time, now is the time. There is finding time and keeping time, equal and unequal time, time by sun and skies and time within the atom. Kevin's giant canvas was painted with stars for navigating by, shadows for judging time of day, water flowing into vessels or running away, flame burning down a candle, bells sounding, sand as timer and metaphor for mortality, and clocks. Ah, clocks, clocks to sound out the hour, Galileo creating the first clock with a pendulum, improvements to the clock escapement, mass production in the industrial age, and clock time carried home from city to country by chronometer. Yes, our sundials have their competition!



Frank King: 'Francesco Bianchini, a study in fuzz (or what John Heilbron didn't tell you)'.

Ever the imaginative sleuth, Frank King went on the trail of "Fuzz". Not of the policeman kind, he explained, but of the blurred image in sunlight projected onto the floor of the basilica of Santa Maria degli Angeli e dei Martiri in Rome. Here lies the giant meridian line of 1701 inlaid in brass, which was calibrated for measuring the precise instant of the equinox. Frank's question was how had it been calibrated and how had the measurements been made when the projected sun image was not sharp but blurred, not round nor truly elliptical but deformed, hard to observe by eye because of



tricks of the light, and of course not fixed but moving all the time. Armed with his own prior analyses, his series of cardboard templates and two straight-edge rules, Frank had gone to Rome, knelt on the floor of the church while the sun shone in, and rediscovered forgotten techniques of three hundred years before.

Tony Moss: 'A transatlantic sundial from Hollandais source'.

Tony Moss had one of his appalling puns in his title. It turned out that Samuel Holland had been King's Surveyor in North America. In 1773 he had had a sundial made in London which he presented in America to the English School. In around 2011, to Tony's complete surprise, he was asked to make a reproduction of the original dial, which had become the property of Dartmouth College, USA. His dial was to be installed at the new buildings of Holland College, Prince Edward Island, Canada. In his hugely competent style, Tony set about working out how to convert the design to a different latitude, copy the original lettering using modern font printing, and engineer a robust Tyneside dial for the other side of the Atlantic on the St Lawrence Seaway. [See p. 48 for the full story.]



Dennis Cowan: 'In the footsteps of Thomas Ross'.

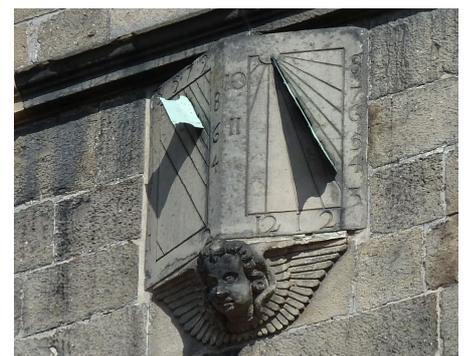
Our resident Scottish photo hobbyist, Dennis Cowan, whose joy is



taking the most beautiful pictures of sundials in endless and extraordinary places, explained to us what had set him on this path. In 1890, Thomas Ross, architect, had compiled descriptions of sundials in Scotland, and much more recently, by coincidence 100 years later in 1990, the late Andrew Somerville had done the same. Dennis has been following in these footsteps and he amused, pleased and amazed us with what he had learned and seen. Virtual reality is nothing new, he discovered. Far away from her true home in Renfrewshire, the lady of Lethington Castle, supporting one of the most beautiful of all dials above her head, had levitated herself into Lennoxlove, East Lothian. And the heaviest of stone cube dials on an impossibly slender metal arch stood outside The Robin's Nest, the favourite pub of his youth!



Pictures of the tour, in the courtyard of George Heriot's School with its many pairs of elegant declining dials.



After the BSS council discussion session [reported elsewhere] and Bill Visick's expert demonstration of some proposed elements of the new website, we had a simple but good lunch before the tour of Edinburgh and its dials.

George Heriot's School. Founded on the immense wealth of the goldsmith and jeweller to King James I (& VI), this building has eight twin dials high up on its four outer walls, and a further three twin dials on its inner walls overlooking the courtyard. In full sunshine, this gave us the perfect setting for the grand conference photo. Moving then to the junior school, for infants upwards, the most massive stone multi-facet sundial cube [probably the boss of an obelisk dial, Ed.] sat on the ground outside the classrooms. Could this be a tetraplethora-scaphe-hedron—the children would know!

Joseph Williamson's 1728 horizontal dial for Aberdeen—clearly on display in the NMS and with a wealth of interesting furniture.



Left: the polyhedral dial at Holyrood House.



Above: The unusual polyhedral dial at Huntly House with its applied brass (or copper?) faces.



The assembled BSS group in the courtyard of George Heriot's School, under on of many pairs of declining dials.

C. Lusby Taylor



National Museum of Scotland. On the wall of the National Museum of Scotland, Mark Lennox-Boyd's declining dial is carved in stone, and within the building there are many more delights. The collection of Scottish dials, a double horizontal dial by Henry Sutton, the oldest signed and dated European astrolabe, a millennium clock, the chronophage with a grasshopper... the list goes on. At this point, the party split for those who wished to remain in the museum, and others who preferred to walk down the Royal Mile.

Huntly House Museum on the Canon-gate. Our intrepid conference organiser had negotiated privileged entry to the private courtyard, to see the most unusual polyhedral dial there. Further down the hill at Holyrood Palace he had done the same, to view the monumental icosahedral dial made for the Scottish coronation of King Charles I. Meanwhile, your reporter had skipped back to the conference room to study the exhibits. As usual, there was much to see. Martin Jenkins displayed his exquisite Mk II heliochronometer and David Brown had a show of sundials he had done, plus a magnificent double horizontal dial in



Left top: Martin Jenkins' excellent heliochronometer.

Left bottom: Val and Mike Cowham receive Margey Lovatt's hand-cut bowl as a thank-you for all their Safari companions.

Left: the Conference Dinner in the magnificent surroundings of the Playfair

Library. In the top picture, Fiona Vincent and Roger Stapleton (on home territory!) together with Jill Wilson and Chris Daniel.



Sunday 7 April

Frank Evans: '**Conservation of an 18th century dial on a church**'. Frank Evans was nothing if not frank with us. He modestly proclaimed that his subject, conservation work on an 18th-century dial on a church, was one on which he knew nothing when he started and his advancement during progress of the work had been minute! However, he did explain that there were many dials on churches in the Northumberland and



slate [an article is anticipated!]. Arthur Newton showed his novel light slit polar dial. Scrapbooks, printed books and sundial ephemera were displayed by Jackie Jones, Dennis Cowan, David Payne, Mike Cowham and John Davis (who also had a collection of excavated sundial oddments). Tony Moss excelled in sundial paraphernalia but called it surplus disposal stock! Elspeth Hill brought an extensive collection of antiquarian and modern books and literature, including BSS materials, for sale – a long drive with a lot of material. A lot of the Rogers Turner stock was offered at much reduced prices following the death of Phil Rogers, though Anthony Turner will continue the Paris end of the business.

Saturday evening brought the BSS gala dinner held in the magnificent Playfair Library of Edinburgh University's Old College. Architect William Playfair designed much of Edinburgh's neo-classical New Town. Dinner was excellent, wine circulated, toasts were toasted and well earned. Mike and Val Cowham received special appreciation and a presentation for organising six enjoyable sundial safaris at home and across Europe. Members had commissioned a beautiful Orrefors crystal bowl for them, beautifully engraved by Margey Lovatt.

Tyneside areas, and in county Durham, where crumbling stonework around a dial and in the fabric of the dial itself could be beneficially restored. One dial in the area was possibly the oldest in the country, predating the Bewcastle Cross in Cumbria. Expert work by a stonemason from York on several of these dials, using lime mortar and modern knowledge, had transformed their appearance and potential life.

John Davis: 'Robert Spurrell's calendrical dials'. John also delved into the 18th century. He was intrigued by details he had found of a calendrical dial, not least because Spurrell the maker was unknown. Now that fingertip access to information, and instant contact with individuals, has become routinely possible in the last twenty years, John was able to learn more than he expected. Jill Wilson's initial contact with a dial-owning acquaintance led eventually to Bath,

where there was a reference to a Robert Spurrell discussing chronology and the calendar in the Bath Natural History & Antiquarian Proceedings. It turned out



Spurrell was a schoolmaster in the early 1700s who had made several dials. An incredibly lucky find produced one that was in an attic, complete including its full set of volvelles, with detailed calendrical information. John is now working to decode it.

Fred Sawyer: 'An excursion in nomography'. Fred showed his true colours in tutoring us about nomography—doing sums on a graph by drawing lines. What got him started was a quadrant Mike Cowham had showed him, which Mike wanted to understand. Fifteen minutes later, Fred had found the answer: it was a universal altitude sundial quadrant. Fred knew because Samuel Foster, professor of astronomy at Gresham College, had written it down in 1638. The fact that Foster went on to solve the spherical triangle using the prosthaphaeretical arc(!) may explain why, at least every century, everyone forgot the details until someone new came up with the solution again and thought they were the very first to discover it. Not to be outdone, of course, Fred has created beautiful new sundial nomograms of his own, which he showed us.

Doug Bateman: 'Mobile apps for the sundialist'. Doug slipped in a word about a talented Russian sculptor friend, Valery Dmitriev, who has a proposal for an impressive Romeo & Juliet sculpture sundial [see p. 12]. Jill Wilson has been sounding out possibilities for a commission for placing it at Stratford. Is there someone who would take this project



on, Doug asked...? The iPad and the App are now everywhere and seem to do almost anything you can imagine, as Doug demonstrated for us on his screen—the Sundial linked to GPS; the Analemma with animation; the Sungraph showing worldwide daylight; the Sunseeker showing light and shade; the Sol-Cal for all sun time calculations; the Clinometer for angles; the Planets and the Observatory for astronomy; and finally the Orrery.

Alastair Hunter: 'The Duncraggan stone'. Sometimes when talking about the past, words

are a gift for catching attention, like 'The Duncraggan Stone'. As Alastair Hunter said, the very name inspires imagination about mysterious events. The stone was small and lettered as a sundial, with 1666 apparently the date, but it was found in rubble at such a wild and lonely place that there were immediate questions: where had it come from, was it really old, should it be restored? Contradictions started to appear: it was recognisable stone from a quarry at Dundee, not anywhere near Duncraggan, and its hour lines belonged to a latitude far away to the south not even near to Scotland. It appears that school lessons on sundials had been followed up at home but had gone rather wrong. Today, the sundial is restored for its owner.



The Andrew Somerville Memorial Lecture. Tony Freeth: 'The Antikythera Mechanism'. In presenting the Andrew Somerville Memorial Lecture, Tony spoke not only of voyaging in discovery to new landscapes but seeing with new eyes. This borrowed quotation was entirely apt for what he was to reveal and explain of The Antikythera Mechanism. Tony has been at the heart of the recent multi-nation, multi-discipline team convened in Athens to try to finally understand all of the purpose and workings of this ancient and extraordinary geared device. It probably dates from 200-100 BC, the Hellenistic era, and it drew on the minutely detailed astronomical observations recorded by the Babylonians for hundreds of years before then. The



modern world only discovered the device when divers found it in a wreck off the coast of Sicily in 1900. There are 82 sea-encrusted fragments to examine and for a century successive archaeologists, scientists and mathematicians carried out research into what was in their hands. Originally the mechanism would have been in a wooden box but now only partial surface detail of some of the gearing was visible. It appeared to be a calendar and astronomical calculator for sun, moon, planets and eclipses, but the researchers lacked enough information to fully comprehend all of its complexities. Tony paid tribute to their respective insights. Technology then broke the deadlock. Surface imaging made text engravings visible and readable that consisted of thousands of characters 2 mm high. X-ray tomography showed layer upon layer of gears and epicyclics. Four gears, apparently concentric, were actually gear circuits in a continuous spiral. A pin-and-slot system was previously hidden, not known, and not even imagined by the team. Being ignorant of astronomical cycles, it is enough to repeat a few of the words—the Antikythera mechanism calculates the Saros and Metonic cycles and takes account of anomalistic months—and does much more. Tony's reconstruction and animations on film are a wonder to see.

The AGM was formally completed in seven minutes and the Conference closed with thanks to the organisers. Dennis Cowan in particular was thanked for his dry wit and pipped piper through Edinburgh. Lunch was taken, goodbyes were said, and the good people of BSS dispersed for home.

Photos from John Davis, Dennis Cowan, Alastair Hunter, Tony Moss and Chris Lusby Taylor.



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COUNCIL MEMBERS

Dr Frank King 12 Victoria St CAMBRIDGE CB1 1JP	(Chairman & Restoration) Tel: 07766 756 997 chairman@sundialsoc.org.uk	Mr Chris H K Williams c/o The Editor	(Secretary) Tel: 01233 712550 secretary@sundialsoc.org.uk
Mr Bill Visick Kites Nest Cottage Kites Nest Lane BOURTON Dorset SP8 5AZ	(Webmaster) Tel: 07901 954568 webmaster@sundialsoc.org.uk	Mr Graham Stapleton 50 Woodberry Avenue NORTH HARROW Middlesex, HA2 6AX	(Treasurer) Tel: 020 8863 3281 treasurer@sundialsoc.org.uk
Ms Jackie Jones 51 Upper Lewes Rd BRIGHTON East Sussex, BN2 3FH	(Membership Secretary) Tel: 01273 673511 membership@sundialsoc.org.uk	Mr Chris Lusby Taylor 32 Turnpike Rd NEWBURY Berks, RG14 2NB	(Conference Organiser) Tel: 01635 33270 conferences@sundialsoc.org.uk
Mr David Brown Gibbs Orchard, Sutton Rd SOMERTON Somerset, TA11 6QP	(2014 Anniversary Coordination) Tel: 01458 274841 2014@sundialsoc.org.uk		

SPECIALISTS

Dr John Davis Orchard View, Tye Lane FLOWTON Suffolk, IP8 4LD	(Editor) Tel: 01473 658646 editor@sundialsoc.org.uk	Mr Peter Ransom 29 Rufus Close Rownhams SOUTHAMPTON Hampshire SO16 8LR	(Education) Tel: 023 8073 0547 education@sundialsoc.org.uk
Mr A O (Tony) Wood 5 Leacey Court CHURCHDOWN Gloucester, GL3 1LA	(Mass Dials) Tel: 01452 712953 massdials@sundialsoc.org.uk	Mr J Mike Shaw 3 Millwood Higher Bebington WIRRAL, CH63 8RQ	(Newsletter Editor) Tel: 0151 608 8610 newsletter@sundialsoc.org.uk
Mr John Foad Greenfields Crumps Lane ULCOMBE Kent, ME17 1EX	(Registrar) Tel: 01622 858853 registrar@sundialsoc.org.uk	Mrs Elspeth Hill 4 The Village Stonegate Nr WADHURST East Sussex, TN5 7EN	(Sales) Tel: 01580 201720 sales@sundialsoc.org.uk
Miss R (Jill) Wilson Hart Croft 14 Pear Tree Close CHIPPING CAMPDEN Gloucs., GL55 6DB	(Biographical Projects) Tel: 01386 841007 biographical@sundialsoc.org.uk	Mr David Pawley 8 Rosemary Terrace Enborne Place NEWBURY Berks., RG14 6BB	(Newbury Meeting Organiser) Tel: 01635 33519 newbury@sundialsoc.org.uk
Mr Nick Orders 14 Gordon Rd Burton Joyce NOTTINGHAM NG14 5GN	(Librarian) Tel: 0115 9314313 librarian@sundialsoc.org.uk	Mr Ian R Butson 60 Churnwood Rd Parsons Heath COLCHESTER Essex, CO4 3EY	(Photographic Competition) Tel: 01206 860 724 photos@sundialsoc.org.uk

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

The Society's website is at www.sundialsoc.org.uk
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