

# The British Sundial Society

## BULLETIN

BSS Bulletin 22(i)



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1. The editor welcomes contributions to the *Bulletin* on the subject of sundials and gnomonics; and, by extension, of sun calendars, sun compasses and sun cannons. Contributions may be articles, photographs, drawings, designs, poems, stories, comments, notes, reports, reviews. Material which has already been published elsewhere in the English language, or which has been submitted for publication, will not normally be accepted. Articles may vary in length, but text should not usually exceed 4500 words.
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A.A. Mills: 'Seasonal Hour Sundials', *Antiquarian Horol.* 19, 142-170 (1990)  
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**Front cover:** *The Henry Wynne horizontal dial at the Inner Temple, London (SRN 1294). Originally made in 1707, towards the end of Wynne's career, the sulphurous atmosphere meant it had to be restored by Thomas Wright only a few decades later and again by Newton & Co., Fleet Street, in 1870. The initials on the gnomon stand for 'Treasurer: Robert Payne' who gifted the dial at the end of his period of office. The dial includes a large EoT table for each day of the year.*  
Photo: John Davis.

**Back cover:** *The Carel Cross in Carlisle, Cumbria, (SRN 0391) has four dials surmounted by a royal lion holding the old coat of arms of Carlisle and sitting on the Carlisle Dormont Book containing the city's bye-laws. An inscription on one side reading "Joseph Reed, Mayor, 1682" may date the dials which are thought to have replaced an earlier market cross.*  
Photo: Robert Sylvester.

# BULLETIN

## OF THE BRITISH SUNDIAL SOCIETY

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### EDITORIAL

We may be called the British Sundial Society but we do not constrain ourselves to dials within these shores. One of the advantages of English is that members across the world often have it as their second (or even first) language and hence can write for us. It is interesting to make comparisons between dials around the world. In this issue, we have articles from Greece, South Africa (two!) and Italy.

Our members holiday abroad and are always on the lookout, camera in hand, for dials. So the 'fillers' in this issue are dials seen in Spain, Russia, Switzerland and Italy. Added to all this, there are some dials currently in the UK but made for the West Indies.

We do also find room for some British dials!



# THE RESTORATION OF EGNAZIO DANTI'S ASTRONOMICAL QUADRANT ON THE SANTA MARIA NOVELLA BASILICA IN FLORENCE

SIMONE BARTOLINI and MARCO PIEROZZI

*First, a description is given of the use of the astronomical quadrant which was made and placed, in the year 1572, on the façade of the Santa Maria Novella church in Florence, Italy, by the cosmographer Egnazio Danti. Then, the methodology adopted for the re-computation of both the existing and missing gnomons is illustrated, which allowed the production of a working copy of the instrument which is now on the corbel in place of the original.*

The astronomical quadrant is an ancient instrument for measuring of solar heights (altitudes) which was invented by Ptolomy (second century AD) who described its features in the first book, chapter XII, of the *Almagest*. It consists of a marble rectangular plate having a graduated quarter of circle, engraved on both sides, which was used to measure the sun's height on any day of the year. The cosmographer Egnazio Danti invented an astronomical quadrant and placed it on the façade of the Santa Maria Novella Basilica in the year 1572 and he gave the motivation for its construction when he described its uses on page 285 of the text *Primo volume dell'uso et fabbrica dell'astrolabio*:

*“La principale operazione del Quadrante Astronomico, per la quale il Gran Duca Cosimo fece fabbricare il suo marmo, nella facciata di Santa Maria Novella, è la medesima, che quella dell'Armillar, cioè l'osservazione degli Equinozi, per poter con essi ritrovare la vera quantità dell'anno, per il che si opera in questa maniera. Si osservi ogni giorno vicino agli Equinozi l'altezza del sole meridiana, la quale quanto sarà più vicina al compimento dell'altezza polare (che in Firenze è 46 gradi & 20 minuti, essendo quivi alto il Polo gradi 43 e minuti 40) tanto dirai che il Sole sia qui vicino all'Equinoziale.”*

(The main function of the Astronomical Quadrant, for which the Gran Duca Cosimo managed that its marble were built up on the façade of Santa Maria Novella, is the same as that of the Armillary, i.e., the observation of the Equinoxes in order to find out, through them, the true length of the year, operating as follows. Observe on every day close to the Equinoxes the meridian height of the Sun which the closer will be to the maximum of the polar height (which is  $46^{\circ} 20'$  in Florence, being here the Pole as much high as  $43^{\circ} 40'$ ), the more you will say that here the Sun is close to the Equinoctial).

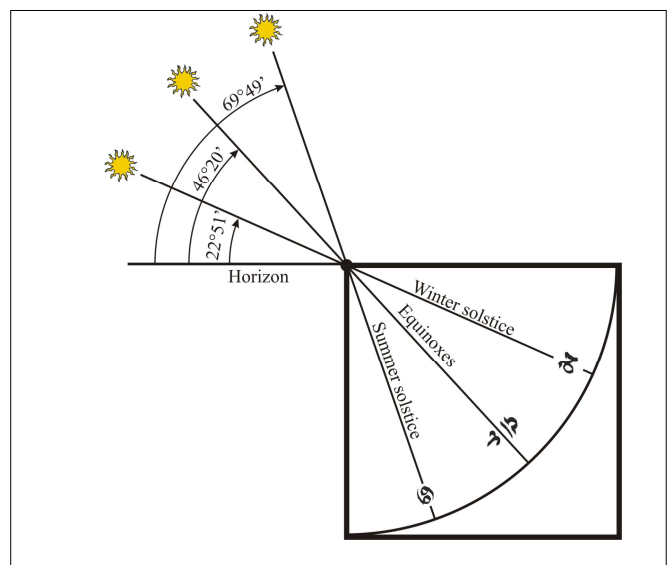
Danti chose the Santa Maria Novella façade not because it belonged to the Order of Dominicans but because “il qual sito fu eletto da S. Serenissima per il più comodo, & sta-

*bile, che fosse in Firenze, essendo di tal fortezza che è atta a stare immobilmente fino che il mondo duri; senza che essendo esposta al mezzogiorno resta aperta & libera da ogni intorno, atta a ricevere i raggi del sole ne' tempi delli Equinozii dalla mattina alla sera”*<sup>1</sup>. (such site was chosen by His Serene Highness as the most comfortable, and stable, location in Florence and so solid that it is well suited to stay immovable until to the end of the world; moreover, being oriented to the south, it stays open & free everywhere around, well suited to receive the Sun beams in all the daylight hours, during the Equinoctial period).

Danti, like Ptolomy, was interested in measuring the Sun's height at particular astronomical occasions, i.e., at the Equinoxes to estimate the length of the year, and at the Solstices to define the value of the Ecliptic obliquity.

Danti draws on the quadrant the Equinoctial line QE corresponding to the value  $46^{\circ} 20'$  and joining the zodiacal symbols of Aries and Libra (points  $\Upsilon$  and  $\text{♎}$ ). Similarly, the symbols of Cancer and Capricorn have been engraved, respectively for the maximum and minimum solar height (Fig. 1), and all the other zodiacal signs, always as corresponding to their own value of solar height as computed by Danti.

All the solar heights relevant to the entering of the Sun into the zodiacal signs have been reported by Danti in his Table of the Solar Height on the Meridian (Fig. 2).



*Fig. 1. The zodiacal symbols of the equinoxes and the solstices carved in correspondence of the values of the relevant solar height at noon.*

**TAVOLA DELL' ALTEZZA DE' SEGNI**  
 Celesti in ciascuna hora del giorno alla latitudine di  
 gradi 43.minuti 40.di FIRENZE.

Hore auanti mezzo giorno.								
	12	11	10	9	8	7	6	5
S O L I X	69.40	67.5	58.25	47.35	36.50	26.28	16.10	6.20
	66.30	63.40	56.10	45.55	34.38	24.15	13.45	3.48
	57.51	56.40	49.0	39.48	29.40	18.48	7.55	
	46.20	44.50	39.15	31.10	21.25	11.10		
	35.1.	33.30	28.45	21.24	12.45	2.45		
	26.9.	24.55	20.40	14.5	5.55			
	22.51	21.30	17.40	11.10	2.55			
	G. M.	G. M.	G. M.	G. M.	G. M.	G. M.	G. M.	G. M.
		1	2	3	4	5	6	7
	Hore dopò mezzo giorno.							

Fig. 2. E. Danti, Primo volume dell'uso et fabbrica dell'astrolabio, page 47.

Danti used the value  $43^{\circ} 40'$  for the local latitude, as it can be seen from the excerpt of the text reported above, instead of the value  $43^{\circ} 46' 25''$ , so committing an error of about  $6\frac{1}{2}'$ . However, such value does not affect the computation of the angular amplitude between the Tropics because the latter comes from the difference between the maximum and minimum solar heights during the year. As a consequence, the obliquity of the ecliptic, whose value is half this difference, is not affected by the error in latitude.<sup>2</sup>

Also in Fig. 2, the latitude value  $43^{\circ} 40'$  is reported and the solar heights are:  $46^{\circ} 20'$  for the Equinoxes,  $22^{\circ} 51'$  for the Winter solstice and  $69^{\circ} 40'$  for the Summer solstice. This last value is probably a printer's error because, using the ecliptic value measured by Danti, one should get the result  $69^{\circ} 49'$  ( $H = 90^{\circ} - \Phi + \delta$ , i.e.,  $H = 90^{\circ} - 43^{\circ} 40' + 23^{\circ} 29'$ ).

Leonardo Ximenes writes on the value of the latitude: "Poi, non si sa con sicurezza, che il Danti abbia osservato la Latitudine a questo quadrante, o almeno noi non siamo da lui avvertiti, che la Latitudine, che egli nel suo Astrolabio

riporta, sia quella stessa, che egli aveva col quadrante osservata"<sup>3</sup> (Moreover, we cannot say for certain that Danti was observing the latitude with this very quadrant or, at least, he does not claim that the latitude which he reported in his Astrolabe, is the same as the latitude he had observed with the quadrant).

Further, he also examines "...la rozzezza delle linee incise nel marmo, le quali nella divisione dell'arco del quadrante sono sì grossolane, che uno di que solchi abbraccia più di uno, e forse due minuti"<sup>4</sup> (... the roughness of the lines engraved on the marble, which are so rough in the division of the arc of the quadrant that one of those engraved lines covers more than one, and maybe two, arcminutes), as an additional difficulty in the accurate measurement of solar height. Ximenes singles out that error after two centuries, when the instruments of his time were able to carry out much more accurate measurements, i.e., with a precision of some tens of arc seconds. As a matter of fact, the precision of the quadrant was considerably worse: supposing it could be read to the millimetre, we would get a value with a potential error of about  $2' 30''$ , to which we should add  $2'$  due to rough engraved lines. So we would end with a potential error of about  $4' 30''$  in the estimate of the height angle of the Sun and we would be very close to the value  $6\frac{1}{2}'$  of the error in the latitude of Santa Maria Novella.

All this shows that, perhaps, Danti did not have observing instruments whose intrinsic precision was much better than the observations he reported.

In the thoughts of Danti we can also discover another purpose for the instrument: "Nel prefato Quadrante si può anco vedere l'entrata del sole ne' Tropici nella maggiore, e minor'altezza, dal che possiamo conoscere la grandezza del moto dello acesso, e ricesso di essi Tropici."<sup>5</sup> (With the afore-mentioned quadrant one can also see the entrance of the Sun into the Tropics at the maximum and the minimum

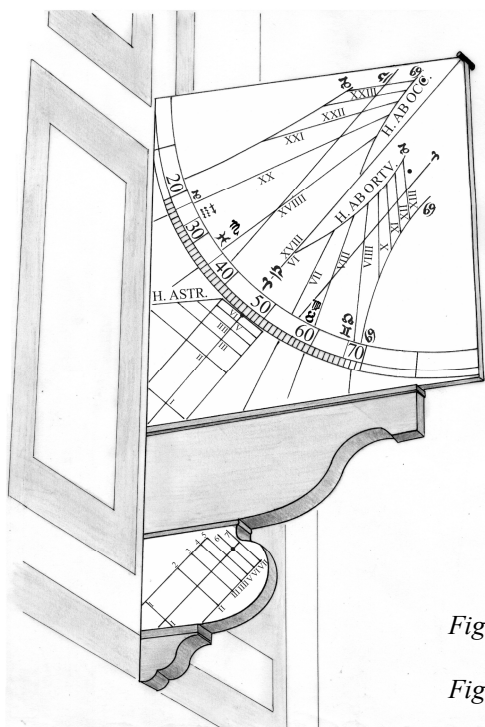


Fig. 3 (left) . The western side of the quadrant.

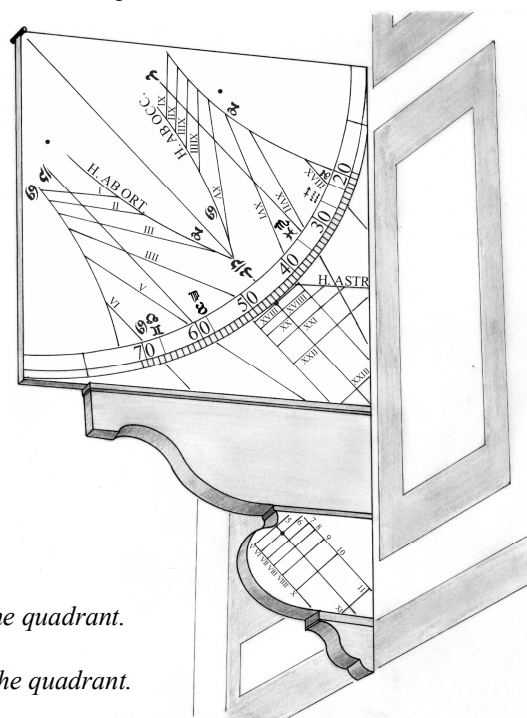
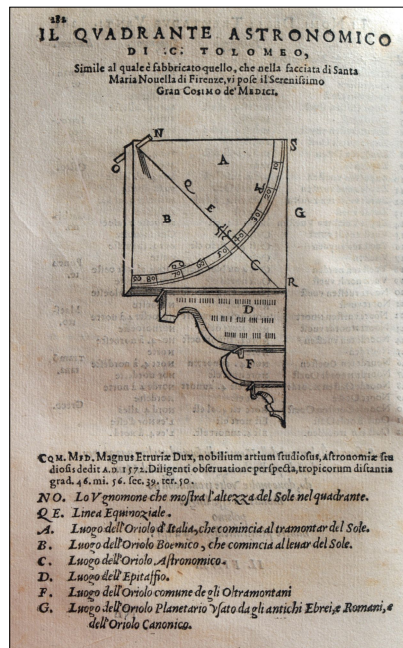


Fig. 4 (right) . The eastern side of the quadrant.

Fig. 5. The quadrant as reported in the Primo volume... p. 282.



heights, so that we can know the amount of the variability of the Tropics' motion).

In his mind we already find the idea of evaluating the variability through the direct observation of the Sun and of its apparent motion. This method will be subsequently put on some theoretical grounds and better developed by Danti himself through the use of a large sundial on the basilica.<sup>6</sup>

Figures 3 and 4 show that there are four engraved sundials (on both sides of the quadrant and on the corbel) related to the various ways of subdividing the day. In addition, there are other two sundials directly engraved on the façade of the church, close to the quadrant.

A picture of this instrument is found in the treatise on the Astrolabe written by Danti in 1578, from which a woodcut (see Fig. 5) describes its various parts.

The reasons for the presence of so many sundials are described by Danti himself: "*Hor la principale intenzione, per la quale sono stati fatti gl'Orioli da sole nel prefato quadrante, come è detto, è per la comodità dell'Armillia, accioché nel punto, che si vede trapassare il raggio del sole dall'altra banda dell'Armillia Equinoziale, si possa voltandosi al quadrante vedere l'hora, che più ci aggrada*".<sup>7</sup> (Now the main purpose to set up the sundials on

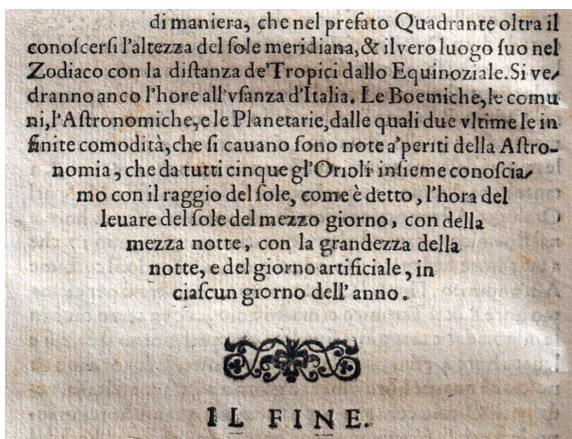


Fig. 6. E. Danti, Primo volume... p. 288.

the afore-mentioned quadrant, as already stated, is the comfortable position of the Armillary, so that in the point hit by the sunbeam from the other side of the Equinoctial Armillary one can read the hour comfortably looking at the quadrant). Moreover, after the description of the use of the quadrant, many other data are described which can be obtained with such sundials (Fig. 6).

In the sixteenth century, five systems for measuring time were used, being derived from different ways to establish the beginning and the end of the day, in combination with different ways to separate the daylight from the night. So, the count of daytime hours could begin at sunrise, at noon, or at sunset, and the day was subdivided into 24 hours; or, the daylight period, like the night, could each be subdivided into 12 hours, independently of their duration. Danti defines such systems in his *Primo volume* at pages 62 and 63 and writes: "*Siccome il giorno è usato in cinque differenti maniere da diverse nazioni del mondo, così anche l'hore sono di 5 sorti. Le prime delle quali sono l'hore ineguali chiamate Planetarie, che già erano usate da' Romani & da gli Hebrei, come è detto, & corrispondono al giorno, & alla notte artificiale. Le seconde sono l'hore Astronomiche, le quali cominciano in un mezzo giorno, & terminano nell'altro, & corrispondono al giorno Astronomico, che comincia quando il Sole è nel meridiano, & finisce nel punto ch'egli ritorna donde si era partito. Le terze sono le communi, che vanno da mezzo giorno, & mezza notte le quali hoggi sono comunemente usate dagli Oltramontani. Le quarte sono quelle, che cominciano al tramontar del Sole, le quali erano già usate da Egittij, & hoggi si usano per tutta Italia. La quinta & ultima sorte dell'hore, è quella che comincia al levar del Sole, usate già dai Caldei & hoggi da' Boemi. Queste cinque sorti di hore si vedono al Sole nel quadrante di marmo, che per comandamento del Serenissimo Gran Duca Cosimo io feci nella facciata di Santa Maria Novella in Firenze.*" (Since the day is counted in five different manners by different countries of the world, likewise, also the hours are of five types. The first one is constituted by the unequal hours, called Planetary hours, used by the Romans and the Jews, as already said, and correspond conventionally to daylight and night. The second type comprises the astronomical hours which begin at noon and end at noon of the subsequent day, and correspond to the astronomical day beginning when the Sun is on the meridian and ending when the Sun is again on meridian. The third one includes the common hours, beginning at noon and at midnight, which nowadays are commonly used by North European people. The fourth one comprises the hours beginning at sunset, which were used by Egyptians and nowadays are used all over Italy. The fifth type includes the hours beginning at sunrise, which were used by Chaldeans and nowadays by Bohemians. These five types of hours can be seen on the marble quadrant which I built on the façade of the Santa Maria Novella church in Florence, following the commands of His Serene Highness, the Grand Duke Cosimo).

About two centuries after its construction, during the restoration of the basilica's façade in the year 1778, the marble of the quadrant was cleaned and it was noticed that the only gnomons still firmly in place were the two cylinders in the corner, while a gnomon for the Italian hours was lost and the remaining ones were lost. That restoration is described by Giuseppe Capone who writes: *"Dopo ripulito il marmo e ricoloriti i segni, si restituì al vero suo posto e lunghezza lo stilo mancante e vennero fortificati ed assicurati nei luoghi loro, con grande esattezza, gli altri nove vacillanti, per opera di Anton Domenico Tofani fiorentino, parroco della chiesa di Santa Cristina a Pimonte, diocesi fiorentina, soggetto versatissimo nella teoria come nella pratica gnomonica facoltà, principalmente per ciò che spetta alla costruzione di ogni genere di orologi solari. Lo stesso Tofani nel 23 settembre di detto anno 1778, a cielo perfettamente sereno, osservò confrontarsi precisamente il punto del mezzogiorno nella gran lastra di questo quadrante"*.<sup>8</sup> (After having cleaned up the marble and painted again the signs, the missing gnomon was replaced, at the same place and with the same length of the original, and the other nine unstable gnomons were strengthened and secured at their own places with great precision by Anton Domenico Tofani, Florentine, parish priest in the church of Santa Cristina in Pimonte, Florentine diocese, who was very clever in the theoretical and practical knowledge as far as the gnomons were concerned, especially regarding the construction of any kind of sundials. On 23<sup>th</sup> of September of the same year 1778, while the sky was perfectly clear, Tofani himself observed the coincidence of the noon point on the great board of this quadrant).

During the following two centuries, the quadrant remained on the corbel, often forgotten and sometimes also erased from the pictures of the façade which could be seen in art books. In the early 1980s, the quadrant was removed from its site to be restored at the Opificio delle Pietre Dure in Florence. Since it was badly damaged, it was decided to keep it inside in a room of the Convent of Santa Maria Novella in order to protect it against acid rain but far from the sunlight whose beams were waiting every day to have their height measured.

Between the years 2007 and 2008, the restoration of the façade of the Santa Maria Novella church was carried out under the control of the Commune of Florence who decided at last to make a copy of the quadrant through a silicone-rubber cast. The new quadrant has been realized using an aluminium frame covered by fibreglass and epoxy resin, while its surface consists of a mixture of marble powder and epoxy resin.

The original quadrant is a marble rectangular plate with dimensions (metres) of  $1.53 \times 1.53 \times 0.08$ . It was secured into the façade to a depth of 0.05 m and rests on a series of corbels at about 7 m above the ground. The marble was placed on the meridian plane with a precision of about 20', as is shown by the ancient marks visible on the supporting

corbel, so that the two sides were oriented to the East and West.

The main part of the quadrant consists of a quarter of a circle, which is drawn from the edge fixed to the wall to the vertical from the gnomon foot, together with a bronze cylinder with a diameter of 22 mm emerging 30 mm from the plane of the two sides of the quadrant, secured at the centre of the origin of the angular scale.

The constructor's name is engraved on the bronze fastening bracket of the cylinder: F. EGNATIUS DANTES.

On the original quadrant, the two gnomons for the Bohemian and astronomical hours on the western side are lost, while the gnomons relevant to the Italian and astronomical hours on the eastern side are also missing. In order to build a completely working copy of the quadrant, all the gnomons have been recomputed and reconstructed using a fibreglass rod (painted with acrylic colours to simulate the bronze colour).

On 20 March 2008 (Spring Equinox) the astronomical instrument was set on its corbel, on the marks of the original quadrant. In order to carry out an authentic restoration, we chose to replace the quadrant in the same position Danti used, even though this now results in it being slightly out of the meridian by around 20'.



Fig. 7. Setting up the gnomon for the eastern Bohemian hours sundial.

The gnomons were positioned over two days: those on the western side in the afternoon of 20 March 2008; those on the eastern side in the morning of the next day (Fig. 7). Over this time, the correct operation of all parts of the quadrant was checked: the time was read to an accuracy of few minutes on all the sundials and for each of them the shadow of the gnomon's endpoint ran precisely along the Equinoctial line. So, a restoration which was initiated over twenty years before has been completed!

Some general remarks are in order for the gnomons of sundials with Italian and Bohemian hours. Usually, these gnomons were secured orthogonally to the quadrant at the origin of the solar lines and the shadows of the gnomons' end-



The replica quadrant in position. All the gnomons have been recomputed and replaced.

Fig. 8 (left). The western side.



Fig. 9 (right). The eastern side.

points were used to read the hour. Then, referring to an ortho-style, this was secured at the point of intersection of the Equinoctial line with the horizon line of each sundial; a method which was not used with Danti's sundials because their gnomons are all placed in a different manner (Figs. 8 & 9).

Regarding this, the gnomonist Giovanni Paltrinieri, in his treatise on Danti's quadrant, supposes that it was due to the thoughtlessness and inattention of the marble engraver, because he had no idea where the holes should be located. This may have been due to a misunderstanding between the designer (Danti) and the engraver himself. This hypothesis could be supported by the fact that, on the eastern side, the title *H. AB OCC.* is engraved upside down (Fig. 9) and the hole for the gnomon of the Italian hours sundial of the western side is positioned in the centre of the letter C (Fig. 8).

In our opinion, another very simple reason could be account for the anomalous position of the gnomons, i.e., the possibility of measuring the hour and the Equinox at any time of the day, which is possible only if the gnomons are fixed outside the part occupied by the hour and solstice lines. In fact, the main condition is that the top of the gnomon should be positioned on the endpoint of the corresponding ortho-style, placed as described before.

## THE COMPUTATION OF THE GNOMONS OF THE QUADRANT SUNDIALS

### The Astronomical Sundial

We start with this sundial because, as we shall see, this method of computation will be used also to determine the length of the other gnomons. The astronomical hour lines traced on quadrants oriented to East or West have the properties of being parallel to each other and to intersect the Equinox line orthogonally. The formula used to compute

such hour lines is very simple:

$$Y_i = H_{\text{stylus}} \cdot \tan(\alpha_i)$$

where  $\alpha_i$  is the hour angle reported in Fig. 10 and corresponds to the hour lines;  $Y_i$  is the distance of the single hour lines starting from the hour line VI or XVIII for the western or eastern side, respectively.

WEST - EAST ASTRONOMICAL SUNDIAL gnomon height H = 12.9 cm				
Hour angle $\alpha$	Hour line	Computed distance $Y_i$	Measured distance (east) $Y_i$	Measured distance (west) $Y_i$
15	V / XVIII	0.035	0.035	0.034
30	III / XX	0.074	0.075	0.074
45	III / XXI	0.129	0.131	0.131
60	II / XXII	0.223	0.226	0.223
75	I / XXIII	0.481	0.476	0.477

Fig. 10. Table comparing the computed and measured distances (in metres) along the Equinoctial line, at the east and west astronomical hours.

The point C in Fig. 11 corresponds to the position of the foot of the ortho-style. According to the previous formula, the distances  $Y_{\text{III}}$  and  $Y_{\text{XXI}}$  should correspond to the measure of the length of the missing gnomons. In fact, for the hour lines III/XXI:

$$\alpha = 45^\circ \rightarrow \tan(\alpha) = 1$$

Therefore, the distances between the hour line III (western side) and XXI (eastern side) and the respective centre of the hole of the gnomon have been measured, giving as a result:

$$Y_{\text{III}} = H_{\text{stylus}} = 13.1 \text{ cm (west) and}$$

$$Y_{\text{XXI}} = H_{\text{stylus}} = 13.1 \text{ cm (east)}$$



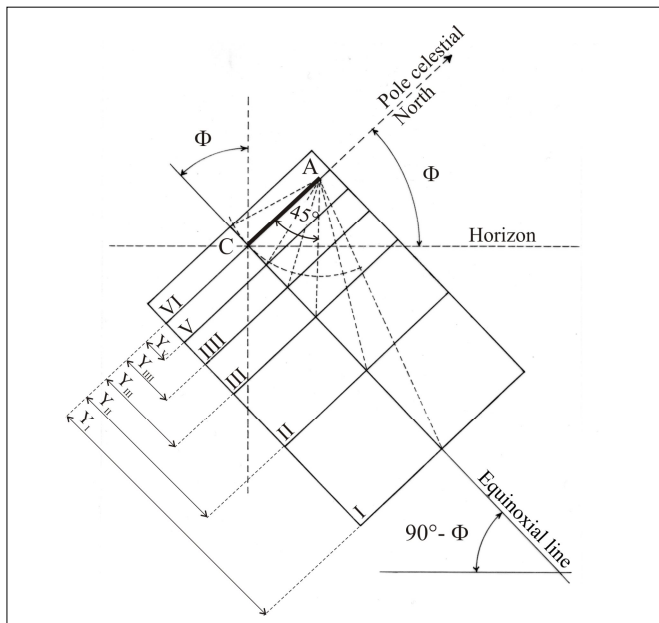


Fig. 11. The geometric construction for the western astronomic sundial,  $AC = H_{stylus}$ .

Using these heights, all the other distances  $Y_i$  have been computed and compared with the distances of the hour lines measured on the quadrant along the Equinoctial line: since differences greater than one centimeter have been found, further computations have been carried out changing the gnomon's height. The height value  $H = 12.9$  cm (Fig. 10) has produced closer distances, so this height has been adopted for both gnomons.

Remember that the hour lines of this sundial are identical to those of the northern European sundial, the only difference being in their numbering from 6 to 11 for the eastern side and from 1 to 6 for the western side.

### The Italian Hours Sundial

The simplest way to construct a sundial with Italian hours is to take a northern European sundial and to use the correlation between Italian hours and northern European hours at the times of solstices and equinoxes (Fig. 12). In this case the Italian hour XII coincides with the northern European hour 6, the hour XIII with the hour 7 and so on until to sunset, i.e., the hour XXIII coincides with the hour 18.

In this case the distance  $Y_{XV}$  between the point of intersection of the Equinoctial line with the hour line XII, and the hour line XV has been measured (Fig. 13).

Using the same formula as above, we have, for the hour line XV

$$\alpha = 45^\circ \rightarrow \tan(\alpha) = 1 \rightarrow Y_{XV} = H_{stylus} = 21.6 \text{ cm}$$

Equinoxes													
N. European hours	6	7	8	9	10	11	12	13	14	15	16	17	18
Astronomical hours	18	19	20	21	22	23	24	1	2	3	4	5	6
Italian hours	12	13	14	15	16	17	18	19	20	21	22	23	24
Bohemian hours	0	1	2	3	4	5	6	7	8	9	10	11	12
Planetary hours	0	1	2	3	4	5	6	7	8	9	10	11	12

Fig. 12. Table comparing the various hour systems, at the Equinoxes.

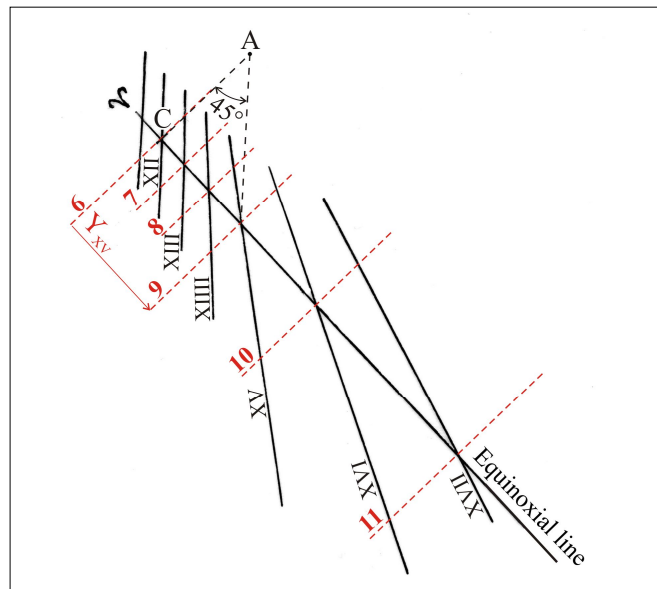


Fig. 13. The correspondence between the (eastern) Italian hour sundial and the northern European sundial (in red).

Using this height value, all the other distances  $Y_i$  have been computed and compared with the distances of the hour lines measured on the quadrant along the Equinoctial line; as in the case of the previous computation, the distances have also been computed for different gnomon heights. The height value which produces least errors in the distances turns out to be  $H = 21.7$  cm (Fig. 14).

As one can see in Fig. 14, the hour line XVI has been engraved incorrectly and the error is also evident looking at the visual aspect of the hour lines: the space between the hour lines increases, while we have the opposite behavior between the hour lines XVI and XVII. The computation of the gnomon of the western side requires a different procedure: we cannot measure the distance  $Y_{XXI}$  between the intersection point of the Equinoctial line with the hour line XXIII and with the hour line XXI, because the last engraved hour line is XXIII.

Thus, another method is used. Since the set of hour lines of the western Italian hours sundial is mirrored by the set of hour lines of the eastern Bohemian dial, the two sets of lines have been superposed and checked to be coincident. Then we note that, in the case of the eastern Bohemian sundial, the point of the foot of the vertical of the ortho-style C

EAST ITALIAN HOURS SUNDIAL gnomon height $H = 21.7$ cm			
Hour angle $\alpha$	Hour line (east Italian)	Computed distance $Y_i$	Measured distance $Y_i$
15	XIII	0.058	0.057
30	XIII	0.125	0.125
45	XV	0.217	0.216
60	XVI	0.376	0.446
75	XVII	0.810	0.813

Fig. 14. Table comparing the computed and measured distances (in metres) along the Equinoctial line, at the east Italian hours.

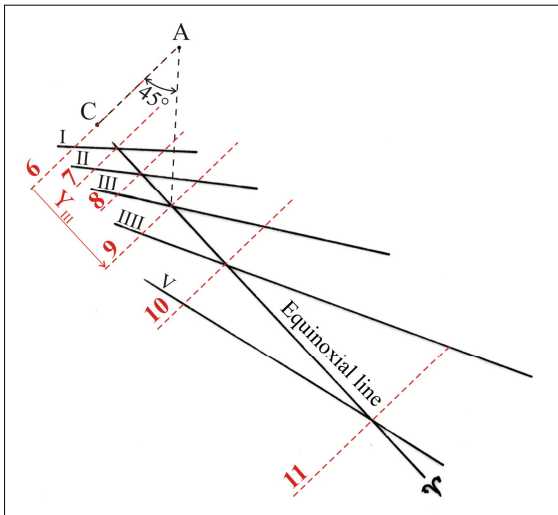


Fig. 15. The correspondence between the eastern Bohemian sundial and the northern European one in red.

(coincident with the intersection point of the Equinoctial line with the hour line 0) has been engraved. As a consequence, we can measure the distances both through the eastern Bohemian hour lines and through the western Italian hour lines, after having reported the point C in the corresponding picture.

Thus, the distance  $Y_{III}$  has been measured on the eastern Bohemian hours sundial of the quadrant starting from the point C to the hour line III (Fig. 15), and applying the same formula we have, for the hour line III

$$\alpha = 45^\circ \rightarrow \tan(\alpha) = 1 \rightarrow Y_{III} = H_{\text{stylus}} = 21.8 \text{ cm}$$

In order to verify, using this height, all the other distances  $Y_i$  have been computed and compared with the distances of the hour lines measured on the quadrant. For the sake of completeness, the distances with  $H = 21.9$  and  $21.7$  cm have also been computed and the latter value has produced fewer discrepancies between the computed and measured distances of the hour lines (Fig. 16).

WEST ITALIAN HOUR SUNDIAL = EAST BOHEMIAN gnomon height $H = 21.7$ cm				
Hour angle $\alpha$	Hour line (east Bohemian/west Italian)	Computed distance $Y_i$	Measured distance $Y_i$ (east Bohemian)	Measured distance $Y_i$ (west Italian)
15	I / XXIII	0.058	0.058	---
30	II / XXII	0.125	0.123	0.124
45	III / XXI	0.217	0.218	0.218
60	IIII / XX	0.376	0.371	0.374
75	V / XVIII	0.810	0.811	0.814

Fig. 16. Table comparing the computed and measured distances (in metres) along the Equinoctial line, at the east Bohemian and west Italian hours.

### The Bohemian Hour Sundial

To draw a sundial with Bohemian hours, the simplest method is to use a northern European sundial, exploiting the correspondence between Bohemian and northern European hours at the solstices and Equinoxes (Fig. 12).

As we have seen in the previous section, the eastern Bohemian sundial corresponds to the western Italian one; as a

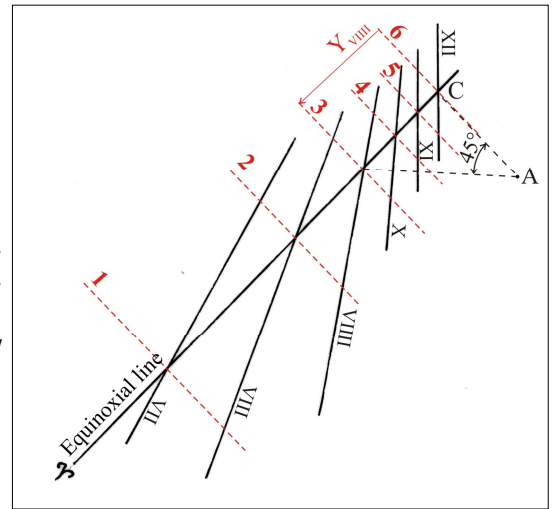


Fig. 17. The correspondence between the western Bohemian sundial and the northern European sundial in red.

consequence, no further computations are necessary to determine the length of this gnomon whose value turns out to be  $H = 21.7$  cm.

Lastly, coming to the computations relevant to the gnomon of the western Bohemian sundial, the distance  $Y_{VIII}$  between the intersection point of the Equinoctial line with the hour line XII and the hour line VIII has been measured on the western side of the quadrant (Fig. 17).

Using the same formula we have for the hour line VIII:

$$\alpha = 45^\circ \rightarrow \tan(\alpha) = 1 \rightarrow Y_{VIII} = H_{\text{stylus}} = 21.6 \text{ cm}$$

As for the previous cases, using the above height all the other distances  $Y_i$  have been computed and compared with the distances of the hour lines measured on the quadrant. Also, the distances have been computed for different gnomon heights and the value producing the least errors in the distances is  $H = 21.8$  cm (Fig. 18). This table shows that the hour line VIII is misplaced. The line is mirrored by the line XVI on the eastern Italian sundial, which is also misplaced; such coincidence suggests the same construction error.

WEST BOHEMIAN SUNDIAL gnomon height $H = 21.8$ cm			
Hour angle $\alpha$	Hour line (west Bohemian)	Computed distance $Y_i$	Measured distance $Y_i$
15	XI	0.058	0.060
30	X	0.126	0.127
45	VIII	0.218	0.217
60	VIII	0.378	0.457
75	VII	0.814	0.819

Fig. 18. Table comparing the computed and measured distances (in metres) along the Equinoctial line, at the west Bohemian hours.

### REFERENCES AND NOTES

1. E. Danti, *Primo volume dell'uso et fabbrica dell'astrolabio*, Firenze, Giunti, p. 319 (1578).
2. As shown in Fig. 1, the solar height values were about  $H_1 = 69^\circ 49'$  for the Summer solstice and  $H_2 = 22^\circ 51'$  for the Winter solstice, so that:  $\varepsilon = (H_1 - H_2)/2 = (69^\circ 49' - 22^\circ 51')/2 \rightarrow \varepsilon = 23^\circ 29'$ .

3. L. Ximenes, *Del vecchio e nuovo gnomone fiorentino* – Firenze, Stamperia Imperiale, p. XLVIII (1757).
4. *ibid.* p. XLVII.
5. *ibid.* (ref. 1) p. 286.
6. S. Bartolini, *I fori gnomonici di Egnazio Danti in Santa Maria Novella*, Firenze, Edizioni Polistampa, Collana Testi e Studi, p. 47 (2006).
7. *ibid.* (ref. 1) p. 287.

8. G. Caponi, *Egnazio Danti*, Alatri, Arti Grafiche Tofani, p. 191 (1986).

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## BOOK REVIEW

**The Double Horizontal Dial - and associated instruments** by J. Davis & M. Lowne. BSS Monograph No. 5. 240 + viii pp, A4, soft covers, colour and b&w illustrations throughout. Price £19.50 + p&p from BSS Sales. ISBN 978-0-9558872-1-5.

It is a pleasure to review this substantial BSS monograph on the history, geometry, design, manufacture and engraving of the double horizontal (DH) dial, the horizontal instrument (HI) and the horizontal quadrant (HQ).

As the proud owner and user of a reproduction HQ and of a DH dial (albeit one whose condition is rightly described in the monograph as 'poor') and as someone who has looked longingly at an HI or two in glass cases, it is worth my considering why the 125 instruments recorded in the monograph are all said to be 'horizontal'. There are two projections involved, the first of the sky down line of sight onto a hemisphere around and above, and the second a (stereographic) projection of that hemisphere onto a circular disk. Horizon directions are projected in two steps onto points on the boundary of the disk and so the disk is 'horizontal' even though in use the HIs and HQs never need to be laid flat.

The monograph is in four parts with extra pages including well deserved praise in a Foreword by Christopher Daniel 'a fascinating work of great scholarship', a helpful Introduction, a short Glossary and a full Bibliography.

### Part 1: Historical Publications: Facsimiles, Transcriptions and Notes

Just as we have Michael Lowne and John Davis, the early 17<sup>th</sup> century had the outstanding mathematician William Oughtred and his close friend the master engraver Elias Allen. Oughtred was the first to explain how the stereographic projection of a celestial hemisphere could be used, and in his 1636 DH '*Description*' tells us that "These instrumental dyalls are made in brasse by Elias Allen dwelling over against St. Clements Church without Temple barre" The horizon, the ecliptic, the paths of the sun day by day and the points on those paths that share the same time all project to circles on the disk thereby making for accurate

engraving and an attractive outcome. Oughtred's remarkably readable 1636 accounts of how HIs and DHs can be used (both with and without the help of the sun) fill much of Part 1 with extracts and transcriptions of two lesser known instruction booklets.

### Part 2: Modern Reprints: Articles published in the BSS Bulletin, the NASS Compendium and the SIS Bulletin

We are in familiar territory with this convenient gathering of articles that have appeared elsewhere but are now reprinted with colour illustrations. Fred Sawyer (March 1997 *NASS Compendium*) and Michael Lowne (December 2001 *BSS Bulletin*) explain how to draw a stereographic disk on an HI and a DH. As expected, papers from the *BSS Bulletin* between 2003 and 2008 relating to Henry Wynne's double horizontal dial at Staunton Harold are reprinted here. That dial was huge (30" in diameter) stacked with information and is regarded by the authors as 'perhaps the most sophisticated of all 17<sup>th</sup> century dials'. It is good to see again their stunning TurboCAD drawing of the dial plate and Tony Moss' March 2006 *BSS Bulletin* description of how he took that drawing and machined it into life as the beautiful replica shown on the cover of the monograph.

### Part 3: New Articles

The new articles have an anonymous look but one can make a reasonable guess as to who wrote what! There are 13 pages on the way that the double horizontal dial (and HIs and HQs) developed historically, followed by 4 pages on their uses. We have 7 pages on how to winkle out hidden information about a dial if, for example, the maker or the date or the working latitude is not displayed. Page 99 is blank, a practice I recommend for taking the pressure off the reader, but it is followed by a fascinating account of the methods used in preparing the metal and engraving it. Metallurgical analysis might lead to information about who made what or, perhaps more likely, who didn't make what. There are short articles on variations of the 'horizontal theme' in the past and present and a four page account of 'The Star Places on Double Horizontal Dials and Other Instruments' surely written by Michael Lowne explaining



what use can be made of star positions when they are placed on HQs and rather less helpfully on DHs. That article expanded your reviewer's own horizons explaining as it does that the ecliptic curves give the Right Ascension and Declination of the sun through the year, a property surprisingly missing from Oughtred's list.

### Part 3.5: The Makers and Their Dials

This sub-section begins with a very useful map of London as it was in the 17<sup>th</sup> century showing where the mathematical instrument makers worked and the extent of the Great Fire. A page showing an 'apprenticeship tree' is followed by biographies of 31 of those principally involved either in theory or in practice, in some cases perhaps less than honestly.

### Part 4: Catalogue of Dials and Other Instruments

Over about seventy pages there are full descriptions of the 125 'horizontal' dials known at the time of publication (33 of them 'modern'). These instruments are in museums worldwide, in private collections and, of course, 'in the

wild'. Nearly all descriptions include at least one photograph.

'Double horizontals' are surely examples of that seamless 17<sup>th</sup> century mix of craftsmanship, artistry, practicality, mathematics and science that gives so much pleasure. They also deliver the perfect response to Belloc's "I am a sundial and I make a botch - of what can be done far better by a watch". No watch presents the reader with so much information about the day, or any other day.

Sundials are time finders and keepers. A double horizontal sundial can be 'fixed on a post' by turning it until the time shown by the two shadows is the same. Once fixed the sundial finds the time by itself – for ever!

This monograph is truly an 'exhaustive treatise' but with enough space on and between its pages to make it a relaxed and stimulating read. There are inevitably some misprints of the sort that will be much more irritating to the authors than to the reader.

*Peter Baxandall*

## NEW DIALS

### A solar acorn in Solar, Russia.

The settlement of 'Solar' is in the centre of a small municipal town on the coast of the Gulf of Finland, near St. Petersburg. It is a very beautiful place with sea, sandy beaches and pines. The location has been known since the time of Peter the Great, when they started to plant oak trees. Some of these now remain as huge trees and they have been named Petrovsky oaks. The symbol of the area, chosen by Solar's elected head of administration, Jury Volohin, is the acorn.

My task was to make a sundial on an acorn theme. An acorn with an oakleaf was already available but it bore no resemblance to a sundial. Two types of sundial were considered – horizontal and equatorial – with the result that a variant of the equatorial dial was chosen. The ideas were developed with the designer Andrey Evdokov and manufactured by the Kolpino workshop.

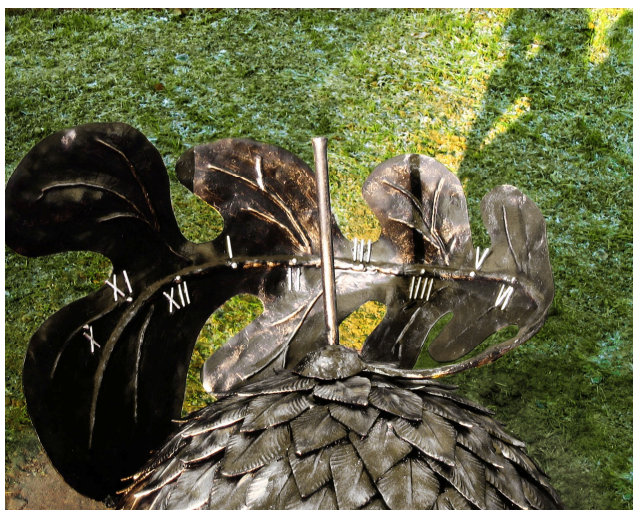
The dial plate used sheet steel manually curved to the required profile. As the resulting curve was not quite ideal, the delineation of the dial had to allow for the non-uniform curvature. After the numerals and acorn had been painted, the dial was set up on 31 October 2009 near the Solar Administration building.

The dial indicates local summer time (solar time plus 2 hours). A plaque explaining how to read the dial, including during the winter, is nearby.

When the solar acorn was set in the earth, I remembered the well-known fairy-tale of Pinocchio, with a magic field and gold coins. So, who knows, maybe the solar acorn is the start of another story?

A detailed report on the solar acorn can be found at [www.sundi-spb.ru](http://www.sundi-spb.ru).

*Valery Dmitriev*



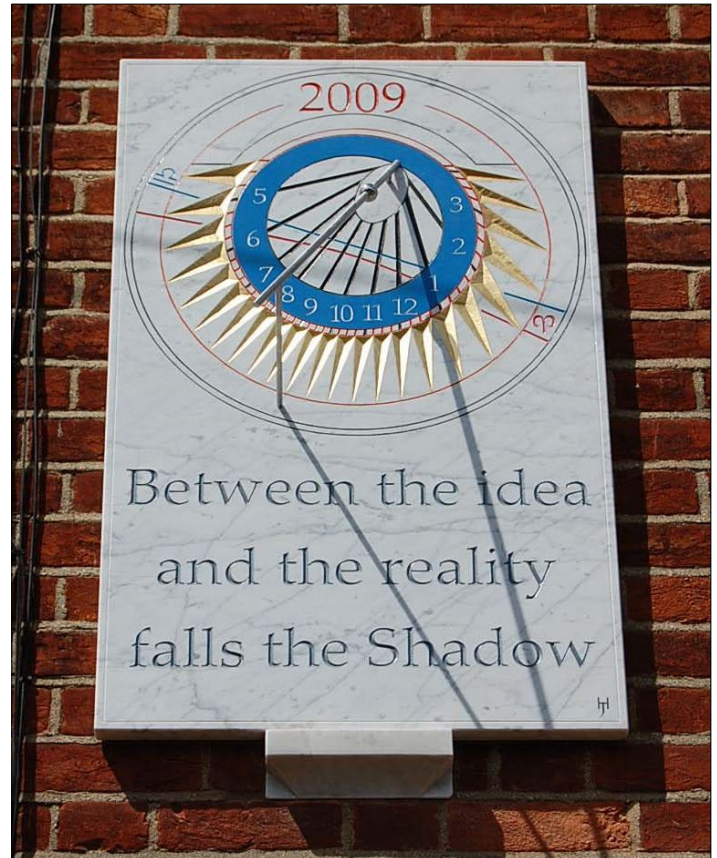
## Oxford Dial Inspired by Christopher Wren

The home of Huxley Scientific Press in Marston Street, East Oxford, has been named Sundial House after the owners commissioned me to make a new sundial for the front of their building. The sundial and motto are carved into Carrera marble and the gnomon and nodus are made of stainless steel.

The sundial declines 30.5° East of South and reads local apparent time. It is a partial imitation of the dial at All Souls College, Oxford which is supposed to have been designed by Sir Christopher Wren. The vertical noon line is offset from the centre of the dial to give the morning hour lines a more even spread within the circles which form the dial. A blue chapter ring with white Arabic hour numerals encloses the main hour lines. Outside this is a ring containing quarter-hour divisions, the hours lines in black and the intermediate quarters in red. A further, non-concentric ring contains gilded 'V'-profile 'rays', the centre of each 'V' extending the hour and half-hour lines. Time is read from the centre of the shadow of the gnomon style.

The shadow of the spherical nodus mounted on the gnomon tracks two declination curves which mark the owners' birthdays on April 11th and September 23rd. The curves are labelled with their relevant zodiac sign.

The motto is an adaptation of a verse from T.S. Eliot's 'The Hollow Men'. The poem (published 1925) has many other lines which would make excellent sundial mottoes. The motto is carved in the Palatino typeface. This came into use



at roughly the same time as the poem was written and is a favourite of the owners of the dial who specialise in scientific editing and publishing.

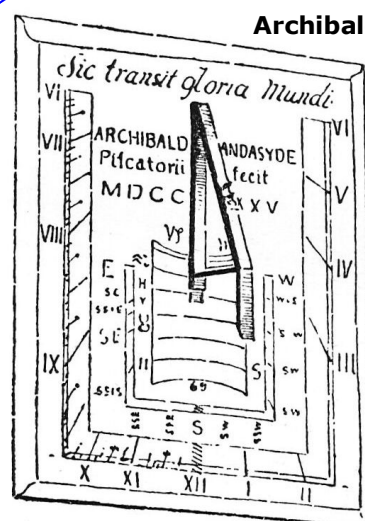
Harriet James  
enquiries@sunnydials.co.uk

## A Commercial Dial from Australia

This 'Sun Disc' is a mass-produced equatorial dial from David Widdowson of Astrovisuals in Australia (for more details see [www.astrovisuals.com.au](http://www.astrovisuals.com.au)). Equatorial dials are not new, of course, but the features of this example are that it comes flat-packed in an A4 package and has a variety of mounting angles so that the 21 cm diameter sun disc can be set at a suitable angle for a wide variety of latitudes in both the northern and southern hemispheres. The disc is of semi-translucent polypropylene so that when, in the winter



months, the shadow of the central gnomon falls on the back of the disc, it can still be seen from the front. The main advantage of the equatorial design is that it has equi-angular hourlines, allowing the disc to be rotated against an in-built scale to provide adjustment for longitude, daylight saving and also the Equation of Time.



## Archibald Handasyde

Mrs Gatty reported that this dial was lying against a wall at Inveresk church, Midlothian, in 1890. Evidently it was put back in place as Andrew Somerville recorded it (SRN 1527) in 1981. It was made by Archibald Handasyde of Fishberrow in 1735. Another dial, a vertical west, by the same maker is also

on the church and he is credited with several other dials. He would be worthy of further research.

# AN EQUATORIAL ANALEMMATIC AND CALENDAR SUNDIAL, ALICANTE, SPAIN

DOUGLAS BATEMAN

This handsome equatorial meantime sundial is situated on the marina of the Mediterranean coastal town, and very popular holiday resort, of Alicante. The dial has a panel with a ‘cut-out’ shape of the analemma and a similar slot for the apparent time. (Would we call this a slot or a stencil gnomon?) The scales show both the local time and time at the meridian of the local time zone, which happens to be 0°. The longitude of the dial is 0° 28' 47" W. The panel with the slots can be swivelled to face the sun and carries the instructions for reading the time.

Carles Pelejero of the Catalan Sundial Society kindly gave me more details, such as extracts from a speech given by the designer to the local Academy of Science and Engineering of Lanzarote, in order to be accepted as a Correspondence Member of the Academy. The designer is Juan Vicente Pérez Ortiz, who is an active member of the Catalan Society. Due to the interactive and educational features of the design, which the designer calls a *Sculptured Analemmatic Calendar sundial*, it was selected by the Association of Science Professors ‘Hypatia of Alexandria’, located in Orihuela, to be installed in the Museum of Science of the University Miguel Hernández of Orihuela.

The first version of the dial, with a slightly different ‘cut-out’ for the analemma, was installed on the terrace

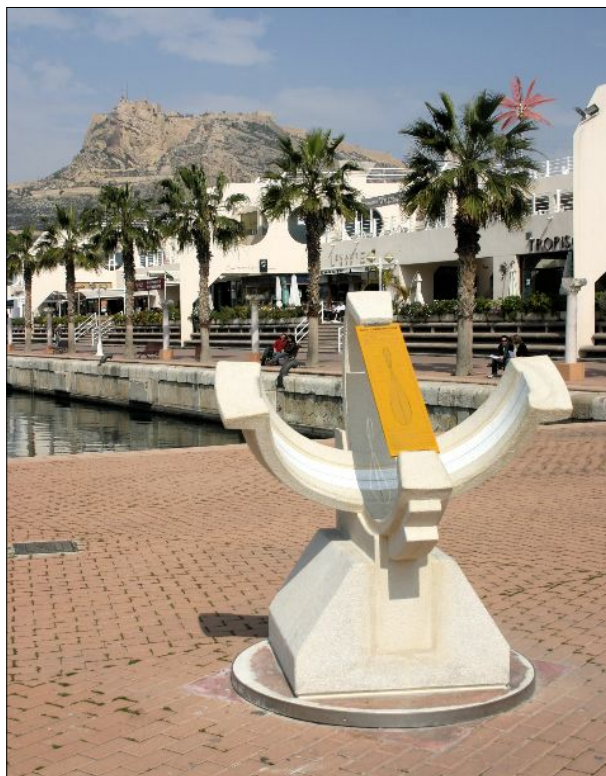


Fig. 1. A modern sundial by J.V. Pérez-Ortiz on the marina. The local medieval castle is high in the background



Fig. 2. A closer view of the gnomon panel showing the complete analemma and its bright outline on the dial.



Fig. 3. The top of the gnomon panel with the date marked every 5 days: the horizontal lines are spaced vertically to show the changing declination of the sun every 1° whereas the vertical lines are separated by one minute in time thus giving the equation of time. The date can be interpolated by masking the slot until the cut-off point is found on the time scale.

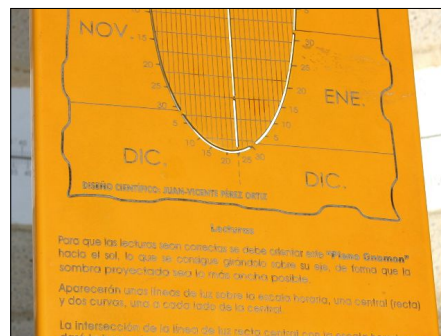


Fig. 4. The lower part of the gnomon panel just showing the small ‘bridges’ that hold the centre of the analemma in place.

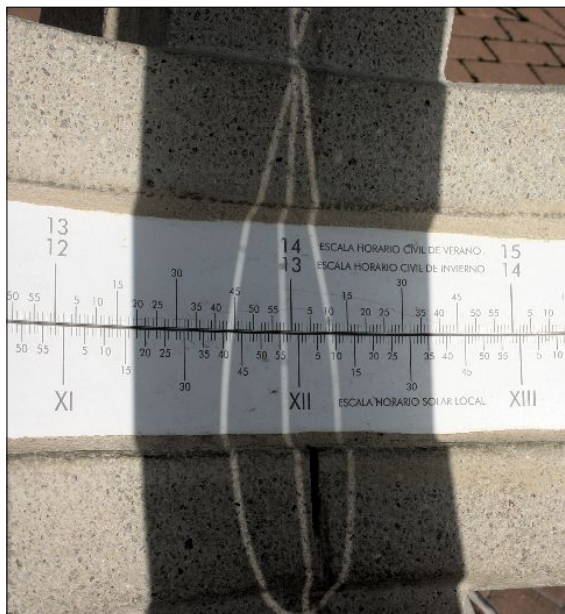


Fig. 5. A close up of the scales. The photograph was taken at 13:10 GMT showing the line from February intersecting the upper scale (summer time and winter time) at 13:10. The straight line gives the local apparent time as about 12:57, corresponding to the equation of time of a little over 13 minutes for the date. Local apparent time is shown on the lower scale.

of the Castle of San Gabriel of Arrecife, Lanzarote. Currently 20 sundials of the same pattern, with minor changes, have been installed around Spain. In addition to the Museum of Science of Orihuela, other appropriate locations are

the Science Park in Granada, in the Cosmos Museum of La Laguna in Tenerife, the Castle of San Gabriel de Arrecife in Lanzarote and in the Faculty of Science of the University of Santander. Besides receiving praise from academic institutions, the design has been registered in the Spanish Patent Office.

The Alicante dial was installed in 1997 by donations to the town by 'CAM' (Caja de Ahorros del Mediterráneo).

Having a strong personal interest in such dials, I think it is an excellent interpretation of a mean time dial. It is very accurate, easy to use, and has a full explanation with instructions.

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## Postcard Potpourri 15 – Marsh Court, Stockbridge, Hampshire

### Peter Ransom

A Pilkington & Gibbs heliochronometer is featured on this postcard, postmarked 12 May 1916. I first came across the heliochronometer in 1999 when I attended a meeting for people involved with local societies in Test Valley (the area of Hampshire in which Stockbridge stands) and noticed the dial in the garden. As soon as the meeting finished I went out to look at it and take details.

The serial number is 142 and as well as Pilkington & Gibbs Ltd., Preston, it has the name Charles Dales, Optician, Bournemouth on the calendar disc. It is not in perfect condition – one flange is missing and a peg on the calendar ring and the time marker block are also gone.



Marsh Court was designed in the Tudor fashion by Lutyens in 1901-4 and is made of chalk ashlar with random bits of flint and tile. My thanks to Roger Bowling for sending me Chapter V of *Houses and Gardens by E. L. Lutyens* by Sir L Weaver (1931) many moons ago. It features a nice picture of the dial with lead inlay.

I have two postcards of Marsh Court that are the same and both posted in 1916. One mentions that it is from Marsh Court Hospital. It appears that it was an Auxiliary Home Hospital in World War I, which, not being a Military or Civil Hospital, acknowledged the authority of, or received assistance from, the County Directors. It was the entrepreneur Herbert Johnson who persuaded Lutyens to build Marsh Court for him. He was an extremely generous man and during the First World War the Johnsons ran a 60-bed hospital for wounded soldiers in Marsh Court entirely at their own expense. Marsh Court was on the market in April 2007 for in excess of £13 million. It is not open to the public.

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# THE ENGLISH SCRATCH & MASS DIAL ERA: ORIGINS TO c.1250

CHRIS H. K. WILLIAMS

Compared to the subsequent (c.1250 – c.1650) evidential period,<sup>1</sup> we are considering a much longer elapsed time, whose origins are lost in the mists of early history, with surviving evidence some two orders of magnitude less abundant – a mere 50 Saxon dials have been recorded.<sup>2</sup> Obtaining a full and accurate picture from such limited evidence poses two questions. The specific context of what survives; and, just as – if not more – important, the context of what has not (see Fig. 1). Recorded Saxon dials cannot be considered representative, and any survival (not yet found) of other (more primitive) mass dial types is exceedingly unlikely. As surviving direct evidence yields a partial and potentially misleading picture, this article also considers the more indirect evidence, factors hitherto bypassed in the dialling literature.

The prime contextual element is that of the churches with which mass dials are associated.<sup>3</sup> On the basis of written records (primarily Bede) there were at least 100 churches in England by 700. Given the fragmentary nature of original sources and the recorded number of monasteries and bishops, this must be but a small (yet unknowable) fraction of the churches by then established. Documentary sources indicate almost all were built of timber; few of the earliest churches were of stone, usually recycled Roman material. The typical early pattern was for monasteries, initially established with royal but subsequently also aristocratic patronage, to act as a base from which a network of dependent churches developed. Not all of these had a full time permanent priest. An accelerating trend towards localism began in the eighth century as lesser lords established their own local estate churches.<sup>4</sup> Many if not most churches were too small for their congregation which gathered outside around the cross. The Domesday Book refers to some 3,000 churches. Detailed research indicates that allowing for those omitted results in an estimate of 6-7,000 at the time of the Conquest.<sup>5</sup> Only about 400 churches are now thought to contain any Anglo-Saxon fabric, three-quarters of which can be dated to post-950.<sup>6</sup> That so little survives reflects both the original preponderance of timber churches and the destructiveness of the Norman rebuilding.

Only the most distinguished and important churches were (re)built in stone. All others were of timber. As indeed was all non ecclesiastical Anglo-Saxon building, including all that for royalty – a reality mirrored in the entire Old English

building/construction vocabulary relating to wood.<sup>7</sup> Churches were the first, and for a very long time the only, departure from timber construction. Even when the tenth and eleventh centuries were witnessing a boom in stone church building, and even if overall expenditure on stone building exceeded that in timber, it is probable most churches were still (re)built in timber.<sup>8</sup>

As most Saxon dials were obviously associated with stone churches, they mainly date to the end of the Saxon period. Recorded dials occur on about 10% of churches with some Anglo-Saxon fabric. Depending on their original incidence there is a maximum attrition over the course of a millen-

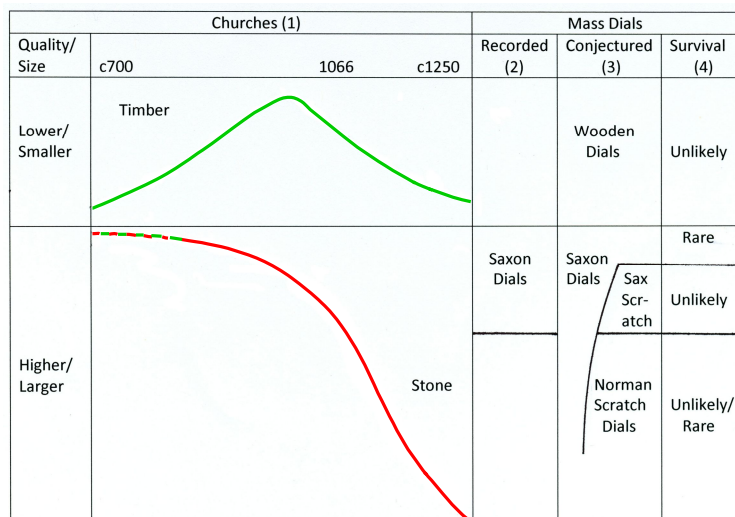


Fig 1. Categorisation of Anglo-Saxon mass dials and churches.

Notes (see main text for discussion)

1. Indicative evolution of churches; their total is represented by the gap between the curves. Most churches were of timber and small. The Great Norman Rebuilding simultaneously destroyed most of what pre-existed and accelerated the trend towards larger higher quality stone churches.
2. This article uses the term 'Saxon dials' as it has come to be understood in the literature – high quality carved mass dials. They were associated with high quality churches, primarily a feature of the later Saxon period.
3. Predicated on dial universality, predominance of timber use, and the virtually complete destruction of original dials. Saxon dial survival might reflect their continued use and manufacture in Norman times. The possibility of Saxon scratch dials cannot be excluded.
4. Survey rates suggest visible survivals have been found. Any additional evidence requires archaeological retrieval and would be of a 'one-off' nature.



nium of 90%. At just 0.25%p.a. this is substantially below the loss to be expected for scratch dials of such great age.<sup>9</sup> But Saxon dials are not scratch dials; they are carved, many deeply, many in relief. That is why they have survived; being more robust not all have weathered out, being artistically attractive they have better cheated rebuilding's destructive nature. Any scratch dial is most unlikely to have survived; none has yet been recorded.<sup>10</sup> Did all late Saxon stone churches have a mass dial? Statistically all we can infer is that unless the majority originally had a Saxon dial their survival rate is implausibly high. As the highest quality churches, is it not inconceivable they were without a mass dial? If not a Saxon dial then at least a scratch dial.

*Fig 2. The Celtic dial at Clynog Fawr, Caernarfonshire. It is presumed to have been originally located within the nearby monastery founded by St Beuno in the seventh century. Photo by Mike Cowham.*



Looking beyond late Saxon stone churches (i.e. to most of the elapsed time and the vast majority of churches), there is limited British evidence in the form of incised/carved dials on freestanding stone columns thought to have been originally erected in the vicinity of churches. Recordings, with one exception, are Celtic (Fig. 2) – a dozen Irish (spanning the seventh to twelfth centuries), a pair of Welsh, and an Isle of Man dial(s).<sup>11</sup> Only a single, stylistically very different, English example at Bewcastle (dated to c.700) is known.<sup>12</sup> Most Celtic dials can be linked to an important monastic site. Clearly England had fewer and later sites of comparable stature. Even so the disparity in recordings is glaring. There can be no doubt these were very expensive dials, limited to churches of ecclesiastical import or with indulgent patrons. These would have been the largest and best of timber churches and the earliest to be (re)built in stone. Dials of such quality would not have graced the typical small timber church.

What, in terms of mass dials, happened at the vast majority of Anglo-Saxon churches – the humble wooden church in need of frequent rebuilding? The only absolutely certain fact is that not an iota of direct evidence has yet been found. The *a priori* case for the universality of mass dials has already been presented.<sup>13</sup> Exhaustive statistical analysis has

demonstrated its validity in the post-1250 evidential period. We have also noted that a majority of late Saxon stone churches must have had Saxon dials. Can we, in the face of a virtual absence of any other recorded dials, presume universality? How far back might it be reasonable to do so?

Recorded freestanding stone dials, of themselves, prove sundials were familiar objects within British monasteries from at least the seventh century. Although Celtic rather than English, monasteries were the intellectual international internet of their day. Given their central role in propagating English Christianity, as well as the particular contribution of Irish monasteries, it must be taken as axiomatic that sundials were from the outset well known to the English church. Time was always a matter of particular interest to the Church; both the hours to organise the day, and the calendar to determine Easter. Bede's temporal deliberations and mention of sundials are well known.<sup>14</sup> A related concern was the broadcasting of time; Pope Sabinianus (604-6) issued a Bull stipulating bells mark the canonical hours.<sup>15</sup> It is also essential to recognise that time indication was not the only, or even (especially in the Church's early days) the primary, function or purpose of dials. They need to be interpreted within their contemporary artistic/cultural traditions. As such a symbolic role is only to be expected, most obviously via allusions to the sun. Sundials could have been part of the Christian riposte to, or accommodation of, pagan iconography.<sup>16</sup>

The paradox between the indirect evidence indicative of widespread awareness, need and use of sundials with the almost nonexistent direct evidence of survivals, can only be reconciled if the predominant material medium of dials was not stone. The locally available repertoire of vernacular craftsmanship was confined to timber.<sup>17</sup> It would have been the economical resource most naturally called upon to make dials for the vast majority of Anglo-Saxon churches, just as it was for the churches themselves. What did wooden dials look like? Probably similar to their stone cousins. Wooden crosses close to churches were common. These could easily accommodate a sundial, in exactly the same way as the Bewcastle Cross.<sup>18</sup> Again mirroring their stone cousins, it is easy to imagine dials made from wood boards. Wooden dials undoubtedly ranged from the crudely incised to the intricately carved.<sup>19</sup> For most of the Anglo-Saxon period timber was the only structural material; stone only began to make significant inroads in late Saxon times, precisely when the frequency of recorded Saxon dials becomes non negligible.

Interpreting the Anglo-Saxon era is thus not just a simple matter of examining its surviving dials. Recorded Saxon dials are a highly skewed sample illuminating, probably reasonably accurately, one specific corner – mass dials at high quality late Saxon stone churches. The rest is in effect a black hole. Any recordings not attributed to the late Saxon period constitute another even smaller and more skewed sample. The two usual reactions to limited data – it is a



Fig 3. Saxon (left, Bishopstone, Sussex - photo by Mike Cowham) and scratch (right, Waltham, Kent - photo by Tony Wood) dials compared. Although equivalent in purely functional terms, the Saxon dial is of a much superior aesthetic quality. Note the

- use of a specially chosen, as opposed to a normal structural, stone;
- fine carving, rather than crude incising;
- elaborately carved decorative frame;
- inclusion of a carved inscription.

reflection of original absence, or await additional evidence – are both misplaced. Whilst it is hoped additional evidence will come to light, the discovery of Anglo-Saxon scratch or wooden dials would be an archaeological triumph.<sup>20</sup> But it is totally unrealistic to expect any such evidence will ever be found in sufficient quantity to discriminate between the two competing hypotheses – were mass dials uncommon or were they (near) universal with the evidence destroyed in the interim? There is no alternative to going beyond direct dial evidence; not to do so would be unscientific.

Is there any way of assessing the validity, beyond that of the factors on which it is predicated, of this article's conjectured hypothesis? A true hypothesis invariably gels with other data and resolves interpretive conundra. Were the mass dials of Saxon times as different from their medieval successors as indicated by what is generally accepted to be Saxon dials versus scratch dials? (Fig. 3.) If they were it would be a degree of retrogression not mirrored in any other contemporaneous field of artistic or cultural endeavour. A convincing explanation why sundials alone should be so prone to severe relapse is not obvious. In our conjectured hypothesis medieval scratch dials had equivalent Anglo-Saxon ancestors. And the true descendants of Saxon dials, the upmarket – the best there is – statement, are clocks and scientific sundials not scratch dials. Turning to another example, exhaustive statistical analysis has established mass dial universality post-1250. Although the data do not exist to prove it earlier, why universality should be as late as c.1250 is not obvious. Our conjectured hypothesis removes such problems, pushing any non universality back towards the origins of Christianity. One cannot consider the Anglo-Saxon period without the Canterbury pendant seasonal hour altitude dial, dated to the tenth century, coming to mind.<sup>21</sup> Made from silver and gold it is an upmarket product. Less well known is that a virtually identical dial, made of bog-oak and bone, survives.<sup>22</sup> The use of wood is noteworthy *per se* and because it suggests portable dials were common, both of which are fully consistent with our conjectured hypothesis.

Readers will have to reach their own conclusions bearing in mind that the statistically proven standard of the evidential period can never be attained for Anglo-Saxon times. Short

of a council of despair, we have no choice but to do the best possible, hence the conjectured hypothesis. Although in an absolute sense unproven, it is the interpretation that most coherently integrates four separate considerations – the characteristics of the Christian church, the dominance of timber, a plausible transition to the evidential period, and the paucity of surviving dials.

Accepting the conjectured hypothesis, would the churn (loss and replacement of in use dials) and redundancy (leading to the progressive accumulation of multi-dialled churches) typical of the evidential period have occurred? They would have manifested themselves differently. For wooden dials at timber churches, churn would have been accentuated to such an extent (by deterioration of the dial itself/frequent periodic rebuilding of the church) as to preclude the accumulation of redundant dials. In the case of stone (including scratch) dials cumulative redundancy would be muted by the comparatively short lifespan of churches.<sup>23</sup> An Anglo-Saxon church with two mass dials would have been unusual, more an exceptional rarity.

#### REFERENCES AND NOTES

1. Chris H.K. Williams: 'The English Scratch & Mass Dial Era: The Evidential Period c.1250 to c.1650', *Bull BSS*, 21(iv), pp.18-19, (2009).
2. We continue to focus on dial prevalence with style and type deferred to subsequent articles. Recorded Saxon dials have recently been reappraised by David Scott & Mike Cowham. Their monograph, *Timekeeping in the Medieval World*, is expected later in 2010.
3. Brevity precludes inclusion of much supporting material and citation of all sources consulted. Three comprehensive works are P.H. Blair: *An Introduction to Anglo-Saxon England*, CUP, 3<sup>rd</sup> Ed., (2003); E. Fernie: *The Architecture of the Anglo-Saxons*, Batsford, London, (1983); R. Morris: *The Church in British Archaeology*, Council for British Archaeology, (1983). Each contains an extensive bibliography.
4. Some had the consent of the minster, others were unilateral. Unlike minster-dependent churches these were in the private ownership of laymen – subject to inheritance, sale and purchase. A private church conveyed 'thegnly' status plus a source of income and influence. This dual provision of minster and propriety churches created, especially as church density increased, financial and jurisdictional disputes, resulting in numerous tenth and eleventh century law codes categorising different types of church.
5. Mention of a church is incidental to the Domesday Book's purpose – taxation and ownership. The estimated number of churches takes account of the differing conventions adopted by

- the five groups of Domesday commissioners, the 1254 and 1289-91 tax surveys, and many detailed local studies suggesting around three quarters of medieval churches are on Saxon sites. See R. Morris: *Churches in the Landscape*, Dent & Sons, (1989).
6. H.M. & J. Taylor: *Anglo-Saxon Architecture Vols. I, II & III*, CUP, (1965 & 1978).
  7. 'To build' is *timbran*.
  8. St Dunstan (Archbishop of Canterbury, 960-88) is recorded building timber churches. His biographer notes that on finding a church incorrectly orientated, Dunstan achieved the desired alignment with his shoulder! See W. Stubbs (Ed): *Memorials of St Dunstan, Archbishop of Canterbury*, (1874). As late as 1020 a court chronicler saw fit to leave no doubt a church endowed by Cnut was of stone and lime.
  9. Williams: *Op. cit.* and references therein.
  10. Statistically expected Anglo-Saxon scratch dial survivals, before allowing for Norman destruction, are in single figures. Moreover, unless any survival could be definitively placed in an Anglo-Saxon horizon, would it be recognizable as such?
  11. M. Arnaldi: *The Ancient Sundials of Ireland*, BSS, (2000); W. Linnard: 'Welsh scratch dials', *Archaeologia Cambrensis*, 156, p141-7, (2007).
  12. C.K. Aked: 'Bewcastle Cross Part I & II', *Bull BSS*, 95(1) & (2), 2-8 & 10-17, (1995); K. Schaldach; 'Bewcastle Cross', *Bull BSS*, 95(3), 47 & 34, (1995).
  13. Chris H.K. Williams: 'The Life Cycle of English Scratch (Mass) Dials', *Bull BSS*, 20(iv), 164-5, (2008).
  14. *De temporibus* (704) & *De temporum ratione* (725).
  15. Efforts to locate an authoritative source for Sabinianus' alleged requirement churches have a sundial failed. The bell ringing Bull can be traced to Onofrio Panvinio (1557), papal librarian and historian. The sundial attribution appears to be a tradition established by subsequent students.
  16. It is a misconception to view Christianity and paganism in binary terms. Evidence of coexistence and accommodation abound. Some kings literally hedged their bets by supporting both. Paganism was polycentric, adopting another deity (or form of magic) was not the absolute issue it was for monotheists. Springs and wells were important pagan sites, yet many early churches were established near them. Animal sacrifices were tolerated if part of feasting rather than the ceremony. There is even evidence priests were present at the casting of spells, parts of which might even take place in church. Traces of paganism were never entirely extinguished. As late as Cnut, law codes forbade the worship of 'idols, heathen gods, the sun or moon, fire or flood, springs, and stones or any kind of woodland tree'.
  17. Until late Saxon times stone work was the alien craft, sourced via the international monastic network, as indicated by the Mediterranean influence discernable in the Bewcastle Cross' carving.
  18. It is interesting to speculate that wooden Celtic dials were made by the Celts; and that the apparent triumph in England of the Bewcastle model over the Celtic could reflect the latter becoming, at least in England, politically incorrect after the ascendancy of the Roman faction at the Synods of Whitby (664) and Hertford (672).
  19. The former dismissive view of Anglo-Saxon carpentry has been decisively rejected. See C. A. Hewett: *English Historic Carpentry*, Phillimore, (1980). During the Saxon, Norman and Early English periods the system used for timber buildings seems to have been constant. Surviving examples of craftsmanship shows a high level of skill and the use of sharp sophisticated tools. Doors used seasoned timber. Anglo-Saxon carpentry was neither embarrassed nor eclipsed by their medieval successors.
  20. On three counts. Any survival would be exceptional – wood for obvious reasons, see note 10 for scratch dials. Next any find would have to be in an undisturbed and indisputably Anglo-Saxon horizon. Finally would any (partial) survival be recognised as a dial by the archaeologists? The other potential evidence is documentary. But it is sadly true that sundials are not on the agenda of scholars who regularly read original sources, and few diallists are competent to do so. Accumulation of such evidence will be a long slow process.
  21. A.A. Mills: 'The Canterbury Pendant: A Saxon Seasonal-Hour Altitude Dial', P.I. Drinkwater: 'Comments upon the Canterbury Pendant', and A.J. Turner: 'The Canterbury Dial', *Bull BSS*, 95(2), 95(3) & 96(1), 39-44, 48 & 46-7, (1995 & 1996).
  22. Turner: *Ibid.*
  23. Almost all surviving medieval churches lived through the entire 400 year evidential period. A 400 year old stone Anglo-Saxon church would have been a rarity. Most were built in the tenth and eleventh centuries and subsequently destroyed by the Normans. Furthermore their small size can only have reduced redundancy attributable to dial relocation.

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## THE ANCIENT ASTRONOMERS OF TIMBUKTOU

In his article on the replica Timbuctou Sine Quadrant (*Bull* 20(iv), pp.166-8, Dec 2008), Malcolm Barnfield described making a quadrant for use as a 'prop' to be used in the making of a film about the conservation project for the ancient astronomical manuscripts of that city. The finished film is now available as a DVD. It costs R170 (about £14) and details, together with a short preview, can be found on the website of Johannesburg Planetarium at [www.planetarium.co.za/](http://www.planetarium.co.za/).



## MRS GATTY ONLINE

The project to make Mrs Gatty's famous *The Book of Sun-Dials* available online has now been completed. It may be found at <http://tinyurl.com/y9r7r4f> (the full URL at Penn University is much longer). The website shows scans and full transcriptions of every page of the 4<sup>th</sup> (Eden & Lloyd) edition from 1900 which is by far the best.

The transcription was part of the collaborative 'Celebration of Women Writers' project so diallists benefit from a little gender bias. Thanks go to Michael Harley for bringing the project to the Editor's attention.

# THE DIAL DESIGNED FOR CHURCH STREET, SHEFFIELD, BY E A PIPPET

MIKE COWHAM

Some years ago my father was given a notebook by his friend Wilfred Pippet (Pip) with whom he had worked for many years. He gave it to him because Pip knew that I was interested in sundials.

The notebook (Fig. 1) belonged to Pip's father, E.A. Pippet, and the front section of it consists of his copying the text from the third edition of *Sun-Dials* by Eden & Lloyd (1890) that describes the construction of sundials: *Geometrical Methods of Delineating Sun-Dials* by W. Richardson. The text has been carefully copied together with the constructional drawings. He has carefully drawn each with compasses and ruler following the instructions in the text. He obviously made a mistake on one and has written "Not Correct" above it.

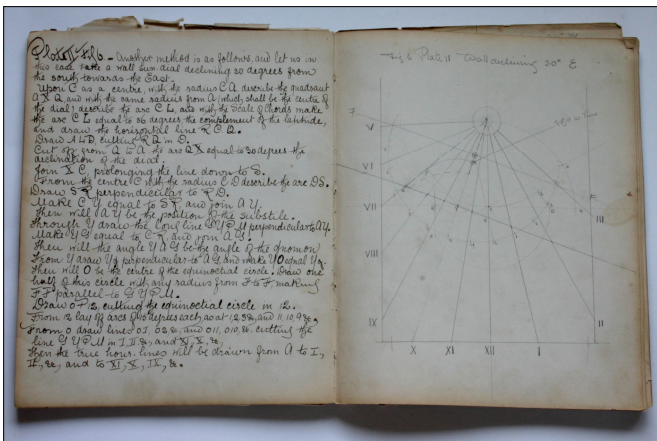


Fig. 1. E.A. Pippet's notebook.

There are also pages copied from *The Art of Dialling* by William Leybourn of 1681.

Between the pages of the notebook are three letters from "R Bailey, Optician to the Eye Hospital, Instrument Maker to the Admiralty, the Honourable Board of Inland Revenue, and Foreign Governments. Manufacturer of Spectacles, Eye Glasses, Opera Glasses, Thermometers, Barometers, Telescopes, Philosophical and Photographic Apparatus, &c, 14 Bennett's Hill, Birmingham" dated 1895 and signed by a James Potts.

The 1881 Census gives Potts' address as 102 Broad Street, Birmingham, and his occupation as 'Optician Master Employing 2 Men, 2 Boys & 5 Girls'. E.A. Pippet had obviously been in touch with Potts, a well known instrument maker, about designing sundials and Potts has advised him.

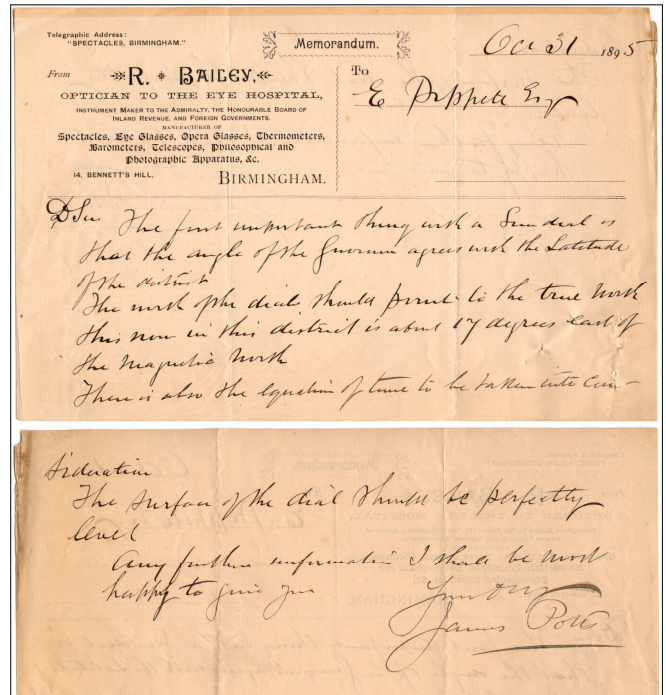


Fig. 2. Letter from James Potts, October 31, 1895.

In his first letter dated Oct 31 1895 to Pippet, he writes (Fig. 2):

D Sir,

*The first important thing with a Sundial is that the angle of the Gnomon agrees with the Latitude of the district.*

*The north of the dial should point to the true North. This now in this district is about 17 degrees East of Magnetic North.*

*There is also the equation of time to be taken into consideration.*

*The surface of the dial should be perfectly level.*

*Any further information I shall be most happy to give you.*

*Yours faithfully,*

*James Potts.*

The two other letters of November 7 and 26 are obviously replies to further questions by Pippet.

One of the pages of his notebook is headed "New Bldgs Ch. St. Sheffield" with "Wall declining 27°W" and giving "Lat

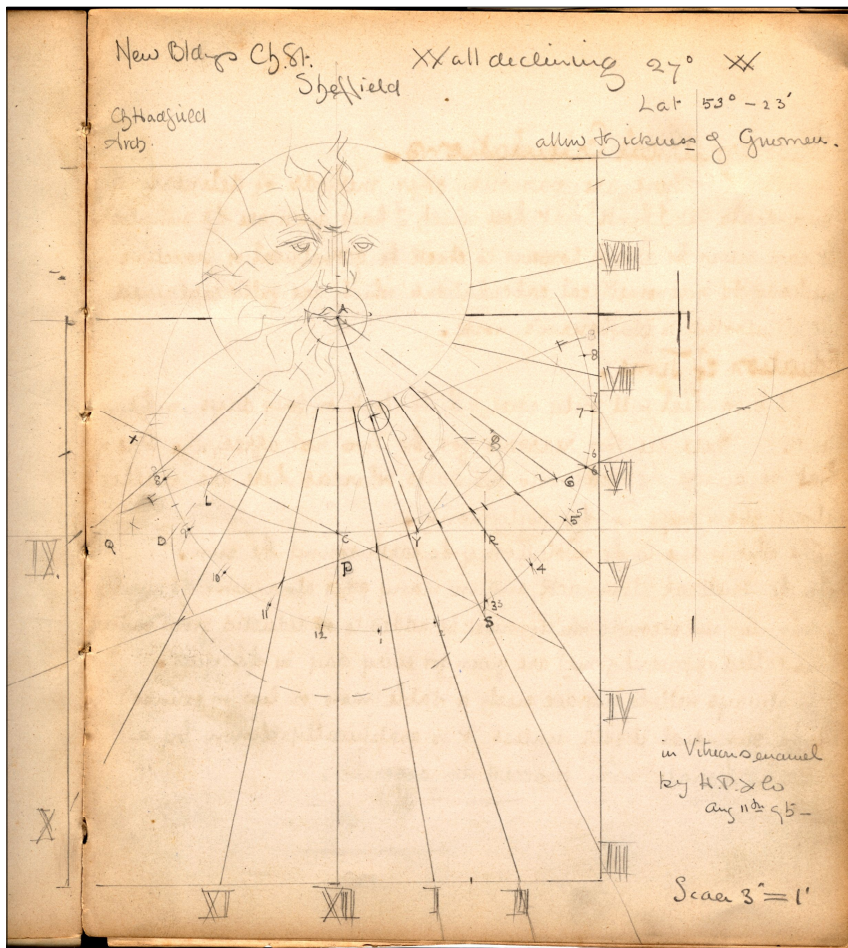


Fig. 3. The sundial design from Pippet's notebook.

53° - 23' ” with a further note saying “allow thickness of Gnomon”. Below this (Fig. 3) is the construction of a fairly standard west declining sundial complete with a Sun's face at the centre at a “Scale 3” = 1””. A further note to the side says “in Vitreous enamel by H. P. & Co Aug 11th 95-”. Near the top left is written “Ch Hadfield Arch” referring to Charles Hadfield who was the architect of Cairns Chambers (20 Church Street) in Sheffield. The building was erected between 1894 and 1896 and was in the Tudor Gothic style with decorative exterior stonework by Frank Tory including a four foot statue of Earl Cairns, a former Chancellor, at the front.

The drawings in this notebook are obviously the original designs for the sundial to be erected on New Buildings in Church Street and shows how Pippet taught himself how to make such a dial. Comparing his drawing with a modern computer plot (ZW2000) reveals that his dial is correct to within the thickness of a line.

The scale of 3” = 1” means that this is quite a small dial with a width of about 20” across the rectangle giving a finished dial size of probably 3 feet high and 2 feet wide, plenty large enough for a vitreous enamel panel.

The BSS Sundial Register was consulted first and a dial is listed at 20 Church Street with the note “Was on District Bank” (SRN2533). A visit to Sheffield was



Fig. 4. The dial currently at 20 Church Street.



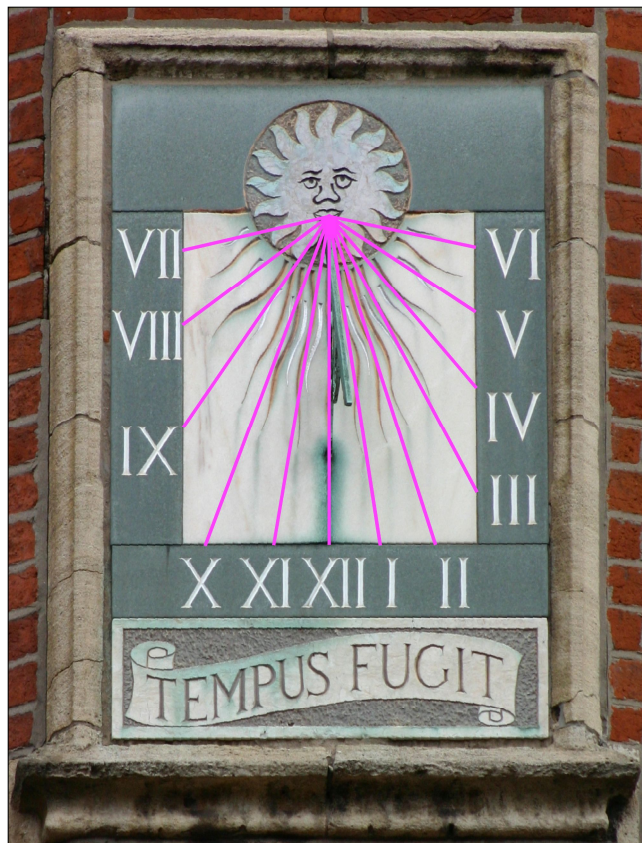
Fig. 5. The corner of 20 Church Street, Sheffield.

made in order to locate this dial and to find out if it was the same dial as in the notebook. The visit confirmed that there is a dial (Fig. 4) on that building (recently sold for development but the local planners have stipulated that external modifications must not be made – Fig. 5). Hopefully the dial will survive these changes.

However, the dial on this building is not quite as drawn by Pippet: it is made from stone (probably marble) and is obviously more modern than 1895. Therefore, it seems that his dial must have been damaged, probably by the weather, but was replaced by a dial with similar detail, subsequently being moved to another location nearby. The present design, although different, retains the Sun's face and now carries the motto 'TEMPUS FUGIT'.

As it is a rather vague layout without hour lines, just using the numerals to indicate the hours, the image was rectified to make the Sun's circle perfectly round and a series of plots were laid over it to determine the current declination (Fig. 6). The nearest fit seemed to have a declination of about 9° west, so obviously not the same as in Pippet's original design that has a declination of 27° west.

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*Fig. 6. Overlaying a dial design for 53.4° north and declining 9° west gives about the best fit.*

## HOLIDAY SIGHTINGS (1)

### Olive Harvesting in Spoleto, Umbria, Italy

Last November I visited Italy to help with the annual olive harvest. Situated on an Umbrian hillside a few kilometres from the town of Spoleto lies the beautiful villa and park of the Villa Pianciani Delizia, an Italian national monument built by the neoclassical architect



*Above: The Villa Pianciani Delizia and, left, the meridian line in its grounds.*

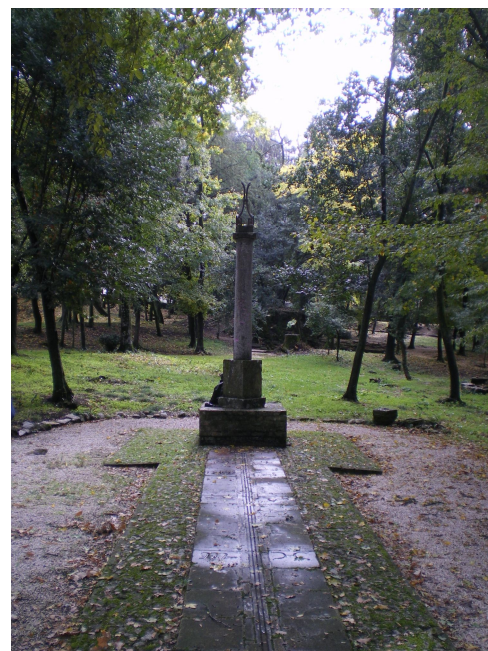


Giuseppe Valadier (creator of Piazza del Popolo in Rome) in the late 18<sup>th</sup> century. This was the summer residence for Count Giuseppe Valadier.

The villa itself is undergoing a major restoration programme. Located within the park is a noonmark sundial which is also in need of some restoration work. Zodiac markings can be seen along the meridian line.

I discovered a similar noon mark sundial at the Villa Redenta, also in Spoleto.

*David Payne, Norfolk*



*The similar meridian line at the Villa Redenta is in slightly better condition.*

# READERS' LETTERS

## Marke altitude dial

I would like to add an observation to the article by Lowne & Davis on the John Marke altitude dial, published in the September 2009 *Bulletin* (21(iii), pp.2-8).

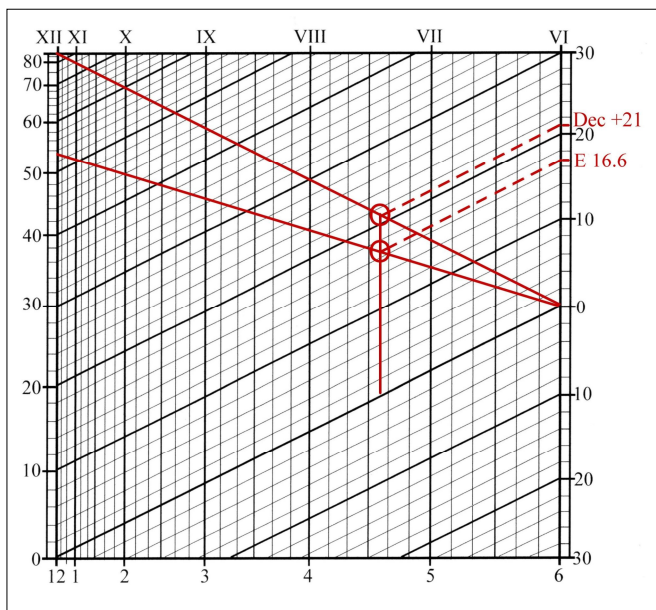
The instrument requires the calculation of  $E$ , the sun's altitude at 6 am or pm. The formula used in the article:

$$\sin E = \frac{1}{2}[\sin(90 - \varphi + \delta) - \sin(90 - \varphi - \delta)]$$

can be expressed as

$$\sin E = \sin \varphi \sin \delta$$

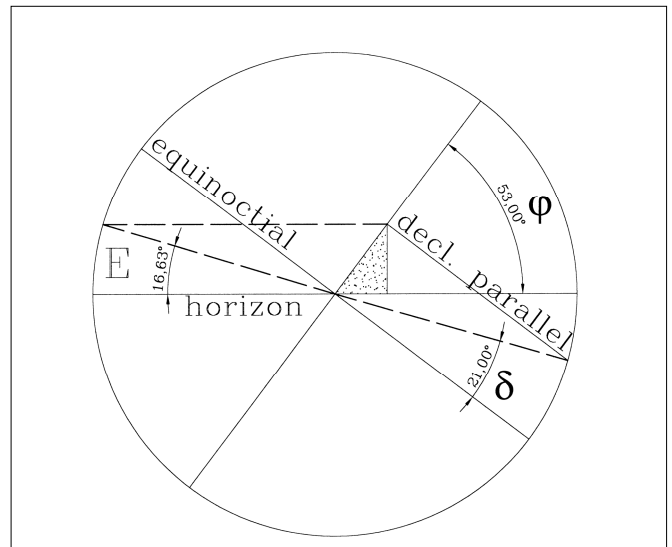
This allows the use of the Marke diagram in a simpler way, with a smaller risk of error.



Marke dial set up for lat  $53^\circ$  N, declination  $+21^\circ$ .

1. Pull the thread of the plumb line through to the dial face and stretch it from the  $90^\circ$  point on the left hand (LH) scale to the  $0^\circ$  point on the RH scale.
2. Mark the intersection point where the thread crosses the diagonal declination line – in the illustration, for  $\delta = 21^\circ$  (the higher dotted line). A small spot of wax could be used for this.
3. Trace or imagine a vertical line (parallel to the hour lines) through this intersection.
4. Position the sliders so that their thread stretches between the latitude,  $\varphi$ , on the LH scale and  $0^\circ$  on the RH scale ( $53^\circ$  and  $0^\circ$  in the illustration). Where it crosses the aforesaid vertical line gives the value  $E$  by following the lower dotted diagonal line up to the RH scale.

I believe that, in the 17<sup>th</sup>-century, graphical solutions to problems were generally preferred to trigonometrical ones, especially in England. The problem is solved by the 'Analemma of Ptolemy', shown in the second illustration.



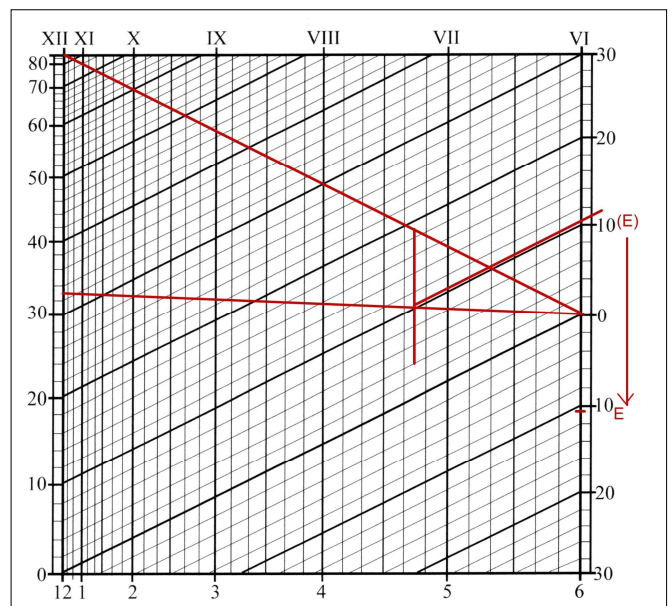
The 'analemma of Ptolemy' showing the sun's altitude at 6 am/pm for lat  $53^\circ$  N, declination  $+21^\circ$ .

Alessandro Gunella,  
Italy

## Michael Lowne comments:

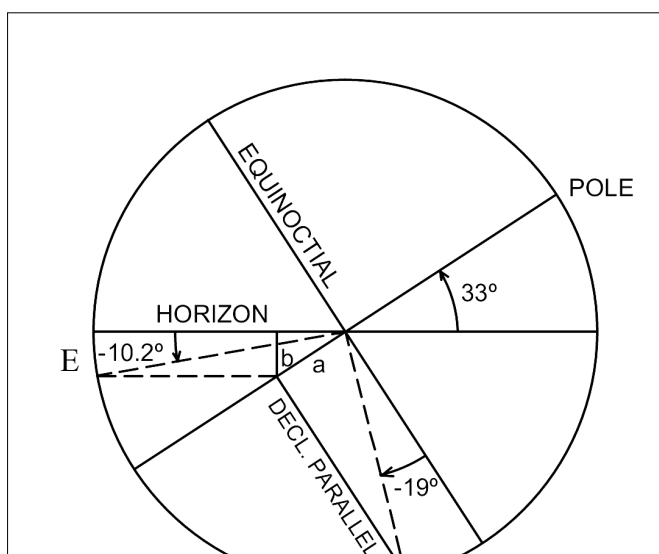
This is an ingenious solution to the problem of deriving the value of  $E$  and is potentially less liable to error than the method we proposed. Some additional explanation and comment appears necessary.

Taking the sides of the square as the unit, the vertical distance of any point on the  $90^\circ - 0^\circ$  line from the  $0^\circ - 0^\circ$  line is equal to  $\sin \delta$ , as is found by step 2. As the slope of the  $0^\circ - 0^\circ$  line is 2 horizontally to 1 vertically the horizontal distance of the perpendicular line (step 3) from the r-h side is also  $\sin \delta$ . The height of the  $\varphi - 0^\circ$  line (step 4) from the  $0^\circ - 0^\circ$  line varies with the distance from the r-h side and by



Marke dial set up for lat  $33^\circ$ , declination  $-19^\circ$ .

similar triangles is equal to  $\sin \phi$  times this distance. But the distance is  $\sin \delta$ , therefore the height at the intersection point of step 4 is  $\sin \phi \cdot \sin \delta$ , equal to  $\sin E$ . Transferring the height to the r-h scale by a sloping line sets the point  $E$  on the scale. This is valid for declinations of the same sign as the latitude, but for those of opposite sign would need to be transferred to the lower part of the diagram, the reverse of the necessary procedure for the our proposed method. The value for  $E$  is of course valid for any one day and it is still necessary to calculate the daily value of  $U$  to set the l-h slider to the correct value.



The 'analemma of Ptolemy' showing the sun's altitude at 6 am/pm for lat 33° N, declination -19°.

Alternatives to the use of the plumb-bob cord could have been to arrange an extension to it on this side of the dial with a sliding bead to indicate the appropriate setting for  $\delta$ , or, as the 90°-0° line is used for every declination, a line could have been permanently engraved on the surface.

In the absence of any written instructions, it is not possible to say with certainty how Marke intended the dial to be used. Of the three methods proposed to find  $E$ , the one outlined here is perhaps to be preferred. However, the use of dividers to lay off distances from scales was common in the 17<sup>th</sup> century.

### Mass Dial Nomenclature and Taxonomy

It is perhaps a measure of how far mass dial studies have progressed that there should be a paper<sup>1</sup> on the etymology of the term 'mass dial'. In general, 'mass dials' and 'scratch dials' are synonymous with 'medieval dials' being a more formal description. Scratched dials created more recently are just that and are noted for reference purposes in case they are 'discovered' and notified to the Registrar.

The Mass Dial Register now being compiled also now includes what have been known as 'Saxon' dials, for long in limbo as they have also sometimes been included, on vague stylistic grounds, with ordinary sundials in the Sundial Register. The standing stone early dials in Ireland and Wales are contemporary with Saxon dials but of Celtic origin.

Consequently 'Saxon/Celtic' will be adopted formally, covering pre-Conquest and early post-Conquest dials. It is expected that recent research by Mike Cowham<sup>2</sup> will extend the known corpus of 'Saxon' dials somewhat, several mass dials being re-classified.

Whilst we do not record Continental dials it is desirable to have as many examples as possible in our files. As those countries did not have the benefit of Norman Conquest and its consequent step-change in dial style, it is of interest to see if our 'Saxon' type is unique or derived from across the Channel.

Please, can our members snap away with their digital cameras at any likely looking 'medieval' dial whilst on holiday?

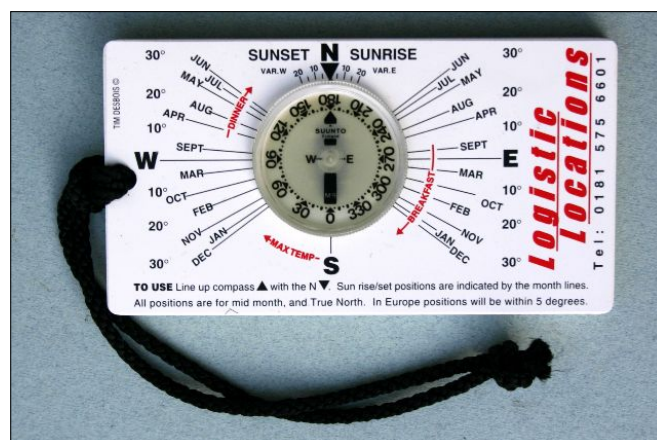
1. D Schneider: *Comment dit-on "cadran cononial" à l'étranger?*, CCF/SAF, Paris. Private communication, t.b.p. (Sept 2009).
2. D. Scott & M. Cowham: *Time Keeping in the Medieval World – a study of Anglo-Saxon and early-Norman sundials*, BSS Monograph no. 6 (t.b.p. 2010).

Tony Wood  
Gloucestershire

### Sun Position Compass

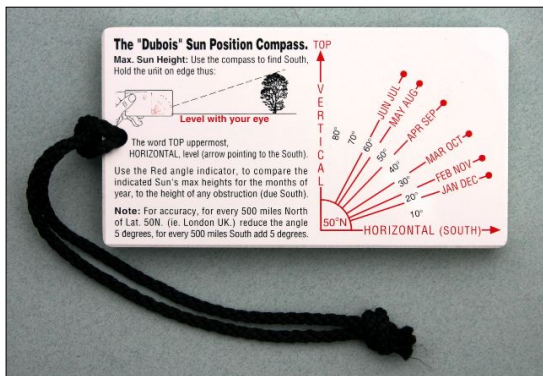
The article by Tony Belk on the 'photographer's sundial' in the December *Bulletin*<sup>1</sup> reminded me of a different form of compass for use by gardeners, house buyers and aviators, with the full title Sun Position Compass. The latter application was the inspiration and I recall reading a feature in the *Daily Telegraph* in 1997 about the difficulties of convincing documentary film makers that the sun's position could not be to 'order' for a helicopter tracking shot of a particular location or valley. The designer, Tim Desbois, is a film location manager and pilot who developed the instrument to show producers that for each season, the sunrise and sunset directions can be quite different from the simple 'sunrise in the east, sunset in the west'.

Although many were sold to photographers, a larger market is for gardeners and house buyers. On the reverse is a solar



The sun position compass that shows the sunrise and sunset directions for the months of the year. Note the additional information for where to position the breakfast table for a sunny start to the day. (The current telephone number is 020 3210 1040.)





The reverse shows the sun's height throughout the year.

declination scale to determine whatever trees or building will obscure the sun throughout the months.

The instrument is in the form of a very durable plastic block with a quality fluid-filled compass. It comes in a soft pouch and with a leaflet giving magnetic variations, a table of world-wide hours of daylight, sunrise-sunset positions world-wide, and maximum height (declination) of the sun, again world-wide. The tables are for 10° latitude increments, and the printing on the sun position compass are based on a nominal 50°N.

Since the original design in 1992, some 20,000 have been sold. The American market has a different delineation for an average latitude between Los Angeles and New York. For marketing purposes the name was given as the DuBois sun compass, although the emphasis is now on 'flight logistics'. More information may be found on their website [www.suncompass.info](http://www.suncompass.info). The alternative site [www.flight-logistics.com](http://www.flight-logistics.com) stresses the aviation background, and points out that customised versions can be made.

1. Tony Belk 'A Photographer's Sundial', *Bull BSS*, 21(iv), 26-27, 39 (2009).

Douglas Bateman  
Crowthorne

## Clockmakers and Dialmakers

I read the article on Robert Cutbush (*Bulletin* 21(iv), Dec 2009) with interest. It may be worthwhile to consider Cutbush in a broader Kentish context.

I am researching the history of time keeping in Ashford (Kent) and its surrounding parishes. Seventeenth-century clockmaking was dominated by successive generations of the Barrett and Greenhill families. From churchwardens' accounts it is clear they also made brass sundials and they have now been included in the 2<sup>nd</sup> edition of Jill Wilson's *Biographical Index*. As skilled metal workers, making a sundial would have been well within the compass of many if not most clockmaking workshops. Delineation need not have been from first principles but from templates, as suggested by the mention of "the Sun Dyal tools" in the inventory of Thomas Deale of Ashford. This inventory is the most illuminating insight into a clockmaker's tools and materials that I have to date seen - a detailed listing some fifty lines in length, rather than the usual summary generic description of at most five lines. There can be no doubt Deale's inventory of tools is far more indicative of reality than the typical inventory which masks far more than it reveals.

I suspect the dual provision of dials and clocks was, until c.1680/90, more the norm than the exception. Certainly it was much more common than either diallists or horologists tend to be aware of or acknowledge. In large part this is a reflection of the fact that they have in the past been two essentially separate (research) communities. As the past (artificial) barriers progressively come down, the true association of sundials with clocks and clockmakers will be increasingly established and appreciated - see for example Sir George White's article in the Sept 2009 edition of *Antiquarian Horology*.

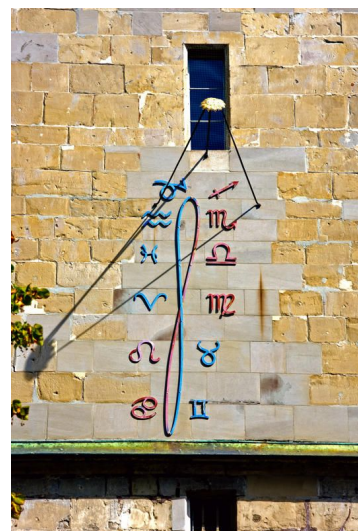
Chris HK Williams,  
Charing

## HOLIDAY SIGHTINGS (2)

### Winterthur, Switzerland

This unusual combination of a vertical declining dial and a noon mark analemma are on the church tower at Winterthur, not far from Zurich. Of particular note is that the vertical dial has been corrected for longitude, as evidenced by the fact that the XII line is not vertical, which it would be if it were indicating local solar noon.

The analemma is cleverly colour-coded into the two halves of the year so that the problem of deciding which line is applicable is made much easier—as long as you can remember the current position of the sun in the zodiac.



Photos from Eddie French, Jersey

# THOMAS TUTTELL'S PLAYING CARDS

JOHN DAVIS

Thomas Tuttell (c.1674-1702) was an extremely talented and energetic individual. He was apprenticed to the mathematical instrument maker Henry Wynne and achieved much in many fields during his rather short career, before being tragically drowned in the Thames<sup>1</sup> which he was surveying as part of his appointment as Hydrographer to the King (William III).

Not only did he make many fine sundials and other mathematical instruments, he was a writer and engraver, collaborating with Joseph Moxon on an encyclopedia of engineering and mathematical instruments.<sup>2,3</sup> As well as being the Royal Hydrographer, Tuttell also held the appointment as Mathematical Instrument Maker to His Majesty at a time when he was barely out of his apprenticeship and his master Wynne was still active in the field. He worked in ivory and silver as well as the more common brass and wood. He was an excellent self-publicist, too, and in 1701 he published two sets of playing cards, on the themes of mechanics and mathematics and which advertised the types of instrument which he could make.

trated some of Shakespeare's works. Clearly Tuttell took the opportunity of his visit to London to have this set of cards drawn, representing what might be regarded as the country's first trade catalogue. Boitard's drawings were turned into copper printing plates by the London engraver John Savage (fl.1683-1701) who may have been a Huguenot refugee.<sup>4</sup> He produced plates for the Royal Society's *Philosophical Transactions* and had a shop at the Golden Head near St Paul's.

Several sets of Tuttell's cards have survived. Not long after they were issued, John Bagford (1675-1716), the antiquarian collector of early printing ephemera, acquired a set and these became part of the Harleian Collection which was purchased by Parliament for the British Museum in 1753. Although most of the Harleian Collection (including an advertisement issued by Tuttell<sup>5</sup>) has since been transferred to the British Library, the actual cards remain in the Dept. of Prints and Drawings at the BM, where they have one complete and two partial packs.<sup>6</sup> There are also packs in

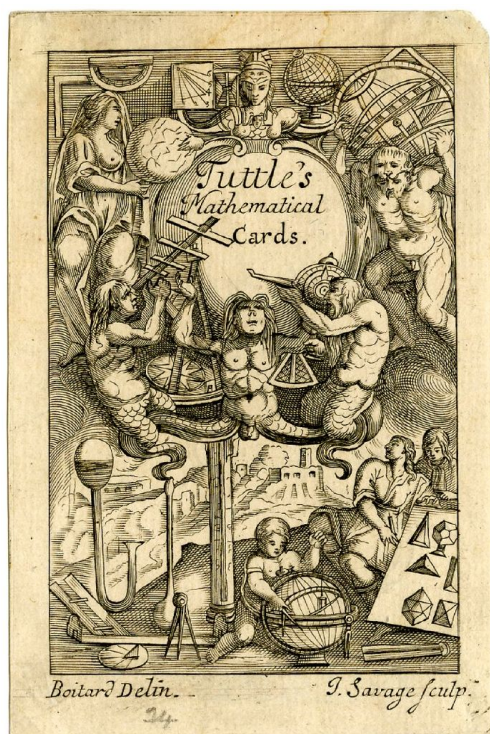


Fig. 1. The title card to Tuttell's set of mathematical instrument playing cards.



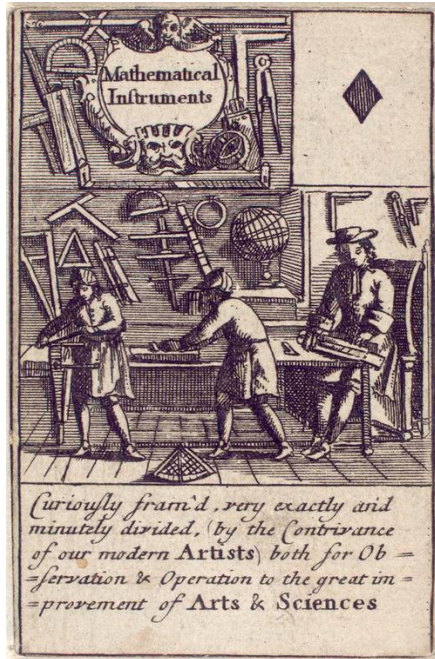
Fig. 2. One of two alternative versions of the King of Clubs, this one identifying Tuttell as the publisher and instrument maker. Courtesy of the Trustees of the British Museum.

As evidenced by the accompanying advertisement shown in Fig. 1, Tuttell's (or Tuttle's) cards were drawn by Boitard and engraved by J. Savage. François Boitard (1667-1719) was a painter, draughtsman and engraver born in France but thought to have died in Amsterdam. He was the student of Raymond La Fage, from whom he learned his drawing style and imitated several works. He was active in France, Holland and England (London), where he illus-

trated some of Shakespeare's works, in the New York Public Library,<sup>7</sup> in The Smithsonian, and in the Winterthur Library.<sup>8</sup> There are some variations in the cards between the sets: for example, in some copies the hearts and diamonds symbols are coloured red. Also, there are two versions of the King of Clubs with one (Fig. 2 from the incomplete set Willshire E.177) listing the goods which Tuttell stocked whilst the other shows the trade of the builder.

A pamphlet describing the cards was sold by the London stationer John Lenthall in 1717.<sup>9</sup> A description of the BM

Fig. 3. Ace of diamonds: mathematical instruments.



set was published<sup>10</sup> in 1848 by William Chatto, an early historian of playing cards, and later by William Willshire, in whose collections at the BM some of the cards may now be found.<sup>11</sup>

Only a small selection of the cards, chosen to be of particular interest to diallists, are shown here but all 52 of them—representing a considerable investment in time and money—show important details of the state of practical skills and instrumentation at the end of the 17<sup>th</sup> century. Fig. 3 shows an over-view of the mathematical instruments available, including a universal equinoctial ring dial, an armillary sphere, a quadrant, a cross-staff and more.

The card in Fig. 4 illustrates “dials”. Tuttell had a particular interest in self-setting dials (i.e. ones that could find the

meridian without a compass). He is perhaps best-known for his ‘elliptical dials’, a combination of analemmatic and horizontal dials on the same plate. Although he did not invent this form, he is responsible for making it popular and he published a description of it as *The Description and Uses of a New Contriv'd Elliptical Double Dial* in 1698. Several beautifully-engraved examples exist, including one in the British Museum<sup>12</sup> and another in the V&A. The other dial types described, the double horizontal dial and the universal equinoctial ring dial, were both inventions of William Oughtred and types which Tuttell made.

The Queen of hearts (Fig. 5) shows the two main projections of the sphere used in dialling. It is good to see them described by their modern names, even if the spelling has changed. The orthographic projection being drawn on the card is more commonly found on astrolabes and the backs of quadrants than on dials: I have not yet come across any examples on instruments by Tuttell.

The illustration of the ‘bow’ in Fig. 6 provides an answer to the question of how the makers of double horizontal dials drew the hour-arcs for their stereographic projections. On large dials, such as those produced by Tuttell’s master Wynne, the hour-arcs within a few minutes of noon have radii of many metres, far too large for any practical beam compass. The bow is just a properly-engineered version of the thin strip of flexible wood still used today in setting out smooth curves, e.g. when making wooden boats. Oughtred himself, in his description<sup>13</sup> of the stereographic projection, showed how to calculate the distances of the curve from the chord necessary to set the bow accurately. Working examples of bows from the 17<sup>th</sup> century are very rare, although ‘exhibition’ examples from the 18<sup>th</sup> century are known by, for example, Thomas Heath.<sup>14</sup> The bow is also illustrated



Fig. 4. Nine of diamonds: dials.

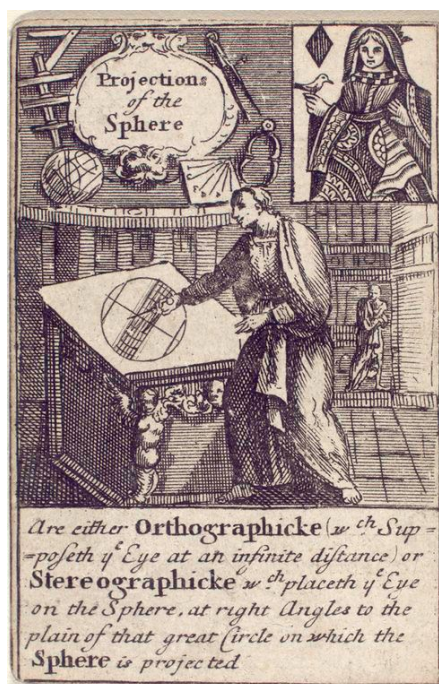


Fig. 5. Queen of diamonds: projections of the sphere.



Fig. 6. Seven of hearts: the bow.

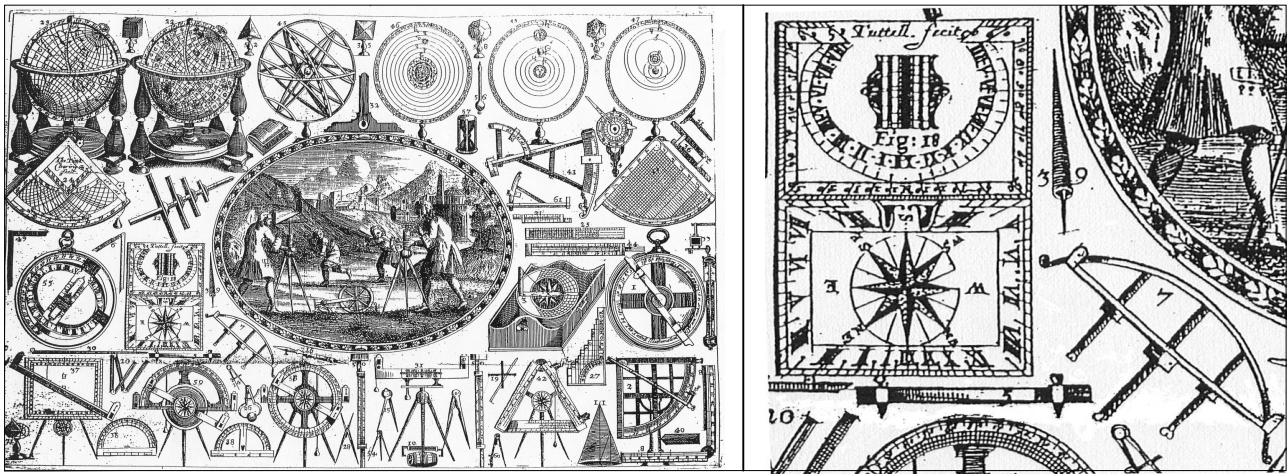


Fig. 7. Left: frontispiece engraving from Moxon's *Mathematics Made Easie*.<sup>2</sup> Right: enlarged section showing the bow (#7) and Tuttell's elliptical dial (#18). Notice also the oakleaf border around the central cartouche, often seen on dials.

amongst the instruments on one of the designs of Tuttell's tradecard and in the frontispiece illustration of his *Mathematical Instruments*.<sup>3</sup> (Fig. 7). The description given there is:

*Bow*: a Beam of Wood or Brass with 3 long Screws, that Govern or Direct a lath of Wood or Steel, to any Arch : used commonly to draw Draughts of Ships, Projections of the Sphere, or wherever 'tis requisite to draw large Arches.

Another card with dialling interest is shown in Fig. 8. The man on the left is delineating a dial while the one on the right is performing a calculation with a sector and dividers. The man in the centre also has a pair of dividers and appears to be setting them on a rule (or scale). Note in passing the spelling of "dialing" with only one 'l' rather than the modern English spelling with '-ll-'. The Pilgrim Fathers took this early form to America where it remains as the

accepted spelling whereas we doubled the 'l' in the 18<sup>th</sup>(?) century.

A rarely-seen item of dialling equipment is the dialling globe, illustrated on the ace of clubs (Fig. 9) and also in the foreground of Fig. 1. Whether these instruments were actually employed by professional instrument makers or were merely demonstration items for wealthy clients is a moot question. This card also includes a portable compass dial and a vertical dial with rather curious delineation.

Other cards in the set depict tradesmen at work (millwright, bricklayer, carpenter, architect, miner, etc.) or tools such as the "triangular quadrant", charts, scales, and the cross-staff. They are all worth studying.

After his untimely death, it seems that the contents of Tuttell's workshop were sold off. For example, his tradecard (Fig. 10) which features many of the instruments on the playing cards and is similar to the frontispiece engraving of



Fig. 8. Ten of clubs: sectors and scales, showing the delineation of a dial.



Fig. 9. The ace of clubs: dialling globes.



Fig. 10. Tuttell's tridecard. Compare with Fig. 7.

*Mathematical Instruments*,<sup>3</sup> was clearly the basis for the card employed by Fisher Combes who was working over the period 1730-7, some time after Tuttell's death.<sup>15</sup> It appears that the centre of the copperplate for the card has been reworked, replacing Tuttell's details with Combes' but leaving most of the instruments largely unchanged (although the signature "Tho Tuttel fecit" has been removed from several of the larger instruments).

Soon after his death, Tuttell's 'signature instrument', the elliptical double dial, was copied by John England. It is surely no coincidence that England's address, like Tuttell's, was "Charing X London" and that he came to prominence in the year after Tuttell's death. His elliptical dial in the Whipple Museum<sup>16</sup> is quite similar to Tuttell's examples.

If only Tuttell had lived, we would have had a far larger corpus of instruments to admire.

#### ACKNOWLEDGEMENTS

I am grateful to staff at the British Museum and the British Library for help in locating the playing cards. Eddie Mizzi kindly supplied the illustration from Ref. 3.

#### REFERENCES and NOTES

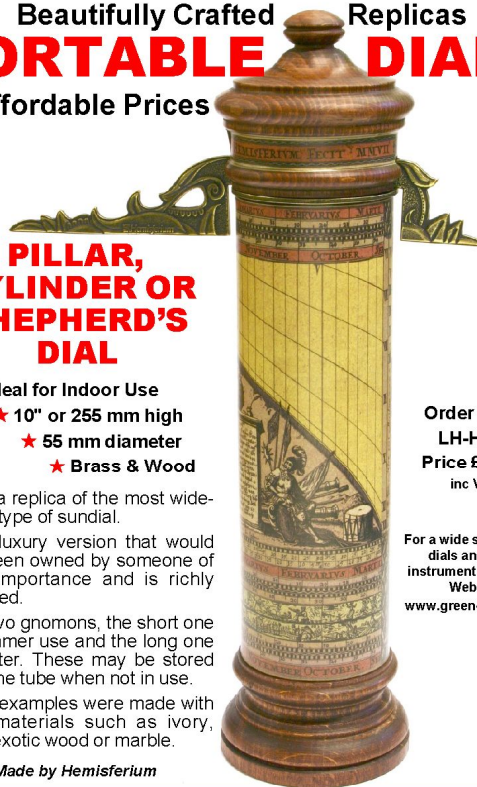
1. Appeal for his body placed by Tuttell's widow in Post Boy, 31<sup>st</sup> January to 3<sup>rd</sup> February 1702 (No. 1048). A copy is in the Heal Collection 105.104, British Museum.
2. Joseph Moxon: *Mathematicks made Easie – or a mathematical dictionary*, 3<sup>rd</sup> edition, printed for J Moxon and T Tuttel, London (1700).
3. Tho. Tuttel and J. Moxon: *The Description and Explanation of Mathematical Instruments...alphabetically disposed as now made with all their Improvements...* Printed for J. Moxon, London (1701). Often bound in with ref. 1.
4. Oxford Dictionary of National Biography. For Françoise Boitard, see the entry of his son Louis-Philippe. John Savage is also listed.
5. Advertisement: *Engraved, for mathematicall instruments made and sold by Thomas Tuttel*, British Library shelfmark Harl.5947(78).
6. The sets of cards in the BM are inventory nos. 1896,0501.925.1-52 (full pack); 1982,U.4662 (31 cards) and 1878,1012.342-345 (4 cards).
7. The cards are part of the William Barclay Parsons collection of the NYPL and are shown online at <http://tinyurl.com/yley5qu>.
8. The Winterthur Collection can be accessed at <http://>

[tinyurl.com/yb9eakh](http://tinyurl.com/yb9eakh).

9. Anon: "The use of the mathematical playing-cards, invented by the late ingenious Mr. Tuttel. Wherein all the instruments are exactly delineated [sic], and historically apply'd to their various uses" BL shelfmark RB.23.a.8672(2). Pub J. Lenthall (1717).
10. William A Chatto, *Facts and Speculations on the Origin and History of Playing Cards*, London, (1848).
11. William Hughes Willshire: *A Descriptive Catalogue Of Playing And Other Cards In The British Museum Accompanied By A Concise General History Of The Subject And Remarks On Cards Of Divination And Of A Politico-Historical Character*, Chiswick Press, London, (1876).
12. The Tuttel elliptical dial in the BM was bequeathed by Octavius Morgan and is item no. 1888,1201.302.
13. William Forster: *The Circles of Proportion and the Horizontal Instrument &c. Both invented, and the uses of both Written in Latine by W. Oughtred Atonens. Translated into English and set forth for the publique benefit by W.F.*, R Davis, Oxford, (second edition, 1660, first published 1632).
14. An example by Thomas Heath in ivory with a flexible brass strip is illustrated on p.56 of H. Dawes: *Instruments of the Imagination: A history of drawing instruments in Britain 1600-1850*, The Dawes Trust (2009).
15. J. Wilson: *Biographical Index of British Sundial Makers from the Seventh Century to 1920*, 2<sup>nd</sup> edition. BSS monograph No.2. BSS, Crowthorne, (2007). Fisher Combes' tridecard is illustrated on p.63.
16. The John England elliptical dial is Whipple inventory no. Wh:1010 and is illustrated in D.J. Bryden: *Sundials and Related Instruments (catalogue 6)*, The Whipple Museum of the History of Science (1988).

Author's address:

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It has two gnomons, the short one for Summer use and the long one for Winter. These may be stored inside the tube when not in use.

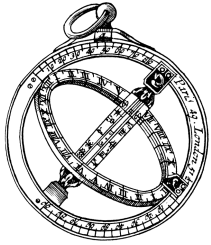
Similar examples were made with noble materials such as ivory, brass, exotic wood or marble.

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## DIAL DEALINGS 2009

MIKE COWHAM

With the World's economy in turmoil, things on the auction front and in antique shops have, like everything else, changed. It seems that only the very best items are still selling and the run-of-the-mill objects are being ignored by collectors. The reasons for this are manifold but the main one is that money in the bank offers so little return that people with any money saved are buying things that they really like. They hope that as things improve, their purchases will have gained somewhat in value.

Prices quoted below include Buyer's Premium unless otherwise stated.



Fig. 1. An English brass Butterfield dial by S Saunders.

**21 January 2009** - Bonhams, New Bond Street (The Gentleman's Library Sale)

This fine English 'Butterfield' dial (9.5 × 7.2 cm) was made by the little known maker, Samuel Saunders. (Fig. 1.) However, he is recorded as working for John Rowley at 'The Globe under St Dunstons' from 1702 to 1715. This dial particularly interested me as it has many of the features of a number of unsigned dials of that period, both Butterfield and inclining, for which I have desperately been trying to find the maker. It is not conclusive evidence that Saunders actually made these other dials but is a suggestion that the unknown maker may have worked for Rowley at one time. One of the features that all of these dials have in common is the fleur-de-lys mark which is quite distinctive. (Fig. 2.) If BSS members know of any similar portable dials, I would



Fig. 2. A selection of fleur-de-lys half hour marks on several unsigned English dials, the Saunders dial being at the top right.

appreciate hearing from them. Unusually, the Saunders dial is set into the lower part of a wooden case, not necessarily original, but almost certainly of a similar age.

This fine brass dial made £1800.

**27 February 2009** - Mellors & Kirk, Nottingham

In this provincial sale was a fine gilt brass compendium by Charles Whitwell (Figs. 3-6). This has to be the finest dial sold in 2009 and Mellors and Kirk were most surprised at the interest that it caused. Their estimate was a mere £2000 - £3000. It was obvious that it would go for a lot more than this. In the end it went for a staggering £36,000 plus premium! This figure still seems quite low for such a rarity.

Charles Whitwell (ca. 1568 - 1611) was one of a handful of fine Elizabethan instrument makers and had been apprenticed to Augustine Ryther. He was a prolific instrument maker and several of his instruments are illustrated in *'Elizabethan Instrument Makers'* by Gerard Turner.<sup>1</sup> Interestingly, Whitwell is known to have made five similar compendia to the one sold in Nottingham, each dated at two-year intervals; 1600, 1602, 1604, 1606 and 1610. This dial



Clockwise from top left:  
 Fig. 3. A fine compendium by Charles Whitwell, 1608.

Fig. 4. The lid of the Whitwell compendium showing the nocturnal scales.

Fig. 5. Perpetual calendar under the lid of the Whitwell compendium.

Fig. 6. A tide computer on the underside of the Whitwell compendium.



On the underside of the lid is a perpetual calendar showing the Epact and Prime for the following 19 years of the lunar cycle. (Fig. 5.) It is marked with the current figures next to its date: 1608 · E23 · P13 ·. After this date the cycle would repeat itself for several more lunar cycles.

On the underside of the compendium is a tide computer. (Fig. 6.) To use this, the central volvelle is turned to the day of the Moon (15 as illustrated, top right). In those days, tidal constants were not given with respect to London Bridge in hours and minutes as they are now but simply with respect to the Moon when full and situated exactly in the south. They did not use hours but simply used the compass bearing (SE by S on the lower pointer). The time of high tide would then be shown by the longer pointer (II in the morning). The small aperture in the central volvelle will also show an image of the Moon for reference. The central volvelle has on it the 'aspects' of *trine*, *square* and *sextile*.

**8 April 2009** - Christies, South Kensington (Travel, Science and Natural History)

Double crescent dials are quite rare and seldom come up for sale. Most were made in Augsburg by Johann Martin or Johann Willebrand. This dial was unsigned but was clearly well-made and may also have come from Augsburg. (Fig. 7.) The base plate was thicker than usual and was undeco-

of 1608 therefore seems to fill in the missing gap. I am sure that he will have made other dials like this and the two yearly sequence is no more than a coincidence. The compendium, when closed, is about the same size as an early pocket watch. When opened, the equatorial dial virtually self-erects. It is just a case of setting the correct latitude on the lower quadrant and then turning the dial with its compass to north to get the precise time. However, the instrument has several other features. On its lid is a nocturnal that operates from the Little Bear. (Fig. 4.) The slot suggests initially that something, perhaps a gnomon, is missing. However, this is the nocturnal 'arm'. In use the lid is opened and after setting the pointer to the correct date, the central volvelle (with the slot) is turned so that the Pole Star (*Polaris*) can be seen through the central hole and the star *Kochab* of the Little Bear (*Ursa Minor*) sits in the slot or in the other hole. The time is then read from the pointer against the I - XII, I - XII scale. Many other nocturnals use the 'pointers' of the Great Bear (*Ursa Major*) but with such a short slot as this, it would be difficult to line these up correctly.

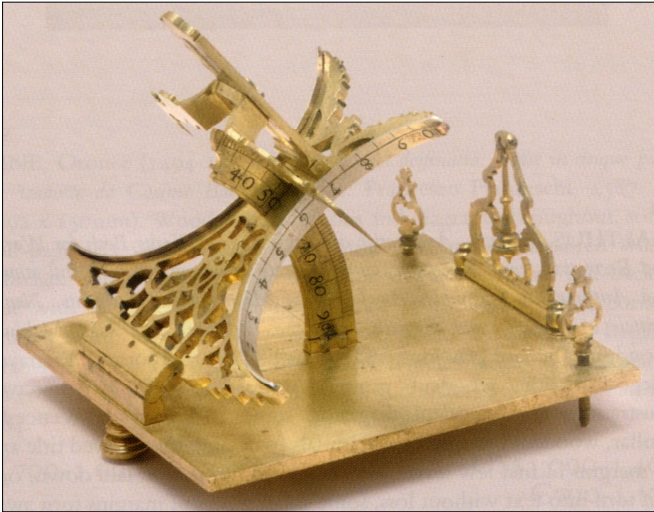


Fig. 7. An unsigned double crescent dial.

rated. I feel that it is possible that the base may have been a replacement. It did not even have the usual list of towns and their latitudes engraved on it. Instead of making several thousand pounds, as other dials of this type have done over the years, this unattributed dial made just £938.

**15 September 2009** - Bonhams

A square slate sundial, 31.5 cm square, was signed 'Rich'd Melvin, Fecit A.D. 1853'. (Fig. 8.) At the four corners were subsidiary dials for 'America/New York', 'Africa/Alexandria Egypt', 'Asia/I. of Borneo' and 'Australia/New Zealand', but their fragile gnomons had been broken off. This is a typical Melvin (also known as Melville) dial and it sold for just £280.

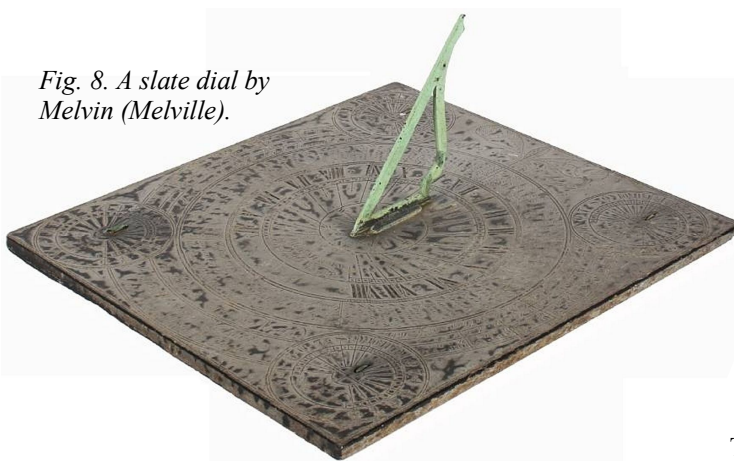


Fig. 8. A slate dial by Melvin (Melville).

**15 October 2009** - Christies, South Kensington (Travel, Science & Natural History)

An attractive gilt brass astronomical compendium had various dials included; three for Italian hours, an equinoctial dial and a horizontal dial. (Figs. 9 & 10.) It was unsigned but was thought to be of Spanish origin or was made for the Spanish market. Its condition was good but the latitude support arm for the equatorial dial was a modern replacement. It sold for £6250.

An interesting gilt brass German scaphe dial (Fig. 11) about the size of half an apple was of a type that I had not seen



Fig. 9. Astronomical compendium.

Fig. 10. The attractively engraved lid.

before but since seeing this, a friend has traced one almost identical that was made by Markus Purmann of Munich, dated 1588. The scaphe was inscribed inside the hemispherical lid, the time being read from the shadow of a spring-loaded gnomon whose tip was arranged to end at the precise centre of the hemisphere. It was incomplete, the latitude arm being lost, but this would have been fitted in the slot on the right side to support the raised hemisphere at the correct angle.



Fig. 11. German scaphe dial.

The small compass was mounted so that it could revolve against a 90° - 0° - 90° scale, possibly for compass declination but it is not obvious why the maker has taken this scale beyond about 30°, unless he was not sure how much the declination was likely to drift in the future.

This dial sold for £6250.

**10 November 2009** - Bonhams, Knightsbridge

Several dials were in this sale but the ones that took my attention were two horary quadrants and a Butterfield dial.

The first was most unusual, but after looking closer at it I realised that it was a type of Panorganon. (Fig. 12.) These are very rare. For more details see my monograph on



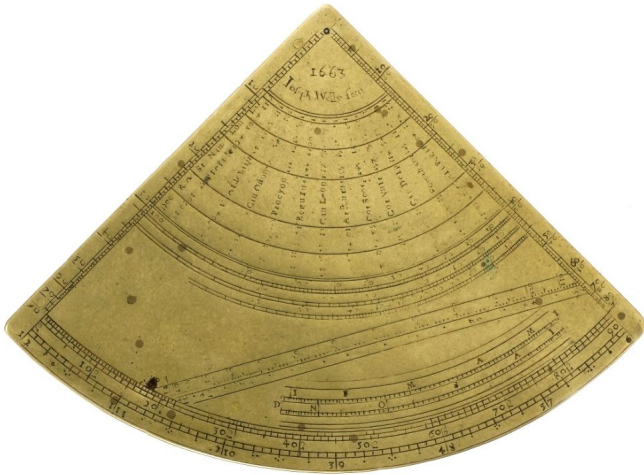


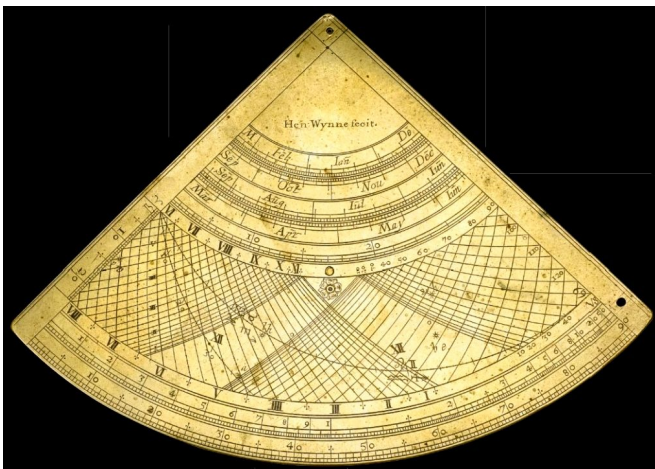
Fig. 12. A Panorganon by 'Iofeph Wells' dated '1663'.

'Altitude Dials'.<sup>2</sup> It was signed in the apex: "1663 Iofeph Wells fecit". He is recorded as working in London 1667 and died 1690. This quadrant was therefore one of his early pieces. On its reverse were two sights and a degree scale around the circumference. This quadrant was 12.5 cm radius. Unfortunately, the quadrant's condition was very poor with much of the information 'rubbed' and illegible. Even so, this interesting quadrant made £2880.

The second quadrant, larger than most at 14.5 cm radius, was by Henry Wynne (working 1662 and died 1709). (Figs. 13 & 14.) It was generally in much better condition although the volvelle on the reverse side was badly rubbed



Figs. 15 & 16. Butterfield dial by 'P le Maire A Paris, A la Pierre d'Aiman', the underside showing his unusual list of northern towns.



Figs. 13 & 14. A Gunter's quadrant by Henry Wynne.

with some loss of detail. This volvelle shows the constellations around the Pole so that it could be used as a nocturnal. This design is usually referred to as a 'planispheric nocturnal'. Simply, face the Pole Star, holding the quadrant, 90° point uppermost (the position as in the illustration), then set the volvelle so that the image of the sky fits the view that you actually see. Then read the time against the date scale. It is not a high precision device used like this but was near enough for the time that it was made. This fine quadrant made £7300.

An attractive Butterfield dial in silver was sold. (Figs. 15 & 16.) It carried the signature 'P le Maire A Paris, A la Pierre d'Aiman(t)', meaning 'P[ierre] le Maire of Paris, at the [sign of the] Loadstone'. What particularly attracted my attention is that although it was made in Paris it was clearly intended for use in Northern Europe. Its chapter rings were for 50°, 55°, 60° and 65° and its gnomon could be adjusted

over an unusually wide range from 45° to 75°. The list of towns on the underside included *Torno 65° 47'* (Tornio in Finland) which lies at the most northerly point of the Baltic Sea and close to the Arctic Circle, *Moscou 55° 30'* and *Uranisbourg 55° 47'*. This last place is an interesting inclusion, being the location of the observatory of Tycho Brahe on the Danish island of Hven, built 1576-1580. It is difficult to say why Uraniborg was included because the observatory was abandoned in 1597 and destroyed in 1601. I also liked his spellings of Oxfort, Edenbourg, StoKolm, Lipsic (Leipzig), Rotterdam, Pragues and DunKerque. The dial may be dated to ca. 1740 from its compass declination of about 15°W for Paris but as it was made for Northern Europe a different declination could have been used by its maker. It sold for £2880.

#### ACKNOWLEDGEMENTS

I would like to thank the following for allowing me to use their photographs.

Bonham's, London for Figs. 1, 8, 12, 13, 14 & 15.

Christie's South Kensington for Figs. 7, 9, 10 & 11.

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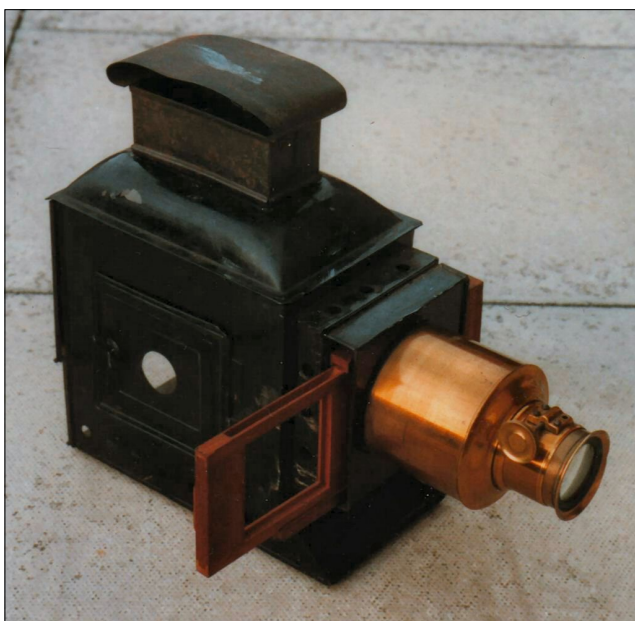
## SUNDIAL SLIDES FOR MAGIC LANTERNS

**PETER RANSOM**

Seeing the superb article<sup>1</sup> on the Seaton Ross sundials in the last *BSS Bulletin* reminded me that I had two magic lantern slides that feature Dial Cottage. I thought it was about time I wrote about these and some other old slides of dialling interest.

A magic lantern was an early form of projecting images onto plane surfaces for an audience to see. Researchers are coming to the conclusion that if there was one inventor of the magic lantern in a usable form then it is most probably Christiaan Huygens (1629-1695). Candles, then gas and latterly electricity, powered the light source of a magic lantern. My magic lantern (Fig. 1) has been adapted to use an ordinary light bulb at some point in its career, but a prominent feature of all magic lanterns is a 'chimney' at the top to dissipate the heat produced by any light source.

I do not know how old the Seaton Ross slides are, but there are two of them, which are very similar. This leads me to believe that they were meant to be shown in a stereopticon, which is a term sometimes (erroneously) used to describe a stereoscope. These were first used in 1875 to identify a dissolving twin-image magic lantern, which could be used to convey information about depth by the blended sequential presentation of a series of planar views of a subject. The slide featured in Fig. 2 is the better of the two and it is possible to distinguish subtle differences between it and the one taken more recently by John Davis: there are fewer quarter hour markers past VI (four to John's six plus one) and there is no creeper on the wall!



*Fig. 1 (left). A basic magic lantern with the chimney raised and a wooden slide holder.*



*Fig. 2 (right). Magic lantern slide of Dial Cottage at Seaton Ross.*



Fig. 3. Magic lantern slide of the sundial at Holyrood Palace.

The second magic lantern slide (Fig. 3) is of the multifaceted sundial at Holyrood Palace in Edinburgh. This, like the Seaton Ross slides, is 3¼" square. It has been dated as 1880 and has the words TRADE-MARK "G.W.W." REGISTERED on the paper frame around it. A little Internet research has discovered that this refers to George Washington Wilson (1823-1893), one of Scotland's premier photographers working for Queen Victoria and Prince Albert. He was based in Aberdeen and the university there holds nearly 40,000 of his glass plates. One of these plates features the dial as shown in this slide. It may well pay dividends for someone to research this archive for other sundial slides, especially ones that are no longer extant. It says a lot for George Washington Wilson that his slides still give great images today, 130 years on. Will our digital images still be accessible 130 years from today?

The final image I have (Fig. 4) is not a magic lantern slide but a glass negative. When I acquired this I was told it featured Cyril at Queens' College, Cambridge, but Frank King very kindly correctly identified this as being the dial in the Great Court of Trinity College, Cambridge. Details of this dial can be found in Brookes & Stanier.<sup>2</sup> Unfortunately little detail of the dial is visible but perhaps Cyril is a prototype BSS recorder! Anyone who can identify Cyril's identity will earn my undying gratitude.

Taking an image from glass slides or negatives is not easy, since the light needs to be shone through the slide. However I bought an Epson V500 Photo scanner last year, which allows me to scan present-day negatives and slides. I have found that, with a little exploration, I can also scan

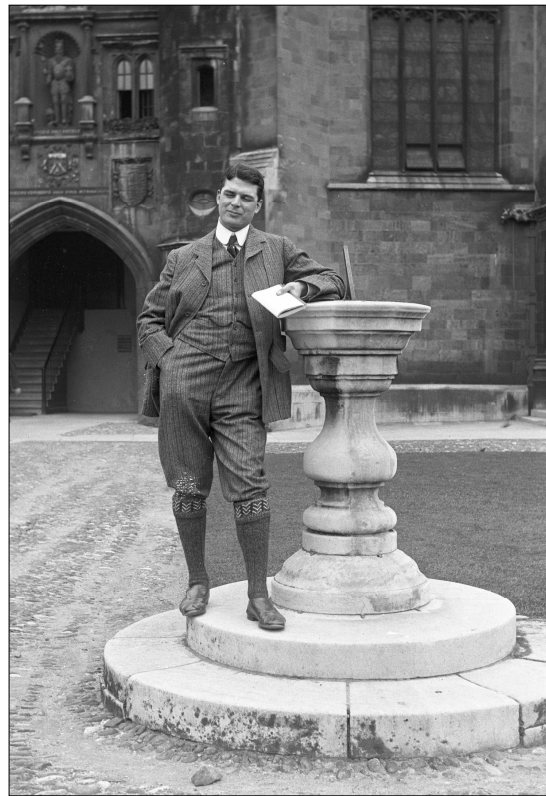


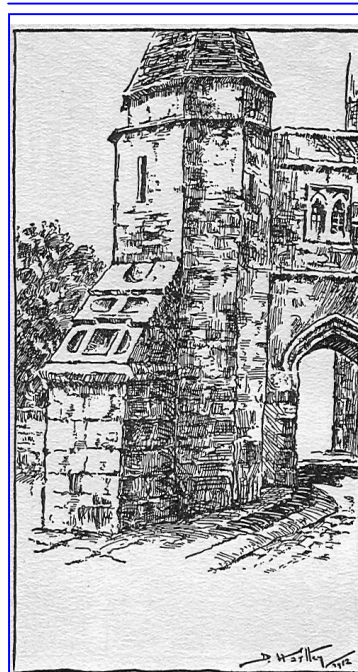
Fig. 4. Image from glass slide of Cyril at the Great Court of Trinity College, Cambridge.

these old slides and negatives, so am now on the lookout for more slides to add to my collection, much to the distress of the rest of the family who are not looking forward to me resurrecting my magic lantern to see if I can project the slides at Newbury later this year!

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The multiple scaphe dials at St Peter's and St Paul's church, Bleadon, Somerset, as shown in *Ye Sundial Booke* by T. Geoffrey Henslow. It is registered as SRN 0059 and is an unusual design for a church (the background shown here may not be true to life as the Register entry describes them as on the chancel buttress).

# THE ONLY ‘MASS DIAL’ IN GREECE

E. THEODOSSIOU & V.N. MANIMANIS

The Byzantine church of the Dormition of the Virgin Mary in the village Chonikas, in the Argolis Prefecture of Peloponnese, at geographical coordinates 37° 40' 16" N, 22° 46' 24" E, is decorated with a vertical sundial. This is the only ‘mass dial’ we could identify in the whole country. The church was built in the 12<sup>th</sup> century, while the sundial was probably carved in the early 17<sup>th</sup> century. Additionally, in the same part of the wall there are inscriptions mentioning two total solar eclipses, in 1661 and in 1760.



Fig. 1. Map of the WNW Peloponnese, with the village of Chonikas at the centre.

## The Three Byzantine Churches of the Virgin Mary in Argolis

In Argolis (eastern Peloponnese) there are three exquisite Byzantine churches dedicated to the Virgin Mary; in chronological order, the oldest is the church of the Dormition of the Virgin Mary in Chonikas village, near the village Neo Iraio; the second is another church of the Dormition, in Agia Triada (Merbakas) village, and the last is the Zoodochos Pege in the town of Nafplio (Antonakatoú, 1968).<sup>1</sup>

These three characteristic Byzantine temples were built in the 12<sup>th</sup> century by the same group of artisans, a fact evidenced by the similarity of their architecture. The Neo Ireo church, the oldest of the three, was initially dedicated to St. Nicholas (Hagios Nikolaos) before becoming the ‘Dormition of Theotokos’. The tradition in these villages has it that the mason of the Chonikas church, when he saw the beauty of the churches in Merbakas and Nafplio, which were built by his assistants, was so jealous at being surpassed by them that he died of his sorrow.



Fig. 2. The southern side of the Dormition of the Virgin Mary (*‘Koimesis tis Theotokou’*) Byzantine church in Chonikas. The dial is closer to the SE (right-hand) corner than to the central door.

The Zoodochos Pege church, identified with the monastery of Areia, Nafplio, was built after an order by Leo, the bishop of Argos and Nafplio, who intended to incorporate it in a nunnery. The southwest corner of the building bears an inset plate, made of marble, with an inscription mentioning the founding of the temple and its founder, as well as the date the church was inaugurated: April 1149.

A preserved memorandum by the same bishop Leo, dated 1144, mentions the church of the Dormition in what later became the Merbakas village. This church was built (probably on his orders) for a men’s monastery, to which the nuns of the Areia Nunnery would resort in case of danger.

The Merbakas church, as has been reported previously,<sup>2</sup> was studied by the German archaeologist Adolf Struck (1909),<sup>3</sup> who also traced the name ‘Merbakas’ to the Latin archbishop of Corinth, Guillaume de Moerbece (Wilhelm von Moerbeke Brabant, 1215-1286, archbishop from 1278 to 1286). This Dominican Flemish cleric knew Greek and in 1274 he had attended the Lyon Convention as a translator; then, during his stay in the Papal court at Viterbo, he translated many ancient Greek scientific texts into Latin, among them the Ptolemaic *Peri Analemmatos* (= *On Analemma*). Therefore, he knew about the construction of sundials and he is probably the constructor of the exquisite sundial of the Merbakas church, described by Theodossiou and Dakanalis.<sup>2</sup>



Fig. 3. The weathered mass dial at the Chonikas church. It is on the 7<sup>th</sup> stone counting from the double base of the building and the 3<sup>rd</sup> from the SE corner.

### The Sundials of the Three Churches

By studying these three very similar Byzantine churches, we noticed that the Zoodochos Pege church does not have a sundial; instead, it bears an inset marble plate on its SW corner with the year of its construction, from which we deduce the period of construction of the other two churches.

The Merbakas church sundial was placed high on the SW wall of the temple. If this vertical sundial was indeed constructed by Wilhelm von Moerbeke, it should be dated between the years 1278 and 1286, when he was the Roman Catholic archbishop in the nearby city of Corinth.

The third church bears as a sundial the only known mass dial in Greece. This is a much more recent construction, probably of the 17<sup>th</sup> century. Both the Merbakas vertical sundial and the mass dial of Chonikas have been previously mentioned by A. Orlandos (1937)<sup>4</sup>. This vertical sundial is one of the very few medieval Byzantine sundials that were discovered last century by the architect, archaeologist and professor of the Athens University Anastassios Orlandos (1887-1979) and are listed at his *Byzantine Monuments in Greece*.<sup>4</sup>

### The Vertical Sundial of the Chonikas (Neo Ireo) Church

Neo Ireo is a small village of the Argolis Prefecture, in the Argos Province. It was called Chonikas before 1989 and its population is 585 according to the latest (2001) census. Its average altitude is 30 m above sea level. The village lies in the fertile Argolic plain, 13.5 km to the NW of the city of Nafplio, not very far from Mycenae and only 5 or 6 km from the city of Argos. It is interesting to note that Neo Ireo, Agia Triada (Merbakas) and Argos form an equilateral triangle, with Neo Ireo being its northernmost apex.

The Dormition of the Virgin Mary ('Koimesis tis Theotokou') Byzantine church in Neo Ireo is made of ochre-red tuff stone and is in the form of a three-nave basilica, domed cross-in-square church of the composite four-column type, with a narthex and porches, which are the main characteristic of the medieval Byzantine churches of Argolis. The wall masonry is pseudoisodomic in the lower section and

'cloisonné' in the upper part. The façades are decorated with a wide variety of brick ornaments. The historical church was built on a double stone foundation and dates from the first decades of the 12<sup>th</sup> century. In the interior there are exquisite frescoes (depicting angels, the Last Supper, etc.) which were saved from a great fire of the Ottoman rule period.

For the Byzantine people, the church was both the house of God and a miniature of the universe. This perception influenced the architectural form and the decoration of the temple; art was a servant of worship. As is also the case with the Merbakas church, all sides of the Neo Ireo church of the Dormition are 'bound' with the marble plates of some ancient temple, probably that of Hera; on both its north and south sides it is decorated with large double crosses made of large white stones.

The sundial of the church belongs to a specialized or a primitive form of sundial, the so called *mass dial*, which was carved, not very deeply, into a buttress at the southern wall of the church.

As mentioned earlier, this is the only known mass or *scratch dial* in the whole of Greece, a construction by an unknown artisan of the beginning or the middle of the 17<sup>th</sup> century, if it is assumed to be of the same age as the older of the two carved inscriptions recording two total solar eclipses visible from the area (see below). These inscriptions indicate that a priest or priests in the village had some astronomical knowledge and was interested in recording the time through its associations with celestial events.

This mass dial was used during the Ottoman rule period to mark the time of the mass and other services. Its position in the south wall, unlike the Merbakas vertical sundial or the Anglo-Saxon mass dials that are usually placed next to the main doorway of the church, is distinctive. It is placed far from the main entrance, while it is relatively close to one of the large white crosses on the sides of the church.

This mass dial has the form of a vertical faint semicircle with some faint hour lines radiating from a central hole, and it is inscribed in a rectangular red tuff stone. It is rather difficult to detect it as it is rather roughly cut and badly weathered. We detected it after careful and systematic observation of the whole south wall of the temple. The rectangular stone that bears it is 0.33 m long and 0.27 m wide, and is identical with the other stones with which the church was built; it is on the seventh stone counting from the double base of the building and the third from the SE corner. It is at a height of approximately 2.50 m above the ground level. The sundial is smaller than the stone: it measures approximately 27 cm × 20 cm. There is no gnomon; however, its hole is easily seen centre-top of the rectangular stone, from where the faint hour lines start. The missing gnomon would have been horizontal, and so the dial would not record the same hours at all times of the year. The mass dial is in any case usually regarded<sup>5</sup> as an event marker for the church services rather than a time piece.



Fig. 4 (top). The 1661 solar eclipse inscription.  
 Fig. 5. The 1760 solar eclipse inscription. In the lower right there is a series of holes forming a capital letter 'A'.

Five hour lines can be discerned in the eastern part (to the right) and another five in the western part (to the left) of the more intense, slightly diffuse, meridian line, so this dial clearly has 12 unequal divisions. The eleven hour lines start from the top and end on a semicircle about 20 cm radius, without any numbering. The second, sixth and ninth hour lines probably mark the morning mass, noon and vespers services respectively, making sure that both the priests of the church and the people of the village were in time for services in those old days in Greece, during Turkish occupation, without mechanical clocks and watches.

Normally, the sundial had to bear a horizontal line representing the astronomical horizon, while at noon the gnomon's shadow should fall on the vertical line (the sixth hour line), which would be perpendicular to that horizon. However, in such a vertical sundial, placed on a wall with an exact southern orientation, the shadow could never reach the horizontal line of the horizon. Probably this is the reason there is no horizon line at or near the upper horizontal edge of the stone; also, the sixth hour line of noon is not exactly perpendicular to the supposed horizon line.

### Two Total Solar Eclipses

In addition to the mass dial, we made an important discovery, which probably causes the greatest impression to the

astronomically-minded visitor. Two rectangular stones below and two to the right of the badly weathered mass dial, there is a carved inscription upon an equally-sized stone, reading:

1661  
 μαρτίου  
 κ.  
 ΕΧΑΘΗΟΗΛΙΟΣ

That is, "1661 / March / 20 / THE SUN WAS LOST"

And on the stone immediately below there is the following similar inscription:

1760 ΙΟΥΝΙΟΥ 2  
 εματα εχα  
 θι Ο ΗΛΙΟΣ

That is, "1760 JUNE 2 / again was lost / the SUN" (the carving of the word "SUN" is shallow).

Indeed, by checking all total solar eclipses on the NASA Eclipse website<sup>6</sup> we found that two total solar eclipses visible in Chonikas occurred at the above dates. The first one occurred on March 30, 1661 (No. 8690) and the second one on June 13, 1760 (No. 8939). The priests who recorded them were correct in writing March 20 instead of March 30 and June 2 instead of June 13, because, at that period, the 'Old Style' or Julian calendar was being used in Greece, which in 1661 was 10 days earlier than the dates of the Gregorian calendar ('New Style' dates) used in the modern eclipse catalogues: by 1770 this difference had increased to 11 days.

The phase of totality for the 1661 eclipse occurred just 35 min before local noon, while totality in June 1760 occurred in the morning (at 9:12 modern civil time of Greece).

These two carved inscriptions indicate that Greek people in the 17<sup>th</sup> and 18<sup>th</sup> centuries or, more specifically, the priests of the church, were not just measuring time by means of the Sun (using the sundial), but were also interested in special events concerning the Sun. Only the parish priest would feel that he had the right to carve something on the wall of the holy temple. So the older priest recorded in March 20,



Fig. 6. Other curious rows of small holes on the stone immediately to the lower right of the second eclipse stone. The stone to the left of this one also carries such markings.

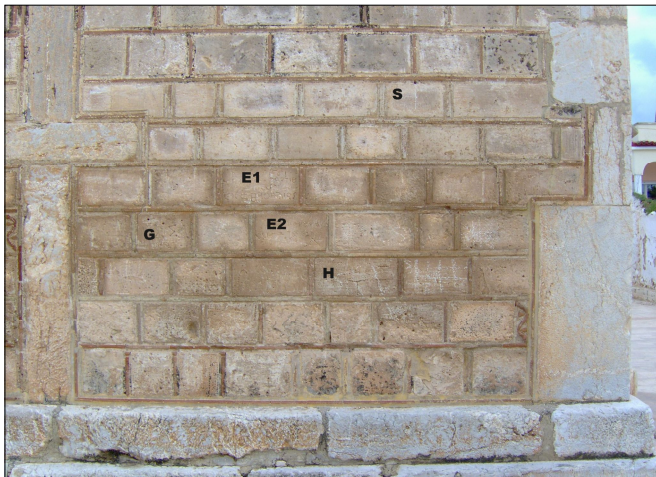


Fig. 7. The eastern part of the S wall with the sundial (S) and all the other interesting features: the 1661 eclipse inscription (E1), the 1760 eclipse inscription (E2), and the curious rows of small holes (H). Three capital Greek letters on a stone to the left (G) are obviously graffiti of the modern period, as deduced by their style.

1661 (O.S.) a total eclipse of the Sun, using the expression ‘the Sun was lost’. Almost one century later, a subsequent priest decided to complement him by writing about another total eclipse of the Sun, in the form “the Sun was lost again”.

Additionally, we observed on the second rectangular stone a series of holes forming a capital letter alpha (A). Also, very close to these two rectangular stones (to the right and below) exist some curious holes, which present an analog with the curious holes in the lettering of the old dial at Beccles Church in Norfolk.<sup>7</sup>

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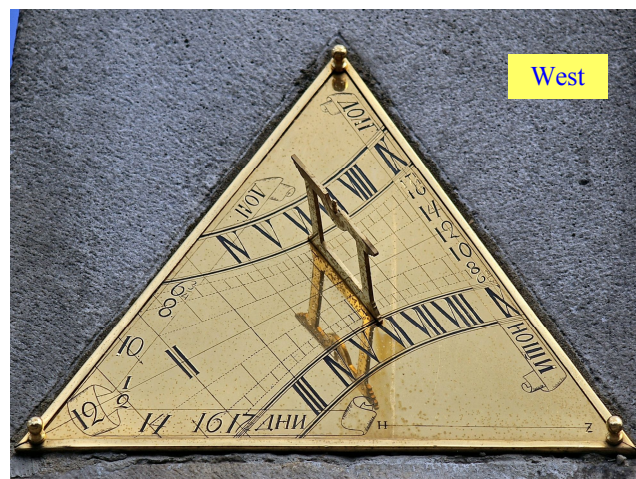
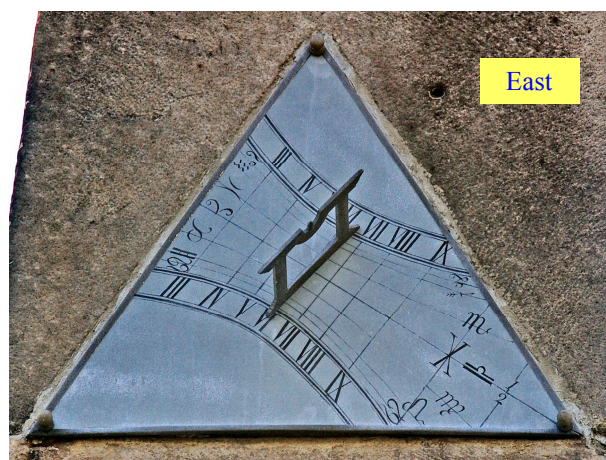
## HOLIDAY SIGHTINGS (3)



These three dials are located on an obelisk at the Monastery of the Holy Trinity of Saint Sergius Lavra, near Moscow. Dials on obelisks seem to be a common thread on Russian dials: see Valery Dmitriev’s article in *Bulletin* 21(i).

There is no date shown on these dials but clearly they are not new. Of particular interest, note that while the east-facing dial has declination lines for the signs of the zodiac, the western one has lines delineated for the hours of daylight, running from 6 to 18.

Pictures from Robert Sylvester



# THE VOORTREKKER MONUMENT

## PRETORIA, SOUTH AFRICA

MALCOLM BARNFIELD

[The article *The Pantheon as a Timekeeper* in the December *Bulletin* prompted Malcolm Barnfield to contribute this article on a modern equivalent. Ed.]

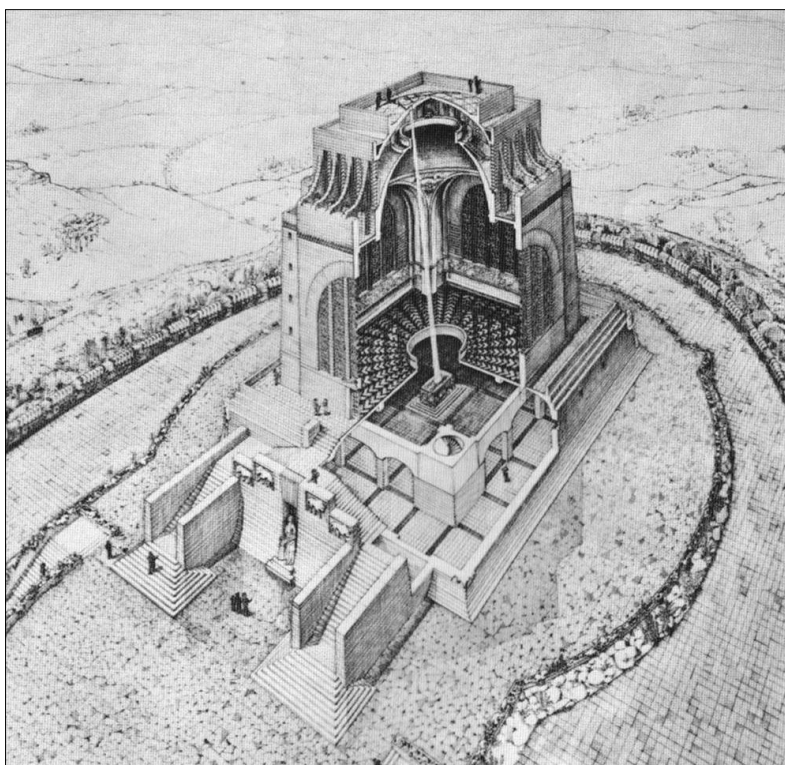


Fig. 1. A cut-away drawing of the Voortrekker Monument showing the beam of light on 16<sup>th</sup> December. Courtesy of the Voortrekker Monument & Heritage Foundation.

The Cape Colony was founded by the Dutch East India Company (*Vereenigde Oost-Indische Compagnie*) in 1652 at the Cape of Good Hope on the southern tip of Africa. It was to be a replenishment station for their ships on the long and arduous journey from Holland to the east and back to Europe, carrying the much-prized spices on the return journey and eastern bound trade goods on the outward trip. Scurvy was rife among seamen at that time and the fresh produce available at the Cape would alleviate this condition.

Settlers were from many trades. Farmers, shipbuilders, viti-culturalists, blacksmiths, carpenters, builders and so on. They immediately planted a large vegetable garden, fruits, vines and even the Cedar of Lebanon so that damaged ship masts could be repaired at the Cape. Wines and brandy

were soon being produced hence Cape Town wore the label 'The Tavern of the Seas'.

Restrictions on the settlers were severe and the colony was small in area. Thus, many farmers soon left the place and trekked (to travel by ox wagon) away along the eastern coast and into the hinterland. There they founded farms and lived in virtual isolation. These were hardy and self-reliant people and they only gathered every three months for Nagmaal (Communion), markets and the exchange of news.

By 1806 the colony was under British control. They then extended its borders to include the inland settlers. The settlers resented this and simply trekked away again. So the British extended the borders again and so on.

This was the ascendant time of David Livingstone and the London Missionary Society and the Voortrekkers (pioneers in English) objected to the LMS attitude towards the local indigenous people who stole livestock and murdered settlers on outlying farms. The LMS then held enormous sway in the Cape government and in Westminster itself. In addition, the frontiersmen felt that the ineffective governance and lack of protection provided by the British, who claimed suzerainty over them, was intolerable.

So began the Great Trek. This was not a single event and various groups departed from the Grahamstown and Graaff-Reinet areas between 1835 and 1838. They were mostly of Dutch, German and French extraction and were fairly homogenous. All were devout Protestants and they shared a common tongue in the then fledgling Afrikaans language. Some went directly north. One group under Piet Retief trekked north and then east into Zululand (now KwaZulu-Natal). There they met the Zulu King Dingane. The Voortrekkers signed a treaty for land with him on the 4<sup>th</sup> February 1838. On the 6<sup>th</sup> Dingane invited Retief's party back to his kraal (village) to celebrate this. He then turned on Retief and his 70 men and murdered them all. The Zulus followed this up with a surprise attack by 10,000 warriors on the Voortrekker laager (a circle of wagons) at Bloukrans and about 500 Voortrekker men, woman and children were massacred.



The remaining Voortrekkers consolidated and soon elected a new leader, Andries Pretorius. He decided that punitive and decisive military action against the Zulus was needed because the Bloukrans massacre was the last straw. For each of the seven days before Pretorius, his 464 men and 64 ox-wagons departed for the battle the men made a vow to God, in prayer, that if He allowed them victory over the Zulu they would forever hold the day sacred and build a church in His honour. On 15<sup>th</sup> December they laagered in a carefully chosen spot on the Ncome River. They knew that it was the Zulu tactic to attack during the night and hung lanterns on whip sticks all around the laager. Then a very unseasonal and heavy mist descended on the laager. The Zulus were superstitious about this, believing that the Voortrekker's ancestors were protecting them and declined to attack during the night. The following morning when the mist cleared there were about 14,000 Zulus in front of the Voortrekkers, the many Impis (regiments) recognisable by their different coloured shields. Battle was joined and by noon the Zulu army was completely routed, its remnants being chased off by the Voortrekkers, cavalry style. Not a single Voortrekker was killed. The river has been known as Blood River ever since. Pretoria, the South African administrative capital is named after Andries Pretorius.

The Voortrekkers honoured their vow and the 16<sup>th</sup> December, 'The Day of the Vow', remains a very important public holiday in South Africa although it is now called 'The Day of Reconciliation'. The Church of the Vow was built in Pietermaritzburg and is still there, now a museum.

Ninety-nine years after the battle of Blood River, work began on the Voortrekker Monument in Pretoria. It was completed and inaugurated on 16<sup>th</sup> December 1949. The building is huge and imposing and honours the intrepid Voortrekkers who founded the Afrikaner nation. It is of concrete and granite and contains the world's largest hand-carved marble frieze depicting the history of the Great Trek. It is surrounded by a laager of 64 cast concrete and marble ox wagons.



Fig. 2. Close-up picture of the rooftop aperture. North is to the left and the time is 11:00am SAST (17 December 2009). Picture by Richard Barnfield.

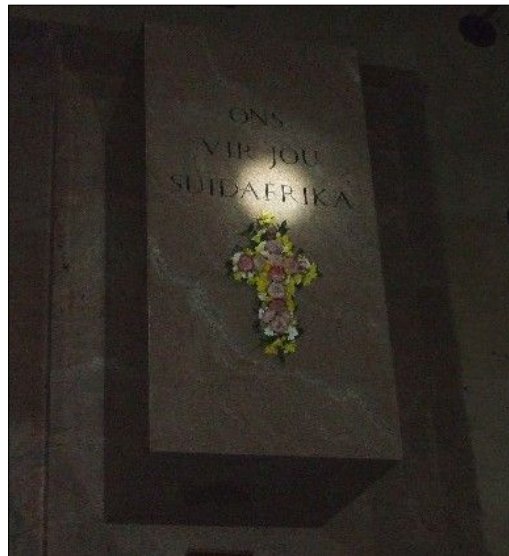


Fig. 3. The illuminated wording on the cenotaph at LSN on 17<sup>th</sup> December. The diameter of the beam is about 400 mm. Picture by Natalia Neophytou.

Only one of its many salient features is the granite cenotaph in the centre of a lower level than the main hall. 41 metres above this is a dome which contains an aperture that allows a ray of sunlight to fall directly onto the cenotaph at Local Solar Noon on 16<sup>th</sup> December each year. The words 'ONS VIR JOU SUID-AFRIKA' (We for thee South Africa) are then illuminated. Figure 1 shows this arrangement. Figure 2 is a close-up picture of the rooftop aperture but why the polished old coin is there is unknown to me. Using the shoe for scale, the diameter of the aperture is about 150 mm. Figure 3 shows the illuminated wording on the cenotaph at LSN on 17<sup>th</sup> December. The diameter of the beam is about 400 mm. Figure 4 shows the cenotaph from above and is taken from the upper viewing deck just below the dome. Figure 5 is a rather grainy copy of the original architectural drawing. It is all in Afrikaans but since mathematics is an international language, I do not offer a translation.

There is no record in the archives of how the calculations for the aperture positioning were made and what follows are two possible methods that could have been employed.

The Monument stands at 25° 46' 31.2" South and 28° 10' 33.1" East. Our ruling time zone meridian is the 30° east



Fig. 4. The cenotaph from above, taken from the upper viewing deck just below the dome. Picture by Natalia Neophytou.

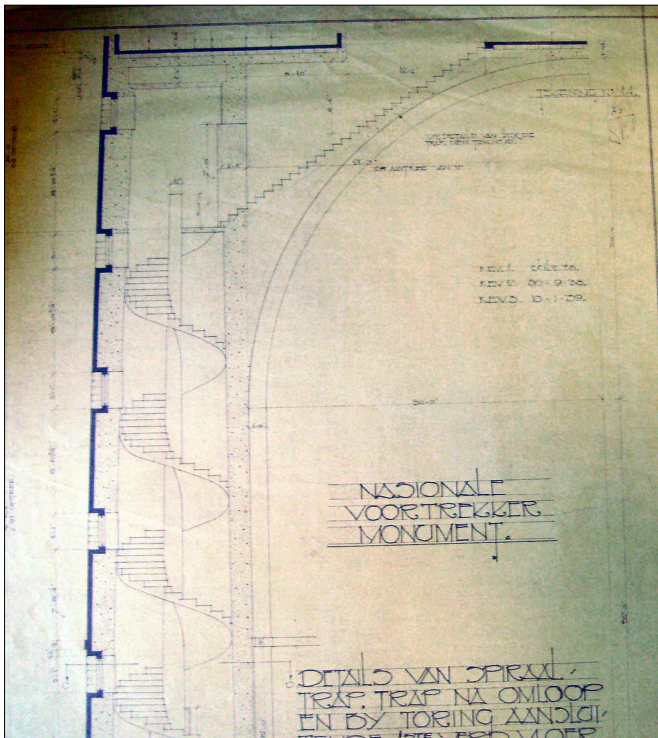


Fig. 5. Copy of the original architectural drawing showing the dome design and its radius of 30 English feet (Cape feet are different). Courtesy of the Voortrekker Monument & Heritage Foundation, picture by Richard Barnfield.

meridian, GMT +2 hours. This then delivers a longitude correction of 7 minutes 18 seconds. The sun's declination on the 16<sup>th</sup> December, this year, at noon is  $-23^{\circ} 19' 50''$ . The Monument is orientated directly true north/south. Thus the aperture is positioned slightly to the north of the zenith above the focus on the cenotaph and canted away from it, the angle from the vertical being the difference between the global position of the Monument and the sun's declination on the 16<sup>th</sup> December. The Equation of Time adjustment for the 16<sup>th</sup> December is minus 4 minutes 17 seconds and, when this is summed with the longitude correction, the ray of light did indeed appear in the middle of the cenotaph at roughly 3 to 4 minutes after 12:00 South African Standard Time. This was very difficult to establish exactly because there was a crush of people around the lower viewing deck, all trying to see the same thing at the same moment. Also, trying to observe the moment and using a wristwatch and photograph it with a hand-held camera, simultaneously, proved difficult. In any event the calculations for this were made over 60 years ago and the ephemeris and EoT now, for the J2000 epoch, would be slightly different to those used then. In addition, I was there at noon on 17<sup>th</sup> Decem-

ber and not noon on the 16<sup>th</sup> when the major commemoration takes place.

The second method of making this calculation could be by using solar altitude. The following figures may seem unusual to some English diallists. Accepting that the obliquity of the ecliptic this year is  $23.44^{\circ}$ , then the maximum solar altitude at the northern hemisphere summer solstice would be  $61.94^{\circ}$  at London ( $51.5^{\circ}$  N) for instance. The Monument, is only about 2.33 degrees south of Capricorn at the southern hemisphere solstice and this then gives a maximum solar altitude of  $87.66^{\circ}$  on the 21st December. Five days before the solstice, on the 16<sup>th</sup> December, 'The Day of the Vow', the maximum solar altitude is  $87.56^{\circ}$  so the dome aperture is just  $2.44^{\circ}$  from the zenith above the cenotaph target. This calculation is basically the same as for the first method.

Very effectively, the lights on the cenotaph level are turned off just before the beam reaches its target on the cenotaph and this highlights it and drives home the message. I am not an Afrikaner but one cannot fail to be moved by the experience in that deeply religious and highly respectful place where everyone speaks in subdued and hushed tones. I felt most calm and introspective yet awed when I left.

On the cenotaph level there is a large tapestry spanning some 70 metres. This depicts the history and activities of the Great Trek. There are also many authentic artifacts like the huge leather-bound family Bibles, diaries, cooking utensils, writing cases, voorlaaiers (muzzle loading rifles) and so on, all from the Great Trek period. A further level below this is a fascinating museum. The Monument has a new well-equipped and well-stocked history library and a South African genealogy facility. This is called the Heritage Centre and is accessible at <http://www.voortrekkermon.org.za>.

The Monument is open 7 days a week at a very modest entrance fee and a visit by students of architecture, history, art, sculpture, heritage, engineering and even sundials is very well worth it.

#### ACKNOWLEDGEMENTS

Estelle Pretorius, Researcher at the Voortrekker Monument & Heritage Foundation for her keen and willing interest in this project, freedom of access to the Monument, its roof and the archives, her outstanding knowledge of the history plus the proofing of this article.

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Chris Daniel, who found this piece, has described it as the earliest known example of a double horizontal dial!

Reprinted courtesy of Dana Summers and the Orlando Sentinel.

# WEST INDIES DIALS IN GLOUCESTERSHIRE

TONY WOOD & JILL WILSON

A recent enquiry about a poem by Charles Paget Wade prompted a visit to Snowhill Manor, a National Trust property in Gloucestershire. Wade was an inveterate collector of anything and everything, with an underlying theme of craftsmanship. To this end, he bought Snowhill Manor in 1919 and set up his collection – “packed to the rafters” and “an Aladdin’s cave of unexpected delights”.

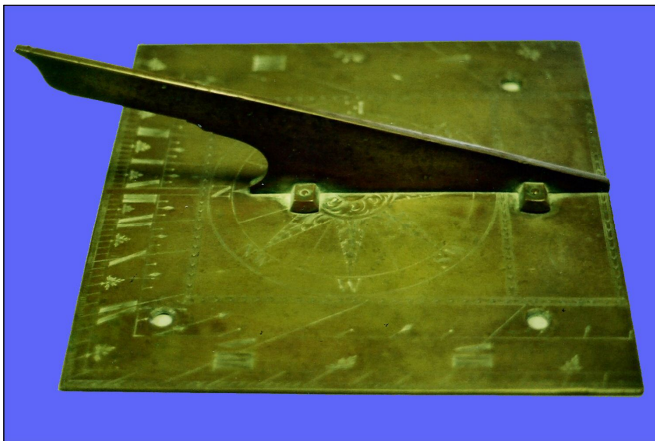


Fig. 1. The John Fowler dial at Snowhill.

Amongst the collection is a London-made sundial (Fig.1). The gnomon angle is  $17\frac{1}{2}^\circ$  and the maker was John Fowler. Fowler, an instrument maker, was active from 1721 to 1750 and so it is likely that the dial was made for one of Wade’s ancestors owning sugar plantations in St Kitts. (By coincidence, the only other Fowler dial so far noted is also in Gloucestershire, at Flaxley Abbey, but sadly is bereft of its gnomon when last recorded.) The brass dial is one foot



Fig. 2. The armillary dial at Snowhill.

square and slightly unusual in that the origin of the gnomon and, therefore, the hour lines, is just off the plate and so no 6am – 6pm line appears. It is inscribed “J Fowler London”.

Fowler’s dial is held in the collection but Snowhill Manor has a dial out in the sunshine, an armillary dial perched on a pole (Fig. 2), so high as to be almost unreadable but in a garden ‘room’ devoted to time-telling.



Fig. 3. The Henry Gregory dial, also with a West Indies design location, at Huntley.



Also in Gloucestershire is another dial from the West Indies (Fig. 3). It is in full sunshine too, at Huntley to the north of the Forest of Dean and mounted on an ordinary garden pedestal. But its low gnomon angle ensures that it will only rarely tell the right time.

It was made by Henry Gregory of London, probably around 1750. A connection with the Snowhill dial is that Gregory was an apprentice to Fowler and so may have acquired business links to settlers in the West Indies. The gnomon angle is around  $13^\circ$  and the brass plate is again one foot square and has a 16-point compass rose and motto “The hour is with God, Hope is with ALL”. The probable location in the West Indies would have been Barbados, St Vincent or St Lucia, south of St Kitts.

These two dials represent a small part of what might well have been a steady business for those with contacts in the West Indies. I wonder how many dials actually found their way there?

Thanks to Jennifer Rowley at Snowhill Manor (NT).



# THE NOEL TA'BOIS FIXED DIAL ARCHIVE

JOHN FOAD

Although Noel died in 1988, just before the formation of the BSS, he is remembered by some of our members as a real enthusiast, and had he lived a little longer, I am sure that he would have been one of our founding fathers. His interests were wide, and in addition to gnomonics, included bell-ringing, and the construction of the Meccano devices<sup>1</sup> which he used extensively when manufacturing dials to his own design. Two dials of which he was justly proud, and for which he used wonderful Meccano constructions in the delineation, are the conical equinoctial dial at the City of London School, SRN 3635, and the Concorde vertical dial, with its iconic nose cone forming the tip of the gnomon, at a friend's house in Witney, Oxfordshire, SRN 1327. It was not until his retirement in 1980 that Noel found the time for such work; but then, as well as his construction projects, he started on a major photographic survey. He was also the first author of 'The Sundial Page' in *Clocks* magazine up until his death: an obituary and a memorial dial to him were published by his successor in that rôle.<sup>2</sup>

From the time of his retirement, there was scarcely a month when he was not capturing fixed and mass dials on film, up and down the country. He recorded them meticulously, labelling all his transparencies with the date and the location, and about 1,500 of his slides of fixed dials are now held in the Society's archives. They have been scanned onto CD and indexed, and are available to members on request. If you would like more information, please get in touch. They



Fig. 1. Noel at Hever Castle, Kent, in 1983.

form a valuable record of the period, and include a large number of our Registered dials that had not previously been photographed. The next published edition of the Register will be the richer for them.

They also include some dials that we do not have in the Register, and a few of these are shown here.

1) A vertical on the church at Newport, Essex (Fig 2), with its unusual motto 'Many be well paid for abusing Time'! This was seen and photographed on the East Anglia Safari. Would someone like to let me have a report for the Register? The photo in the *Bulletin* of December 2009<sup>3</sup> shows the dial almost unchanged in a quarter of a century, pretty good for a wooden dial which shows no sign of restoration.



Fig. 3. Woodford Green, Essex.



Fig. 2. Newport, Essex.

2) Another in Essex, on the Jubilee Hospital at Woodford Green (Fig 3).

3) Figs 4 and 5 show an interesting horizontal on a very fine pedestal at Ascott House, Wing, Bucks. The crossed arrows motif in the gnomon appears on the gateposts at the end of the drive, so I assume it represent family arms. The topiary dial at Ascott House is well known (SRN 0403), and the Register records that "there is also a horizontal pedestal dial on the south patio near the house". Noel's dial does not appear to be 'on a patio', so perhaps there is a third one to seek out there.



Fig. 4 (left) & 5 (above). Ascott House, Wing, Bucks.



Fig. 6. Haveningham, Suffolk.

4) The vertical in Fig 6 was labelled by Noel as being at Haveningham church, Suffolk, and I think that this is an old name for Heveningham. I wonder if the dial can still be found.

5) Finally, Figs 7 and 8 are of dials that Noel photographed at Hever Castle, Kent, in 1983. The square dial, designed for a very wide gnomon, probably stone, was at the centre of the maze. The photograph does not do it justice, but it was clearly once a fine piece of work. The octagonal dial, with the date 1714 and showing what I think may be Italian and Babylonian hours, was found "near the maze".<sup>4</sup> Both were in a state of disrepair when Noel photographed them, but it is hardly conceivable that they were scrapped. Does anyone have any news of them?



Fig. 8. Hever Castle, Kent.



Fig. 7. Hever Castle, Kent. Note the incorrect centres of delineation for the 'back' hours.

In addition to Noel's 1,500 photographs of fixed dials, he left more than 1,000 slides of mass dials. Look out for an article on these by Tony Wood in a future *Bulletin*.

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This interesting multiple dial is on a church buttress at Oldhamstocks, Berwickshire, in the Scottish Borders. It was recorded by Andrew Somerville and registered as SRN 1231 but we do not seem to have a modern photograph.

After Gatty.

# A SIMPLE SUNDIAL MAKER IN SOUTH AFRICA

HENK VAN DER HAM

I am 60 years old, retired and living in Centurion, South Africa. One of my hobbies is the making of flat, horizontal sundials out of brass. I would love to share with you how I got involved in making sundials, as there are not many sundial makers in South Africa who manufacture really accurate ones!



Fig. 1. The author at his pantograph engraver.

It all started in 1986 during the July winter holidays when we were in Durban, strolling through a beautiful park near the beach promenade. I noticed a sundial in the centre of a rose garden and, being a stargazer who is attracted to old types of instruments, I looked at it with great interest. When I compared the time shown on the dial with my watch I was very disappointed to discover the dial was not correct. How could somebody put in so much effort to make such a beautiful sundial but not make it accurate? It was almost six minutes behind my new wristwatch which had been set correctly. This issue bothered me very much.

Since I saw that sundial in Durban, I eagerly wanted to have one in my own garden. In my opinion there could be no better focal point than a beautiful, accurate sundial. Very soon I was looking in all garden centres, but all I could find were these ugly ones made out of ceramics, plastics or cheap alloy materials by amateurs. Being very disappointed, I started thinking.... why not make my own? I did inherit from my father an old lathe which I use for small engineering jobs, and an engraving machine which I had never used before. He had used it many years ago in his own business for making calendars. I realized that to make a really accurate sundial one should know all the basic scientific principles on how it works. Why is the indicator pin

(gnomon) not simply standing up straight? Why is it slanted and to what degree? How do I figure out the calibration? As more and more questions arose I decided to make a study on this subject. There was no Internet in those days, so I went to the library and started browsing through encyclopedias and many books on this subject. In these books I found out the simple secrets of how a sundial works. Here I learned about the different type of sundials of which the flat horizontal and the equatorial sundials are the most common. I learned that the most important fact about a real working sundial is that the gnomon has to be slanted to the degree of latitude for the location, thus being parallel to the earth's axis. Very important to what I learned was the time difference between real 'sun time' and the 'clock time', namely the 'Equation of Time'. It was by studying these facts that the mystery about the inaccurate sundial in Durban was partly solved! Now I knew the importance of having a table or a graph for the 'Equation of Time' mounted together with a sundial! Another important feature I learned was about the different information that a sundial can be made to indicate, i.e. local time (on the specific local meridian) or standard clock time (time of the time zone).

Earlier, I said 'simple secrets' because as a very practical man I believe that even the most complicated inventions and machines are based on simple basic principles. Where the mathematically-orientated man can easily perform calculations to make a perfect product, I had to do it the hard way, but according to the basic principles. I decided to construct a dial to show the legal clock time, so the calibration would be with 'Longitude correction'.



Fig. 2. The most southerly dial in South Africa, at the Cape of Agulhas. Note anticlockwise, longitude-corrected, hour numerals!



Fig. 3. An installed dial, with EoT plaque.

Because I am the more practical type of man, I chose the long way of making my sundial extremely accurate not by calculations, but marking the calibrations by hand! I made a level platform on the roof of my house on which I fixed a thick carton board and a gnomon made out of piano wire. I chose this string type gnomon to make the most accurate markings due to the ultra thin line. The next step was to find true geographical north, by fixing a pin straight up in the centre of the circle and marking the shadow of the tip on the circle line in the morning hours. Then I marked the shadow of the tip in the afternoon when it touched the other side of the circle line. Now I could divide the resulting angle in half to make the true geographical north-south line. This was meant to be the solar noon line on my dial. The preparations were finished now and I was ready to start the markings the next day. I remember very well that particular day, as forecasted by the weather bureau it was fortunately a completely sunny day on the 15<sup>th</sup> of December. As the Equation of Time on that day was sun time 5 minutes fast of clock time, I adjusted my watch 5 minutes ahead. The sun was scorching, but I stayed the whole day on the roof of

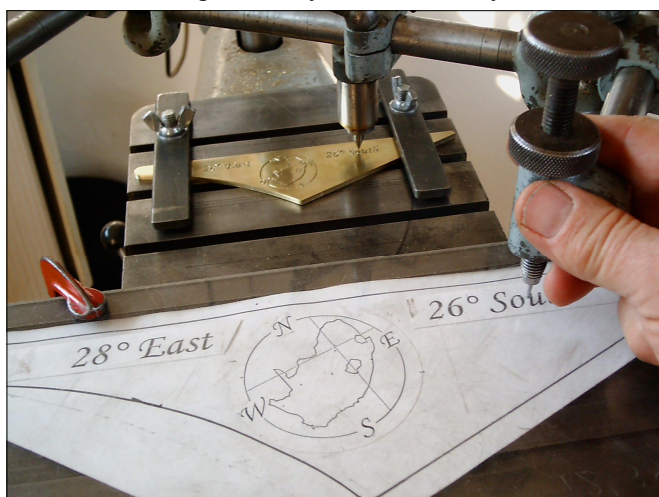


Fig. 4. Engraving a gnomon on the pantograph machine.



Fig. 5. An example of the small dial design.

my house to mark every 15 minutes on the carton dial according to my watch. This was done from 6 am to 6 pm. Between the markings I could quickly leave to get water, coffee and sandwiches for lunch. I was very happy at the end of the day with the result of my work, knowing that a very accurate sundial would come out of this!

Yes, I really wanted to make a special sundial, complete with the most important information – the compass, dates of the seasons, solstices and equinoxes. Part of the artwork I wanted was the Zodiac. A separate plaque for the Equation of Time also had to be a vital part of the sundial. It was a very time consuming task to design good artwork, because I did design all the details myself. Many hours and new attempts were necessary to combine all the information together with the calibration in such a way that it is all in proper proportion. Then I also had to spend a lot of time to put the old engraving machine back into commission. I had to spend many hours to do preliminary engravings to get the feeling of how to engrave. After about six months I was at last ready to make my very own special sundial.

This very first sundial was completed during 1988 and I had to find a proper pedestal. I went to a well-known concrete products manufacturer, and the manager was so impressed that he insisted that I had to make the same dial for him at, of course, a very good price. So I did, and proudly delivered him the new dial after a month of hard work. It was not even a week later that he phoned me to say that he had sold the sundial and wanted another one. So I was very excited with the idea that this might be the beginning of a small business! And so it was.... regularly I got new orders and also friends wanted sundials; the word-of-mouth marketing was escalating. I did try to design different dials but not with huge success. My original design was the only one that always was loved the first time seen. However, I did design a smaller sundial with a graph for the Equation of Time engraved on it to be more affordable.

Today, I still make the same sundials but on a small scale. I made permanent templates for all the details, but make use of the new computer technology to calculate the exact cali-

brations for any location in the world. I also personalise the sundials on request for any kind of occasion. Many of my sundials are scattered around the country, where the most northerly one is at Rundu, Namibia<sup>1</sup> and the most southerly at Cape Agulhas (Fig. 2). I have also made several dials which are now in Spain, Belgium and the Netherlands.

In 2002, I saw an article in a local magazine by a South African professional sundial maker, Malcolm Barnfield. I phoned him to make an appointment to share our interests in sundials and to show him my product. To my joy he found my dial very professional and soon we became friends. I have assisted him with several of his bigger pro-

jects by engraving special requests on sundials which are situated now in Antarctica, Botswana, America and here in South Africa. My love for sundials is very much enhanced by him. For me this is a wonderful hobby and it gives a lot of pride and satisfaction to see people through my work getting interested and fascinated in the wonderful world of sundials!

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## QUESTION 87 FROM THE LADIES' DIARY

In the December issue of the BSS Bulletin<sup>1</sup> I wrote about the dialling questions that appeared in The Ladies' Diary from 1704 onwards and posed Question 87 as an amusement for readers. There were two follow-ups from the article. Fred Sawyer contacted me swiftly after the article to mention that *NASS Compendium*, published by the North American Sundial Society, had recently published articles about some of the dialling questions in The Ladies' Diary<sup>2,3</sup> and he very kindly sent me copies of the excellent articles. Michael Harley emailed me a solution a week before the winter solstice wondering whether there was a prize for solving it. So, was Michael correct? The question was:<sup>4</sup>

#### IV. QUESTION 87, by Mr. T. Williams of Middleton-Stoney.

A person bought a quantity of land the bounds of which are to be marked out by the shadow of a tree 103 feet high, between the hours of eight and one on the 10th of March 1721: now supposing the sun should not appear on that day, how may the bounds and area be determined the latitude being 52° N.

The two solutions given are

#### Answered.

	hours	☉'s alt.	azim.	leng. shade	
The 10th of March.	VIII	17° 56'	65° 32'	318·2	} Feet.
Latitude 52.	IX	25 43	51 45	212·9	
	X	32 13	36 14	163·4	
	XI	36 29	18 47	139·23	
	XII	38 0	0 0	131·83	
	I	36 29	18 47	139·23	

The figure will be triangular, the shadow at 8 and 1 being two of its sides, and right lines; the third (the path of the nodus or top of the tree) a curve line, of the conic sections, about 334 feet. The content 22200 square feet = 210. 1 per. and 148 square feet. Those who have taken the horizontal distances with respect to the pole, instead of the azimuths, have given false solutions.

#### This Question may be wrought thus:

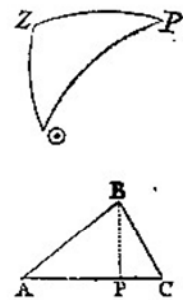
As rad. ....	90° 0'	As cotang. lat. 52° 0'	9·89250
To cosine lat. ....	52° 0'	To radius .....	10·00000
So is cosine of the hour 60 0		So tang. altit. . . . .	9·51005
To sine of the altitude 17 56		To sine azimuth 65 32	9·61724

As sine 17° 56' : log. 103 :: sine 72° 4' : log. 318, and so for the rest. And you'll have several triangles with 2 sides and an angle between them given, to find their contents; which in one sum gives the area of the whole more exact than by taking it as one single triangle, by reason of the curve line in each of them.

#### Additional Solution.

The piece of land in this question is a triangle on the horizontal plane, of which two sides are the shadows of the tree at 8 and 1 o'clock, and the third side the line described by the shadow of the top of the tree between the same two hours; and this third line will be right as well as the two former, and not a conic section, because the sun is in the equinoctial, it being the 10th of March old stile. The said third line will also be directly east-and-west, or perpendicular to the meridian or shadow of the tree at 12 o'clock.

Now, if  $p$  represent the pole,  $z$  the zenith, and  $\odot$  the sun at any hour: Then are given  $pz$  the co-latitude,  $p\odot$  a quadrant, and  $\angle p$  = the hour from 12; to find the  $\angle z\odot$ , the sun's azimuth or bearing at that hour. And, taking the extreme hours 8 and 1 in the question, their azimuths will come out 65° 32', and 18° 47'; which are the two angles  $apz$ ,  $cpz$  contained by the meridian shadow  $pr$ , and the two extreme shadows  $pa$ ,  $pc$ , the place of the tree being at  $p$ . Now the sum of these two angles is 84° 19' = the  $\angle abc$ , and their complements are 24° 28' and 71° 13' = the angles  $a$  and  $c$ . So that all the angles are then known.



Again, the meridian altitude of the sun being 38° = the complement of the latitude 52°, we shall have as 1 : tang. 52° :: 103 feet (the height of the tree) : 131·834 =  $pr$  the length of the meridian shadow. From hence, and the given angles,  $ap$  and  $cp$  are easily found = 289·73 and 44·837, and then the area = 22053·65 square feet = 2·0218 roods.  $\square$

Since there is no credited solver, one presumes that a correct answer (or the expected answer!) was not presumed and the comment that "Those who have taken the horizontal distances with respect to the pole, instead of the azimuths, have given false solutions" makes me think that Charles Hutton did receive some incorrect solutions.

Michael correctly calculated the length of the shadow at noon for which he received a Mindbender Puzzle of Gloucestershire Sundials, but unfortunately did not calculate the published area correctly.

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# MYSTERY DIALS

JOHN FOAD

The Noel Ta'Bois archive consists almost entirely of Agfachrome colour reversal slides, each carefully labelled with the date and location. However, together with the four boxes of slides came one Kodak negative film, processed but not printed, and not identified in any way. It seems quite possible that it was taken not by Noel, but by his wife Margaret. This film includes pictures of three dials which I have not been able to trace.

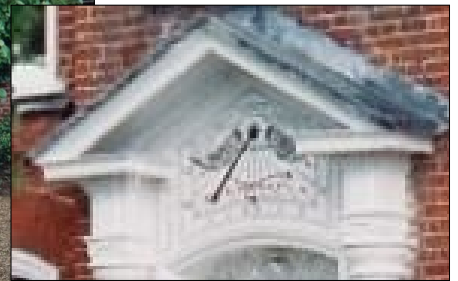
The first has a remarkably substantial octagonal (slate?) dial plate, and is shown with small sections of the adjoining building, and an elaborate pedestal, both of which may help identification.

The next appeared to have been photographed from a moving car so very little detail can be seen, though it looks as if it may have been a dial of some character.

The final pictures (below & right) again lack much detail, but possibly the location of the canted dial in a gable above a mullioned window at the end of a south transept may help.

It may be that they are already registered, but if so I have missed them. If you know where any of them are, or were, I would be delighted to hear from you.

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# PHOTOGRAPHER'S DIAL— PART 2

TONY BELK

In a previous article,<sup>1</sup> I described a photographer's sundial that indicates the direction of the sun at any time on any date based on a setting made at one particular time and date. It is designed for a specific latitude ( $51.5^\circ$  N) and some information was given on the errors involved in using it at other latitudes. The flexibility of using British Standard Time (BST) instead of Local Apparent Time (LAT) was also pointed out. The error made in setting the dial is compensated for because an opposite error is involved in reading the required time.

In the present article I include a scale to indicate the sun's altitude at any time and date, examine again the accuracy of the device when used at a different latitudes, and offer a method of extending its range to cover other latitudes. Also included is a dial designed for use at  $54^\circ$  N. Together, the two dials give adequate coverage for the whole of England from  $50^\circ$  N to  $55.5^\circ$  N.

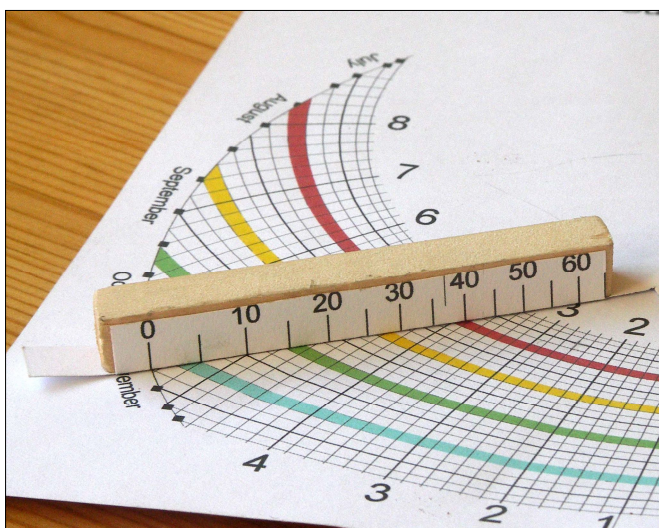


Fig. 1. Scale along the gnomon indicating the sun's altitude.

## Height of Sun

This can easily be read from a scale along the side of the dowel. Fig 1 shows the scale in use. Having set the dowel at the correct time/date intersection, the scale reads off the sun's altitude at that time and date.

## Using the Device at a Different Latitude

It was shown in the previous article that for relative use, i.e. to find the direction of sun at one time and date based on its direction at another time and date, if the dial is used at a latitude up to  $2^\circ$  from its design value it gives less than 15 minutes of time error.

A horizontal sundial, if used at a different latitude, can be tilted so that it still reads the correct time. The photogra-

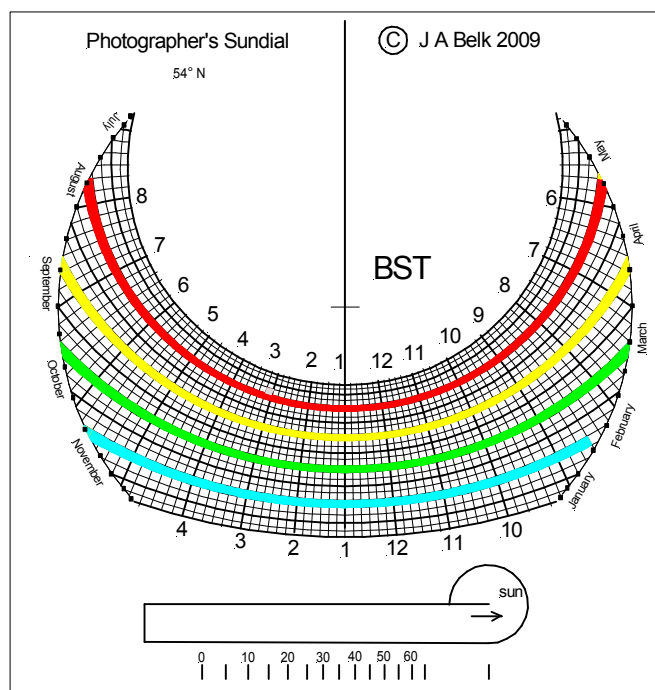


Fig. 2. Photographer's dial designed for  $54^\circ$  N.

pher's dial cannot be used like this because the photographer is interested in the illumination of vertical walls and these do not tilt with the dial and so tilting the dial is not a solution.

Comparison of Photographer's dials designed for  $51.5^\circ$  N and  $54^\circ$  N shows that the 'U'-shaped curves are similar but the centre of the dial is a little offset along the meridian axis. For dials 150 mm in diameter, a transposition of the centre by 4 mm brings the 'U'-shaped curves together, but the centres 4 mm apart. As a compromise if the centre is moved 2 mm the dial can be used at  $2.5^\circ$  latitude error with reasonable accuracy. If a  $51.5^\circ$  dial is used at  $54^\circ$  the errors in relative time reading are from 21 to 25 minutes. If the centre of the dial is offset as described the time errors are reduced to from 5 to 8 minutes. So a dial can be used at a different latitude if its centre is displaced a little along the axis.

A much better and more rigorous solution is to use a dial designed for  $54^\circ$  N (York) and this will cover Northumberland to Leicester to within 15 minutes error. Such a design is shown in Fig 2, including the altitude scale. So the whole of England can be covered with the use of two dials to within the accuracy possible from a small hand held instrument.

## REFERENCE

1. T. Belk: 'A Photographer's Sundial' *Bull BSS*, 21(iv), 26-27,39 (2009).



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