The British Sundial Society

BULLETIN

VOLUME 20(iv)
December 2008

BSS Bulletin 20(iv)

December 2008

GUIDELINES FOR CONTRIBUTORS

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.
2. Format: The preferred format for text is MS Word or text files sent by email to *john.davis51@btopenworld.com*. Material can also be sent on CD or as a single-sided typescript, single- or double-spaced, A4 paper.
3. Figures: For photographs, colour or black-and-white prints as large as possible (up to A4). Slides and transparencies are also acceptable. Pictures can be sent electronically as separate jpg (do not over-compress) or tif files—do not embed them in Word files. For email attachments, do not exceed 10 Mbytes per message. Tables should be treated as figures and numbered as part of the same sequence. Drawings and diagrams should be in clear, strong black lines (not pencil) on a white background. Each figure illustrating an article should carry on the back the author's name and a number indicating its relative position in the text (Fig. 1, Fig. 2 etc…). Label the top of the figure if it is not obvious. Captions for the figures should be written on a separate sheet in numerical order. They should be sufficiently informative to allow the reader to understand the figure without reference to the text.
4. Mathematics: symbols used for the common dialling parameters should follow the conventions given in the Symbols section of the *BSS Glossary* (available online on the Society's website). Consult the editor if in doubt or for help in laying out equations.
5. The *Bulletin* does not use footnotes. Where additional information is required, notes should be numbered as a Reference with a superscript number. For very long notes, use an appendix.
6. References: Sources are referred to in the text by a superscript number. They are listed in numerical order under the heading 'References' (or 'References and Notes') at the end of the article. The *Bulletin*'s convention is as follows:

   For books: Author's name; Title of book, in italics; Name of publisher, Place and date of publication.
   For papers and articles: Author's name; Title of article in single quote-marks; Name of journal, in italics (this may be abbreviated); volume number, underlined in Arabic numerals; first and last page numbers; date, in brackets.

   Examples:

   A.E. Waugh: *Sundials, their theory and construction,* Dover, New York, (1973).
   D. Colchester: 'A Polarized Light Sundial', *Bull BSS,* **96.2**, 13-15 (1996)
   A.A. Mills: 'Seasonal Hour Sundials', *Antiquarian Horol.* 19, 142-170 (1990)
   W.S. Maddux: 'The Meridian on the Shortest Day', *NASS Compendium,* 4, 23-27 (1997).

   If you simply wish to give a short list of books associated with the subject of the article, this may be given at the end of the article under the heading 'Bibliography', using the convention as given for 'Books' above.
7. Acknowledgements: These should be as brief as is compatible with courtesy.
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Front cover: *The superb multiple dial at the convent of Mont Ste-Odile is admired by a group of BSS members during the recent Alsace tour. See page 193 for the full story. Is that a reclining polar dial on the top corner, without its gnomon? – see the article from Tony Belk on page 170. Photos: Mike Cowham.*

Back cover: *A different multiple dial, this time a brand new one carved from Crimean limestone by Alex Boldyrev. The dial is in honour of Apollonius of Perga whose work on conic sections two millennia ago was the forerunner of gnomonics. On the north face of the dial, there is a carving symbolising the cold star named after him. Another example of Alex's work is on page 159.*

Designed by J. Davis. Printed by Henry Ling Ltd., Dorchester, 01305 251066

BULLETIN
OF THE BRITISH SUNDIAL SOCIETY

ISDN 0958-4315

VOLUME 20(iv) - December 2008

CONTENTS

EDITORIAL

I hope that when you get this issue of the *Bulletin* you will notice a new and more colourful appearance. Printing technology is advancing quickly so, by moving to new and bigger printers, we are able to take advantage of the changes to provide higher quality for a relatively small change in cost. Thus, if the Treasurer continues to give his blessing, this issue will set the direction for the future. As always, our funding is dependent on membership numbers so please do try to recruit your friends.

It will take a while to develop the style of the *Bulletin* to make best use of colour. It should add impact to dial pictures: please enter the Photographic Competition with lots of interesting shots. My artistic skills are severely limited but I am pleased to say that Jackie Jones has agreed to provide help with the overall 'look' of the journal. Other contributions are welcome!

Included with this issue should be a pocket-sized card with the Equation of Time and other solar data. I am grateful here to Fiona Vincent for the basic data and to Doug Bateman for the layout (a more difficult job than you might imagine). There is no excuse now for not checking the accuracy of all the dials that you come across.

THE UNIVERSAL EAST AND WEST POLAR DIAL

MIKE COWHAM

My attention was brought to this type of dial by a friend who had seen the photograph of one from a private collection and wanted to know what it was and how it worked. It is similar to a dial made by BSS member Harriet James (Fig. 1) but without the EoT corrections. Other closely related dials include the direct East or direct West dials frequently found on churches or as east and west faces of a cube dial. A similar design, a portable cube dial, (Fig. 2) was made by David Beringer, working in Nuremberg c.1725-1776. In the case of all of these cube dials, the directions of north and south are crucial for their correct operation. The fixed ones should have been correctly positioned on their building or on a pillar at the time of installation and the portable ones have an inbuilt compass to align them.

The 'universal East and West polar dial' shown in Fig. 3 is also a portable dial but it does not have a compass, so there has to be some other way of achieving a correct alignment. The dial face is very similar to the east and west faces of the dial by Beringer, but instead of the 'T' gnomon it has a pin gnomon set at the centre of the VI–VI line. The length of the gnomon needs to be set at the exact distance as the VI-VI line is from the IX-III line, a useful indicator in case the gnomon has been lost. Note that the scale on this dial is calibrated lengthwise with the date. This type of dial is universal, capable of being used anywhere between the Equator and the North Pole. To get the correct alignment and find the time, the first step is to set the latitude just below the suspension point, then rotate the dial so that the tip of the gnomon shadow falls on the appropriate date line: this same point will give the current time. As a consequence of this alignment, the dial will automatically be set correctly to face either east or west, depending on whether it is morning or afternoon.

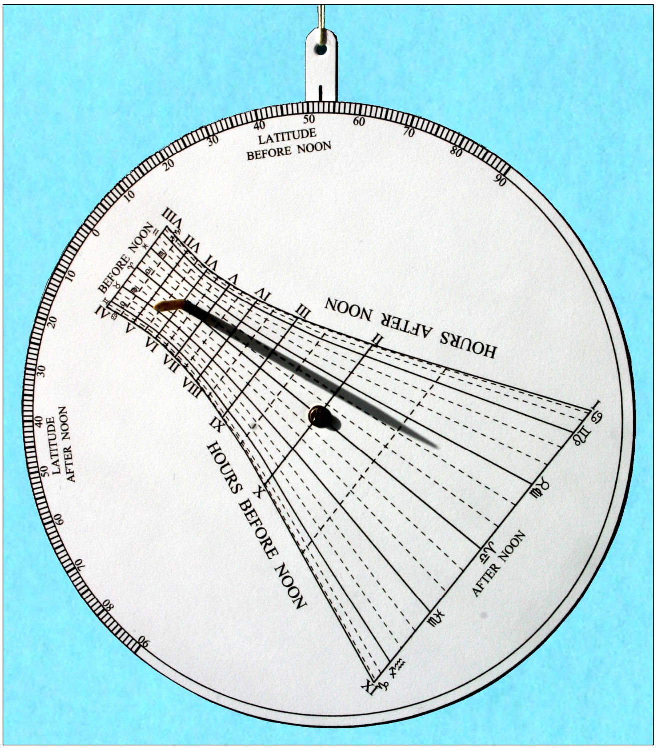


Fig. 3. A model of the 'universal East and West polar dial' made for this study, showing a time of approximately 10:40 'before noon' for Pisces 7° or Libra 23° (equivalent to February 26 or October 16).

Fig. 1. The west face of a double-sided universal East/West polar dial in brass, by BSS member Harriet James.

Fig. 2. Cube dial by David Beringer of Nuremberg with a direct west facing dial on its right face

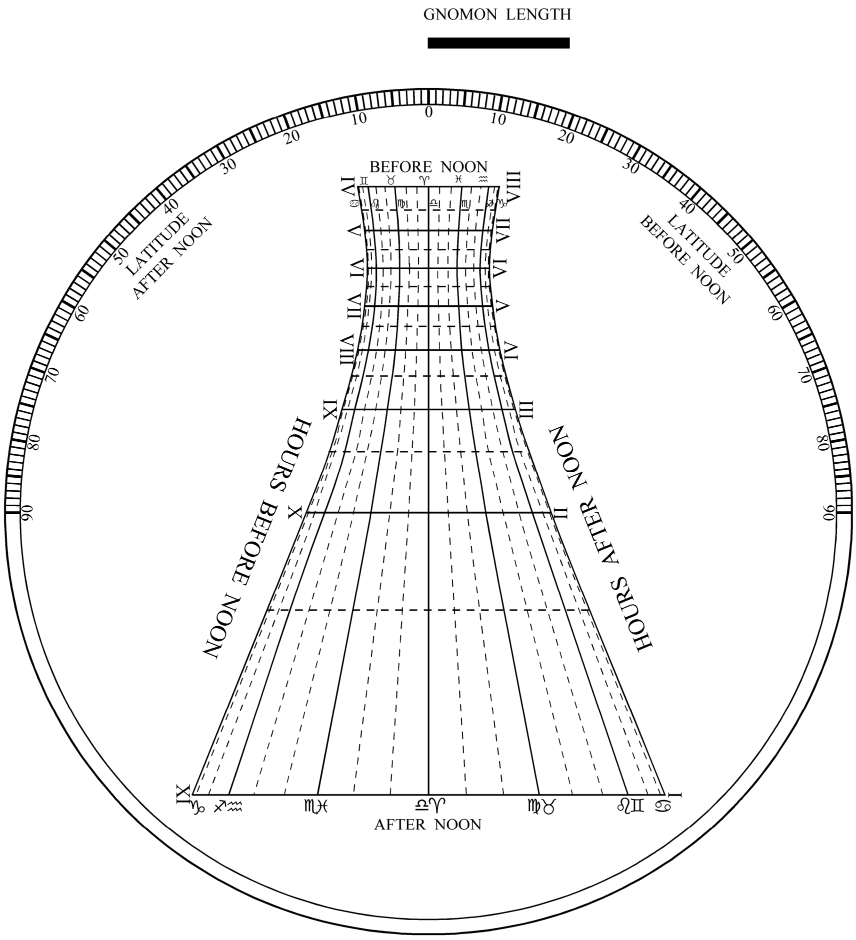
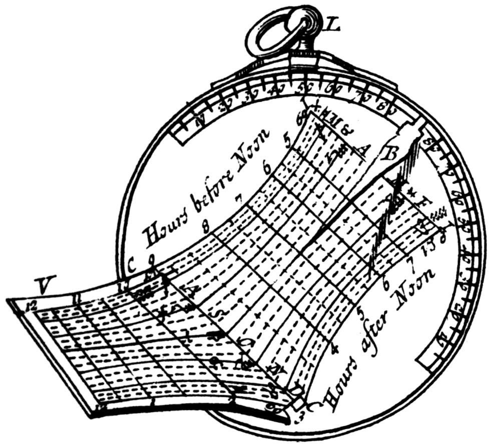


Fig. 4 (left). The 'cooling tower' shaped layout for the universal East and West polar dial.

Fig. 5 (below). The improved version of the dial with its hinged-down flap as illustrated in the book by Bion.



As this is an east *and* west dial it is necessary to reverse the settings between morning and afternoon, (unnecessary on double-sided dials like that by Harriet James). Each of the date lines (signs of the zodiac) are subdivided into three 10° divisions with the dates for morning being shown at the top end of the scale and a reverse sequence for afternoon being shown below the scale. The hour markings for morning are annotated on the left side and those for the afternoon on the right. This at first seems quite complicated and in my first attempts to use the model I got things switched a few times, but once the dial had become familiar, I was pleased to find that it gave consistently good results. Sharp-eyed readers will also have noticed that the dial does not go beyond XI and starts reading again at I, leaving a two-hour gap around noon. This is due to the fact that at noon the shadow actually stretches to infinity so can not be recorded on a vertical dial of this type. This small point can hamper the user and may be the reason why it did not achieve popularity. A further problem with this dial is that the hours around 6am and 6pm are rather cramped and towards XI–I the scale is very spread.

I remembered seeing a dial very similar to this in Nicholas Bion's book *The Construction and Uses of Mathematical Instruments,* in the English edition by Edmund Stone, London 1758 (see Fig. 5). Bion's version has an important difference; it has a fold-down section that shows the hours from IX to III on a plate perpendicular to the main dial plate. This solves the problem of loss of readings around noon and also helps to give an expanded scale at other times; the width of the scale is virtually doubled compared with the former type.

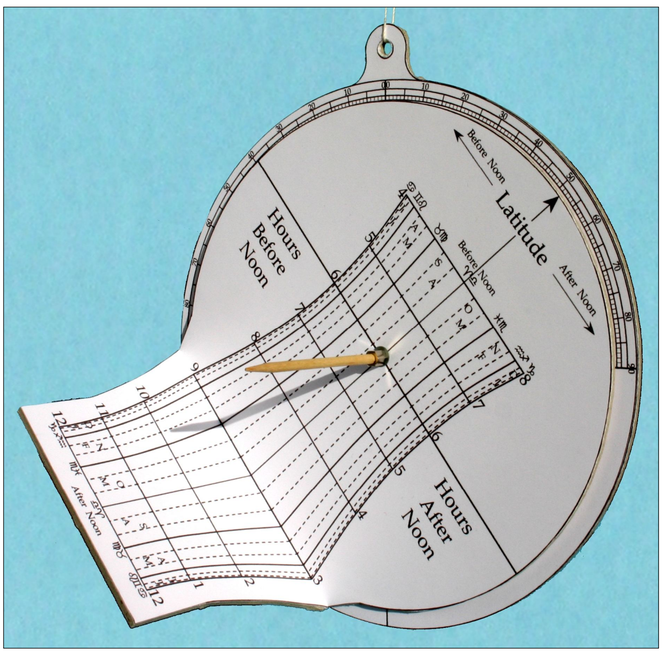


Fig. 6. Model of East and West dial similar to that given by Bion, showing a time of 2:10 'after noon' at Scorpio 9° or Aquarius 21° (equivalent to 2 November or 10 February).

A model of this dial was also constructed (Fig. 6) to enable me to get a good feel of how it would perform. The gnomon was positioned so that it came from the centre of rotation (purely for convenience of manufacture) but could equally well have come from any point, such as that in Bion's drawing which comes from the top, because it is only the shadow of the tip of the gnomon that is used to tell the time. His design will simply fold flat whereas mine needs to have the gnomon removed first.

The initial results with this dial were disappointing until I realised that the weight of the hinged-down flap and, to some lesser extent, the gnomon to one side of the disc, were causing a serious imbalance: the dial was no longer hanging vertically or correctly at my latitude setting of 52°! This problem could be solved with a counterweight but this would also need to be rotated as the latitude and the morning/afternoon settings were changed. Bion does not show such a device, probably because his flap is much lighter in proportion to the dial's weight than the one that I used.

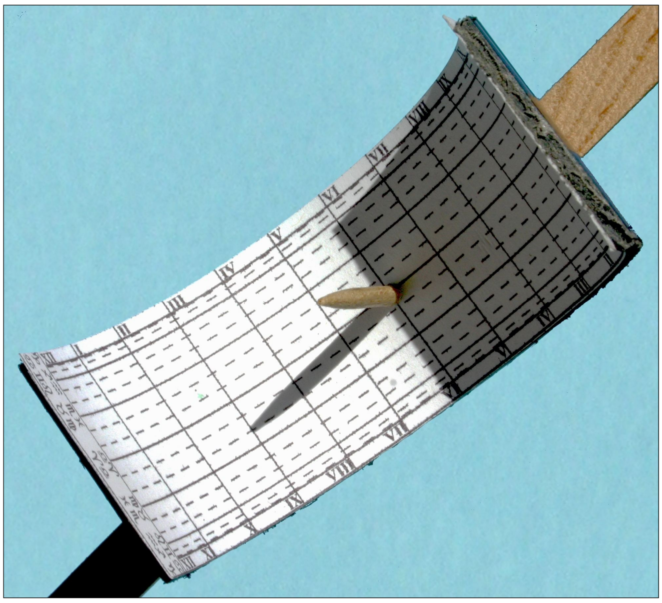


Fig. 7. A model of an East and West dial but made inside a half cylinder. It is rather bulky and therefore not very suitable as a portable dial. It is showing a time of 3:00 'after noon' at Aries 20° or Virgo 10° (equivalent to 10 April or 3 September).

My next attempt, Fig. 7, was to make a further improvement on the design of Bion by placing the hour scale on the inside of a cylinder, thereby making all of the hour spacings exactly 15° with the scale at a constant distance from the gnomon tip. The gnomon, of course, could have been of any form, but a pin type was used as all that was necessary was for the tip to be at the centre of the dial scale's arc. The dial now produced was half of an equatorial dial. Due to the width of the ring, which must also be rigid, the dial can no longer fold flat for transit, being much bulkier than the two former designs.

Fig. 8. A double crescent dial from Johannes Martin of Augsburg, c.1700.

At this stage it then became obvious that, in order to achieve a compact design, the gnomon has to be moved in order to agree with the date lines. This then allows the ring to be of minimal width. A dial to this design had already been made prior to 1700. It was the 'double crescent dial', made in Augsburg (mostly from the workshop of Johannes Martin – see Fig. 8). It usually has two separate semi-circular dials, one for morning and the other for afternoon, mounted back-to-back with a double gnomon like a pair of horns mounted so that they can be moved to correspond to the correct date setting, the tips of the 'horns' forming the shadow on the appropriate equatorial ring.

The dials described above are therefore all closely related. They are all 'universal', being capable of operation at any latitude and are all self aligning, not requiring a compass at all. They are fully portable, all but one folding neatly for transit in a pouch or pocket.

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A Butterfield dial by P Le Maire, seen in the Kirschgarten Museum, Basel, during the BSS Alsace tour.

BSS NEWBURY MEETING
27 September 2008

JOHN DAVIS

It almost goes without saying now that it will be a bright sunny day for our annual trip to Newbury, however poor the summer. This year we were a few days after our normal equinox date and the day started very foggy but after that lifted it was clear that the organisers, David Pawley and Peter Ransom, had been in touch with the weather gods. David, unfortunately, was recovering from a very rapid descent of a ladder and had his foot in plaster but he was still zooming around on an electric buggy.

The first talk of the day was from Tony Moss, a long way south of his homeland. His title of 'Towards a Stainless Reputation' allowed him to talk about the trials and tribulations of making sundials in the enduring but very difficult-to-work material of stainless steel. Tony concentrated on the techniques of etching using aqua-regia, though having proved to himself that he can do it he says he now prefers to contract-out this step to a local specialist. Waterjet cutting is the preferred method of cutting this very tough material but Tony machines the various odd shapes of gnomons himself.

The second talk, from Tony Belk, was on 'Polar Dials for any Declination'. With the aid of some cardboard models and not too difficult mathematics, he described how dials with parallel hour lines could be designed for planes facing directions other than the cardinal points. The full description is on p.170 of this issue. Tony said that he was not aware of any real examples of this sort of dial other than on the subsidiary faces of multi-facetted dials. The audience could not supply one – can the readership do better?

Next up was Peter Ransom on the use of the Texas Instruments 'nspire' graphical super-calculator to give dynamic sundial designs and even, with gnomons attached to the display screen, real sundials. In 'Old dials, new technology in Berlin', he reported on a presentation he had given in Germany. The purpose of the development was to teach mathematics to whole classes of school-children and, perhaps, to sow the seeds for a future interest in dialling. Peter explained that there were fewer distractions to the students by using the calculators rather than laptops.

As Tony Moss is not able to get to Newbury very often, he had a stock of short PowerPoint presentations to give. One of these showed a method, originally from NASS member Steve Luecking, by which an equi-angular fan of hourlines could be translated to the delineation of a horizontal or vertical dial in a single stroke. This mathematical transformation works for any latitude and for divisions to individual minutes if required. Another animation showed very graphically the movement of the hourlines and earliest sunrise - latest sunset as the latitude varies from the tropics to within the Arctic Circle. Although we might know in principle how this happens, there is nothing like seeing it happen in front of your eyes.

Kevin Karney has been exploring the capabilities of the free Google software *Sketch-up* to produce 3-D drawings of buildings with dials on or near them. Facilities within the program then allow the site, which may include features such as nearby trees, to be illuminated with sunlight appropriate to any date and time. Kevin demonstrated with a live example how this could quickly show when a dial would be overshadowed by its surroundings or, as the title of his talk had it, 'Is your sundial snookered?'.

Last before lunch, Tony Wood presented the survey which he and Irene Brightmer have been making of early horizontal dials in Flintshire. These are characterised by having the hour lines carved directly into the tops of stone pillars, usually with a metal gnomon leaded into the stone. Quite a few examples have been found, some even dated to pre-1600 and with the initials of the Dean of the time. Various hypotheses about whether this technique pre-dates the general introduction of metal dialplates are still being debated.

An extended lunchtime allowed us to eat our sandwiches in the sun, look at the exhibits and also peruse the bookstall which Elspeth Hill had kindly brought along. This time, as well as selected items from the Rogers Turner stock, she

Top: Chris Lusby Taylor explains his reflecting noon mark to interested observers.

Centre: An unusual horizontal dial in phosphor bronze from Tony Moss.

Bottom: Tony Belk explains polar dials to Ben Jones.

also had the BSS publications available. Outside, we found what Chris Lusby Taylor had made from the large lump of slate which he had purchased in the conference auction earlier in the year. The answer was a 'noon mark' where a small mirror (or even mirrors) reflected a spot of light onto an analemma. The dial also featured lettering engraved by Chris's CNC machine. Also outside, Mike Shaw (another refugee from the north) had his fibre-optic dial in operation and also his 'drainpipe' spiral dial. Inside, amongst other exhibits, were several examples of work-in-progress from Tony Moss – all to his normal high standard of workmanship – and also a nicely-made sun- and moon-dial from Mike Lee. An article on this last item is promised for next year. As with most BSS meetings, a group photograph was needed to record the event for posterity: contact me if you would like your own copy.

For the first talk after lunch, your Editor described some 'Sundials on paper'. These included several examples from the manuscript collections of the British Library and the Royal Society. Cases where a brass dialplate had been used as a printing plate were shown, as well as the difficulties associated with engraving in mirror-image.

Peter Ransom next showed some slides of sundials in Mexico which he had been given during an 'educational' trip there. We were intrigued to see the low gnomon angles but that the majority of the dials were very high up on buildings – good for unobstructed sunlight but hard for those of us with indifferent eyesight!

Finally, Mike Isaacs showed a number of high quality dial photographs by his son David. Most of these were from the southern hemisphere and so were unfamiliar to us, as was the amount of sunshine that was on show.

After coffee, some of the exhibitors described their items to the audience. Mike Cowham's many altitude dials (BSS monograph in preparation) were displayed and early plans for next years' dial safari to East Anglia attracted interest. I had to leave at this point but there was still much discussion going on.

A few well-known faces were missing but it was good to see some new ones too. Newbury remains as popular as ever and a wonderful venue: our thanks to David, Wendy and Peter.

NEW DIAL

A Multiple Dial in Shevelkovo Village

Our Russian member Alex Boldyrev has had a busy summer. Among several dials that he has made is this one for 55° 49'51.50" N; 38° 05' 31.95" E. It features the upper half of an equatorial dial (there is not much sun in Russia for the winter half of the year!) and a south facing scaphe dial in Greek style.

Made from limestone, it was carved entirely by hand. The gnomons are cold hammered and patinated copper rods. The owls on the east and west sides are the symbols of goddess Athena, patron of Athens. The letters AΘE denote Athena in Greek. The upturned letter 'A' on the eastern face is a carefully reconstructed mistake made 2000 years ago when Hellenes coined their money. A rusted spot on the scaphe face is a print of iron-nickel meteorite. The customer received it as a gift.

See the back cover for another example of Alex's work.

ANALEMMATIC DIALS – DESIGN DATA

KEN HEAD

INTRODUCTION

My article in the Bulletin for June 2007[1], and subsequent correspondence[2], described and commented on the 'sunrise and sunset' markers which can be included in the layout of an analemmatic sundial, and made particular reference to dials laid out in a garden. These markers have also been discussed by Rouxel[3], Carmichael[4], and Bailey[5]. The present contribution aims to summarise all the data and equations that are needed in order to delineate and set out an analemmatic dial, in the hope that it will be of use for anyone contemplating the construction of a dial of this type.

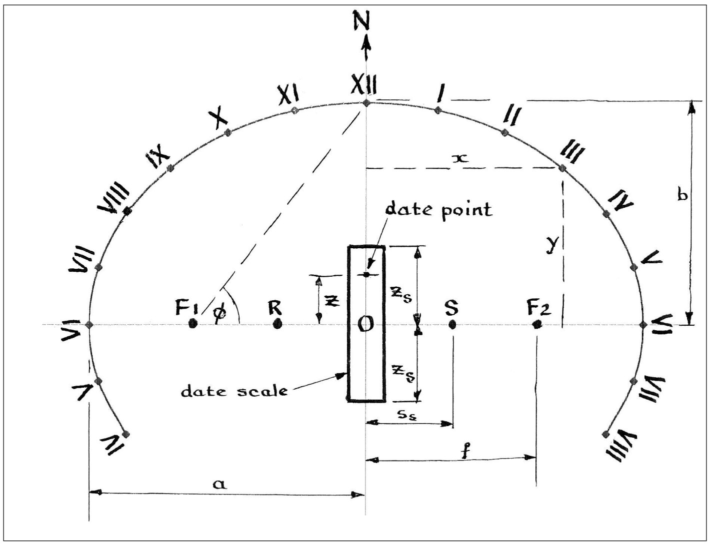

Fig. 1. Typical layout of an analemmatic sundial.

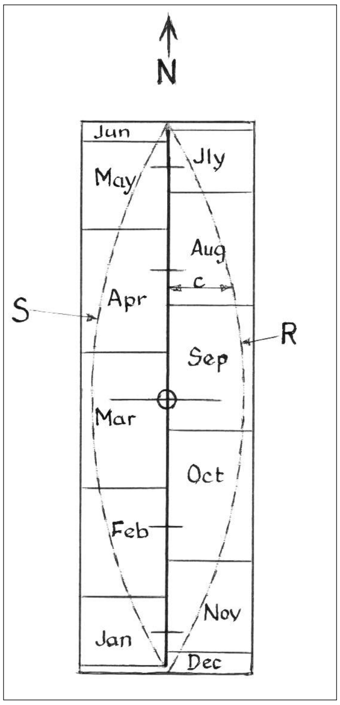

Fig. 2. Typical date scale. The superimposed dashed curves are offset scales for deriving sunrise/sunset directions using the points **R** *and* **S** (in Fig. 3)*, on any date.*

The analemmatic sundial is effectively a projection of an equatorial dial on to a horizontal surface and so the circular scale becomes an ellipse. If the point on the style that forms the shadow on a particular day is also projected onto that surface, a vertical gnomon can be used at that point, but its position will vary from day to day with the declination of the sun. This type of dial is often set out as a garden dial, in which the function of the adjustable vertical gnomon is performed by a person standing astride the centreline on the date scale. A typical dial layout is shown in Fig. 1 and the relevant date scale is shown in Fig. 2.

SYMBOLS

Centre of ellipse	**O**
Foci of ellipse	$\mathbf{F_1}$, $\mathbf{F_2}$
Solstice sunrise and sunset markers ('Bailey points')	**R**, **S**
Hour markers (4am to 8pm)	**IV** to **XII**, **I** to **VIII**
Centre of Lambert circle	**L**
Local latitude	ϕ deg
Obliquity of ecliptic	ε deg
Declination of sun (for date)	δ deg
Day number	n (from 1 Jan)
Time	t hours (of 24)
Hour angle	h deg
Azimuth of sun at sunrise	A_s
Major axis of ellipse	a mm
Minor axis of ellipse	b mm
Distance to foci from **O** (major axis)	f mm
Distance to date point from **O** (minor axis)	z mm
Distance from **O** to sunrise/sunset intersection points (major axis)	s mm
Distance from **O** to these points at equinoxes	s_e mm
Distance from **O** to markers **R** and **S** (solstices)	s_s mm
Difference between s and s_s	d mm
Difference between s_e and s_s	d_0 mm

EQUATIONS

Time scale

Hour angle (from solar noon): $h = 15(t - 12)$ deg

Axes of ellipse: $b = a \sin\phi$

Coordinates of hour markers (origin at **O**, x measured along major axis): $x = a \sinh$,

$y = b \cosh = a \sin\phi \cosh$

Date scale

Distance from **O** (at date): $z = a \tan\delta \cos\phi$

Maximum distance (solstices): $z_s = a \tan\varepsilon \cos\phi$

Sunrise and sunset markers

Azimuth at sunrise:

$A_s = \arccos[-\sin(-\delta)/\cos\phi]$

Distance of marker from **O**:

general: $s = a \tan\delta \cos\phi \tan A_s$

$$= \frac{a\cos\phi\sqrt{\left(\cos^2\phi - \sin^2\partial\right)}}{\cos\delta} \quad (1)$$

solstices (least) ('Bailey points' **R** and **S**):

$s_s = a \tan\varepsilon \cos\phi \tan A_s$

$$= \frac{a\cos\phi\sqrt{\cos^2\phi - \sin^2\varepsilon}}{\cos\varepsilon}$$

equinoxes (greatest) $s_e = a\cos^2\phi$

Correction offset on date scale:

generally: $d = (s_s - s) \quad (2)$

equinoxes (max): $d_0 = (s_s - s_e)$

Radius of Lambert circle:

$$= \frac{a(\sin^2\phi + \tan^2\delta\cos^2\phi)}{2\tan\delta\cos\phi}$$

Distance of centre **L** from **O**

$$= \frac{a(\sin^2\phi - \tan^2\delta\cos^2\phi)}{2\tan\delta\cos\phi}$$

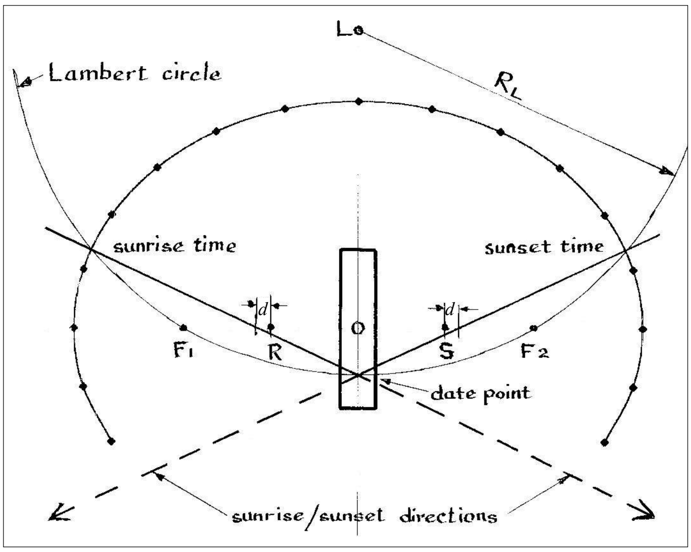

Fig. 3. A typical Lambert circle, showing derivation of times and directions of sunrise and sunset. The direction lines do not, in general, intersect the major axis at **R** *and* **S***, but at points displaced by the offset denoted by d.*

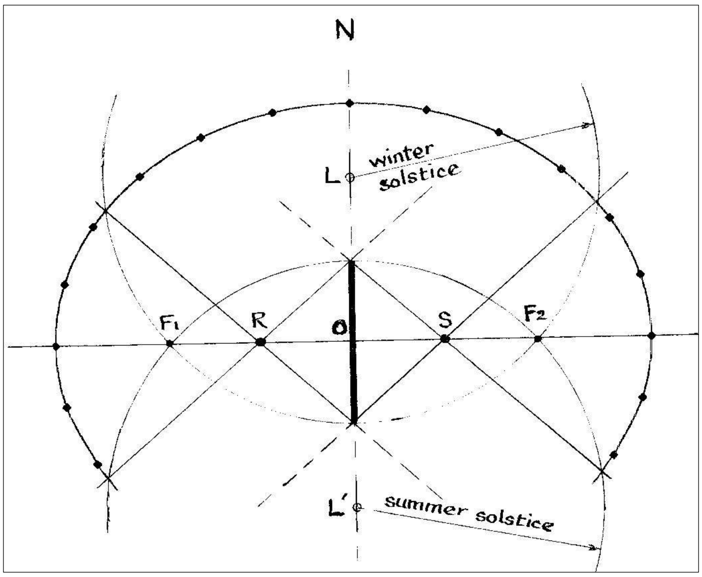

Fig. 4. Lambert circles for winter and summer solstices, showing the derivation of points **R** *and* **S.**

Foci

Distance of foci from O

$$f = \sqrt{a^2 - b^2} = a\cos\phi$$

COMMENTS

A circle passing through the two foci and the date point is called a 'Lambert circle'. It intersects the elliptical scale of hours at the (solar) times of sunrise and sunset for that day (Fig. 3).

The points **R** and **S** on the major axis**,** known as the 'Bailey Points', are derived by drawing lines through the extremities of the date marker (corresponding to the solstices) in the direction of the sun's azimuth at sunrise and sunset on those days (Fig. 4). These points are only approximate indi-

Sign of zodiac	Longitude at entry	tan δ	
Aries	0	0	Vernal Equinox
Taurus	30	0.2029	
Gemini	60	0.3670	
Cancer	90	0.4336	Summer Solstice
Leo	120	0.3670	
Virgo	150	0.2029	
Libra	180	0	Autumnal Equinox
Scorpio	210	-0.2029	
Sagittarius	240	-0.3670	
Capricornus	270	-0.4336	Winter Solstice
Aquarius	300	-0.3670	
Pisces	330	-0.2029	

Date	tan δ	Date	tan δ
1 Jan	-0.4259	1 Jul	0.4276
1 Feb	-0.3120	1 Aug	0.3282
1 Mar	-0.1373	1 Sep	0.1495
1 Apr	0.0752	1 Oct	-0.0515
1 May	0.2661	1 Nov	-0.2536
1 Jun	0.4034	1 Dec	-0.3984

cators of sunrise and sunset directions and times on other days (except at equinoxes), but are sufficiently accurate for a garden dial. The discrepancy in direction is greatest at the mid-points between equinox and solstices on the date scale, and increases with increasing latitude. The offset of the intersection point for days other than solstices, measured from **R** and **S** along the major axis, is denoted by d.

Compensation may be made by adjustments to the positions of the marker points, based on equation (1). Alternatively, a pair of correction curves could be added to the date scale, as shown in Fig. 2. These are obtained by offsetting the value of d derived from equation (2) from the centre-line at the relevant date point. The offset point, aligned with **R** or **S,** would then give the correct sunrise or sunset direction. The corresponding time is obtained from a parallel line through the date point itself. The curve to use is the one on the opposite side of the minor axis from the relevant marker point.

Values of tan δ

These values are used in the equation $z = a \cos\phi \tan\delta$ for calculating distances of date points from **O**.

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5. R Bailey: 'Seasonal Markers for Analemmatic Sundials', *NASS Compendium,* 19(3), 1-7 (September 2003).

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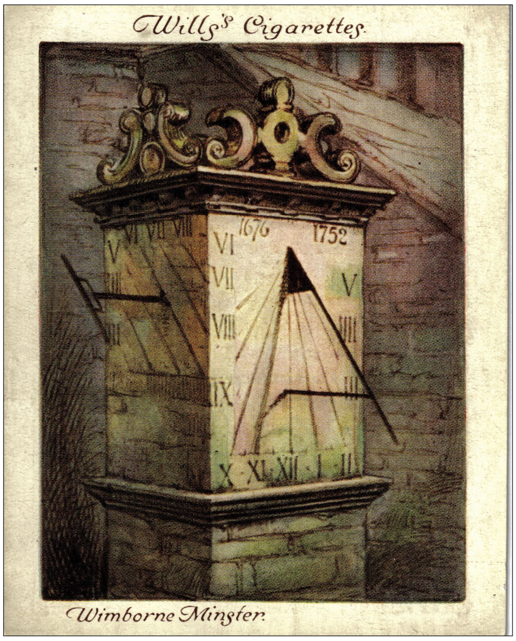
Postcard Potpourri 10 – Wimborne Minster, Dorset

Peter Ransom

Three views this time, but only one postcard (though I have quite a few of this famous dial). The postcard is at least 100 years old (the postmark is 1908) and shows the south face and dates 1676 and 1752. The gnomons on the east and west faces can also be seen. Each face is about six feet high. The cigarette card (Wills *Old Sundials*, 1928) also shows the west face. I recently came across the print in *The Youth's Instructor and Guardian for 1830* and you can see the dial up on the gable of the south transept, so at some point between 1830 and 1908 the dial was brought down to earth. Perhaps this happened in the restoration that took place between 1855 and 1857.

Mrs Gatty refers to this dial in *The Book of Sun-dials*, though the information there does seem slightly awry. She quotes the date as 1732 and mentions that it was on the north transept. The cigarette card also mentions the north transept, but surely it should be the south transept, or am I missing something here?



The Minster is well worth at least a half-day visit. It is basically Norman in design. As well as a chained library there is an astronomical clock and a jack on a window outside that has appeared in various guises throughout the ages! Alfred the Great's brother, Ethelred (not the unready one) is buried somewhere inside.

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THE MALVERN PILLAR DIAL

TONY WOOD

A picture from Gatty in the June issue of the Bulletin (20 (ii), p.87) of the dial at Malvern Priory Church requested further information of its whereabouts.

The latest state is that the cube dial has been removed from high up on the old cross shaft and has been replaced by a gabled cross, seen in Fig. 1. The dial itself has been refurbished or, more likely, replaced by a new carving. All that remains is the cap finial: even the ball has gone. (SRN 4525 under 'Great Malvern, Herefs. & Worcs.') The assembly is now mounted a little nearer to the south of the church on a short column with all four faces clearly delineated (Figs. 2 & 3).

Fig. 1. The Malvern pillar, now without its dial.

Fig. 4. A modern cube dial, by Liz Leighford based on the old one at Oldbury-on-Severn.

There is a small tailpiece. A recent visit to a garden produced the dial in figure 4 on display and for sale. It looked very much like the Malvern dial so I enquired of the sculptor Liz Leighford who said it was based on Oldbury-on-Severn's dial which was very similar. She also had the wonderfully hand-carved pedestal (Fig. 5) on display for £1610.

Fig. 5 (above). A hand-carved pedestal by the same sculptor as the cube dial of Fig. 4.

Figs. 2 & 3 (left). The Malvern cube dial (reproduction?), now in the churchyard.

THE LIFE CYCLE OF ENGLISH SCRATCH (MASS) DIALS

CHRIS H K WILLIAMS

We have seen that most English churches do not have a surviving scratch dial[1] and that dial losses far exceed survivals[2]. Whilst such findings are of interest in their own right in illuminating the status and context of surviving dials, a far greater prize would be the recreation of the past original scratch dial position. That must of course be linked to what survives; but how can the link be deciphered? The linkage is not simple. Indeed, half a millennium of scratch dial usage renders the words 'past' and 'original' at best ambiguous and, at worst, meaningless. This article develops an approach for linking the present surviving scratch dial heritage to its past.

After extensive consideration, the author is convinced the only way to discern linkage is to view scratch dial evolution as a continuous dynamic process – the net outcome of several separate independent dynamic factors. The proposed framework constitutes a single methodology allowing all known scratch dial data and influences to be simultaneously incorporated in a consistent and numerical fashion.[3] It is not too fanciful to view scratch dial evolution in life cycle and evolutionary terms – scratch dials had birth, death and extinction rates; we are left with the fossils.[4]

The most enduring dynamic forces, operable both during and after the scratch dial era, are the destructive processes of weathering and church rebuilding. The true scale of *dial loss* has not hitherto been appreciated; neither has its implications. When imagining where all the lost dials might once have been, logic alone quickly persuades one they came not only from churches with, but also those without, surviving dials. Weathering and rebuilding affected all dials – it did not discriminate by how many dials a church had! Churches with surviving dials have lost some of their dials, those without have lost all of them.

Can we be sure all medieval churches once had a scratch dial? Whilst visible evidence is impossible, circumstantial evidence is abundant. As simple, low cost, easily imitated devices there were no natural barriers to the spread of scratch dials. Surviving examples alone are sufficiently numerous and geographically dispersed to indicate know-how, capability and adoption must have been universal. Allowing for lost dials, the point can be made even more strongly. Moreover, the geographically dispersed survival of Saxon dials indicates awareness predated medieval times. In combination, the foregoing considerations make the case in favour of universal scratch dial adoption overwhelming.[5]

Many more churches must once have had multiple dials than is currently indicated by surviving examples. That such was the case is statistically corroborated by the database[6]: the more dials surviving in a county, the more of its churches have dials and the more dials there are on those churches. Figure 1 illustrates the interplay between the extent of dial survival and the number of dials per church. Allowing for lost dials, the unavoidable conclusion is that churches must once have had more than one scratch dial – most had several.

The prevalence of multiple dials is evidence of dynamic processes resulting in *dial redundancy*.[7] The need to make a new scratch dial can be attributed to several possible causes. Firstly, the shadow cast by the building of porches or growth of trees could render a dial inoperative. Secondly, events as innocuous as using a different entrance to a church or a change in the priest's dwelling place could leave a dial inconveniently located. Thirdly, as scratch dial design and appearance[8] changed and evolved, dials would become unfashionable or otherwise considered inappropriate. Fourthly, personalisation: the desire by some vicars, if only a minority, to have their 'own' dial would leave a dial redundant for no apparent reason.[9] Redundancy would have accumulated throughout the scratch dial era – half a millennium. In combination, these considerations suggest multi-dialled churches should be the expected norm rather than exception.

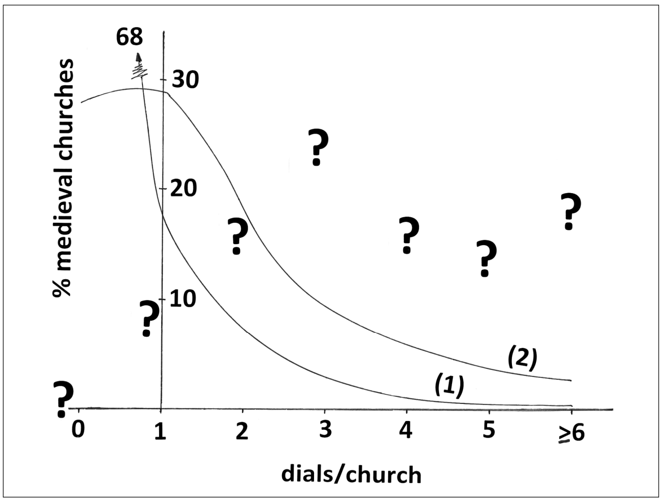

Fig 1. Relationship between the incidence of multi-dialled churches and the extent of scratch dial survival. Curve 1: Somerset surviving (30% of churches with dials). Curve 2: Gloucestershire surviving (70% of churches with dials). Curve **?***: Illustrative 'original' (100 per cent of churches with no subsequent dial loss – discussed further in future articles).*

The remaining dynamic process was *dial displacement* by alternative technologies—scientific dials and mechanical clocks. Exactly when they were displaced is critical to scratch dial assessment. The horological literature is surprisingly muted in its examination of either the geographical or temporal distribution of the shift from seasonal to equal hours. The classic early (14^{th}-16^{th} century) examples of scientific dials, mechanical clocks and documentary or literary references to equal hours have to be judged for what they are – isolated examples confined to wealthy patrons (individual or institutional) within cosmopolitan and courtly circles. They cannot be considered representative of the generality of parish churches. Examination of primary documentary sources leaves little doubt most parishes gave up scratch dial use, at an increasing rate, during the seventeenth century.[10] It is clear that previous authorities were apt, when dating the demise of scratch dials, to be unduly influenced by early examples of, rather than any awareness of their general, displacement.[11]

Pulling all the strands together we obtain a framework within which both the actual and post scratch dial eras can be jointly considered. On each and every parish church new dials would have been cut, though only a single dial actively used, until such time scratch dial usage was displaced. The displacement was a prolonged process, but most parishes converted during the seventeenth century. The maximum number of scratch dials across all churches would have been attained towards the end of their displacement, say c. 1650-1700 i.e. when new dials at the few remaining churches still using them was offset by losses at the bulk of churches no longer using them. This represents a significant turning point. Prior to c. 1650-1700 all three dynamic forces – redundancy, displacement and losses – were in play; thereafter only losses operate and the number of surviving dials progressively declines.

Remarkably, as will be evidenced in future articles, the dynamic life cycle framework we have developed, in combination with surviving scratch dial (the database) and other information, yields many quantified and dated historical insights that brings to life and recreates the scratch dial era.

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2. Chris H.K. Williams: 'English Scratch (Mass) Dials: The Ravages of Time', *Bull BSS*, 20(iii), 110-111, (2008).
3. Moreover, as will be seen in subsequent articles, where quantified data does not exist, it permits ranges of parameter values consistent with all other known information, to be derived.
4. Fossils are an apt analogy when we consider (in a subsequent article) the possible appearance of scratch dials when they were in use. What remains is a partial, monochrome, skeletal image.
5. Reassurance that this is correct is provided via a rigorous devil's advocate challenge. Should possible areas of non-adoption be discerned from the pattern of surviving dials and loss estimates, formulating a diffusion model that simultaneously explains the patchy intra-county adoption, inter county adoption relativities, and their persistence throughout the scratch dial era, is mission impossible. There is no logically credible alternative hypothesis to universal adoption.
6. See Fig. 2 in Ref.(1).
7. It has on occasion been suggested in the literature that multiple dials exist because they are practice dials (by the original makers) or copy dials (by subsequent miscreants). It is not explained why practitioners did not practice in a more private manner, nor why subsequent graffiti should be so uniform/ uninspired. Whilst such eventualities cannot be dismissed as never occurring, to postulate one or both to explain the prevalence of multi-dialled churches is inherently implausible.
8. To be considered in detail in future articles.
9. In judging the realism of redundancy due to personalisation, bear in mind the number of priests involved. For the author's own parish (Charing, Kent) the average incumbency was nine years between the 13^{th}-17^{th} centuries.
10. Kentish churchwardens' accounts are being systematically reviewed by the author. The first procurement by parishes of scientific dials or mechanical clocks is overwhelmingly in the seventeenth century. Numerous parishes never had a clock and did not procure a scientific dial until the eighteenth century (unpublished work in progress). This pattern of conversion from seasonal to equal hours is supported by the spread of clock ownership as revealed by Kent and Glamorgan probate inventories. See C.H.K. Williams 'Seventeenth and Eighteenth Century Clock Demand, Production and Survival', *Antiquarian Horology*, 28,571-583, (2005) and 'Clock Ownership from Provincial Inventories', *Antiquarian Horology*, 30, 253, (2007).
11. See for example E. Horne, *Scratch Dials. Their Description and History,* Simpkin Marshall, London (1929) p49-51,59; and T.W. Cole, *Origin and Use of Church Scratch Dials,* The Hill Bookshop, Wimbledon (undated, 1935) p.6-7, *Classification of Church Scratch Dials,* The Hill Bookshop, Wimbledon (undated, 1936) p1-2 and 'Church Sundials in Medieval England', *Journal of the British Archaeological Association,* 10 (3^{rd} Series), (1947) p.77.

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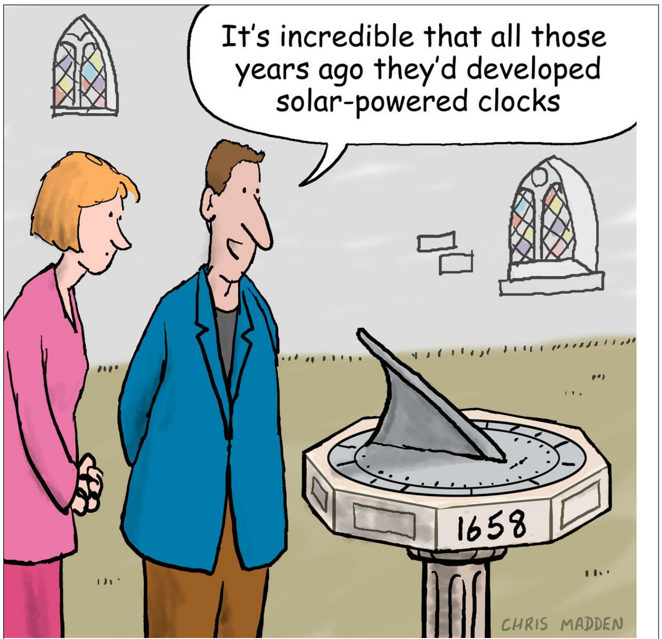

This cartoon by the artist Chris Madden first appeared in the BBC Focus magazine of August 2008, illustrating an article entitled *'The Last Word - I have a passion for mechanical devices that use sheer ingenuity to do what some nerd can knock off in two lines of programming'* by Robert Matthews. Thanks to Jill Wilson for submitting it.

TIMBOUCTOU SINE QUADRANT

MALCOLM BARNFIELD

Known in English idiom as Timbuktu and only as some far-flung outpost, the place in the past was actually far, far more. Located in the land-locked West African desert nation of Mali, Timbouctou was founded in the 11th century. It flourished as a trading post, agricultural centre, caravanserai and university town. The university at its peak boasted more than 15,000 students studying a myriad of subjects, with a strong emphasis on the sciences and astronomy in particular. Successive invasions and the attendant plundering brought the town into decline and it was basically defunct by the time it was occupied by the French in the late 1800s and has remained so till now.

Some years ago whilst on a State visit to Mali, South African President Thabo Mbeki was taken to Timbouctou and shown the ruins of the university. He noted the many ancient manuscripts lying about the place and was told of others kept by locals in wells, under beds, buried and so on. None were being properly stored, catalogued or preserved and many were being lost to weather damage, insects and fire. Thus, President Mbeki offered to build a temperature- and humidity-controlled storage facility for Malian preservation of this part of their heritage and to conserve the history and information in the documents. He also offered to have the manuscripts translated from the Arabic to English by South African Arabic-speaking scholars. The building of the museum and the collection of the scrolls and books is now virtually complete. The translations are ongoing.

A film documenting the whole story and publicising the new library was planned. One of the preserved manuscripts described the use of a sine quadrant and this is to be enacted as a part of the film. The funding for the film came from various government departments, religious and private organisations.

The instrument described is a sine quadrant, which was produced in several forms. The most common form was produced as either a stand-alone quadrant or included on the back of astrolabes. The quadrant form was equipped with a cord and bead for locating angles and their sines. This served the same purpose as an alidade on an astrolabe. In either form, the purpose was to allow the solution of certain classes of trigonometric problems without manual calculation. For example, the unequal hour, T, can be calculated from the sun's noon altitude, a_n, and current altitude, a, by solving the equation: $\sin 15T = \sin a / \sin a_n$. This equation gives satisfactory results for low latitudes, such as Timbouctou, and although is less accurate for far northern latitudes it is the basis for the unequal hour scale shown on the quadrant below. The quadrant is very easy to use for simple problems but great dedication would be required to attack more difficult ones. Some of the solutions described in surviving treatises demonstrate the virtuosity of medieval Islamic astronomers.

I was commissioned to make a reproduction of the instrument for the film and was given a partial translation of the Timbouctou manuscript, which was rather difficult to

Fig. 1. Pages of an original Timbouctou manuscript. Photographs by Sharron Hawkes.

Figs. 2 & 3. Dr Thebe Medupe of Sutherland Observatory demonstrating the quadrant's use to students. Photographs by Sharron Hawkes.

follow as the translator apparently had little background in this type of treatise. I sent the 'translation' to James E. Morrison, author of *The Astrolabe*,[1] which discusses this type of instrument in the form used on old Islamic astrolabes. He gave me guidance as to the exact instrument described and requested confirmation of his interpretation from Dr Charette of Munich, an authority on Islamic astronomy and author of *Mathematical Instrumentation in Fourteenth-Century Egypt and Syria: The Illustrated Treatise of Najm al-Din al-Misri*.[2] The manuscript content was also validated by Dr Petra Schmidl of Frankfurt, an authority on Islamic astronomical instruments and treatises. François Charette replied:

> "Sibt al-Maridini is a well-known astronomer from 15th-century Cairo, who wrote several treatises on the sine and astrolabe quadrants, which had a very wide circulation as they were used for teaching elementary astronomy in religious schools of the Ottoman Empire (especially in the Near East) until the late-19th century. The treatise whose translation you sent me is al-Risala al-Fathiyya on the use of the sine quadrant: this is indeed a very standard sine quadrant. The recent bibliography by Rozenfeld and Ihsanoglu lists 91 copies of this work, and there are doubtless many more."

Sections of the original documents are shown in Fig. 1 and part of the translation reads:

> Chapter thirteen
> How to know the extent of sunset time and that of sunrise time?
> Put the string on the Sixty, and then mark on the cosines of the difference of the latitude. After that move the string until the mark comes to the cosines of inclination. Where the string will be from the beginning of the Arc is the estimation of the extent of sunrise time, it is also equal to the extent of sunset time. If you like, put the string on the difference of the latitude starting from the beginning of the Arc then mark on the cosines of the inclination, and then transport the string to the Sixty; you will get the cosines of the extent. Only God knows.

Most of the film will be shot on site at Timbouctou but certain sections will be done at the Sutherland Observatory in South Africa. Figures 2 and 3 are of Dr Thebe Medupe of that observatory using the sine quadrant and instructing students on its use. The South African Large Telescope (SALT) in the left background is the largest in the Southern Hemisphere and illustrates where we are now and where we were then, in relation to astronomy. The documentary will be released on DVD later and those details will be advised when they become available.

An authentic sine quadrant from that period would have been calibrated in a base 60 system, sexagesimal, but I chose the now conventional 90° and decimal scale for the instrument made for the film for ease of contemporary usage. The quadrant (Fig. 4) includes lines for cosines as well as sines.

Budget constraints prevented the use of solid brass, water jet cutting and my normal etching process so the

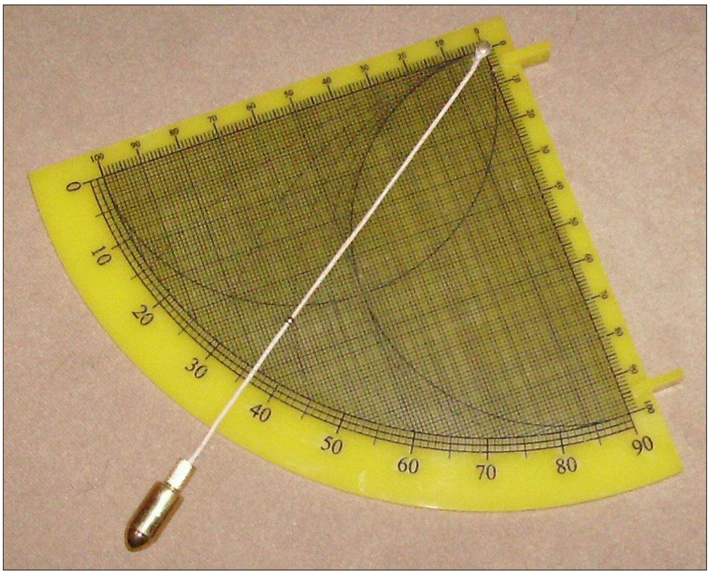

Fig. 4. The sine quadrant produced by the author for the film.

instrument, a quadrant of 150 mm radius, was laser cut from 3 mm yellow perspex and then laser engraved, finally being filled with black enamel paint. The paint was worked into the engraved grooves and wiped off whilst still wet. The bob, bead and thread suspension swivel were turned from brass. Perspex taps easily so the suspension swivel was screwed into place. The bob thread is braided cotton and not the traditional silk. The bob itself screws together to allow easy replacement of the thread if needed. The sights were also laser cut and laser 'drilled' for the 1mm sight holes, then glued into place with perspex adhesive.

The drawing of the sine quadrant is very easy and the addition of the temporary hours as simple. I use Corel Draw which is most accurate and directly compatible with laser cutting and engraving machines. The calibration of the altitude angle scale is by half-degrees and marked by 0.045 mm line thicknesses which are clearly visible after filling.

Although this is not my first astrolabe it is my first quadrant. The result is a very economic and practical instrument. Basic surveying, like finding the height of a tree or building is easy even without a shadow square on the drawing and its uses for the stargazer are many. It can also find local solar time quickly and mean time after a few not-so-easy calculations.

It was a nice project with a good purpose and what remains is a perfectly usable instrument. However, a third hand would help greatly because obtaining accurate altitude readings takes some practice at first.

ACKNOWLEDGEMENTS
Thanks to James E Morrison, François Charette, Petra Schimdl and John Davis for proofing, advice and help in the project. Also to Sharron Hawkes of Dogged Films, the film's producer ,and to Guy Spiller, the film's director.

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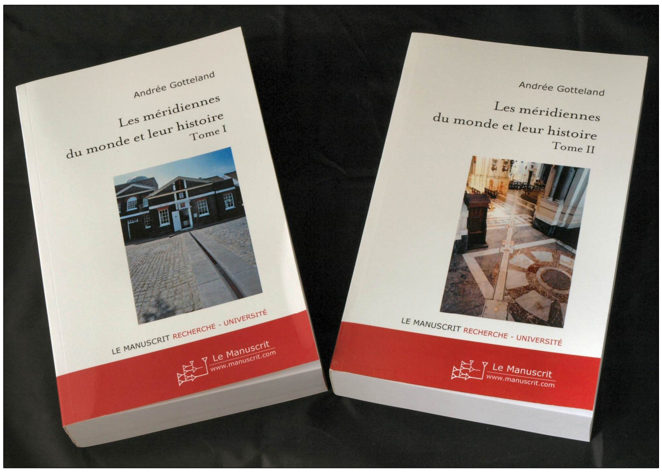
BOOK REVIEWS

Les Méridiennes du Monde et Leur Histoire,
by Andrée Gotteland.
2 volumes, 140×225 mm, pp. 484 & 492, b&w drawings throughout. ISBN 978-2-304-00469-4. €78.00 + postage, from *www.manuscrit.com*. The book is also available as a downloadable PDF file for €15.80.



Having first met Andrée Gotteland through her earlier book *Cadrans Solaire de Paris*, which she co-authored with Georges Camus, I was not surprised to find another comprehensive work, attractively presented with numerous black and white photographs, diagrams and useful tables of reference. *Les Méridiennes du Monde et Leur Histoire* is in two volumes, paperback, each of some 490 pages.

Andrée Gotteland is a member of the *Commission des Cadrans Solaires de la Société Astronomique de France* and it was with this Society that the project originated. The preface is by Denis Savoie, President of the *Commission.*

A *méridien* is defined as an imaginary great circle drawn on the earth's surface and passing through both poles. A *méridienne* is defined as a device used to ascertain the time of midday by the sun and thus Andrée Gotteland's researches include what we would call vertical and horizontal analemmas, noon marks and meridian lines.

Volume 1 deals with the classification of meridians in chapter 1 and their history in chapter 2, each of which has a useful index. The world tour starts in chapter 3 and continues to chapter 28 at the end of volume 2. 850 *méridiennes* are described covering 24 countries.

The last two chapters are entitled *Instruments Méridiennes,* which include midday canons, and *Méridiennes Industrielle,* bringing the total listing to 1100 in 28 countries. Chapter 29 is a bibliography. British meridians are described in chapter 11 at the start of volume 2.

These two fairly weighty tomes are, at first sight, somewhat overwhelming to a non-French-speaking reader but, since the subject matter is familiar to diallists, a rudimentary knowledge of the language would render the books accessible.

The content of the first two chapters can be found elsewhere and read more easily in English but the listing is an excellent resource and well worth the effort of translation. The division into countries, the indexing of those chapters with a large number of meridians, and the many photographs makes reference a less daunting task. Any traveller with an interest in the subject should be able to track down the listing for a country and from that the location of a particular meridian – all are identified by latitude, longitude and postal address – so that it remains only to translate the descriptions of meridians (which includes their histories, function and state of preservation) one at a time.

Jane Walker

Mass Dials On Yorkshire Churches (BSS monograph No. 3) by Alan Cook.
A4, soft cover, v + 47 pages, b&w illustrations throughout. ISBN 978-0-9518404-9-8. Published by BSS (Crowthorne), Price £7.00 inc UK postage from BSS Sales.

BSS monograph No. 3 is a most welcome addition to the literature on mediaeval mass dials. This is in the tradition of previous regional studies such as those of Somerset by E. Horne (1917), Hampshire by A.R. Green (1926), Derbyshire by F.N. Fisher (1935) and, most recently, Lincolnshire by A.J. Adams (2001) on a BSS CD.

The monograph opens with a brief history of time measurement which gives a useful context for an introduction to the role of mass dials, how they were used and why they may have varied over time. The author selected for his study the 100 km OS grid square SE, roughly centred on York and covering most of the county of Yorkshire. In all 318 churches were visited, 83 have mass dials, 32 have two or more. Maps locate all these churches and a gazetteer describes and illustrates each dial.

In the analysis of search results several issues are discussed such as variations in style and distribution. The author suggests a role for the industrial revolution, with economic change and population redistribution accounting for the spatial variation in survival rates.

The study is well illustrated, with scaled line drawings of all 139 mass dials; ten photos are included, two in colour.

The author acknowledges that "much is still to be understood about mass dials", but meticulous explorations like his bring increased understanding of these intriguing marks from over half a millennium ago and also provide a model for future county or regional studies. There is urgency for more such research before continuing weathering causes further damage. It is to be hoped that the deposit this year in the York archives of the extensive BSS mass dial records may encourage new researchers in this endeavour.

Irene Brightmer

A Diallist's Alphabet

A is for Apparent – our favourite local time
B is for British Summer – that is a very short time
C is for Celestial – heavenly, no earthly fuss
D is for Declining, the Sun, a wall – anything but us!
E is for Equation of time, an equation we all trust
F is for Furniture you can't sit on or dust
G is for Gnomon – the Greeks said it with style
H is for Heliocentric we've been that for quite a while
I is for Inclination – some have it, some do not
J is for Jaipur – good sundials but too damned hot
K is for Knowledge – more to know than a London cabbie
L is for Latitude – we need plenty or we get in a paddy
M is for Meridian – right down the middle
N is for Noon line, check your clocks we don't want a fiddle
O is for Oughtred – a name not to spurn
P is for Pole – it tells us which way to turn
Q is for Quadrant, the dials precursor
R is for Reclining, it makes the equations even worser!
S is for Somerville our light hearted founder member
T is for Time, that's what dials are for - remember
U is for Umbrella for BSS visits to dials
V is for Vertical, of South, polar or declining styles
W is for Winter Solstice after which we get more sun
X is for hour angle on a dial face, like between 12 and 1
Y is for David Young who started these Safaris
Z is for Zodiac, Zone, Zero, zzzzzzz.

Tony Belk

POLAR DIALS AT ANY DECLINATION

TONY BELK

In an earlier article[1] I showed that there was a simple formula linking the latitude ϕ, the declination d and the inclination i of a polar sundial. This article examines that relationship and indicates how a polar sundial can be designed for any latitude and declination.

A polar dial has its style parallel with the dial plane and all the hour lines parallel with each other. Common types[2] face east or west and are vertical, or face south and have the dial plane inclined at the same angle as the latitude.

In the general case a polar sundial requires that:

$$\cos d = \frac{\tan\phi}{\tan i} \qquad (1)$$

Any declining reclining dial which satisfies equation (1) has its style parallel with the dial plane and all the hour lines. The latitude, declination and inclination determine the angle θ that the equinox line (or equinoctial) on the dial face makes with the horizontal, and the value of the sub-style hour angle γ. They are given by the following equations:

$$\cos\theta = \frac{\sin\phi}{\sin i} \qquad (2)$$

$$\cos\gamma = \frac{\cos i}{\cos\phi} \qquad (3)$$

(The derivation of these equations is given in the appendix.)

It must be remembered that the values of both θ and γ could be positive or negative as $\cos(-\theta) = \cos\theta$. The angle from the horizontal to the equinox line is clockwise for an east declining dial (d positive) and anti-clockwise for a west declining dial (d negative). The angle γ is positive on an east declining dial and negative on a west declining dial.

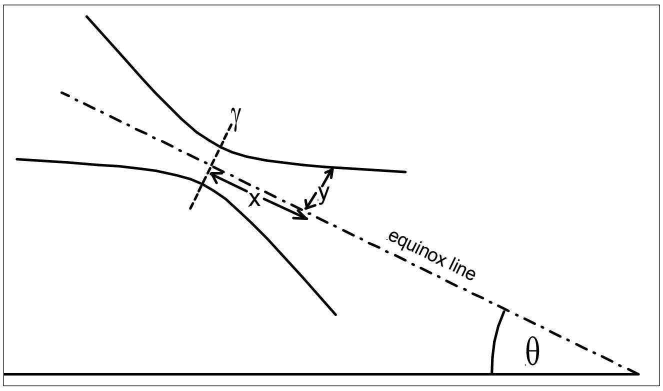


Fig. 1. Diagram of polar dial showing angles θ and γ and co-ordinates of hour lines and declination lines.

These angles are shown in Fig. 1, as is the distance x of the hour line h from the sub-style line along the equinox line which is

$$x = G\tan(\gamma + h) \qquad (4)$$

If the sun is above the horizon it will shine on the dial from exactly 6 hours before time γ to 6 hours after, whatever the sun's declination. This is a unique feature of polar sundials. The 24 hour time $T_{24} = 12 + \gamma/15$. For east declining dials (d positive) γ is negative and for west declining dials (d negative) γ is positive. For all polar dials in the northern hemisphere the hour numbers increase from left to right.

Equation (1) requires that $|i| \geq |\phi|$. For given values of ϕ and i the value of d can be positive or negative. If i is negative (and ϕ positive) then $|d| > 90$. If $|d| > 90$ the dial faces north of east or north of west and all such dials have i negative, so the dial face inclines towards the observer.

Declination lines

The height of the style above the sub-style line is G. The x co-ordinate of the sun's declination line for hour angle h_1 after time γ is given by

$$x = G\tan h_1 \qquad (5)$$

The length of the shadow from the style to the dial face is $G/\cos h_1$. The y co-ordinate of the δ declination line from the equinox line is

$$y = \frac{G}{\cos h_1}\tan\delta \qquad (6)$$

Declination lines can be drawn for any value of δ from these equations.

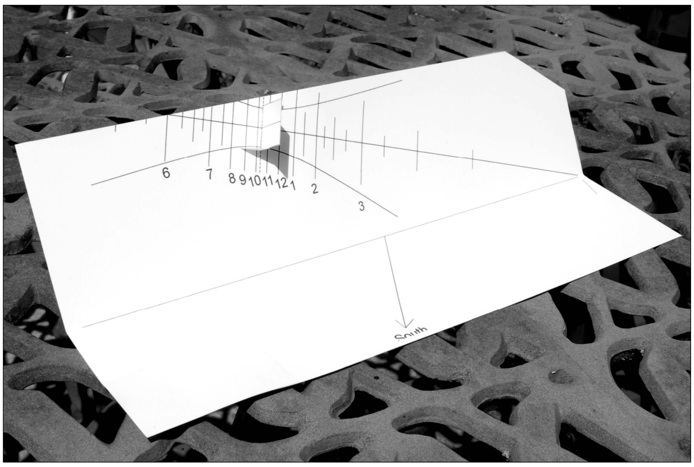


Fig. 2. Photograph of cardboard model of polar dial for ϕ = 51.6°, and d = 30°.

A photograph of an east declining polar dial model is shown in Fig. 2, which shows that the dial both declines and reclines. In this case $\phi = 51.6°$, $d = 30°$, $i = 55.53°$, $\theta = 18.09°$, and $\gamma = 24.35°$ which converts to 10 hours 23 mins for an east declining dial.

Conclusion

With the aid of four simple formulae, a polar dial may be designed for any latitude and declination. This allows a simple alternative to the vertical declining dial to be produced for any location.

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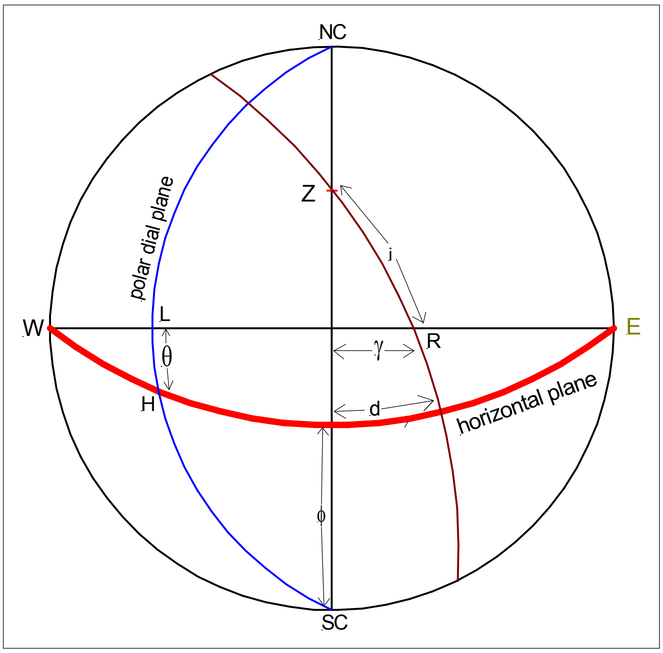

Fig. 3. Stereographic projection illustrating the horizontal plane, the polar dial plane and the angles φ, d, i, γ and θ.

APPENDIX

The angles are shown on a polar dial in Fig. 1 and on the stereographic projection in Fig. 3.

ϕ	latitude
d	declination of dial
I	inclination of dial
γ	hour angle of sub-style line
θ	angle between equinox line and horizontal
NC	north celestial pole
SC	south celestial pole
E	east
W	west
Z	zenith
R	perpendicular to dial plane

To draw a polar dial two angles are necessary. These are the hour angle γ of the sub-style line and the angle θ between the equinox line and the horizontal on the dial face.

The direction cosines of the polar dial plane are

$$(p, 0, r), \quad p = \sin d \sin i \quad \text{and} \quad p^2 + r^2 = 1.$$

The direction cosines of the horizontal plane[1] are (0, sin ϕ, cos ϕ).

The direction cosines of R, the perpendicular to the dial plane are [p, 0, r]. The angle γ of this direction with [0, 0, 1] is

$$\cos\gamma = r$$

thus $\cos\gamma = \cos\phi\cos i + \sin\phi\sin i\cos d$

For the polar dial this simplifies to

$$\cos\gamma = \frac{\cos i}{\cos h}, \text{ that is, Eqn (3) above}$$

The horizontal direction H is the intersection of the horizontal plane (0, sin ϕ, cos ϕ) and the dial plane (p, 0, r) and is

$$\left[\frac{-r\sin\phi}{sss}, \frac{-p\cos\phi}{sss}, \frac{p\sin\phi}{sss}\right]$$

Where $sss = \sqrt{(r^2\sin^2\phi + p^2\cos^2\phi + p^2\sin^2\phi)}$

$$= \sqrt{(\sin^2\phi + \cos^2\phi\sin^2 i\sin^2 d)}$$

The angle θ between direction L [$-r$, 0, p] and H is

$$\cos\theta = \frac{r^2\sin\phi}{sss} + \frac{p^2\sin\phi}{sss} = \frac{\sin\phi}{sss}$$

For a polar dial this simplifies to

$$\cos\theta = \frac{\sin\phi}{\sin i}, \text{ that is, Equation (2).}$$

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A stained glass dial, dated 1731, seen in the Kirschgarten Museum, Basle, during the BSS Alsace tour.

A SUNDIAL AT THE BODLEIAN LIBRARY IN OXFORD

ANTHONY CAPON

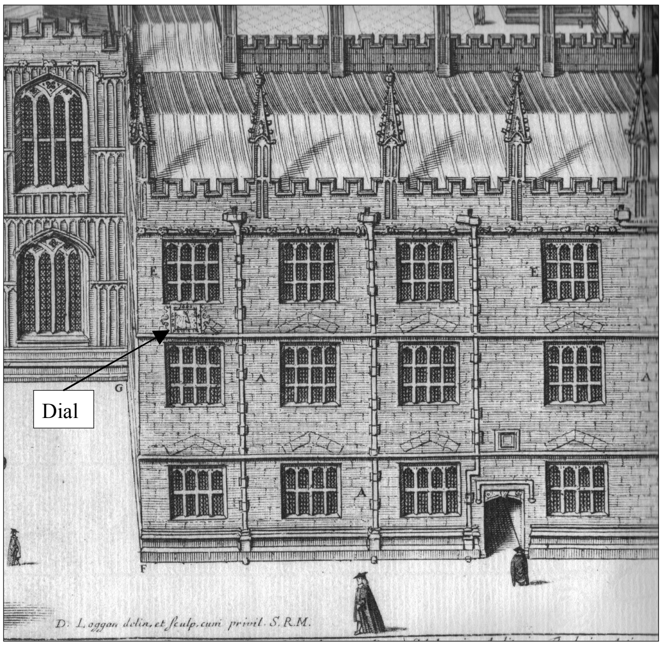


Fig. 1. Part of the south face of the Bodleian Library as drawn by Loggan.

Introduction

David Loggan was an engraver, painter and draughtsman. He studied in Danzig (now Gdansk) under Willem Hondius (c.1600–1658) and then in Amsterdam under Crispijn van de Passe II, before coming to London c.1656–8. He married in 1663 and moved to Nuffield near Oxford in 1665. He was living in Oxford by 1669, when he was appointed 'public sculptor' to the university. He then proceeded to produce his *Oxonia Illustrata*,[1] a series of drawings and engravings showing bird's eye views of the colleges and other buildings of the university.

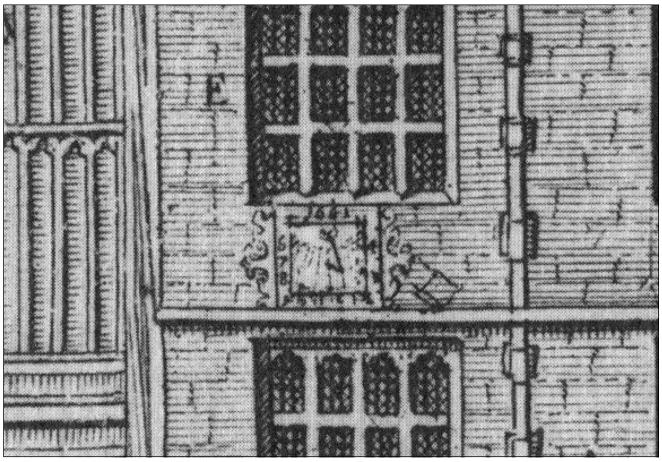


Fig. 2. A detail from Loggan showing the dial.

Fig. 3 (top). The location of the dial as it is today.
Fig. 4 (above). A close-up showing that all trace of the dial has disappeared.

Loggan's drawing of the Bodleian Library shows a sundial on the south wall of the library which faces onto Radcliffe Square. The dial is located at the extreme western end just below the window of the upper reading room (see Fig. 1).

Observations

From the rather small and indistinct image of the dial on the print, it appears to be a vertical south declining dial with Arabic numerals and some decorative shaping along each vertical border. Across the top of the dial is what appears to be a date which I believe to be 1641 (see Fig. 2).

Looking at the south wall of the library from Radcliffe Square today, there is no trace of a sundial (see Fig. 3). The stonework has clearly been cleaned, replaced and repaired many times over the centuries (see Fig. 4). This leaves us with the question: did the dial ever really exist or is its presence on the drawing a case of artistic licence?

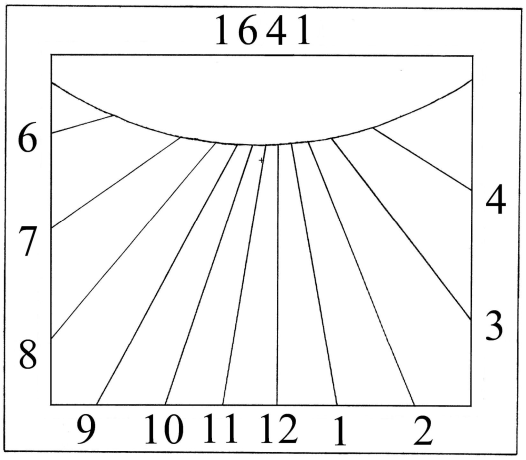


Fig. 5. The basic layout of a dial for the south face of the Bodleian Library.

Evidence For The Existence Of The Dial

On the reliability of Loggan's drawings as an accurate record of the existence of the Bodleian dial, Gunther[2] is in no doubt, "Loggan is celebrated for the accuracy of his plates and for his remarkable powers of observation". Supporting Gunther's confidence in Loggan as an accurate observer and recorder we note the following two points:

1. The Loggan drawing shows the dial to be positioned off-centre with respect to the reading room windows above and below it (see Fig. 2). Surely the dial would not be so positioned if its presence in the drawing was simply to 'decorate' the scene. Its positioning looks more like the draughtsman's efforts to record faithfully what he actually saw.

2. The wall on which Loggan shows the dial does not face due south. This means that a sundial designed to function correctly when fixed to this wall would have asymmetrical hour lines, i.e. the left half of the dial face would not be marked out with hour lines at the same angles as the right hand half. (see Fig. 5).

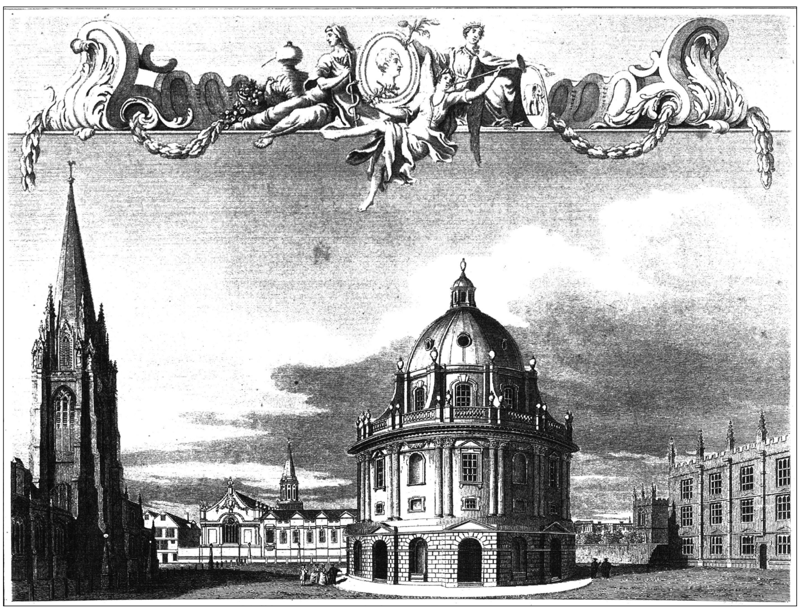
The dial shown in Fig. 5 is correctly delineated to show local solar time when affixed to a wall which declines 13° to the east of south which is approximately the declination of the south wall of the Bodleian Library. Note the strong similarity between this dial and the one depicted by Loggan, i.e. the three numbers, 6, 7, and 8, down the left hand side of the dial and the two numbers, 4 and 3, down the right side.

However, notwithstanding the points 1 and 2 above, the most convincing way to prove the reality of the dials existence would be to find another image by a different artist which also showed the dial. Happily we have just such an image, shown in Fig. 6. This engraving by Joseph Skelton was made in 1818 and published in his book, *Oxonia Antiqua Restaurata* in 1843.[3] It is based on an original by James Green made in 1752. The central feature of the scene is of course the Radcliffe Camera but to the right can be seen part of the south face of the Bodleian Library. At first glance, no sundial is visible but if we zoom in closer the dial is revealed (Fig. 7). Here the artist shows the dial to be centrally positioned with respect to the windows: remember that Loggan shows the dial offset from the centre, but Green and Skelton appear to be aiming for a more 'artistic' and less scrupulously accurate image than Loggan. The fact that a second artist shows a dial in this position and at a much later date, I believe, confirms that there really was such a dial.

What Happened To The Dial?

But as is so often the case, answering one question simply leads us to the next which is: what happened to the dial? If we accept that it was made sometime in the 1640s and it was still in place in 1752, when did it disappear and why?

In 1814 Rudolph Ackermann published his book *A History of the University of Oxford its Colleges, Halls and Public*



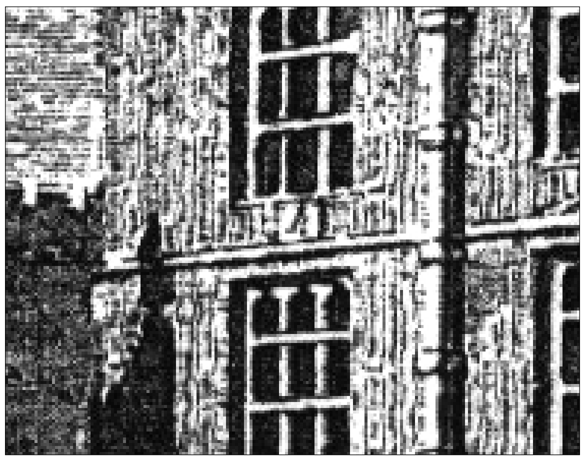


Fig. 6 (left). Joseph Skelton's depiction of Radcliffe Square.
Fig. 7(above). A detail from Skelton showing the dial.

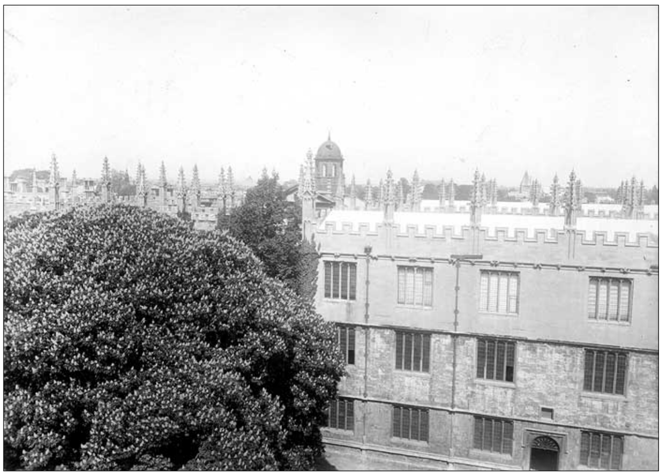


Fig. 8. Henry Taunt's photograph of the south wall of the Bodleian Library.

Fig. 9. Richard Hawkins (1611-1699). Courtesy of Oxford City Council.

buildings.[4] This work contains a number of coloured illustrations depicting buildings and scenes around Oxford. One such scene is a view of the south face of the Bodleian Library as seen from the roof of the Radcliffe Camera. This illustration shows no sign of a dial in place below the western-most window of the upper reading room. In fact, the scene that Ackermann depicts is very similar to the one captured in 1880 by Henry Taunt when he photographed (Fig. 8) the same scene. His photograph clearly shows that by this time the dial had completely disappeared. It should appear below the upper of the three windows just to the right of the tree.

Up until about 1800, sundials were essential for setting and correcting the rather unreliable watches and clocks which were then available. Also, before the coming of the railways and the idea of a Standard Time for the whole country, people were quite content to set their watches and clocks to the local solar time as indicated by a sundial. However, by 1800 sundials were starting to become redundant as meaningful time keepers and it seems likely that this redundancy and the effects of the weather caused the Bodleian dial's demise.

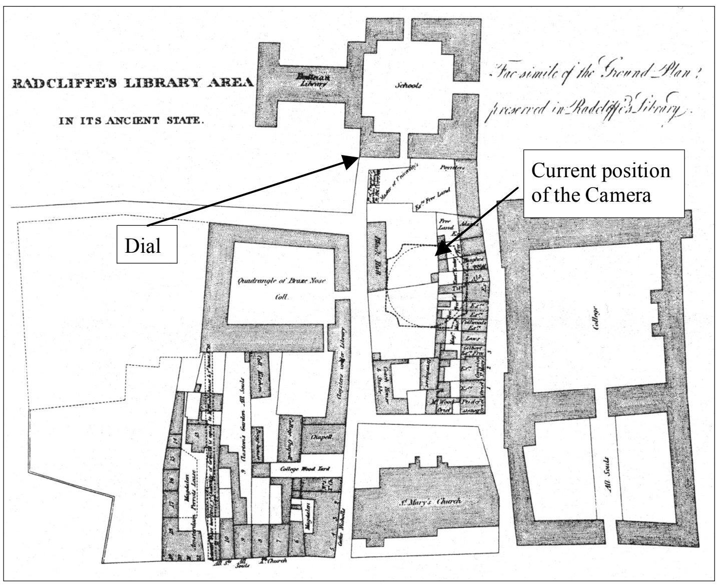


Fig. 10. A plan of the area that is now Radcliffe Square before the space was cleared for the building of the Radcliffe Camera. From Victoria County History, Oxford.

Who Made The Dial?

From the *Life and Times* of Anthony Wood[5] we learn that one Richard Hawkins (1611-1699), a painter, was paid £3 in 1641, "…for painting the south diall on the Schools." In his book *Clockmaking in Oxfordshire,*[6] C.F.C. Beeson gives us the same information about the painter of the dial but goes on to say that Richard Hawkins also worked on the porch of St Mary the Virgin in 1637, the Divinity school in 1669 and the Ashmolean in 1683.

In 1665 Hawkins is recorded as living in the High Street. His house was on the site of what is now number 116. He took a number of apprentices including, in 1667, one Henry Wildgoose who himself went on to paint sundials in Oxford, in particular the one on the church of St Peter in the East.

Hawkins served on the council for many years and on 16 September 1689 at the grand old age of 78 he was elected mayor. The portrait of Hawkins reproduced in Fig. 9 is attributed to John Taylor and hangs in the council chamber of Oxford Town Hall. It is dated 1638.

The Schools referred to here are the rooms around the ground floor of the Schools Quadrangle of the Bodleian Library, visible in the upper right hand portion of Fig. 1. The doors around the quadrangle still have painted over them the names of the schools to which they formerly led, e.g. Logic, Grammar, Rhetoric etc.

Fig. 11. How the Bodleian Library might look with its sundial restored.

The Position of the Dial

To anyone visiting Radcliffe Square today, the positioning of a dial on the extreme western end of the south wall of the Bodleian might seem strange and a more suitable location would appear to be in the centre of the wall, above the south entrance perhaps. However, we have to understand that the dial was erected in 1641 long before the Camera was built (1749) and the square assumed its current layout. Figure 10 (in which north is at the top) shows the area now occupied by the Camera as it was between 1714 and 1733.

A study of Fig. 10 will explain the dial's position as it makes clear the fact that only by placing the dial in line with the pathway along the western edge of the city block which then occupied the space now covered by the Camera could it be conveniently viewed. Placing it in the centre of the wall would make the viewing angle from the pathway along the northern edge of the block impossibly steep.

The Future of the Bodleian Dial

In recent years, prompted possibly by the millennium, there has been a vogue in Oxford, as elsewhere, for erecting new dials and resurrecting dials from the past. Examples are the fine dial on the new buildings at Magdalene and the huge dial recreated at New College.[7]

From what we know of the Bodleian dial it should be possible to recreate it too. Figure 11 shows how the Bodleian might look with a fine dial once more adorning its south wall to delight passers-by in Radcliffe Square.

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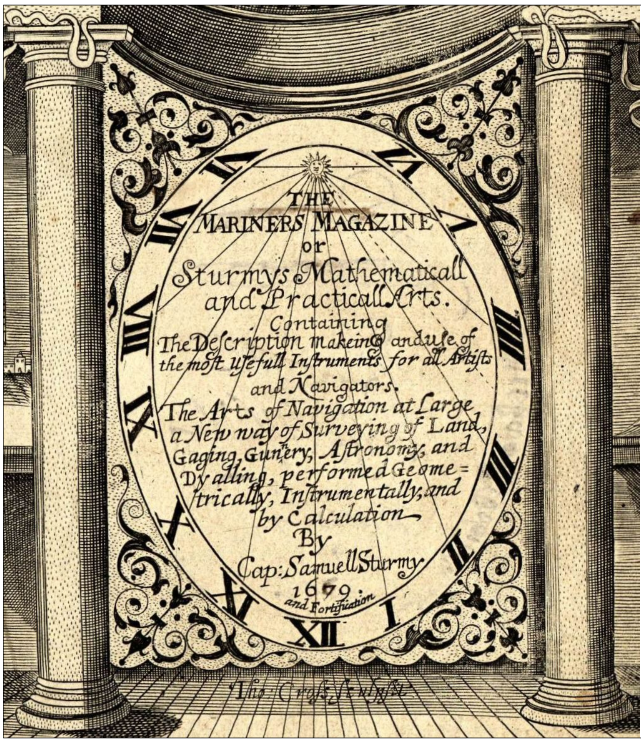

SAMUEL STURMY

This dial is the central portion of the frontispiece of Captain Samuel Sturmy's book *The Mariners Magazine or Mathematical and Practicall Arts*.

Although Book 7 of the publication was on the subject of dialling, no actual dials by Sturmy are known. Nothing much changes—it is still the writers and academics that get the credit, not the artisans! At least the engraver signed the plate.

JD

LIVERPOOL ROAD STATION SUNDIAL, MANCHESTER
A Second View

JOHN WALL

In the September 2008 issue of the *Bulletin* (Vol. 20(iii)), there appeared an article by Roger Bowling on this topic. By sheer coincidence, I was researching the same subject at roughly the same time. I submitted my draft article also about the same time. Roger pipped me to the post! However, I arrived at some conclusions of my own as to the purpose of the sundial (Fig. 1) and I know that Roger will forgive me if I set them out below by way of complementing his comprehensive account.

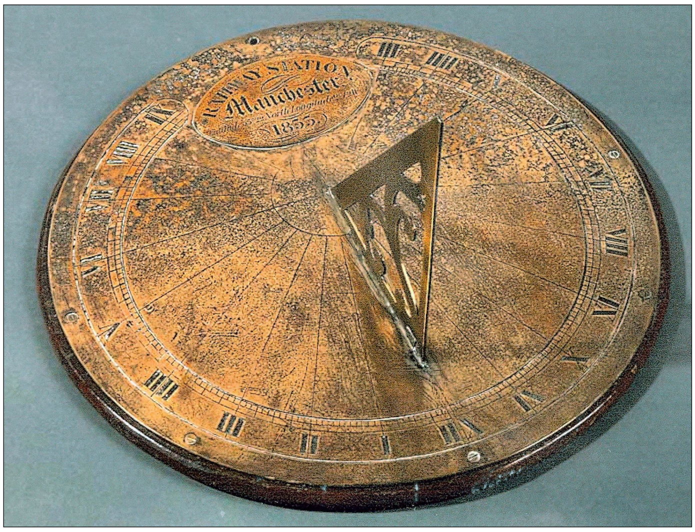

Fig. 1. The original sundial. Photo courtesy of the North-West Museum of Science and Industry, Manchester.

From the main entrance, the station building is the most distant of the five buildings that constitute the North West Museum of Science and Industry. There is little to suggest its historic importance. From the opposite side of Liverpool Road the sundial can clearly be seen above what used to be the main entrance (now closed) and on a level with the first floor of this two-storied building. A nearby plaque (Fig. 2) records:

> "Building of Architectural or Historical Importance Grade 1. LIVERPOOL ROAD STATION. The world's first passenger station. Terminus of the Liverpool and Manchester Railway which was opened by the Duke of Wellington on 15th September 1830."

The question arises: why was the sundial positioned at first floor level, so that it cannot be read by passers-by on the road beneath? When the line approached this first terminus it was obliged to cross the River Irwell, George Stephenson providing an iron bridge with grand porticos.[1] As a consequence the track and the platforms were elevated above the roadway. In fact the sundial could only be read through a window in the First Class waiting room.

The L & M R was opened in 1830, but the sundial was not installed until three years later, in 1833. Both dates are some years prior to the gradual introduction of uniform 'Railway Time' in the 1840s. Until then each railway company, indeed each local community, observed its own Local Apparent Time – 'sun time' – to regulate its affairs. Although the officers responsible for the despatch of trains from such termini as Manchester (Liverpool Road) could have recourse to clocks and watches, they were notoriously unreliable.[2] What more natural then, than to regulate the timing of trains by means of a sundial whose accuracy, once it was properly set up, was indisputably dependent on the unvarying sun. With the expansion of the railways we can imagine the confusion that would arise when a single train in the course of its journey arrived and departed from a number of stations, each observing its own, different, local time. The compilation of a reliable timetable would be well nigh impossible.

Henry Booth, Secretary of the L & M R, was a strong advocate of much needed uniformity. In June 1844 he persuaded the directors to present a petition to Parliament for the adoption of a 'universal time'. He himself wrote a pamphlet in support of the change, observing that "there is sublimity in the idea of a whole nation stirred by one impulse, in every arrangement one common signal regulating the movement of a mighty people". Dickens alluded to the matter in *his* way, remarking of Camden Town that "there

Fig. 2. The plaque on the station building.

was even railway time observed in clocks, as if the sun itself had given in".[3] Though hard to believe now, it was not until 1880, by which time all the L&MR directors who had campaigned for it must have died, that a bill was passed: the Statutes (Definition of Time) Act. Thus for the first time in history, Greenwich Mean Time, transmitted from Greenwich Observatory, London, became the legal standard time for all the railways and for Britain generally. Standard time stems from a brilliant and visionary piece of initiative for which the Liverpool and Manchester Railway is not always awarded its quantum of credit.

It was a happy chance that the railways and the electric telegraph developed by Charles Wheatstone (1802-1875) were introduced at much the same time. Because the telegraph enabled messages to be transmitted in advance, faster than the trains themselves, one of its first applications was to enable clocks to be synchronised all over the land - standard 'Railway Time' was a prerequisite for railway timetables.[4] One consequence was a gradual decline in the use and manufacture of sundials for the telling of time. It was the gradual introduction of Railway Time that led to the introduction of Greenwich Mean Time for the whole of the United Kingdom. Finally, at an international conference in Washington D.C. in October 1884, it was agreed that the Greenwich Meridian should be recognised as the prime meridian of longitude. Together with the adoption of 24 one-hour-wide time zones, Greenwich Mean Time became the reference point for time world-wide.

Both the Stockton and Darlington Railway and the Manchester and Liverpool Railway lay claim to the distinction of being the first steam-hauled public railway for both passengers and goods. Naturally I support the claim of the Stockton and Darlington Railway - hence the title of my history of the S&DR 'First in the World'. The L&MR's claim can only rest on its being the first Inter-City steam hauled public railway. The S&DR was opened in 1825, five years before the L&MR. I have been unable to find any reference to time keeping on the S&DR prior to the introduction of 'Railway Time'. If initially they relied on sundials, it is possible that the L&MR copied this practice since some of its directors were present at the opening of the S&DR, and sent a number of fact-finding delegations in the years that followed.

Given the absence of any reference to a sundial at the Liverpool end of the L&MR, we may confidently claim for this fine example at Manchester (Liverpool Road) the honour of being the first operational railway-related sundial.

In conclusion, the role of sundials in regulating the timing of trains in general is aptly expressed by Frank Ferneyhough's history of the L&MR:

> "Time for the early Victorian travellers, though not exactly anyone's guess, was nevertheless rather haphazard. L&MR directors at first were content to time their train departures half-hourly. It was not until the 1840s when more connections were being made with new railways that their timetables needed honing down to minutes. Local time taken from sundials, which varied longitudinally across Britain by as much as half an hour, were the vogue and, indeed, in several legal disputes concerning mixed connections, carried the force of law."[5]

Nothing could better illustrate the power and influence of the ubiquitous sundial!

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"Meet me in St Louis" at the 14th NASS Conference, 7-10 August 2008 - a UK visitor's impressions

Mike Isaacs

Fig. 1. The Jefferson Memorial Arch, over 600 ft high.

Mary and I were fortunate this year to be able to attend the 2008 NASS conference in St Louis, on the banks of the Mississipi, during our annual visit to our son Richard, who lives near Ann Arbor in Michigan. He very kindly offered to drive us, together with our eight-year-old grandson, Marshall, to St Louis for the Conference, covering the small distance of 500 miles in one day!

The British contingent this year was sadly depleted in comparison with previous years. In fact Mary and I were the only representatives from Europe. The usual UK visitors, especially the three musketeers (Tony Moss, Mike Shaw and Geoff Parsons), were sorely missed. Other 'foreign' attendees were also very few. In fact, apart from us, there were only two other overseas members present, who came from Japan.

The Conference

The conference opened with registrations at the Clayton Crown-Plaza Hotel on the Thursday evening, where Fred Sawyer provided no fewer than ten door prizes. These ranged from replica sundials to desirable books by authors such as Frank Cousins and Mrs Gatty. These were 'raffled' - every registrant was given ten raffle tickets, on which you wrote your name and placed the tickets in a bag by each gift. If you particularly wanted one of the items, you could put all of your tickets into one bag, which would increase your chance tenfold! We were fortunate to win a popup sundial book by Mitsumo Anno, *Anno's Sundial*, which we thought would be useful as a primer for our grandson.

The Coach Trip

Friday was devoted to the coach tour. This year's trip, organised by Don Snyder, started generously at 8:30 am. (NASS meetings are designed for early birds - the Conference proper on Saturday and Sunday was scheduled to start promptly at 8 am!)

We left the hotel in a splendid air-conditioned coach, (the temperature during the entire conference varied from the high 70s to nearly 90°F) and travelled 11 miles into St Louis to drive by the Jefferson Expansion Memorial - the Arch - all of 600 feet high (see Fig. 1). This was built in the 1960s to commemorate the expansion of the USA by the Louisiana Purchase in 1803, which doubled the size of the United States at one stroke. The Arch is a spectacular sight, with small trains running up inside both arms of the arch to a viewing gallery at the top.

We then went to the National Geospatial-Intelligence Agency at The Arsenal, an old pre-Civil War army base, which is now a very high-tech establishment. Being a Government department, we had to be vetted well in advance, and checked in laboriously through a security gate. I don't think that that they had ever had had to cope with a 40+ coach party!

Once inside we were shown a horizontal dial made in the late 19th century. This had the distinction of being in an armoured enclosure made from musket barrels and small cannon! The dial was about 18 inches in diameter and had been well polished by generations of cleaners so that most of the engravings were indecipherable. One unusual feature was a triangular gnomon cover, which hinged from one side of the dial. The hinge pin itself was about 1" in diameter, and looked as though it had been liberated from a small field gun. The dial, after all, had been constructed in the Arsenal! Being in a high security site, we had to surrender all our cameras before being allowed to enter, so that no-one was able to take photos of this interesting dial.

Figs. 2a & b. The Jefferson Barracks Dial overlooking the Mississipi.

The second dial was located at another government establishment, the Jefferson Barracks, 11 miles to the south, on the banks of the Mississipi. The security here was much less onerous, it being a Missouri Air National Guard site. This dial (Fig. 2) is a plain horizontal dial, with a winged hour-glass as a motif, and roman numerals, but with a 'O' at 12 noon. The barracks were on a ridge overlooking the river, and the city of St Louis with the Arch could be seen in the far distance.

The third dial (Fig. 3) was located 14 miles back in St Louis at the St Louis University Hospital. This one is a vertical dial held in the arms of a statue, on a south-facing wall.

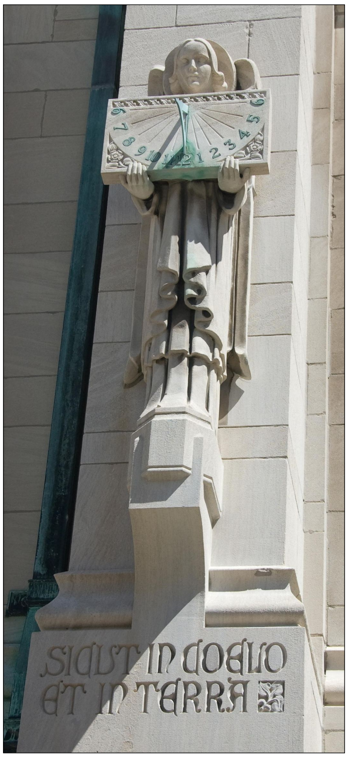
After a brief halt at the Hospital we moved onto Forest Park, a huge park (nearly 1400 acres) containing a zoo, science centre, theatres, art and history museums, ice rinks, etc, etc!

Our first stop here was at the 17 acre Jewel Box, a splendid botanical garden, which has magnificent flowers, water lily ponds

Figs. 4a & b. The Jewel Box Dial – note the winged hourglass similar to the Jefferson Barracks dial.

and a large Tropical House. Two dials are close to each other here, the first being a horizontal dial dedicated to Mary Leighton Shields, the founder of the Missouri Society of Colonial Dames. Her dial (Fig. 4) is similar to that at Jefferson Barracks, with the same winged hourglass emblem and a 'O' at noon.

The other dial (Fig. 5) is a large structure dedicated to the Korean War Veterans. It is eight feet high and is made of stainless steel. The gnomon casts shadows on both vertical and horizontal markings.



Figs. 3a & b. The St Louis University Hospital vertical dial.

Figs. 5a & b. Fred Sawyer describes The Korean Memorial Dial.

Fig. 6 (below left). Washington University – Danforth Campus Vertical Dial.

Elsewhere a solar compass with pointers to sunrise and sunset at the equinoxes is set into a walkway leading to the Department of Earth and Planetary Sciences. It was unfortunate that surrounding buildings prevented the dial from seeing the sun most of the time!

Inside the Department we were shown a full sized model of the Mars Exploration Rover vehicle, with the Woody Sullivan Mars sundial visible (Fig. 7).

Our final stop on the tour was at the magnificent Missouri Botanical Gardens, where there were no fewer than five dials. On arrival, we took part in the dedication of a new dial (Fig 8.), designed, constructed and presented by NASS member Ron Rinehart, to commemorate the 150th anniver-

On the other side of the park, in the Historical Museum, a recently-discovered 8 inch square dial designed by President Thomas Jefferson was on display. Lunch was taken in the museum's restaurant on an upper floor overlooking the park – a very pleasant setting.

After lunch we travelled to Washington University - Danforth Campus. This part of the university is built in the style of an Oxbridge college, plus a few battlements! On the south-facing wall of a very large quad is a vertical dial (see Fig. 6). Unfortunately, a large covered open stage had been constructed immediately in front of the dial, so that the dial was only visible from a distance or if one stood directly below it.

Fig. 7. Full-size model of the Mars Rover, with Woody Sullivan's Mars dial on the left hand edge.

Figs. 8a & b. Dedication of the Missouri Botanic Gardens 150th Anniversary Dial, donated by Ron Rinehart.

sary of the Gardens. The Director of the Gardens generously accepted the dial from NASS, and Fred Sawyer noted that this was the 3rd successive year that a dial had been presented and dedicated by NASS at its annual conference.

The next dial to be viewed was a Schmoyer Sunquest dial, which had been finished from rough castings by NASS member Bill Gottesman and placed in the gardens in June 2008, next to the Linnean House.

We progressed by a series of lily ponds, with fantastical figures of bathers spouting water from all of their surfaces, to a newly created Ottoman Garden, a splendid setting of fountains, pool and magnificent flowers. Here a large marble horizontal dial, based on another at the Topkapi Palace in Istanbul and designed by Roger Bailey, was placed. It too had been recently located there, in fact work had continued up to the moment of our visit! See Fig. 9.

The party then mounted a 'train'. This reminded me of the road trains seen at the seaside resorts in the UK and consisted of a series of open-sided trailers towed by a golf buggy. We needed two trains to take us all and we travelled through the gardens to see the fourth dial (Fig. 10) in the Herb Garden, depicting a small child sitting next to a horizontal dial in a flowerbed.

We continued on a delightful journey through more of the gardens, where apparently the trains don't usually go, through a very large Japanese garden, passing a large wedding party on the way!

Thus the tour ended back by the new anniversary dial. The weather was fine, in the mid 80s and very comfortable all day. We were told that had we undertaken the trip four days earlier, the temperature had been in the mid 90s (the more usual temperature for mid August) and we would not have enjoyed it at all.

Figs. 9a & b (left). Roger Bailey describing his Ottoman Dial.

Fig. 10 (below). The Herb Garden Dial.

The Conference - Saturday

Saturday started at 7:30 am with breakfast in the conference room, and Fred opened the proceedings promptly at 8 am.

Don Petrie described how his church's new extension had a large blank wall calling out for a dial. The dial he designed was constructed from HDU (high density polyurethane), a modern material used for external signs. (This dial is well described in the *BSS Bulletin,* 20(i), March 2008 pp.28.9.)

The second talk was a discussion by Michael Friedlander, the Professor of Physics at Washington University, who had shown us around the campus on the coach trip. He gave a talk on the Cahokia Sun Circles. Cahokia is a World Heritage site about 20 miles east of St Louis, which had a population of 10,000 – 15,000 between 800 to 1200 AD, who have all since completely disappeared. The site has numerous mounds up to 100 ft in height, and also contains traces of posts set out around five circles. The most complete circle has a radius of 205 ft, with posts aligned with the equinoxes and summer solstices. The talk described some of the surveys and theories concerning the circles' significance.

Fred Sawyer next described a new version of the dialling scales originally designed by George Searle in 1657. Fred had always been concerned that the latitude scale was heavily compressed from about lat 45° upwards. He recalled that he had acquired a British Thornton slide rule which had differential trigonometrical scales, which gave him the idea of making a differential latitude scale. By having two scales, 45° – 90° and 0° – 45°, next to each other on the same side of the scale, any 'angular' distance on the *x*-axis of a horizontal dial could be marked. Latitude distances between 0° and 45° can be marked directly, and larger angles can be delineated, e.g., 51°, by placing the 51° mark on the 45-90 scale on the origin of the dial, and marking the other point on the 0-45 scale at the 51 – 45 = 6° mark. Copies of the new scales printed on cardboard were distributed.

After the break, Roger Bailey described how he had been commissioned to design a dial for the Ottoman Garden at the Missouri Botanical Gardens. He chose a dial he had seen at the Topkapi Palace in Istanbul. The work was executed by a local sculptor and was installed just in time to be seen on the coach trip.

The next speaker, Steve Leuking of Chicago unfortunately could not attend, so Fred Sawyer brought his next talk, *On Tampering with the Equation of Time*, forward. This talk was essentially one he had given at a BSS conference in recent years, using a spiral polar gnomon and sliding scales on a base plate, and was a typical Fred tour-de force!

After the lunch break, Ron Rinehart described the dials he has been making commercially for the last few years. The are made from sections of PVC tubing of different diameters, cut to shape, and using a smaller diameter section of tube cut at the appropriate latitude angle. The scales, with analemmas for each hour, are photo etched onto thin brass sheet, or latterly laser etched onto thin stainless sheet and then glued to the pipe section. One of Ron's dials was presented to the Missouri Botanical Gardens at the dedication during the previous day's coach trip (see Fig. 11).

Bob Kellogg described work in progress on the *Design of a Digital Wall Dial*. It was less a dial than a means of arranging arrays of open boxes in a vertical plane, and adjusting the sides of the boxes to cast shadows of varying size. In this way, a sort of half-tone image could be produced, which as the sun moves on, changes to a different image. Bob showed a computer-generated image of Benjamin Franklin transforming into one of George Washington.

Roger Bailey talked on the Sisters of Charity of Ottawa sundials, which were a pair of vertical dials on adjacent walls of the Charity building. These were designed in 1850-51 by Fr J-F Allard, a priest who became a bishop and later a cardinal.

Fred Sawyer gave a philosophical talk on *Connections: from Skeletons to Differentials* starting with a photo of James Burke (the ex-BBC presenter from *Tomorrows World*), who had produced many TV programs shown in the US entitled *Connections*. Fred followed with a fascinating stream of comments and ideas, ranging from traces of construction lines as furniture(!) which were still visible on old dials, through to new methods of geometrical construction.

Following this, Fred presented the 2008 Sawyer Dialing Prize, an etched glass sundial, to the sculptor Kate Pond (see Fig. 12). Kate gave a talk

Fig. 11. Ron Rinehart's dials on show at the Conference.

Fig. 12. Fred Sawyer presenting Kate Pond with the Sawyer Dialling Prize.

entitled *Sculpture with an Eye to the Skies*. She has been engaged in her World Sculpture Project since 1993, building site-specific works in five different continents around the world. Each sculpture has a unique alignment with the sun and/or stars, and is associated with children's artwork placed in a time capsule at each location. Sculptures were placed in Quebec, Canada; Oslo, Norway; Sendai, Japan; Honolulu, USA; and Nelson, New Zealand. Kate showed photos of the ceremonies at each location, together with examples of the artwork buried in the local time capsule.

The Conference Dinner, held at a nearby restaurant, was a great success, with all of the conference attendees, both full and accompanying partners. The meal enabled everyone to mix socially and was very enjoyable. During the evening, Fred distributed packs of notelet cards with sundial designs, and also 2Gb USB Flash drives, marked with the NASS logo.

Sunday Morning

As the programme had been rather truncated due to some speakers being unavoidably absent, Sunday started, by general agreement, half an hour later than scheduled. So at 8:30 am, Fred gave a talk on the software he had placed on the flash drives distributed during the previous evening. About 500 Mb had been used, leaving 1.5 Gb spare for personal use. All of the presentations of the Conference were present, plus a large quantity of open-source dialling software, including Sonne, Zonvwlak, Dialist's Companion and many other dialling programs. Additionally, a scientific calculator, browsers, viewers for multiple formats, eg pdf, gif, jpg etc., were included, plus Open Office, spreadsheets etc, etc. All of this software could be run from the flash drive, and did not leave anything on the host computer when the drive was removed – a most useful gift from NASS. Fred was happy for this software to be widely distributed – it is all open source and self-contained.

Roger Bailey described how, on a Portuguese holiday, he enjoyed watching the sunset over the Atlantic, and felt that a 'time to sunset' dial would be a suitable addition to the west-facing terrace of his holiday accommodation. The calculations and a mock-up on a 6″ square tile were shown, and Roger hopes that the landlord will make a full-sized version.

The next presentation was by Barry Duell, who lives in Japan. He described a method of determining Standard Time using a transit instrument. The method was originally published in the 1880s by Clark, who used a small astronomical transit instrument to determine the transit of the sun and known stars, and using published Astronomical Almanac tables for star positions. Barry was using a surveyor's level, which could measure angles to an accuracy of less than 20 seconds of arc, and used it to set out meridians with great precision.

The final full presentation should have been a 40 minute video, but due to the wonders of Microsoft Vista, Fred was unable to get the video to run on his laptop, so it was abandoned.

The last part of the programme was allocated to short, 10 minute, talks. Only two items were actually offered, one by Bob Kellogg on the problems of working on a website, and the other was by myself.

My talk was a short show of *World-Wide Dials*. Those BSS members who attended the Latimer conference may have seen the sundial calendar made by my son David. When he heard that we were hoping to attend the St Louis conference, he produced a PowerPoint show of some of his pictures, mainly dials from Australia and New Zealand, and some more unusual dials from Paris and the UK. The presentation, despite being affected by Fred's Vista problems, seemed a bit of light relief after some of the more technical papers.

The conference closed with the NASS AGM and everyone was on their way home by noon.

Looking back at our visit to St Louis, the North American conferences do not seem to be as well attended as the BSS meetings, but considering the vast distances across the continent, it is not surprising that fewer people are able to attend. We have been to two NASS conferences, in Chicago in 2005, and St Louis in 2008, and the numbers at each of these venues did not exceed 50 people, including partners. However, the standard of the meetings has been high and the coach trips and social events very enjoyable, and we would be very happy to go to the next Conference in 2009, in Portland, Oregon, if at all possible.

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THE LOGARITHMIC SPIRAL AS THE BASIS FOR A POLAR SOUTH SUNDIAL

ORTWIN FEUSTEL

It is the key feature of this sundial that for calculating the gnomon and the dial face only one mathematical function has been needed, namely the logarithmic spiral. One segment of spiral serves as the gnomon profile, with the sun rays tangential to this segment, and another segment of spiral functions as the dial face, showing the gnomon shadow.

Characteristics of the Logarithmic Spiral

The logarithmic spiral is a curved line which intersects all radius vectors (starting from the coordinate system origin) with the same angle, σ, (see Fig. 1).

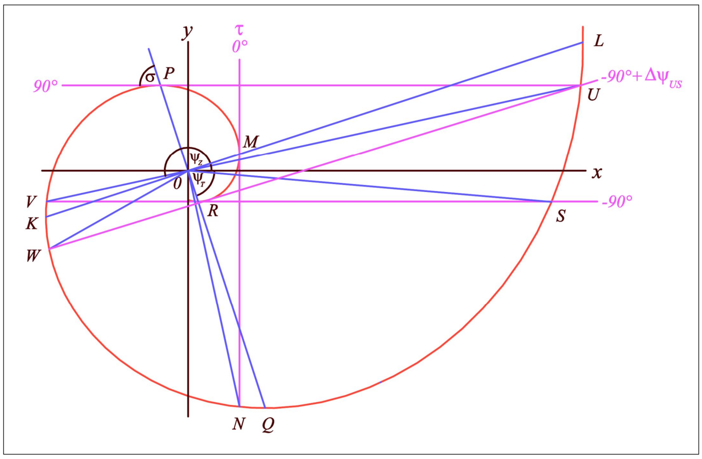


Fig. 1. The logarithmic spiral is characterized by a constant intersection angle between radius vectors (e.g. 0P) and tangents (e.g. PU). The arcs PMR and UNV can be used as gnomon and dial face respectively for a polar south dial. In reality the arc US reduces slightly the range of LAT indication.

Polar coordinates, parametric presentation

The equation of the logarithmic spiral in polar coordinates (ρ, ψ) is

$$\rho = a\,e^{c\psi} \quad (a > 0, -\infty < \psi < \infty) \qquad (1)$$

and therefore the parametric equations are

$$x = a\,e^{c\psi}\cos\psi \qquad y = a\,e^{c\psi}\sin\psi \qquad (2, 3)$$

where

$$c = \frac{1}{\tan\sigma} \qquad (4)$$

and a embodies the radius vector at $\psi = 0$.
Note: angles measured in radians!

Equation of the tangent

The partial differentials

$$\frac{dx}{d\psi} = a\,e^{c\psi}(c\cos\psi - \sin\psi) \qquad (5)$$

and

$$\frac{dy}{d\psi} = a\,e^{c\psi}(c\sin\psi + \cos\psi) \qquad (6)$$

yield the slope of a straight line which is a tangent to the logarithmic spiral in a Cartesian coordinate system

$$\frac{dy}{dx} = \frac{c\tan\psi + 1}{c - \tan\psi} \qquad (7)$$

Index T in the following equation of the tangent marks a point on logarithmic spiral curve

$$y = \left.\frac{dy}{dx}\right|_T x + y_T - \left.\frac{dy}{dx}\right|_T x_T \qquad (8)$$

Inserting

$$\left.\frac{dy}{dx}\right|_T = \frac{c\tan\psi_T + 1}{c - \tan\psi_T} \qquad (9)$$

in relation (8) and with regard to (2) and (3) we obtain the required equation of the tangent

$$y = \frac{c\tan\psi_T + 1}{c - \tan\psi_T}\,x + a\,e^{c\psi_T}\left\{\sin\psi_T - \cos\psi_T\,\frac{c\tan\psi_T + 1}{c - \tan\psi_T}\right\} \qquad (10)$$

Extreme values in Cartesian coordinates

We require the Cartesian coordinates of the points R, P and Q (where the tangent slope is zero) as well as M, K and L (where the tangent slope is infinite) in Fig. 1. Setting the numerator of relation (7) equal to zero and with regard to (4) we obtain from

$$\frac{1}{\tan\sigma}\tan\psi_T + 1 = 0 \qquad (11)$$

the polar angle values $\psi_{T,R} = -\sigma$, $\psi_{T,P} = 180° - \sigma$, and $y_{T,Q} = 360° - \sigma$.

Similarly, setting the denominator of relation (7) equal to zero yields

$$\frac{1}{\tan\sigma} - \tan\psi_T = 0 \tag{12}$$

and therefore the values $\psi_{T,M} = 90° - \sigma$, $y_{T,K} = 270° - \sigma$ and $\psi_{T,L} = 450° - \sigma$.

Inserting these angle values for points K and L as well as P and Q in relations (2) and (3) and then forming the following sums

$$\Delta x = \left|x_{T,K}\right| + \left|x_{T,L}\right| = a\sin\sigma\left\{\exp\left(\frac{270° - \sigma}{\tan\sigma}\right) + \exp\left(\frac{450° - \sigma}{\tan\sigma}\right)\right\} \tag{13}$$

and

$$\Delta y = \left|y_{T,P}\right| + \left|y_{T,Q}\right| = a\sin\sigma\left\{\exp\left(\frac{180° - \sigma}{\tan\sigma}\right) + \exp\left(\frac{360° - \sigma}{\tan\sigma}\right)\right\} \tag{14}$$

we get two characteristic quantities for the dimensions of the logarithmic spiral, depending on a and σ. The ratio of (14) and (13) yields the form factor

$$Q_{yx} = \frac{\Delta y}{\Delta x} = \frac{\exp\left(\frac{180° - \sigma}{\tan\sigma}\right) + \exp\left(\frac{360° - \sigma}{\tan\sigma}\right)}{\exp\left(\frac{270° - \sigma}{\tan\sigma}\right) + \exp\left(\frac{450° - \sigma}{\tan\sigma}\right)} \tag{15}$$

The graphical representation of relation (15) is shown in Fig. 2, i.e. the influence of the intersection angle on the proportions of the spiral.

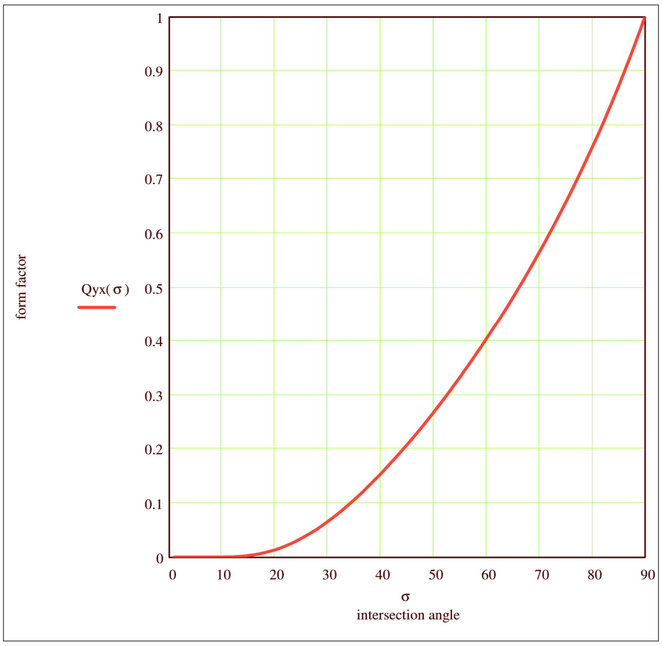


Fig. 2. Graphical representation of relation (15). At an intersection angle $\sigma = 90°$ between the radius vector and tangent, the form factor value is $Q_{yx} = 1$, hence the spiral transforms into a circle.

Intersection point of tangent and spiral

We need the functional connection between the polar angle y_T of the tangent to the spiral and the intersection point's polar angle y_Z of this tangent and spiral.

Substituting the variables x and y in relation (10) with relations (2) and (3) with $\psi = \psi_Z$ produces

$$e^{c(\psi_Z - \psi_T)}\left(\sin\psi_Z - \cos\psi_Z \frac{c\tan\psi_T + 1}{c - \tan\psi_T}\right) - \sin\psi_T + \cos\psi_T \frac{c\tan\psi_T + 1}{c - \tan\psi_T} = 0$$

...(16)

This equation will be used for calculating by iteration the dependence of the spiral angle y_Z on the tangent's polar angle y_T. An iteration method is necessary because an explicit function for the sought-after angle y_Z cannot be derived from (16).

Lengths of arc

By definition the polar coordinates of a curve's element of arc is defined by

$$ds = \sqrt{\rho^2 + \left(\frac{d\rho}{d\psi}\right)^2}\, d\psi \tag{17}$$

Considering the logarithmic spiral one gets

$$\frac{d\rho}{d\psi} = a\,c\,e^{c\psi} \tag{18}$$

and hence

$$ds = a\,e^{c\psi}\sqrt{1 + c^2}\, d\psi. \tag{19}$$

Solving the definite integral within the limits of integration y_{Z1} and y_{Z2} (two polar angles along spiral)

$$s = a\sqrt{1 + c^2}\int_{\psi_{Z1}}^{\psi_{Z2}} e^{c\psi}\, d\psi \tag{20}$$

produces

$$s = a\frac{\sqrt{1 + c^2}}{c}\, e^{c\psi}\Big|_{\psi_{Z1}}^{\psi_{Z2}} \tag{21}$$

Therefore the arc length between two points with polar angles y_{Z1} and y_{Z2} amounts to

$$s = \frac{\sqrt{1 + c^2}}{c}\left(\rho_{Z2} - \rho_{Z1}\right) \tag{22}$$

Assuming a fixed Δy_Z between adjacent polar angles, the applicable radius vectors ρ and arc lengths s each form geometric progressions with the constant quotient

$$q = \frac{\rho_{i+1}}{\rho_i} = \frac{s_{i+1}}{s_i} = e^{c\Delta\psi_Z} \tag{23}$$

Spiral Arcs for Gnomon and Dial Face: Range of LAT Indication

In Fig. 1, tangent lines are drawn at spiral points *P*, *R* and *M*. They symbolize sunrays with hour angles $\tau = \pm 90°$ and 0° respectively and should make clearer the general functioning of the logarithmic spiral as a polar direct south sundial. For example, the sunray which is tangent to point *P* at the spiral's 'outside' hits the point *U* at the spiral's 'inside'; accordingly the assignments $M \Rightarrow N$ and $R \Rightarrow V$ are valid. In general, the arc *PMR* acts as the gnomon and the arc *UNV* represents the dial face (see also Fig. 3).

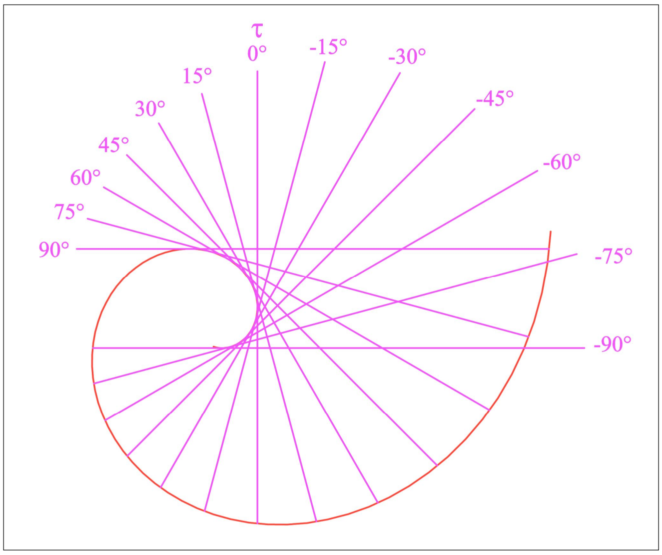


Fig. 3. The sunrays, tangential to the gnomon arc, as well as their intersecions with the dial face are both formed from the logarithmic spiral. Depending on the choices made, the time indication will be reduced by about $\Delta\tau = 15°$ at each end of the range.

Particular attention should be paid to arc *US* here. It restricts the light's incidence and therefore reduces slightly the range of LAT indication. For calculating the hour angle difference $\Delta\psi^{US}$ according to arc *US*, the interdependence of the tangent's polar angle, the intersection angle and the hour angle must be known. We read from Fig. 1: $\psi_{T\,P} = \psi_{T\,\tau=90°}$, $\psi_{T\,R} = \psi_{T\,\tau=-90°}$, and $\psi_{T\,M} = \psi_{T\,\tau=0°}$. Taking into consideration (11) and (12) it follows

$$\psi_T = 90° - \sigma + \tau. \tag{24}$$

The tangent at point *R* intersects the dial face at points *V* and *S*; we require polar angle ψ_{ZS} of point *S*. When $\tau = -90°$ we get $\psi_{TR} = -\sigma$, i.e. the equation of the tangent becomes

$$y_R = a\,e^{-c\sigma} \sin(-\sigma). \tag{25}$$

Substituting $\psi = \psi_{ZS}$ in (3) and equating (3) with (25) we obtain the following equation defining the polar angle ψ_{ZS} of the dial face

$$e^{c(\psi_{ZS}+\sigma)} \sin\psi_{ZS} + \sin\sigma = 0. \tag{26}$$

Point P ($\tau = 90°$) is characterized by $\psi_{TP} = 180°-\sigma$; its tangent intersects the dial face arc at point *U*. Using the same procedure as before, the equation of condition for the face's polar angle ψ_{ZU} is given by

$$e^{c(\psi_{ZU}+\sigma-180°)} \sin\psi_{ZU} - \sin\sigma = 0. \tag{27}$$

Explicit functions for ψ_{ZS} and ψ_{ZU} cannot be derived from (26) or (27). Thus an iteration method is indispensable for calculating these angles.

The difference

$$\Delta\psi_{US} = \psi_{ZU} - \psi_{ZS} \tag{28}$$

corresponds to the required difference of hour angles. It reduces the range of LAT indication to

$$(-90° + \Delta\psi_{US}) \le \tau_{LAT} \le 90° \tag{29}$$

and

$$-90° \le \tau_{LAT} \le (90° - \Delta\psi_{US}) \tag{30}$$

because $\angle U0S$ (=$\Delta\psi_{US}$) equals $\angle V0W$. Accordingly, the range of LAT indication will be reduced to the dial face arcs *UNW* and *SNV* respectively.

Thickness of the Polar Sundial

The maximum distance between gnomon and dial face has a profound influence on the thickness of dial body. With respect to (2), (3) and (16), the distance A_{TZ} between the gnomon tangential point x_T, y_T and the corresponding tangent intersection point x_Z, y_Z at dial face is given by the Pythagorean theorem

$$A_{TZ} = \sqrt{(x_T - x_Z)^2 + (y_T - y_Z)^2}\,. \tag{31}$$

In order for the gnomon shadow to be on the dial face within sun's declination range $-23.439° \le \delta \le 23.439°$, the polar dial's thickness has to fulfill the condition

$$D > \sqrt{(x_{T,\tau=90°} - x_{Z,\tau=90°})^2 + (y_{T,\tau=90°} - y_{Z,\tau=90°})^2}\,\tan 23.439°. \tag{32}$$

Time Lines of the Dial Face

The parallel time lines on the dial face – for instance with intervals of time $\Delta\tau = 15°$ – may be positioned either relative to the meridian point *N* by arcs $s = f(\psi_Z(\psi_T(\tau)))$ in accordance with (22) or absolute by Cartesian coordinates $x = f(\psi_Z)$, $y = f(\psi_Z)$, in accordance with (2) and (3) and using polar angle values $\psi_Z = f(\psi_T(\tau))$.

Calculation Example of a Model

Fig. 4 shows the calculation scheme for a polar sundial with gnomon and dial face based on the logarithmic spiral. That design procedure may be iterative. For example, one must vary the assumed input quantities, if the intermediate and/or

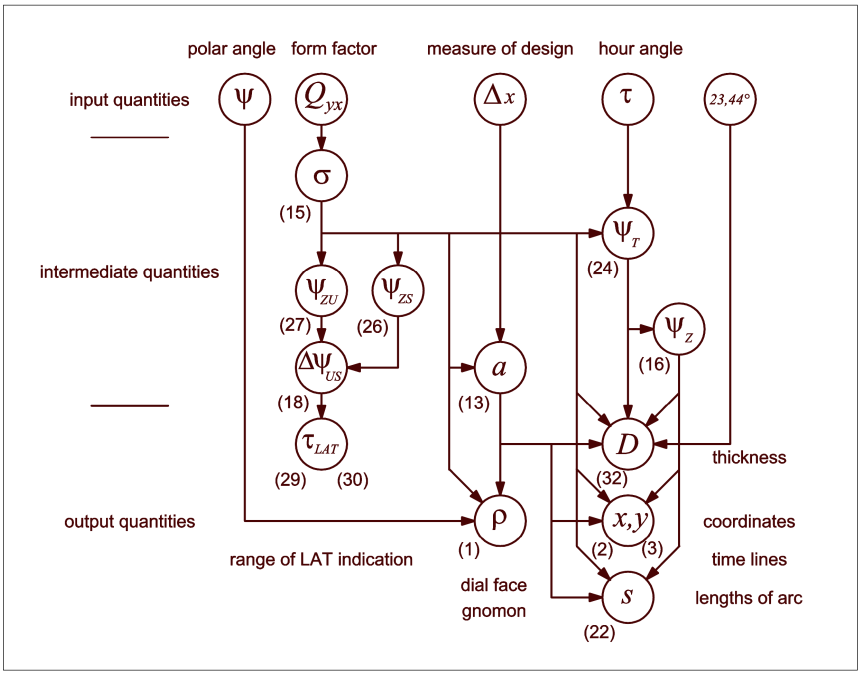


Fig. 4. Flow diagram for calculating a polar south sundial with spiral-shaped gnomon and dial face. The numbers in brackets refer to the relevant formulae.

output quantities are required to be integral values or with one digit after the decimal point. The calculation was started first of all with Q_{xy} = 0.618 (corresponding to the golden section $\Delta y = (\sqrt{5}-1)\Delta x/2$ and Δx = 220. It yielded σ = 72.968° and a = 22.178 as well as Δy = 135.960. For further calculations, the parameters σ = 72° and a = 20 had been chosen so that Q_{yx} = 0.6, Δx = 220.716 and Δy = 132.488. The following table shows the final values of polar angles for the gnomon and the dial face as well as the coordinates and arc lengths for time line distances. These values have been used for the dial design drawn in Fig. 5.

The s values form a geometric progression with the constant quotient q = 1.0888. The maximum distance between gnomon and face is given by A_{TZmax} = 172.78 so the minimum thickness required is D_{min} = 75.13. The range of LAT indication amounts to -72.89° ≤ τ_{LAT} ≤ 90° resulting from ψ_{ZU} = 372.27°, ψ_{ZS} = 355.15°, $\Delta\psi_{US}$ = 17.11°.

τ	(-90)	-75	-60	-45	-30	-15	0
ψ_T	(-72)	-57	-42	-27	-12	3	18
ψ_Z	(192.27)	207.27	222.27	237.27	252.27	267.27	282.27
x	(-58.15)	-57.59	-52.20	-41.53	-25.47	-4.34	21.07
y	(-12.65)	-29.68	-47.44	-64.61	-79.65	-90.94	-96.7
s		17.10	18.61	20.27	22.07	24.03	26.16
τ	0	15	30	45	60	75	90
ψ_T	18	33	48	63	78	93	108
ψ_Z	282.27	297.27	312.27	327.27	342.27	357.27	272.27
x	21.07	49.45	79.04	107.63	132.68	151.50	161.38
y	-96.87	-95.94	86.96	-69.18	42.45	-7.26	35.09
s	26.16	28.48	31.01	33.76	36.74	40.02	43.61

Table 1. Design parameters for the example dial.

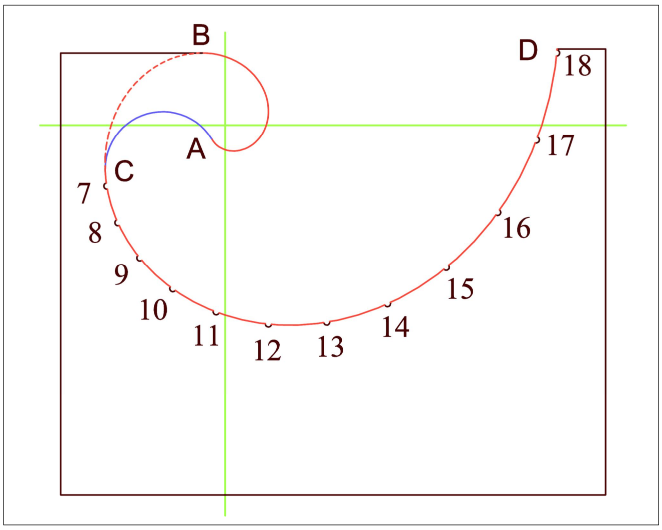


Fig. 5. Sectional view through a polar sundial body. The gnomon arc AB and the face arc CD belong to the common logarithmic spiral ABCD. The arc inserted between A and C is an arc of a circle.

Realisation of a Model

Using the above values (linear measures in mm) and a thickness of 100 mm for the sundial's body, a fully functional model had been manufactured with a numerically controlled milling machine. The material chosen is a brown-violet coloured plastic named *Uriol*. It machines like wood making accurate shaping possible. It has a high dimensional stability and so it is very suitable for making models. The material thickness amounts to 50 mm, i.e. the sundial consists of two halves assembled with two alignment pins.

The first step for each dial half was to bore the holes for the time line positions along the spiral curve in the block of *Uriol*, see Fig. 6. Next, it was milled to the

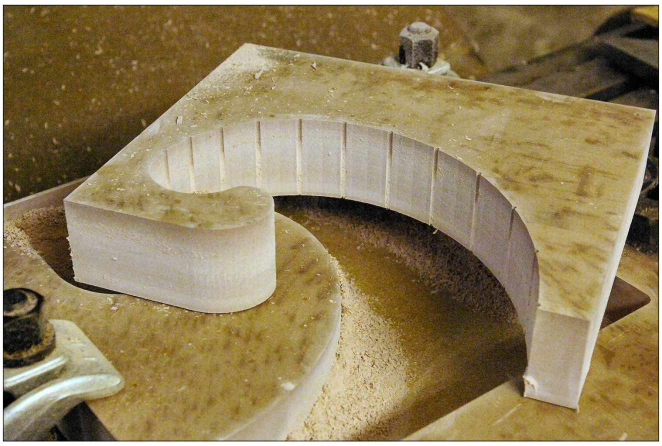
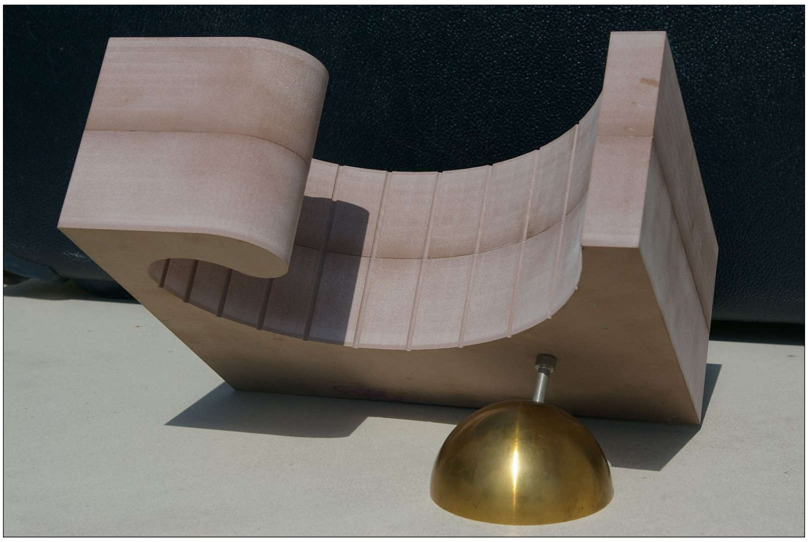


Fig. 6 (top left). Drilling the sundial time line points with a numerically controlled milling machine.

Fig. 7 (left). Milling the sundial contour.

Fig. 8 (above right). Finished half of the logarithmic polar sundial.

Fig. 9 (below). The completed logarithmic polar sundial in operation.



dial contour, see Figs. 7 and 8. Fig. 9 shows the complete polar sundial casting a sharp shadow. The final polar sundial will be equipped in addition with a device for adjusting the geographical latitude.

JOHN BLAGRAVE

The picture shows a diallist noting "The scituation of a wall to finde how much he declineth", as published in John Blagrave's *The Mathematical Jewel* (p.101). The building could well have been Blagrave's own house. He was born (c.1558) and died (1611) in Reading: there is a monument in the church there to him.

The picture includes a square and plumb-bob, and two forms of simple theodolite, one of which appears to be being used, very dangerously, to get the direction of the sun.

JD

Joanna Migdal: Professional Artist, Professional Sundial Maker

A Visit Report By Douglas Bateman

I first met Joanna Migdal when judging the sundial design competition in February 2000. Together with fellow panel member Nick Nicholls, we were to see two entries by Joanna: both were in private grounds in hard-to-find locations. In fact our paths must have crossed earlier as both of us attended, amongst 78 other enthusiasts, the very first meeting of the Society at Exeter College, Oxford, in 1990. Of the two dials, the armillary was high on the list and the panel had no hesitation in giving it an award (see below).[1]

Joanna with a model and full size mock-up.

Joanna is well known in artistic circles and her work, and her engaging personality, ensure that she is featured frequently in *Country Life*, *House and Garden* and similar publications. These usually have a photograph of Joanna with a few sundials in a style to suit the journal, so I was delighted when our editor asked me to visit Joanna to delve a little deeper into her skills and undoubted success.

Following her initial passion for art at school, her career began with a year-long foundation course at the Ealing College of Art. From there she won a place at the Central School of Art. But having been captivated by the work of a silversmith demonstrating at the recently set up *Art in Action* (this has become a major national annual showpiece for all types of arts and crafts) she enquired of one of the organizers where she could receive some thorough training and experience. Joanna was directed to a sculptor, Edwin Russell, and wife, Lorne McKean, both of national standing. Having met the couple and worked with them for a month, she set out on a planned gap year. She reached Venice, when an inspiration led her to return and ask the Russells to take her on. As she said, she "needed a teacher" and in Venice she realized that she had just left one.

An armillary sphere made in bronze with a beautifully engraved motto and additional rings to coincide with the sun's altitude on certain birthdays.

Below and right: An abstract sculptural form complementing the formal garden. The inset shows (on a very similar copy) that the almost hidden equatorial dial is more subtle than expected by having two hour bands, one giving the hours, and the upper give the half hours.

The Hong Kong golf club armillary in silhouette showing animals relevant to the location and culture.
The supporting dragons are also shown in close-up.

The seven years of training entailed hard work with long hours for bed and keep, and in return, very thorough tuition in many forms of the arts, working in various media and extending an interest in calligraphy. Edwin Russell has several links with sundials and at the time of the apprenticeship he was sculpting the dolphins for the very well known Dolphin Dial at the National Maritime Museum. This was conceived and calculated by our Chairman, C St J H Daniel, the stunning dolphins being designed and made by Edwin Russell. Joanna also found herself on scaffolding checking templates for the two vertical declining dials on St Margaret's Church Westminster (also calculated by our Chairman for Brookbrae and designed by Edwin Russell). Another Russell project during 1989/1990 was the massive granite dial for an office entrance area in Marlow, Buckinghamshire, and recently relocated.[2] Joanna found herself in charge of the delineation and making the four bronze subsidiary polar dials and equation of time 'dial' in the pedestal.

A collection of burins for engraving.

To gain more experience in lettering and engraving, Joanna was sent to Larry O'Connell, who did the engraving for Edwin Russell's Marine Society dial. It is with Larry that she learnt some of the techniques of hammer and sharp chisel and engraver's burin.

Coinciding with these major projects, Joanna did much of the manufacture and engraving of batches of horizontal dials for Brookbrae Sundials, of which Edwin Russell was a Director. With such a grounding, the Russells also encouraged freelance dial making. Joanna stressed how much of her life has been happy coincidences. She tells the story of how at this time there was a series of amusing one-line letters in the Times newspaper, in which correspondents described their professions. On an impulse she wrote "Without a shadow of doubt my trade puts all others in the shade" and it was published.

This led to many commissions, including two from the Worshipful Company of Scientific Instrument Makers. The first was an armillary sphere, the second a striking pillar of glass and steel with lettering on the glass, situated at the St Paul's end of the Millennium Bridge over the Thames. Further contacts encouraged joining the Worshipful Company of Clockmakers and gaining a husband on the way (see below).

Asked about commissions, Joanna said that the majority come by word of mouth, and some via occasional articles in the garden- and house-related journals mentioned earlier. Having received an enquiry, she first invites the client to her studio to look at her portfolio of previous work and models of various dials. She then visits the location to get a feel for the place and for the needs of the client. She then makes a small mock-up for an initial assessment with the client, followed by a full size mock-up for trial on site. Astronomical measurements are determined by traditional methods, although the more recent Google Earth methods are useful for initial sketches.

Engraved inscriptions or special dedications are discussed, although hints or guidance may be given, now based on 25 years of experience. Final installations will be on a sunny day, so that the alignment can be precisely done.

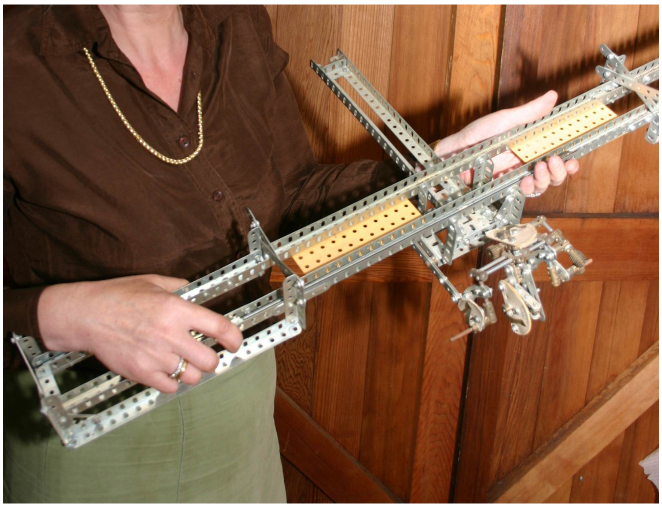
Asked about the choice of bronze in preference to cheaper brass, Joanna pointed out that bronze has many desirable features such as being hard but malleable. It can be soldered, brazed, or TIG (tungsten inert gas) welded. Joanna claims considerable expertise with the welding, as is testified by the many invisible welds in the complex structure and joints of a dial such as an armillary sphere. For some complex shapes with elaborate cut-outs, the bronze can be shaped initially by water jet cutting. The work can then be hand-finished and hand engraved. The completed work is then chemically patinated.

Calligraphy is clearly something special on the dials. I asked if Joanna worked from a selection of fonts, choosing from, say, a font book. The answer was an emphatic no, relying on her training, eye for proportion, and suitability for the dial. The latter may entail varying letter heights and angles to suit the curvature of the hour marker ring. All lettering is designed specifically for the job in hand.

As mentioned above, for the lettering a variety of tools may be used. Achieving the varying depth of a cut in numeral or letter is very important because this gives extra 'life' and character, and working by hand gives subtle variations between apparently identical letters. For greater depth bronze can be literally carved with a very sharp steel chisel and hammer. Alternatively Joanna has developed an unique method of engraving with hand-held rotating tungsten burrs. For very fine work or for serifs, conventional gravers are used. The task is demanding and very time consuming, but the overall quality shows whilst the client appreciates the sheer dedication.

Hand engraving a double horizontal dial.

After sharing accommodation with the Russells, the time to be fully independent coincided with Joanna's parents moving out of London. A house in the village of Bix, near Henley, with the remnants of an existing workshop enabled planning permission to be obtained for a new custom-made studio. Working with an architect, Jon Allan, whom she had known for some time, they designed a wood framed building, all based on the proportions of the golden ratio[3] together with the architectural guideline of the internal height of a building related to the height of the occupants, in this case Joanna's height of 1.6 m (5 feet 3 inches). Green oak from Wales was used for the main timbers, and the building itself won an award for the 'Best New Building in the Chilterns' in 2002. Members who attended the Oxford conference in 2004 and chose the tour to the David Harber's workshops and Joanna's studio will remember the warm ambience of the studio.



The Meccano 'trigon' made by Noel Ta'Bois for drawing declination lines.

Given the propensity for 'top drawer' clients the inevitable question was - have you met members of the Royal Family? Whilst only one of her sundials has been made for the Royals, they have unveiled several. A related question was about overseas commissions and gave the answer: Hong Kong, Australia, America, Germany, Gulf States, Ireland and Jersey.

Mention of the Hong Kong dial brought questions about the manufacture of such dials. The circular components will be cut or rolled in an engineering workshop, whilst the cut-out detail and engraving will be done by Joanna. This dial has castings of two dragons (traditions and superstitions had to be very carefully followed!) and these were modelled and cast in bronze by fellow artist and sculptor Stuart Garner.

The 2005 Award Scheme winning horizontal dial in Guildford.

Coming closer to home, so to speak, I asked about her link with the Society. Joanna recalled attending an informal gathering to obtain some advice and ended up with Andrew Somerville, Christopher Daniel, David Young and Charles Aked (considered the 'founding four') and Noel Ta'Bois. She believed that Noel was the link, who was very helpful, and even made a full size Meccano 'trigon' for her to mark out the declination lines on a vertical dial. (There is a link here with myself because the late Noel Ta'Bois, who at the time wrote the Sundial Page in *Clocks* magazine, gave me some vital encouragement whilst assisting in the restoration of an unusual dial. Some members may remember that many of his sundial books and dials were donated to the Society for our first auction in 1995.) Joanna subsequently joined the Society with membership number 65. She mentioned how extremely helpful members always are, most recently Allan Mills and John Davis.

A waiting list of orders for the next 18 months is not surprising, but this has not prevented work on other non-sundial projects. Her teacher and mentor, Edwin Russell, told her not to become too specialized in one field, and other commissions have included the plaque in Westminster Abbey commemorating the clockmaker John Harrison (which she made with the sculptor Gary Breeze), a plaque for the Duke of Bedford in Covent Garden and, more recently, designing the unique 'Newgate Street Clock'. This clock is on the north side of a ventilation shaft for the London Underground, just north of St Paul's Cathedral. The clock has a 'wandering hour' display, based on a clock by the 17th century clock and watchmaker, Joseph Windmills. Joanna recently worked with two young artists, Hannah McVicar and George Saunders-Singer, on a project for the entrance foyer of a new polyclinic medical centre in Aldershot, Hampshire. It is a two metre diameter globe, made of four hundred and fifty hanging squares of glass, each painted with leaves, birds and flowers. It depicts 'The Tree of Life'.

Returning to some of the dials we know, for the 2005 Award Scheme, Joanna won the top award for the charming low level horizontal dial in West Nye Gardens, Guildford.[4] Joanna was keen to give credit to Kay Munt who designed the garden setting and had the idea of inscribing the nearby bench with the explanation of the equation of time.

Another sundial reported in the Bulletin was the very symbolic Memorial Dial for the loss of life in Tavistock Square during the July 2005 bombings in London.[5] Other work, almost too numerous to mention, includes vertical dials, a large ring dial and many versions of equatorial dials.

Earlier I had mentioned gaining a husband, and in 2006 Joanna married Sir George White, Consultant Keeper of the Clockmakers' Museum at Guildhall, London. George was the host to the Society for a tour of the museum.[6] I should add that George is the grandson of Sir George White Bt., founder of the Bristol Aeroplane Company. He has inherited practical skills, as applied to clock restoration, and in 1989 published a 500-page book on lantern clocks. One dealer describes the book as the definitive study of the history, mechanism, restoration and conservation of the lantern clocks, recently selling on eBay for upwards of £1000. Clearly no ordinary match between individuals, to give a rare combination of affections and artistic skills.

There is no doubt that in her field, Joanna Migdal is Britain's most successful sundial maker.

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2. D A Bateman: 'The 'Akeler' Equatorial Dial: relocated in Marlow', *BSS Bulletin*, 14(iv), pp.146-149, (December 2002).
3. The golden ratio is considered to be the ideal proportions for a rectangle with the ratio of the side as 1 : 1.618... or precisely as 1 : (√5 + 1)/2. The ratio has fascinated philosophers, architect, artists and mathematicians for some 2,400 years.
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BSS SUNDIAL SAFARI TO THE ALSACE

6-11 September, 2008

Our Safari this year took us to the Alsace region of France, which nestles between the Vosges Mountains and the River Rhine. It is probably France's most un-French region. Over hundreds of years the region has belonged to both France and Germany in turn. This is evident in its cuisine, architecture and its language. Most Alsatians speak French, German and Alsatian, which is an Alemannic dialect of High German.

This is an area that Mike and I enjoy and we wanted to share it with our sundial friends. Over the next six days we hopefully whetted their appetite for a return trip. We were generally lucky in that the weather was mostly dry and even sunny. We visited museums, towns and picturesque, flower-bedecked villages. We had some interesting venues for lunch, in particular La Ferme des Moines (the monastery farm) at Thierenbach. It was extremely busy but it was not just the food that draws the crowds. Around the restaurant are several automaton figures of monks and at 13:45pm each day the figures come to life in turn. Each figure is illuminated as he takes part in telling the story of the work done on the farm by monks. We had visited the previous year with our friend Maurice Kieffer and his wife Dominique and thought this 'a must' for the Safari. This sort of find can only come from local knowledge and we are grateful to Maurice for his help and suggestions.

One day we went into Germany to visit Freiberg-im-Breizgau and on the final day those who did not have an early departure visited Basel in Switzerland. Of course, I must mention the traditional 'cabaret' on the last night. It was a time to have fun and to enjoy each others' company, and I would like to thank those who took part. We hope that people will now be tempted to return to The Alsace or visit for the first time.

Val Cowham

Saturday 6 September

The Alsace Sundial Safari commenced on Saturday with a visit to Strasbourg. The River Ill divides in two, flowing around both sides of old Strasbourg, forming a kind of moat around it, with a dam built by Vauban residing on its western side. Super-sleek modern trams run through the city's cobbled streets, a contrast between the old and the new. As you walk into the cathedral square, suddenly the great red-brown cathedral dominates the view: its spire is 142 m high, with only the pyramid of Cheops being 4 m higher at the time it was built. In the cathedral we met our guide and she stressed that in order to understand the region's history and culture, one had to appreciate the swapping back and forth between it being French and German (we even saw a street named 'Rue Klein'!). The church contained incredibly beautiful stained-glass windows dating from the 13th and 14th centuries, and its rose window is the largest one in France. Inside the cathedral is a meridian line on the wall, with a hole in the roof outside the adjacent window. Nearby is an astronomical clock built in 1776, showing the mean time, apparent time, movements of the sun and moon, and calendrical information. On an outside wall are the dials of Dasypodius, the 'Youth' dial and the 'Astrologer' dial.

The 'Astrologer' dial on Strasbourg Cathedral Soultz.

The cathedral's bells started ringing at 12 noon and continued solidly for 15 minutes as we were next taken by our guide through narrow winding streets with overhanging half-timbered buildings having steep roofs containing rows of tiny dormer windows. The steep roofs were built as a result of an edict from the emperor in the 14th century, forcing people to dry and store their food while they waited for rescue when besieged. This style of roof was done away with after the French Revolution, so buildings now can be dated by this feature.

The picturesque area Petite France was seen from a bridge on the riverbank. Half-timbered houses dating from 16th and 17th century were occupied by fishermen, millers and tanners taking advantage of the flow from the river.

Lunch was taken at L'ancienne Douane (the former Customs House), which had lovely painted ceilings.

After lunch, we had a free afternoon in the city. Some of the group visited the Museum of Fine Arts, others went on a little train ride through the city, and the rest explored parts of the old city.

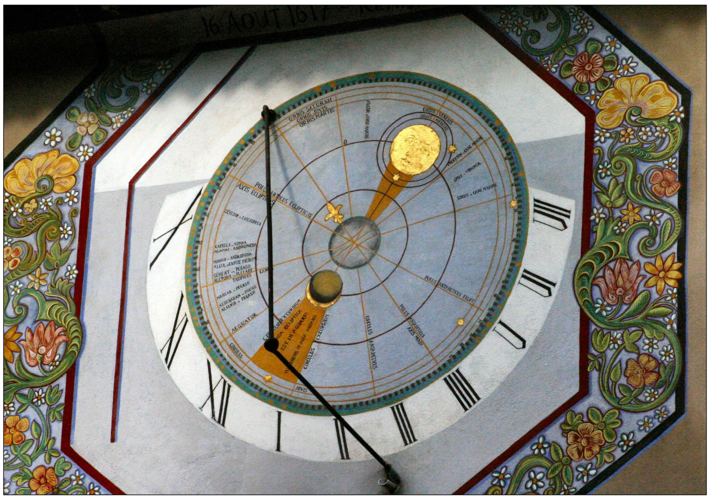
Janet Jenkins

Sunday 7 September

We drove to the village of Soultz where there is a very impressive east decliner (1755) painted on the octagonal church tower. Nearby on the apex of the roof we had a first view of a stork nesting box, a large circular steel ribbed construction firmly fixed to the building to provide a platform for the weight of the huge storks' nests.

The dial on the church of St-Maurice in Soultz.

We then drove in bright sunshine past acres of neat vines cultivated on the lower slopes of the Vosges hills to the Gsell Cellars, a winery in Orschwihr. Here there is a carved vertical declining sundial that unfortunately was showing a time 33 minutes fast of AST. However, this gnomonic blow was soon softened by an interesting hour looking at the wine processing plant and sampling four different wines. In excellent spirits the cheerful group paused at a modest dial lacking lines and numerals on a chapel before reaching Guebwiller. We inspected a very large west decliner with zodiacal lines painted on the gable of a house. We were



The 'Eclipse' dial in Rouffach, restored by René Rohr.

Maurice Kieffer

The BSS group and Alsace Sundial Society members at the convent of St-Marc.

joined by some members of the Alsace Sundial Society and after an excellent lunch, the coach climbed up to the convent of St-Marc where there are two identical east decliners overlooking the kitchen garden above a double stairway ideally sited for a group photograph.

In the village of Rouffach there is an interesting painted sundial restored in 1989 by R. Rohr, perhaps the most important dial on the whole tour. This dial is known as the 'eclipse dial' because the celestial positions of certain stars at the time of the eclipse of 16 August 1617 are included in the extensive dial furniture together with a pre-Kepler geocentric view of the heavens. As a sundial it suffers greatly from the shadows of two huge yew trees; it declines west significantly, it has solstice lines with no obvious nodus, there is a degree scale on an inner chapter ring for the star positions, it has a beautiful outer hexagonal border in a plaited floral theme. There are a number of oddities and unanswered questions about this exceptional sundial, which may relate to the geocentric theory and could be explored in a short article. [This dial was the subject of an article by René Rohr in Bulletin **93**(3) - Ed.]

We walked through the Sunday-quiet village, along narrow streets lined with dark timbered houses some 400 years old. There were flowers everywhere, mainly geraniums of pinks and red. On the church of Notre Dame de la Assomption there is a recently restored meridian line angled to face true south. Beneath this line the Sundial Society of Alsace had very kindly brought several of their interesting and innovative sundials which they were able to demonstrate working in late afternoon sunshine.

Graham Aldred

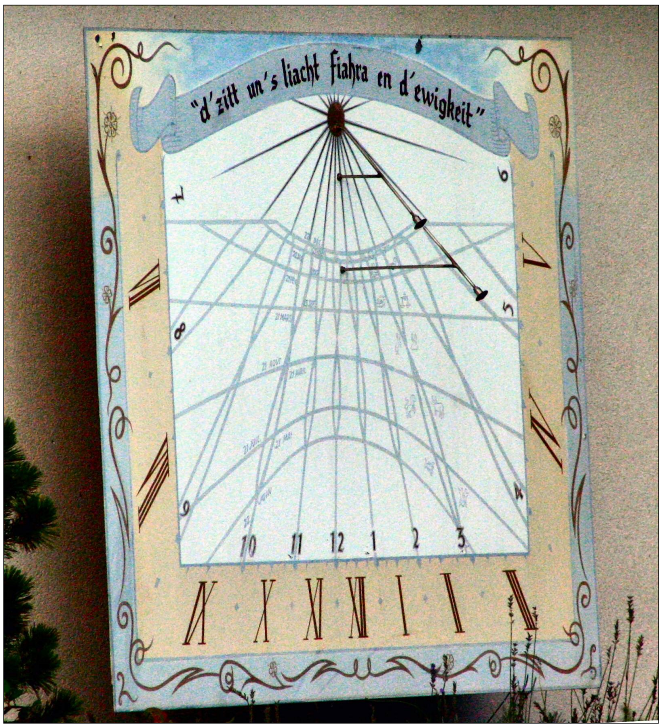
Monday 8 September

The third day of our tour began with a visit to Colmar, happily in sunlight and with a good forecast ahead. With a population of 67,000, Colmar is the principal centre of the Alsace and regarded as the capital of Alsace wine.

A short walk took us to the Rue des Têtes where there is the extraordinary house built in 1609 with many carved heads decorating the building. Three sundials were next to be seen, all on the cathedral-like Collegiate church of Saint Martin. The most accessible was another of the cast iron meridian lines with analemma by L Adam. The other two were extremely inaccessible being very high on the tower. These are large vertical declining baroque painted dials in rather faded condition. By my estimate they must about 30 metres above ground level – guaranteed unobstructed sunlight, but difficult to read. A short walk took us to the former Customs House with a charming vertical declining dial high on the tracery stonework at eaves level. However, close inspection showed that the original painted fresco of 'sun rays' was faded and almost certainly has an incorrect replacement gnomon protruding horizontally and normal from a south-west facing wall.

Lunch was held in the railway buffet! Far from our preconceptions, it was a pleasant restaurant decorated with reproductions of paintings by Gustav Klimt. The afternoon gave free time to wander and visit museums.

Next on the itinerary was the small town of Eguisheim, characterised by narrow medieval streets. A modest vertical dial could be seen over a courtyard wall, but the star of the visit, and possibly the whole tour, was a vertical dial on the wall of a private house. Equipped with vague directions a small group ventured into a residential area, and only by asking about 'cadran solaires' did we find the house and managed some photographs over the hedge. A few others found the dial so by now the owner realised what was causing the interest and they were rewarded by close up inspection. The dial has an analemma at each hour, lines of declination and a puzzle of what appeared to be two separate noduses (nodi?). On the other hand, many did find a simple low level vertical dial where, very conveniently, some were taking their ease with a cup of coffee, a fitting end to a very pleasant day.



The analemmic puzzle dial with two noduses at Eguisheim.

Douglas Bateman

Kevin and Irene Barrett with Peter Kunath, Christiane Berger, Jutta Kunath and Guenter Berger from the DGC (German Sundial Society) sit under a dial at Eguisheim.

Doug Bateman

Tuesday 9 September

Tuesday began with an early ride to Riquewihr, a well-preserved medieval town. Here we saw spy windows, flying martins, portcullis & drawbridge, and three sundials, the most interesting of which was a painted wall dial in la Cour des Nobles; it had been nicely restored some time in the '70s by René Rohr.

Our trip continued through stork country. Next, in Bergheim, we saw a beautifully painted dial (restored in 1977) somewhat reminiscent of the Queens' College dial in Cambridge, complete with declination lines for the zodiac and months, and notations of times of sunrise and sunset throughout the year [see front cover of *Bulletin* 19(iii)].

The highlight of the day was a trip to the convent at the top of Mont Ste-Odile, a wooded plateau surrounded by a prehistoric defensive wall; today it is an active place of pilgrimage, honouring the patron saint of Alsace. Here on a terrace overlooking the entire valley 2500 feet below, we found an 18th century stone polyhedral dial with 24 facets, all but one of them in good working order with properly

Left: The multi-facetted dial at the convent of Mont Ste-Odile. See also the front cover.

Right: Der Sonnenuhren Mann of 1230 on the cathedral at Freiburg.

placed gnomons. Four of the faces show antique, hebraic, babylonic and italic hours; the remaining 20 show the time at different locations around the world (see above).

After a quick drive by of a forlorn cube dial stuck in the middle of a roundabout in Dorlisheim, we ended the day with a walk around Molsheim. On the former Jesuit Gothic church we found five (modern) dials scratched into the stone walls but none of them has a gnomon. On the south transept, the easiest of these to see includes the inscription *per DeCeM LIneas soL reLegIt VIas* which refers to the miracle of the dial of Ahaz, with the sun turning back 10 steps; it also includes a chronogram for 1758 (summing the upper-case letters as Roman numerals). Another scratched horizontal dial was found on a windowsill of the church tower after a climb of some 72 steps.

Finally, in the Cour des Chartreux, on the wall of a museum that began its existence as a convent, we were treated to a 4 square metre wall dial declining somewhat east of south. The design dates from 1703 but the dial has been repainted a number of times since then and is in good working order today.

Fred Sawyer

Wednesday 10 September

We awoke to overcast skies but by afternoon we had warm sunshine. The bus ride took us across the Rhine to Freiburg, a charming German city surrounded by the Black Forest Mountains. Popular opinion has it that Freiburg is the warmest city in Germany.

Our first stop was the Munsterplatz, Freiburg's largest square and site of the massive gothic Cathedral of Our Lady. Its building was commenced in 1146 and continued for several centuries. In 1330, the western spire was completed. It is 116 m high and crowned with a unique stone pyramid dome completely in openwork. We made our way through the busy farmers' market to the entrance of the nave with its twelve statues of the apostles each on a tall stone pillar. The dark interior of the cathedral is brightened by a succession of glorious stained glass windows, which combined with the carvings, paintings, sculptures, etc. to magnificent effect.

We saw several dials, the most prominent being Der Sonnenuhren Mann of 1230, holding a semicircular dial in his hands. Below this are two modern incised dials, the tip of the vertical dial's gnomon acting as the nodus for an analemma below it. Two other dials are located on the west porch, one old and one a more recent copy.

Our second stop was the Augustinermuseum, which has been under reconstruction since 2006. Although the scientific instrument section of the museum was closed, its curator, Peter Kalchthaler, had prepared a display of several dials for us to see and handle. These dials were part of the estate of a private collector and included a combination horizontal-analemmatic dial, several small pocket dials, two diptych dials and a small ring dial – all in beautiful condition.

We then trekked to the Kleiner-Meierhof restaurant for our usual 3-course 'lunch' at which a dealer had several dials for display and sale. The afternoon was then free for traipsing around the city shopping and rubbernecking, all the time being careful to avoid stepping into a 'Bachle', one of the systems of gutters containing free-flowing water along the sides of the streets.

That evening, after dinner, we had the usual BSS Cabaret featuring a number of recitations by the usual suspects. Kevin Karney announced that Jim Marginson was the winner of the 1st, 2nd, and 3rd prizes for his contest to provide a collective noun for a group of gnomonists. A good time was had by all and thanks were given to Val & Mike Cowham, and to Dominique and Maurice Kieffer for their efforts in arranging such a well organized and interesting Sundial Safari.

Don Petrie

A modern armillary dial in Basel.

A portable polar dial in the Kirschgarten Museum.

Thursday 11 September

On our last day in the Alsace, the day started with fog obscuring the very splendid views of tree-covered hills but it soon dispersed to give another sunny day.

First to Mulhouse, to leave seven people at the station, then the airport for a further six. The rest of us toured the Kirschgarten Museum of Basel. We saw an exquisite collection of portable dials, an 1820 noon cannon, an unusual square heliochronometer together with a good collection of clocks and other time recorders from various countries. For those with other interests, there was a superb collection of Meissen and other figurines, some lovely wrought iron work and a large toy collection.

And so to home and a regrettably very delayed flight for the Liverpool contingent.

Gillian Nicholson

HENRY GYLES

This drawing, labelled "ye effigies of Mr Hen: Gyles the celebrated Glasse-Painter at Yorke" by an unknown artist is in the British Museum collection (1852-2-14-372). It can be compared with the self-portrait which Gyles used as his tradecard (reproduced in Jill Wilson's *Biographical Index of British Sundial Makers from the Seventh Century to 1920*: the original is in the National Portrait Gallery). This likeness is rather fuller-faced and with less curly hair, but the nose is unmistakable.

We do not have portraits of many of the early dialmakers so to have a choice of two for perhaps the most prolific of all the stained glass dialmakers is very pleasing.

JD

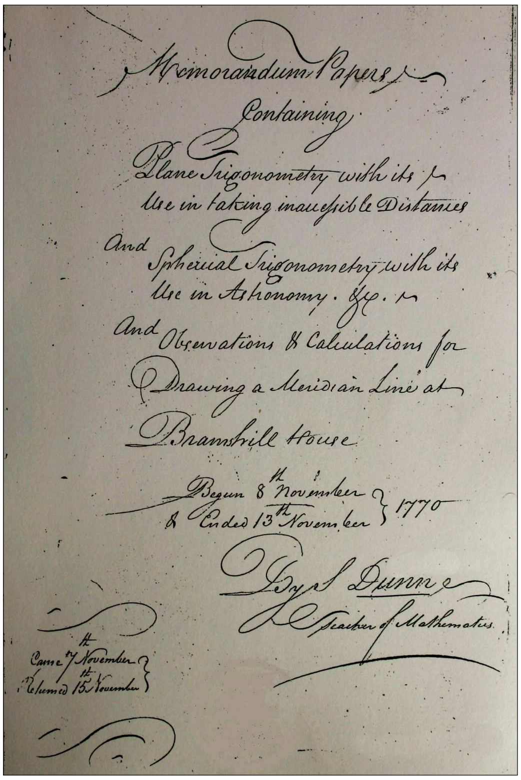
AN EARLY MERIDIAN LINE IN A FORMER STATELY HOME, HAMPSHIRE - ADDITIONAL INFORMATION

DOUGLAS BATEMAN

As mentioned in the Newsletter in the September Bulletin, since the article[1] was typeset, the Curator of Bramshill House found a 58 page manuscript, dated November 1770, of handwritten notes and formulae about spherical trigonometry, astronomy and calculations for a meridian line. Furthermore, some corroborative information has been located that relates to the missing horizontal dials.

The manuscript, in an elegant flowing script, is a fascinating compilation of what seems to be instructional material for the owner of Bramshill House, Sir John Cope. It is entitled *Memorandum Papers Containing Plane Trigonometry with its use in taking inaccessible Distances and... Spherical Trigonometry with its use in Astronomy and... Observations and Calculations for Drawing a Meridian Line at Bramshill House. Begun 8th November and ended 13th November 1770. S Dunn Teacher of Mathematics.*

The first 42 pages cover plane trigonometry (with an emphasis on surveying) and astronomy (with examples of spherical trigonometry), together with numerical examples using 7-figure logarithms. Four pages follow with the title "The Method of taking the Altitudes of the Sun, Moon, and Stars by the Quadrant with its telescope fixed to the Radius, and the Plumb Line hanging at Liberty." The next section has the intriguing title "Concerning the Meridian Mark". This is only two pages long and turns out to be little more than how to set out a long meridian line employing a firmly fixed quadrant which "should be first exactly perpendicular to the Plane of the Horizon" and other instructions. Dunn states "Then depressing the Telescope towards the Horizon gives the place about a **Quarter of a Mile** or less where the Mark may be placed." (My emphasis.)


Memorandum Papers
Containing
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And
Spherical Trigonometry with its
Use in Astronomy. &c.
And Observations & Calculations for
Drawing a Meridian Line at
Bramshill House
Begun 8th November
& Ended 13th November } 1770
By S Dunn
Teacher of Mathematics
Came 7th November
Returned 15th November

The title page of the S. Dunn manuscript.

Armed with this information, the Curator and I examined old maps and the general area for any sign of a pillar or distant cairn, and for any likely structure that could have supported a quadrant. Nothing was found, nor has any hint of any physical structure been given in a history of Bramshill House by Sir William Cope.[2]

The next mathematical section is a short note entitled "Concerning Regulating the Clock" and I quote:

> "By help of the Equation of Time Table, set your Watch to as many Minutes and Seconds before or after twelve, as the Equal Time is before or after the apparent Time, because this must be the Hour Minute and Second Equal Time when the Sun is exactly on the Meridian of the place; Then watch carefully when the Meridian Line is bisected by the Sun's Image thro' the Hole, and at that instant set your Watch agoing. Then go immediately to the Clock and set the Clock, exactly to the Hour Minute and Second of the Watch, and it is true to Mean or Equal Time."

Regrettably, this is the only tenuous and oblique reference to the meridian line in the Loggia. On the other hand, it does confirm the date of the aperture and line as being before 1770.

The final pages give latitude observations with some made by Dunn in 1770 together with observations made in March 1768 by Sir John Cope Bart. A table of eight observations have a mean of 51º 20' 30" compared with the modern 51º 19' 30". However, we do not know the exact location where the early observations were been made.

As a comment, given the skills with astronomy and latitude observations it remains a puzzle why the error in time of about 9 minutes in the meridian line was not commented on.

Incidentally, the teacher of mathematics, S Dunn, may have had a good reputation. Anthony Turner offered the information that "S. Dunn could be the well known mathematics teacher and writer Samuel Dunn, who was native to Tiverton, and mainly resident in London".[3] In addition, John Amson wrote[4] to put the mathematical aspects in context "By 1770 'mathematical sophistication' was greatly in evidence throughout 18th century English & Scottish society (not to mention Europe and the American colonies), to an extent that we perhaps do not properly appreciate." He added a reference to the effect that it was likely that Samuel Dunn had a school in Chelsea from about 1758.

The next piece of information, although not directly helpful, came from a visit to the Cope family archives held in the Hartley Library, University of Southampton. Nothing relating to the meridian line was found, not even in the book by Cope. This is somewhat surprising given his enthusiasm for the "great architectural beauty" of the south-eastern terrace front with two ornamental arches at each end. Neither is there any reference to sundials.

Some positive information, however, comes from Mrs Gatty.[5] She quotes a lengthy Latin motto derived from Virgil and says: "This is the motto of a sun-dial on one of the terraces at Bramshill Park, Hants. At the same place there are three other dials, which bear the arms of the Cope family with dates and initials, but they have no mottoes." I take this as confirmation of what was likely to have been a large dial, detectable in silhouette in figure 12 in the main paper.[1] If the other dial on the terrace was to have had the family coat of arms, then this implies that the humble horizontal dial in figure 9 is a cheaper replacement. One notes that the balustrade surface seem to have an untidy excess of cement, inconsistent with the initial mounting of a new large dial. The 'third' dial could well be the dial on the north east lawn (figure 13), long since gone. Finally, if Mrs Gatty is correct, the location of a fourth dial is a mystery - perhaps in one of the formal gardens.

ACKNOWLEDGEMENTS

Ms Lindsey Kerr, Curator, NPIA, for further assistance. Photograph of the Dunn manuscript cover by permission of the National Police Improvement Agency. Peter Ransom for drawing my attention to Mrs Gatty.

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A PUZZLE AT RAVELLO, ITALY

NICOLA SEVERINO and JOHN DAVIS

[This interesting story was brought to the attention of the dialling community by a message from Nicola Severino to the Sundial Mailing List this summer. Several people, particularly Frank King and Chris Lusby Taylor, contributed to a discussion highlighting the inconsistencies of the dial. I have tried here to give the essence of the discussions. Ed.]

The history of the Villa Cimbrone at Ravello on the Amalfi coast of southern Italy, can be traced back to the 11th century. At the end of the nineteenth century, Ernest William Beckett, later known as the second Lord Grimthorpe, discovered the site as a ruined farmhouse while on the Grand Tour. In 1904 he purchased it and set about transforming it into a fortified palace with towers, battlements and a mixture of Arabic, Venetian and Gothic details, and called it Villa Cimbrone. Between the house and the cliff edge he built a garden, high above the Gulf of Salerno. The garden is an eccentric mixture of formal, English rosebeds, Moorish tea houses, picturesque grottoes and classical temples.[1] Today the house is a luxurious hotel, and the garden is open to the public. It is believed that some of the garden design was by Vita Sackville-West, a friend of one of Beckett's daughters.

Fig. 1. The dial in the Rose Garden at Villa Cimbrone.

Fig. 2 (top left). The face of the Rose Garden dial.

Fig. 3 (bottom left). Side view of the dial, clearly showing the 32º angle of the stone and the gnomon appropriate for an English horizontal dial.

Fig. 4 (above). The second dial at the Villa. It is a horizontal dial in iron and placed in the courtyard.

The sundial in the Rose Gardens (figures 1-3) is a rather fine design, incorporating an hour-glass as the column of the pedestal and also as a motif carved on the side of the dial block. At first sight it appears to be a rare inclining dial, set on a base sloping at 32° or 33° to the horizontal. The (slightly bent) gnomon, however, is far too near the vertical for the location of Ravello, latitude 40° 40' N. The gnomon angle is around 50° so initial speculation was that the dial had originally been designed as a horizontal one for England and had been moved to Ravello where it had been intended to be inclined to suit its new location. In principle, this would have been possible but both the amount and the direction of the inclination are wrong for this. Ernest William Beckett was the nephew of the first Lord Grimthorpe, the designer of the Great Clock at Westminster, and was himself knowledgeable about clocks, being involved with one in the Great Court at Trinity College, Cambridge. He would surely have known something about sundials and is unlikely to have made this mistake.

A more detailed analysis of the dial face showed that the hours appear to be set out with an equiangular spacing of 15° as would be appropriate for an equatorial dial. But the current gnomon is not perpendicular to the dial face which would be necessary for that category of dial. Perhaps the gnomon is not original (though it has to be said that it appears well leaded-in and has quite nice decorative engraving on its sides). However, even if an earlier gnomon had been perpendicular to the dial face, there is still the problem that the face is looking to the south rather than the north as would be required for an equatorial dial.

There is another dial, in the courtyard of the Villa (Fig 4). This is a conventional horizontal dial but without its gnomon, so one suggestion was that the missing gnomon had been used on the Rose Garden dial. This second dial carries the date 1720 and the hour lines suit a dial at latitude 57° so the match to the gnomon is not good. It is of cast-iron construction and its general appearance, with informal Arabic numerals, does not appear appropriate for an English dial of that date.

Compass directions carved on the face of the Rose Garden dial show that it is in its intended orientation and has not merely been installed the wrong way round. Despite all these problems, it has been reported that the dial was indicating the correct time when visited!

So, the dial remains a puzzle. The current consensus is that it is a non-dial, an early example of what we might describe as a garden-centre dial. Certainly, its motto: “The light bright the hours on me” seems to be rather poor English and more in keeping for a 20th century dial than an earlier one. Someone undoubtedly took care in carving it so it seems a great shame that it was not delineated properly.

REFERENCE

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