

The British Sundial Society



BULLETIN

VOLUME 15 (iii)

SEPTEMBER 2003



Front Cover: A large horizontal dial in stainless steel for Melton Mowbray. (photo: M.Shaw)

Back Cover: Spiral Dial designed and made by David Young (photo: D.Petrie)

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BULLETIN

OF THE BRITISH SUNDIAL SOCIETY

ISSN 0958-4315

VOLUME 15 (iii) - SEPTEMBER 2003

EDITORIAL

September's offerings in the Bulletin include much of interest and some items of amusement also. Mike Cowham's 'Fakes & Forgeries' may raise some smiles as he tells us how to avoid being deceived when viewing or buying an old sundial. Allan Mills tells us the source of those words sine, cosine, tangent which you have been using ever since (or even before) you made your first sundial, and perhaps have wondered how the words started: now you know, and a slightly comical story it is.

There are several 'one sundial' articles, but most authors rightly try to place their particular dial in a context. The spherical stone ball at Hilton village is compared with other spherical sundials and their possible mode of working; the ingeniously-made 'armillary octahedron' is linked with the Borromean Rings of renaissance Italy and with a sculpture

in North Wales; the account of the Benoy Dial leads us to search for the others elsewhere.

This issue also has reminders of a past and a future event. Ten years ago, the North American Sundial Society was founded, and this notable anniversary is being marked by the publication of a festschrift: Fred Sawyer, President of the Society, has produced a scholarly and thorough compilation of Sources of Analemmatic Dials.

Looking ahead to 2004, the British Sundial Society will be holding its five-yearly Design Competition, an encouragement for makers (including young ones) to offer designs of originality and beauty. Of the making of sundials there is no end.

FAKES AND FORGERIES

(OR HOW TO IDENTIFY AN IMITATION DIAL)

MIKE COWHAM

In this article I will discuss how to recognise 'imitation' dials that may be found in-situ, in antique shops, in garden centres and occasionally in museums! These dials may be forgeries, reproductions, replicas or just 'incompetent' dials. Prof. Gerard Turner published a useful set of definitions in 1999¹ and he has kindly allowed me to reproduce them here: Table. 1.

A later article will concentrate on the relatively good reproductions that were made by Pearson Page in the 1930s that frequently mislead even the expert.

In order to spot fakes, (better called imitations), it is first necessary to understand the usual techniques for making a dial and to determine whether these are correct for the dial in question. Over the years techniques have changed so would we expect to find a dial of 1637 with acid etched lines and numerals? No! Definitely not, but other wrong features may not be quite so obvious.

Evidence should be gathered by careful consideration of the following points: -

- 1 What is the material used and is this what you expect to find?
- 2 Is the material (if metal) of constant or is it of irregular thickness?
- 3 Was the dial plate hammered flat from the rear?
- 4 Decide how the markings were applied. Were they engraved, punched, acid etched or have they been cast with the plate?
- 5 If the markings have been filled with wax, does this

hide any evidence?

- 6 Was the gnomon made using the same techniques and material and is it original to the dial? Many will have been replaced over the years.
- 7 Is the dial signed? If so, will that particular maker's name add significantly to its interest or value? Decide whether the quality of its workmanship is likely to have come from that maker.
- 8 Has the dial ever been screwed down to a plinth? Look for witness marks around its fixing holes.
- 9 Was the dial wrenched from its plinth? Look for bending and stress marks.
- 10 Has the dial been correctly delineated? In particular, does its gnomon angle agree with its hour line angles for its intended latitude?

These are just a few of the basic questions to be asked and the answers to each will not necessarily confirm that the dial is an imitation or otherwise, but each may provide cumulative evidence, one way or the other. In some cases there is nothing to compete with experience and a 'gut feeling' about the dial. If at first sight it feels wrong then it probably is wrong.

INVESTIGATION TOOLS

A basic set of tools will be necessary to determine some of these facts. The most important of these is probably a **Protractor** to measure the angle of the gnomon and to measure the angles of the hour lines. In most cases it is sufficient to measure the angle from noon to the 9am and 3pm lines. They should both be the same angle (unless it is a declining dial).

TABLE 1 - ORIGINALS AND IMITATIONS: SOME DEFINITIONS

Original	<i>An instrument whose genuineness is well-authenticated</i>
Imitation	<i>A generic term for all non-original instruments</i>
Reproduction	<i>An object made in the style of an earlier period</i>
Reconstruction	<i>An object for which there has never been a three-dimensional original: it has been made after a verbal or illustrated description</i>
Copy	<i>An imitation of a particular, single, antique object</i>
Facsimile	<i>A look-alike, which closely resembles an original, but is not made of the same materials</i>
Restoration	<i>An amalgam of original parts and modern additions</i>
Forgery	<i>A false instrument (including a false signature or date) made with the intention that it should be accepted as genuine, to the prejudice of another person</i>

If there are small differences take the average of the two readings. Check the figure found with the simple formula $L = \text{Sin}^{-1}(\text{Tan}A)$, where **L** = Latitude and **A** = the measured Angle. If you are put off by mathematics, then think again. This sum is easily done. On my calculator all I do is type in the angle, let's say 38° , press **TAN**, press **INV** then **SIN** and the answer comes up immediately = 51.378° . Therefore for lines at 38° it is probably a dial for London (which is normally quoted as $51^\circ 32'$). If the gnomon angle then agrees with this figure it is almost certain that the dial has been correctly delineated.

The next most useful tool is a **Micrometer** (or vernier calliper). Use this to check the dial plate thickness in several places and even the gnomon thickness. Older dials were made from a cast plate, (brass or bronze), which would then be hammered flat onto a smooth surface plate. The dial thickness will therefore vary, perhaps considerably. Look also on its underside where it should be

possible to see the hammer marks. Rolled brass was gradually introduced between about 1780 and 1820. If the dial was made later than this it will almost certainly have been made from rolled brass where the dial plate will be a constant thickness. However, look carefully, as sometimes the forger will hammer the back of modern rolled brass to make it appear old! The thickness check will normally find this out. Another good guide will be the colour of the brass but this will normally be hidden by patination. If the raw material can be seen, then old cast brass was yellow and modern brass is much redder.

A **Measuring Rule** should be used to check and record the dial's dimensions. Try to find out if the dial was made to imperial or metric measurements. If it is metric then it will be quite recent unless it is from Europe but even there the metric system was not introduced until after 1799 but was not generally accepted until 50 or more years later.

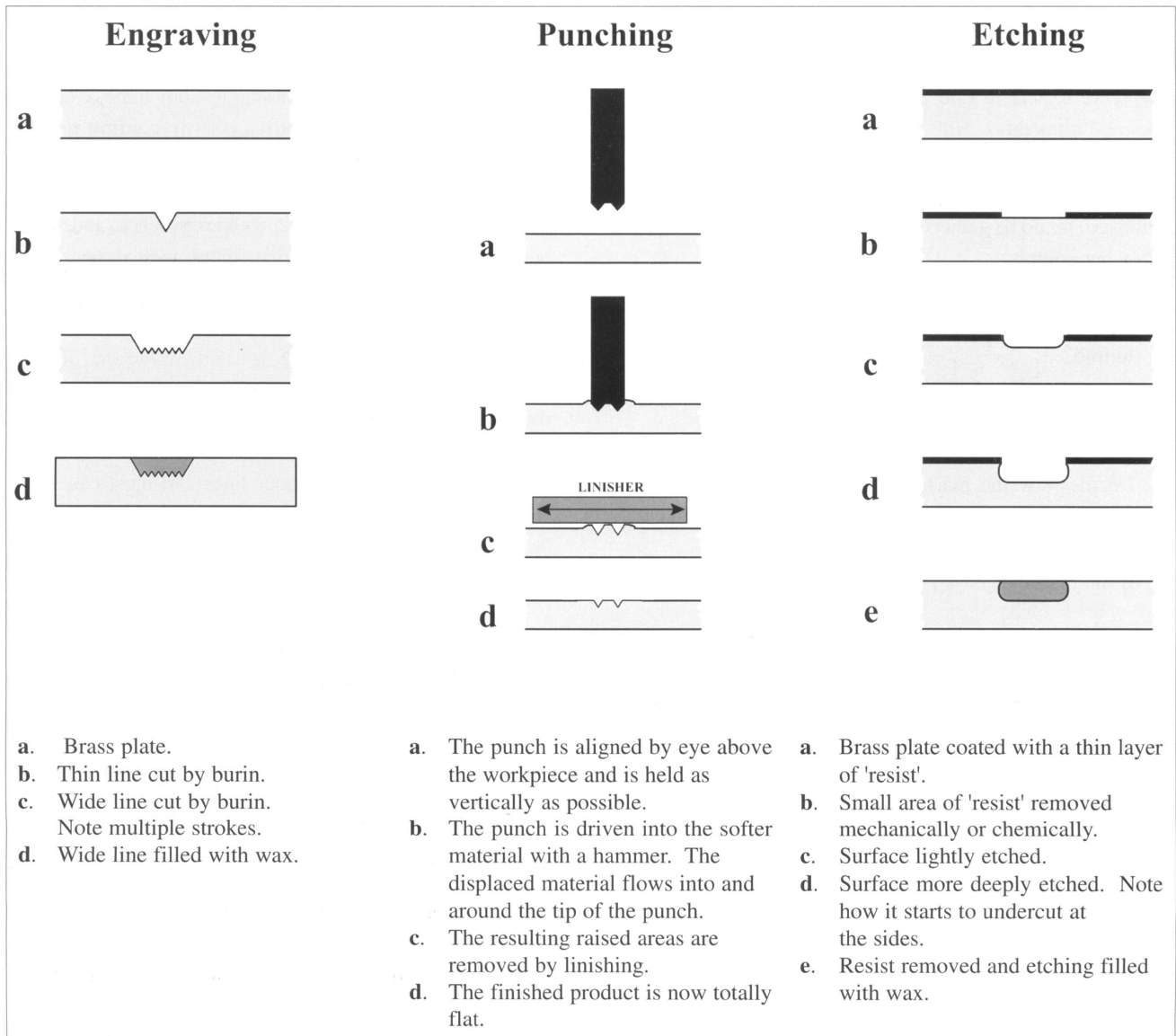


Fig. 1 Three Common Methods of cutting Lines and Numerals into a Dial Plate.



Comparison between engraved, (a & b), and punched characters, (c). Engraving is a skilled process where the characters are formed with an engraving tool or burin. It is a form of handwriting and, as such, slight variations will occur between characters. Look in particular for differences between similar characters.

- a. Note how the **s** and **t** of each word are slightly different.
- b. Note the letters **E**, **S**, and **T** are slightly different.
- c. Typical misalignment of punched characters.

Punch marking is done by hand and it is notoriously difficult to align the punches by eye. Look for identical characters with poor alignment. Note also depth variation and sometimes a heavier or lighter imprint on one side of a character due to the punch being slightly off vertical.

Fig. 2

A **Magnifying Glass** or even a microscope will be an asset for examining the markings to decide if they were applied by engraving, punching, etching or casting: Figs. 1 & 2. If the markings have been filled with wax this may hide some of the evidence. However, it is very difficult to etch both wide and narrow lines on the same plate. To get the depth necessary for etching, say, the wide part of a Roman hour numeral, the plate would need a long time in the acid bath and narrow lines would inevitably become wider than ideal.

A **Camera**, particularly a digital one, with a macro lens is useful to record what you have found. The picture can then be used for later analysis or can be sent to someone for a further opinion.

A **Computer** is also an asset for storing the digital images but particularly for rectifying images that may have been taken from an oblique angle: Fig. 3. Several photo-handling programs will do this but I have done this with Paint Shop Pro.

MOTTOES

One of the commonest features of a fake dial is the addition of a motto. If you see a motto such as '**TEMPUS FUGIT**' or '**I Only Count Ye Sunny Hours**', then look carefully at other features. The word '**Ye**' in particular is probably there to make you think that it is an old dial. In practice, very few early dials had mottoes, perhaps less than 10%. Those that did would normally have been made for a local dignitary with his family motto and his crest. Few dials were dated, so a date should also be treated with suspicion. On the other hand, a signature on a dial is fairly common. Many London dialmakers signed their products and usually added the word 'London'.

ERRORS

Mistakes are interesting but do not necessarily indicate that the dial is a fake or its maker incompetent. Some of the best makers are known to have made mistakes. Consider the case of an engraver who may have spent hours or even days working on a dial and finds that he has missed a letter or placed a numeral against a wrong line. Will he scrap the dial and start again? Almost certainly, he will not. He may try to rectify the mistake by perhaps hammering the plate from the back to raise the area of the mistake before stoning it out and re-engraving. He may just put the missing letter above or squeeze it between other characters: Fig. 4. Mistakes in delineation are more serious. Sometimes such a dial would be abandoned or it may have been turned over and started again. Material was very expensive and somehow he would try to re-use it. Sometimes it seems that the mistakes have gone unnoticed. The Butterfield dial in Fig. 5. shows some horrendous errors.

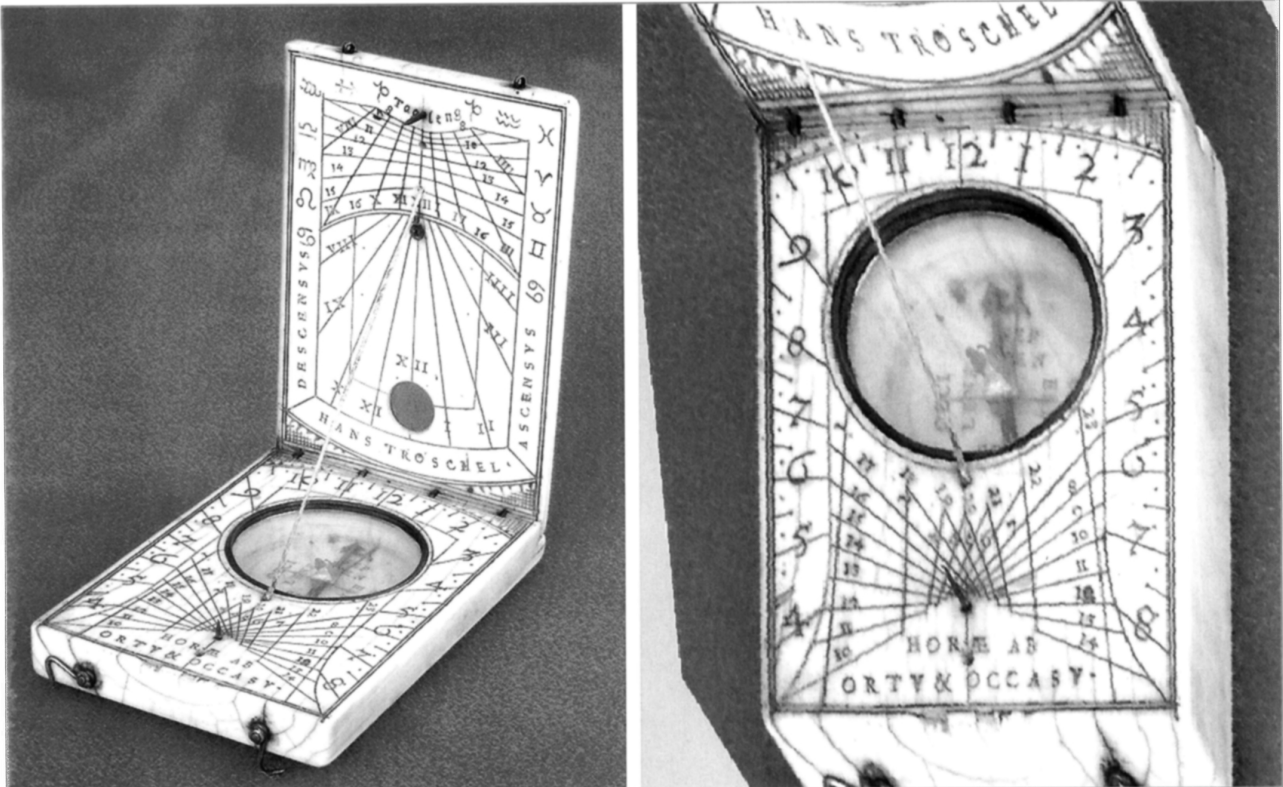


Fig. 3. Use of computer software to 'rectify' an oblique image. From the rectified image angular measurements are then possible. The 9 - 12 - 3 lines can now be measured as 36° and 37°. By taking the average, 36.5°, and using the formula the calculated latitude is 47.7°. For a Nuremburg dial the expected latitude is 48°.



Fig. 4. An engraving error from a silver Perpetual Calendar. the R was missed in the word **PE^RPETUUM** and has been fitted in later.

DIAL PRODUCTION METHODS

Punch marking is relatively uncommon for garden dials but was frequently used for portable dials². It was often a quick way to number the scales: Fig. 6. Certain materials could not be satisfactorily engraved, particularly ivory and wood. A character with a small enclosed area such as o, a, e, 4 or 8 would be almost impossible on these materials as the fibres would be cut by the engraving tool and the small centre would probably flake out. If the characters were punch marked the fibres would merely be crushed but most would stay intact. The only ivory dial that I know that was engraved has Roman numerals thereby avoiding any small-enclosed areas.

Etched dials can often be detected if the wax is removed from a character such as a Roman numeral. The bottom of the numeral will be flat and have a matt or granular finish whereas an engraved character will be made with a series of lines from repeated strokes of the engraver's tool.

Casting is a technique used mostly for mass production and is common on the sort of dials now sold in garden centres. These are relatively easy to spot and, as we know, very few are correctly delineated, at least for UK latitudes. Some even have curved gnomons - perhaps to make certain that at least some part of the shadow falls in the correct position! When dials are cast this process normally leaves a rough sandy finish. To remove this the dial will be polished on a buffing wheel. This usually removes edges producing rounded corners on the dial plate, the gnomon and even the edges of the numerals.

Methods of fixing the gnomon seldom tell us much. Most gnomons were held from the underside by two screws, some were riveted in position and occasionally held by cross pinning. However, the gnomon on Fig. 7. from a garden centre, is held by a screw from the top! This would not deter vandals for many seconds. Furthermore note the error in marking where **VII** and **VI** have been transposed. Perhaps in this case it deserves to be vandalised?

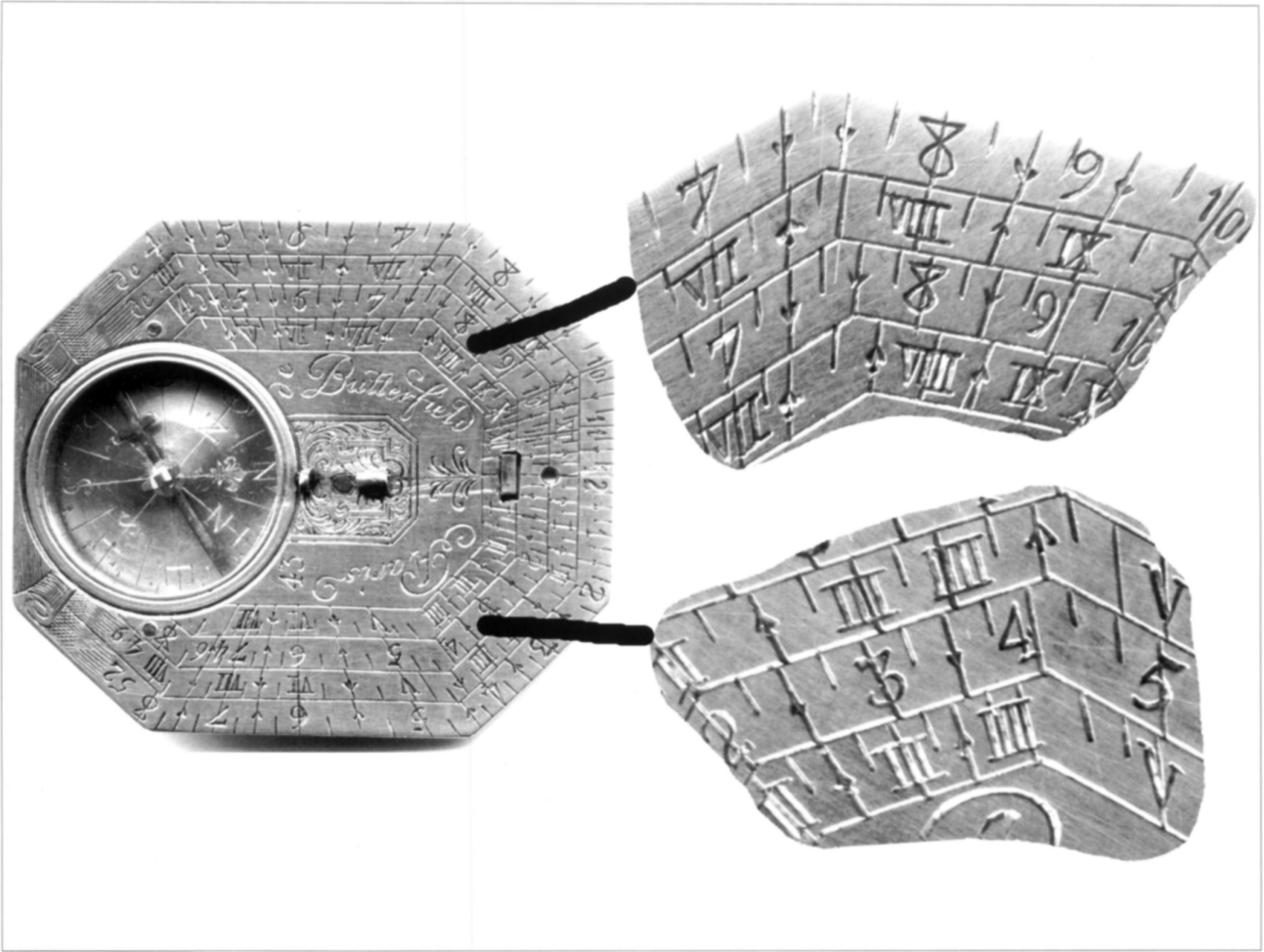


Fig. 5. Mistakes on silver Butterfield dial. In the two regions shown the maker has mistakenly marked an odd number of 'quarters' between certain hours. In truth he has got completely mixed up. This dial was originally thought to be a 'contemporary copy' due to its relatively poor engraving. (Makers would often sign their work with Butterfield's signature to take advantage of his reputation). More recent research has revealed a number of similar style dials, although without these mistakes, so it is possible that the Butterfield workshop was making these as a 'budget line'.



Fig.6. Punch marking from two parts of a brass Nocturnal. Note that the same punches were used for both inscriptions. In particular, note how the enclosed part of the A is filled in, probably due to a clogged punch.

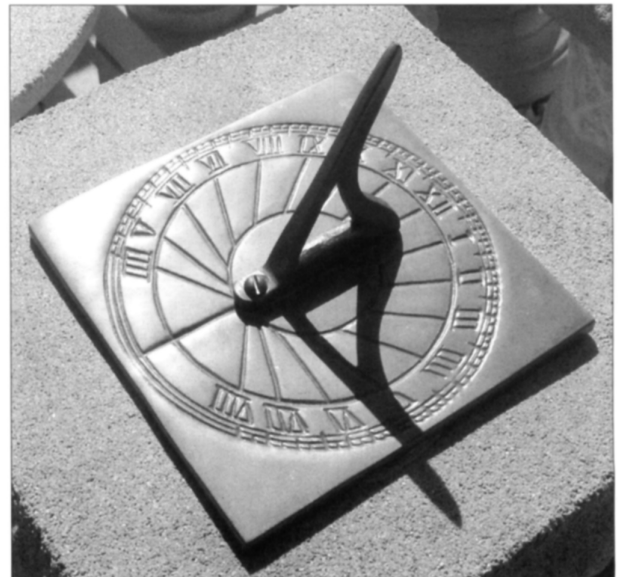


Fig. 7. Modern Dial seen in a local garden centre. Its gnomon is held on by one weak screw. Notice also the error of the transposition of numbers VI and VII.

SUMMARY

The various notes given in this article should help you to determine if a dial may be a imitation; but against all odds, that dial that you now think to be suspect may just be correct. Only experience can give you the confidence to boldly proclaim 'a fake'. Take the opportunity to examine as many dials as possible, perhaps visiting major auction rooms where you will be able to handle the objects. Finally, remember that even experts can sometimes get it sadly wrong.

FURTHER READING

Peter de Clercq, (ed): Proceedings 'Scientific Instruments: Originals & Imitations'. Museum Boerhaave, 1999.

This symposium was held at the Museum Boerhaave, Leiden, 15 - 16 October 1999. The Proceedings have

several interesting papers, particularly that from Ref. 1 below.

REFERENCES

1. G. L'E. Turner: *An Inquiry into the Imitation of Scientific Instruments*. Proc. Sci. Inst's: Originals & Imitations. Mus. Boerhaave, Leiden. 48-60 (1999).
2. M. Cowham: 'Punch Marking of Scientific Instruments' *Bull.SIS*. **73**, 27-30 (2002).

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THE ORIGIN OF SINE, COSINE AND TANGENT

ALLAN MILLS

Based on a talk given at the BSS Annual Conference, Yarnfield. 25-27 April 2003

THE BEGINNING OF TRIGONOMETRY

Trigonometry is the application of triangles, and at its simplest is concerned with right-angled triangles drawn on a flat surface. It is generally thought to have an origin in ancient Egypt, where the annual inundation of the Nile laid down a life-giving deposit of fertile mud but at the same time obliterated field boundaries. A number of skilled civil servants - surveyors or 'rope stretchers' - were therefore required to redefine these lines.

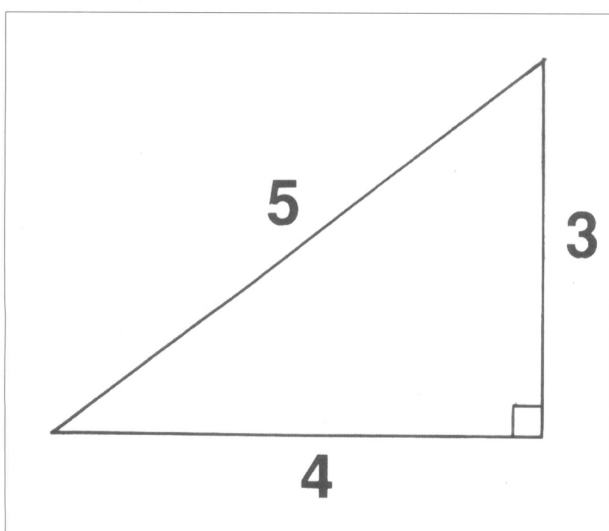


Fig. 1

Both the name and hieroglyphic records indicate that these surveyors were familiar with the fact that a triangle with sides of 3, 4 and 5 units enclosed a right angle: (Fig 1.)

They knew that the units could be measured in any system provided it was used throughout, so the relationship applied to triangles of any size. However, they do not appear to have concerned themselves as to why a 3,4,5 triangle worked, or to have actively sought other rules and applications. Ancient Egypt was a very conservative, traditional culture.

THE GREEKS

In his textbook, Pythagoras generalised the 3,4,5 triangle by the theorem:

'In any right-angled triangle, the square on the longest side (the 'hypotenuse' - opposite the right angle) is equal to the sum of the squares on the other two sides.'

Pythagoras did not claim to have discovered this rule, but even compiling a textbook is indicative of a very different attitude to that displayed by the Egyptians. The Greeks not only wanted knowledge but also sought reasons, and wondered if an accomplishment in one field could be extended to another.

Their major application of trigonometry was to astronomy, but Greek mathematics was rooted in geometry,

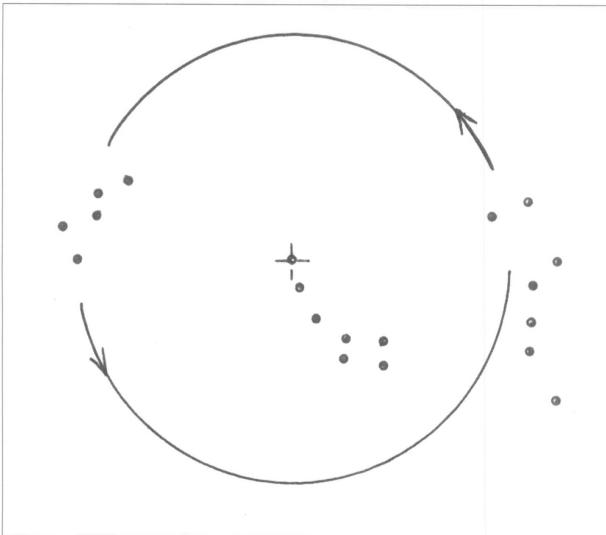


Fig. 2

particularly that of the circle. Perhaps this began when, in the northern hemisphere, those who watched the night sky looked north and saw the constellations circling in an anti-clockwise direction around the celestial pole. This means that the right-hand side rises: (Fig 2.) Astronomers still use the term 'right ascension' as a coordinate in positional astronomy, as well as Latinised versions of the names the Greeks gave to the constellations.

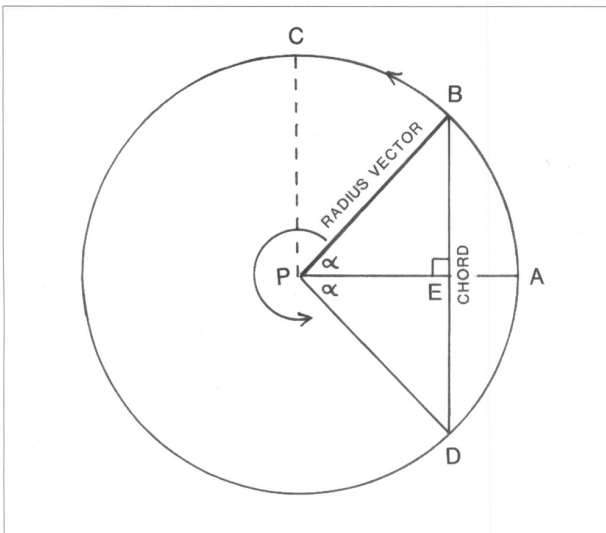


Fig. 3

Greek mathematicians (e.g. Hipparchus) imagined a circle to be generated by the anticlockwise motion of its radius about the centre P: (Fig. 3). A rightangled triangle BPE is generated by dropping a perpendicular from the end B of the radius vector to the 'horizon' PA, and its included angle may be labelled α . The '1ST quadrant' includes angles up to 90° , and we still use this area and its axes to present most graphs. However, rather than considering the right-angled

triangle BPE in isolation, Greek geometers preferred to extend the perpendicular BE to D as shown, the angle 2α then being subtended by the chord BD joining the ends of the 'double arc' BAD. Geometrical methods then enabled them to find 2α , and halving this gave α .

To us, this seems a clumsy procedure - but Ptolemy's *Almagest* proves the Greeks to have been quite successful with it. They were even able to extend it a little into the realm of spherical trigonometry, as required for problems involving the celestial sphere.

MUSLIM TRIGONOMETRY

The Arabs preserved Greek science and mathematics during the Dark Ages in Europe, but also added to it by:

- a) Utilising the vastly superior numeration involving zero and place value invented in north India. We still use these 'Arabic' numerals.
- b) Inventing algebra - the method of calculation whereby letters are substituted for unknown quantities. (The Greeks used letters of their alphabet for numerals so, it has been argued, had none left for an algebra!)

Al-Battani (Latin Albategnius) was a 10th century Governor of Syria resident in Damascus. Said to have been an Arab prince, he was certainly a mathematical genius, for he saw the advantages to be gained from simplifying Greek trigonometry by reducing it to the basic right-angled triangle, and then using algebra to formulate the relationships between angles and lengths of sides. His basic ideas are summarised by (Fig. 4)

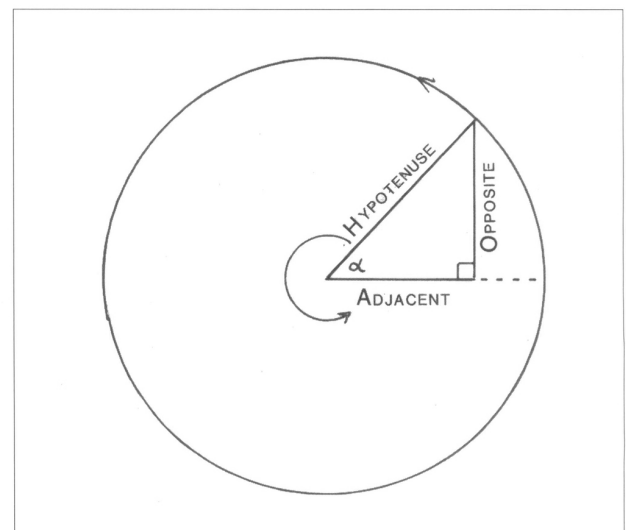


Fig. 4

At school, we were told that:

$$\text{sine } \alpha = \frac{O}{H}$$

$$\text{cosine } \alpha = \frac{A}{H}$$

$$\text{tangent } \alpha = \frac{O}{A}$$

The mnemonic SOHCAHTOA might be quoted to help remember them, with O=Opposite, H=Hypotenuse, and A=Adjacent. All are ratios, so are independent of the system used to measure the lengths of H, A and O. Knowing one angle and one side of any right-angled triangle, we could then calculate the other sides - provided we were issued with miraculous tables of sines, cosines and tangents.

And this is about all one did get: it was (and is) a very rare school that informed pupils where these strange terms came from. In fact, they prove to be a mixture of redundant Greek geometry and mistranslated Arabic.

THE TANGENT

It is convenient to begin with the 'tangent'. We have already seen that $\tan \alpha = O/A$, but this does not include the important radius vector H, which the Greek geometers liked to designate as of unit length. Fig. 5. below shows how, by extending the generating radius beyond the circle and dropping a tangent to the baseline, we obtain a similar triangle where:

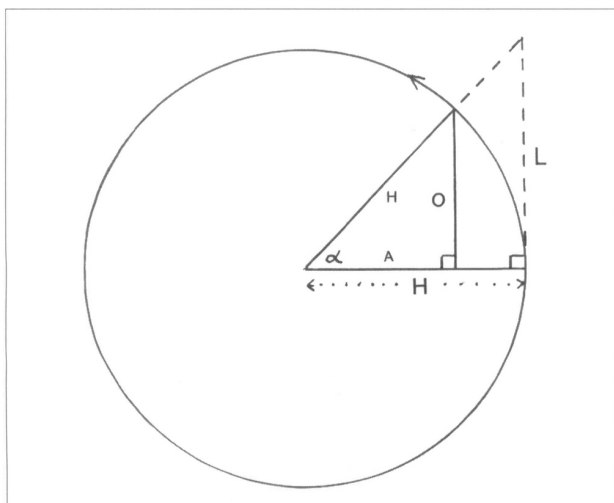


Fig. 5

$$\text{Tangent} = \frac{O}{A} = \frac{L}{H} = \frac{\text{Intercept on the tangent}}{\text{Radius vector}}$$

When radius = 1, this simply becomes:

$$\text{Tan } \alpha = \text{intercept on the tangent}$$

Our term 'tangent' (later 'tan') had its origin in this tangent ratio, which readily translated to *tangentus* in Latin.

A MEDIEVAL ALTERNATIVE: THE 'SHADOW' OR 'UMBRA'

In general, the tangent of an angle is most commonly used for the calculation of height.

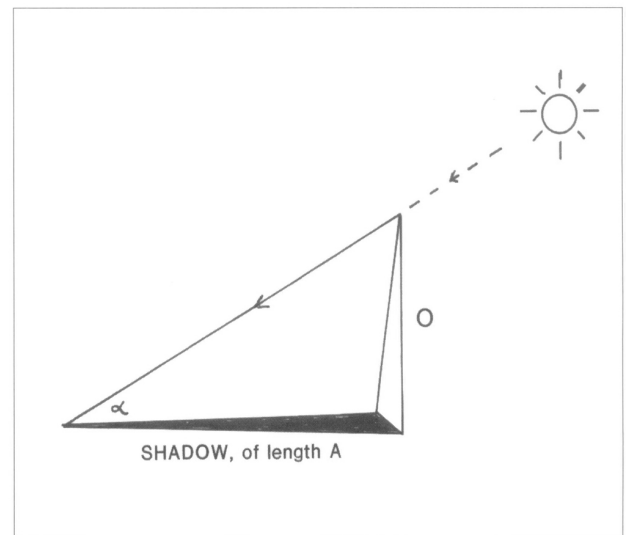


Fig. 6

The principle is made clear by considering the shadow of a tower thrown by the sun Fig. 6.

Without invoking any formal knowledge of trigonometry, it is easy to see that the ratio of the height of the tower O to the length of its shadow A is related to the angle of elevation α by:

$$\text{'Shadow' or 'umbra' of } \alpha = \frac{O}{A}$$

so that:

height O = shadow length multiplied by 'shadow angle' of α .

A table of shadow angles, or a scale for giving them directly, may frequently be found on the backs of astrolabes, for one function of this instrument was to measure angles of elevation. The length of the shadow (i.e. distance from observer to base of tower) could simply be paced out or, more accurately, measured with rods.

THE SINE

We say $\text{sine } \alpha = O/H$. This definition already incorporates the length H of the radius vector, so if $H = 1$ then $\text{sine } \alpha$ is automatically proportional to the half-chord O in the diagrams above. Al-Battani called this half-chord the *jiba* in Arabic. It is purely a technical term, probably derived from the Hindu *jiva*. So, students of Al-Battani would use a table of 'jibas'. He also described and reproduced these quantities in a textbook, but the snag is that early Arabic (like Hebrew and other Middle Eastern scripts) did not include the vowels. Early writing was to aid the memory of a privileged group of scribes, and they were expected to recognise the words! Therefore *jiba* was written simply as *jb*. (Transliterated into Roman letters.)

Later, at the Renaissance, translations of Arabic treatises were made, particularly in Spain. This was because the southern part of this country was for a long period under Arab rule, so had many citizens knowledgeable in both Arabic and European languages. Leading translators of mathematical material were Gerard of Cremona and Robert of Chester. (These locations indicate where they came from: both worked in Toledo.)

They had no difficulty with tangent ratio, but the vowel deficient *jb* was an out-of-context technical term unfamiliar even to an educated person. The best the locals could do was to identify it with *jaib*, which meant either:

- a) The opening of a garment at the neck
- or, b) A bay or inlet with a narrow entrance, i.e.:

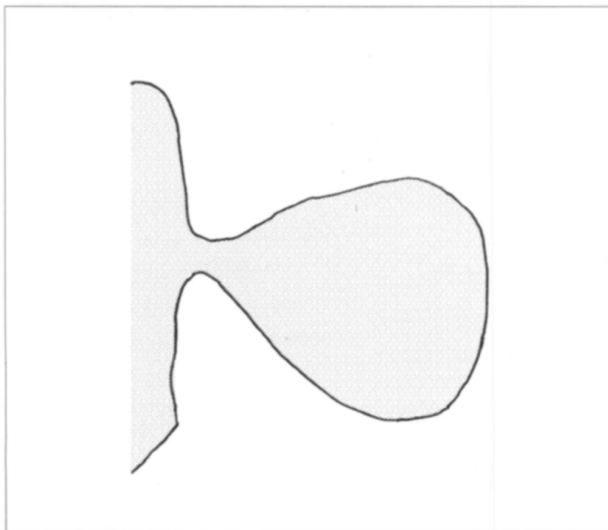


Fig. 7

In Latin, the latter is a sinus, as in Sinus iridum on the Moon. (Fig. 8.)

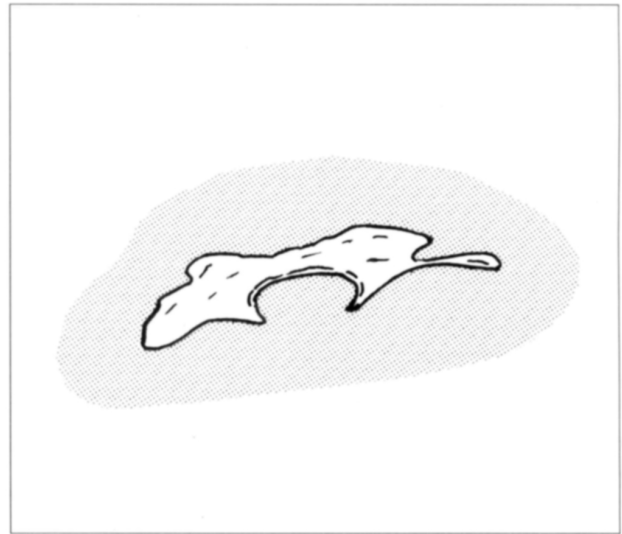


Fig. 8

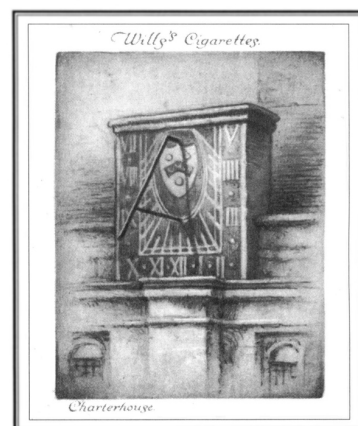
The sinus cavities near the nose in the human skull have similar restricted entrances. The translators therefore rendered *jb* as sinus, and soon we find a progression of new technical terms:

Sinus ▶ sine ▶ sin

The cosine is simply the complementary ratio A/H .

Robert of Chester returned to his home monastery of Chester in AD 1150. None of his works have survived (he lost the lot in his baggage) but he is commemorated for all time in this glorious mis-translation!

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THE ANCIENT ATHENIAN SCULPTURED CALENDAR

E. THEODOSSIOU & V.N. MANIMANIS

ABSTRACT

A small Byzantine temple of the 8th Century, St. Eleftherios, is located to the south of the temple of the Annunciation of Virgin Mary, the present Cathedral of Athens and initially it served as the Cathedral of the city. This quite small but excellent church, probably a gift of Byzantine Empress Irene the Athenian to her native city, was built by re-using building material from ancient Athenian monuments. On the west side of this small church, above the main entrance, there is in the wall a frieze of marble with a symbolic depiction of the formal festivals of Attica. This frieze is only sculptured illustrated calendar that is preserved from the ancient Athens and indeed from ancient Greece in general.

1. THE CHURCH OF ST. ELEFThERIOS

The Temple of St. Eleftherios, or 'the Small Cathedral', or 'Panagia Gorgoepecoos' (St. Mary the Immediate Listener), is probably the most elaborate small Byzantine church of Athens. It is located in the Metropoleos (Cathedral) Square, next to the south side of the Athens Cathedral, which is dedicated to the Annunciation of the Virgin Mary.

The Temple of St. Eleftherios was built in the late 8th Century A.D. with large blocks of marble, carved in Antiquity, and sculptured pieces of ancient monuments. It is considered to be an offering by Empress Irene the Athenian (775-802) to her native city, and it was erected upon the ruins of an ancient temple dedicated to Eileithyia (Figure 1). Other researchers date it in the 12th Century.

The temple's stones have been taken from ancient buildings and monuments of various periods of ancient Athenian history. Within this ancient material there are several pieces bearing reliefs carved on the marble, both depictive and decorative. Their incorporation in the small Byzantine temple somehow rescued them, since they did not end up in a limekiln to be turned into lime. Instead, St. Eleftherios preserves in both its architectural elements (gables, pediments) and its wall structure (epistyles, friezes and pectorals) the classical Athenian sensibility.

As a construction, the church is four-column in its center, inscribed in a cross-like shape and with a tripartite church-porch whose central part is vaulted and higher than the two side parts. The whole wall structure is constructed with marble pieces of ancient Greek, Hellenistic, Roman and

proto-Byzantine monuments; no brick structure is discernible in any part, except the wall structure of the dome. Archaeological research has shown that the relief sculptures, 90 in total, have been placed in the upper part of the walls, creating a unique decoration for a Byzantine church.

Almost nothing is known about the history of the temple during its first nine centuries. In the 17th Century it is mentioned as a part of the residential complex of the Bishop of Athens. In 1833 the four columns supporting the dome were substituted for four small cubic columns, and in 1841 it sheltered for a while the public library of Athens. It was dedicated to St. Eleftherios in 1863. In 1864, in the same area next to St. Eleftherios, a large church, the new Athens Cathedral, was built and dedicated to the Annunciation of the Virgin Mary (Figure 2).

St. Eleftherios, this small Byzantine temple, differs from the other Byzantine churches of Athens in that it was not constructed in the usual manner with stone or brick walls. It can be said that it forms a set of sculpture samples, or a small outdoor museum of ancient sculptures, presenting many types of sculptures placed in a certain sequence and symmetrical order. Friezes, gables, cornices, epistyles, pectorals, sepulchral columns with relief figures, crosses etc., with originally dissimilar and unmatched surfaces, were fitted nevertheless by the unknown classicist architect who constructed the temple in a harmonic way, so that the church gained in grace and elegance.

2. THE ANCIENT GREEK CALENDARS

In ancient Greece there was no common calendar; each city-state or region had its own calendar, which in general did not agree with the others, therefore the festivals of the ancient Greeks also did not agree.

The most notable and detailed calendar was the ancient luni-solar Athenian or Attic calendar, according to which the year began on the first New Moon after the summer solstice¹.

The month began on the day when the moon would first show after conjunction. Since the classical period, the months began at the phase of the New Moon. The Athenian calendar had a year of 354 days, which was divided into 12 lunar months of 29.5 days each on the average.



Fig. 1 Engraving of the temple of St. Eleftherios in Athens

Since each month should have an integer number of days, the months were 30 and 29 days long, alternatively ('full' months and 'hollow' months). Thus the sum of the days in 12 consecutive months was 354. That is, the Attic calendar was a luni-solar one of 12 months of alternately 29 or 30 days and an intercalary month (13th month) with a period of 29 or 30 days (the month Poseideon II). When the intercalary month was used, it always fell after the sixth month, Poseideon I.

The names of the 12 months forming the civil year of ancient Athenians and their approximate correspondence with the periods of the modern Gregorian calendar are given in the following Table.

The names of these months were directly associated with corresponding festivals in honor of Greek deities which were being celebrated in them.

The year began at the summer solstice, which fell around July 2 at the inception of the calendar in 776 B.C. The Olympic Games – a festival of great interest since we have again in Athens the Olympic Games of 2004 – were always held on the eleventh through the fifteenth day after the New Moon following the summer solstice².

Name	Duration (days)	Respective Gregorian month
1. Hecatombaeon	30	July / August
2. Metageitnion	29	August / September
3. Boedromion	30	September / October
4. Pyanepsion	29	October / November
5. Maemacterion	30	November / December
6. Poseideon	29	December / January
7. Gamelion	30	January / February
8. Anthesterion	29	February / March
9. Elaphebolion	30	March / April
10. Munychion	29	April / May
11. Thargelion	30	May / June
12. Scirophorion	29	June / July

Table 1: The 12 months of the ancient Athenian calendar

3. THE CARVED ANCIENT ATHENIAN CALENDAR

Due to a felicitous circumstance, a depiction of this ancient Athenian calendar was preserved immured as the western frieze of the Byzantine church of St. Eleftherios, in Athens. It is not known from which ancient building of Athens this carved calendar was detached in order to be incorporated in the Christian temple. It dates most probably from the 4th Century B.C., though some archaeologists consider it a work of the 2nd or 1st Century B.C.



Fig 2. the Athens Cathedral dedicated to the Annunciation of Virgin Mary and side by side the small church of St. Eleftherios



Fig 3. The second part of the sculptured calendar, actually the first, is starting with the figure of the month Pyanepsion and zodiacal symbol of Scorpius

This exquisite sculptured calendar, bearing astronomical representations and zodiacal symbols, is a priceless monument by itself. Essentially it consists of two pieces of white marble with a total length of approximately 6 m and a height of 0.40 m. It appears that the architect of the temple, wished to place it at the front of the building just above the entrance. The entrance of the Greek Orthodox churches is usually on the western side of the building, because the sanctuary, if possible, must be towards the east). So he was forced to shorten it by cutting some parts of it, since the western side of this small church is about 5 meters. Another mistake he made, as he ignored the ancient Athenian months and calendar, and thus the true meaning of the figures depicted on his frieze, was that he placed its two pieces – each of 2.40 m of length – in the wrong order, the second one in the place of the first (Figure 3). Moreover, in order to render it more suitable for a Christian temple, Byzantine carvers inserted three crosses, visible in circles in the engraving of Figure 1.

In total, the carved calendar is divided into 12 parts, as many as the Athenian (Attic) months. Each part starts with a personified figure of a month and ends with the corresponding zodiacal symbol. Thus the calendar starts with the figure of the month Pyanepsion and the symbol of Scorpius (Figure 4). Between two successive parts there are depictions of the agricultural occupations, such as the pressing of grapes, the ploughing and the seeding, or of the month's festivals, e.g. the Panathenaea. In addition, in front of the months are also depicted the personified figures of the seasons of the year.

This work of art is considered unique, since up to now nothing similar has been found from Classic or Hellenistic Greece. It is most important in that it conveys for astronomers and archaeologists a lot of information on the ancient Greek calendars. Several archaeologists and researchers, such as the late Prof. I. Svoronos (1863-1922), director of the Numismatic Museum of Athens, divide this functional calendar into five seasons: *Metoporon* (meaning 'after the fruits') with only one month (Pyanepsion), *Winter*, *Spring* and *Summer*, each having three months, and finally *Autumn* with two months (Metageitnion and Boedromion). These five seasons were denoted with five relief figures, each of which shows or hints to the character of the respective season. Unfortunately, the figure of the spring

was destroyed, most probably during the shortening of the artwork in order to be inserted in the front of the temple.

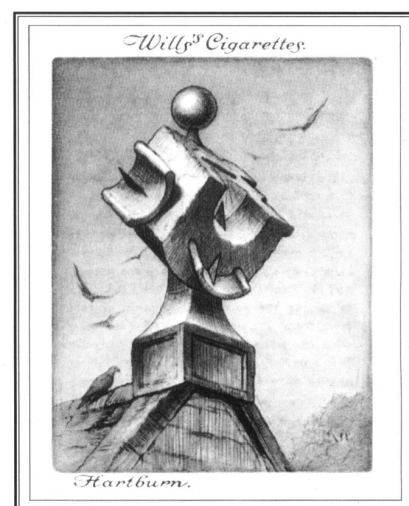
We mentioned that the carved calendar actually starts with the month Pyanepsion (October / November), which is strange since the first month of the Athenian calendar was Hecatombaeon (July / August), as in Table 1, while Pyanepsion is the fourth month. This is an interesting fact for the astronomers, since we know that Pyanepsion's period (late Autumn) was the first month of the year, although under a different name, in other regions of the Greek world, such as in Macedonia, where the year began on the first New Moon after the autumnal equinox, the first month being known as Dios, the Macedonian counterpart of Pyanepsion. Most archaeologists attribute this to the fact that in ancient Athens this frieze of marble was decorating a sanctuary whose worship was associated with (or it was donated by) Greek regions (Rhodes, Macedonia, Achaic Confederation) whose luni-solar calendar had Pyanepsion as its first month.

REFERENCES

1. Theodossiou, E & Danezis, E: *The Odyssey of the Calendars, vol. I: Searching the roots of Knowledge*. Diavlos Publ., Athens 1996, (in Greek), pp. 315-374.
2. Parise, F. (Editor): *The Book of Calendars. Facts on File, New York, 1982*, p. 55.

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NOTES FROM THE EDITOR

Awards for Sundials

One function of the British Sundial Society is the encouragement of the design and construction of new sundials. The Society's five-yearly Awards Scheme is one way in which this objective is carried out. The Awards currently on offer (see flyer inserted in with this Bulletin) are for dials made and in place from January 2000 onwards. Many dials, both in private houses and in public places, were put up to celebrate the millennium, in the years 2000 and 2001. Do you know of one, in your village or town or on your local school or church hall? Do you admire it? Do you know who designed it? If so, encourage the designer to apply for a BSS Award. There is plenty of scope, because separate awards are given for professionals and amateurs; and another award for a sundial restoration, a task sometimes just as difficult as making a new dial. (There is also a junior award, for a sundial by a young applicant: encouragement for the next generation of gnomonists). The judges of the current quinquennial scheme are hoping for a large number of entries. Then (lucky fellows) they will have fun travelling all over the country looking at new and beautiful sundials: down your way, perhaps?

Foreign Journals

Free copies of each issue of the Bulletin of the BSS are sent out to the editors or secretaries of a number of overseas Sundial Societies. The Editor of the Bulletin would be pleased if such an arrangement were to be reciprocal; we would be happy to receive copies of the journals/newsletters/bulletins of Sundial Societies elsewhere in the world. Name and address of Editor, to which such copies may be sent, is on the inside back cover.

If copies of such foreign journals are received, the Bulletin may print an abstract or report from time to time; it may be of interest to British sundial enthusiasts to read news of sundialling activities from other parts of the globe. Currently we gratefully receive 'Compendium' from North America, 'Cadran Info' from France and a Periodical from Austria, (the Gnomonicae Societas Austriaca)

If copies of foreign journals are not received, the British Sundial Society will be forced to re-consider its free-copies distribution policy.

Listed below are 8 names-and-town-addresses to which free copies of the Bull.BSS are currently sent but from which, according to our records, nothing is received.

- (a) F.J.De Vries, 6541 Eindhoven ,
The Netherlands ('De Zonnewijzerkring')
- (b) H Vinck, P-9510 Rupelmonde,
Belgium ('Zonnetijdingen')
- (c) N.Severino, 03030 Roccasecca Staz,
Italy (U.I.A.Sez Quad Sol)
- (d) J.M.Vallhonrat, 08006 Barcelona,
Spain (Societat Catalana de Gnomonica)
- (e) M.L.Soto, 28040 Madrid, Spain
(Asociacion de Amigos de los Relojos de Sol)
- (f) Carracedo,28036 Madrid, Spain
- (g) K.Eicholz D-44797 Bochum, Germany
(Deuts Gesell Chron Arbeit Sonnenuhr)
- (h) A.Zenkert, D-14467 Potsdam, Germany
(Arbeit. Geschichte der Astron. Serk.Gen.)

MORVAH CHURCH DIAL: A CLOSER LOOK

LEN BURGE

There is a slate sundial on the porch of the church at Morvah, a village on the north coast of Cornwall some 10 miles from Land's End; and this dial was recorded and photographed in 1991 for inclusion in my 'Cornish Church Sundials'. Fig. 1 gives an extract from the page of the book relating to the Morvah Dial. (The 'bearings' give the direction of the plane surface, from 0° = due east). A careful rubbing taken from this dial has now made it possible to consider the design in some detail and to draw conclusions from what was found. On many dials the time-keeping performance, after due allowances are made, will tell you whether or no the dial has been properly designed, made and erected. This dial, having sustained general damage and the particular loss of its gnomon, had no chance of proving itself against the clock, and therefore called for a different kind of investigation.

The dial is obviously Direct South in design: its top line has 'six' at either end, and the evident symmetry of the whole design is still apparent, in spite of the damage and the hazards of reconstruction. As placed, the plate faces some five degrees east of south, but for Cornwall this is not a significant deviation from what a remedial 'wedge' attempts to achieve (see Figure 7.12 in *Cornish Church Sundials* for the varying success the county's D.S.dials have in trying to face south). It was obviously not designed as a declining dial.

The actual pattern of hour-lines carved on the dial, as far as these could be discerned, has been traced on to a diagram (Fig.2). Alongside these 'full' lines, true positions for the hours have been added, drawn dotted. When the two sets of lines, actual and ideal, are compared, the original layout of the dial seems to have been somewhat in error. The facts of

d ref:	14020354
Location:	porch
Latitude:	50.162
Longitude:	5.638
Visited:	13/10/92
At(GMT):	-
Revisit:	-
Photos:	170 10/92 6-7
Plate material:	slate
Plate size:	-
Dial type:	vertical s
Wall bearing:	109
Plate bearing:	85
Equation of time:	-
Time by dial:	-
Fast/slow (min):	-
Roman four:	IV
Nodus distance:	-
Gnomon length:	-
Gnomon bearing:	-
Gnomon w. gap:	?
Gnomon material:	(-)
Substile at:	-
Hours shown:	VI-VI
Calc. L.A.T:	-
Calc. Substile:	-
Scales divs. (min):	15
Maker:	-
Date:	1828
Other furniture:	-
Motto:	UT UMBRA SIC VITA
Other inscription:	-
Decoration:	Hearts on half-hours. Fizzy half-sun in break- arch.
Remarks:	Hour lines are extentions of sunrays. Dial fell down within memory and was repaired. Gnomon was lost later. Is the date on the masonry that of the dial? What are oblique rusty fixings on the face?

Fig 1. Extract from 'Cornish church sundials'

the layout and their implications may be summarised in a table, (Table 1).

In the first three columns, figures calculated for the times a.m. might be taken further, down past noon into times p.m.; but later figures would do no more than mirror the morning particulars, symmetry about noon being normal

Hour as named on dial	Hour Angle from noon, HA	Correct Plotting Angle PA	Plotting Angle Used on the dial PAU	Hour Angle Implied HAI	Implied Time	Dial Fast/ slow (min)
VII	75	67.3	70.5	77.2	6:52am	+08
VIII	60	50.0	53.0	64.2	7:43am	+17
IX	45	32.6	37.9	50.4	8:38am	+22
X	30	20.3	24.0	34.8	9:41am	+19
XI	15	9.7	11.9	18.2	10:47am	+13

Table 1

for a direct south dial. The remaining four columns compare the actual hour-lines with ideal ones and show how far the design will have contributed to good timekeeping. It does not seem fair in view of the damage on the right-hand side of the dial to continue the analysis into the afternoon, though the diagram does show for the whole day the two versions of the hour lines.

The first three columns are steps in calculating the correct 'plotting angles' (PA) for drawing the hour-lines for a dial at Morvah, column three listing these (as ready for a dial-maker to set out). The procedure, say for the hour of VII, would be to subtract seven from twelve to get the 'distance' from noon, five hours, then multiply this time interval by fifteen to get an 'hour-angle from noon' of seventy-five degrees. We know the local latitude, and now that we have found the hour-angle the required PA can be calculated, the classic formula being $PA = \tan^{-1}(\sin LAT \times \tan HA)$.



Fig 3. The Morvah dial; (photo 1991)

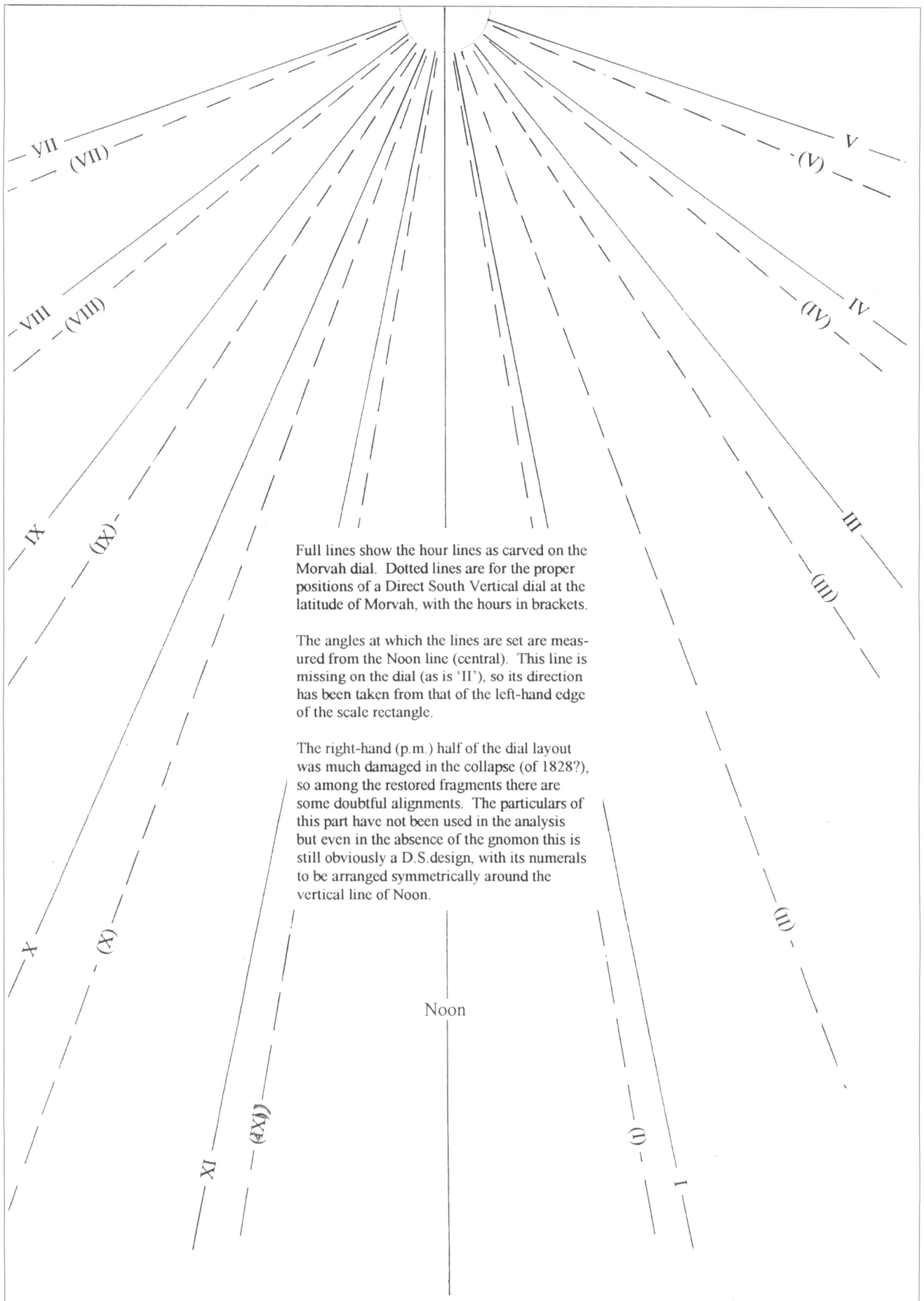


Fig 2. Diagram showing hour lines on a dial, and correct line for a direct south dial

This comes out at 67.3 degrees, and the dotted line for hour VII is to be drawn at that angle to the vertical noon line. A similar calculation is made for the other numbers before noon. For the hours after noon similar lines would run in the reverse order (the design being symmetrical left-right). The remaining four columns examine the dial to see how far its design agrees with the theoretical design. It turns out that the plotting angles of the hour-lines engraved on the dial (the measurements listed under Plotting Angles Used) do not, for any time of day, agree with the calculated angles PA. If we are to trust our calculations, the PAU lines (drawn full on the diagram) are not truly representing the hours whose names they bear. If the engraved lines are not truly marking the hours, what times are they standing for?

To try and see what is going on, the formula above is rearranged to show HAI, the hour-angle implied. This will tell us what would have been the true time of day when the dial was pointing to some indicated hour (VII, etc.). Take the line for hour 'VII'. We have LAT, and the plotting angle used, PAU, has already been measured from the dial at 70.5 degrees. With the equation transformed and these values put in, the hour angle can be found by $HAI = \tan^{-1}(\tan PAU \div \sin LAT)$. The calculation yields an hour angle of 77.2 degrees. That hour angle in turn implies a time of 6:52 a.m. (got by turning the hour angle back into hours and subtracting that period of time from noon). So 6:52 is the true time when this dial says 7:00. The final column notes that the dial, in saying seven o'clock at 6:52, is performing eight minutes fast. This time difference has its equivalent on the diagram, represented by the gap between the two kinds of line, the full line and its dotted neighbour. The dial's fastness in the morning turns to slowness after noon, and although the tabulated figures do not extend to the afternoon they are used in the diagram to make an afternoon symmetrical with the morning.

One is bound to wonder whether such amounts 'fast' or 'slow' were noticed by observers in the dial's heyday. Mechanical clocks and watches were rare before the 19th century; moreover, the natural perturbations due to the Equation of Time would themselves introduce differences from Mean Time that might approach the size of the dial's personal errors.

There is another thing that we might look at in our attempt to understand the Morvah dial: the matter of Morvah's latitude. Already by the likely date of the dial, the latitude of Cornwall was established to within a small fraction of a degree, so poor sundialling cannot be blamed on the limitations of the accuracy to which the latitude of Morvah was known. However, the manner in which 'the latitude' was used seemed worth looking at.

The fertile formula that we used above: $PA = \tan^{-1}(\sin LAT \times \tan HA)$, belongs properly to the design of horizontal dials (garden type, on a pedestal), and it will serve for vertical dials only when the latitude (LAT) is replaced by the co-latitude (i.e. 90 degrees minus the latitude). Some textbooks (e.g. the well-known 'Sundials' by Waugh) would use the 'horizontal' formulation for 'vertical' use but with an added reminder to first subtract the latitude value from 90. It is interesting to speculate why the 'vertical' formula itself was not appropriately written, in the form $PA = \tan^{-1}(\sin COLAT \times \tan HA)$, i.e. not needing any adjustment to the meaning of LAT. Why, again, was the circumstance of a vertical dial in the northern hemisphere sometimes related in theory to that of a notional horizontal dial ninety degrees away on the other side of the equator? True, this invocation of the other hemisphere does contribute a reason for the hours on a vertical dial running anticlockwise, where a horizontal dial in the same place would be running clockwise.

Perhaps it is time to find just what latitude the Morvah dial was designed for. With another transformation of the plotting equation we can make the basic formula confess what latitude was implied in the calculation. It becomes $LATI = \sin^{-1}(\tan PAU \div \tan HA)$. Applied to each of our five morning hours in turn, the implied latitude comes out as follows:

The resulting implied latitude values are all very similar, averaging about 50.5, and allowing for the maker's error in setting-out, or mine in measuring, it is virtually certain that

Hour Mark	Hour Angle HA	Plotting Angle Used PAU	Latitude Implied LATI
VII	75	70.5	49.2
VIII	60	53.0	50.0
IX	45	37.9	51.1
x	30	24.0	50.1
XI	15	11.9	51.9

Table 2

the Morvah dial design used the latitude of Morvah (modern value 50.162 degrees). This may sound right but is of course wrong: our transformed expression should not be coming out with the implied latitude, but with Morvah's co-latitude. Whether this angle was used in calculation or in some drawing 'construction', the value used for Morvah should have been 90-50.162, i.e. 39.838 degrees. I must now own up to my devious proceedings in the calculation of the first table: in working out the proper angles for setting out the hour-lines (the angles listed as plotting angles in column three), I did in fact use the co-latitude where the formula called for LAT. I had long been aware of the convention of calling 'latitude' what is really the co-latitude, so my plotting-angles and the dotted lines drawn

from them are correct. It was quite a surprise to find that the Morvah dials design is proved to have got hold of the wrong end of the Latitude stick.

More than this, I was and am alarmed that the very first Cornish dial I have got round to interrogating in this respect - checking the propriety of its basic layout - proves to have been wrongly laid out, perhaps for the above reason: that the latitude was used in the design where the co-latitude was needed. How many more of the hundred or so dials which I have not checked for their plotting angles may similarly be wrong, perhaps because of that convention of

specifying 'latitude' in a formula that needed its 'complement'? Retirement from the study of Cornish Church Sundials suddenly seems a long way off!

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THE BENOY DIAL - PART 1

A O WOOD

W. Gordon Benoy, a member of the Society, who died about eighteen months ago, invented a dial which indicated time by means of a beam of light rather than by a shadow. In spite of its apparent simplicity, A.P. Herbert¹ did not know of any similar dials so it is possible that the 'New Optical Dial' (Fig. 1) was a British scientific first.

Through the generosity of Colin McVean I recently acquired a Benoy dial. It sits in my garden telling remarkably accurate 'by eye' time.

It must be said that one of the dial's outstanding features is its weight; in terms of lb/hr it is ranked pretty highly, for garden dials at least. This is because it is largely concrete; a concrete sphere in fact, sliced off to give support to a circular dial face in white plastic. What we must still call the gnomon, I suppose, consists of a glass cylinder filled with water which produces a 'focused' beam of sunlight. The apparent simplicity mentioned actually hides some points of technical detail which the inventor says took 'many years of experiment and development'²

Firstly the 'water' must contain anti-freeze, probably alcohol, to prevent winter-time disaster. One could, I suppose, take one's dial in for winter, especially as it is an equatorial which works only in summer months.

Secondly the fact that it is a summertime dial has led to its being marked in British Summer Time from 7 in the morning to 19 in the evening. Mr Benoy must have realised that G.M.T. was important to some people so the scale can rotate by one hour, and you can choose your own time zone.

Thirdly, the word 'focussed' describes a beautiful double cusp of light which strikes a low ridge of plastic just inboard of the numerals thereby terminating the beam in a small and effective 'sunburst'. There is a gap at noon making an effective marker (Fig. 2).

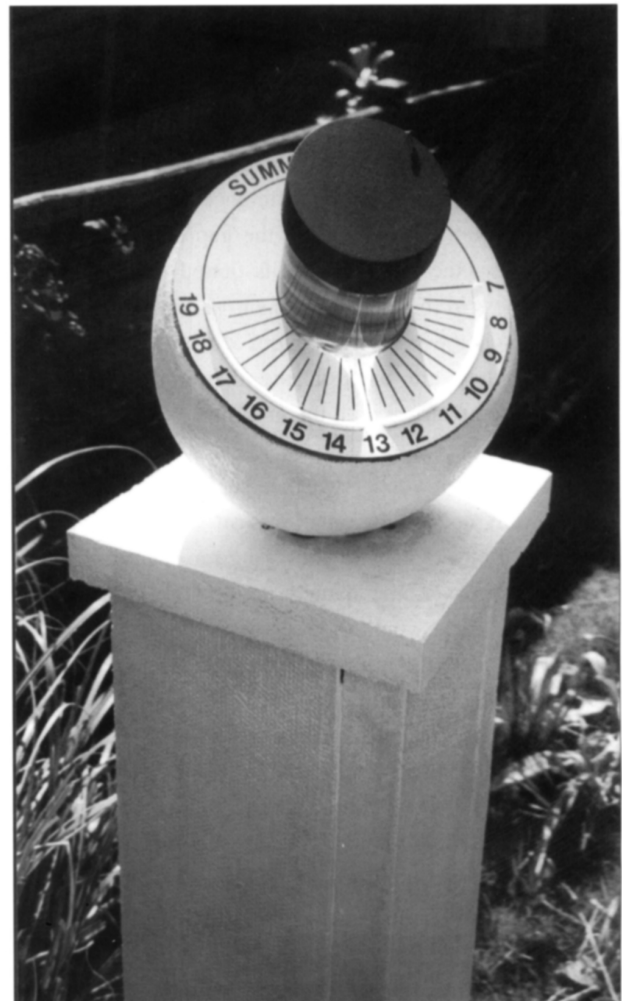


Fig 2.

THE NEW OPTICAL SUNDIAL

WHAT IS IT?

A sundial on which time is indicated by a clear pointer of light instead of a shadow.

WHAT WILL IT DO?

Tell the time when the sun is shining.

THROUGHOUT THE YEAR?

No. In summer only.

NEW?

The dial is the first of its type in the world.

BUT DON'T THEY ALL SAY THAT?

Maybe, but this time it is true. The shadow sundial goes back into antiquity — so it is time something was done about it.

In 1967, Sir Alan Herbert said in his book *Sundials, Old and New (or Fun with the Sun)* — "Some knowing amateur, when he is tired of the shadow, may stumble on some means of converting it, so to speak, to light."

It was the same A.P.H. whose enthusiasm sustained us through many years of experiment and development, and it was he also who came up with our name — SUNCLOCKS. "Britain," he said, "has long been a leader. Here maybe she can start a new hare in the heavens." A.P.H.'s milestone has now been reached. Would that he were here to join in the excitement.

Double Unit Sundial



Fig 1.

Mounting the great lump of concrete was achieved by four 36"x 8" paving slabs and screwed to wooden formers top and bottom. The concrete sphere has a hollow in the base and three 6" screws poke up inside to provide adjustment. SUNCLOCKS would sell you the 'double unit' mounting with two concrete spheres as shown on the leaflet.

These dials were produced in the 1980s; members may have come across them around the country. A quick Register search has found:

SRNo 4074 at Upton Hall, headquarters of the British Horological Institute near Newark in Nottinghamshire.

SRNo 3650 at the Manor House Museum, Bury St. Edmunds, Suffolk.

SRNo 2587 belonging to Anne Somerville in Cheshire.

SRNo 3295 at Carnfunnock Country Park, Antrim in Northern Ireland.

SRNo 3702 in the stable block yard, Longleat, Warminster, Wilts.

Benoy Dial, Part 2? – Watch this space.

References

1. Herbert A. P. *Sundials Old and New*, Methuen, London 1967
2. SUNCLOCKS 'New Optical Dial' leaflet. W. G. Benoy, Collingham, Notts.

Thanks to Patrick Powers for the Register search.

Author's address:
5 Lacey Court
Churchdown
Gloucester
GL3 1LA



Full Working Model - 60mm dia.

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READERS' LETTERS

THE 'BIOGRAPHICAL INDEX OF BRITISH SUNDIAL MAKERS'

I should like to take the opportunity to express my thanks to all who have been sending me information about sundial makers and useful sources for more material. I was hoping that the publication of the Biographical Index would produce this sort of help and I have not been disappointed. I hope others who can contribute will write or e-mail me with further details. I should also like to express my gratitude to the Gloucestershire County Library service that has gone to great lengths to find the books I've asked to borrow- even if it has sometimes taken months to find another library with a copy available, perhaps in far distant corners of the United Kingdom.

When it was suggested, some years ago, that I should attempt to produce a list of British sundial makers with, if possible, some biographical material if any could be found, the idea was that it would be a sort of companion to the Fixed Dial Register. In fact I started with just the Register, the Shire book on Sundials and very little more. The first thing I had to do was to assemble a list of names of known makers, as no such list then existed. After a while I had a list, some with known fixed dials to their credit, some dated, some found in sale catalogues of scientific instruments as having signed portable dials. At this point I found I had unwittingly extended my remit to cover all sorts of sundials. I began to pick up further information from books. It still surprises me that so many reference books do not mention sundials in their index. Also many specialist books on clockmakers, instrument makers and mathematicians fail to mention that particular individuals also made, designed or calculated sundials. As a result I've gone through the same books more than once to check on recently listed names.

For the early centuries in particular I had come across writers who were well versed in gnomonics and were clearly capable of calculating dials. Had they done so? Had some maker made a dial on their behalf or used their publications as a basis for their own dials? Again I found them sufficiently interesting in the history of dialmaking to add to my lists.

By this time the working title of the Index was 'Sundial Makers and Some Others.' Sundials seen in museums, listed in catalogues, and in photographs, photocopies and descriptions received from correspondents swelled the totals. Now when my County Library found me a book I had requested I could search the index for known names.

Often a tentatively listed name turned out to have signed a dial; and equally often a completely unsuspected clockmaker or instrument maker turned out to have supplied sundials. Now came a further question: if they supplied a dial had they made it?

There will never be an end to the search! Information only produces further questions. I found, when the time came to draw a line, that I'd included with the known and certain makers quite a few 'others.' All had been found of interest to me (and I hope to readers) and, who knows, perhaps some day someone will show that they did design or make a dial.

I hope that one day a revised second edition of the Index will incorporate all the extra details, corrections and helpful suggestions received - and some drawings and pictures too. Thank you all once again.

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SUNDIALS ON PUBS

Following on from M.R.Norris's letter in Bulletin 15(ii) concerning the rarity of dials on pubs, I enclose an image of a dial which must be unusual in any location, let alone a village hostelry. The pub in question is the Five Elms at Weedon, Buckinghamshire(Reg.No.1690). How it came to be there is as yet unexplored, but it is probably an unusual story. Nor is this dial alone: two more are to be found in the



neighbouring town of Whitchurch, plus several others across this central part of the county.

*Graham Stapleton
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The letter in June's Bulletin about pub dials will no doubt attract some entries. Here is my two euros worth:

1. The Rainbow Inn, Cooksbridge/Conyboro, near Lewes, E.Sussex, 1749, over a coat of arms.
2. The Victoria, Kirkby Malham, W. Yorkshire, 1840: gnomon support is a cornucopia with a bunch of grapes; may be the original name was 'The Grapes'.



The Rainbow Inn



The Victoria

Further pubs of interest may be:

The Meridian, Lewes, E.Sussex: on the prime meridian, with a plaque on the pavement outside to say so.

The Green Man, Hurst, Twyford, Berkshire: has a highly polished dial plate on the bar, inside the pub, but no gnomon. I look forward to Mr. Norris's Pub Sundial Trail.

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Re the letter from M.R.Norris in the recent Bulletin about a pub dial, I doubt if they are as uncommon as he supposes. I can think of three, not too far away from here:

1. 'The Angel' at Corbridge, Northumberland (SNRO 0389)
2. 'The Black Lion' Sedgefield, Co Durham (SNRO

0843)

3. 'The Bay Horse' Hurworth, Co Durham, (SNRO 0830)

Pub dials face a particular hazard not apparent elsewhere. The brewery sends a team of decorators to smarten-up the pub, and they paint over the dial. This happened to the Hurworth dial some time ago but a fuss was made as the dial had been made by a famous local mathematician, William Emerson, and the perpetrators were made to restore it. But I suspect that several extra meaningless lines were added by the restorers.

Currently the Sedgefield dial lies under a coat of paint continued from the rest of the wall, completely obliterating its markings, with the exception of the gnomon, which is painted gold!

There is another pub dial at Ferryhill, Co Durham; and another on a former pub on Holy Island.

Frank Evans (frankevans@zooplankton.co.uk)

DATING A SCRATCH DIAL

Scratch dials, the most recent as well as the crudest of the family of mass dials, are notoriously difficult to date. It is often possible to assess the period of construction of the church wall on which the dial appears but there the information stops. There is no gnomon, there are no named hours and no lettering of any sort. While the scratch dial cannot be older than the stone on which it appears and while that stone is most likely of the same period as the rest of the church wall it may sometimes have been moved to its present location from elsewhere in the church building.



The Bolam Parish Church Scratch Dial



The photos show the south side of Bolam Parish Church, and the Scratch Dial.

Moreover, the dial may be later by many years than the wall on which it appears and there will be no indication of this.

At Bolam Parish Church in Northumberland (NZ093826) is a scratch dial whose installation may unusually be bracketed in time. The dial consists of three ragged lines inscribed on the nave wall. It lies to the right of the dog-toothed nave doorway but within the porch. Because the dial is inside the porch it must predate it. Mike Salter, in his book: "The Old Parish Churches of Northumberland" (Folly Publications, Malvern, WRI4 4AY of 1997) states simply that the south aisle of the nave is of about 1200 while abutting it is the south porch which he dates as about 1280 to 1300. So we may place this crudely produced dial fairly in the thirteenth century without much leeway either side.

The puzzle remains as to why these artless constructs replaced the more sophisticated "D" dials post-Conquest in England although "D" dials continued to be made in mainland Europe as late as the time of the Bolam dial.

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NASS TENTH ANNIVERSARY CELEBRATION

The North American Sundial Society is celebrating its tenth anniversary this year by publishing a book: '**Analematic Sundial SourceBook**'.

This is a compilation by Fred W Sawyer, President and Editor of NASS, of books, descriptions, publications, diagrams and much else, on the subject of analematic dials.

The price of the volume is £35 plus postage and packaging, £17

Cheques in pounds sterling, payable to NASS UK may be sent to: Graham Aldred, 4 Sheardhall Avenue, Disley, Cheshire, SK12 2DE

Further information and order forms are obtainable from fwsawyer@aya.yale.edu. The print run is limited, so orders must be received by 1 Dec 2003.

MARKING TIME IN GNOSALL

CHARLES DE BOER

Gnosall is a village situated on the A518, about six miles west of Stafford. It has a long history dating back to Saxon times, with a church, a daughter of the Collegiate church of Penkridge, in the Hundred of Cuttlestone. The Saxon Church was served by three Prebends supported by the income from three local crofts.

After the Norman Conquest and mention in the Domesday Book, a new church was built and subsequent generations have added and subtracted. (Fig.1) Because it was supported financially by church funds it never required local patronage and is therefore remarkably free of the resting places of the "Lords of the Manor".

I have entitled this report 'Marking time in Gnosall' because for many centuries Gnosall has been marking the time, originally for an agricultural community, now for a commuting and retired community. On a south facing buttress, part of the original Norman structure, there is a medieval scratch dial. Sadly, it is only just discernible. (Fig. 2).

Saint Lawrence's Church is fortunate in that it has Churchwardens' accounts which date back to the year 1669 and it is because these are available that I can continue the story of how the village has marked time through more recent centuries.

In 1669 there is a record that the sum of £2 16s and 2d was paid to a clock maker for his work in "setting up a clock and others with him". This was only 12 years after Huygens had demonstrated how a pendulum could be used as the oscillator for a timepiece, but I fear we do not know the type of clock that was installed.

In subsequent years there were recurring payments in respect of the clock, either for looking to it, mending it or providing oil for it. William Golding was in regular attendance upon the clock at a half-year wage of 12/- but Francis Paine was called on for special work. Paine may well have made the clock in the first place.



Fig 1. St Lawrence's Church, Gnosall, Staffordshire



Fig. 2 Scratch Dial on buttress

In 1697 a "Dyall" was set up in the churchyard. The plate cost 6/- and the stonework, including the pillar, cost 8s/2d. It would seem that our clock came before our dial.

In 1700 the churchwardens reported that three of the wheels of the clock were so far decayed that they were worth little and that the clock would not go through 12 hours. A special clock appeal was set up. A formal contract was drawn up [in 1701] and signed between the Churchwardens and Francis Paine and his son (also Francis) to provide a new clock and to maintain it for as long as they should live. The price was £10, with 5/- per year for the maintaining.(Fig. 3) (The Paines' house in Gnosall in 1756 was recorded as rateable in relation to the Church finances, which makes them true Gnosallians.) The old clock was sold to the warden of Chebsey, a village some seven miles away, for £1 10s. It was later reported that he was not happy with the deal!

Four years later, in 1705, perhaps because the new clock was running so well, the Sundial was declared redundant. The plate was removed and sold, the pillar was refurbished with iron cramps and studs and an alabaster cross set upon it. It was obviously an impressive sight; and all for £3. 2s. 4d.

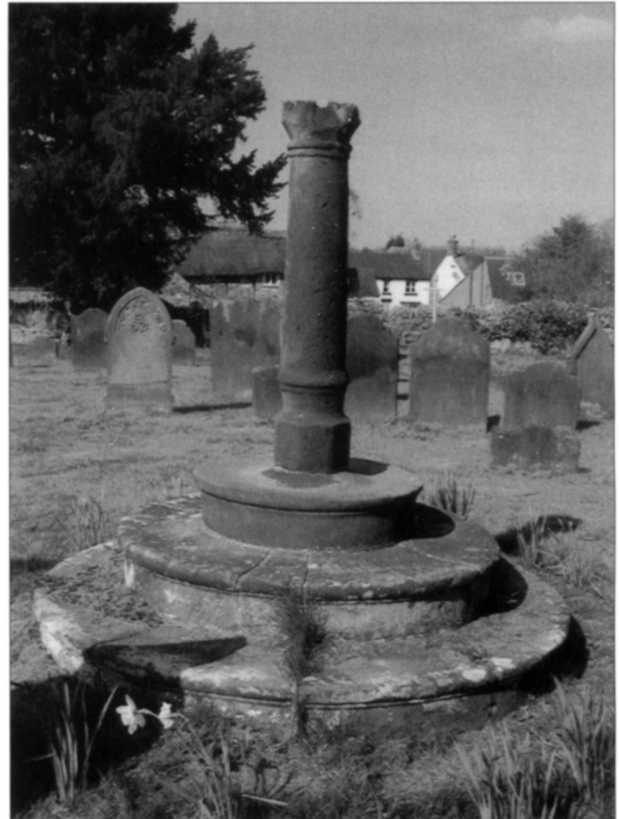


Fig 4. Sundial pillar in Gnosall Churchyard

But in 1721 the churchwardens paid Richard Boden £2 for a new Dial. This dial needed repair in 1730, again in 1746, and in 1764; which facts attest to the importance of the sundial in those days, and to the activity of vandals in all ages. The name of Boden occurs again in the records in 1723 as being paid for "writting a table in the Church".

In 1775 a new clock was commissioned but the dial continued to mark time with accuracy and precision

In 1902 the sundial pillar itself became unsafe and had to be rebuilt, but the old stones were used so what is now seen is as it used to be.(Fig.4)

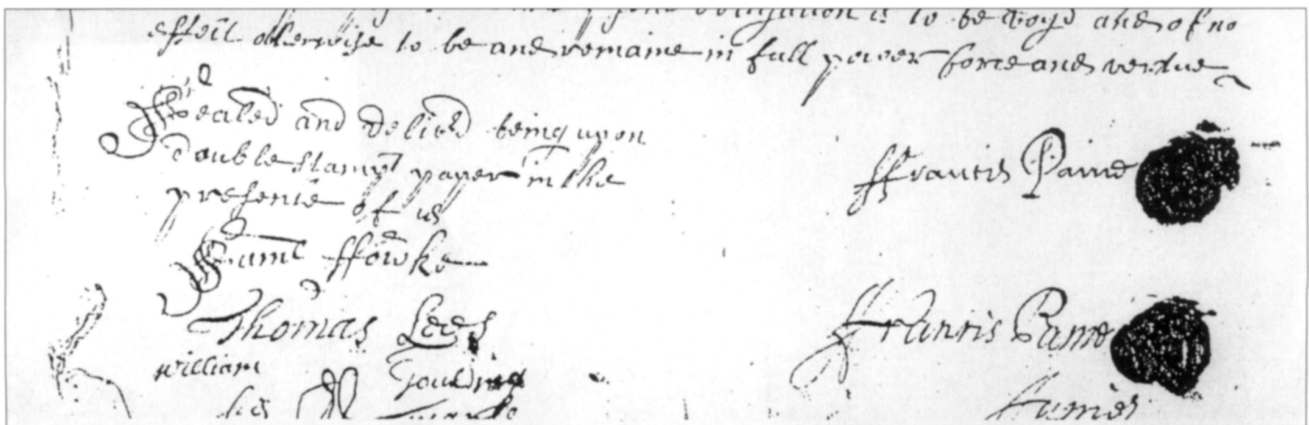


Fig 3. Portion of contract for making first clock

I first met this Sundial in 1996 when I came to live in Gnosall and I contacted Mr David Young, then secretary to the British Sundial Society. He showed me the report by Noel Ta Bois and advised that the dial plate should be removed for safe keeping because it was unique. It was agreed in the PCC that this should be done. It was suitably mounted and now sits indoors, on a windowsill enjoying the evening sunshine. It is in our New Vestry, which is this generation's contribution to St Lawrence's church. When the Gnomon was lost we do not know, neither do we know what the original was like. The present Gnomon is removable and for demonstration purposes only. When first installed this dial was indeed a working dial and it was not then the custom to include educational mottoes. We have now added a motto, if only to keep up with the Victorians, but not of course to the plate itself.

Noel Ta Bois described the plate in his Sundial page of 'Clocks' magazine and called it "a puzzling dial". His diagram of the unique feature of the dial is far clearer than on the dial itself and he gives a description, and his thoughts. So that you may have the pleasure of thinking of the purpose of this set of scales, I will give his details but not his thoughts!

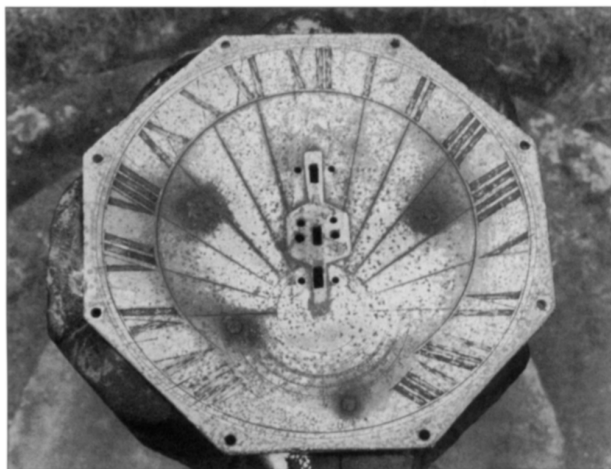


Fig 5. Octagonal dial plate, c1721, now inside the church

The dial plate is conventional, octagonal in shape, and some 10ins across (Fig.5). Above the six o'clock line is a semicircle 4 1/8ins in diameter with its centre at the point where the six-o'clock and noon hour lines cross. (Fig.6) Within the semicircle are five calibrated scales. The outermost scale is subdivided by lines into four sets of 31 divisions numbered 10, 20 and 30. The next scale is similarly divided but only onto 30 divisions. Both these scales start just below the six-o'clock line and read 10 where they cross the noon line. The next scale has zero on the noon line and is calibrated up to 23 in both directions from the centre. The two innermost scales, which are back-to-back, have similar calibrations. Both are marked from four to eight but in opposite directions, and both have six

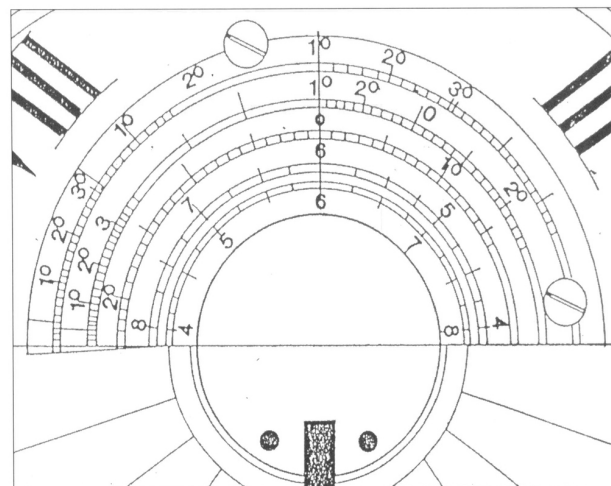


Fig 6. Drawing of a portion of the 18th century dial-plate

on the noon line. Noel Ta Bois comments that before 1752 and our adoption of the Gregorian Calendar the equinoxes fell on the 10th of March and September. Members present at the BSS Yarnfield Conference in 2003 had no particular comments on the unusual markings. Personally I feel that it was to allow the clock-warden to check the hours of sunrise and sunset throughout the year. In the centre of the semicircle there are two engraved initials, FP. The F is written as a double lower-case f, which was apparently the custom in those days; it is the origin of the tradition used in some families of spelling their surname with a double-f start. I suspect that these initials indicate that the plate was designed by Francis Paine himself, and that Boden just engraved it. In future perhaps we should refer to this as the Paine Sundial Plate.

After removal of the Dial plate, which of course had been redundant for a good number of years, consideration was given to what should be done with the pillar. In due course a combined sundial and cross was made in 1992 by a local agricultural engineering firm, and given to the church in commemoration of Margaret Urwin. This dial, therefore, is now the Marker of Time in Gnosall. It was placed on the ex-sundial-pillar, but it was deemed by the Diocesan Advisory Committee too modern in style to adorn an old pillar. It was agreed that it should be given a new pillar and site. This will be done, and the old pillar must remain unadorned.

Acknowledgement: I am grateful for help given by the staff of the Staffordshire Record Office during the preparation of this study.

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THE DISCOVERY OF A SPHERICAL SUNDIAL AT HILTON, CAMBRIDGESHIRE

MIKE COWHAM

I have lived in Cambridgeshire for the last 30 years but having recently retired I am now able to find the time to explore the locality. One local curiosity that I had wanted to investigate was Hilton Turf Maze, more properly called a Labyrinth. Fig. 1. These mazes go back into antiquity and are believed to have ritualistic origins. This one, and several others, are thought to have been modelled on one from Chartres Cathedral. It was believed that the Devil could only travel in straight lines and a person following along these curvaceous tracks would be sure to loose him. Another maze in Saffron Walden, Essex, is even larger and the total length of its walking trail is over one mile.

On arrival in Hilton during the wet January of 2002 we found this maze and in its centre was a stone pillar with a ball on top. Several inscriptions could be seen on the pillar and I would have taken little further interest in it had I not seen a familiar motto, '**SIC TRANSIT GLORIA MUNDI**'. I now had to investigate further. At the time the ground was waterlogged and the maze was roped off but through binoculars I thought that I could see some markings on the sphere. Photographs taken through a telephoto lens and subsequent computer enhancement definitely showed these markings to be in a sort of circle. This led me to look through local records and in several the pillar is described as a 'sundial', confirming my suspicions. Arthur Mee¹, (1939), says that *'The pillar is topped by an incised ball-sundial, something of a rarity, which was replaced in its original position some years back after it had been removed from a nearby gate post.'* The local Public Record Office in Huntingdon has much information about the Maze but relatively little about the monument at its centre. We know that it was a monument to William

Sparrow who was born in 1641 and he 'fashioned the circles' of the maze in 1660. Records state that the gnomon was restored in 1928 but fell out again in 1982. The record office have several photographs of the maze and pillar taken over this period but none show any trace of a gnomon. I was able to speak to an elderly resident of Hilton who could not recall any gnomon but he told me that he had inserted one in the 1980's 'which soon fell out'.

It was to be a long time before I was able to return, with the ground now dried out, armed with a stepladder and a camera. I could now see that the stone ball was about 18" in diameter. It was possible to make out beneath the coat of lichens some quite crude markings of Roman numerals and a hole, higher up and centred on the dial outline, presumably for its gnomon. Fig. 2. Neither the scale nor the hole were in any familiar pattern. I have since been trying to determine what sort of dial this could be. The fact that the ball had been removed, (and some say that it was replaced by one of a different size), suggest that the dial markings may have 'changed' from its original design. Another report describes how it was stolen by some youths. The present 'dial' is certainly not lined-up to face exactly south although Hilton is very close to the Greenwich Meridian. The accuracy of its markings must therefore be treated with suspicion.



Fig 1. The Hilton Maze with the Sundial at its centre



Fig 2. Markings on the Hilton Ball as seen today.

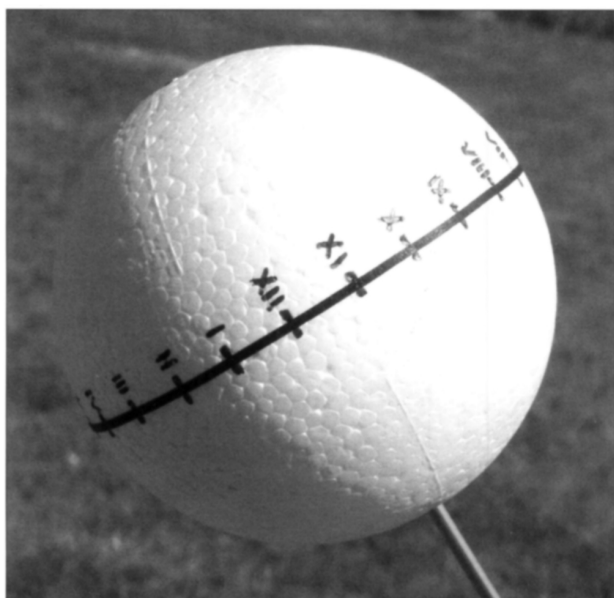


Fig 3. Model of Simple Ball (Crepuscular) Sundial.

My efforts since have been to construct, or at least to find illustrations of, similar spherical dials. The most common sort is as shown, Fig. 3., where no gnomon is fitted, the edge of the sphere acting as its own gnomon and showing the time on two sides. I will call this a 'crepuscular' dial, i.e., one relating to twilight. Although a very simple form of dial its main drawback is in the lack of crispness of its shadow in the crepuscular region which will often spread over half an hour or more.² According to Drinkwater³ such dials were commonplace and would have been merely painted on the outside of a sphere. The cube dial with a sphere above it at Gillamore in Yorkshire was almost certainly one of these. Fig. 4.



Fig 4. Sundial at Gillamore in Yorkshire.

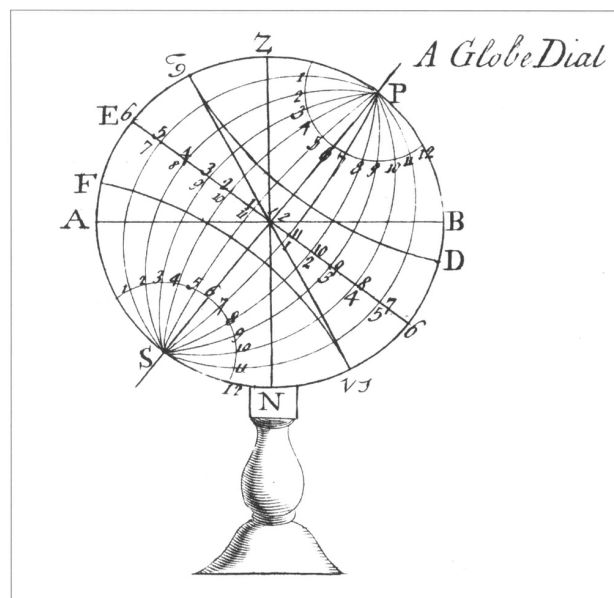


Fig 5. Drawing of Simple Dial from Leadbetter.

Investigations of similar balls may reveal further dials of this type; but without a gnomon hole all evidence may have been lost. Leadbetter⁴ also illustrates one of these dials but in addition he extends the axis to protrude from each of the two poles and places Summer and Winter dials around them. Fig. 5. Leadbetter says that 'This Dial is the most natural of all others, because it resembles the Earth itself, and the exact manner of the Sun's shining thereon.' 'Also if two Wires be set in, one at P and another at S, and 12 at the Meridian, and the Hours numbered as you see, that Wire at P, will give the Hour in the Summer; and that at S the Hour in the Winter.'

The second most common type of spherical dial is as shown in Fig. 6. This has a rotating vane type gnomon that has to be moved by hand until its shadow on the ball is of minimum thickness, i.e., exactly in line with the sun. Both the shadow and the vane then show the correct time on the



Fig 6. Model of Sphere with moving Gnomon.

scale around the ball. However, as this type of dial needed some human input for use, it was normally made relatively small and low enough to reach with ease. Several portable dials of this type are known.

When I looked more closely at the Hilton dial it did not seem to be like either of these two types and it led me to wonder whether a spherical dial could be constructed with a gnomon on its surface. Yes! Obviously it could, but what would the results be? If we assume that the surface of a sphere can be represented by many infinitely small flat surfaces joined together then we could make a dial on any of these flat surfaces. The problem then is that these dials would be far too small to see. Any dial on the sphere would have to be large enough to be read from some distance. I therefore decided to construct a form of polar dial on the surface of a sphere, covering the maximum space available. Fig. 7. Immediately I realised that the shadow would soon leave the sphere as the sun moved any appreciable distance from its zenith. However, a dial of this type is feasible even though it may not show more than the hours of **IX** to **III**. An alternative gnomon of a single pin type would give similar results. Were either of these the type of dial at Hilton? Again, I don't think so, but it may be the way that some later restorer believed it should be.

Looking through several old dialling books I came across a dial that looks very similar to the Hilton dial markings, in a book on globes published by Moxon⁵ in 1686. A magnified view of the sphere on top of a column is shown. Fig. 8.



Fig 7. Polar Dial Mounted on a Sphere.



Fig 8. The Ball from the top of the Leaden Hall Dial

The text does not fully explain how the dial functions but the picture shows a very impressive dial made for 'Mr. John Leek, and set up on a Composite Column at Leaden Hall Corner in London'. It differs from the Hilton dial in that it has '6' at its lowest point whereas Hilton clearly has 'XII'.

Oronce Finé⁶ describes a different sort of 'Sundial upon a Dome'. This has a vertical gnomon at the zenith. The dial drawn on the sphere is therefore similar to an analemmatic dial and its scales are mostly in the shade. He remarks that this type of dial 'is not much use as a time-telling instrument'. However, several such dials were made. The dial by Nicholas Kratzer made for Corpus Christi College,

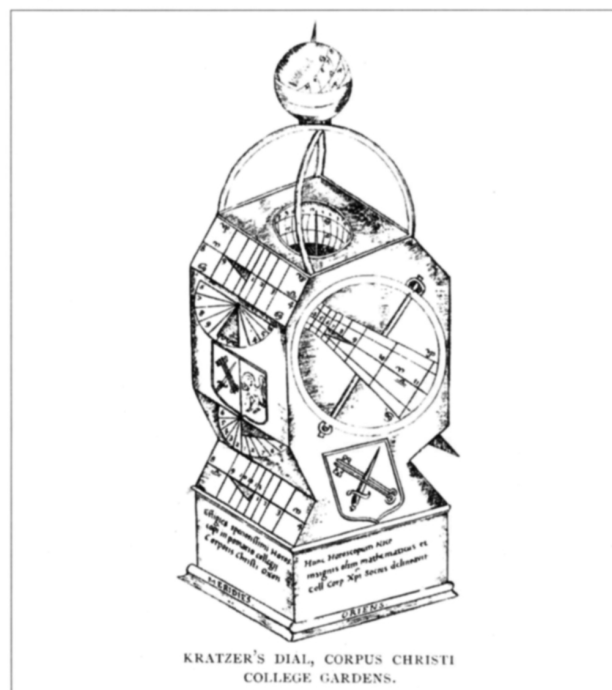


Fig 9. Sundial by Kratzer

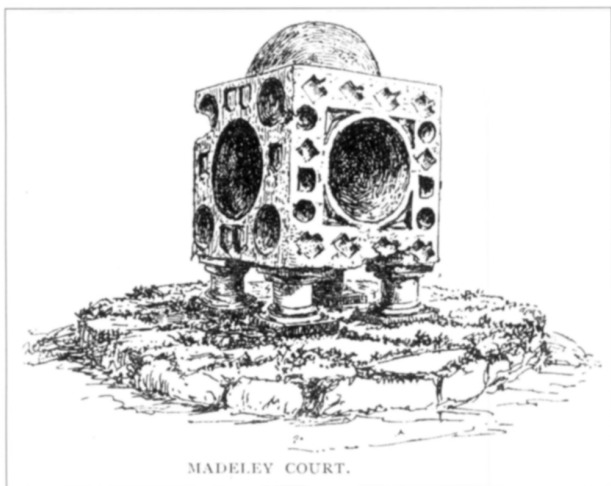


Fig 10. Dial at Madeley Court, Shropshire.

Oxford⁷ shows exactly this type of dial. Fig. 9. The dome surmounting the dial at Madeley Court in Shropshire⁷, Fig. 10., would also have been of this type.

Unless further evidence comes to light, the actual form of the dial at Hilton will remain a mystery. I feel that it is more than likely that it has, at some time, been incorrectly 'restored' and that the original dial was probably of the commoner Crepuscular type.

REFERENCES

- 1 A. Mee: *The King's England – Bedfordshire & Huntingdonshire*. Hodder and Stoughton, London, 1973.
- 2 J. Richard: 'The Spherical Sundial as a Mean Time Dial'. *Bull.BSS.* **91.2**, 5-7 (1991)
- 3 P. Drinkwater: 'The Spherical Sundial'. *Bull.BSS.* **90.3**, 12 (1990)
- 4 C. Leadbetter: *Mechanic Dialling*. Leadbetter, London, 1776.
- 5 J. Moxon: *Use of both the Globes Cælestial and Terrestrial*. Moxon, London, 1686.
- 6 O. Finé: *A First Book of Solar Horology. Proposition XVI, 23*. Drinkwater, Shipston-on-Stour, 1990.
- 7 H. Eden & E. Lloyd: *The Book of Sundials*. Bell & Sons, London, 1900.

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JOURNAL REVIEW

COMPENDIUM, JOURNAL OF NASS, VOL.9 NO.1 (MARCH 2002)

At the beginning of this issue the Editor, Fred Sawyer, announces his intention of reproducing the prefaces of a number of books, each a 'rare old work on dialing'.

Accordingly, in this March issue he reprints the prefaces from three of Samuel Foster's posthumously published works, to which Edmund Wingate and John Twysden had written prefaces. Here is a sentence from one of these prefaces, giving the elaborate and long-winded flavour of the seventeenth century style: "For by it thou wilt see, that the representing the true Houre by the shadow made by the Axis of the World is but one of those infinite wayes which may be invented, and that it is as possible to do the same thing by the shadow of the Axis of one of the vertical Circles, and by the projection of one Ellipsis upon a plain, supply the place of all the Parallels comprehended within the Tropicks."

We are given, in more business-like style, two articles on 'Gnomonic Modes': one by J.A.F deRijk of the Netherlands, who has invented the term and uses the concept of modes to show how future types of sundials could be invented; then, one by Fred Sawyer, who applies the concept of modes to Ptolemaic co-ordinates.

Maddux has invented an ingenious sundial consisting entirely of spars and ropes, which could be made in a back-garden or campground and needs nothing but a high fixed point such as a hook on a wall for a support. Hour-lines are marked on a spar held horizontally by a pair of ropes running from near its two ends to a point low on the wall and another pair to a point high on the wall. From the high point, the style, a thick cord, is fixed to a short peg or to the ground, at the appropriate angle parallel to the earth's axis. The shadow of the cord is cast onto the hour-lines on the spar.

There is a detailed description of a bronze dial recently made to commemorate the millennium and placed in the window of a girl's school in Connecticut, in a south facing wall declining 16° west. The structure consists mainly of bronze rods. A horizontal bar near the top of the window, but below its rounded upper edge, is fixed at each end to the surrounding brickwork. A bronze 'sun' disc at the midpoint of this bar acts as the root of the gnomon rod, which is fitted with small nodus. A rectangle of rods, of which the horizontal bar forms one of the short sides, is welded onto this bar, and small hour-labels in gilt Roman numerals are fixed down the long vertical sides and short base of the rectangular structure. The vertical rods are joined by bronze declination-lines placed across the window, for the solstices and equinoxes. In the upper part of the window,

filling a semicircular space, five sun-rays adorned with small bronze figures of schoolgirls form the dial's decoration; and the gnomon support consists of three bronze schoolgirls.

It is claimed that the dial can be read from either outside or inside the window, and that the time can also be read by viewing the shadow of the whole dial on the floor of the room inside the building. The impression given by the photographs in the article, however, is that it would be very difficult to read the dial at all from outside the building, as the shadow of the gnomon would be hard to see against the bright reflections of sunlit exterior objects in the window glass; and there are no hour-lines connecting the root of the gnomon with the numerals.

Steven Woodbury's 'Sightings' feature is always good value. In this issue he shows cast bronze dials from Naval Hospitals, including one originally at the US Naval Base at Pearl Harbor. Three of these dials are now at the National Naval Medical Center at Bethesda, Maryland. The one from Pearl Harbor, Latitude 22°, and another that came from New York, have been adjusted for latitude of Bethesda, on Mr. Woodbury's suggestion.

COMPENDIUM, JOURNAL OF NASS, VOL.9 NO.2 (JUNE 2002)

On the cover of this issue is fine photograph of a spherical sundial with pivoted shadow-vane, in the grounds of Monticello, Thomas Jefferson's estate in Virginia; and a quotation from Jefferson: 'My dial captivates every body foreign as well as home-bred, as a handsome object & accurate measurer of time'. The present dial is a recent re-creation, from contemporary accounts, of Jefferson's own dial which stood on or near the same spot, and for which Jefferson himself designed the plinth. An article in the issue describes the process of the re-creation.

Fred Sawyer continues his series of Gnomonic Prefaces with the preface of Thomas Fale's 'Horologiographia', reminding us that "Concerning the profite of this Art, daily experience teacheth how needful it is in well ordered Common-wealth, seeing nothing can be done in due and conuenient season, where this Science is neglected..".

There follows a delightful article describing the painting of an analemmatic sundial on the pavement of a mid-town street in Juneau, Alaska. With the blessing of the mayor and town council, the making of the dial became a community project, with the local schools and boy scouts and other groups being involved in painting the numerals and decorating the dial face. There was an official installation on the day of the summer solstice in 2001.

Bill Gottesman has produced a detailed description of the business of getting proper alignment for your sundial; and he supplies a website address giving access to his program for the job.

An interesting article by Virendra Nath Sharma entitled 'Subtleties of Shadows: the Penumbra at Noon' describes the huge Jaipur Sundial and the problem of reading the shadow with its inevitably large penumbra. The author describes the use of a string held above the gnomon as a shadow-sharpener, reading the point where the string's shadow merges with that of the gnomon's edge. Even so, the effect of the width of the gnomon means that it takes about 80 seconds for the midpoint of the sun's disc to travel across it at noon. A consequence is that time-readings of the shadow on the western quadrant (morning hours) are ahead of true local time, and those on the eastern quadrant are later than true local time.

The 'Sightings' section includes a piece of sculpture cast from bronze powder, polymer resin and fibre-glass, showing in relief the activities of the employees of the Eastman Chemical Factory. It was erected in 2001 to celebrate 81 years of the work of Eastman's in Kingston, Tennessee. Along the top of the sculpture is a horizontal gnomon terminating in an eyelet hole which casts a shadow on an analemma on the ground, (an aluminium 'Figure 8') functioning as a noon-mark and calendar.

A more elegant 'Sighting' is a simple equatorial dial made of brass on a brick platform, and placed close to the water in Grand Harbor, Michigan. The meridian is at 1.45pm, to account for Daylight Saving Time and Grand Harbor's position in its time-zone. The inscription is 'Donated and crafted by the employees of Grand Haven Brass Factory 1985'.

COMPENDIUM, JOURNAL OF NASS, VOL.9 NO. 3 (SEPTEMBER 2002)

The 'Preface' in this issue comes from Thomas Storde's 'New and Easie Method to the Art of Dyalling' of 1688. The Courteous Reader is told: 'I do not Publish this as to prefer it before Trigonometrical Calculation of Dyals, for no way can be Exacter than that; but this is to save that Labour in Young Beginners, lest they should be dejected with the tediousness of the other...' One may suggest that it is not only *young* beginners that may be dejected by the tediousness of trigonometry.

There is a fine set of photographs in Steve Woodbury's 'Sightings' showing an old (1858) iron sundial in Barnwell, South Carolina, a large square dial face with clear numerals around the edge and a detailed EoT table occupying most of

the centre. Then, in the town of Aiken, west of Barnwell in S. Carolina, there is a modern sundial on a wide sidewalk outside a Science Education Center and Planetarium. It takes the form of a large sculptured wedge and obelisk, with hour-lines inscribed on the pavement below. The upper edge of the sloping wedge is the fiducial edge of the gnomon, and the shadow of the tip of the obelisk shows the summer and winter solstices, marked by red lines embedded in the pavement.

A short article on Ridge Dials gives readers an introduction to this interesting form, surely worthy of considerable development. Then comes a learned article from Spain, on 'The Canonical Hours according to St. Benedict's Rule'. This is a thorough and comprehensive work, and it must surely be the last word on the subject.

We are introduced, in an article by Art Kaufman, to an intriguing piece of Inca archaeology from the ruins of Machu Picchu. In the floor of a house excavated in 1911 there are two hollowed-out stone bowls each about 1" ft in diameter, and each with a rim rising 4" or so above floor-level. These holes were named mortars, and were thought to be used for grinding maize or frozen potatoes by means of rocking-stones. The writer of the article proposes that these holes, if filled to the brim with water, could be used as reflecting surfaces for the sun, moon or stars, thereby making astronomical observations. A solar or lunar calendar could be made by using sun or moon light, reflected from the bowl's surface as an image on the east wall of the room. It is an interesting idea, but one wonders whether the occupants of the house would have to take off half their roof, whenever they wished to read their calendar.

Claude Hartman's 'Back to Basics' series has a useful feature in this issue, designing wedges to correct a dial made for a different location. There is not much problem about the latitude correction. But what about a longitude correction? This involves tilting the dial in the east/west direction, and then making the wedge of the right size to hold it: a tricky operation but not impossible, with Hartman's help.

COMPENDIUM, JOURNAL OF NASS, VOL.9 NO.4 (DECEMBER 2002)

This issue opens with two articles on 'Pinholes and Shadow-sharpeners'—how to make them, how they work, and why we need them. The articles, by William Walton and Gianni Ferrari, are well illustrated with clear diagrams and photos. They will be useful for reference in years to come. The next two articles, by John Carmichael of Tucson, Arizona, concerns the making of a sundial out of the enormous structural element of a solar telescope at the

observatory complex at Kitt Peak, Arizona. This huge concrete 'solar axis' slopes at the latitude angle, and its appearance suggests to a sundial enthusiast its use as the gnomon of a horizontal sundial built around its base. Carmichael wrote to the authorities of the National Optical Astronomy Observatory proposing such an addition to their amenities. The proposal was quickly accepted, and Carmichael, with the help of four or five other gnomonists, marked out the dial in 3 days in June 2002, about the time of the summer solstice. The solar axis has a diamond-shaped cross section. Each of the four corners of the diamond in turn becomes the fiducial edge of the gnomon: there are in fact four gnomons, each one of which would be in use for a few hours of the day. This interesting exercise caused Carmichael to consider multiple style gnomons in general terms, and his next article showed the numerous possibilities in shapes of the gnomon's cross section.

A short article from Iran by Mohammed Bagheri describes the making of the first analemmatic dial in Iran, set up (by the author) in Bustan-e Mellat, the National Park in the city of Rasht, in the province of Gilan, on the southern coast of the Caspian Sea. Two photographs illustrate his article. The sundial appears to be an oval of white stones inserted into a dark paved background, with the hour markers on the edge of the oval, and the line of month-markers on the short axis, for the standing of the human gnomon. The author tells us that there are plans to construct several types of sundials in this park, to make it a tourist attraction. He appeals to gnomonists, planetariums, astronomical societies 'to contribute to these goals by sending their ideas, designs and sundial kits..' to Mohammed Bagheri at P.O.Box 13145-1785, Tehran, Iran. The article mentions that Rasht, being surrounded by the Caspian Sea and by the Alburz mountain range, has much cloudy and rainy weather. But on the day of the official inauguration ceremony '...in the presence of the official and academic authorities of the province and scores of astronomy enthusiasts, the sky was clear and the sun was shining'!

Steve Woodbury's Sightings section is called 'Old and New in Augusta, Georgia.' It describes and illustrates a plain horizontal bronze sundial with iron knife-edge gnomon, standing in the grounds of a building which was formerly the Augusta Arsenal from 1827 until 1955; it is now the site of Augusta State University. A new analemmatic sundial has been made on the Riverwalk, an urban development along the river bank; the dial is elegantly carved in granite inserted into the brickwork of the walkway. It tells day-saving time, and includes a longitude correction.

COMPENDIUM VOLUME 9 SPECIAL
SUPPLEMENT

The North American Sundial Society has reprinted, as a special supplement for 2002, extracts from 'The Timepiece of Shadows: a History of the Sun Dial' a book by Henry Spencer Spackman, first published in New York in 1895. The original work must have been about 100 pages. The Supplement, well-produced and illustrated with the original

sketches, comprises 32 pages. It starts with Greek and Anglo-Saxon dials, continues with the well known horizontal and multiple dials, and includes a few from continental Europe and one each from Philadelphia and Florida. There are two pages on dial mottoes and several pages on how to make dials of different types. It is an entertaining little work, and typical of its era.

AN ARMILLARY OCTAHEDRON

JOHN MOIR AND JOHN DAVIS

Some years ago, whilst David Young was preparing the ground for his Welsh sundial tour, he chanced upon an intriguing sculpture, entitled *Genesis*, in the grounds of the University of Wales at Bangor. (Fig 1).

This was the work of sculptor John Robinson, who has surprisingly taken up this craft at the age of 35 years, after previously serving in the Merchant Navy and then spending years in Australia jackerooing and later running a sheep farm in the desert.

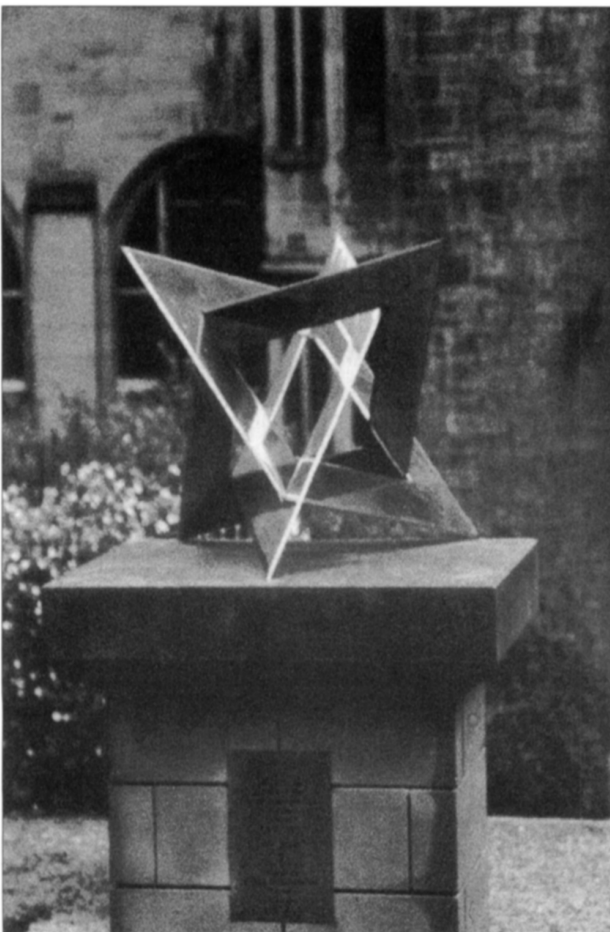


Fig 1. *Genesis* - the genesis of a sundial

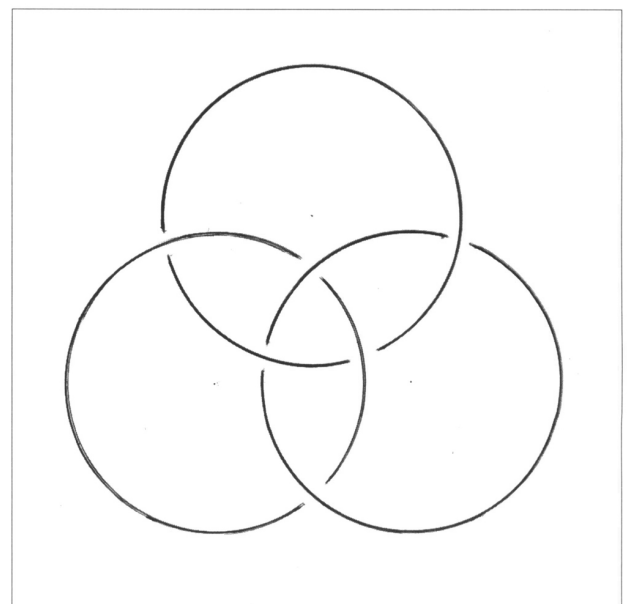


Fig 2. Borromean Rings

Genesis was one of a series of works exploring mathematical patterns and relationships. Its geometric theme derives from the Borromean Rings, an emblem of the Borromea family of Renaissance Italy. This emblem consists of three rings, no two of which are linked, but which together form a structure which cannot be taken apart. (Fig 2). In *Genesis* the rings are replaced by diamond shapes.

On his return to London, David enthused about *Genesis*, but was most unhappy that, with so many potential gnomons it could not tell the time! Of course, something had to be done to rectify this serious omission, and so we decided to take up the challenge. JM worked on the design whilst JD undertook the construction.

First of all it was obvious that the diamonds would need to be re-orientated into meridian, horizontal and vertical

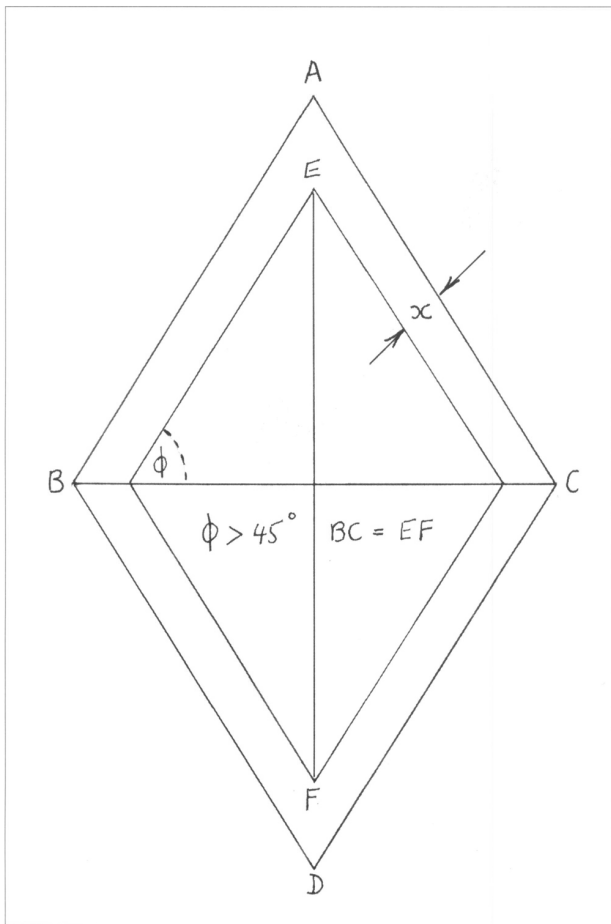


Fig 3. The Meridian Diamond

planes in order to provide a suitable gnomon and two shadow receiving surfaces in the manner of a diptych sundial. The meridian diamond is shown in Fig 3., with AB being the style and angle ABC the latitude. In order for the diamonds to interlock, it can be seen that, as angle ABC reduces so the width x must reduce. When the angle is 45 degrees the diamonds become squares and the width x becomes zero. This in effect puts a lower limit of 45 degrees on the latitude. In practice, the limit is higher, since on the receiving planes x has to be wide enough to accommodate the hour lines. Happily the required latitude (London) fitted the bill perfectly.

The detailed design of the dial, shown in Fig 4., involved some tedious trigonometry especially as the precise shape of the dial's components depends on their thickness, and the vertical hour line origins were in space. As an added feature, three holes were to be drilled through the edge of the gnomon to show light spots on the inside edge of the opposite arm, at noon on the Equinoxes and Solstices. The holes were arranged so that the beams of light pass through the centre of the octahedron, though this is not strictly necessary. With the dimensions chosen for the actual dial, the aperture angles for the holes are just over 6 degrees, so illumination occurs for a small range of declinations and times.

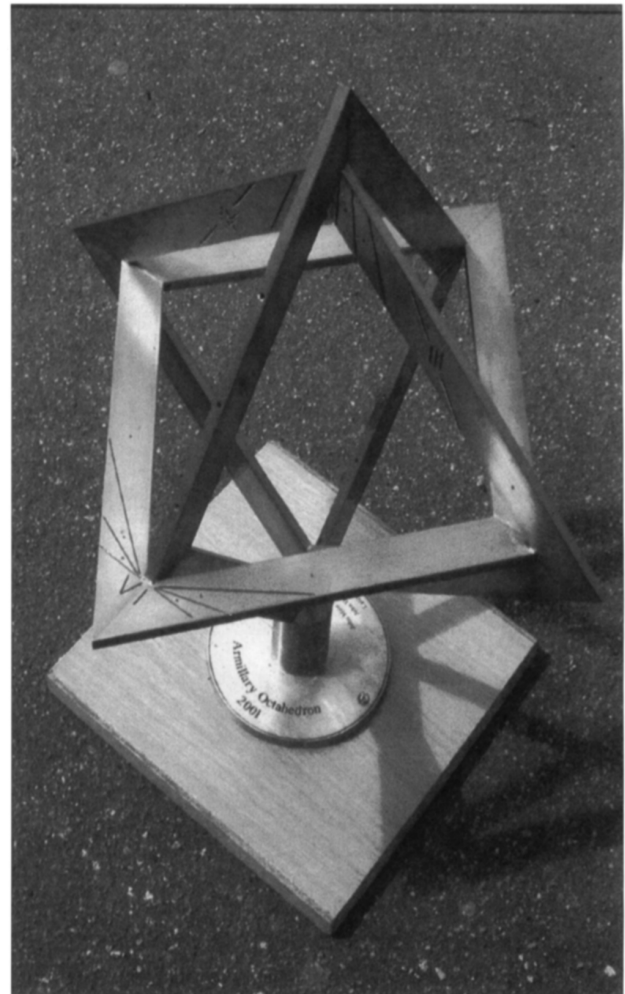


Fig 4. The completed dial.

In operation the shadow switches from the horizontal to vertical dial at 8.30 a.m. and back to the horizontal at 3.30p.m., a pleasing arrangement with a minimum of overlap. Although there is no connection between this dial and the armillary sphere, we had to call it something and the name we chose has stuck!

CONSTRUCTION

For reasons of simplicity and economy, the octahedron was constructed from 1" x 1/4" brass bar. By careful choice of where to break the diamonds, each of the 12 arms had an identical shape and the number of milling operations could be minimised. The hour lines and numerals were engraved onto the front horizontal and vertical members with a pantograph engraver (such as used by jewellers to engrave cups and shields) as the level of detail was small and it avoided the complex masking arrangements needed for photochemical etching. Drilling the 2mm equinox hole through the edge of the gnomon arm posed no difficulty as it is perpendicular to the face. However, the two solstice holes are at 23 1/2 degrees to the perpendicular, requiring a small flat to be milled in the correct location before the drill bit would cut accurately.

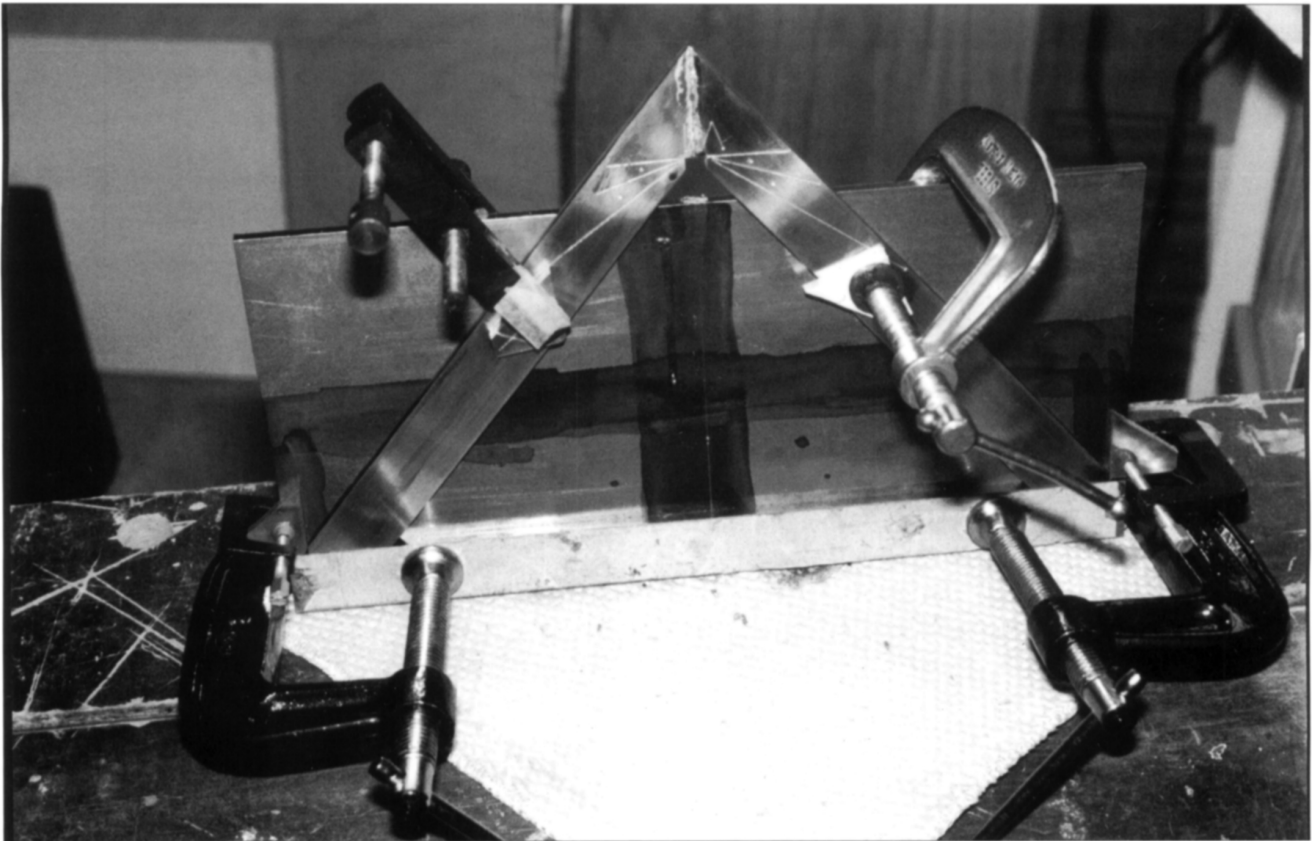


Fig 5. Soldering one of the "V"s

Next, pairs of arms were clamped into a simple jig (Fig 5) and soldered into "V"s. Four of the "V"s were assembled into two diamonds which would interlock, but then the whole structure had to be assembled piecemeal before the final joints could be made. Heat had to be applied quickly as thermal expansion of the arms tried to spring the structure out of shape. Once completed, the interlocking nature of all the joints gives it a considerable strength.

Mounting the octahedron on its base was a compromise between a mechanically strong structure and the desire not

to spoil the aesthetics of the symmetrical interlocking diamonds. The solution adopted was to clamp the bottom tip into a groove cut in the turned brass base. The structure was completed with a standard photo-etched brass plinth.

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A LARGE HORIZONTAL DIAL IN STAINLESS STEEL FOR MELTON MOWBRAY

D A BATEMAN

Tony Moss (Lindisfarne Sundials) has once again combined his skill in dialling with the metalworkers craft. The result is an impressive dial 1.2 metres in diameter set in the corner of a public park. Like all good dials, there was a progressive development of the concept, which in this case, also involved other members of the Society.

The Rotary Club of Melton Mowbray had the idea of some form of commemorative sundial, and hearing of the Society, contacted Jane Walker who in turn referred the

query to Gerald Stacey, who lives about 9 miles away in Rutland. This was early in 2001. It soon became clear that the Club was thinking of some very grand structure with something like a long pole for the inclined gnomon, which would be well beyond the scope of a small workshop. Tony Moss was recommended as having worked on a large variety of dials, and he gave a talk to the Rotarians about dials generally, outlining the practical difficulties with each and every type of dial.



Eventually, the design concepts turned towards a horizontal dial, but to be large and dramatic, and to be directly associated with the Rotary Club.

Even when the design concept was fixed, the Sundial Society was still involved, as yet a third member, Graham Aldred, was asked to lay down the north-south line. This was marked with long line between pegs driven into the ground, something that the builders could work from in laying out the base and the compass markers.

Although Lindisfarne dials is primarily concerned with the metalworking side of the dial design and manufacture, an addition to this project, also by Lindisfarne, are the fixed 'compass points' at the perimeter of the paved area. The N S E & W markers are in the form of stools at a height of 500mm. The NE, SE, SW and NW are 300mm high and intended for children. The markers were made in Northumberland out of reconstituted stone.

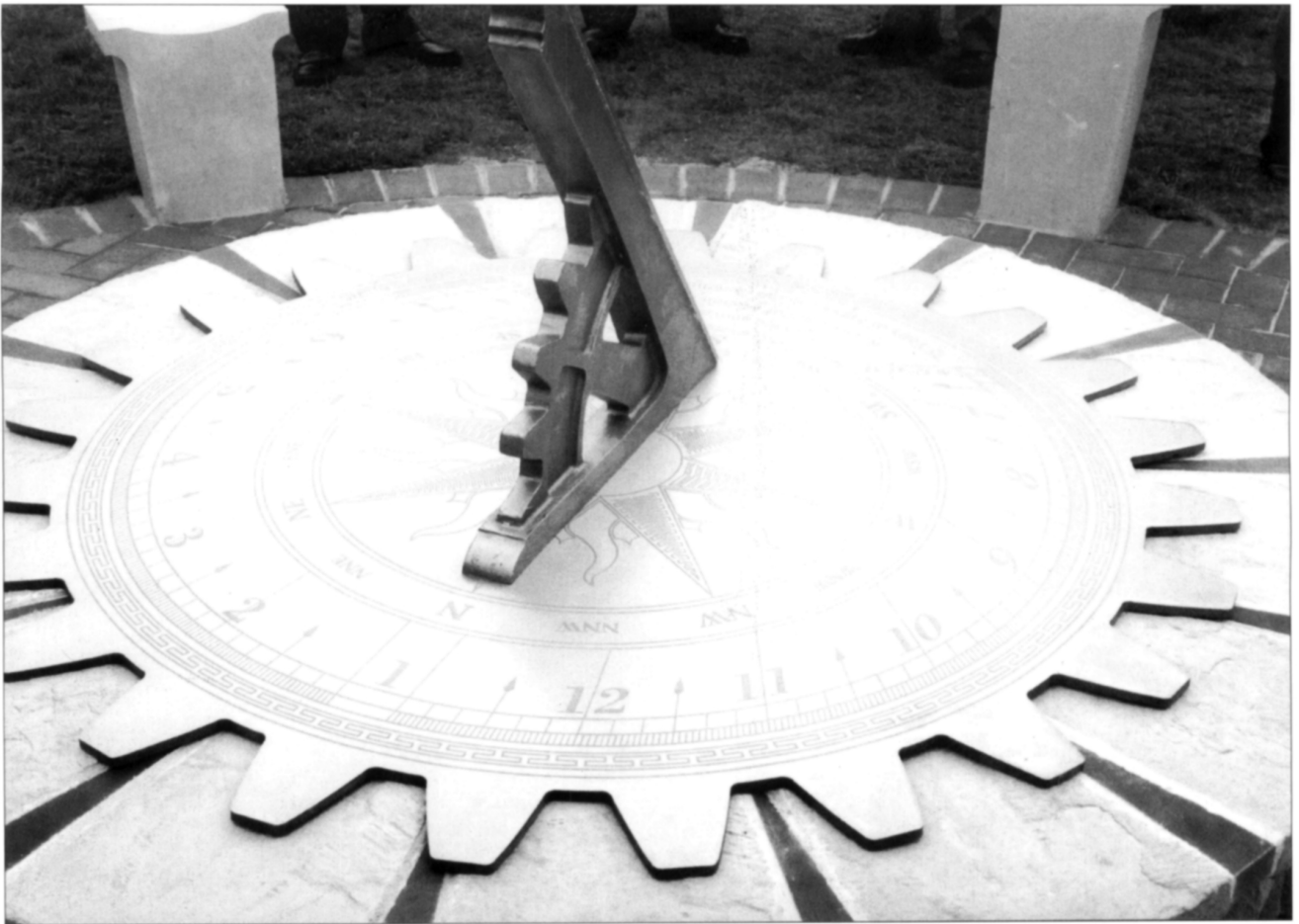
The base for the dial is 500mm high and about 1.5m diameter. The overall paved area is 4.4m in diameter.

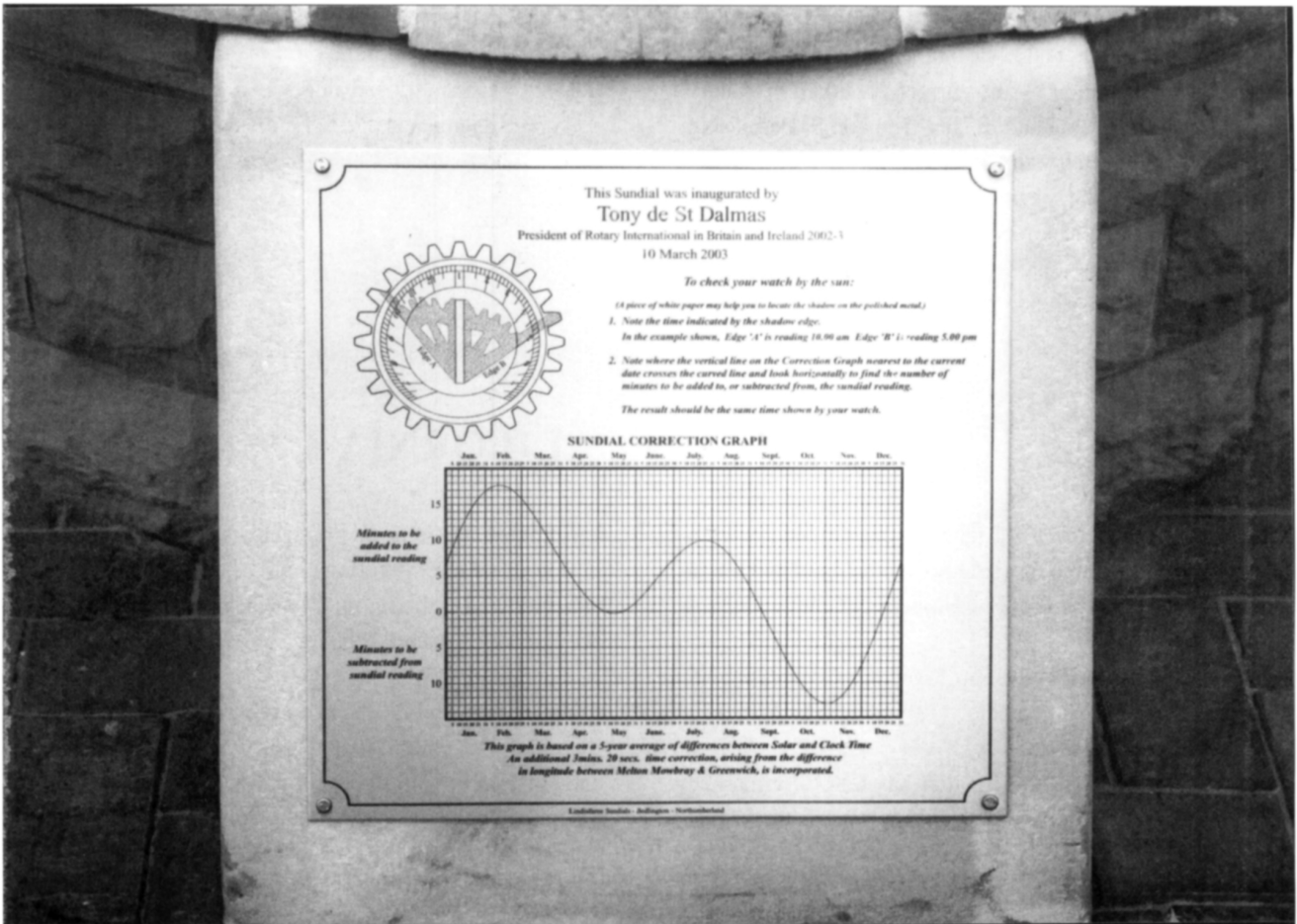
The dial itself is an impressive 1.22m diameter sheet of stainless steel, 10mm thick. The most obvious feature is the

gear wheel motif of the Rotary Clubs. The dial then appears to be fairly conventional until one spots that summer time has been 'built in' by having the noon as 1pm. Considerable detail has been etched into the steel - time divisions down to two minutes, a compass rose giving 12 points of the compass, the latitude and longitude, and the dedication from the Rotary Club.

The strength of the gnomon has been taken extremely seriously. It is 54mm wide (gnomon length 724mm) and has long tenons that attach to the dial plate and project well into the supporting masonry. The gnomon is in cast stainless steel, with the pattern made by Lindisfarne dials, and it too, has the gear wheel theme. A statistic not usually given about a sundial is the mass, which gives another indication of the ruggedness of the dial. The plate has a mass of about 138kg and the gnomon 60kg.

An explanatory plaque is provided, which to my mind, is a model of its type. It gives two examples of how to read the dial, and there is a detailed explanation of how to correct to 'watch time' with the graph of the equation of time. In fairness to engraved dials, however, once the etching process is used, there is no limit - apart from legibility - to the amount of text or diagrams that can be incorporated.





At the inauguration ceremony on 10 March 2003, a large number of Rotarians and civic dignitaries attended, with the actual inauguration by the current President of Rotary International for Britain and Ireland, Tony de St Dalmas. In addition, no less than 5 members of the British Sundial Society attended the inauguration. The event was then followed by daytime fireworks, consisting of dramatic multiple aerial explosions, which were as much enjoyed by a local school in their lunch break as by the official party.

The dial may be seen on the left of the A607 road, entering Melton Mowbray from the south-west, in Egerton Park just before crossing the bridge over the river Wreake. Acknowledgement is due to Leicester County Council for a Shire Grant to cover 70% of the cost.

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[Photographs by T.Moss, D.Bateman, M.Shaw]

A SUNDIAL IN CALIFORNIA

We have received from a friend in the United States a photograph of a large horizontal sundial situated on a traffic-island in a suburb of San Francisco, California.

A short description from the San Francisco Chronicle by S Whiting accompanies the photo.

“The Marble and Concrete Sundial has faithfully marked time since its dedication on October 11, 1913 as the largest in the world at 34’ in diameter and 28’ in height. It is located in the centre of Urbano Drive.... in the still fashionable Ingleside Terrace section of San Francisco, off Ocean Avenue.

“Built in 1913 as a come-on to the new Ingleside Terrace development, the sundial is hidden in a traffic island

surrounded by California bungalows. The 28-foot vertical pointer, which functions only on sunny days, is synchronized to the summer solstice in June. Then it will be obscured by fog until fall.

“The gnomon and face are concrete, with Roman numerals the size of a child. Anyone who has struggled with the sundial concept can figure it out by checking a wristwatch for time, then going and standing on the corresponding spot on the dial. The line where sun meets shade should be just a step or two away, becoming a baby step as the solstice gets closer. There is a decaying beauty to the timepiece, like an old grandfather clock”

[Photo: R.H.Vaughn]



TRANSPORT THROUGH THE AGES

The penny-farthing cyclist outside the Harlow Cycle Museum pedals through sun and showers, alarming the neighbourhood geese.



Photo: D.A.Young

The steam locomotive, seen in shadow on the wall, puffs along the top of the dial-face, canted out to give a direct west-facing dial. The rail-track-sleepers become the hour lines for this dial on John Ingram's house in Warminster.



Design and Photo: H.James

A DIAL WITH A ROYAL CIPHER

A.O. WOOD

One of the problems attendant on the privatisation of the Post Office would be the removal of some thousands of royal ciphers from our post boxes. It would involve lots of angle grinding and no doubt teeth grinding by the Letter Box Study Group¹.

It is to be hoped no such fate would be in store for the new dial at St John's Church, Ruardean, Gloucestershire, at the northern edge of the Forest of Dean, between Cinderford and Ross-on-Wye. However, privatisation is unlikely, following the Nationalisation² in 1536 under Henry VIII: "Le Roi est l'État"³.

It is believed to be the only church dial commemorating the Queen's Golden Jubilee, and also possibly the only dial to bear the Royal Cipher E II R.

It was conceived by local Councillor Andrew Gardiner, and his suggestion was adopted by the Parish Council; he found



Fig 1.



Fig 2.

himself responsible for not only the paperwork surrounding such a project but also the design and delineation. He had to deal with the Parish Council, Diocesan Archdeacon's Office, Surveyors Office, Buckingham Palace via the Lord Chamberlain's Office, the local quarry and mason's yard, Monumental Masons, the press and – the British Sundial Society (elevated in correspondence at one point to the Royal Sundial Society!)

Andrew contacted the Society via Jill Wilson who showed him round Chipping Campden and its many sundials, directed him also to Naunton with its two painted dials, and speedily handed him over to me as 'nearest living member'.

The Sun Dial Register entry indicates a true 'design by committee' and reads: design – A. Gardiner; delineation – A. O. Wood; gnomon – G. Duberley; maker – M. A. Truman of Damsel Monumental Masons. This combination, together with funding from the Parish Council, ensured that it was not eligible in either category of the 2005 Sundial Awards Competition.

In addition to the Royal Cipher in gold, the dial features two mottoes: 'LUX UMBRA DEI' borrowed from Naunton, and 'ROYAL PATHWAY IN TIME' linking the Jubilee with time-telling. (Fig. 1).

Jill Wilson, with an eye to future biographers, had insisted that the maker's initials and a date should appear – which they duly do. Additionally there are two fish, reflecting

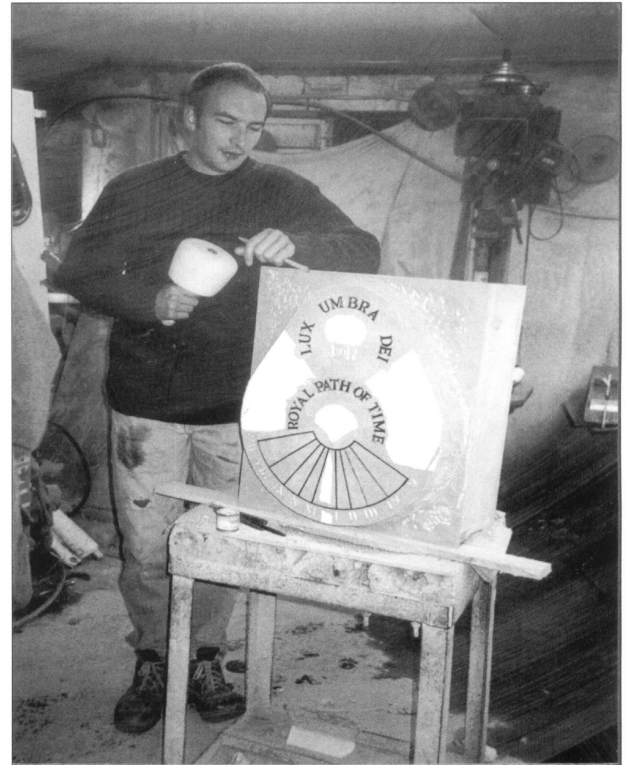


Fig 3.

those which appear on a stone in the church and are of the famous medieval or Saxon Herefordshire school of carving. A swallow, inhabitant of the porch, also appears on the dial.

It is marked for G.M.T. so the unveiling at 'noon' on June 21st 2003 required hasty explanations as to why we were exactly an hour adrift; the glorious sunshine and attendance of the whole village ensured that everyone learned about G.M.T. and B.S.T.

The sundial cake at the festivities afterwards was delicious (Fig. 2) but disappeared before it could be registered.

As for the Royal Cipher – unique – unless We inform one otherwise.

References:

1. Letter Box Study Group. Weaving the Tapestry. National Monuments Record Meeting. London, 29.10.1999
2. Flanders M. and Swan D. 'At the Drop of a Hat', Revue, London, 1957
3. Woodward G. W. O. and McIlwain J. *Dissolution of the Monasteries*. Pitkin Guides Limited, Andover, 1993

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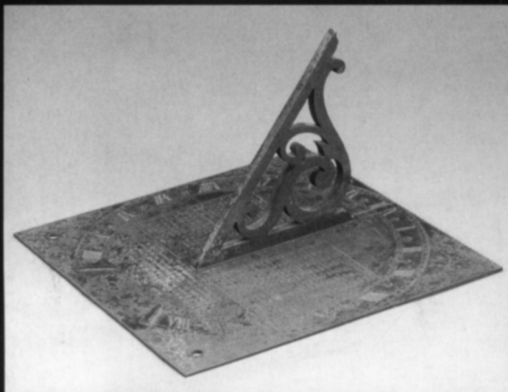
PETERBOROUGH: EQUINOX BUSINESS PARK

A large armillary sphere of stainless steel is the centrepiece of a newly established Business Park on the western edge of Peterborough. The dial was made by David Harber Sundials of Oxfordshire, and unveiled at an official opening by Mrs. Milne, the Chief Executive of the Greater Peterborough Investment Agency, on 19 June 2003.





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