The British Sundial Society

BULLETIN

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BULLETIN

OF THE BRITISH SUNDIAL SOCIETY

EDITORIAL

It was to be expected that many groups of people up and down the country, when considering a tangible commemoration for the year 2000, would suggest a sundial: a large eye-catching object, which can be made austerely simple or decoratively ornamental, and which stands as a reminder of the passing of Time, of the Past and Future. Dozens of towns and villages, colleges and schools, societies, guilds and institutions are commissioning and creating sundials; and reports of many of these find their way into the pages of the Bulletin.

The trickle which started in our February issue with Harriet James' New College Dial (MM and WW for William of Wykeham's College) has now become a flood. In this issue we have three new and sturdy dials along the Thames, initiated by Piers Nicholson's design for the Tylers' and Bricklayers' Company; and five village sundials of a good variety of types; two vertical declining, one each of horizontal, equatorial and analemmatic. They show an admirable ingenuity of design and appropriate decoration and embellishment.

The flood of 'millennium dials' will inevitably continue. For the February 2001 issue, our first Bulletin of the Third Millennium, we are promised at least three more sundials. So here is the place to beg the designers/article-writers to record their dials for posterity by placing them on the BSS Register. You, the designer, alone will know the exact dimensions, the gnomon angle, the owner/curator, the precise lat. and long. So before sending your article to the editor, *please* send a completed sundial-register form and a photograph to our hard-working Registrar.

THE GENESIS OF THE TYLERS' AND BRICKLAYERS' SUNDIAL

PIERS NICHOLSON

I have often been asked how the ideas for the Tylers and Bricklayers sundials evolved, since many people are interested in the actual process of design work. The essence of it, I think, is that you never know at the beginning where the design will end up, and that it will always take a lot more time than you thought! So, for what it is worth, I have set out as closely as I can remember it the early stages of the design.

In late 1996, I was invited to serve on the Millennium Committee of the Worshipful Company of Tylers and Bricklayers, which is one of the ancient livery companies of the City of London in England. The committee was charged with selecting a suitable project or projects highlighting the Company's interests: a project that they should support to mark Millennium year.

Having a long-standing personal interest in sundials, I was naturally keen that the Company should be involved with a sundial, but it was a bit difficult to see how this could sensibly be done in a way that would also be an interesting piece of brickwork. My initial suggestion was that the Company should consider something along the lines of the Great Sundial at Jaipur in India, but such a massive structure was unfortunately considered impractical on the grounds of cost and space.

So, for several weeks on my daily cycle journey from Epsom to London, I puzzled over how to design a sundial which would also be also an interesting and challenging piece of brickwork. This resulted in a proposal which I presented to the committee, for a polar dial, with a large brick plinth sloping at 51.5 degrees to the vertical. The gnomon would be made from a brick raised out from the surface of the dial plate, and the dial plate itself would be made from tiles with the hour numerals marked on each tile. This design turned out to have considerable practical difficulties: the tiles would have to be specially made to exact dimensions, and some permanent method found of putting in the hour numerals. Ideally, each tile would have had slanting edges so that gradual wear over the years would leave the mortar joint marking the hour in the same angular position from the gnomon.

The gnomon assembly had to be at a reasonable height if it was to be read easily, and it had to be sufficiently wide to accommodate the brick gnomon. There was an advantage in having it quite wide, since it would show more hours of the day. One advantage of brick is that it is a very durable material, so that a sundial made of brick should, barring accidents, have a very long life expectancy. It was at this stage that the design acquired the name of the "Sundial for the Third Millennium". A calculation was done of the number of bricks required to make the plinth, and it was found that, with a little juggling of the dimensions, it could be made with exactly 2000 bricks! It seemed entirely appropriate that a sundial for the third millennium should have one brick for each year of the first two millennia.

A wooden model was built in Epsom in order to test out the visibility of the shadow at a distance from the gnomon. Because the sun has an angular diameter, the shadow gets somewhat fuzzy at a distance from the gnomon. The small area between shadow and full sunlight is known as the penumbra, the part that is illuminated by one part of the sun but is in the shadow from the remainder of the sun. The area of penumbra on the polar dial plate is larger in the early morning and the late afternoon when the shadow is furthest from the gnomon. It had originally been hoped that it would be practical to have the width of the sundial at around 1800 mm (6 ft). Tests showed that the shadow was not sufficiently clearly defined at that width, so it was decided to limit the width of the dial plate to 1575 mm (5 ft 2 ins)

These experiments also showed that it was possible to have lines indicating every ten minutes rather than every hour (which had been a feature of the brick-and-tile design). It was decided to make the gnomon and dial plate out of stainless steel, which would be very strong, resistant to damage, and could take accurately engraved lines at close intervals. An added bonus from the use of stainless steel was that it permitted the ends of the dial plate to be bent up parallel to the gnomon, so that the dial scales could be read for the full 12 hours. (Polar dials, with their dial plates parallel to the earth's axis, present their front face to the sun for 12 hours from 6am to 6pm. If a dial plate of this width is flat, the shadow is too fuzzy to read for most of the first and last hour of the twelve).

There was a further decision to be made about the length of the gnomon edge and the height of the dial plate. If both these dimensions were the same, the shadow would only cover the dial plate completely at the spring and autumn equinox. In the summer, when the sun is higher in the sky,

the shadow would fall only on the lower part of the dial plate, and in the winter only on the upper part. We therefore decided to extend the width of the gnomon into an "oxhead" shape, so that the shadow edge of the gnomon is substantially longer than the width of the dial plate, thus ensuring that the shadow falls across the whole of the dial plate at all times of year.

The design of the sundial was now finalised. Then began the long drawn-out process of asking the City of London Corporation whether they would accept such a gift, and seeking the necessary site and approvals.

The siting of a sundial is obviously critical, if it is to show the correct time. It is less obvious that the most critical parts of the arc are roughly from east to south-east, and west to south-west, since it is in this sector that the sun rises and sets in the winter, and it is therefore desirable to have a clear view of the horizon. The sector to the north of this is almost completely unimportant for a polar dial, since the sun will not be shining on the dialplate before 6 in the morning or after 6 at night. The sector to the south is of intermediate importance - it is not necessary to have a view of the horizon in this sector, but any tall obstructions nearby will obscure the sundial at some times of year.

Fig.1. Blackfriars Sundial outside City of London Boy's School

The implication of this is that the best sites are likely to be on the north bank of the river. The City of London has a number of such sites. The first one we suggested - at Old Billingsgate - was considered unsuitable by the City Engineers, but they kindly suggested two others. One of these, outside the City of London School for Boys on the riverside walkway near Blackfriars Bridge, is technically an excellent site, and has the added merit that it gets a high volume of foot traffic We could not have asked for a better site. (Fig.1)

This was the finish of the design process, but it was really only the beginning of the story. It is one thing to think of these things in the mind and to build a model, but it is quite another to ensure that it is actually possible to build, and in such a way as to ensure a very long life. Fortunately, it was at this stage that the Royal Engineers became involved, and did all the detailed design of the brickwork and the gnomon, and the project management of the building work. This involved many different people contributing their individual skills to the success of the enterprise.

Fig.2. Chatham Barracks Sundial opened in the presence of the Chief Quatermaster General
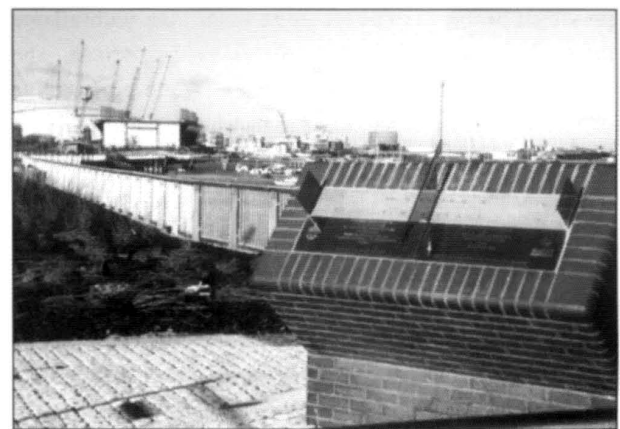

Fig.3. Greenwich Sundial

The involvement of the Royal Engineers resulted in another sundial to the same design being built outside their Museum in the Brompton Barracks at Chatham. (Fig.2) The Tylers and Bricklayers Company also had the opportunity to present a third sundial of this design to English Partnerships, who are redeveloping the Greenwich Peninsula. This one is located midway between the Dome and the Thames Barrier, on the east side of the peninsula near the Millennium Village. (Fig.3) We hope that all three sundials will prove a lasting point of interest to visitors, and a lasting point of pride to the team who worked so hard to produce the final, outstanding result.

A paper on the design and building of the three Tylers and Bricklayers will be presented jointly to the 2001 British Sundial Society Conference by Piers Nicholson and Lt. Col. Ian Ogden of the Corps of Royal Engineers. Two of the sundials form part of the new Thames sundial trail in London, which is described on the Internet at www.sundials.co.uk/~thames.htm

Author's address:
9 Lynwood Avenue
EPSOM,
Surrey, KT17 4LQ

MEDIEVAL MONASTIC SUNDIALS WITH SIX SECTORS: AN INVESTIGATION INTO THEIR ORIGIN AND MEANING

MARIO ARNALDI

The four-part and the octaval systems of day-division, as used by the Anglo-Saxons among others, are of great antiquity[1]. So also is the six-part system, the main topic of this article. Not every known medieval sundial shows the same number or arrangement of time lines. Apparently the lines were often positioned in an arbitrary way, sometimes with irregular angular separations. Moreover, the number and the position of the hour lines of prayer time engraved in the European medieval sundials could vary depending on the different monastic rules, on the liturgical times and on papal beads.

The sixth century rule of St. Benedict of Nursia required that the services of None, Vespers and Compline should take place considerably earlier than had been the previous practice, hence requiring the moving back, in abstract or in reality, of all the lines of the monastic sundial. Many time indicators therefore followed real temporal models, having four, six, eight, ten, eleven, or twelve partitions and even more. Among these systems we propose to consider one in particular, the division of the artificial day into six equal parts.

TEMPORAL HOURS AND CANONICAL HOURS

It is first important to understand what was the ancient definition of "hour". All the medieval texts, including those written by the most famous authors, take their basic information from the books of Isidore of Sevilla or those of the Venerable Bede, where in each case it is clearly written that an hour is the twelfth part of the day, whether the day be long or short *(Hora duodecima pars diei est)*. This fraction of time could be further divided in smaller,

infinitesimal parts, useful only for astronomical, astrological or calculation studies[2]. For practical use it was enough to partition the hour into two halves *(semis)*, rarely smaller periods, and in any case to do so in an approximate way *(circa hora tertiam, quasi hora sexta)*.

The time line engraved on a medieval sundial indicated the end of each hour, or of part of it, but it never indicated the beginning, or the exact instant as happens today, because the hour was measured as a whole period of time.

During the Middle Age monks and Church people were almost the sole users of sundials, their object being to govern the diurnal time for prayers. Over season and place the ancient twelve time spaces changed their location and their number. Their length changed, therefore, based on the number of hours engraved on the sundial. That is why it is not possible to make a comparison between modern and monastic hours (even computer calculations give misleading results) and the way to understanding is to start from a different point of view, similar to the medieval way of thinking. Furthermore, the majority of the medieval sundials of churches and monasteries were not based on any astronomical knowledge. We understand that sundials, even in ancient time, were often used as a symbol of the time passing, a kind of *"memento mori"* for monks and layman. They merely represented a graphic description of the sky. The simple method of dividing a semicircle in as many sectors as was required by monastic discipline was more than sufficient to indicate both liturgical and secular time.

Until the beginning of the sixteenth century the day's division into six parts, including variations within this system, was one of the several different time systems used in Europe. What was the source of this particular splitting? For what reason did it survive for such a long time, even beside such other systems as the duodecimal and four-part ones?

It is difficult to find an answer, but it may be possible to find understanding up to a certain point by the careful reading of those medieval texts that have played a teaching role for many centuries.

THE BABYLONIAN DOUBLE HOURS

It is well known, thanks to some lucky finds in the Mesopotamian region during the last century, that long before the destruction of Nineveh (607 BC.) ancient Babylonians and Assyrians divided the entire day, including night-time, into twelve hours called *Kaspu* or *Beru*. We know this principally through two of the many reports constantly sent to the Assyrian kings by the priests of Nineveh. By reading these two tablets it is evident that the unit of time used in that period, the *kaspu*, lasted two equinoctial hours, these being measured with accuracy probably using, as Sextus Empiricus and Macrobius wrote[3], water instruments[4].

This time unit, closely connected to the zodiac, was introduced into Greece, where it was later divided in two halves to form the twenty-four equinoctial hours used later in the whole Roman Empire. The double hour, considered as a single unit, lasted during both classical and late antiquity (note 1). Numerous texts testify to this, for instance *'Adversus Octaginta Hæreses'*, written in the fourth century by the Cypriot bishop Epiphanius, where he set out some particular computation uniquely soluble and understadable using the double hour system[5]. The double hours survived sporadically until the eight century, when the Venerable Bede gives an unquestionable description of it in one of his best scientific works, the *'De temporum ratione'*. In the thirty-ninth chapter, Bede clearly writes that some computators of his time measured the year's length to be 365 days and three hours, instead of six. This computation, heavily criticised by Bede, is understandable only if the division of the entire day is considered as twelve equal parts, instead of twenty-four. Nevertheless, despite this important testimony, only one six-sectioned sundial of this period has ever survived: the one at Pittington[6].

Some very ancient Irish monastic sundials have a strange anomaly in the position of the hours of Terce and None celebration. The lines referring to these prayers are located symmetrically at 60 degrees to the midday vertical line, and thus the 30 degrees separating them from the horizon are equivalent to the space occupied by two temporal hours[7].

It is well known that a very ancient source for computation in Ireland came from Greece[8], but it is not possible to establish the intensive use of double hours in the sundials of the VII / VIII centuries. It appears to be just a mere question of computation or very small communities. In fact, many monastic sundials, equally six-sectioned, that have reached us, have resulted from a cultural renaissance that happened later on, at the great French and German medieval schools.

THE COMPUTUS OF PHILIPPE DE THAON

As we have noted, the double hours method of division seems to reappear during the twelfth century, when so many classical and Arabic texts were rediscovered. Although the reference was no longer to equinoctial time, but to artificial time, the hours of the Divine Office well fitted the same partitioning.

The position of the canonical hours in the six-part division of the day is made perfectly evident by Philippe de Thaon in his poetic treatise on ecclesiastical computation, written in 1113 / 1119[9]. In these rhymes Philippe describes the practice, in both popular and religious spheres, of assembling the twelve temporal hours in six groups of two hours each: three groups for morning, three for the afternoon. This is how his verses sound in antique French idiom:

Nepurquant par demures,	And so this amount of time
Que nus apelum 'hures',	That we call 'hour',
En est divisïun	Is divided
Par itele raisun,	In this way,
Char prime apelent le une,	That the first one is called 'Prime',
Tierce, midi e nune,	'Terce', 'midday' and 'None'
La quinte, remuntee,	The fifth one, 'arising'
E la siste, vespree.	And the sixth one 'Vesper'.
Encore entre chascune	Nevertheless, inside each dwelling
En i laissent il une,	They skip one [temporal hour],
Ço est pur le cunter	This is for to count them
E pur tost remembrer.	And for remembering them easily.
Mais ki dreit volt numbrer,	But men who wish to number them aright
Duze en i pot truver;	Twelve at all may find;
En ordre lur curs	In order to follow their course
Tenent tuz a estrus.	They will start again from the begining.

Philippe's text is particularly clear[10], and represents some of the best evidence as to this subject. The author divides the day into six parts commonly called hours *(hures)* or dwellings *(demures)* (note 2). The first has been given the name of 'Prime' *(prime)*, the second one 'Terce' *(Tierce)*, the third one 'midday' *(midi)*, the fourth one 'None' *(nune)*, the fifth one 'arising' *(remuntee)* and the sixth one 'Vespers' *(vespree)*. It is a mixed method of time location, in part ecclesiastical, in part popular. Certainly we are not talking about canonical hours exclusively, since the *'remuntee'* is not a prayer time. The six *'demures'* of which Philippe wrote are equal and each comprises two temporal hours; this fact is confirmed by the line: «*Encore entre chascune / En i laissent il une*», that is to say: inside each section we skip one [temporal hour]. This method was just a practical way to remember easily the various moments of the day *(Ço est pur le cunter / E pur tost remembrer)* because, as he wrote, the correct number of the hours is still twelve *(Mais ki dreit volt numbrer, / Duze en i pot truver)*.

It is not easy to understand whether the names given to the six hours quoted by Philippe de Thaon refer eventually to the lines of the sundial, but if so, to which does he refer? It would appear most likely that he refers to the whole hour, that is the entire space between each line. But which line gives the name to the hour, according to Philippe de Thaon?

Dante Alighieri and Francesco Da Buti named the different parts of the day by using the name of the last line composing the section, not paying attention to the number of temporal hours included in it. But, more often, their name derived from the religious service celebrated at the beginning or at the end of the section. Dante, for instance, thought that the names of the four sections of the day were designated by the final temporal hour. In fact the name of the first part is 'Terce', the second is 'Sext', the third is 'None' and the fourth is 'Vespers'. The four parts of daylight were often divided in two halves, forming the eight sections that we may see in many medieval sundials. These half points were called, because of their position, 'half Terce', 'half None', 'half Vespers[11]' (Fig. 1). Francesco Da Buti (we will see this author further on), on the contrary, used a method which appears more complicated than Dante's. He divided the day, probably in a secular way, into six equal parts taking into account only the final moment of each section: the moment in which the divine office was recited. But which moments does Philippe de Thaon use? Considering the names used for the six 'hours', we could say that the temporal moment giving name to the entire section is a moment set in the middle, most probably at the beginning of the first half (Fig. 2).
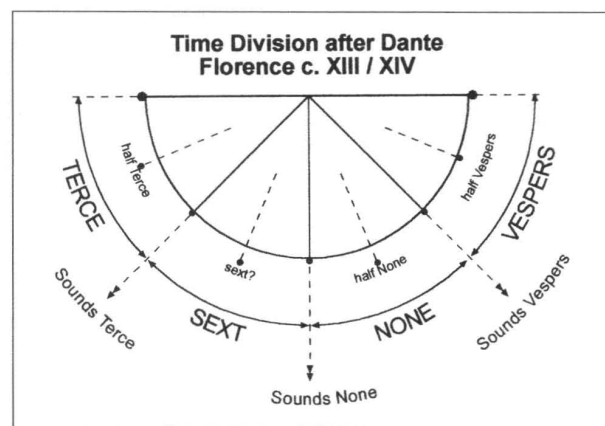

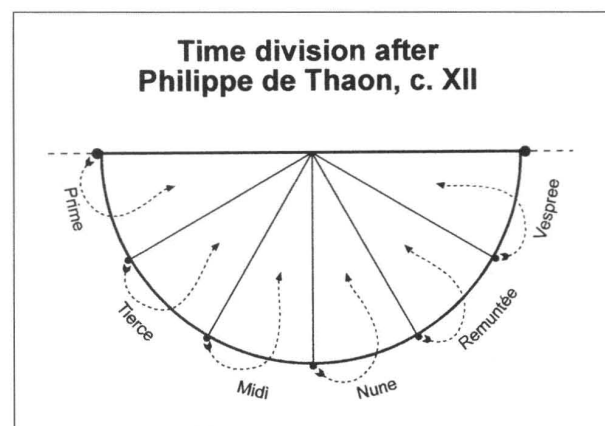*Fig.1. Time division scheme after Dante Alighieri, Florence, Italy, c. XIII.*

Fig.2. Time division scheme after Philippe of Thaon, France, c. XII.

The *"remuntee"* hour, the strange time located by the author after None, helps us to understand this matter. The *'remontée'* hour, or *'remontiére'*, also called the time of *'ravaler'* or *'relevée'*, was the time of the waking in the afternoon following the short break for the noon meal, or, as we may read in the old statutes, the final moment of the afternoon rest of the workers[12]. This hour is exactly located between *'basse nonne'* (lower None) and *'vespre'* (Vespers), sometime called *'haute vespre'* (highest Vespers).

Once again, as we have indicated in other articles[13], the service of None is confirmed as the hour of the noon meal. If we follow the meticulous research of Gustav Bilfinger[14] about the popular way to name day hours during Middle Age, we surely have no doubts in fixing the 'remuntée' time on the final line of the eighth hour, which is the end of the fourth section in a six-sectioned medieval sundial. And this line marks precisely the hour at which, during the summer months, the resting period that had started a little after midday, ends. We may read this in the thirteenth century Book of Usages of the Cistercian monks[15].

TEMPORAL HOURS AND ZODIACAL SIGNS

It is, of course, nowadays clear that there is a strong relationship between temporal, also called seasonal, hours and the movement of the ecliptic. Numerous older authors have expressed this.

In the eighth century, Bede was one of the first medieval writers to give us testimony, even if veiled, of that relationship. One hour, he writes in his *De Temporum Ratione*[16], is partitioned in fifteen 'Parts'. The 'Part', writes Bede, takes its own name from the peculiar partition of the Zodiacal circle *(Partes a partitione circuli zodiaci)*. One Sign is made by thirteen 'parts', that are like two equinoctial hours, half of a Zodiacal sign is like one hour and that is the time used by a half sign to ascend or descend over the horizon. This is almost what Byrhtferth of Ramsey says in his *Glossae*. With this, Bede considers the constant everyday rising of six Zodiacal signs over the horizon, as the cause of the different length of the days during the four seasons.

Honorius d'Autun writes more or less the same things *(Unum ergo quodque signum per duas horas oritur, per duas occidit;* 'Every Sign takes two hours for rise and two for set'). But this is not satisfactory enough to let us see a specific relationship between the division of the temporal hours and the movement of the ecliptic.

William of Conches, in his famous treatise *Dragmaticon Philosophiae*[17], seems to confirm what we just supposed. His method of describing the notion of the 'hour' is so persuasive that Vincent of Beauvais (1190 - 1264), notwithstanding the well known descriptions of significant authors, like Isidore and Bede, just avails himself of William's *Philosophiae* in writing the chapters *'De partibus temporis et proportio de momentis et horis'* (Of the division of times and proportions of the moments and the hours) and *'De distinctione horarum equinoctialium in ortu et occasu signorum'* (Of the difference between the equinoctial hours during the rise and set of the zodiacal signs) of his well-known encyclopaedic work *Speculum Maius*[18].

THE DRAGMATICON PHILOSOPHIAE OF WILLIAM OF CONCHES

It is not at all easy to unite the many aspects of the subject considered by the medieval authors. Often their assertions are less lucid than they may have believed, so we need to read between the lines and, taking great care, put together all the pieces. But William of Conches, one of the most representative luminaries of the twelfth century scientific-theological renewal of Chartres, is not so obscure. He, better than others, explains some concepts relative to the time-computation related to the movement of the zodiacal signs.

William exposed this concept so carefully that he writes: *"Every day has XII hours, and every night also XII. In fact, every day six zodiacal sign rise and every night the other six"*. and Vincent of Beauvais adds: *"What is called Zodiac is partitioned in XII equal parts said Signs,and sometime the day is long, sometime short, and the same at night"*.

As we noted above, the leading texts of that time concerning computation were those of Bede and Isidore, and such authors as Hrabanus and Honorius rested their theories chiefly upon them. In their books the hour is always defined as the twelfth part of the daylight.

William, on the other hand, determinedly assumes a new definition of the term 'hour': "the hour is the time employed by a half zodiacal sign to rise or set *(Hora est spacium in quo dimidium Signum oritur)"*. With these few and clear words William of Conches overturns the old version of the hours' meaning, and, most importantly, he links its length to the real motion of the zodiacal circle. Bede and Honorius d'Autun required every sign to rise at intervals of exactly two hours; William, on the contrary, establishes the length of the hours according to the right times of the constellations. His thesis owes much to Martianus Capella for his explanation of the right and oblique ascensions times of the twelve Signs[19].

NICOLAUS OF LYRA AND THE SUNDIAL OF KING ACHAZ

In the thirteenth century we find certain medieval authors describing time divisions employing different methods. One is a well-known Biblical commentator, the Norman Fransiscan, Nicolaus of Lyra (1270-1340). We refer to him here because of the passage in the Fourth Book of Kings concerning the miraculous falling back of the shadow on King Achaz's sundial by ten steps.

Discussing what had happened on that famous occasion, Nicolaus indicated two ways by which the length of an hour was understood during his own time[20].

"Some men" - he wrote - "say that two lines (on a dial) make one hour, ... On the other hand, others say that one hour is shown by each dial line..."

Notwithstanding this, the drawings in the manuscripts do not show dials correctly divided into six parts but always into twelve. This could be an error made by the illustrator, but nevertheless many European sundials testify to the use described by this author. It is not unusual, in fact, to find medieval sundials twelve-partitioned but with the double hours marked with crosses or some other special graphic, as shown in Figure 3.
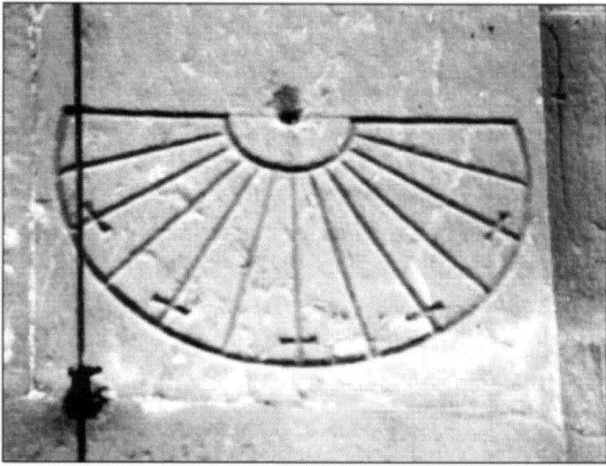
Fig.3. Medieval sundial on the Schöngrabern parish church, Grabern, Austria – lat. 48° 36'N; long. –16° 04'E. (photo by Karl Schwarzinger)

THE COMMENT OF FRANCESCO DI BARTOLO DA BUTI ON THE DIVINE COMEDY

In his Commentary to the *Divine Comedy* of Dante Alighieri, Francesco di Bartolo Da Buti (1324 - 1406) expressly refers to the relationship found between the twelve hours of the day and the zodiacal signs[21]. His work, although long known among scholars, was publicised only five centuries later and perhaps did not obtain its deserved recognition. But for us who take an interest in both gnomonics and the history of the time his work presents some points of real attraction. As I have already written in a preceding article[22], commenting on the first tercet in the fifteenth song of Dante's Purgatory, Da Buti writes clearly about a six-parted daily division.

A first idea of what he thinks about is written in this little passage:

"In these five tercets, Dante denotes the time, and shows what happened to him, telling that the same space, between the ending of the third hour...; that means that the Sun has mounted up from the horizon to that point where is told Terce, because this is the third part of a half day".

Here he gives us a strange, but arguable, etymology of the Service of Terce. In a few words, he tells us that that canonical hour is so named, not because it is the third hour of the day, but because it is only the third section of the space that runs between dawn and midday. His statement leads to a more accurate explanation of the division of the day in the period in which the author lived.

"And because I want to be more clear, we must know that our hemisphere is divided into six equal parts, from the east to the west. So the Sun mounting in the morning for the first part does Terce; for the second does Sext; for the third,

None and we have reached half of the day: then the sun begins to descend, and descending the first part, it does half Vespers; for the second does Vespers; and for the third, Evening".

Six hours a day, and another six at night; an uncommon hourly division, but recognisable in many medieval sundials. The learned man continues:

"I will mark for ternary numbers those twelve parts up to 36, beginning from this last number, in order to complete twelve Signs (zodiacal constellations), because six come up in the day and six in the night. So at number 3 is called Terce; and at 6, Sext, and to 9 None, and descending from the ninth to the twelfth it does half Vespers, and then to the 15 it does Vespers; and at 18, Evening" (Fig. 4).
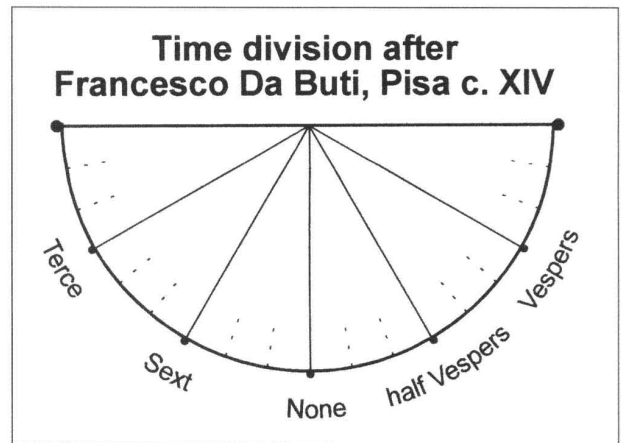

Time division after Francesco Da Buti, Pisa c. XIV

Terce

Sext

None

half Vespers

Vespers

Fig.4. Time division scheme after Francesco di Bartolo da Buti, Pisa, Italy, c. XIV.

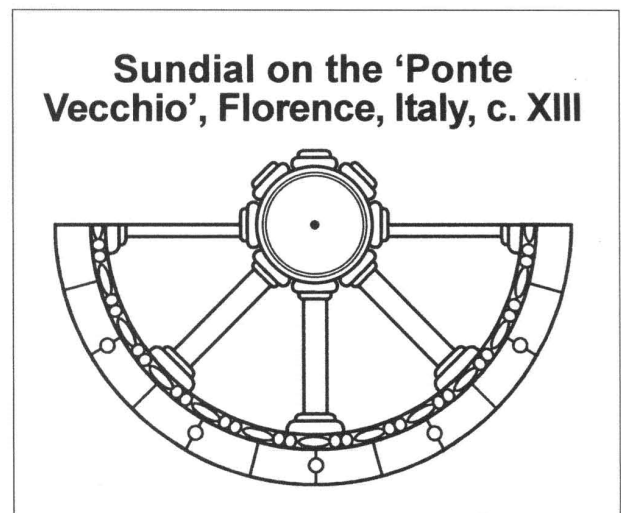**Sundial on the 'Ponte Vecchio', Florence, Italy, c. XIII**

Fig.5. Medieval sundial on the 'Ponte Vecchio', Florence, Italy, XIIIth Century. On this dial are visible three medieval time systems living together: four divided by the wheel spokes, six divided by the nail-head-shaped reliefs on the outer board, and twelve divided by the radial lines on the external border.

The author here tells us no more. He does not reveal to us, for example, the origin of this daily division. But from his words may be clearly understood the teaching role of William of Conches or, if we prefer, of the French School (see Philippe of Thaon). Surely this teaching was filtered by Italian usage and relates almost exclusively to a canonical system. Maybe it is one of the last ecclesiastical systems of measuring time to be found before the definitive disappearance of seasonal hours[23]. The old sundial on the Ponte Vecchio in Florence is one of the extant examples of the natural coexistence of the many hourly systems together in Italy (Fig. 5).

CONCLUSION

With the knowledge we have it is hard today to draw unquestionable conclusions, nevertheless we would like to try. The flourishing of scientific and philosophical thought in the medieval French and German Schools took place in the twelfth century. At this time the Roman division of the day into four parts was slowly given up, and new hypotheses formulated on the division of the day, either natural (twenty-four hours) or artificial (twelve hours). The introduction of the new Arabic texts into the Christian Europe of the Middle Ages spurred on the eleventh and twelfth century minds to read or re-read the classical books, then mostly previously unknown. The spread of the new scientific instruments, like the astrolabe and the quadrant, encouraged more and more men to verify the many astronomical and astrological theories. These innovations probably regenerated the division of the daytime into six portions, or double hours.

The relationship between the hours and the constellations, behind the logical heavenly mechanics, was already felt in the ninth and tenth centuries. Gregory of Tours, for instance, firmly pointed to the observation of the stars in order to know the right time for night prayer[24]. Handbooks, mostly reminder sheets for the monks nominated to make the night calls, were drawn up in many monasteries[25]. A well-known example is the famous poetry of the Archdeacon Pacificus from Verona on the *Horologium Nocturnum* (nocturnal clock). So renowned is it that we find it copied in many manuscripts.

Concluding, we may say that the double hour divisions of antiquity had a revival, after many centuries, in the educated and scientific environment of the great medieval schools, and made fit for the usage of those days. But there were six canonical hours too, and very often they did not correspond at all with their original place in a sundial, at the third, sixth and ninth temporal hours. The easy construction of the medieval sundial on a wall led the monks of that epoch to use a base graphic model made with six lines in a semicircle, all equally spaced. It was, after all, easy to subdivide the quarter into three sectors. Handiness was more important to small religious communities living in country monasteries than making scientifically laid out dials. The anticipation of the canonical time of prayer was already deeply rooted in the twelfth century in Europe. This fact made inaccurate the reckoning of the right canonical times on the old four-sectioned sundials, and those, which were twelve-divided, were less practical. So it was extremely easy to remember the canonical hours just grouping the temporal hours twice at one time (as confirmed in the words of Philippe of Thaon). And then again they added preciseness to the four-sectioned dials and simplicity to the ones with twelve sectors. The six-divided day was, therefore, a suddenly well accepted new practice, and this is demonstrated by the very large number of sundials of this kind extant in France and Germany. From there they spread out to the closest nations linked by the great medieval pilgrimage roads.

ACKNOWLEDGEMENTS

Author's address:
Viale Leonardo 82
48020 Lido Adriano-RA
Italy

NOTES

Note 1. Bilfinger cites as testimony many very well known authors of the first three centuries. But because I want to study the middle age epoch, I just pass them now.

Note 2. *Demurée,* here takes the old meaning of 'to rest'; so, the Demures are simple amounts of time, as the Saxon *Tides.*

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PHOTOGRAPHING SUNDIALS

ANDREW JAMES

If I had to condense this article into three points, it would be "Carpe Diem" (seize the day!); use a tripod; and think carefully what the camera sees before you press the shutter.

The first is obvious; it is impossible to get a really good photograph in poor light (although the BSS Web site Dial of the Month recently featured a flash photograph taken after sunset ...). For the second, many fixed dials - unlike mass dials - are best photographed with long focus lenses or small apertures leading to long exposures. Both these need a steady platform for the camera - ideally, a tripod and cable release. Any support to steady yourself or the camera will help - can you somehow rest it and perhaps wedge up the lens?

Some thoughts on equipment: there is a huge range to choose from. Owners of medium or large format cameras, capable of giving the best possible image, should not need to read this article! As an amateur photographer, for twenty years I have used the same 35 mm single-lens reflex (SLR).

I used to use a 28-200 mm zoom lens all the time, but gradually acquired several fixed lenses instead; second-hand they are quite cheap and give better results than a wide range zoom. Some dials really need a long focus lens, as demonstrated below, so I have a 200 mm and a very unwieldy old 400 mm.

As I tend to travel to the scene by car, I do not mind carrying an SLR and a bag full of lenses, but compact cameras can give very good results, especially with a zoom lens; I have one and use it a lot. However I do feel that the Advanced Photo System with its smaller negative size was developed for convenience rather than image quality. Digital cameras are improving rapidly but at present they still cannot give results as good as film, particularly if long focal length is needed ("digital zoom" does not help here); but the better ones (still expensive) are more than adequate for many photographs and have the advantage that you can see instantly what you have taken. It is even easier to manipulate the image afterwards with software: nowadays

the camera can almost always lie. A specialist camera shop is a great source of expert advice and should be very helpful if you are a good customer.

But remember; anyone can take a bad photograph with a good camera. I certainly do not want to discourage anyone with simpler equipment from taking a photograph, because. whatever you use, care, thought and patience will be well repaid. It is also the case that travelling to a dial often costs a lot more than a few photographs so an extra shot or two are cheaper than a revisit when you realise what you missed. Some cameras will not allow you to override their decision on how to take the picture and this can be a problem.

An automatic exposure system - and the automatic printing machines used by film processors - has as its ideal a nice uniform grey scene and pushes everything towards that. So colour film printing will regard a photograph of a small white stone dial against a lot of green grass as altogether too green and compensate by making both grass and white stone more magenta. I cannot show this in black and white but Fig. 1, made from three prints, gives an even more striking example.
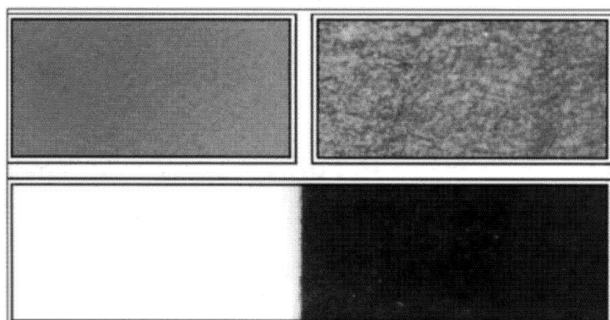

Fig. 1. Top left quarter - white paper only. Top right quarter - black felt only. Bottom half - white paper and black felt.

Using automatic exposure, I photographed first a sheet of white paper, then a piece of black felt, with each filling the frame in the same good light. The camera reacted by giving a short and long exposure respectively to make them the same grey; only the texture of the felt, not the colour, shows the difference. I put the felt on the paper, so that it came to the centre of the field of view, and the camera saw left-hand half white and right-hand half black. The resulting photograph is shown in the lower half of Fig. 1; with a correctly averaged exposure, paper and felt appear white and black as expected. You can thus see how a bright sky background will tend to make the camera underexpose a stone dial on a column. Exactly the same applies to a white dial filling the frame. Many skilled photographers take an exposure reading off a grey card with 18% reflectance in front of the camera. If you have no card, just use your hand

and increase the exposure it indicates by one stop. It is important that card or hand are in the same light and direction as the surface of interest - if the dial is sunlit then it is no good taking a reading with the card in the shade of a tree!

It is best to use as much as possible of the frame for the subject, rather than enlarge part of the photograph later. Beware that automatic processing crops all the edges of the image slightly so something that just fits in an accurate viewfinder will be truncated on the print. To have the negative hand-printed to get round this is very expensive by comparison with standing a little further back and allowing a small margin when composing the photograph. This applies particularly to the height (shorter) dimension. Some camera viewfinders deliberately allow for this, so it is a good idea to check by taking a photograph, noting exactly the edges the viewfinder indicates, then comparing with negative and print.

INACCESSIBLE VERTICAL DIALS

Fig. 2. Bodicote. 50 mm f/8 automatic exposure. Compensating for the tree shade in the foreground has made the whole sunlit dial area so pale that it is hard to pick out.
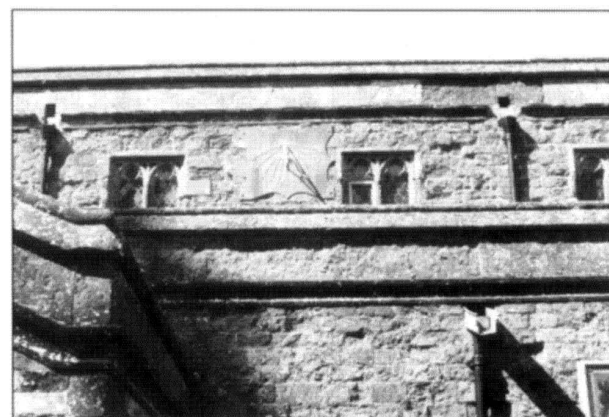

Fig. 3. From 40 feet, the best I could do with a 50 mm lens.

Figures 2 to 5 show St John's Church, Bodicote, Oxfordshire, where a modern dial SRN 1694 - apparently made of lead sheet - is on the nave wall below the parapet. The South aisle prevents a close view and so a long focus lens is essential for best results. Note the effects of reflected light and automatic exposure averaging on the view on a sunny afternoon.
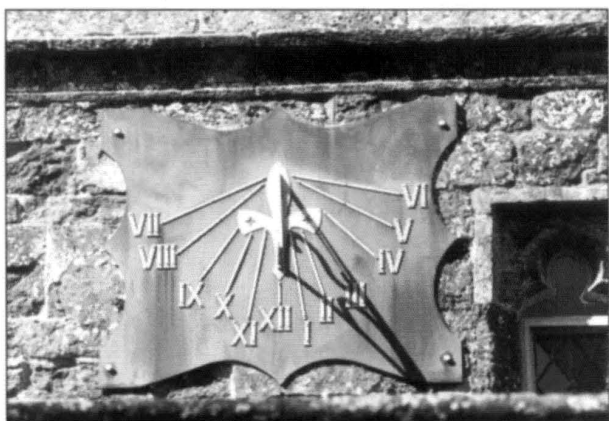

Fig. 4. A 200 mm lens gives a good view from the same spot. The shadow clearly shows the gnomon shape. f/5.6, 1/1000.
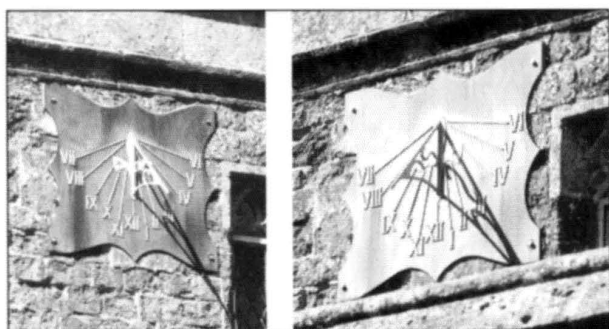

Fig. 5. Views from SW and SE show how the appearance of the gnomon and applied white numerals and lines changes according to the reflection off the dial surface and whether the sunlit or shady side is visible. 200 mm f/11 1/200 80 feet.

Figs 6 and 7 show SRN 1336 at St Mary's Church, Bloxham, Oxfordshire, some 30 feet up on the tower. Trees prevent a direct view from the South at a comfortable angle of elevation. In estimating the size of such a dial and its height-to-width ratio one must allow for the skew of the viewpoint.

HORIZONTAL DIALS

In contrast with vertical dials where often it is difficult to get a close enough view, horizontal dials present an opposite set of challenges. It is often hard to get far enough above the dial to get an image that fits in the frame yet is not too oblique. Although I am tall I often wish for a nearby hot-air balloon or at least a stepladder. A wide angle lens can help though it will make the top part of the gnomon
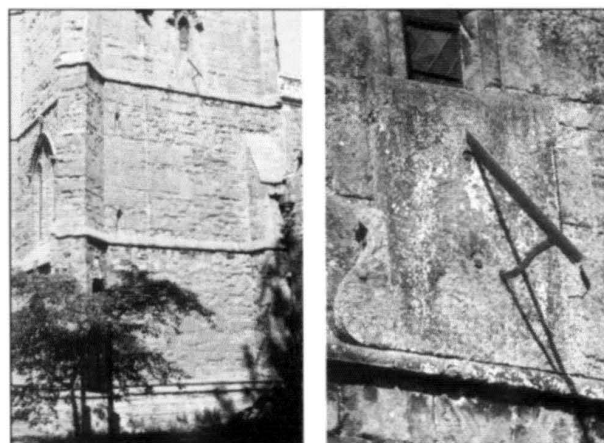

Fig. 6. Left, a general view of the tower from about 60 feet. Note the shadow of trees which prevent a direct view. Right, a 400 mm lens from a little further back on the churchyard wall gave a print in which the inscription can just be read.
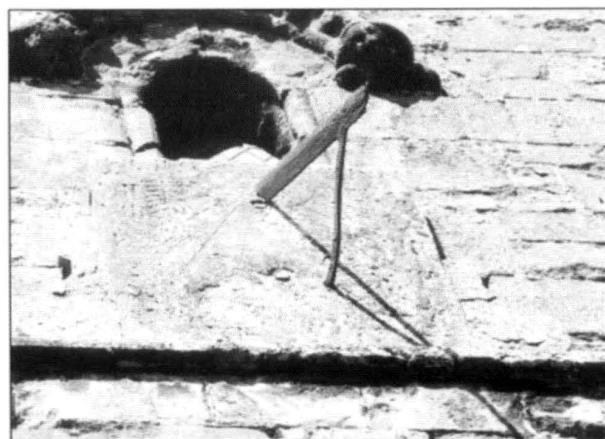

Fig. 7. Much too close - looking up at the dial from 4 m from the base of the tower results in very severe foreshortening of the dial and a curious view of the gnomon - but it does show some markings and the way corrosion follows the grain of wrought iron! 200 mm, f/11, 1/250, 40 feet.

disproportionately large. It is possible to get a better viewpoint by holding the camera at arms' length above the dial - and even to hold it further above the dial by grasping the tripod legs and setting it on self-timer - but it is very helpful in this case to have an assistant to tell you where it appears to be pointing and it is also easier if it has auto focus. If you do not get blurred photographs of half dials or of your feet then you are better at this than I am!

Whereas a perpendicular view from directly above is ideal to show the scale and layout, it will not show the gnomon, unless by its shadow if the light is favourable; see Fig. 8. A particularly fine gnomon merits a horizontal shot from due East or West, whichever side is lit, to give an undistorted view. Generally a compromise view is easiest, but it is a good idea to study the dial very carefully from all

angles before deciding on the viewpoint. Will the gnomon stand out against the background (Fig. 10)? Will it obscure the scale, and if so what part? Will it be confused with its shadow?
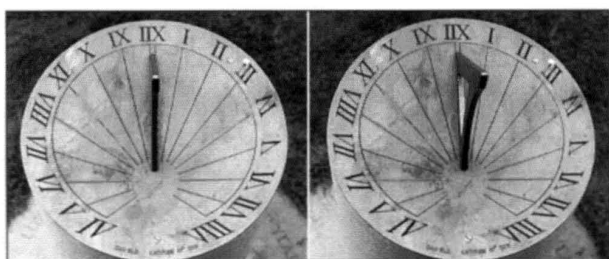

Fig. 8. In Aldbury churchyard, Herts. (reported to Register), on a dull afternoon. Left, a centred vertical view; right, a displaced viewpoint makes clear that the gnomon is reversed.

If you take an engraved dial with the Sun behind you the engraving will on the whole be lit and show up less. If the dial is between you and the Sun the further edges of engraved lines will be more or less shaded depending on the solar altitude. However a bright specular reflection may cause a problem. In fact hazy bright sunshine can provide excellent conditions for using the reflection to enhance contrast. Sometimes wetting the dial can help to show faint markings. The sky reflection can make a bronze dial look like silver or stainless steel - this may be ideal for showing markings but another view showing the true colour is useful. Flash, when mounted on the camera, is generally unhelpful with engraved dials; but I would be interested to learn of others' experience in using off-camera synchronised flash at a glancing angle. Unfortunately, of course, the best view for lighting may be poor from other considerations.

Having decided the viewpoint, pause and check that the camera can actually see what you think you can. It is easy to imagine that you can see something which you know to be there and important but is really invisibly small or hidden!

Be careful about focussing on the correct part of the dial. With a relatively shallow view, from further to one side than above the dial, the ratio between the distances to the far and near sides of the dial is usually considerable and this means that one or other or both will be out of focus - it is a question of balance, and it is best to focus slightly in front of the centre of the dial. Beware an auto focus camera "looking" past the dial to give you sharp grass. To get as much sharpness over the whole dial as possible requires a small aperture - say f/16 or less. This leads to a long exposure - and in the absence of a tripod, camera shake may result in the whole photograph being blurred, not only the parts that are out of focus!

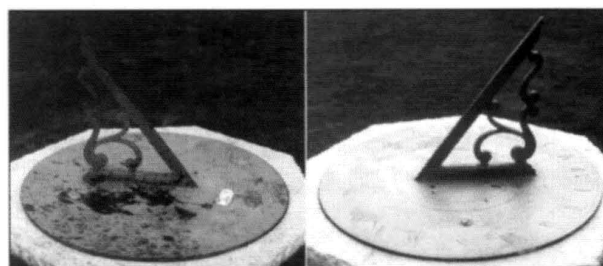## LIGHT, SHADE, REFLECTION, AND CONTRAST

Fig. 9. SRN 1726. Left, from West. Right, from East.
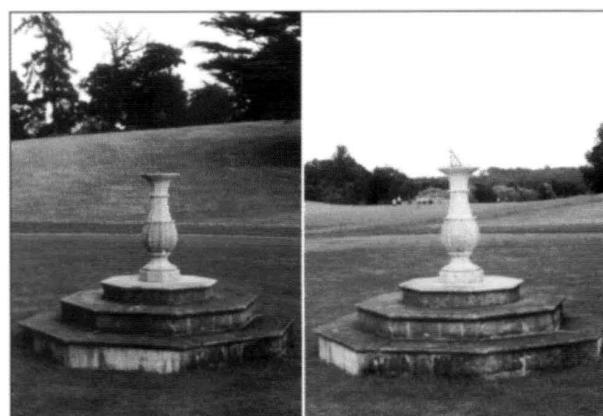

Fig. 10. On the left, the gnomon is invisible against the grass which is of similar tone. Move a few yards South (note the light side to the plinth) - the gnomon miraculously reappears.

Figures 9 and 10, taken with a 50 mm lens on a cloudy bright August afternoon, are of SRN 1726 at Calke Abbey, Derbyshire. Sadly, its surface is so corroded that almost no detail is left. Fig. 9 shows views from West (sun behind me) and East (sun beyond dial). On the left the dial shows areas of differing patination and bird lime, and the top part of the gnomon is lost in the background. On the right the patination difference and white patch have disappeared, engraved numerals can be seen, and the dark side of the gnomon stands out against the lighter grass. Of course the colour prints show more; the former yields detail of the sunlit gnomon surface condition, and some dial engraving can just be seen - and in a more realistic colour - while the latter gives a better idea of the rough and hopelessly corroded state of most of the surface as well as showing the numerals and lines quite well.

OTHER TYPES OF DIAL

Multiple dials generally have some surfaces in shadow, as often do those which decline greatly. Ideally, a second visit at the appropriate time - and in summer in the case of North dials - would find them sunlit. However remember Carpe Diem; do take a photograph anyway! Take care to bring out the number of faces - a direct view can make an eight-sided dial look very like a six-sided one. As explained above, a North dial (and for that matter an East or West) seen against

a bright sky should be exposed according to the light reflected off the dial not the whole scene. An automatic exposure will allow too much for the bright unwanted sky and the dial will be underexposed, possibly by several stops. The print will in any case tend to make the dial too dark, but if the negative is good it can be reprinted at a more appropriate exposure.

Equatorial dials tend to present difficulties of depth of field and very often problems of one part hiding another. If you find a winter equatorial surface (as underneath SRN 0475) during summer then the exposure remarks for North dials apply; of course the winter light would be much better. I often prefer to use a longer focus lens on a tripod from some distance away, and multiple views and/or close-ups to assure coverage. An auto focus camera is very likely to look straight through an open-work armillary dial and focus on the background; check the instructions to see whether you can override this, usually by half pressure on the shutter release.

Analemmatic dials are also awkward as it is usually impossible to get far enough above them for the numerals to show up well. A wide angle lens can help although the nearer hours will look much bigger than the further ones. One or more views of the central date scale from nearly vertically above will show it more clearly than any general view; a wide angle lens will often just get it all in (together with your feet).

Stained glass dials are rare, but it is worth remembering that their colours depend on what is seen through them, ideally a light grey sky; green trees beyond will turn red glass to black!

SUGGESTIONS FOR REGISTER PHOTOGRAPHS

A photograph adds greatly to a report. Of course an imperfect photograph is better than none at all. Ideally, though, it should be taken in good light, fill the frame, show the dial to best advantage and be such that it could be used to re-create the dial if stolen or destroyed. It will need to show both gnomon and scale clearly and without obstruction and this often means more than one view. For horizontal dials another view should show pedestal and location. If there is additional detail visible (signature, details of scale, coat of arms ...) then that should be recorded in two or three extra photographs. (Some form of close up extension capability or macro lens will be ideal in the case of a horizontal dial.) If there is a particular difficulty in getting a good photograph - bad light or weather, too far away, unsuitable equipment, poor access - then send whatever you can and explain the problem; someone else may be able to do better. Although the Registrar accepts all kinds of photographs, and indeed for

giving lectures transparencies are essential, 6 x 4 inch glossy colour prints are preferred as they are easier to handle - and an A4 paper copy is a bonus as it is bound into the Register, while the print goes to the archive. It is a good idea to check the photographs carefully against the report form before submission, as it is very easy to err in filling in a form or copying field notes; I know how often I notice, or can decipher, something on the photograph that escaped me in a windswept churchyard!

USING THE CAMERA TO ESTIMATE SIZE

It is worth remembering that if you know the distance to the subject D then its size can be estimated from its appearance in the viewfinder or the negative knowing the lens focal length F. For 35 mm film the image is 36 x 24 mm so the field of view is 36 x D/F wide and 24 x D/F high. The factors are fixed for a given lens and film, so here are some numbers for common 35 mm lenses: multiply them by the distance in <u>metres</u> to obtain the field of view in <u>millimetres</u>.

Lens	Width	Height
35 mm	1030	690
50 mm	720	480
135 mm	270	180
200 mm	180	120
400 mm	90	60

This is particularly useful with a long focus lens and an inaccessible dial; remember that its height is foreshortened by the cosine of the angle of elevation of the view. For example, if you are looking up at 30 degrees from the horizontal then the apparent height is $\cos(30°) = 0.866$ times the true height, so you need to add about 15% to the estimated figure. Of course the same applies to the width for a sideways view.

CONCLUSION

I hope these thoughts will be helpful to dial photographers with all kinds of equipment, and not just those weighed down with many lenses. In most cases an informed photographer can get better results than one who is merely well-equipped. For many reasons, not all dials have been well photographed in the past, and recording their changing condition is always valuable; so if you notice one such, have a go, and you may be able to improve the Register - and do have fun in doing it!

ACKNOWLEDGEMENTS

THE CONFERENCE AT CIRENCESTER, MARCH 31-APRIL 2, 2000

MICHAEL LOWNE

The eleventh Annual Conference of the Society was held at the Royal Agricultural College and Conference Centre at Cirencester, a pleasant location in the Cotswolds. About 100 members were present, among them many faces new to Conference.

The proceedings followed the well-established pattern of arrivals on Friday afternoon, with ample time to greet friends before the evening meal. The first talk of the evening was given by Julian Lush, who described two dials he has made and installed at his home in the French Pyrenees. He gave explanations of the references to the mythology of the region which are incorporated in the vertical dial.

An informative and amusing talk by Roger Bowling followed, on garden dials from their earliest representations in 17th-century illustrations to modern dials in contemporary settings. The emphasis was very much on the use as a garden centrepiece, quite the proper function for a sundial.

On Saturday morning Allan Mills gave one of his interesting and information-packed talks, illustrated with practical demonstrations. This year's subject was ancient methods of timekeeping in the absence of sunlight, by means of sand-glasses and particularly water-clocks whose properties and development from sinking bowls to Chinese water-driven mechanical clocks were explained.

Next Jill Wilson took us on a photographic tour of sundials in her home town of Chipping Camden, with brief historical summaries. I lost count of the number of dials we were shown, mostly occurring in the length of a few hundred yards of the main street and ranging from medieval mass-dials to 20th-century instruments.

Sir Mark Lennox-Boyd talked about the reflecting and aperture dials which are to be installed in the stair-tower of a house (called La Meridiana) at Coemese, in Italy. The project has been described in Bulletin 11, (iii), page 148 (1999). This talk generated great interest and many comments from the audience, and the speaker was offered much advice, some of it contradictory!

Presentation of the awards to winners in the Award Scheme came next. A full report of this has appeared elsewhere, but as a member of the Awards Sub-committee I was impressed by Alan Smith's masterly distillation of about five hours of discussion into a two-minute summary! In accepting the major award, Dr Frank King amused us with the story of trying to persuade a scaffolder to move one of his scaffold poles out of the line of sight of the noon sun.

Saturday afternoon saw the welcome reinstatement of the coach tours around local sundials. Two trips were offered with slightly different itineraries: I chose the one which visited the church at Fairford, with a mass dial and a magnificent collection of medieval stained glass windows, the most complete set in the country. From there we went to Bourton-on-the-Water where Tony Wood mentioned five dials to see, in various stages of preservation. Four of these were easy to find but the fifth could only be distantly seen over a garden wall. By then the rain was coming down fairly steadily and we were glad to board the coach for the final call at the largely Norman church of All Saints, North Cerney. Here there are three dials, a well-preserved mass dial, a rather decrepit vertical dial and a badly-eroded horizontal dial on a bracket projecting from the south wall. On the outside walls are the incised outlines of two manticores, fearsome creatures with human heads and arms, animal bodies, porcupine quills and tails of scorpions. They are said to be man-eaters and are clearly best avoided. Inside the church are many items of interest, including a 15th-century stone pulpit and a relatively modern reconstruction of a medieval rood loft. Some agile members climbed its steep and narrow stairway.

After the Conference Dinner in the evening Tony Moss took us through the properties of various metals and alloys and their suitability for sundial use. Of interest here is the 'electrochemical series' from which can be deduced the likelihood of corrosion due to electrolytic action between two dissimilar metals in contact.

The auction of sundial items followed. I found this rather disappointing: the items offered for sale were fewer than in previous years and seemed to consist mainly of back numbers of various journals. Nevertheless, the Chairman as auctioneer managed to arouse the bidding enthusiasm of the audience, with the result that £123 was raised for Society funds. Perhaps it is time that this event was rested for a while. After the auction David Young was presented with an elegant set of twelve silver-plated spoons with a sundial

motif, in recognition of his ten years' service as Secretary to the Society.

Proceedings on Sunday morning were opened by a male-voice choral tribute to mothers on Mothering Sunday, organised by David Pawley. This demonstrated that sundial aficionados are not noted for their singing abilities. To our disappointment we learned that due to urgent family matters the Andrew Somerville Memorial lecturer, Dr J A Bennett, would be unable to attend.

The first speaker was Peter Ransom, attired in a nautical costume complete with eye-patch. His subject was the use in navigation and surveying of simple angle-measuring devices such as the cross-staff. A little audience participation was involved: Martin Jenkins used a cardboard cross-staff to derive the width of an object at a distance with fair accuracy. Even the human hand can be used as a simple angle-measuring device, as was shown when Jim and Jackie Holland confirmed that the angle subtended by the width of the four fingers at arm's length is quite consistently eight or nine degrees.

The final speaker was Barry Mason, who showed us slides of his 'Helios' sun-related sculptures, both actual and projected. In these, he has successfully married the functions of dials, noon-markers and calendrical indicators to attractive sculptures, some with water features. One design (Helios XXII) is described in Bulletin 98.3, page 8.

In the absence of the Memorial lecturer, the Annual General Meeting was brought forward to the morning after-coffee slot. This was in some ways advantageous: some members with long distances to travel who intended to depart early were able after all to attend the meeting. The Secretary's minutes of the AGM will appear elsewhere. The taking of the group photograph was enlivened by Robert Sylvester's annual athletic display to get himself in the picture after releasing the exposure-delay of his camera, which this time involved the leaping descent of a stone stairway. Thus concluded the eleventh Conference and after lunch the meeting dispersed, although some groups were still to be seen in animated discussion, and some visited the handsome turret clock of the Royal Agricultural College.

The traditional Conference features were all present. The Society bookstall did a good trade, with the new Sundial Register compiled by Patrick Powers the chief attraction. The Rogers, Turner bookstall seemed rather sparse this year, unless of course the best items had been snapped up before I got there.

The members' exhibition was well supported, with interesting displays of dials and other gadgets. Of particular interest to me was John Moir's rainbow dial, which uses the radius of the bow from the antisolar point (42°) in combination with the date and the latitude to find the time. It can also use the antisolar point (effectively the shadow of one's head) to derive the time. As far as we both are aware, this is an original concept.

In spite of the disappointing absence of the principal speaker this was certainly a successful Conference, with well-balanced talks, in an attractive locality. Our thanks go to the organisers, Doug Bateman, David Young and Tony Wood for all their hard work in the preparation of the event, and to the College staff: the first-class catering deserves especial mention.

Author's address:
24 Ditchling Way
Hailsham,Sussex,BN 27 3LU

BSS ANNUAL GENERAL MEETING 2000

Minutes of the 11th Annual General Meeting of the British Sundial Society held at The Royal Agricultural College, Cirencester, 2 April 2000.

The meeting was opened by the Chairman, Christopher St J H Daniel, at 11.50am. Approximately 90 members were present. The Chairman remarked that the Society had had a good year. The only organisational changes were the previously planned handover to the new Secretary in January; and also the present Treasurer, Peter Ransom, wished to step down with effect from this meeting.

Apologies were received from Anne Somerville, Mr and Mrs Evans, Owen Deignan, Mr and Mrs McVean, and Graham Aldred.

The minutes of the 10th Annual General Meeting held at Dunchurch on 2 May 1999 were read by the Chairman. The minutes were adopted and signed: there were no matters arising.

SECRETARY'S REPORT

It had come to the attention of the Society that the Horniman sundial trail was being closed due to a massive

rebuilding project. A meeting had been held between officers of the Society and the Museum authorities to ensure that the museum would not lose interest in the many dials. The rebuilding work may continue until late 2001 and the museum had given assurances about the sundials.

Articles in the press continue to appear and 1999 was no exception, with many enquiries following such articles. Planning is well under way for the Scottish Tour on June 3 -11 with 35 members enrolled. The Society has produced its first monograph. It is on the ancient sundials of Ireland by Mario Arnaldi (translated by the late Charles Aked, edited by David Young). The monograph is available to members and will be promoted through booksellers, especially in the Irish Republic. Another monograph is planned; this is a comprehensive glossary of sundial terms. The lead has been taken by member John Davis. The change of secretary has been reported to 5 separate directories and some libraries. An academic enquiry arose from the Chalmers University of Technology, Sweden on a certain aspect of medieval dials. The response from 3 of our experts - A Mills, P Powers and C Daniel, was extremely well received. Other enquiries have been from a school, from the Carne Funnock Gardens, Larne, and other groups. Future conferences have been considered, and for 2001, the conference will be in York. Finally, a special mention must be made of another successful one-day event in Newbury organised by member David Pawley.

TREASURER'S REPORT

The treasurer reported that the Society's financial situation was sound with some £28,000 in hand. Book sales had done well, and major planned expenditures had been the new register (£2490) and the Award scheme (£2500). Both are within the remit of the Society and therefore legitimate, if large, expenditures. Reserves are invested in a special fund that caters for charitable organisations. The treasurer did, however, state that the subscription year would be easier to administer if it ran from the 1st of January each year. He also recommended that the joint membership with the North American Sundial Society, and the five year subscription, be reviewed. Both caused significant accounting problems. On the other hand, credit card payment schemes could be useful. The treasurer pointed out that the subscription had been constant for some time, and if reserves were to be maintained, or capital held for publication projects, then the subscription may need to be increased. There was some debate over details in the accounts, and the treasurer conceded that his apportionment of some expenses had distorted the picture for these items. Another recommendation by the treasurer, partly prompted by queries from some members, was that the whole membership see the accounts, (and not just those attending the AGM), and that the Bulletin should eventually carry a report. The treasurer said that he would endeavour to clarify the points raised in such a report. Nevertheless, the balance sheet as presented was accepted by the meeting and signed by the Chairman. As a final word, the treasurer (Peter Ransom) had tendered his resignation, and regretted that his current commitments prevented him from giving the time that the Society's accounts required, especially in its current state of complicated membership schemes. On behalf of the membership, the Chairman thanked Peter for his efforts and considerable enthusiasm for the Society.

MEMBERSHIP

The membership secretary reported that the subscribing membership stands at 621. Free membership (27) applies to our patron and president, and associated interest groups and copyright libraries. There had been an increase of 55 since last year. A remarkable 27% of our members reside outside the United Kingdom.

BULLETIN

The editor said that there was no difficulty in filling 3 issues of 52 pages a year. A 10 year cumulative index was being prepared. The editor suggested that recent lengthy articles could be made into booklets. In response to a query, the editor said that the print run for the Bulletin is 600 copies with just a few in reserve (family members, of course, get only one copy)

REGISTER

The registrar reported that while the sightings of dials had peaked in 1994-96, reports were still coming in, with over 300 in 1999. The latest issue of the Register had been timed for this Conference. In terms of a county-wide search, the Northamptonshire WI were embarking on a project to record every dial in the county: advice had been given by members of the Society. Another collaborative project had been with the Imperial War Museum on memorials that also contained sundials. Questions were raised about updated issues and submitting images of dials - digital or photographs. Updates could be supplements ~ either a new book or CD-ROM; nothing was yet decided. Images were still preferred by conventional, i.e. photographic methods.

INTERNET

The webmaster stated that 1999 had seen the introduction of the Society's own web site. It was not intended to compete with the established Sundials on the Internet (SOTI) or the NASS site, but to give information about the Society, and to supply information to members.

LIBRARY

A written report had been received to say that planning was well in hand, the books (about 200) had been valued and the host library was prepared but announcements would be deferred until the books are in place and the catalogue is complete. Consideration will be given to putting the catalogue on the web site.

ADVERTISING

This required quite a lot of effort, but did produce a small but steady income (£418 in the last financial year). Members were exhorted to encourage more advertisers.

MASS DIALS

A successful safari had been held in Nottinghamshire, and another had been proposed for Northamptonshire. The register of mass dials was being transferred to an Access database, prior to publication, ideally in 2000

BIOGRAPHICAL PROJECTS

The list of dial makers has grown to 1173. The biographical details were ever increasing, and it is hoped to produce a comprehensive index system, and possible a publication.

RESTORATION

A written report had been submitted. It was stated that restoration work does not generate impressive statistics! However, 15 enquiries had been dealt with. It was believed that there could be many more because it appeared that the Society is not widely known-about in circles, even professional, that could benefit by our experience with restoration.

EDUCATION

The booklet 'Make a Dial' is still extremely popular, selling 4 or 5 a week. Advice, particularly to schools, is also given over the telephone. The education officer also deals with the sweat shirts, but has no plans for a repeat order this year.

AWARD SCHEME

The scheme has been very successful this year, with no less than 28 entries, and some fine examples of dials. This subject has already been reported on more fully in the June 2000 Bulletin.

ELECTION OF OFFICERS

Alan Smith, as Northern Liaison officer and chairman of the Awards panel, wished to stand down. The Chairman, on behalf of the membership, thanked Alan for all his work, much of it from the inception of the Society. It was accepted that the post lapse, and that a new awards chairman would be appointed nearer the time of the next award scheme. On the other hand, council recommended the creation of the post of exhibitions officer and David Young had been nominated for this post. Gerald Stancey had been formally nominated for the post of treasurer. All the other officers were willing to stand again, and the appropriate nomination sheets with proposers and seconders had been posted during the conference weekend. On a show of hands, all those nominated were unanimously elected.

ELECTION OF AUDITORS

The new treasurer, speaking from experience and the requirements of the Charity Commissioners, stated that the Society's turnover was such that auditors were not a formal requirement, and that checking by a competent person was acceptable. The treasurer pointed out that this could save £400 a year, and he would like to have the freedom to operate either way. It was proposed by Mr Nicholson and seconded by Mr Ashmore, that the treasurer have this freedom. The meeting gave its approval.

ANY OTHER BUSINESS

Mr Young wished to remind the meeting about the publication of The Ancient Sundials of Ireland by Mario Arnaldi: it is on sale at £7.50 to members, £9 to the public. Mrs Bateman suggested that a loop system be available at these meeting, to the benefit of those with suitable hearing aids: the meeting endorsed this. Mr Daniel then made an announcement about the logo. He had decided to register the design, at his expense, with the intention of preserving it for the Society. If, on the other hand, the Society in the future adopted a different logo then the design would revert to himself. The meeting showed its approval for this act of generosity. Mr Lusby-Smith made the suggestion that at future conferences, a dial should be designed for the location and presented to the host conference centre. The Chairman said that Council would investigate this idea, either for a dial or some form of plaque.

The meeting was closed at 1.15pm.

SUMMARY OF THE 1999 ACCOUNTS

GERALD STANCEY (HON. TREASURER)

The following is a summary of the accounts which were accepted at the AGM at Cirencester. Those wishing to have a full copy of the accounts are asked to write to the Treasurer enclosing an A4 SAE

Funds held at the beginning of the year	£30,124.08
Funds held at the end of the year (See Note 2)	£27,384.68
Excess of income over expenditure	£2,739.40
Income received during the year	£36,229.13
Expenses incurred during the year	£33,489.73
Excess of income over expenditure	£2,739.40

Income by major category

Subscriptions (See Note 3)		£12,816.54
Sales (See Note 4)		£1,495.65
Meetings/Conferences		£17,464.00
Other:		
Interest	£1,481.21	
Covenant tax Refund	£781.78	
Donation	£125.00	
Advertisements	£723.50	
(See Note 5)		
Auction at 1999 Conf	£1341.45	
		£4,452.94

TOTAL INCOME **£36,229.13**

Expenditure by major category

Council		£2,980.67
Activities		
Bulletin/Newsletter	£8,787.10	
Computer program	£500.00	
T-shirts and stock transfer	£497.54	
		£9,784.64
Meetings/Conferences(See Note 6)		£15,486.48
Other Expenses		
Computer for Register	£1,573.33	
Internet	£417.50	
Advertising: Manager's expenses	£68.60	
Accountants' Fees	£381.88	
Somerville Lecture	£120.00	
Nottingham Library	£395.00	
Auction 1999 Conference	£650.45	
(Repayments to donors)		
To NASS	£768.44	

UKIC Fee...£31.00
Miscellaneous..£831.74

£5,237.94

TOTAL EXPENDITURE..**£33,489.73**

NOTES TO THE ACCOUNTS

1. The accounts are prepared on a payments and receipts basis: that is, money is booked when it is received or spent. This is in line with the Charity Commission's guidance.
2. The end-of-year funds are held partly in an approved investment account and partly in a current account. They also include £6960 which represents future subscriptions already paid by members paying under the five-year scheme
3. Including moneys collected on behalf of NASS
4. Items sold are ties, books, back-number bulletins, programs etc. Sales are mainly due to Jane and Peter Walker, Margery Lovatt, Anne Somerville, and David Young
5. This is due to the efforts of John Churchill.
6. These include the AGM, NE Trip, etc. Meetings and Conferences are priced in such a way as not to make a loss.
7. Stocks of ties, bulletins, etc are valued at nil as it is difficult to see that they would have any value in the event of the Society being would up. This does not affect our cash flow.

22 Peterborough Avenue
Oakham, Rutland, LE15 3EB

SUNDIALS FOR THE YEAR 2000 AD

HENBURY, CHESHIRE

Sir Francis Graham-Smith F.R.S. (President of the B.S.S.) writes:

I recently completed the installation of a large sundial on Henbury Millenniun Green, which is one of the projects funded by the Countryside Agency to commemorate the Millennium. We will have a grand opening on June 10, after some two years' work by a local group of Trustees.

Among my jobs was the design of a prominent feature, which I immediately specified as a sundial. The photograph shows the result. It uses a one-tonne piece of local sandstone, and pieces of the same sandstone for the hour marks There is a plaque on the side to allow enthusiasts to compare sundial time with the time on their watches, which most people think of as *'The Time'!*

You may like to consider using the photograph and plaque design for the Bulletin. There is nothing subtle in the design so it scarcely deserves any text, but I thought that as you so seldom hear from your President you might like to have his picture with a real dial!
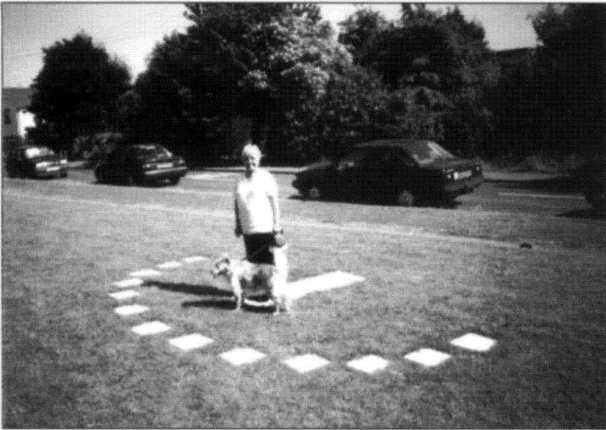
HASLINGFIELD, CAMBRIDGESHIRE

Mrs. Yvonne Wells writes:

The Haslingfield Millennium Analemmatic Sundial on the Village Green (52°09'N, 0°04'E) was inspired by Christopher St.J.H.Daniel's design for the dial made at the Liverpool International Garden Festival 1984 (Shire Booklet, p.32)

Haslingfield: Sundial and Village Sign


Henbury: The Sundial and its designer

Haslingfield: The dial in use

Laid on Tuesday/Wednesday 16th and 17th May 2000
Officially opened noon 21st May 2000 by Alice Delves,
aged 7 weeks, under overcast showery skies!

Kevin Cribb	Stone Letterer
Patrick Fullick	Photographer and Labourer
Howard Stringer	General Orchestration
Alan Wells	Delineator and Labourer

Susan Bridgeland and Maria Stringer edited the
information on the stainless steel plaque. Text of the plaque
was engraved by Algar Signcraft Services Ltd. The joinery
of affixing the plaque was done by Michael Peters.
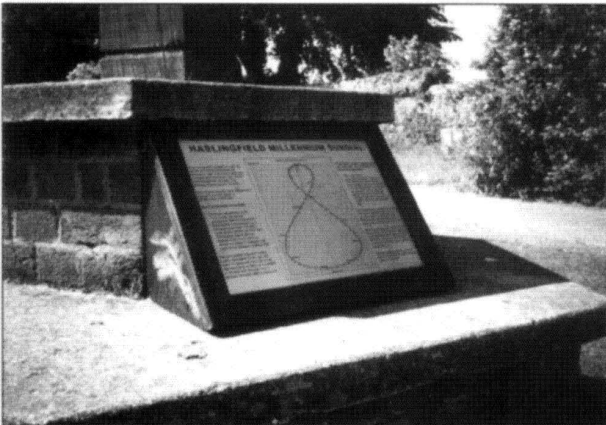
Haslingfield: Plaque on the sign

During removal of turf on the Green, pea gravel and some
red brick were recovered at a depth of 5-10 cm. This
suggests that Richard Relhan's depiction of the area with a
very small Green area (c. 1814) is correct.

GUILDEN MORDEN, CAMBRIDESHIRE

A fine equatorial dial of cast bronze stands in the
churchyard of St.Mary's Church, Guilden Morden, a
village in western Cambridgeshire. The dial, near the south-
east corner of the church, is surrounded by a circular paved
area and seats, the whole area forming a unit with the war-
memorial terrace along the eastern end of the church.

Guilden Morden: The Sundial

The sundial and its setting were planned and designed by a
hard-working village Millennium Committee over the last
two years: Rev. Colin Price, Mike Taffs, Maurice Hempsell.
The builders of the setting were Brian Haines and Bill
Davies. The dial ring, 290mm in diameter, is a handsome
casting by Westwood Dials of Mundon near Maldon, Essex.
The hours are marked in quarters and there is an equation-
of-time graph on the top surface of the plinth.

Guilden Morden: The Sundial in its setting

The villagers, many of whom had contributed to the
scheme, were present at a short opening ceremony on the
afternoon of Sunday, 2nd July. The Rev. ShamusWilliams
of Guilden Morden conducted a service of blessing, and the
hymn 'Jesus shall reign where'er the Sun..' was sung.
Margaret Stanier representing the British Sundial Society
undid the ribbon around the lace tablecloth over the dial,
which was then revealed in its glory; and for a few
moments the sun was bright enough to create a shadow and
make the dial functional.

SWAFFHAM PRIOR, CAMBRIDGESHIRE

The placing of a vertical dial on the front wall of the village
Primary School is one of the ways in which Swaffham Prior
commemorates the year A.D. 2000. The wall declines about
40° east of due south, so there are more morning than
afternoon hours. It was designed by Margaret Stanier, who
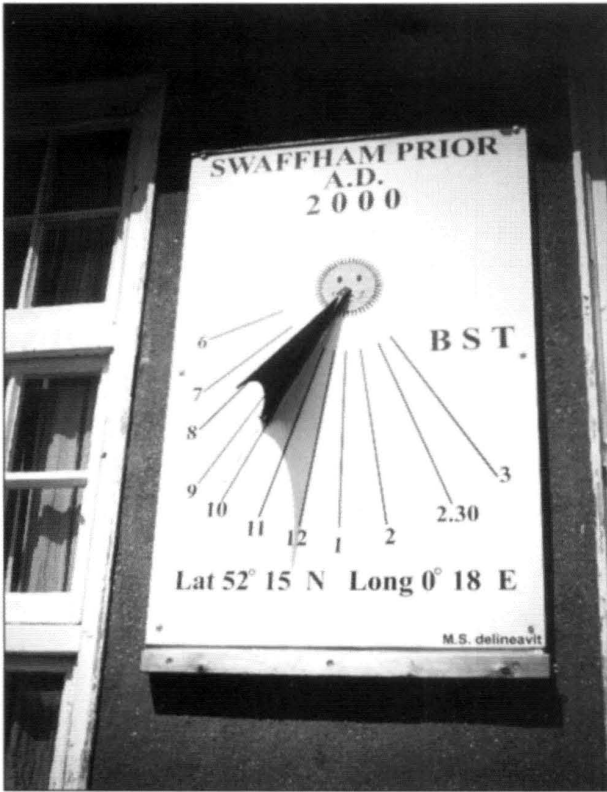
Swaffham Prior: The Sundial

Swaffham Prior: The unveiling day; Parish Council Chairman with schoolchildren;the girl on the right holds a pot of paint for marking the meridian on the playground (Photo: Newmarket Journal)

also gave a talk beforehand to the top class at the school, to explain declining dials. The brass gnomon was made by Mike Hatley of Mackay's Small Works in Cambridge; and the dial-face, of heavy plastic mounted on 2" varnished ply, was made by Colin Jones of Advanced Sign Technology, Newmarket.

The unveiling was performed by Andrew Badcock, Chairman of the Parish Council, on Sunday 26th March, just after the vernal equinox and on the first day of British Summer Time for which the dial is calibrated.. And the sun came out at the right moment!

LITTLE MELTON, NORFOLK

Little Melton: Owl Sundial

The dial on the front wall of Little Melton First School, visible from the road, was designed and made by Sundial Society member Bernard Ambrose. Mr. Ambrose also wrote a booklet about the dial, from which the following extracts have been taken.

"The year 2000, whether it is the start of the 3rd millennium or the end of the 2nd does not matter, is a significant date and so I considered carrying out a project which would be of value to the school and the village. What could be better than the construction of a sundial which symbolises the passage of time and which also has educational value?

The owl is a symbol of wisdom and is often used as a caricature of a school teacher so a suitable picture of an owl was found and roughly sketched so that the owl's beak could act as the gnomon and its shadow could fall on the owl's face which would be suitably marked out. A reminder that the dial was constructed in the year 2000 was made by using the owl's eyes as two of the 0's in 2000 which is included in the design. The motto 'Use Time Wisely' was added, together with the geographical co-ordinates of Little Melton 52deg.37min North, 1deg.12min East......... I decided to try casting [the dial] in polyester resin. I made a full size clay model of the owl with all the dial markings laid out according to my calculations. Its size was approximately 60 by 45 cm. When this had dried out it was used to make a mould using silicone rubber. This entailed surrounding the clay model with a frame, mixing liquid silicone rubber with a catalyst and pouring it into the frame. When it had set the back was covered with a thick layer of plaster of Paris to act as a support. The mould was then peeled from the clay model which being unfired disintegrated but the mould was perfect.

I wanted the finished dial to look as though it was made from stone and so chose to use a castable resin which could be filled with Bath stone dust. Next the mould was placed face up and again surrounded by its frame, the resin, catalyst and stone dust mixed and poured............ (Here Mr. Ambrose describes two unsuccessful castings, and then continues)......Third time lucky! The colour of the filling had been lightened by adding yellow pigment and I was now satisfied that there would be a sundial resulting from my efforts.

A piece of brass sheet was cut and filed to make the gnomon and it was fitted and glued into a slot cut in the dial......The sundial is now in position on the wall and is a memento for the village of the year 2000. It also serves as a teaching aid, for the children to learn about the motion of the earth and the measurement of time".

Mr. Ambrose's booklet also includes instructions about the use of the dial, British Summer Time, and the Equation of Time, laid out as a table month by month on six dates for each month. He includes a poetic mnemonic for use in EOT calculations:

'On September one you can trust the sun,
Come Hallowe'en, subtract sixteen
On Christmas Day, the dial's OK,
For your Valentine true, add a dozen or two.

Add no more, the mid of month four
The mid of May, take four away,
On June fourteen, don't add a bean
When August begins, six little mins.

The rest is easy. For any date,
All you do is interpolate.'
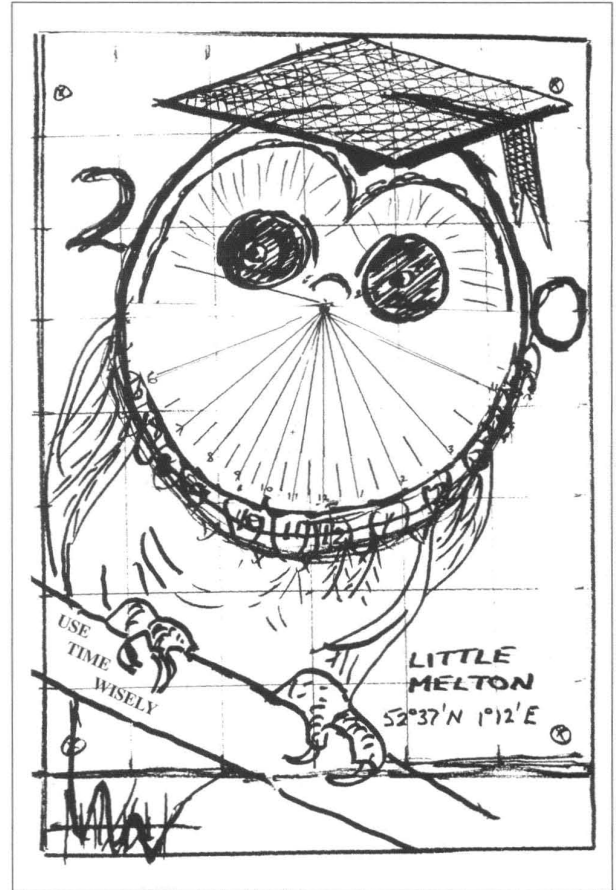
Little Melton: Sketch for Owl

Mr. Ambrose writes in his covering letter:
I gave a short talk to the children on how time is measured from the sun and they showed considerable interest. In the near future I hope to make a simple orrery for the school and would like to know if any members have any designs which might be of use to me.

THE BRITISH SUNDIAL SOCIETY IN SCOTLAND
3-11 JUNE 2000

FRANK EVANS

It began with a cheerful reunion of members in Carlisle Station, followed by a coach trip across the border into bonny and (as it proved) wet Scotland. When we finally assembled at the excellent Castle Douglas hotel it was to discover that Douglas Bateman was absent through a fall in the ice rink (no more double-Lutz for you, Doug) but that the usual suspects had been joined by several welcome newcomers, six from Germany, two from Canada and two from Free Cornwall, as well as by the intrepid Hollands from Illinois who were setting out on their first British sundial safari.

It would be too lengthy a task to list the very large number of dials visited in the course of the week but particular memories of individual dials and of individual locations must remain with us all. The gardeners among us surely felt themselves transported to the more privileged scenes from TV's "Gardeners World" in our visits to such places as Hensol House, home of Lady Henderson (fine lectern dial) and Dunscore, where Marilyn Crawford allowed us to view her fascinating sculpture of two children leaning over a stone wall and incorporating the dial which won this year's BSS competition for amateurs. At both of these places we were treated to the most generous hospitality and kindness, as indeed we were at other stopping places along our route and we record our gratitude accordingly.

Hensol House: Lady Henderson with her back to dial
(Photo: M. Cowham)

At Threave, home of the Douglas dynasty, we unfortunately were unable to see either of the dials found there, apparently the only omissions of our tour, but in compensation we later encountered numerous examples of the heraldic heart of the Douglases and their motto; "Forward", said to have been a battle cry from a Douglas

ancestor as he hurled the encased "brave heart" of Robert the Bruce at the Moorish enemy.

Our guide during the time we spent in Galloway was David Gulland. He carefully distinguished the two former administrations of the region. Each boasted a museum; the Stewartry at Kirkcudbright was a town museum and that at Dumfries the county museum The latter possessed an equatorial Bonar dial of around 1630 which for security was heavily bolted to an internal wall, thus completely obscuring the reverse face. Needless to say, the BSS soon had it off the wall for inspection. It listed the tidal establishments (interval from lunar transit to high water) for numerous ports, as well as other lunar data. At Kirkcudbright we found a 1636 equatorial dial of Iacobum (James) Brown. This had a family resemblance to the Bonar dial but on its winter side was a series of concentric planetary circles representing a geocentric cosmos. Copernicus had not yet reached Kirkcudbright.

Stewartry Museum, Kirkcudbright: Iacobum Brown Equinoctial Dial. L-r Anne Somerville, Walter Wells, Ken McKay, Christiane Berger (Photo: M. Cowham)

In the Dumfries Museum there was also a pleasant memorial window to our late member, George Higgs, made by David Gulland. It was a great pleasure to be taken to David's own workshop in the town, there to be instructed in the art of glass engraving and to view his hundred engraving wheels. Pamela Gulland kindly served us coffee and allowed us to see her charming, small and private garden. The Dumfries home of the successful Scottish artist, B. A. Hornel, now in the care of the National Trust for Scotland, was our next call. Standing in his studio was an almost lifelike representation of the artist himself at work, dressed in the clothes of a century ago, stockings and

breeches, waistcoat, and stiff cuffs and collar. The garden was skilfully laid out so that it could not all be viewed at once, with many secret diversions, and it contained no less than five dials, several restored by the ubiquitous George Higgs.

Dunscore, with the two bronze children and a delicious lunch, more dials and then finally Drumlanrig Castle which is more a pink palace than a castle, completed our day. On a balcony outside the dining room at Drumlanrig is found the fine double horizontal dial of the master clockmaker, Henry Wynne, dated 1692, one of two double dials we saw in the course of our week, the other being at St. Andrews.

Double Horizontal Dial, Drumlanrig Castle: Ken McKay, David Young. (Photo: F. Evans)

By Tuesday it was time to depart for Perthshire, calling on the way at Culzean Castle. The famous multifaceted dial there, although far into the castle grounds, was easily located by the cluster of BSS umbrellas surrounding it. Traversing Glasgow motorways we circled Baillieston (twice) before homing on another multifacet in the rose garden of Daldowie Crematorium. Then on to our billet for our remaining time, the Glenfarg Hotel, where we arrived in good time for the removal of travel stains, and dinner.

Sheltering the multi-facet dial, Culzean Castle: Frank Evans (Photo: Rosie Evans)

The next day was devoted to the Drummonds. The Society's Patron, the Earl of Perth, a Drummond, received us at his residence, Stobhall, bearing a dressed shepherd's stick, to which, in deference to his age, was affixed a rubber end. The establishment, within extensive grounds, consists principally of a grass court surrounded by medieval buildings including a tower house and separate chapel and is strongly positioned on cliffs above the Tay. The views within the stronghold were quite charming. As at other locations much interest was aroused among our horticulturists in the beautiful gardens. Lord Perth described the history of the house and chapel and of his family connection. He has numerous dials, some again carrying evidence of the work of George Higgs as well as another example of a Gulland glass dial. Lord Perth entertained us to coffee in his library before our departure.

In the afternoon we proceeded to Drummond Castle, a real castle with an immense Italianate garden laid out in the form of a saltire. At the centre of the matching convolutions of box hedge was an obelisk dial of 1630 having fifty faces, which the more assiduous of our members at once proceeded to miscount and debate. The stonework of the

Stobhall: Walter Wells, Tony Belk, Lord Perth, Ken McKay (Photo: M. Cowham)

dial was in noticeably good condition for its age, no doubt protected by the absence of urban acid rain. The garden perspective, seen from the elevation of the castle, was stunning, and for once the sun shone brilliantly. Back at Glenfarg after supper David Young produced a projector and slides to recall the Society's 1994 visit to Ireland. Some of us looked painfully younger in the pictures.

Thursday, and we were up betimes in order to be within the grounds of Glamis Castle before opening time, as requested by the authorities. This was to allow us a private view of the castle's monumental twenty foot sundial bearing eighty four dial faces. There is perhaps a certain sameness about its multiple facets and comparing the dial with the popular lectern dials of the same period the latter offer more variety of approach, with polar dials and curved scaphes mcorporated. Indeed the older Drummond Castle dial presented more challenging facets of heart-shapes, hemispheres and rectilinear surfaces as well as declining and reclining facets. But it was all of value and the remainder of the Castle was there to entertain us with its visitors' centre, restaurant and shop. Among the artefacts which caught our eye in the castle museum was a cast of a stone engraved with runic symbols which had been dug up

in a nearby garden. The runes translated read: *Soldiers' coffins of the killed earls, Earl Alsa and Earl Little. This is the tomb of the twain. Ah!* The unfortunate noblemen were, it seems, the sons of King Oswy ofNorthumbria, slain in 658 by the Picts. Ah!

Pillar Dial at centre of garden, Drummond Castle (Photo: M. Cowham)

From Glamis we went on to Dundee, to the observatory, a public building which houses a ten inch Cook refracting telescope of the nineteenth century. It was amusing to observe that while many gazed open-mouthed at this ancient monster poised on its massive cast metal base, our "rude mechanicks" were clustered around the device which kept the instrument in line with the stars by means of a pendulum clockwork control; and delighting at their personal discovery of a concealed flywheel which smoothed out the ticking mechanism as the telescope tracked the heavens. Have some of our people been born in the wrong century? Outside, on the surface of a flat roof was a painted analemmatic dial, bravely facing the downpour.

Come Friday the skies cleared but then it rained again (Perhaps we should form a British Raingauge Society? There is obvious scope.) But most of our quarry at St.

Andrews lay fortunately indoors. Much of it concerned James Gregory (1638-1675), the mathematician and astronomer whose learning so irritated his dull colleagues that they drove him to emigrate to Edinburgh and a new chair in mathematics. He was a brilliant forerunner of Newton, with whom he corresponded concerning his own (Gregorian) reflecting telescope. In a room above the Parliament Hall, in 1706 briefly the home of a turbulent Scottish parliament, Gregory built a telescope frame to hold his instrument while over a mile away he caused the erection of a pillar to give north-south alignment. Within the room itself a simple noon line of narrow wood was inlaid into the floor planking. This wooden noon line was first discovered for the Society in a television programme on Gregory by Adam Hart-Davis in the "Local Heroes" series. In its course he briefly drew back a carpet to reveal the line, which was noticed by a viewer who was a BSS member.

In the building were several treasures attributed to Gregory's efforts. Three fine clocks by Joseph Knibb of London rested in the Senate Chamber, one said to be the first to beat more frequently than once a second, while downstairs was a double horizontal dial intricately engraved, made by the master diallist, Hilkiah Bedford, and dated 1668. It is likely that all these instruments were bought in London and brought to St. Andrews by Gregory on his academic appointment.

Part of our afternoon was also spent indoors but achieving this was dampening. Our coach delivered us to rainy Anstruther where across the shore lay the home of Alexander Scott. He had most kindly invited us to see his instructional sundial creations, largely made of wood. Along the shore route to his house lay a flight of stepping stones spanning a burn. Little were we aware that on our return the burn would have become a torrent and the steps leading down to it a veritable waterfall. But that was for the future; for the present we listened in his studio to Alex's exposition of his instruments while in his garden a sodden flag proclaimed the symbol of the British Sundial Society.

One more dial awaited us before the day ended. At Cameron Cross Roads near St. Andrews Mr. Ian Watson, master mason, was carvmg an obelisk dial designed by the sculptor Gerald Ogilvie-Laing and commissioned by Sir Paul Getty. The calibrations for the thirty eight small dials had been undertaken by Ken McKay, who was a member of our party. It was pleasing to see the appearance of a new dial in creamy Portland stone after our visits to so many ancient ones. Sir Paul's coat of arms was engraved and coloured on the column. It contained heraldic references to cricket, seemingly a passion of his, and several of the small

dials told the time at test match locations, Delhi, Sydney, Johannesburg and Barbados being examples.

*Crossing the Dreel Burn, Anstruther Shore (Photo: Christine Crow)*

Driftwood Dial in the garden of Alexander Scott, Anstruther (Photo: F. Evans)

In the evening after dinner a presentation was made to David and Lilli Young for all their labours in organising our tour. Everyone declared that they had done a fine job. It took the form of a glass bowl appropriately engraved by David Gulland. Thanks were offered, too, to the persons who, with local knowledge, had directed individual parts of the tour, namely David Gulland himself, Frank Coe, John Amson and

Ken McKay. Not all of these were with us the whole time and our numbers had fluctuated a little but the total attenders over the week numbered close to thirty five, an excellent figure. It had been a pleasure to welcome John, the son of George Higgs, together with his wife, for part of the week.

There remained one more day of sundials and it was mostly spent in Edinburgh, at first among the numerous comer dials at Heriott School, which those who attended the
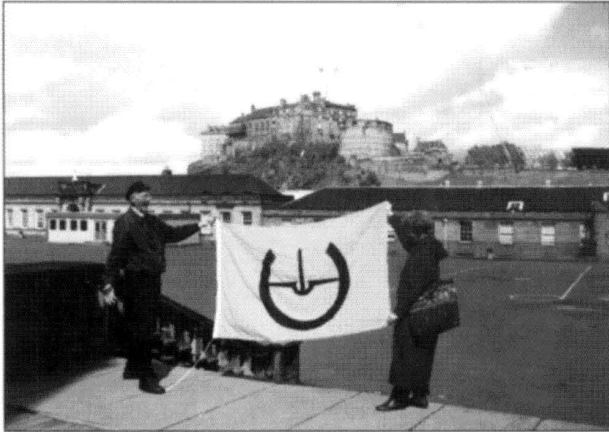
BSS Flag in Heriot School grounds, and Edinburgh Castle
(Photo: M. Cowham)

Edinburgh conference of 1991 will recall, and then in the twin Royal Museum and Museum of Scotland in Chambers Street. Here much that was not sundialling was of interest but we observed one small dialling wrinkle performed by a member on an undated eighteenth century dial on the ground floor: the matching of the equation of time engraving on the dial plate to the date of the month. This revealed that the dial was constructed during the period of the Julian calendar, the values differing by eleven days from the modem dates.

A final call, to Hopetoun House, a grand house with a modest dial, set beside Benjamin Baker's spectacular Forth Railway Bridge, then back to the hotel for our last night, which included a little informal after-dinner entertainment by members. On Sunday we sadly departed Glenfarg, some to be dropped off in Glasgow and the remainder returning to Carlisle. Our coach driver, Steve, said he was sorry to leave us and even hinted that he might join the Society!

And so in the words of the old sundial motto: "We pursue a shadow", but a shadow that for this week has been enlightening as well as most pleasurable. Haste ye back!

READERS' LETTERS

THE LASER THEODOLITE

When making sundials of the projection or reflection type one may desire to delineate a dial upon a distant irregular wall or domed ceiling. The coordinates of the Sun in terms of its local altitude and azimuth at chosen times may be calculated readily enough from the formulae of spherical trigonometry: the real problem is to translate them to accurate marks on the appropriate surfaces that may subsequently be joined to form the dial or dials.

A simple technique is to adjust and set an ordinary theodolite to the desired angles, look through it, and then have an assistant move a pencil over the wall until its point coincides with the cross-hairs. Trouble is, there may well be problems in getting one's head into position in cramped situations. The laser theodolite is therefore ideal, but appears to be little known to practical diallists. It consists of a surveyor's theodolite (reading to 1 arcminute or better) bearing a low-power red laser. The latter is adjusted to shine out along the optic axis of the theodolite's telescope when required. The instrument is simply positioned on a firm temporary platform so that its axes cross at the point which will subsequently be occupied by the aperture or mirror, and accurately levelled with its built-in screws and bubbles. The direction towards

true geographic south - the zero point of azimuth in this application - must then be set. Provided a properly designed solar diagonal is furnished with the theodolite, this may be found by observing the culmination (point of maximum altitude) of the Sun. It marks noon. A check is to bisect the angle between the azimuths on either side where the Sun has the same altitude. Without the diagonal eyepiece and its associated dark filter one must never look directly at the Sun with any optical instrument. Alternative techniques are discussed in books on dialling, but note that the magnetic compass tends to be unreliable in and around buildings. The calculated angles (or their reciprocals) may then be set on the instrument's scales, the laser activated, and the red spots marked with pencil or felt-tip pen.

It is, of course, possible simply to tape a lecturer's laser pointer to the barrel of an ordinary theodolite, but then allowance must be made for the displacement of the optic axes and results may be less accurate. However, as there is no requirement in this application to look simultaneously through the telescope with the eye, it is worth investigating whether the eyepiece may be removed and the laser pointer fitted in its place. It will help to employ two sets of clamping screws a little distance apart, so that the laser

beam may be aligned with the telescope's cross-hairs/optic axis and the angle-measuring dials.

Nowadays compact battery-operated laser theodolites are manufactured, but older models incorporate a mains powered helium-neon laser. An instrument of this nature may be hired by the week from Watts Optronics Ltd, 26 Somers Road, Rugby CV22 7DH. Tel: 0178 857 3944.

Allan Mills
Astronomy Group
University of Leicester
Leicester, LE1 7RH

MASS DIAL RE-CUTTING

In Newsletter No.17 reference is made to ancient mass dials being recently re-cut. This is not a new problem. In the early days of photography (in the mid-19th century) enthusiastic amateur photographers often carried a hammer and chisel in their tool-kit, with which to 'improve' partly-illegible monumental inscriptions.

A letter deploring this practice was published in the *Gentleman's Magazine* in March 1866, page 370, under the heading 'Archaeology versus Photography'. It begins:

"We are threatened, I fear, with a new danger to archaeology, and that from a quarter whence we might expect, and do indeed receive, material assistance. Photography is of inestimable value to the antiquary, but if the photographer have license to restore and brighten up old worn-out inscriptions before copying them, I fear their authenticity will be seriously imperilled."

The writer went on to describe an incident at Bewcastle in Cumberland "so famous for the obelisk or cross bearing Anglo-Saxon runes", which itself had received the attention of would-be improvers. A shepherd had discovered another runic inscription on a stone nearby. A photographer, accompanied by an antiquary, in order to make the letters more visible "had actually *re-tooled* [writer's italics] the whole of the inscription!" Although in this instance the work was done "according to the reading of the archaeologist", the writer commented that it was now impossible to be certain of the original form of the letters: "How do we know that the antiquary read it aright!"

John R Millburn
40 Stirling Avenue
Aylesbury
Bucks
HP20 1BE

BEDE AND TIMEKEEPING

May I respond to D.K. Ebdon's enquiry about 'Bede and Timekeeping'?

The Venerable Bede has rightly been described as 'The Father of English History' but he could equally and justifiably be dubbed 'The Father of English Science' and even 'The Father of British Chronology'. To his seminal work 'A History of the English Church and People' (HE) Bede appended a bibliography of his own prolific writings. There he lists 'two books, one on the nature of things, and the other on chronology (de temporibus): also a larger book on chronology (item de temporibus librum unum maior)~ The modern title of that larger work is De temporum ratione, which Bede called his 'little book about the fleeting and wave-tossed course of time'. We are fortunate that it has recently been fluently translated into English by Faith Wallis under the title Bede: The Reckoning of Time (Translation, with introduction, notes and commentary, Liverpool University Press, 1999).

Four chapters (31-34) deal with the measurement of sunlight by a sundial. They cover how a sundial registers time, and why the shadow of the gnomon on the same day is longer in some places than others. At the close of chapter 30 he writes: '.... .we are instructed not only by the authority of the Fathers, but also by examining the sundial (horologica consideratione)'. In addition, in the HE itself Bede reproduces a letter of Abbot Coelfrith to King Nechtan of the Picts - a letter commonly assumed to have been written by Bede himself - where it is claimed that "we can confirm" that 21 March is the equinox "by consulting a sundial " (ut epiam ipsi horologica inspectione probamus. HE 5.21 (542)).

Alas, and pace David Ewing Duncan, I can find no evidence that Bede himself actually made a sundial, although he may well have done so. For a discussion of Bede's familiarity with the sundial see Wallis, pp. 315-17.

John Wall
Drystones, 12 Waydale Close
Kirkbymoorside, York, YO62 6ET

BEDE AND SUNDIALS

I am writing with reference to Mr. Ebdon's enquiry about the Venerable Bede in the June Bulletin. Having been alerted to Bede as a dialmaker by *The Calendar*, I've been able to find a reference to his work on the subject. According to Mrs Gatty's *Book of Sundials* (1900) the book in question is his *Libellus de Mensura Horologia*. She refers to a seventeenth century edition, 'Bede, Op. Colon, 1612, tomii p. 392.' As yet I've not located a copy, not

having had much opportunity to search, and also being doubtful if my technical Latin would be up to coping! If anyone has further information I'd be glad to hear from them.

Miss R.J.Wilson
14 Pear Tree Close
Chipping Campdem,Glos. GL556DB

MORE ON BEDE

Mr D.K.Ebdon raises a very interesting question concerning the nature of the sundial which Bede may have used. From the little I have been able to read, this question does not appear at all easy to answer. Bede's computational writings are not confined to 'De Temporibus' and 'De Temporum Ratione' but are scattered through his other works as well. Since he wrote in Latin, and nothing apart from his Ecclesiastical History has been translated into English, the information is not readily accessible to most of us including myself.

It has been suggested to me that it is possible that he never used any instruments at all since his greatest talent was to extract information from earlier writers and select that which he regarded as most rational and consistent, afterwards including it in his own writings and teaching it to his students. This viewpoint is supported by a remark by C.W.Jones[1] in his scholarly edition of Bede's 'Cpera de Temporibus'.

"In the main, Bede does not present the world of an observer of nature, but of a teacher and reader of books. Bede would prefer to quote the Roman Vegetius and the Spanish Orosius about the Roman walls not ten miles from his cell than to state in his own words what his own eyes saw."

This view, however, becomes less likely when we learn that Bede's teacher, the Abbot Ceolfrid, quoting Proterius, wrote:

"Aequinoctium.autem, iuxta sententiam omnium Orientalium et maxime Aegyptorum, qui prae ceteribus doctoribus calculandi palmam tenent, XII Kalendarum Aprilium die provenire consuevit,ut etiam ipsi .horologica inspectione probamus". [However,the equinox, according to the opinion of all Eastern authorities and especially the Egyptians who above the rest of the teachers hold the palm for computus, is wont to occur on March 21st as likewise we prove by observation of the horologe.. (My translation - *caute age*).]

Bede himself used virtually the same quotation on three different occasions (as, for example in Chapter XXX, De Aequinoctus et Solstitus of De Temporum Ratione) . Jones comments: "It would surprise us if a study of shadows had proved to the monks of Wearmouth that the equinox, which by that time had moved forward to March 17th, was on March 21st". He goes on to say;"This fourfold repetition about the horologe, placed as it is in a position otherwise easy to identify, suggests that the Northumbrians were studying shadows seriously and conscientiously, but certainly not accurately. I do not know a type of horologe which would give such deceptive results. Rather, I suspect that Bede refers to a simple monastic dial where the calibration was so roughly marked that the student could read into it an error of four or even eight days if he were so disposed."

Wesley M.Stevens[2] in his 1985 Jarrow lecture said it was "a plane horizontal sundial with gnomon" but this could not have been a gnomon aligned parallel to the earth's axis since such an arrangement would never have been considered by anyone whose universe was geocentric. Bede in his Ecclesiastical History commented on the length of daylight at his Wearmouth monastery saying; ~'... in summer too the nights are extremely short; so are the days in winter, each consisting of six standard equinoctial hours." He emphasised that he was referring to a standard hour length : "those twelve equal hours of daylight from sunrise to sunset at equinox when they are the same everywhere in the world." It has to be remembered that the word horologe was also used to describe a table showing shadow lengths for the various hours of the day throughout the seasons.

Bede would have learned from Pliny's 'Natural History', which he regarded as "pulcherrimum opus", methods of finding the meridian, determining latitude and identifying the equinoxes and solstices but whether he ever put these to practical use himself is not clear. However, when we consider his work on tidal variations round the coast of England it becomes certain that he must not only have used a dial of some sort but also instructed others in its use. He enlisted the help of monks in places as distant as Iona and the Isle of Wight and detailed the observational methods they should use to study the times and amplitudes of tides at their various locations. They should measure tidal height from a station near the mouth of a tidal stream rather than on the shore itself and an hour-glass should be used along with the dial for greater accuracy.

Guesses have been made as to the nature of Bede's dial. It might have been a Roman dial like the one in the Museum of the History of Science in Oxford or it might have been

something like the Saxon dials we can still see today. In this context the series of articles on Sundials in Anglo-Saxon England by David Scott is very relevant. Bede is not likely to have had an astrolabe since in spite of the fact that these instruments were in existence by the 4th century A.D. they do not seem to have found their way to Western Europe until the late 10th century. For the purposes of his investigations into the tides, the type of dial used would not matter provided that all his collaborators were using the same type with the same inaccuracies. Variations due to their latitude and longitude would be small compared with the lengths of time being measured.

It would be interesting to hear more about this topic from Bede scholars and Latinists who can read his works with ease and I look forward hopefully to further correspondence.

J.P.Lester
24 Belvidere Road
Walsall, WS1 3AU

1. Jones, C.W: *Bedae;Opera de Temporibus* The Medieval Academy of America, Cambridge, Mass. (1943).
2. Stevens, Wesley: *Bede's Scientific Achievement* 1985 Jarrow Lecture, Newcastle upon Tyne.
3. Scott, D. 'Sundials in Anglo-Saxon England' *Bull. BSS, Feb 1999 to Feb 2000.*

SEARCH FOR PRE-SAXON SUNDIALS

In the most interesting article by John Wall, Bulletin 12 (ii) June 2000, it is suggested that early medieval sundials in England may have their origins in Roman Britain.

Sharon Gibbs in 'Greek and Roman Sundials' included two Roman dials found in Belgium, pp 355 and 336. We do not know whether they were made locally or taken to Belgium by collectors in relatively modern times. They are both typical Roman horizontal planar dials, and the drawing shows the one found in 1961 at Huy near Liège.

Arthur Green, in his book 'Sundials', suggested that the sundial depicted on the mosaic floor of the Roman villa at Brading in the Isle of Wight, (p.8) 'is evidently a horizontal one'. But we know from the ones found in Belgium that the Roman horizontal dial is quite different in shape. The dial depicted is probably a plane surface projection of a scaphe dial, the type frequently used in far-away Italy.

Margaret Gatty, in her book 'Sundials' (p.43) when writing about Housesteads on the Roman Wall, says 'A stone fragment has been dug up which 'seems' to be half of a semicircular vertical dial'. This was in 1900 and since then

it is often taken as a fact. Several alternatives have been suggested for the fragment, such as part of a window or door arch. It is difficult to imagine the purpose served by a sundial at the Roman Station of Borcovicus.
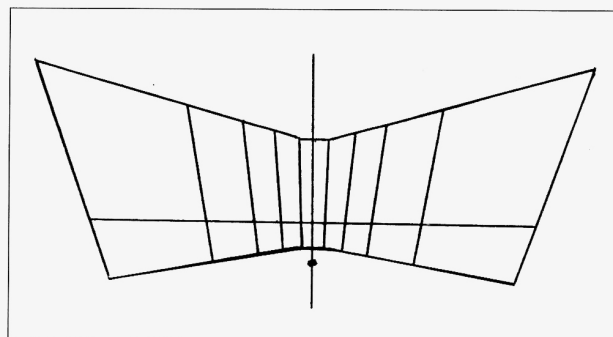
Roman Horizontal Sundial found in 1961 near Liège in Belgium

It is possible that the fragment was not part of a sundial, but a piece from a relief carving of the pagan god Mithras who is known to have been worshipped by soldiers serving on the Wall. Charles Daniels, in his book 'Mithras and his Temples on the Wall', (p.25) says about a statue of Mithras found at Housesteads, '... his tunic is pleated at the waist over a belt ..' and the photograph from the temple shows that the tunic looks very similar to the stone fragment thought by Margaret Gatty to be part of a sundial.

Sundials may have been used in Roman Britain, and we might expect that one would have been found in places such as Bath and Silchester, but none have been discovered so far. The Saxons were thorough in their destruction of Roman Britain, and the Romano-British people were killed or enslaved, or they fled to the south-west and west of the country. If they knew about sundials and their use, they kept such knowledge to themselves.

David Scott
26 Barrswood Road
New Milton, Hants
BH25 5HS

SOME 'AWARDS 2000' SUNDIALS

The Chairman of the judges' panel of the BSS Design Competition, Professor Alan Smith, considers that some of the designs submitted for the competition merit more detailed comment than he was able to make during the Awards ceremony at Cirencester (BSS. Bull. 12. p81, 2000). The multiple dial at Christ Church Oxford (BSS Bull. 12. 55) and the vertical dial at Blazefield, Yorkshire (BSS. Bull. 11. 18, 1999) have already featured in this journal. We print here some comments on two 'Commended' Dials and a 'Winner'. The notes were compiled partly from the submissions made by the competitors to the judges. An article on the Pembroke College Dial (Winner, Professional Class) submitted by Dr. Frank King will appear in a later Bulletin.

ANALEMMATIC SUNDIAL BY NOEL STEPHENS (COMMENDED, AMATEUR CLASS)

Noel Stephens writes:

The inspiration for this sundial came originally from a small book entitled 'Sundials' by Christopher St.J.H.Daniel. I was looking for an idea for a simple commercial gift-product, which could be developed as a low cost private venture.

The dial on a plinth

The picture of the equiangular sundial sited at Herstmonceux Castle captured my imagination.....I thought about a scaled-down garden version but a moving gnomon was not practical. This led to the idea of a fixed gnomon with several fixed circular dials for different times of the year.... The sloping face was a distinct disadvantage in terms of a low-cost product. I realised I could do the same thing using a horizontal face and vertical gnomon with elliptical rings instead of circles. Ellipses are just as easy to generate using computer software....The advantage of this scheme is, it can be constructed on a simple plate with gnomon screwed to project at right angles to it (no difficult angles to engineer). I decided to manufacture a trial batch of 100.

I ...obtained 100 off scrap aluminium cut-out plates...The raw material is not however the main cost, but that of its processing. The single most expensive process is screen printing the pattern onto the plate. I designed and had made a gnomon holder, in brass..... The gnomon itself is proprietary glass reinforced plastic (GRP) decorated with a coloured bead.
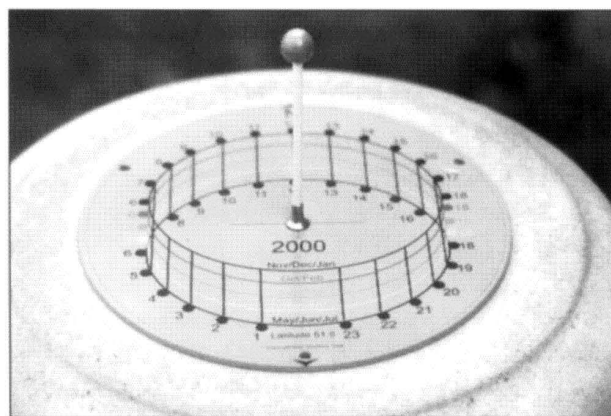
The Analemmatic dial

After describing the equations for generating the ellipses and hour points, the designer continues:

Choosing the position of rings on around the 22nd of each month allows Spring month rings to share Autumn rings. For simplicity and to avoid confusion, November and January rings are combined with December; and May and July rings are combined with June. The [five] rings are colour coded to assist their selection...

The 3 millimetre thick aluminium plate, powder-coated in neutral grey/green eggshell finish, is 182 millimetres in diameter. The gnomon rises to a height of 95 millimetres above the surface.

The product is a garden ornament commemorating the millennium. It is also an educational time piece with an estimated accuracy of five to ten minutes.

The designer provides an instruction sheet for installing and using the Sundial, and includes an EOT correction table. Here are some extracts.

Attach the gnomon to the centre of the plate using the countersunk screw provided. Set the sundial on a horizontal surface with the 12 noon direction aligned accurately to geographical north... Screw to surface (a stand or pedestal), or secure with suitable glue, using a spirit level to check for horizontal. The dial consists of five coloured coded elliptical rings for different months of the year, displaced to be equally separated in the north/south direction. The 24 hour dial time is read by selecting an appropriate month ring (disregarding the other rings) and noting the hour at which the shadow of the gnomon intercepts this ring Parallel hour lines are provided for this purpose By interpolating (dividing intervals) between hours and dates, it is possible to estimate Greenwich Mean Time (GMT) to within 5 or 10 minutes of its true value using this dial.

ARMILLARY 'BIRTHDAY' SUNDIAL BY JOANNA MIGDAL, (COMMENDED, PROFESSIONAL CLASS)
Joanna Migdal writes:
MCMXCIX brought a commission for a birthday present sundial. On the initial meeting with the client a number a points became very clear. The lady loved simplicity and elegance, her family was most important to her and her quiet nature held within it a fiery creativity. She is a garden designer. The design of one of the spheres which I had made previously appealed to her. So when we had looked around the garden an area was designated for the dial. This area was intended as a rose garden; the site also lent itself to the inclusion of a stone base to complement the formality of the rose garden design. So in an unusual move we visited the quarries first and chose the base, before any design of
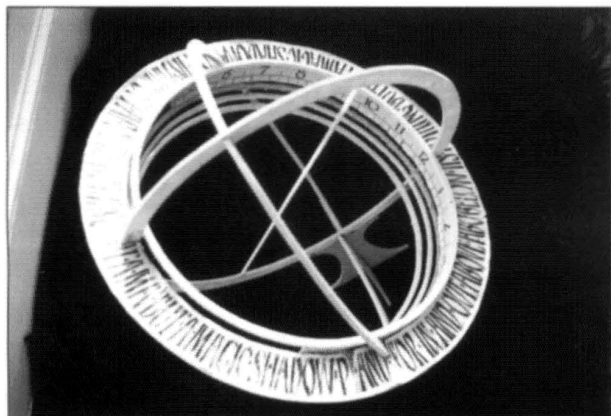
Full-size mockup

the dial was done. A perfect green slate standing stone was found and was cut down to the right height.

The material for the sundial was to be bronze, and calculations were made of the dates of birthdays of the family so that it could be seen at what declinations birthday rings would be placed. The location of these was important in the rest of the design, so that a balance of proportion would be good.

The birthdays are:

Sue and Richard	7th Sept	Sun +6.05
Simon	2nd April	-3.40
Claire	25th August	+10.47
Olivia	5th August	+16.59
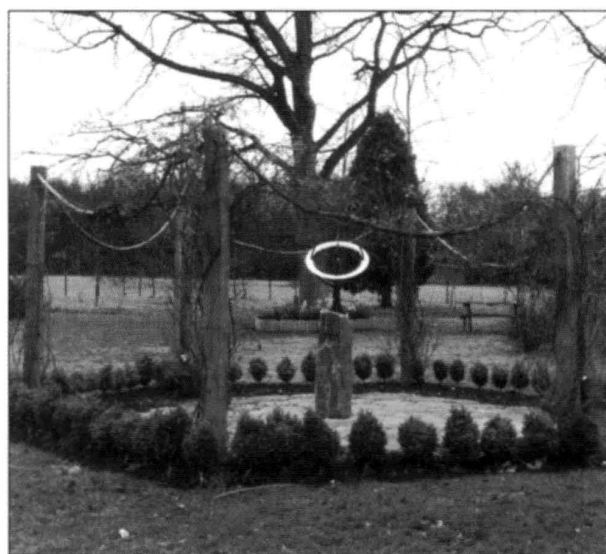
Armilliary in its setting

The hour ring was designed to show every quarter of an hour.

To show the inner creativity of this lady, a large equatorial ring plate was attached to the outer face of the hour ring, carrying her favourite quotation:

For in and out, above, about, below, 'Tis nothing but a magic shadow show, Play'd in box whose candle is the sun, Round which we phantom figures come and go

This was drawn up in such a way that it looked like the sun's rays, and the ring would be gold leafed so that when the sun struck it would shine.

The centre of the dial had a gold leafed globe whose shadow would fall on the birthday rings on the actual birthdays. This made it necessary to take the hour ring only partly round, and to set the gold ring on edge, so that the sun's rays would be as little obstructed as possible. The

Armilliary 'birthday' sundial

twins Sue and Richard have a decoratively plaited wire along their ring, to indicate their togetherness.

A full sized cardboard mock up was made and set up on he base so that the client could approve of the design and any adjustments could be made.

Detailed drawings were made after readings had been taken from the GPS.

The quotation was redrawn by hand to fit exactly into the circle.

A VERTICAL, DECLINING, MEAN TIME, NOON DIAL (WINNER, AMATEUR CLASS)

('Two Children' was designed by Marilyn Crawford with technical assistance from John Moir)

Marilyn Crawford writes:
This dial was made for two purposes; to show noon GMT, and to decorate the top of our garden wall. I thought of making a figure apparently climbing in, whose dangling legs would be a sort of joke for road-users behind the wall, while his upper half appeared in the garden. The idea of a noon dial appealed since I first saw the charming illustration in Albert Waugh's Sundials, of a portly frock~coated gentleman consulting his pocket watch below the noon dial on a tower.

A mean time sundial suited my family and friends, who are hard to persuade that solar time is " accurate". Also the curves that mark the mean time hour seemed graceful for a garden. A vertically divided analemma would be easier to understand, so I put two children on top of the wall, with an S curve for each child, the boy's appropriate from December 21~ until June 21st, the girl's from midsummer back to midwinter.

"Two children" noon marks

To get the wall's declination I would have waited impatiently for sun and local noon to coincide, but John lent me his invention for measuring the sun's angle relative to the wall. Over three days I took readings whenever the sun shone, and gratefully consigned these data to him (See Note 1).

The Times Atlas provided our longitude and latitude. I read until I perfectly understood—in theory!—how to find the wall's declination and draw up correct curves to put upon it. Then, remembering how I once worked through a school mathematics exam on the basis of the hundred-minute hour, I telephoned the Sundial Society and asked for assistance. John, with entirely typical generosity and enthusiasm, undertook to work out the curves.

The girl's hand was too high for a gnomon if she sat upright, so she holds a leaf, similar to the irises growing nearby. This curves outwards, from one angle making an arch over

the boy's head. The lettering below the dial is both a decorative border and a "user's guide". It needed to be short but explanatory, and reads: -

> He from midwinter to midsummer then
> She from midsummer to midwinter
> Mark noon Greenwich Mean Time

The theme of "two contrasted" recurs in the design. There are two half -analemmas of different lengths. There are two sorts of gnomon, - the tip of the girl's leaf casts a shadow, but the boy's hand forms a ring that places a dot of light on the dial. The children contrast: while he reclines, intent on his own side of the dial, she sits upright, assertively pushing his arm aside with her foot. Finally, two of us, John Moir doing the calculations, and myself doing the artwork, have produced the dial.

"Two children" noon marks

The figures I modelled in clay life size, then made a gargantuan plaster-of-Paris mould from the clay. This weighty chunk had to be separated, cleaned and loaded into the car to go to Edinburgh, for casting in bronze. The car was not big enough. I sped up the motorway with sinister-looking white arms and legs poking out of windows and sunroof, semaphoring to startled lorry drivers, who (as I swept past) might catch sight of severed heads on my back seat.

Only after the bronze figures and slate dial were fixed on the wall could the exact distances and positions of dial relative to gnomons be confirmed. To measure and locate dial to leaf tip was straightforward, using a large set-square and ruler. However with the "hole" gnomon, the hand got in the way of the set-square, so I made a device like three sides of a picture frame, with fuse wire forming the fourth side. (By scrupulous machinations the wire met the frame at a true right angle!) Holding the frame edge flat on the dial, the wire was threaded through the hole (wire marked, and later measured.) Where wire met dial was the "origin" of this half analemma. This device worked well.

Having the information he needed, John plotted the analemma halves onto graph paper. (See Note 2) To transfer these to the wall, we stabbed each point with a needle, and stencilled paint-dots through the holes in the paper onto the slate dial. With care and a sharp pencil the dots were joined up to form the curves.

Observation over nearly a year showed it was safe to inscribe the curves into the slate The dial is satisfactorily accurate: even my family admit it, and garden birds find the girl's head a splendid vantage point for singing and cracking snails.

NOTES

1. How we found the declination of the wall:
   Using J.M.'s protractor-based gadget, I first measured the bearing (1) of the sun relative to the wall, noting GMT and Date.

We then calculated the sun's bearing B, from North, (2) using the formula:

$$\text{Tan } B = \text{Sin } h \ / \ (\cos \phi \ \text{Tan } \delta \ - \ \text{Sin } \phi \ \text{Cos } h)$$

where ϕ = Lat = 55.13° N

   δ = Declination of sun at date of reading

   h = Sun's hour-angle, obtained by correcting GMT reading for longitude (3.8°W) and Equation of Time.

The difference between (1) and (2) above gave us the declination of the wall, i.e. 5.02° W of S (averaged from several readings on different days/times)

2. How we produced the Analemma - Curves

To save doing copious calculations, the co-ordinates of our curves were obtained using F.J .de Vries' excellent computer programme, with the following inputs

Lat = 55.13° N

Long = 3.80° W

Declination of dial = 5.02° W of S.

Gnomon height = 100 mm.

For satisfaction rather than necessity, J.M. calculated a few points on the curves using basic but tedious trigonometry, and they agreed exactly with the computer results.

To produce the actual $\frac{1}{2}$ analemma-lines, the X,Y co-ordinates were multiplied by 2.12 and 4.00, to correspond with the measured heights from the dial plate of the boy's hand and tip of the girl's leaf, i.e. 212 and 400 mm. respectively.
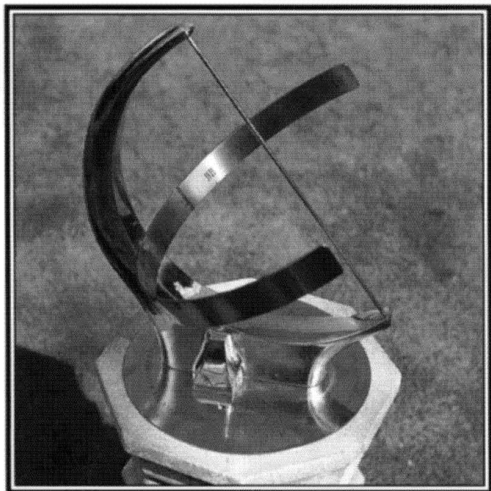
BACKWARDS MOTION OF THE SHADOW ON A SUNDIAL

ALLAN A. MILLS

..... And Hezekiah answered, "It is a light thing for the shadow to go down ten degrees: nay, but let the shadow return backward ten degrees." And Isaiah the prophet cried unto the Lord: and he brought the shadow ten degrees backward, by which it had gone down in the dial of Ahaz ....

It appears impossible that the unidirectional motion of the Sun in its daily arc across the sky could throw a shadow of the tip of a fixed vertical pillar that moves first in one direction (say clockwise when viewed from the base of the pillar) and then in the opposite sense. Indeed, the incredible nature of such a phenomenon is reflected in its name – the 'Miracle of the Dial of Ahaz' – that is recounted in the above quotation from the Bible.[1] Attempts have been made to produce it by utilising the refraction of light in a pool of water standing over a flooded horizontal dial.[2,3]

Nevertheless, theory indicates that a small but detectable reverse motion of the shadow of the apex of a vertical gnomon can occur naturally, and must have been occurring every year throughout history. However, specific conditions of latitude and time of year must be combined with precisely recorded observations, so it is not entirely unexpected that (so far as I can discover) neither chance nor deliberate observation of the natural phenomenon has ever been witnessed and published.

ANTECEDENTS

The 16th century Portuguese astronomer Pedro Nuñez[4,5] (1502-1578, best known for his invention of the nonius[6,7]) is credited with first deducing that reversal of the daily motion in azimuth of the shadow thrown by a vertical pillar could occur at sites within the tropics if the Sun was near an appropriate solstice – summer in the northern hemisphere or winter in the southern. The predicted phenomenon subsequently interested Jacques Ozanam (1640-1717), and the final revision of the translated edition of his book[8] includes a cluttered diagram that unfortunately does little towards explaining the geometry involved. The unexpected motion also intrigued Flammarion and Guillemin[9], whilst Rouse Ball mentioned it in his well-known book *Mathematical Recreations and Problems*.[10] A few years later Chomard[11] published an extensive mathematical study of shadow retrogression displayed on the elliptical 'analemmatic' dial, whilst the phenomenon is an incidental property of Foster's diametral sundial.[12] Most recent is Overkamp's reconsideration of the matter.[13] Unfortunately,

none of these mathematicians provided a clear analysis for the general reader, and only Flammarion appears to have attempted to witness the reversal in a practical situation.
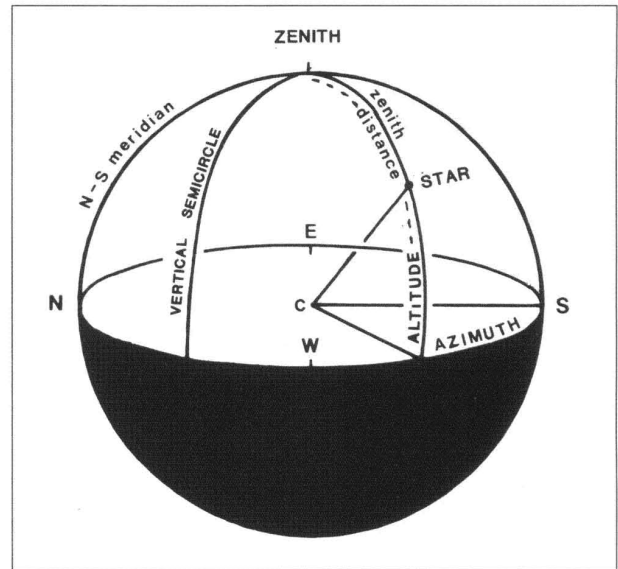
ASTRONOMICAL CONSIDERATIONS
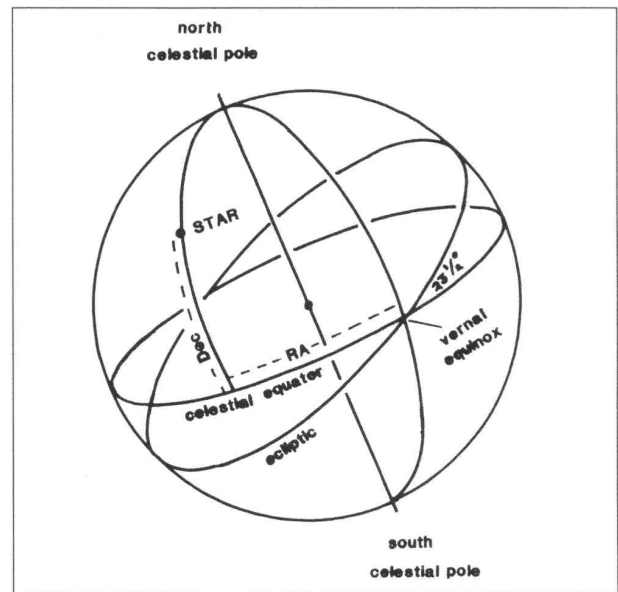

Fig. 1 The altazimuth system.

Fig. 2 The RA/Dec system.

Figs 1-3 in the appendix illustrate the altazimuth and RA/Dec systems of co-ordinates applied to objects in the sky, and the combination used to convert from one system to the other when latitude and time of observation are known. It should be pointed out that the diagrams given in

these figures are not perspective views. Thus, the poles are placed on the boundary circle, rather than before and behind it, as would be required by the elliptical shape of the equator. These illustrations are simply diagrammatic conventions to aid understanding. Astronomical texts (e.g. Shroeder,[14] Kaler[15]) also prove the relationship invaluable to early navigators:

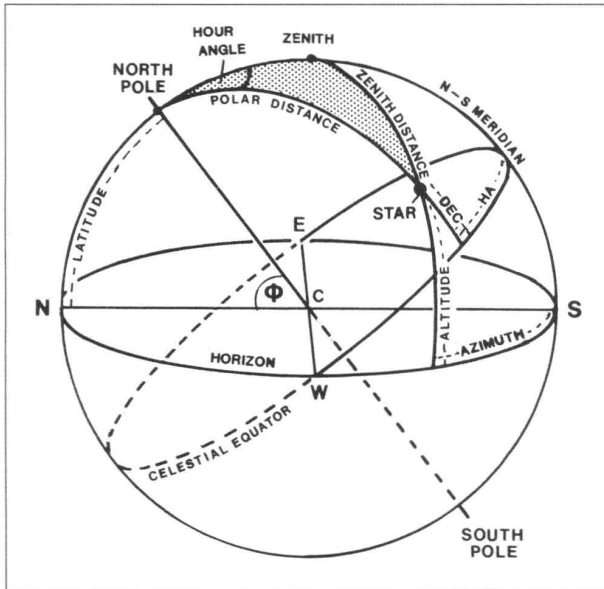Altitude of the celestial pole = Latitude of the observer

Fig. 3 Combined system.

Fig. 4 is another common diagram, showing how the declination of the Sun varies in the course of the year. This gives rise to different rising and setting points around the horizon, and variable periods of illumination. At the equinoxes we experience equal lengths of day and night, and the Sun rises exactly east and sets exactly west. The summer solstice marks the Sun's maximum excursion to the north, and the longest day of the year. The reverse occurs at the winter solstice.

The elevation of the celestial pole shows that Fig. 4 is drawn for a latitude of about 50°: a north temperate or European situation. The midday Sun never passes over the zenith, although in high summer the E-W meridian may be crossed once in the morning and once again in the afternoon.

The shadow of the top of a pillar upon the ground will each day move around the foot of the pillar-gnomon in a unidirectional clockwise direction following a hyperbolic curve. This geometry arises from the cutting by the ground plane of an imaginary cone described by the Sun's daily path about the tip of the gnomon.[16] 'Dial furniture' consists of two sets of hyperbolae separated by the straight line of the equinoctial: they are almost entirely on the northern side of the vertical gnomon. That these curves are
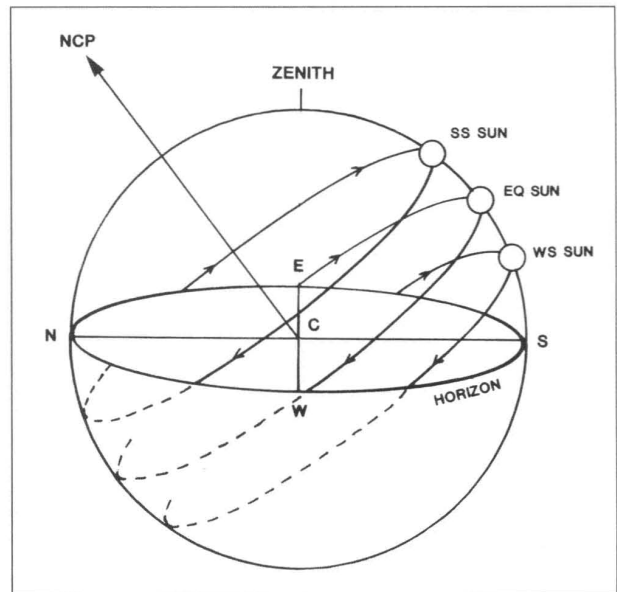
Fig. 4 Motion of the Sun through the year for a site at around 50°N.

hyperbolae is shown by the fact that both the cone and its mirror-image nappe are cut by the ground plane.[17] Only at sites between the arctic or antarctic circles and the corresponding pole will the shadow describe an ellipse, degenerating to a circle at the poles themselves.

QUALITATIVE DISCUSSION OF SHADOW REVERSAL

One rarely encounters the diagram of Fig. 4 re-drawn for a site in the tropics. Nuñez probably made his deduction as a result of constructing just such a figure, for no mathematics interrupts the elegant calligraphy of his text.[5] A drawing for a location just north of the equator, with the Sun near its maximum northerly excursion at the summer solstice, is attempted here in Fig. 5 Corresponding geometry will
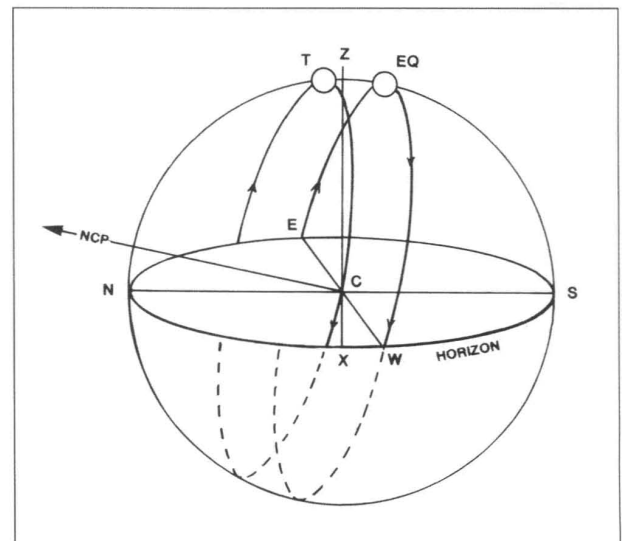

Fig. 5 Motion of the Sun between equinox and summer solstice for a site in the mid-northern tropics. For clarity, only an afternoon track is shown.

apply to sites south of the equator at the winter solstice. The zenith of the site falls between T and EQ, and the solstitial Sun passes to the north of it and the E-W line, so all shadows will be south of the latter. The diagram suggests that the path of the afternoon Sun intersects the vertical semicircle ZX in two places. This means that it exhibits the same azimuth twice in one afternoon - and, by symmetry, twice in the morning. Note though that its altitude is very different between members of each pair.

The shadow thrown by a post at point C upon the horizontal ground plane must therefore at some time reverse its motion in azimuth around the horizon. However, the length of the shadow will be determined by the altitude of the Sun. As this is continuously increasing up to noon, the radial shadow length will diminish continuously from infinity at sunrise to a minimum at noon, and then increase again in the usual way. In other words, we must distinguish and separate the radial component of the shadow's motion on the ground plane from its circumferential motion in azimuth. Only the latter reverses, in the sense that the shadow tip crosses a radius of the dial first in one direction and then in the other. It is nothing like a dramatic pause and reversal of the entire clock-hand-like shadow thrown by the stile of a triangular gnomon in temperate latitudes!

It may reasonably be surmised that the reversal will be best displayed when the Sun is as far from the celestial equator as possible – i.e. at the relevant solstice. The site of observation is limited to somewhere within the tropic T-EQ, for outside these limits the phenomenon will not occur at all. One might guess that a latitude about half-way within this zone would be best. To go further than this, and provide a rigorous proof that the phenomenon does indeed occur, necessitates a mathematical approach based on spherical trigonometry.

QUANTITATIVE MATHEMATICAL TREATMENT
We have seen that the fundamental requirement for a shadow to move in opposed circumferential directions on the horizontal plane is that the Sun should arrive at the same numerical value of azimuth twice before noon on a certain day. The symmetry of the arc of the Sun's travel then ensures that the same phenomenon occurs again in the afternoon. One mathematical approach is therefore to calculate the azimuths assumed by the Sun at a site in the tropics when it is at (or near) an appropriate solstice, and see if numerically identical values can occur twice before it reaches a maximum altitude at noon.

The 'astronomical triangle' (Fig.3) is imagined to be drawn on the surface of a sphere (the celestial sphere) so the ordinary relationships of plane geometry (such as angles

adding up to 180°) do not apply. Plane trigonometry is therefore invalid. That the key to solving the astronomical triangle is to utilise angles subtended by planes at the centre of the sphere was first realised by Al-Battani,[18] a brilliant Arab mathematician who flourished in the 10th century AD. His extension of plane trigonometry to triangles on the surface of a sphere is, reasonably enough, called spherical trigonometry, and became known in Europe through the translation of Arabic works at the Renaissance. (This was when a mistranslation gave us the peculiar term sine.) Al-Battani's equations are nowadays, of course, proved and rendered in modern nomenclature.[19] Ideally their derivation is at least read through, but after that most users are content to simply copy out the formulae and apply them. (You don't need to know how a TV set or computer works in order to use it effectively!)

Spherical trigonometry applies to all triangles drawn on the surface of any sphere, but astronomers are (were?) by far the major users of the technique. For their purposes Al-Battani's most important relationship is the COSINE RULE. Using the symbols listed in the appendix, this states that:

$$\sin\delta = \sin\varphi . \cos Z + \cos\varphi . \sin Z . \cos Az \qquad \text{[I]}$$
$$= \sin\varphi . \sin Alt + \cos\varphi . \cos Alt . \cos Az \qquad \text{[II]}$$

From II it follows that:

$$\cos Az = \frac{\sin\delta - \sin\varphi . \sin Alt}{\cos\varphi . \cos Alt} \qquad \text{[III]}$$

It may also be shown that:

$$\text{Cos } H = \sin Alt . \sec\varphi . \sec\delta - \tan\varphi . \tan\delta \quad \text{[IV]}$$

At sunrise and sunset Alt = 0, so this simplifies to:

$$\text{Cos } H = - \tan\varphi . \tan\delta \qquad \text{[V]}$$

Fortunately, these complex equations may nowadays be solved quickly and easily with an inexpensive 'scientific' pocket calculator.[20] (The humble 19th century employees of Greenwich Observatory who were required to hack them out with 8-figure log tables were officially known as 'computers'!)

With the guidance of Fig.5, one may set d at its maximum value of +23.5° for the summer solstice (June 21), and then use III to calculate the azimuths corresponding to altitudes from 0° (sunrise) to whatsoever maximum is attained at latitudes varying between 0° and 25°N. These are plotted in Fig. 6. It may be seen that:

a) Vertical semicircles between 66° and 77° are indeed intersected twice in the morning (and twice in the afternoon).

b) The excursion away from south reaches a maximum of some 12° between the sunrise (65°) and 77° vertical semicircles at a latitude of 20°N.
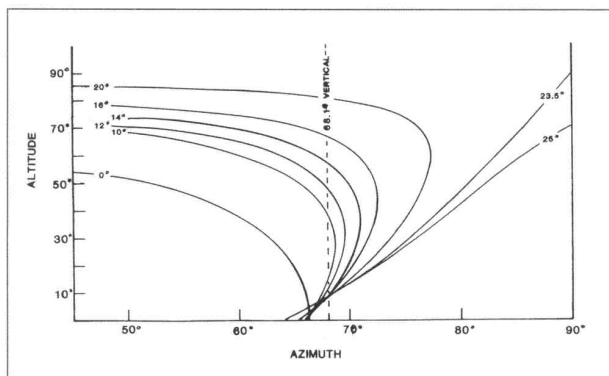

Fig. 6 Calculated altitude vs. azimuth of the Sun at various tropical latitudes on the day of the appropriate solstice. The choice of scales magnifies the excursion in azimuth.

It might therefore appear that this latitude would be best for viewing the phenomenon and satisfying a latter-day Hezekiah. However, it will also be observed that the Sun's second crossing of the 65° (or even 70°) vertical semicircle occurs at a high altitude very close to noon, so the second passage of the shadow will take place in the proximity of the base of the gnomon and be most difficult to see. Lower latitudes might give a better compromise between crossing times and excursion. It is therefore essential to calculate the times applying to various points along the curves before making any final choice. This was done with equation IV, which gives results in local solar time. The corresponding radial lengths of shadow r for a gnomon of unit height are given by:

$$r = \frac{1}{\tan \text{Alt}} \qquad \text{[VI]}$$

With this information, diagrams could be drawn of the movement of the shadow tip on the ground plane for various chosen latitudes, using a vernier protractor to set out the azimuth angle and a ruler to measure the scaled shadow length r along it. It appeared that 14°N was optimal. Table I shows data relevant to this latitude: it will be seen that, as expected, the sun is shooting up the sky almost vertically at its rising. Fig. 7 reproduces the corresponding plot of the motion of the tip of the shadow on the ground plane on the day of the summer solstice. Between sunrise and 8 am LST the entire shadow moves anti-clockwise in azimuth: it then pauses for about an hour

(although still shortening) before discernibly commencing to move in azimuth in a clockwise direction between 9 am and noon. The angular rate increases as it does so, the motion of the short shadow becoming very rapid over the final hour.
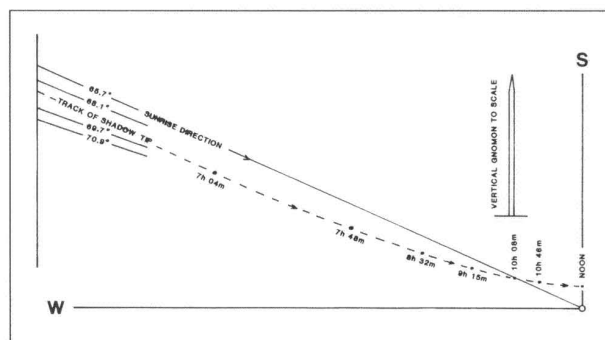
Fig. 7 Calculated path of the shadow of the tip of a vertical gnomon at lat. 14°N on the morning of the summer solstice.

The solar declination is, as the name implies, changing very slowly at a solstice. Therefore the phenomenon could probably be viewed for a week either side of this date. Latitudes between 14 ± 2° could also be considered, along with their counterparts south of the equator at the winter solstice.

DIRECT OBSERVATION

It's hardly a world-shattering event, but there can't be many natural phenomena that have escaped direct observation over all recorded history. Remembering that places in the tropics tend to be excessively hot around the appropriate solstice, some possible locations tempered by altitude or proximity to the sea are:

Northern hemisphere, on or around 21 June

    Martinique : 14° 30'N or St. Lucia: 13° 46'N
    Thailand (Bangkok is 13° 44'N)
    Philippines (Manila is 14° 36'N)

Southern hemisphere, on or around 21 December

    Western Samoa : 14° 00'S
    Katherine, N. Australia: 14° 27'S (A very hot inland site!)
    Zambia (Lusaka is 15° 25'S) Unfortunately, the total solar eclipse of 21 June 2001 occurs at the other solstice.

A level beach or hilltop site with a clear horizon from east through south to west should be sought. Corrections to local solar time would be equation of time (sundial slow 1.5 minutes), a longitude correction for distance from the time zone meridian, and any daylight saving time in use.

Observations would have to be carefully planned and practised in the days leading up to the solstice. A rigidly secured sharply-pointed gnomon is essential, perhaps sloping a little to give a clear area around the spot indicated by a plumb-line hung from the tip. (Recall that only the tip is the index: the rest of the gnomon and its shadow must be ignored.) A perpendicular height of 1.5 metres might be about right for, apart from transportation and erection problems, long shadows tend to be fuzzy as a result of the $\frac{1}{2}°$ angular diameter of the Sun. Even so, use of a card pierced with a small hole (a 'shadow sharpener' [21,22]) is recommended. The near-sunrise azimuths might perhaps be pegged-out visually until the Sun achieves sufficient brilliance to throw clear shadows. (A variable-density filter suitable for these brief observations of a low Sun may be made by smoking a piece of glass in a candle flame to deposit a film of increasing density. Protect it with a cardboard frame and another piece of glass, taping the assembly around the edges). Mark out the shadow path with felt-tip pen, nails etc., as appropriate for the receiving surface. The afternoon provides another chance to observe the shadow pause and reverse direction in the sense described above.

I am sure our Editor would be pleased to receive an account from anyone who succeeds in this enterprise.

ALTERNATIVES FOR STAY-AT HOMES

If one is working at a mid-England latitude of 52° N, then a south-facing inclined board bearing a 'pillar' inclined at 38° to the vertical mimics the situation at a latitude of 14° N. This is shown if Fig.8, where it will also be seen that the curvature of the Earth permits the Sun to be above the real horizon when it is no longer illuminating the sloping board, and has set at 14° N. Similarly, it has risen at 52° when it is still below the horizon at 14°. Calculation using equation V shows that geometrical sunrise occurs at 3.45 am LST at 52° latitude, which may be compared with 5.35 am LST at 14° latitude, (Table I). The difference of $1^h 50^m$ has two potential advantages:

i) It enables the Sun to be above the cloud belts that, in the UK, commonly blanket the horizon around dawn and dusk.

ii) By extending the 'pillar' below the plane of the board it becomes possible to follow the shadow (or manually mark the solar direction) for an extended period of time, giving rise to a larger apparent excursion.

Alt°	Az°	Local Solar Time	Shadow length	Comments
0	65.7	$5^h.35^m$	∞	Sunrise
5	67.0	5.58	11.43	
10	68.1	6.20	5.67	1st crossing of 68.1° vertical semicircle
20	69.7	7.04	2.75	
30	70.7	7.48	1.73	
35	70.9	8.07	1.43	Pause at max. angular excursion
40	70.9	8.32	1.19	
50	70.0	9.15	0.83	Azimuth decreasing
57	68.1	9.46	0.65	2nd crossing of 68.1° vertical semicircle
60	67.0	9.59	0.58	
62	65.7	10.08	0.53	2nd crossing of sunrise vertical semicircle
70	58.9	10.46	0.36	
80	17.7	11.47	0.18	
80.5	0.0	12.00	0.17	On N-S meridian

Table I Data for a site at 14°N on the day of the summer solstice

A practical arrangement is diagrammed in Fig.9, and should much less expensively display the reverse motion around the summer solstice[9]. The 'pillar' could be represented by a thin steel rod pointed at both ends (e.g. a knitting needle) arranged to be a friction fit in a perpendicular hole piercing
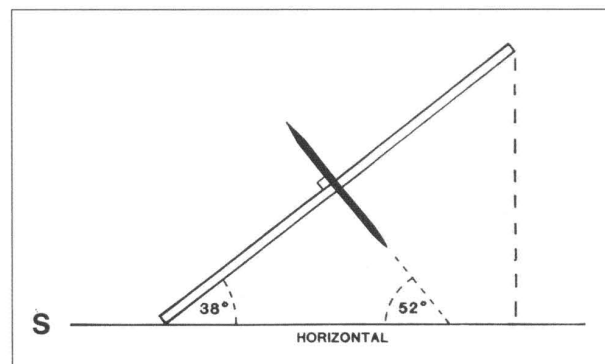

Fig.8 Geometry required at 52° N to mimic behaviour of a vertical pillar at 14°.

Fig.9 Practical realisation of the geometry of Fig.8, since the shadows around sunrise and sunset will fall on the underside of the tilted board.

a large rectangular board. The latter should be emulsioned matt white on both sides, and propped in such a way that a low Sun can fall upon the underside. It is obvious that the assembly must be firmly secured at an elevated site with a clear horizon. At the conclusion of the experiment points on the lower face could be transferred to the upper surface by measurement from the edges.

Coincidently, because of the two latitudes chosen, the apparatus of Fig.9 is equivalent to an equatorial dial for 52° rotated through 180° about the dashed vertical line.

Finally, perhaps the easiest way of all is to use a solar motion simulator.[23,24] This may even be set to incorporate an exaggerated value for the solar declination (Fig. 10). When the 'sunrise' position was marked with a radial strip of cardboard it was found fairly easy to observe the speeded-up back-and-forth motion in azimuth of the shadow of the tip of the vertical nail. The apex of a conventional triangular gnomon also serves, but is not quite so easy to differentiate from the remainder of the shadow.
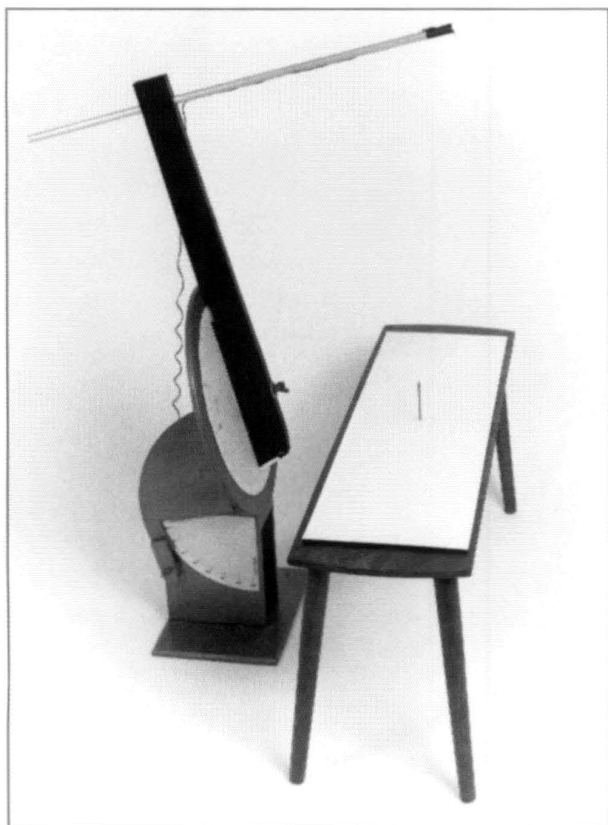
Fig.10 Solar motion simulator set-up for a latitude of 14°N, with an exaggerated value of the maximum northern solar declination.

ACKNOWLEDGEMENTS

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Author's address:
Astronomy Group
University of Leicester
Leicester LE1 7RH

APPENDIX

Altazimuth or local system (Fig. 1)

Zenith	Z	The point on the celestial sphere directly overhead an observer at a location C.
Nadir	-	The point on the celestial sphere diametrically below the observer's zenith.
Vertical semicircles	-	Great semicircles connecting the observer's zenith and nadir, and intersecting his horizon at 90°.
North celestial pole	NCP	The point where the northern prolongation of the Earth's spin axis appears to touch the celestial sphere.
N-S meridian 'The meridian'	-	A great circle connecting the observer's zenith with the NCP, and then passing completely around the celestial sphere to intersect the SCP and nadir and eventually rejoin the zenith. It cuts the observer's horizon at the geographic north and south points, and acts as the circular boundary of many astronomical diagrams.
Altitude	Alt	Angle at the observer subtended along a vertical circle between a given star and the horizon.
Azimuth	Az	Angle at the observer subtended around the horizon between the foot of a vertical circle passing through a given star and the north or south point acting as 0°. Measured in degrees up to ± 90°. (Navigators use 360° measured clockwise from zero at the north point.)
Prime vertical	-	A name sometimes given to the vertical circle at 90° to the N-S meridian, and so cutting the observer's horizon at the E and W points.

RA/Dec or universal system (Fig. 2)

Celestial meridians	-	Great semicircles connecting the northern and southern celestial poles.
Celestial equator	-	The great circle on the celestial sphere at 90° to the polar axis, and midway along it. Equivalent to the Earth's equator extended into space.
Ecliptic	-	The projection into space of the plane of Earth's orbit around the Sun. The tilt of the Earth's spin axis causes a displacement of 23 ½° relative to the plane of the celestial equator.
Vernal equinox	♈	The point of intersection between ecliptic and celestial equator that occurs in the Spring, when day and night are of equal duration.
Right ascension	RA α	Angle between the intersection of a star's meridian with the celestial equator and the position of the vernal equinox. It is so named because, to an observer facing the NCP, the apparent rotation of the celestial sphere causes stars to rise on the right hand side.
Declination	Dec δ	Angle subtended at the centre of the celestial sphere between a star (which may be the Sun) and the celestial equator.

Annual motion	-	Apparent motion of the Sun around the ecliptic in the course of the year. Its declination will therefore vary between $0°$ and $\pm 23\frac{1}{2}°$.
Daily motion	-	The apparent rotation of the celestial sphere due to the turning of the Earth on its spin axis. Divided into 24 hours, originally noon-to-noon but now midnight-to-midnight.

Combination (Fig. 3)

Latitude	φ	Angle subtended at the centre of the Earth between the terrestrial equator and the radius to a given site.
Co-latitude	ω	$(90 - φ)°$
Hour angle	H	When time is involved, it is usual to measure it by the angle subtended between the planes of the star's meridian and the southern half of the N-S meridian. Clock times are obtained from the relationship $15°$ of arc = 1 hour of time, measuring backwards or forwards from a zero at the south point.
Zenith distance (Beware confusion with the zenith point in altazimuth system.)	Z	Angle between a star and the zenith. Equivalent to $(90 - Alt)°$ so that $\cos Z = \sin Alt$.
Polar distance	-	Angle between a star and the celestial pole. Equivalent to $(90 - δ)°$
Astronomical triangle	-	The shaded area. With apices at zenith, celestial pole and star, and 'sides' of zenith distance and polar distance. (The angle at the star and the side along the N-S meridian have no special names, and rarely come into calculations.)

THE GATTY FAMILY - PART 2
THE BOOK OF SUN-DIALS

'FUGIT HORA, ORA'
The Hour Flies, Pray

FIRST EDITION

As I explained in Part 1, the first edition of this work contained mostly mottoes collected by Margaret Gatty with the help of Eleanor Lloyd. Bell and Daldy, York Street, Covent Garden published it in 1872. Its dedication is worth repeating for the benefit of Members who do not have a copy.

TO
THE DEAR HUSBAND,
TO WHOM I AM INDEBTED FOR THE BEST
HAPPINESS OF
THE HOURS OF EARTHLY LIFE,
AND WITH WHOM I HOPE TO SHARE THE
EXISTENCE IN WHICH
TIME SHALL BE NO MORE,

I Dedicate this Volume,
IN THE COMPILATION OF WHICH HE HAS
TAKEN SO GREAT
A PART AND INTEREST.

M. G.

The book consists almost entirely of mottoes, with 377 being quoted and about 20 drawings of dials bound at the end. The drawings appear to be by various contributors, some carrying the initials or monogram of their artists. Those of continental dials, and most of the continental mottoes, can almost certainly be attributed to Eleanor Lloyd as described in the Preface. The book's second chapter is 'Introductory', followed by the main bulk of the work 'Sun-Dials'. The remainder of the work is comprised of, 'Further Notes on Remarkable Sun-Dials', an Index and finally the illustrations.
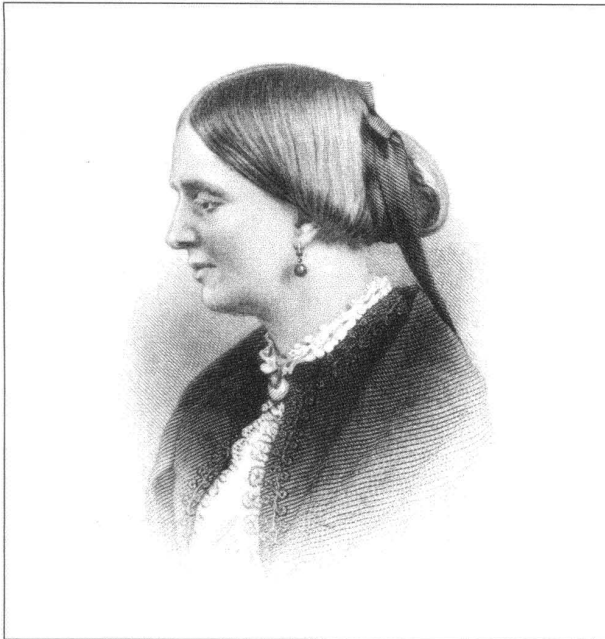
Fig.1. Margaret Gatty "She is slight, tallish and intellectual looking..... and I can quite fancy her blazing up - when strongly excited" - Dr. Wolff.
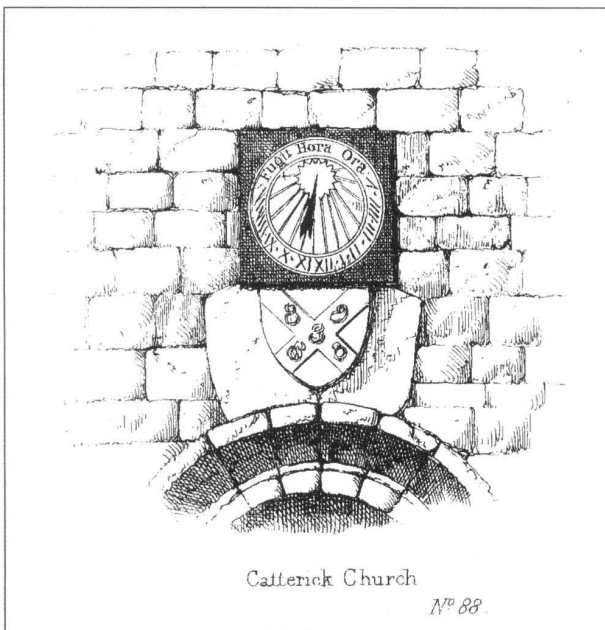

Fig.3. The Dial over the Church Porch at Catterick.

Margaret Gatty (Fig. 1. portrait from Ref.1) had been collecting mottoes for much of her life. She was the daughter of a vicar, and the churches where they lived had had dials, and some had mottoes. She was born at Burnham vicarage in Essex. Her father, Alexander John Scott, was vicar of both Burnham and nearby Southminster. A large vertical dial still exists on the side of the nave at Southminster bearing the date 1814, (when she was 5 years old), (Fig. 2.) and below that, a Norman doorway with an indistinct mass dial. Margaret would certainly have been familiar with the big dial on 'their' church, if not the mass dial. When she was 10, the family moved to Catterick in Yorkshire. The church there had

a dial over the porch with the motto 'Fugit Hora, Ora' (Fig.3.). This dial was taken down when the church was restored in 1872, and was somehow broken. An exact replica was made and erected 'through the kindness of William Booth of Oran, near Catterick'. It still exists, but is now in need of repainting. According to Margaret, in her Introductory Chapter, there were several dials in the Catterick area with mottoes. It was to be a long time before these were all brought together in her famous volume.
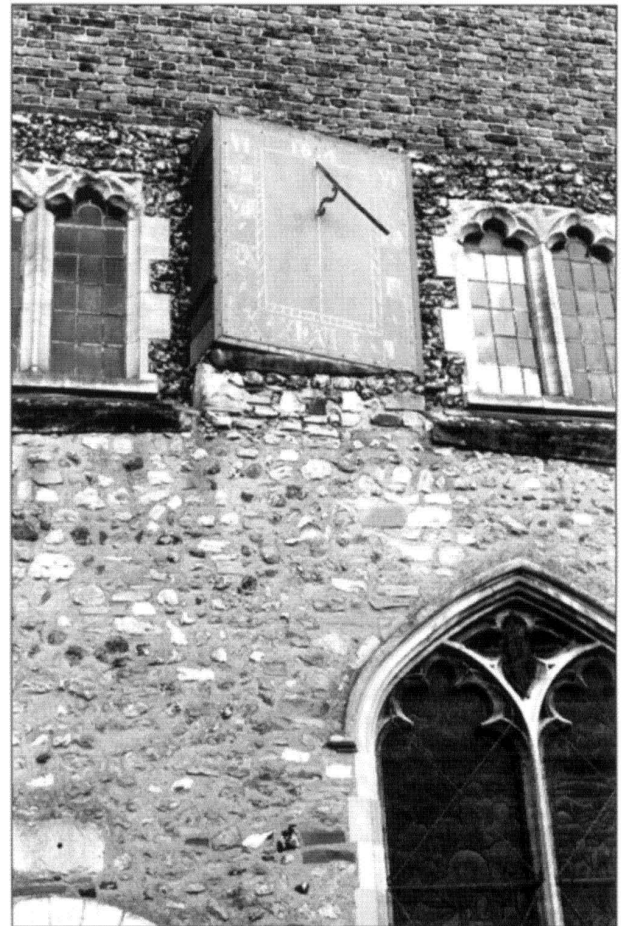
Fig.2. Large Vertical Dial at Southminster dated 1814.

Margaret Gatty died the year following the year of publication of The Book of Sun-Dials, so she was unable to see the success that it achieved.

SECOND EDITION

A second edition was published in early 1889. It was similar to the first but corrected and enlarged by her daughter Horatia and their family friend Eleanor Lloyd. In this 'NEW AND ENLARGED EDITION', the number of mottoes had virtually doubled to 738 plus a short Addenda with 21 more. It was of smaller format being 8¾" x 7" instead of 11¼" x 9" of the first edition. It contained a new Preface by H. K. F. Gatty. The quantity of line drawings had increased, and these were now inserted into the text in their appropriate place. Many of the new drawings were by Eleanor Lloyd. What has happened to the old drawings

from the First Edition? They had been re-drawn for this new volume and are generally of inferior quality. These inferior drawings are also carried on to later editions. Its Appendix contains a new section by Wigham Richardson in which he shows how to construct sundials. The section, 'Further Notes on Remarkable Dials' had been increased considerably in size. In particular it contains drawings of Yorkshire dials from Rev. D. H. Haigh[2].

I am lucky to have the original author's copy of the First Edition used by Horatia, with her copious hand written corrections, plus a further 54 manuscript pages bound in at the back. This exciting copy has been the main inspiration for my present research into this interesting family. Inside the book's front cover is the signature Horatia. K. F. Gatty. (Fig. 4.) Throughout the text, corrections have been made, mostly in ink. Where these were simple, it was sufficient to leave the note against that entry. For the more complex and lengthy changes, and for additions, a note refers to the manuscript pages at the rear, which are fully indexed. It seems that all of these changes were included when the second edition was published. In the section of manuscript pages are three pencil drawings (Fig. 5.), and several newspaper cuttings.
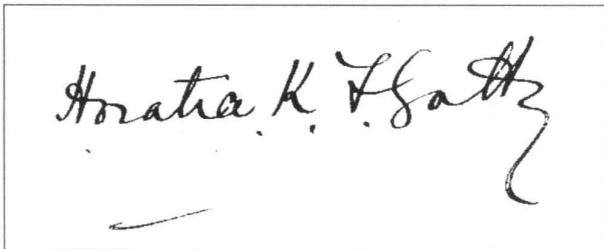
Fig. 4. Signature of Horatia Gatty.
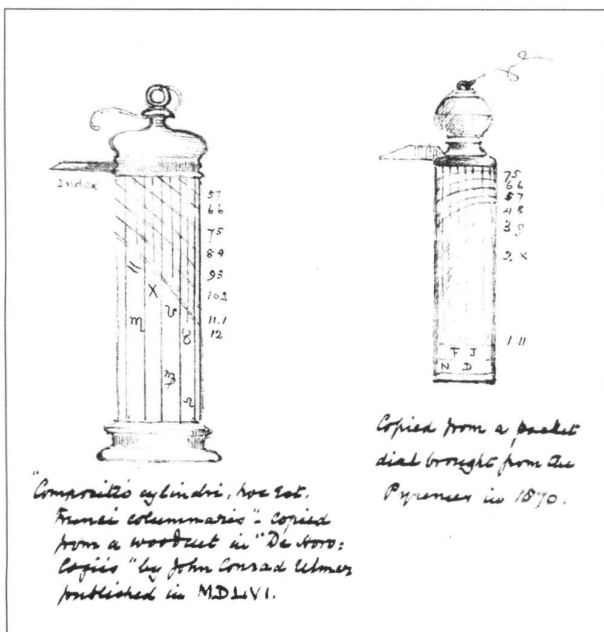
Fig. 5. Pencil Sketch of Pillar Dials from Horatia's Notebook

Between the pages of this volume were several scraps of paper with dial mottoes in a neat calligraphic script. As these mottoes can already be found in the First Edition, it seems almost certain that they are in the hand of Margaret Gatty. She was known for her calligraphic writing skills and for her drawings. I am convinced that most, if not all, are from her hand. Also between the pages are some loose leaves of a notebook. These are pastel coloured pages, blue, yellow, pink and white, and have gilt edges. These pages contain mottoes with some sketches and paintings. There is also part of an index page. It seems that these are pages from Margaret's own notebook, in which she had neatly recorded her dial mottoes over many years. Of particular interest is the motto Tempus Fugit. (Fig. 6.) This is on the only page that is dated - July 8. 1839. This is a most significant date as it was that of her wedding to Alfred. She still had time to collect mottoes even amidst such excitement! Perhaps more interesting is a later pencil note on this page saying `Village between London & Hampton'. We do not know this for sure, but it was probably recorded after their wedding at St. Giles in the Field, as she and her new husband were travelling to their first night's accommodation together. She had been married from Sir Nicholas Tindall's house in Bedford Square and presumably the young couple were anxious to get away together. They may therefore have travelled by coach to the Hampton, about 13 miles away, to a friend's house or even a hotel. We may never know for certain.
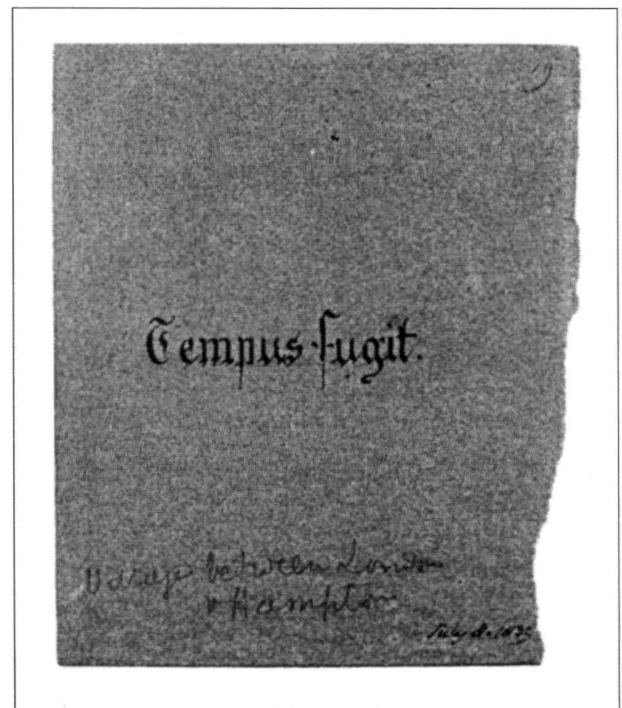

Fig. 6. Motto from Margaret Gatty's Notebook, just after her Wedding, July 8, 1839.

THIRD EDITION

The third edition followed closely on the second, appearing in the next year. It was virtually identical to the second edition, but with the Addenda increased from 21 to 129 new mottoes.

FOURTH EDITION

The fourth edition of 1900 is the one best known and sought after by diallists. Consequently it has become scarce, and copies are now selling for over £200. This edition was completely re-written by H. K. F. Eden (née Gatty) and Eleanor Lloyd. It was greatly enlarged, with many line drawings of dials plus a few photographs. It returned to the larger format page size of the first edition. The quantity of mottoes had now risen to 1682, a large increase from Mrs. Gatty's original edition of 377. The appendix by Wigham Richardson is retained with a few small changes. Further useful additions are detailed tables for the Equation of Time and Sun's Declination for each day of the year (1899). A section was added on 'PORTABLE SUN-DIALS' by Lewis Evans, F.S.A., F.R.A.S. He has illustrated this chapter with examples from his own extensive collection.

AUTHORS AND CONTRIBUTORS:
HORATIA EDEN

Horatia Katherine Frances Eden, (née Gatty) lived for a time at her brother's house in Kensington after leaving home in Ecclesfield. It was at this time that she edited Aunt Judy's Magazine. She also wrote forewords for many of her sister Juliana's books, including her biography following her early death from cancer in 1885. Horatia then married a schoolmaster, Thomas Bainbridge Eden, who taught at Orwell House, a preparatory boarding school for boys, at Clifton-upon-Dunsmore, just outside Rugby. They later moved to a similar school for young gentlemen in the town, Hillbrow House, close to Rugby School. 'Tommy' Eden and Horatia were joint headmaster and headmistress there for some years. Amongst their pupils was the young Rupert Brooke, later to become famous as a poet. Thomas Eden was elected chairman of the Rugby Urban District Council for five years, and became J.P. by virtue of that office. (Around 1957, Eden Road, on the new Abbots Farm Estate, Rugby, was named after him.) The couple then moved to Fortune Green Road, London around 1910, and nearby to 94 Cannon Hill about 1918, where they stayed until at least 1940, Horatia eventually dying in 1945 just two months short of her 100th birthday.

ELEANOR LLOYD (Fig.7.)

Little is known about Eleanor Lloyd. She is referred to in several books of the Gatty family. She is usually referred to as 'our young friend' and is accredited with sketches that

appear in several of the family's books, for her architectural knowledge and for her continental mottoes and sketches. Some of her drawings are signed with the monogram *Ea*. Acknowledgements refer to her as 'a true friend and an accurate worker', and similar sentiments. (Fig.8.)

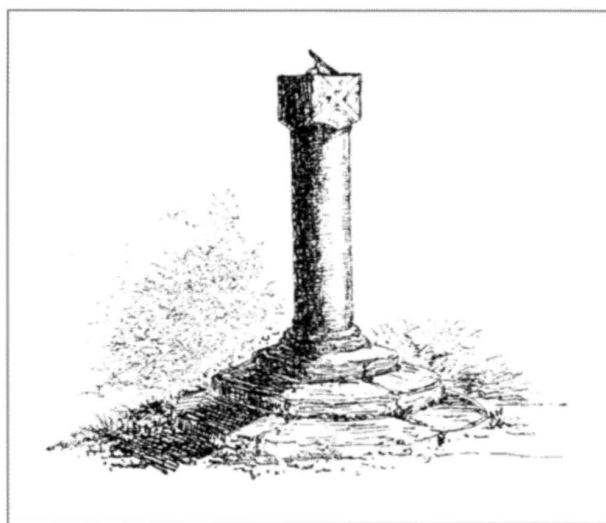*Fig. 7. Signature of Eleanor Lloyd.*

Fig. 8. Drawing of a Sundial by Eleanor Lloyd from her Story, 'The Old Sundial' published in Aunt Judy's Annual Volume, 1883.

Yorkshire church records[3] show that she was christened at Cowesby, just 16 miles from Catterick, on 8 August 1843, the parents George and Elizabeth Henrietta Lloyd, apparently lived at Cowesby Hall quite close to Margaret's Scott's childhood home in Catterick. In the 1881 census[4], she and her family are recorded at Hazlecroft, Killinghall near to Harrogate, where she may have taught in the local school. It is probable that she never married as references[5] still show her as Eleanor Lloyd as late as 1906 when she would have been 63 years of age.

WIGHAM RICHARDSON[6]

J. Wigham Richardson was quite a character, so a few notes about him are appropriate. He was born 1837 on Tyneside, and being from a Quaker family was educated at a Quaker school. At 16 he was apprenticed to a tug builder in Gateshead. After his apprenticeship he studied languages and mathematics at London University. In 1860, aged 23, his father gave him £5000 to buy Neptune Yard. During his career there, he helped to build the steamship Great

Eastern. His yard flourished and was amalgamated with Swan Hunter next door with Wigham Richardson taking 40% of the new company's shares. The new enlarged company was responsible for the building of the two famous ships, Lusitania and Mauritania. He wrote his autobiography[6] in 1870 and died in 1908.

D. H. HAIGH

Rev. Daniel Henry Haigh is best known to diallists for his 88 page work on Yorkshire Dials[2]. In this work he describes the Saxon dials of Yorkshire and interprets their inscriptions. Many of his illustrations have been used in Sun-Dials, first included in the second edition.

LEWIS EVANS (1853 - 1930)[7]

He had been trained as a chemist at University College, London, eventually becoming chairman of the family paper making business, John Dickenson & Co. Ltd. His magnificent collection of Portable Dials was collected over a period of 50 years. He exhibited some of these at The Royal Society, The Society of Antiquaries, and The White City between 1890 and 1911[7]. His collection of Astrolabes and other mathematical instruments were to increase significantly in this period. In 1922 the collection was offered to the Ashmolean Museum in Oxford, being placed there in 1924. In 1935 these items were to form the basis of the well known collection of the Museum of the History of Science, in Broad Street, Oxford.

WARRINGTON HOGG

He wrote his smaller, but attractive 'A Book of Sundials'[8], published in the mid 1890s. Eden & Lloyd have used several of his distinctive sketches in their final version of 'Sun-Dials'.

ACKNOWLEDGEMENTS

I am indebted to the many correspondents and friends who have helped me in compiling this article. I would like to thank the following in particular:- Christopher Daniel, Frank Evans, Alan Hooker, Melvyn Jones, Joyce Smith, and David Young.

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A further article will follow describing other sundial books, many of which were influenced by the Book of Sun-Dials.

Mike Cowham
PO Box 970
Haslingfield
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<mike@eastlands99.freeserve.co.uk>

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    >   A.A. Mills: 'Seasonal Hour Sundials' *Antiquarian Horol.* **19,** 142-170 (1990)
    >   W.S. Maddux: 'The Meridian on the Shortest Day' *Compendium, Journ. NASS.* 4, 23-27 (1997).

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(Restoration)
Tel: 01663 762415
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Mr. D.A. Bateman
4 New Wokingham Road
CROWTHORNE
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Tel: 01344 772303
douglas.bateman
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Mr. John Churchill
55 Rushington Avenue
MAIDENHEAD
Berkshire
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(Advertising)
Tel: 01628 627382
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Mr. C.St.J.H. Daniel
8 The Maltings, Abbey Street
FAVERSHAM
Kent, ME13 7DU

(Chairman)
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Mr. P. Nicholson
9 Lynwood Avenue
EPSOM
Surrey   KT17 4LQ

(Internet)
Tel: 01372 725742
BSS Email List
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Mr. P. Powers
16 Moreton Avenue
HARPENDEN
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Dr. M.W. Stanier
70 High Street
Swaffham Prior
CAMBRIDGE
CB5 0LD

(Editor)
Tel: 01638 741328
margaretws@stanier-
cambs.demon.co.uk

Mr. Robert B. Sylvester
Windycroft, Alexander Place
ASKAM-IN-FURNESS
Cumbria LA16 7BT

(Membership)
Tel: 01229 465536
Sylvester @windycroft.
cumbriainternet.co.uk

Mrs. Jane Walker
1 Old School Lane
West Lydford
SOMERTON
Somerset TA11 7JP

(Education)
Tel: 01963 240421
janeandpeter.walker
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Miss R.J. Wilson
Hart Croft
14 Pear Tree Close
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Gloucestershire   GL55 6DB

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Mr. A. O. Wood
5 Leacey Court
CHURCHDOWN
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Dr. I.D.P Wootton
Cariad Cottage
Cleeve Road
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