The Sundial in Old Court

Frank King — Diallist

Sundials are familiar as ornaments in gardens or on the walls of buildings. A casual passer-by may admire the craftsmanship of a sundial but will generally not be too impressed by its time-keeping properties.

A quick comparison of the time indicated by a typical sundial with the time indicated by a watch often shows a discrepancy of several minutes. If summer time is in force, the discrepancy will very likely be an hour or more.

Part of the explanation is that there are different ways of measuring time and some of these ways are better suited to sundials and others are better suited to clocks.

Fig. 1 — The New Sundial in Old Court

Clocks are very good at measuring equal intervals of time but become extraordinarily complicated if, for example, they are required to indicate the time of sunrise or time of sunset.

Clock time is also surprisingly susceptible to interference by governments. Summer time is really a trick to persuade people to get up an hour earlier by telling lies about the time. The occasional leap second is another example of time being changed by decree. Establishing time zones is yet another.

It is unfortunate that most sundials are designed to indicate local sun time which is close to but different from clock time. In consequence, the casual passer-by has a point. Sundials do not appear to be precision astronomical instruments.

A would-be sundial owner is better advised to choose a design that accurately indicates a time which is so different from ordinary clock time that there is no danger of being confused with it.

This is the thinking that underlies the choice of design for the new sundial in Old Court, a gift to the College by alumnus Jim Dickinson who read Engineering at Selwyn from 1975 to 1978. This sundial indicates two kinds of time: the number of hours since the most recent sunrise and the number of hours since the most recent sunset.

Sundial enthusiasts, diallists, refer to these times as Babylonian hours and Italian hours respectively. They bear only the most tenuous relationship to ordinary clock time.

During the first six months of the year, sunrise steadily gets earlier and sunset steadily gets later. The Old Court sundial elegantly and precisely tracks these changes without using any moving parts except for the Earth itself! As a bonus, sunrise and sunset are not susceptible to change by legislation.

Fig. 2 shows an early sketch of the new sundial. This illustrates the principal features and shows how to read the time.

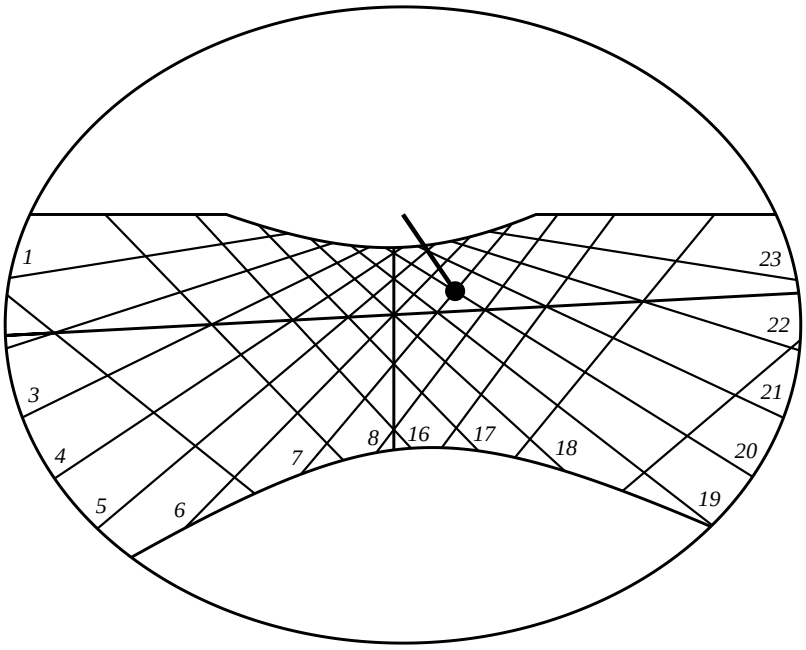

Fig. 2 — 7 hours after sunrise, 20 hours after sunset

The sundial does not have a conventional *gnomon* or pointer whose shadow falls along hour lines. Instead this sundial has a *nodus* which takes the form of a small disc which is suspended parallel to the dial at the end of a short rod. The shadow of the rod and the nodus appear as a drum-stick in Fig. 2.

The centre of the shadow of the nodus indicates a point on the dial and, in Fig. 2, the point falls on the intersection of two diagonal lines, one labelled 7 and the other labelled 20. These two values indicate the two times: 7 hours after the most recent sunrise (Babylonian hours) and 20 hours after the most recent sunset (Italian hours).

The average of these times, 7 and 20, is $13\frac{1}{2}$ which corresponds to 13:30 or 1:30 pm. This is the time (sometimes called French hours) that would be shown on an ordinary sundial. That's how you could set your watch, at least approximately. One hour later, the two indicated times will have advanced to 8 and 21.

Babylonian hours and Italian hours both run from 0 hours to 24 hours but they run from sunrise to sunrise and sunset to sunset respectively. It is often useful to subtract Italian time from 24 which gives the number of hours *until* sunset; a time of 18 Italian hours means there are 6 hours until sunset.

The Babylonian hour-lines are labelled 1 to 8 on the dial (although 2 is missing in Fig. 2) but continue, unlabelled, for another three hours. The short horizontal line on the left is, strictly, Babylonian hour 0 (or 24). In theory, the shadow of the nodus falls on this line at sunrise. In practice, buildings and trees normally intervene when the sun is on the horizon.

The Italian hour-lines are labelled 16 to 23 on the dial but start, unlabelled, two hours before 16. The short horizontal line on the right is, strictly, Italian hour 24 (or 0). In theory, the shadow of the nodus falls on this line at sunset.

The vertical line in the middle of the dial is the noon line. The shadow of the nodus crosses this line each day when the sun is due south. Astronomers refer to this time as the moment of superior solar transit and, in Cambridge, this happens close to (though generally not exactly at) noon Greenwich Mean Time (GMT).

Although the sundial is not attempting to indicate normal clock time even approximately, astute observers will note some interesting relationships between clock time and the times indicated by the two families of hour-lines.

During the day of an equinox, sunrise and sunset are close to 6 am and 6 pm GMT and the shadow of the nodus follows the gently sloping line that runs across the dial from left to right. The shadow crosses the noon line at 6 hours Babylonian time and at 18 hours Italian time.

The two curved lines are hyperbolic arcs. They show the path followed by the shadow of the nodus at the two solstices. At the winter solstice, the sun is low and the shadow follows the short upper arc. At the summer solstice, the sun is high and the shadow follows the long lower arc.

It is particularly instructive to look at this sundial at noon each day. In the summer months this is 1 o'clock (about lunchtime). Near the summer solstice the dial will show that this is about 8 hours after sunrise or 8 hours before sunset. As the summer moves towards autumn, these intervals will gradually shorten first to 7 hours and then to 6 hours at the autumnal equinox.

After the equinox, the intervals continue to shorten, to 5 hours and then to 4 hours. Notice that the Babylonian hour-line labelled 4 crosses the Italian hour-line labelled 20 on the noon line.

The early sketch of Fig. 2 represents the start of a long process. One of the early tasks is to determine the dial parameters, principally the latitude of the site and the orientation of the wall.

It is generally easy to determine the latitude but determining the orientation of the wall to high precision is more challenging.

These days highly specialised surveying kit is used which exploits the Global Positioning System (GPS) and Hurst Surveys of Toft undertook this work. See Fig. 3. Hurst Surveys have previously undertaken topographic surveys for the College.

Fig. 3 — Surveying the Wall using GPS

It was decided early on that the sundial should be executed on an elliptical slab of slate and that the details of the design, the cutting, gilding and painting should be undertaken by the Cardozo Kindersley Workshop in Victoria Road, Cambridge.

Fig. 4 — Russell Purdham marking out the Summer Solstice Curve

The slate was supplied by Ivett & Reed of Newmarket Road, Cambridge and the nodus and nodus support were fabricated by Mackay Engineering of Cherry Hinton.

In the early stages, the design was largely represented by scores of figures tabulated on spreadsheets. These were translated into pencil markings on the slate.

Fig. 4 shows the slate in the Workshop. Both sets of hour-lines have been marked out. A strip of flexible wood has been bent into the shape of the summer solstice curve and clamped to the slate. Russell Purdham, who did all the cutting, is seen marking out the Summer Solstice curve.

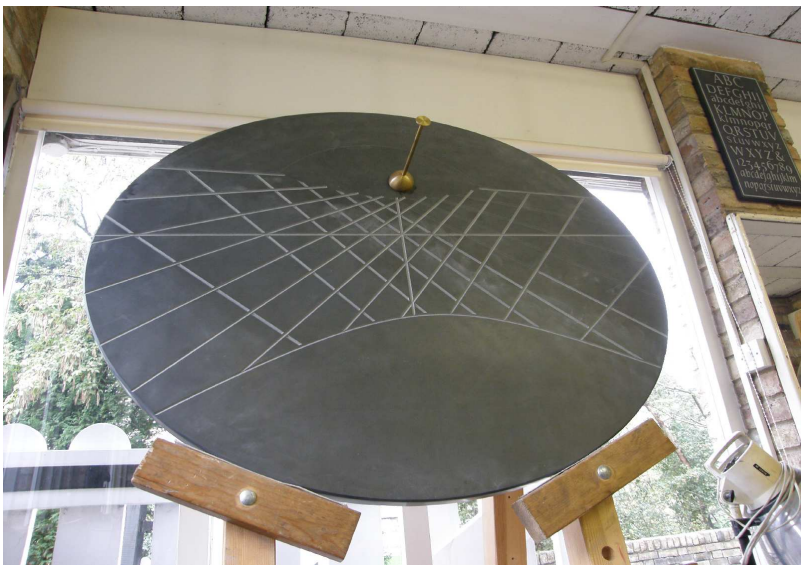

Fig. 5 — Trying out the Nodus, most Hour-Lines now cut

After marking out, the cutting begins. In Fig. 5, most of the hour-lines have been cut and the brass nodus has been put into position for the benefit of the photograph.

The hour-lines and other information on a sundial are collectively known as dial furniture. As with many sundials, the Old Court dial is embellished with inscriptions and other ornamentation.

In the centre of the glorious sunburst at the top of the dial (see Figs 1 and 6) are the two Greek words, ΚΑΙΡΟΝ ΓΝΩΘΙ, attributed to Pittacus, one of the Wise Men of Greece. These words translate as 'know the time' or 'recognise an opportunity'. This inscription also appears on a sundial on the south side of Ely Cathedral.

In the space below the summer solstice curve there is a Latin inscription, *Collegio suo lactarius Eboracensis me dono dedit*, which is a reference to the benefactor: To his college the Yorkshire dairyman gave me as a gift.

There are two further inscriptions round the rim of the dial in the thickness of the slate itself. These are explanations: BABYLONIAN HOURS SINCE SUNRISE and ITALIAN HOURS SINCE SUNSET.

The inscriptions were almost the last items to be cut. In Fig. 6, the hour-lines and the sun burst have all been cut and the middle line of the Latin inscription is being cut in the photograph.

The labels on the hour-lines are the major outstanding items in Fig. 6 and were the subject of considerable thought. To reduce clutter, it was decided early on to restrict the labelling of the Babylonian hours to the morning side of the noon line and the labelling of the Italian hours to the afternoon side.

A more difficult decision was how to accommodate the label for Babylonian hour 2. This label is missing in Fig. 2 because, in its natural position, it would fall across the left-hand end of the equinoctial line.

The solution that was adopted was to have labels 1 to 5 *below* their respective hour-lines and labels 6 to 8 *above* their respective hour-lines.

Fig. 6 — Russell Purdham cutting the Latin Inscription

On a historical note, Babylonian hours and Italian hours came into use after the advent of early mechanical clocks. Far from causing the demise of sundials, the introduction of clocks spurred the development of new designs of sundial and new ways of thinking about time.

Until well into the medieval era, most people used a quite different way of reckoning time. They thought of the period from sunrise to sunset as being the natural day, *dies naturalis*, and divided this into 12 parts.

These intervals are known as unequal hours because they are longer in summer than in winter. References to 'the sixth hour' or to 'the ninth hour' in the Bible or Shakespeare relate to unequal hours. The end of the sixth hour was the middle of the day.

It is quite easy to design a sundial that indicates unequal hours and many such dials survive from Roman times and medieval times. There is an example on Little S. Mary's Church in Cambridge.

Unfortunately it is almost impossible to design a mechanical clock that indicates unequal hours. Early clocks, like the clocks of today, were designed to tick away equal hours and it must have been quite difficult to adjust to using this new form of time.

Somehow, those living in Europe and the Arab world came to agree on having 24 equal hours in a day but, perhaps surprisingly, there was no consensus as to when the 24-hour period should begin and end.

Although the ancient Romans had days which ran from midnight to midnight this was not an obvious choice for mechanical clocks. It is not easy to determine the moment of midnight when setting a clock.

Starting the day at sunrise was a more obvious choice for some. Sunset was the reference time chosen in Italy. Indeed, this scheme survived in Naples until the second half of the 19th century.

Running the day from noon to noon was another possibility and it is not widely appreciated that Greenwich Mean Time itself ran from noon to noon until as recently as 1926. Until then, the dates in navigators' logs changed at noon and not at midnight.

Until the introduction of time signals and the speaking clock, most clocks were set by the sun and, clearly, the traditional unequal-hours sundials were unsuitable for setting equal-hours clocks. This is why clocks spurred the development of new designs of sundial.

Today, sundials which show Babylonian hours or Italian hours are not uncommon in the Arab world and (unsurprisingly) in Italy but they are very rare in Britain. The best known example is a sundial in a ruinous state on the south wall of S. Katherine Cree Church in Leadenhall Street, London.

A visit to the new sundial in Selwyn is altogether more rewarding.

Fig. 7 — The Underside of the Old Court Sundial

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