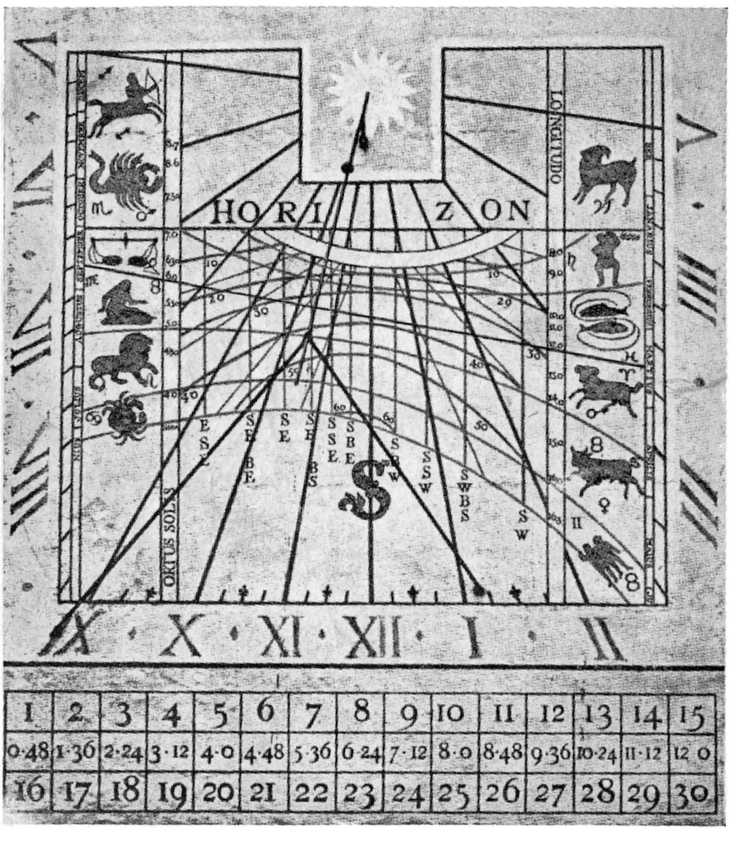
QUEENS' COLLEGE DIAL



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THE DIAL

MANY visitors to the College, after entering through the main gate, have had their attention attracted by the large Sun and Moon Dial painted on the North wall of Old Court. However, having approximately ascertained the time by it (assuming that the Sun is shining); they invariably ignore the rest of the markings. Even Queens' men themselves are usually quite unable to explain this " dial furniture " as it has been called, and so this article has been written in an attempt to provide the explanation. Certainly Queens' Dial is one of the best examples of Sun-dial art in this country, and one has to roam many scores of miles to find a dial of comparable interest and comprehensiveness.

The Dial is not as old as some imagine. It was originally painted in 1733. It is thought to replace a former dial painted in 1642, but it is not known whether this occupied the same position in Old Court. The Dial was repainted in 1911, and it is hoped that by the time this article appears another coat of paint will have been applied. Owing to bad copying either in 1911 or at some earlier date several curious mistakes have crept into the design, and these will be discussed in due course. Also, a small brass ball used to be fixed to the gnomon, but it fell off a few years ago and has never been replaced. We shall assume in the following description that this ball is in place, since it is hoped that it will be restored to its former position in the near future. Briefly, the Dial may be used to ascertain various astronomical quantities, and we shall now discuss the methods of doing this.

(*a*) *The Time by Day.*

Since the chief purpose of any Sun-dial is to indicate the time of day, it will be worth while going into some details of how this is to be done accurately. The shadow of the gnomon (the metal rod that projects from the face of the Dial) crosses the outer blue border in which the hours are indicated in golden Roman numerals. These numerals refer to the markings on a scale just inside the blue border, and this is subdivided into quarter hours. The time should be read off this scale, and even though the gnomon's shadow is of considerable thickness, by estimating its position between the markings it is usually possible to determine the time correctly to within three minutes.

However, if the time so determined is compared with that shown by the clock above, a difference of anything up to a quarter of an hour may be noticed. This is not, as may be imagined, due to any inaccuracy in the Dial, but due to a fact well known to astronomers.

Date	E	Date	E	Date	E	Date	E
2 Jan.	+4	1 Apr.	+4	17 Aug.	+4	11 Nov.	−16
4 ,,	+5	5 ,,	+3	22 ,,	+3	17 ,,	−15
7 ,,	+6	8 ,,	+2	26 ,,	+2	22 ,,	−14
9 ,,	+7	12 ,,	+1	29 ,,	+1	25 ,,	−13
11 ,,	+8	15 ,,	0	1 Sept.	0	29 ,,	−12
14 ,,	+9	20 ,,	−1	5 ,,	−1	1 Dec.	−11
17 ,,	+10	25 ,,	−2	8 ,,	−2	4 ,,	−10
20 ,,	+11	2 May	−3	11 ,,	−3	6 ,,	−9
24 ,,	+12	15 ,,	−4	13 ,,	−4	9 ,,	−8
28 ,,	+13	28 ,,	−3	16 ,,	−5	11 ,,	−7
3 Feb.	+14	4 June	−2	19 ,,	−6	13 ,,	−6
20 ,,	+14	10 ,,	−1	22 ,,	−7	15 ,,	−5
27 ,,	+13	14 ,,	0	25 ,,	−8	17 ,,	−4
4 Mar.	+12	20 ,,	+1	28 ,,	−9	19 ,,	−3
8 ,,	+11	24 ,,	+2	1 Oct.	−10	21 ,,	−2
12 ,,	+10	29 ,,	+3	4 ,,	−11	23 ,,	−1
16 ,,	+9	4 July	+4	7 ,,	−12	25 ,,	0
19 ,,	+8	10 ,,	+5	11 ,,	−13	27 ,,	+1
23 ,,	+7	19 ,,	+6	15 ,,	−14	29 ,,	+2
26 ,,	+6	4 Aug.	+6	20 ,,	−15	31 ,,	+3
29 ,,	+5	12 ,,	+5	27 ,,	−16		

The clock shows Greenwich Mean Time (or, alternatively, British Summer Time), whereas the Dial indicates True or Apparent Solar Time. Greenwich Mean Time is an invention of man, but one of great convenience, since it makes every day exactly twenty-four hours in length. The length of time from one " southing " of the Sun to the next is not constant, but varies slightly during the year, being usually a fraction of a minute different from twenty-four hours.

This is due to two causes : the Earth's speed in its orbit round the Sun is not constant, and this orbit is not exactly circular. Consequently the time determined by the Sun, and Greenwich Mean Time, differ during most of the year. This discrepancy is known as the " Equation of Time " or " E," and is tabulated on the opposite page, correct to the nearest minute.

The + and − signs mean that the equation of time is to be added to or subtracted from the time indicated by the shadow on the Dial.

Thus :—suppose that on August 17th you observe the shadow of the gnomon crossing the scale at the point 1 hour, 43 minutes. Since " E " is + 4 minutes, the Greenwich Mean Time is 47 minutes past 1 o'clock. Consequently the clock above, which will be showing Summer Time, will read 2.47 p.m.

From the table it will be seen that the Dial only reads Greenwich Mean Time on four days in the year, namely, April 15th, June 14th, September 1st, and December 25th. Between October 27th and November 11th, it is more than 16 minutes in advance of G.M.T.

(b) The Time by Moonlight.

Below the Dial are some rows of figures for determining the time by moonlight.

The method of doing this is as follows :—

Suppose that the Moon casts a shadow of the gnomon on the Dial. This must be read in hours and minutes on the outer scale in exactly the same way as when one is determining the time by day. We now have to determine the age of the Moon in days. You can do this with moderate accuracy near a " quarter-moon " merely by looking at it. Take the first quarter as occurring when the Moon is $7\frac{1}{2}$ days old, full moon at 15 days, and last quarter at $22\frac{1}{2}$ days. When it is nearly full moon it is advisable to refer to a diary to find its age, since an error of only one day upsets your calculation of the time by more than three-quarters of an hour.

Now find the age of the Moon in days in the first or third row of the table of figures below the Dial, and read off the corresponding hours and minutes in the second row. In the case of fractions of a day, allow twenty-four minutes for half a day, twelve minutes for a quarter, etc. With a little mental arithmetic the necessary calculation can be made. This time is to be *added* to that determined by the Moon's shadow, and then, after the correction mentioned in paragraph (a) has been applied, the result will be an approximation to Greenwich Mean Time.

For instance, earlier this year, at about 11 p.m., on the evening of February 26th, I noticed that the Moon was casting a shadow that gave the reading 9 hours 35 minutes. From my diary I found that there was a full moon on Tuesday, 24th February, at 5.16 p.m., so that the Moon was approximately $15 + 2\frac{1}{4}$ days old. Now 17 days (in the bottom row of the table) corresponds to 1 hour 36 minutes in the second row, and the quarter day (12 minutes) gives 1 hour 48 minutes in all. The Equation of Time (see paragraph (a)) on February 26th was + 13 minutes, and so the Greenwich Mean Time determined by moonlight was $9.35 + 1.48 + .13 = 11.36$ p.m., whereas the clock above showed 11.50. Not very accurate you will remark! I'm afraid not, but if you get the time correct to within half an hour, you have something to be proud of! The Moon's motion is very irregular, and no one (not even the most skilled computers allowing for hundreds of possible sources of error) can predict it completely. Consequently, as a Moon-dial it is to be chiefly regarded as providing a little mental exercise rather than an instrument of any practical value!

Moreover, since the sky is usually clouded over, and the Moon is very rarely bright enough to compete with the electric lights in Old Court, the opportunities for trying the instrument are very rare.

Just one last remark—when estimating the age of the Moon, reckon from the nearest quarter or full moon, since the maker of the Dial assumed that the month is exactly 30 days in length. If you take the *actual* age in days, your resulting time may be many hours in error.

(c) *The Azimuth or Bearing of the Sun.*

On the face of the Dial are a set of vertical black lines marked E.S.E., S.E.B.E., S.E., S.E.B.S., S.S.E., S.B.E., S., S.B.W., S.S.W., S.W.B.S., and S.W. in this order, letters referring to the points of the Compass. If the shadow of the small brass ball falls on one of these lines, the direction of the Sun is indicated by the corresponding letters. In this manner the Sun's bearing can be determined correct to a point of the Compass, and intermediate bearings can be estimated by eye.

(*d*) *The Altitude of the Sun.*

The altitude of the Sun is its height above the horizon expressed as an angle in degrees. This is indicated by the position of the ball's shadow relative to the red curves (hyperbolae) painted on the Dial, so that if the shadow lies on the curve marked "40," the sun is 40° above the horizon.

Thus the curves give the altitude correct to 10° and intermediate altitudes may be estimated.

(*e*) *The Sign of the Zodiac in which the Sun lies.*

If it were possible to see the stars by day as well as by night, the Sun's position among them would be seen to alter slightly from day to day. In the course of a year the Sun makes a complete circuit of the heavens relative to the stars, along a path called the Ecliptic. As is well known, groups of stars are called constellations, to which the ancients gave the names of mythical creatures or heroes. These names (in a Latinised form) are still used by astronomers, despite the fact that to modern eyes they bear very little resemblance to the objects they are supposed to represent.

The Sun's yearly path passes through twelve of these constellations, each one of which originally corresponded to a month of the year. Unfortunately, owing to reforms of the civil calendar, and to an effect known to astronomers as " precession of the equinoxes," the months and constellations are now completely out of step. Names still linger on, however, and the Sun is said to be at " The First Point of Aries " on March the 21st, even though it is nowhere near the constellation Aries at that time. Hence, conventionally, we divide the Sun's yearly path through the sky into twelve parts starting at the Vernal Equinox on March 21st. These parts are called " Signs of the Zodiac," by name Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius and Pisces. These signs of the Zodiac no longer correspond to the constellations of the same names, and their only use seems to be in casting horoscopes !

The English forms of the names of the twelve signs can easily be remembered by means of a rhyme which gives them in their correct order:

The Ram, the Bull, the Heavenly Twins,
And next the Crab the Lion shines,
The Virgin and the Scales,
The Scorpion, Archer and the Goat,
The Man that bears the Watering Pot
And Fish with glittering scales.

It is of interest to determine in which sign of the Zodiac the Sun lies, and this is easily accomplished by looking at the Dial on a sunny day. Crossing the face of the Dial are a series of green curves running outwards as far as the border marked with the months. The black line running between the pictures of the Scales and Virgin on the left, and between the Fishes and Ram on the right also belongs to this system of curves. If the shadow of the ball falls between two of these green lines, run your eyes along to right and left, and note the drawings lying between the same two green lines. Since you know whether the days are lengthening or shortening, it is easy to deduce which of the two signs is to be taken. If they are lengthening, the drawing on the right, and if they are shortening, the drawing on the left indicates the sign of the Zodiac in which the Sun lies.

By each of the small pictures corresponding to a sign is a symbol ascribed to it by ancient astrologers. For reference these are: Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquarius ♒, and Pisces ♓. For further remarks on these symbols, see below.

(*f*) *The Date.*

It will be apparent from the description given in section (*e*) how the date is to be determined from the Dial. Merely run your eye along the green curves to the right or left as far as the border, where the names of the months are printed in Latin vertically. The correct side is determined as before. By estimating the position between the green lines the date can be ascertained to within a few days.

Owing to the fact that the Sun changes its sign on the 21st of the month, it has been necessary for the painter of the Dial to split the names of two months—December and Junius. These occur in two parts, one on each side of the Dial.

(*g*) *The time of Sunrise.*

Just inside the column of drawings representing the signs of the Zodiac on the left-hand side of the Dial is a column marked " Ortus Solis." Using the green lines as guides (as in (*e*) and (*f*)) the time of sunrise can be read in this column. The modern undergraduate has little interest in the time of sunrise however, and to him the time of sunset, when proctors begin to prowl, is far more important. This may be determined by subtracting the time of sunrise in hours and minutes from twelve hours. These readings are only approximate ; an error of up to 20 minutes often occurs.

To illustrate some of the points raised in the last three sections, we shall discuss the reading of the Dial when the shadow of the ball falls on the intersection of the vertical black line marked S.W.B.S., with the red curve marked 50, and we shall also assume that it is known that the days are lengthening. We deduce at once that the Sun lies in direction South-West by South, and it is 50° above the horizon. Since the days are lengthening, we note the sign on the right-hand side on the Dial, which in this case is Taurus, the Bull. This is the sign of the Zodiac in which the Sun is lying. The date (by estimating the position of the shadow on the scale of months at the right) is about the 6th of May. The time of sunrise is 4.25 a.m., and thus the Sun sets at 7.35 p.m., which compares favourably with the correct G.M.T. of sunset on that day (7.30 p.m.).

(*g*) *The Right Ascension of the Sun.*

Then we notice that the shadow of the ball corresponds to a reading of about 15.0 in the column marked " Longitudo " on the right-hand side of the Dial. From this we can deduce the Longitude or Right Ascension of the Sun in its path through the heavens. This Right Ascension is measured in hours from the first point of Aries. To find the Right Ascension we have to make the following calculations. If the length of the day is increasing, add or subtract twelve hours from the reading of the Longitudo column, whichever is required to make the result less than 24 hours. If the length of the day is decreasing subtract the reading from 24 hours.

Hence, on May 6th, the R.A. is 3 hours, whereas if the shadow had been in the same position, and the days decreasing in length (about July 30th), the R.A. would be 9 hours.

(*h*) *The distance of the Sun East or West of the Meridian.*

There now remains only one set of lines on the Dial whose function is to be explained : those radiating from the point where the vertical line marked S. meets the line marked HORIZON. These are of little interest, since they are not numbered, but they were presumably added so that one could tell the distance of the Sun in degrees East or West of the Meridian. It is scarcely likely, of course, that anyone should ever want to know such a queer quantity !

In conclusion, a few words must be added about some of the mistakes and unsolved problems about the Dial, though, presumably, some of the former will be corrected when the Dial is repainted this year. Firstly, the sign for Taurus has inadvertently been " closed up " to form a figure 8. The other two 8's on the Dial remain complete mysteries, however. Two of the quarter-hour divisions are missing, and the plotting of these, together with some of the curves near the upper right-hand corner of the Dial is " shaky," to say the least. A few planetary symbols occur amongst the signs of the Zodiac, the meaning of which remained obscure until recently. It now appears that they indicate the positions of the planets in April, 1725, implying that the Dial was designed in that year. Sir Isaac Newton died in 1727, and it is therefore just possible that he was responsible for the design, though he did not live to see it painted in 1733.

If these remarks have in any way helped to explain some of the mysteries of the Dial, they will have fulfilled their purpose. If any of you are requiring a few minutes' amusement one sunny day, why not try reading the Dial in all its detail ? I think that the pleasure derived will amply repay the trouble that is taken.

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