A Selection of Cambridge Sundials

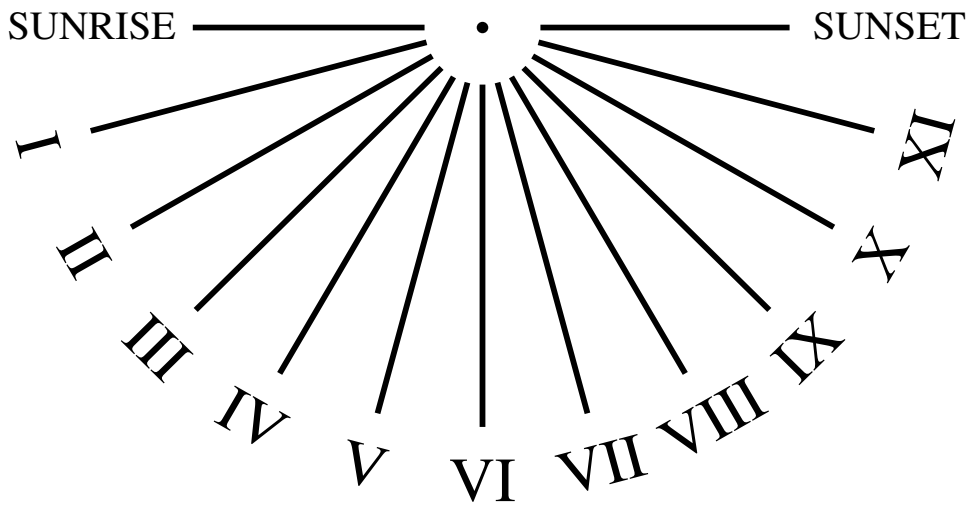
There are scores of sundials in Cambridge and most of the really interesting ones can be admired without having to seek special permission from anyone. This handout gives a brief description of some of the dials which can be seen on a walk lasting one to two hours. The time taken depends on how long you spend looking at each dial!

1: Hypothetical Temporary-Hours Sundial

Most sundials have a *gnomon*, a rod or straight-edge which casts a shadow. The gnomon is usually polar oriented; it is parallel to the Earth's axis. This means that the direction of the shadow at a given time of day is independent of the time of year.

This kind of gnomon was unknown before the 14th century. Prior to that most sundials were intended to indicate *temporary hours* where the day is divided into 12 hours from sunrise to sunset. Such hours are short in winter and long in summer.

The standard design was very simple and not very accurate! A horizontal gnomon was mounted perpendicularly to a roughly south-facing vertical wall and hour-lines were marked out at 15-degree intervals as shown in the figure:



A Simple Temporary-Hours Sundial

The hours were numbered I to XII so that VI was midday, as in the expression 'at the sixth hour'.

Provided the wall is vertical and roughly south-facing, the shadow of a horizontal gnomon at sunrise will be horizontal (and to the west) and the shadow at sunset will also be horizontal (but to the east). This primitive sundial would certainly show the correct time at sunrise and sunset but...

Although arranging the in-between hour-lines at regular 15-degree intervals seems the obvious next step, this is not mathematically correct. Such sundials were very common but they divided the day somewhat irregularly from sunrise to sunset.

2: Downing College — Armillary Sphere

This is the only dial in the handout which requires special permission to visit. It is in the Downing College Rose Garden which is normally kept private for Fellows of the College and their guests.

An armillary sphere is a sphere made from a number of rings. The term comes from the Latin *armilla* meaning a ring or bracelet.

Like the majority of sundials this one is equipped with a *gnomon*, the straight rod which runs between the two poles of the sphere. It is arranged to be parallel to the Earth's axis and, accordingly, lies in a vertical north–south plane. Its inclination to the horizontal matches the local latitude. The word comes from the Greek $\gamma\nu\acute{\omega}\mu\omega\nu$ meaning indicator.

Like a minority of sundials this one is also equipped with a *nodus*, the solid spherical ball on the gnomon in the centre of the sphere.

It is only slightly naïve to imagine this instrument as a model of the universe itself. The nodus represents the Earth and the enveloping rings represent the Celestial Sphere. The gnomon runs from the North Celestial Pole to the South Celestial Pole,

The two most important rings are the horizon ring which is horizontal and the equatorial ring which is in a plane at right-angles to the gnomon. This ring is parallel to the Earth's equator and carries the time markings. This is the *dial* proper.

Time (strictly the local *hour-angle* of the sun) is determined by noting where the shadow of the gnomon falls among the time markings. At noon, an approximation to the date can be determined by noting where the shadow of the nodus falls on the ring which lies in a vertical north–south plane. The shadow is at its highest in late December.

3: Downing College — Horizontal Dial

The most common form of sundial, found in numerous gardens, is the horizontal sundial, so called because its dial is horizontal.

The example outside the Downing College Library building was made for the bicentenary of the College in 2000 by Quinten Hollick, a local sundial maker (notice the letter Q near the foot of the gnomon). This has a slate dial and a slate gnomon too. The various features on the dial are collectively known as *dial furniture*. Much use has been made of gold leaf.

In order to have sufficient strength, a slate gnomon has to be quite thick and its two edges, known as *styles* are separated by the thickness of the gnomon. When looking at the shadow it is important to note which edge indicates the time...

In the late morning hours leading up to 12 noon the west style is used and in the early afternoon hours the east style is used. This is not quite the whole story because the reverse is true before 6 a.m. and after 6 p.m.

4: Downing Site — Polyhedral Dial

The Downing Site lies to the north of Downing College and is the home of many University Science Departments. The rather battered (and not very pretty) dial near the Downing Street entrance to the site is actually a collection of 17 sundials all cut into a single block of stone.

Each sundial has its own gnomon and a flat dial. The 34 styles of the 17 gnomons should all be parallel to the Earth's axis and therefore parallel to one another. Some are sadly bent!

A simple consequence of having all gnomons parallel is that those which stem from roughly south-facing dials appear to point down into the ground and those that stem from roughly north-facing dials appear to point up into the sky. A few which are associated with dials that face due east or west have to be supported a short distance from their dials.

The 17 dials face in 17 different directions. At the top there is a horizontal dial (compare this with the Hollick dial in Downing). Lower down there are eight vertical dials and in between there are eight sloping dials. These sloping dials are the most difficult to calculate and it must have been very challenging to determine the markings on the four triangular dials before the days of computers.

This sundial was presented by Professor Sir William Ridgeway (a famous archaeologist and classical scholar) and his wife Lucy in 1913. Their daughter, also named Lucy, married the son of John Venn (of diagrams fame). Sir William and (daughter) Lucy later set up the University's Ridgeway–Venn Travel Fund. According to University Ordinances, the first call on this Fund is for the maintenance of this sundial.

5: Pembroke College — Foundress Court Dial

The original proposal for this large wall sundial came from Eric Parry, the architect of the Foundress Court Building. The diallist was Frank King and the overall design was by Lida Cardozo-Kindersley of the Cardozo-Kindersley Workshop. Most of the stone cutting was undertaken by Helmut Hochrein. He cut the main dial in 1997 and the Equation of Time Panel in 1998.

The principal dial furniture consists of hour-lines marked from 6 a.m. to 4 p.m. and three constant-declination curves (a pair of hyperbolic arcs for the two solstices and a straight line, called the equinoctial line, for the equinoxes).

This sundial has a gnomon and a nodus, both made of stainless steel. Time is determined by noting where the shadow of the gnomon falls among the hour-lines and the declination of the sun can be estimated by noting where the shadow of the nodus falls among the constant-declination curves.

6: Pembroke College — Memorial Dial

This horizontal sundial should be compared with the Hollick dial in Downing. It was originally made in 1957 as a memorial to James Vere Stewart Wilkinson a well-known orientalist. That sundial suffered badly from weathering and a new dial was made in 2005. This new dial additionally commemorates Sidney Kenderdine a noted astronomer.

7: Little S. Mary's Church — Mass Dial

This dial is scratched onto a vertical surface of a roughly south-facing buttress of the Church. It probably dates from the 14th century and is of interest to sundial enthusiasts!

It was quite common in medieval times for Churches to have rather crude sundials marked out so that the Priest knew when to call people to prayer, at certain *Canonical Hours*.

These Hours included the times of the offices of Prime, Terce and None which were loosely linked to the 3rd, 6th and 9th (temporary) hours.

This kind of sundial should be compared with the hypothetical temporary-hours sundial on page 1. The gnomon is missing but it would have been perpendicular to the dial.

Such sundials are known as Mass dials or, more descriptively, scratch dials.

8: Queens' College — The Queens' Dial

The Queens' Dial, painted on a wall in Old Court, is the best-known sundial in Cambridge. A dial was first set up here in 1642 and there have been many repaintings since that date. The appearance of the original dial is unknown. The present dial was painted in 1971.

Very few sundials have more dial furniture than this one! It incorporates more features than most users would ever have understood!

As on the Pembroke Dial, there is a gnomon and a nodus and, as usual, time is determined by noting where the shadow of the gnomon falls among the hour-lines.

The position of the shadow of the nodus indicates everything else. As at Pembroke there are constant-declination curves, though here there are six. Most of them are green but the equinoctial line is black.

It is common to have seven constant-declination curves, three pairs of hyperbolic arcs and a straight equinoctial line. Here the uppermost arc which would correspond to the winter solstice is obliterated by a golden arc which serves no serious dialling purpose.

The 12 Signs of the Zodiac have been painted in the spaces between the ends of the constant declination curves.

The family of red hyperbolic arcs indicates solar altitude; a low arc corresponds to a high altitude. The lowest such arc is labelled 60, for 60°. The highest arc in the family is the straight (black) line labelled HORIZON which, of course, corresponds to an altitude of 0°.

The family of thin black vertical lines indicates solar azimuth, the bearing of the sun. Notice the dominant gold S for South and the less obvious labelling such as SWBS for South-West By South.

There is another, fan-shaped, family of thin black lines which, via the shadow of the nodus, indicates temporary hours much more accurately than the sundial on page 1. At the latitude of Cambridge a temporary hour lasts a normal 60-minutes at the equinoxes but, in winter, it can be shorter than 40 minutes and, in summer, longer than 80 minutes.

There are numerous other features. One can tell the time of sunrise, the length of the day and, via the look-up table below the dial, the time by the moon. This is the only moon dial in Cambridge.

9: S. Botolph's Church — Dial Pair

The pair of vertical dials on two faces of a buttress of S. Botolph's Church are the result of a restoration in 1913. The dials are very clear to read and quite accurately laid out. When there are two dials, it can be embarrassing if they indicate different times!

10: Caius College — Gate of Honour Dials

There are six vertical sundials on the Gate of Honour at Gonville and Caius College. These dials were made in 1963 though there were dials here at a much earlier date. They are made of enamel and look almost new after nearly half a century.

Before these dials were set up, Dr P.J. Message (an astronomy fellow of the College) undertook some very careful surveying. This enabled the sundials to be very precisely constructed and set up. In consequence, these sundials are particularly accurate.

One of the dials faces almost exactly east and another almost exactly west. The gnomons on these two faces are therefore almost parallel to their dials and have to be supported by special brackets. Notice that the time lines are almost parallel too.

Each of these two gnomons is equipped with a small ball nodus and there are three constant declination curves on the associated dials.

Two of the other dials face either side of due south. Their gnomons appear to point down into the ground.

There are two further dials which face either side of due north. Their gnomons appear to point up into the sky. These two dials rarely see the the sun.

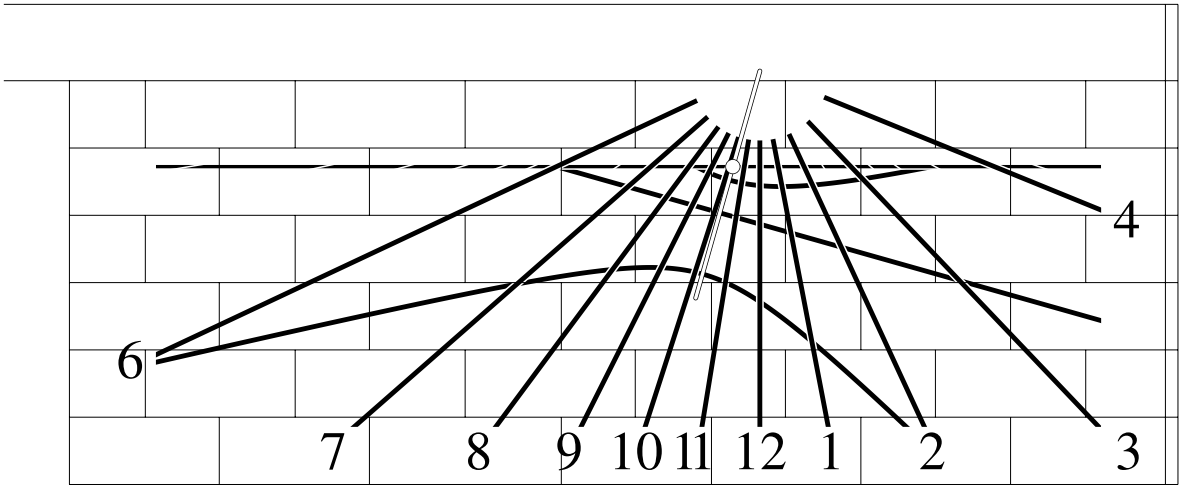
Acknowledgement

Much of the information in this handout has come from *Cambridge Sundials* by Alexis Brooks and Margaret Stanier, Pendragon Press, *ca.* 1990.

Frank King, Diallist 16 April 2009

Some Features of the Foundress Court Sundial at Pembroke

The figure shows the Pembroke sundial in elevation. The gnomon is about 1900mm long and the nodus, the stainless steel ball mounted on the gnomon, is 100mm in diameter.



All the markings on the dial are formed by deep V-cuts. Those for the hour-lines are 32mm wide. When the sun shines, the shadow of one edge of a V-cut falls into the depth of the cut and this shadow contrasts starkly with the bright limestone wall. In this way the sun brings the whole dial to life.

During the course of a day the shadow of the gnomon sweeps anti-clockwise across the dial and falls along the V-cuts of the hour-lines in turn. It is instructive to watch the shadow creeping up to an hour-line. It is quite hard to judge precisely when the shadow and an hour-line coincide.

The sundial indicates local sun time. A graphical rendering of the Equation of Time is cut into a stone panel below the right-hand end of the dial. Subtract the Equation of Time from local sun time to determine local mean time.

The shadow of the nodus also sweeps across the dial and this shadow is confined between the two hyperbolic arcs. At the winter solstice the shadow follows the upper arc, starting at the left-hand end where this arc intersects the horizon line, the straight line on the same horizontal level as the nodus. You can tell that sunrise is about 8.15 am and, at the right-hand end, you can tell that sunset is about 3.45 pm.

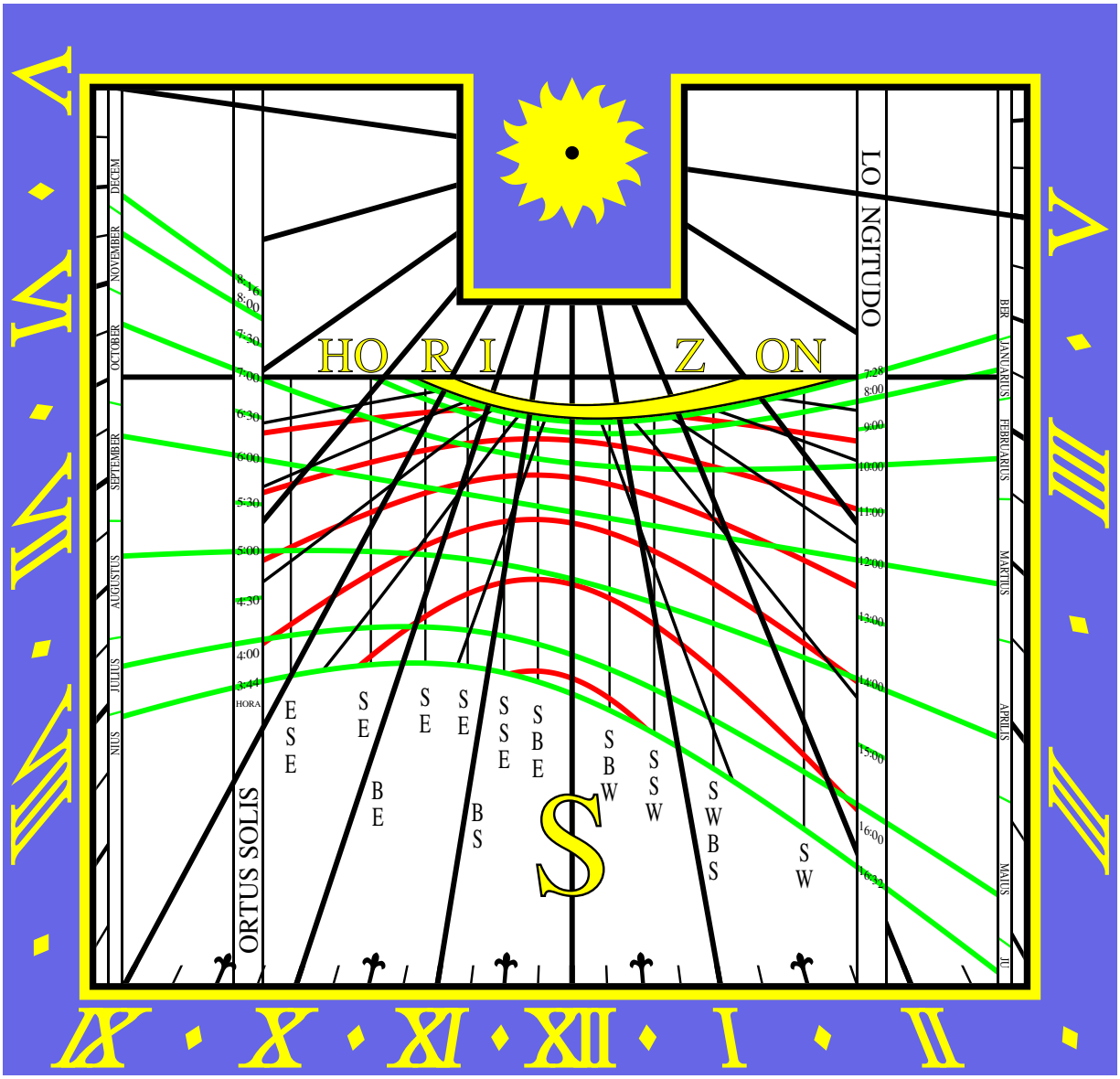
At each equinox the shadow of the nodus follows the diagonal equinoctial line. Sunrise is at 6 am and well before sunset the sun is on the wrong side of the wall so there is no shadow. At the summer solstice the shadow of the nodus follows the lower hyperbolic arc.

Notice that the horizon line is broken between the more widely separated hour-lines. Like the hour-lines, the breaks radiate from the root of the gnomon. They indicate half-hours, quarter-hours, and in a few cases eighth-hours.

F.H. King 11 February 2002

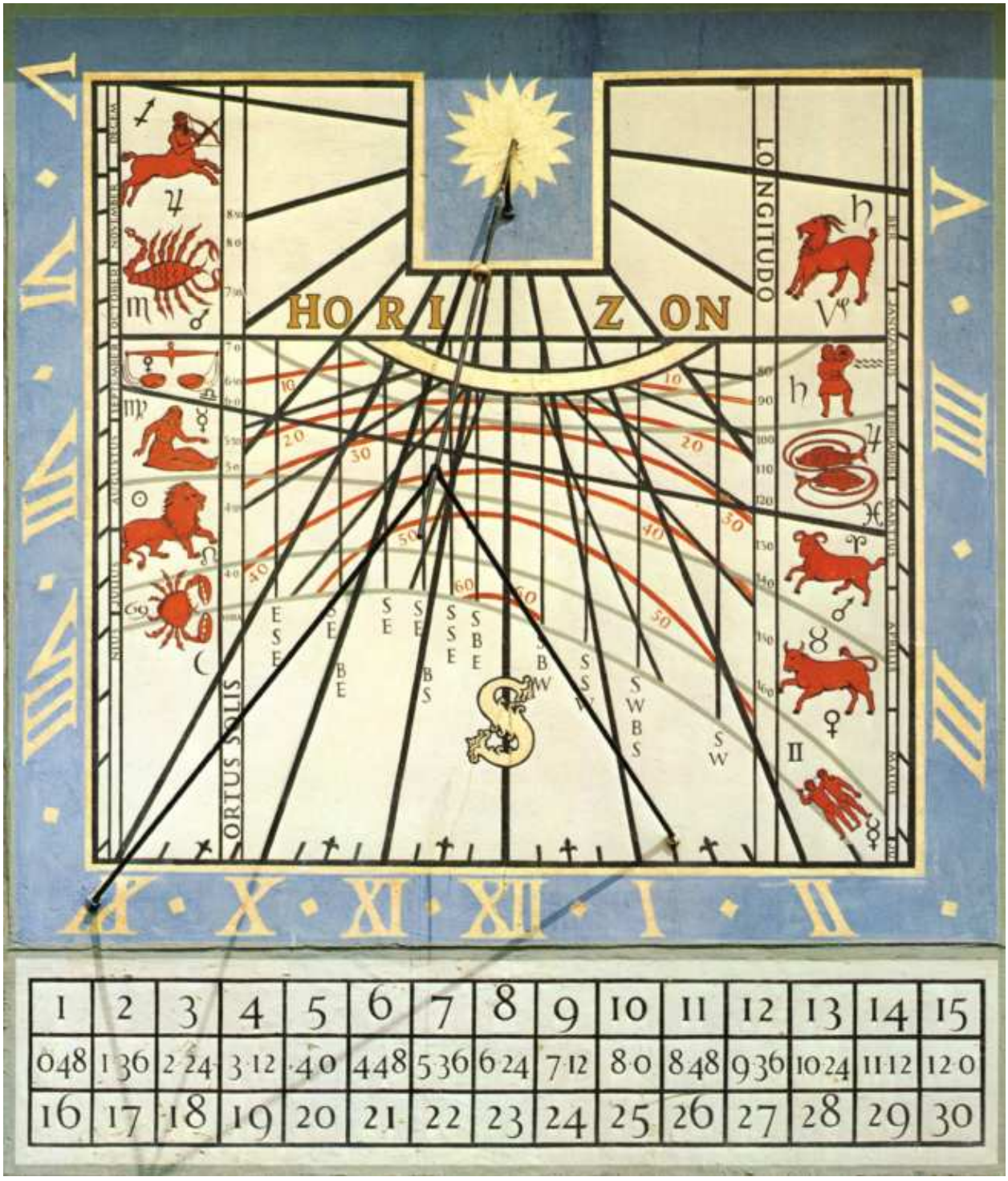
The Queens' Dial

1000 mm



F.H.K. 28 August 2006

The Queens' Dial



Photograph: Cambridge University Press, 1971