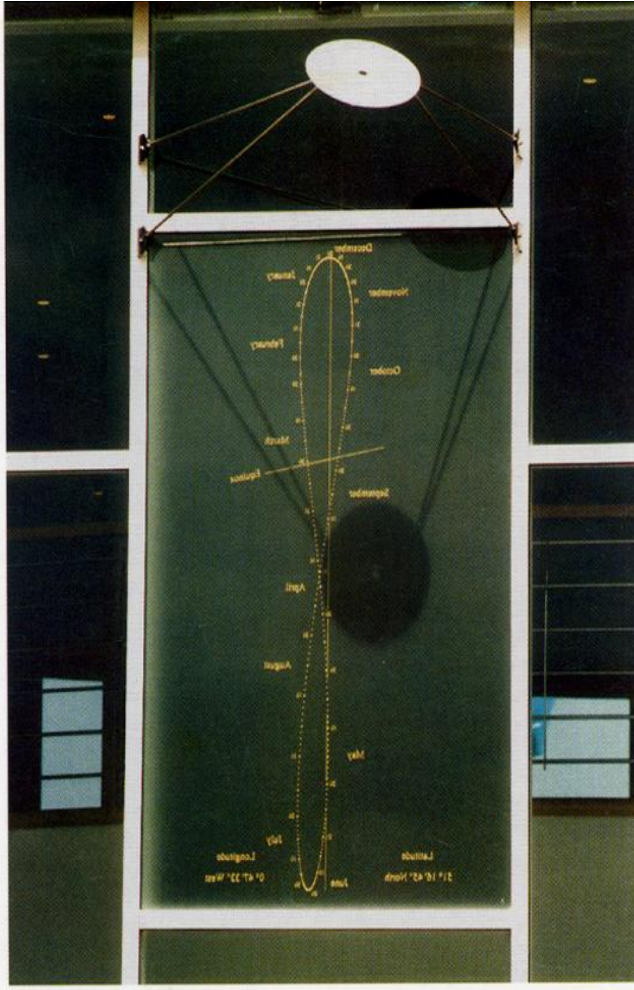
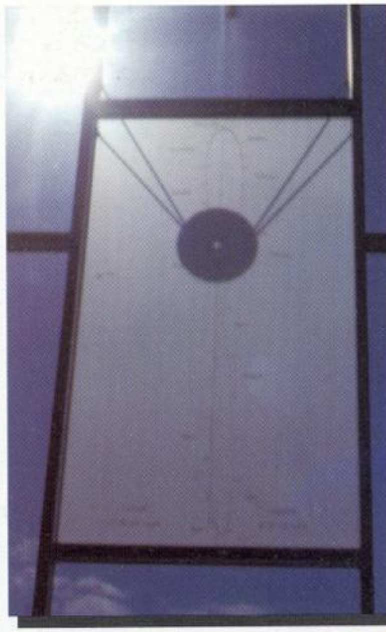


The Noon Sundial

DERA

The Noon Sundial

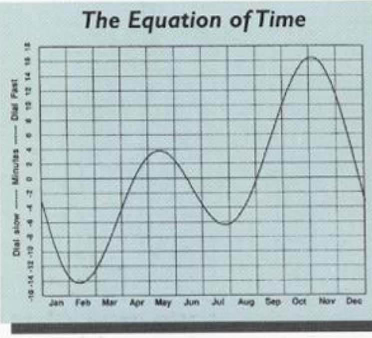


This rare type of sundial gives three separate, but related, pieces of information - the local apparent noon, the mean time noon, and the date. In the context of a Research Establishment it is a functional scientific instrument and represents the principles of observation, analysis and application.

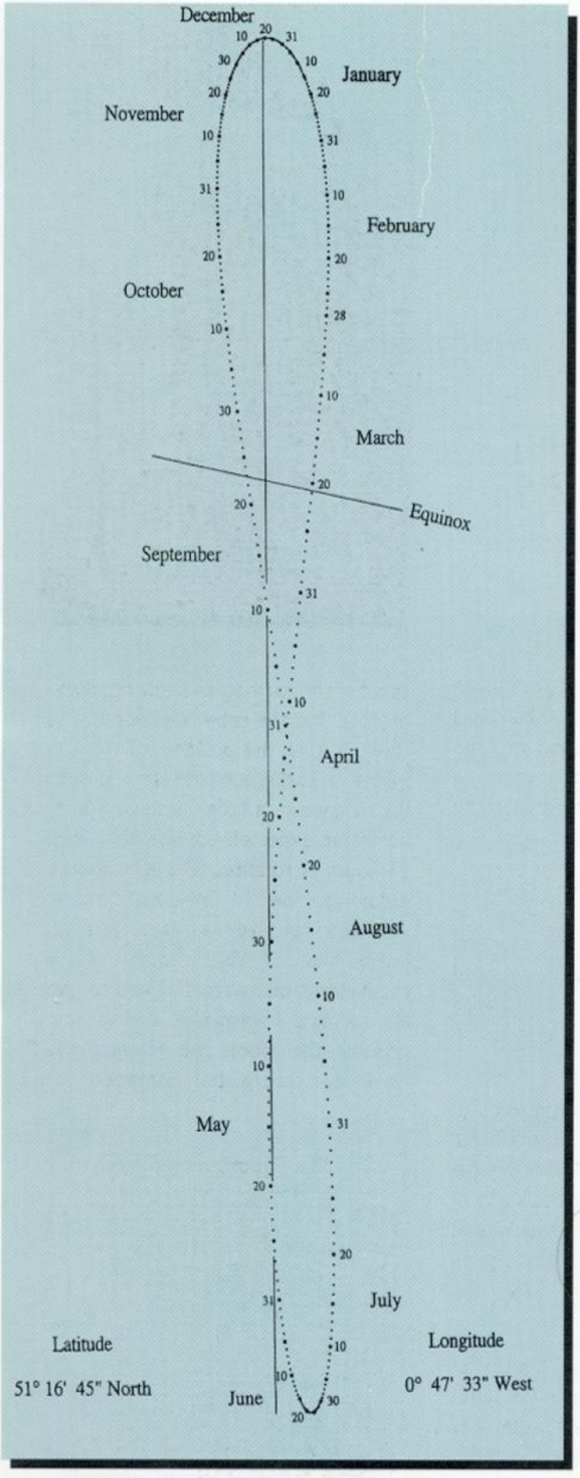
The Gnomon On the external glazed wall is a steel structure supporting the gnomon - the "pointer" of a sundial. In this case it is an elliptical disc with a central hole. The sun shining through the hole gives a spot of light which acts as the pointer. The ellipse is calculated to give a circular shadow (and spot of light) at the equinox.

The Vertical Line When the spot of sunlight crosses the vertical line the time is defined as the local apparent noon. The sun is at its highest elevation of the day and is exactly due South. This elemental form of noon dial is more commonly found in cathedrals in Central Europe where a shaft of sunlight through an aperture will cross a brass line in the floor of a transept.

The Curved Line When the spot crosses the curved line in the appropriate month the time is the mean time noon - the time that we set our watches by. The difference between the two types of time is due to the effect of the earth's axis being tilted and the fact that the orbit is elliptical. The result is that the position of the sun against a background of stars is such that it appears a little ahead or a little behind an expected position after each 24 hours of rotation. The accumulated error can be 14 minutes slow in February or 16 minutes fast in November. Very early clock mechanisms that were designed to give astronomical information, such as the position the moon and planets, gave crude corrections, but Flamsteed, the



The Equation of Time



The Unique Dial: the analemma is 1.8 metres tall

first Astronomer Royal, used Kepler's laws to analyse the effect. He called his result the Equation Of The Natural Days and published a work on this in 1672. The graph shows the so-called Equation of Time as it normally appears in text books on astronomy or sundials, or engraved on good quality dials.

The inclusion of these corrections in a dial that uses a spot of light gives the strange figure-of-eight shape known as an analemma. Dictionaries attribute the first use of this word to Ptolemy where the analemma was a pointer to produce stereographic projections of a sphere. Over the last century or so, the term has also been applied to the specific form of projection which combines the seasonal elevation of the sun and mean time.

Another correction to be made to a sundial is the direct link between longitude and time, in other words the position of the dial in its time zone. In our case it is relative to the Greenwich Meridian and our dial is located in time 3 minutes and 10.2 seconds after Greenwich. This is incorporated as an offset in the position of the whole analemma relative to the vertical line.

The date can be read from the dial except at the Summer and Winter solstices where the change in elevation from day to day is very small. Furthermore, the additional day in the Leap Year has to be omitted. To avoid the problem of an 'average' date, the date positions have been calculated to be exact for the final year of each leap year cycle. The maximum differences are ±0.1° of the sun's elevation in March/April and September/October, which is about 1/6 of the size of the spot of sunlight. However, in the year after the leap year the date position differs by up to 0.2° during the spring and autumn.

The main purpose of the dial is to provide a time check at noon and the dial will do this very accurately. The computed line is better than one second in time and again is computed for the final year of the leap year cycle. Other years show twice yearly variations of about ±7 seconds except for the year after the leap year when the largest differences can amount to 14 seconds or 1/10 of the spot size. Note that the refraction in the outer pane of glass in the double glazing has been taken into account.

Latitude and Longitude The position of the dial is at latitude 51° 16' 45" North and longitude 0° 47' 33" West. To achieve an accuracy of better than a second of arc is not easy and even then the earth model must be carefully defined. These values were checked using the Global Positioning Satellite system. The dial position in the WGS 84 x, y, and z coordinate frame is x = 3997.510 km, y = -55.296 km and z = 4953.087 km.

Note that the glass wall containing the dial is not facing exactly due South. For a sundial designer the wall is defined as declining 13.5° West of South.

Dials of this type are quite rare. There are a few in Continental Europe and a basic version is at the Old Royal Observatory at Greenwich. A very fine dial, carved in slate with a gilded analemma has been installed at Green College Oxford on the bicentenary of the Radcliffe Observatory. None of these dials show the individual days.

Construction The analemma has been produced by shotblasting the outline through a stencil into the glass and then finishing in gold leaf. The surrounding sheet of glass has an acid-etched surface finish. The analemma is on the outward facing surface of the internal sheet of the double glazing, in other words, the dial is inside the double glazing. The analemma on its sheet of glass was made by a specialist sub-contractor, T & W Ide, Glasshouse Fields, East London. The gnomon is made from austenitic stainless steel.

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A view of the dial from inside the foyer

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Further Reading

A Mills. More about the Equation of Time and the Analemma, Bulletin of the British Sundial Society No 94.1, pp 30-31, 40, February 1994.

D W Hughes. An Introduction to the Equation of Time, Bulletin of the British Sundial Society, No 93.3, pp 8-12, October 1993.

B M Oliver, The Shape of the Analemma, Sky and Telescope, Volume 44, pp 20-22, July 1972.