A PORTABLE HOROLOGIUM

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This article is based on the talk given by the author at the 2011 BSS Newbury meeting.

Medieval portable instruments are rare so, when one is located, there is a significant challenge to interpret how it was intended to be used as the corpus of other material with which it can be compared is a relatively small. An example is the device shown in Fig. 1: it was located in a field near Shotesham (about 10 km south of Norwich) by the metal detectorist Peter Aspinall in March 2003 and reported to the Portable Antiquities Scheme who classified it as a sundial.[1] An attempt was made to sell it at auction but this was unsuccessful, perhaps because there was no precedent for such an item, and it reverted to the ownership of the landowners where it was found.

Fig. 1. Photographs of the Norfolk horologium.

Above: front, shown at approx. 2.5× full size.

Right: back.

Description

The device seen in Fig. 1 is just 36.8 ± 0.2 mm in diameter (approximately 1½″) and 0.9 ± 0.1 mm thick, evidently of a copper-based alloy of some description. It has four very small 'lugs' approximately evenly spaced around the edge. It is not certain whether these lugs have retained their original size or are the remnants of much longer spokes; i.e. the disc may have been the hub of a larger device. One lug, though, can be seen through a microscope to have the engraved radial line through it running right over the tip, suggesting that it has not been truncated. The reverse face is basically blank but has a rectangular block or 'handle' of copper alloy, approx. 14 × 9 × 4 mm, rivetted to the centre of the disc.

The front surface is engraved as shown and has a small hole, nominally 1 mm diameter, in the centre. This hole may have been for inserting a perpendicular pin gnomon or compass needle pivot. It penetrates through the disc and at least 3 mm into the rectangular block. The whole device is in remarkably good condition.

Engraving

The engraving of the device, showing that it could function as a compass and as a horologium, is remarkably fine. The lettering in particular has been cut very deeply by a narrow burin. Viewed with a stereoscopic microscope, it can be seen that it has an included angle of 40° or even less. The circles and longer lines are shallower and appear to have been made with a scribing point but the subdivisions of the scales have probably been cut with the burin.

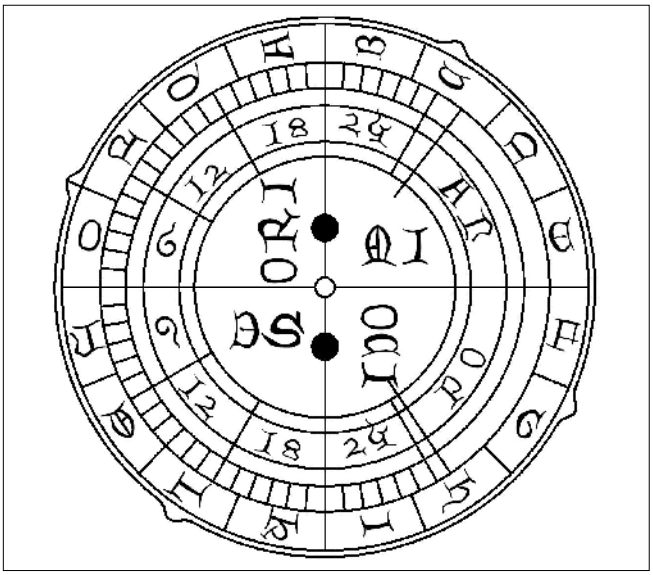

Fig. 2. Drawing of the horologium.

Fig. 3. Left: the numerals '25' on the horologium compared with, centre, '58 /49' from the 1396 Richard II quadrant (see p. 42) and, right, '53, 35 / 45, 37' from the c.1400 MS De Umbris...[24] *The form of the '5' on the horologium, with the hook originating from the centre of the vertical stroke, is comparable to that of a c.1300* quadrans vetus *at the Oxford MHS (Inv. 52020).*

The face is divided in four quadrants by a pair of diameters, one of which is continuous over the tops of the rivet heads. In the centre, the cardinal points of the compass are labelled, in Latin, MI (*meridies*, south), OCI (*occidens*, west), SE (*septentrio*, north) and ORI (*oriens*, east). The engravings are oriented so that the abbreviations stand on the lines to which they refer and, in Fig. 1, East is positioned upwards as was conventional for medieval maps even into the middle of the 15th century.[2]

The compass is further subdivided into 16 directions around the periphery of the disc, being labelled clockwise alphabetically A to Q (omitting J) starting with East (the most important point) at the top and with the letters again standing on the lines to which they refer. The form of the letters may be described as *Early Gothic* or *Lombardic Capitals* and are difficult to date, though they do seem to be of 14th-century or possibly earlier.[3] The use of letters to label directions is quite standard for the Middle Ages (e.g. on the 16-fold divisions of a windrose) and Chaucer even used letters to denote the 24 equal hours around the edge of his astrolabe.[4]

The basic horologium scale is a division into approximate 30° segments, starting at the north ('noon') line and measured symmetrically though the East and West points towards the South. These segments are numbered both ways 6, 12, 18, 25. Note that the final number is not 24 as would be expected by a simple arithmetic sequence: the medieval numeral '4' is a quite different shape looking like a Greek 'alpha' on end and the character engraved here is very clearly the medieval '5' – see Fig. 3. These numbers, although engraved centrally in their segments, refer to the lines to their right, as is standard for medieval instruments.[5] Notice how the numerals in the upper half of the device are oriented inwards but those in the lower half are outwards with the result that the device has clearly been designed to have been read with the orientation shown, with East at the top, rather than symmetrically like a watch.

The time segments are further sub-divided by a number of short radial lines into nominally 5° segments and it is these which are counted by the numerals. Between the North and the East/West lines, there are six divisions per segment but to the south of the East/West line it is clear that there is an extra division with a longer dividing line, as will be discussed below. The actual spacing of these small divisions is somewhat variable and leads to the impression that the division was performed by eye.

To the south (right) of the numerals are the letters AN and PO, again oriented to be read from the 'bottom' of the disc. It might be suggested that these are abbreviations for anti meridian and post meridian but, if so, the positioning is problemmatic.

Function

In what way could this device have acted as a sundial? To modern eyes, a dial delineated with equi-angular spacing immediately suggests an equatorial (or equinoctial) sundial and the Norfolk device could indeed function as such, for the summer half of the year, if it was fitted with a perpendicular pin gnomon in the centre hole, aligned to the north celestial pole and with the plate tipped to the co-latitude of the location. But there is no reliable evidence that such devices, or any dial with a polar-aligned gnomon, existed in Europe until the early 15th century. By the mid-15th century, pocket compendia consisting of a compass, equatorial dial and a primitive nocturnal were available.[6] Evidence of a stone equinoctial dial from the late medieval period has also recently been uncovered in Bristol.[7]

However, the presence of the engraved compass directions on the Norfolk horologium strongly suggests that it was

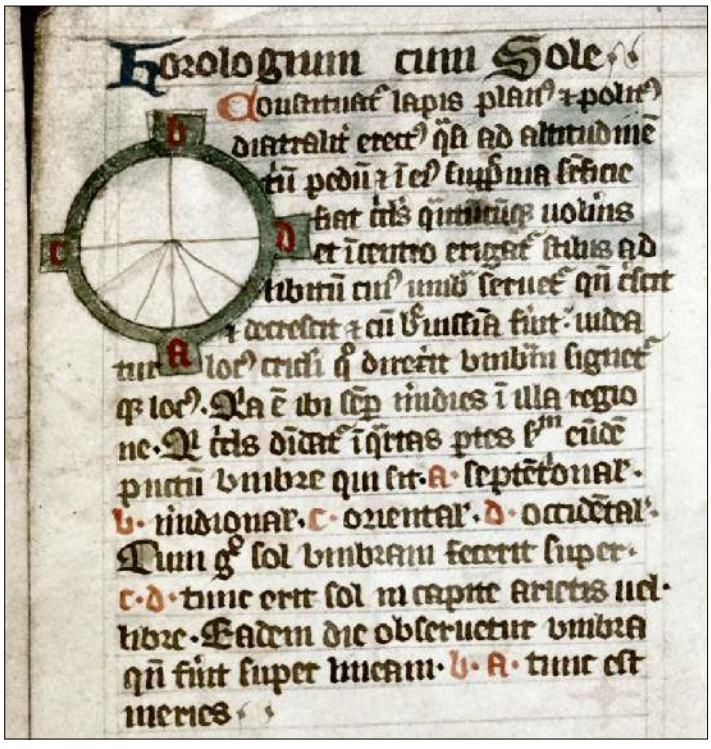

Fig. 4. MS Rawl. D. 939 f.5r. Courtesy the Bodleian Library.

Horologium cum sole	Sun Dial
Constituatur lapis planus et politus diatraliter erectus quasi ad altitudinem trium pedum et in eius suprema superficie fiat circulus quantumcumque voliens et in centro erigatur stilus ad libitum cuius umbra servetur quando crescit et decrescit et cum brevissima fuerit, videa- tur locus crideri quo direxerit umbram signetur quae locus. Quia est ibi semper meridies in illa regio- ne. Qui circulus dividatur in quartas partes secundum eundem punctum umbre qui sit: A septemtrionalis, B meridionalis, C orientalis, D occidentalis. Cum grado sol umbram fecerit super CD, tunc erit sol in capite arietis vel libre. Eadem die observetur umbra quando fuerit super lineam BA, tunc est meridies.	Make a flat and smooth stone erected more or less at a height of three feet and on it upper face trace a circle wide as you like and in the middle put up a style long as one likes which shadow is used when elongate and it shorten, and when it will be shortest, one can see the direction shown by the shadow and sign that place. That it will be always noon in that direction. In some way the circle should be divided in four parts following his shadows' points that are: A North, B South, C East, D West. When the sun shadow falls over CD, then the sun is in the first degree of Aries or Libre. In that day will be observed the shadow When it will be on line BA, then is Noon.

Fig. 5. Transcription (with contractions expanded) and translation (courtesy of Mario Arnaldi) of MS Rawl. D. 939 f.5r.

designed to be held horizontally, with a vertical gnomon and hence looks back to an earlier form of timekeeping,

The standard timekeeper in the middle ages was, of course, the mass or scratch dial. This was usually a vertical device with a horizontal gnomon, placed on a south-facing wall. Two recent studies of these devices are by Arnaldi[8] and by Scott & Cowham[9]. Both of these studies also show that horizontal dials, broadly following the principles of the vertical mass dial, did also exist but in much small numbers. A study of five small stone examples of horizontal stone mass dials[10] showed them all to be delineated at 15° intervals over the full circle, rather than just the region where a shadow of a vertical gnomon might fall. Some of these devices, e.g. the one from Nendrum, Co. Down in Ireland, are also discussed by Arnaldi.[11] None of them have sub-divided time scales.

A contemporary manuscript which may be describing a device using the same principles is in the Bodleian Library, MS Rawl. D. 939 f.5r (Fig. 4). The manuscript is described by the library scholars as English, from the second half of the 14th century, and it consists of a six-part set of unbound calendrical and astrological pieces. A transcription and translation is given in Fig. 5. Although the device described in the MS is clearly a large stone dial – a precursor to the stone pedestal sundials of a later era – it has two features which are also seen in the Norfolk horologium. The first is the inscriptions of the cardinal compass points. The second is the division of the northern half of the circle into 30° segments. The text makes it clear that the shadow is to be found on the East/West line only on the equinoxes (Aries and Libra) and that noon corresponds to a shadow on the meridian.

The subdivision of the timescale on the Norfolk device into units of 5° is very unusual for a sundial. The 90° interval between noon (north) and the east/west line may be interpreted as 6 equinoctial hours and since this is divided into 18 subdivisions, each subdivision is equivalent to a third of an hour. This is the unit of time which Geoffrey Chaucer refers to as a 'mileway' (or *mile-wey*) in both his famous *Canterbury Tales* and his less popular, but perhaps more relevant, *A Treatise on the Astrolabe* of c.1391.[12] The derivation is that it is approximately the time that it takes a man to walk a mile and it must refer to an equal hour rather than a seasonal hour – people do not walk twice as fast in winter! There are some references in the literature[13] to use of the term around 1330 and it definitely had Chaucer's meaning by 1370, though its use seems to have died out by the middle of the 15th century. The correlation of time with distance was not uncommon in the Middle Ages.[14]

The sub-division of the hour into thirds has a very long history. King Alfred the Great (r. 877-899) had a candle clock in which each candle, burning for 4 hours, was marked in 12 segments.[15] Later, c.1268, a waterclock described on tablets found at the Cistercian Abbey of Villers-la-Ville in Brabant had a wheel labelled with 24 letters of the alphabet, each calculated to indicate approximately a third of an hour.[16]

The mileway divisions on the Norfolk device continue for a further 7 units to the south of the East/West line, which we take as the sunrise/sunset at the equinoxes. This is one unit beyond the two-hour major spacing of the rest of the scale. The significance of this is probably that the sunrise/sunset times on the summer solstice at Norwich, latitude 52½° N, are 3:42am and 8:18pm LAT, very close to two hours and one mileway before and after, respectively, the equinoctial times. It is most important to remember, however, that the shadow of the vertical gnomon will not fall on these lines at the solstitial sunrise/sunset: the device is <u>not</u> calculated as a horizontal azimuthal dial.

The positions of the final (25th) mileway divisions at the southern ends of the timescale are rather variable. The two lines, approximately to the southeast and southwest, are longer than the other sub-divisions and more similar to the 30° sector lines. The line to the southeast, passing towards the compass point 'C', makes an angle of 52.5° to the meridian line so that the interval between 24 and 25 is significantly larger than the others. Although it is tempting to suggest that this angle has been selected because it is the local latitude, this is probably only coincidental as the corresponding line on the southwest side, passing towards the compass point 'H', makes an angle of 57° to the meridian line which does not appear to have any geographical significance.

The letters AN and PO each stand the wrong side of the meridian line to refer to the morning (***anti*** *meridian*) and afternoon (***post*** *meridian*) shadows of a central pin gnomon. They would be correctly positioned if it is to be taken that they refer to the direction to the sun, rather than of its shadow but this is at odds with the fact that the timescale has its gap at the south. They may, of course, stand for something totally different, such as the name of the maker or owner, though it is difficult to get away from the idea that they are related to the function of the device.

Two other physical features of the device invite speculation. One is the block rivetted on the back. This is aligned in the E-W direction and is too small to be comfortably held in the fingers though it does suggest a use as some form of handle or mounting. It could perhaps have been fitted into a larger handle of, for example, wood, with its rectangular shape ensuring correct alignment. Alternatively, it may have held the device into a larger mechanism.

The other feature is the set of four small lugs on the periphery. These are only approximately equi-spaced around the circumference, and are offset from the cardinal directions by between 25° and 30°. They clearly appear to be intentionally made but their purpose can only be guessed at. The possibility that they are the remains of 'spokes' so that the original device would have been a rather larger volvelle was mentioned earlier. Another excavated medieval device which is believed to have been a nocturnal and is currently under study, also shows clear signs of having had a spoked volvelle.[17]

If they are not the remnants of some form of spoke (so that the disc was originally part of a larger diameter circle), they could perhaps have been a form of cam operating a mechanism or indicator revolving around the disc. The fact that the AM and PM numerals are engraved to be read from the west side of the disc indicates that it had a fixed position relative to the use. This position would have needed to have been set to the compass directions.

A simpler and more likely suggestion is that the 'lugs' were used to connect the disc to the end of a short cylinder by interlocking into corresponding cut-outs, thus forming a shallow cylindrical box. This was the method of construction of the cases of compendia such as that seen in the famous illuminated manuscript[18] of the *Horologium Sapientae* from the mid-15th century. The cases contained a magnetic compass, a relatively new innovation in 14th-century Europe. If this is the case, the central hole in the disc may have been for the pivot of a compass needle rather than for a gnomon and the walls of the cylinder would have precluded its direct use as a sundial. It could still, though, have been part of a compendium which included a sundial.

Fig. 6. Map of the region to the south of Norwich.

Discussion

It is perhaps coincidental that this device is the third medieval timepiece found in Norfolk by a metal detectorist in the past decade. The other device, a fragment of a quadrant which has been dubbed the 'Norfolk quadrant'[19] was discovered in a similar rural location, also to the south of Norwich and only about 10 km away from the Shotesham field where the horologium was found. A third instrument fragment from Norfolk, a nocturnal, is also under investigation.[20] Although none of the devices is firmly dated, the balance of the evidence suggests that the horologium could be older than the quadrant by around a century, though this is subject to revision. Given that the author became aware of them because they were reported on a national database and nothing similar is listed for elsewhere in the country, the question which arises is whether this is pure chance, due to the particular diligence of Norfolk's metal detectorists, or to some special place of Norwich in the history of horology.

As was described in the earlier paper on the Norfolk quadrant,[19] the city of Norwich was second in importance only to London in medieval England and its cathedral was one of the very first to have a clock: it was already being repaired by 1291. Over the period 1322-5, a new astronomical clock

of considerable complexity was built at great expense (£52 9s 6d), with the clockmaker Master Roger of Stoke (who later worked with Richard of Wallingford on the celebrated St Albans astronomical clock) being a key figure for a period of over two years.[21,22] Another clockmaker who worked with Roger was a younger man (possibly his son), Laurence of Stoke. Laurence (or someone of the same name) also worked at St Albans, later going on to take orders and become a senior monk: he is described as *horologiarius* when he accompanied a successor of Richard of Wallingford to the papal court in Avignon in 1349. Stoke is a fairly common placename so it is not clear where Roger's and Laurence's origins were. One suggestion made by John North as "plausible" is Stoke Holy Cross, around 6 miles south of Norwich.[22] As can be seen in the map of Fig. 6, this is in fact only about 2 miles from the location where the Norfolk horologium was found. It is also apparent that the find site is only a few hundred yards from the long-ruined medieval St Martin's church. By a curious coincidence(?), the address of the church is Roger's Lane, Shotesham. It is very tempting to put these facts together and invent a scenario where one of the two local clockmakers visits their home church and loses the horologium: although this is pure speculation, the links between Norfolk and horology do seem to be strong.

The connection between officials of the Church and astronomy is demonstrated by the fact that Richard Courtenay, a chancellor of Oxford University and friend and envoy of Henry V, purchased an astrolabe from the great French maker Jean Fusoris in 1414.[23] Courtenay was made Bishop of Norwich in 1413 until his death in 1415. The direct link to astronomical instruments at Norwich Cathedral is, however, rather tenuous as is is believed that Courtenay never actually visited his seat there. Nevertheless...

ACKNOWLEDGEMENTS

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For a CV and portrait of the author, see *Bulletin* 23(ii), p.13 (June 2011).