A VERY EARLY DESCRIPTION OF A HORIZONTAL DIAL IN ENGLISH

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Quite soon after the introduction of the polar-aligned gnomon into Europe in the early 15th century, descriptions of how to lay out vertical-south dials and, less often, horizontal ones began to appear in manuscripts from numerous monasteries. Most of these descriptions were in Latin, the standard language of both the monasteries and universities across all of Europe. It is this *lingua franca* that allowed rapid diffusion of the knowledge in just a few decades. The manuscript which is the subject of this article is unusual in that it is in English and, being dated to c.1440, it may be the earliest description known in our native tongue.

The manuscript is now in Aberdeen University Library (MS 123) and has clearly had a hard life, with parts of pages missing and repaired and many badly waterstained. Nevertheless, most of it is still legible and the description of how to make a horizontal dial, complete with diagrams, gives an invaluable insight into the earliest 'scientific' (i.e. showing modern, equal hours by use of a polar-aligned gnomon) dials of this country.

This small codex (approx. 160 × 105 mm of text per page) contains around 160 leaves written by several hands and on a miscellany of topics. Although some of these are on quite general subjects, including moralised tales and questions and answers about liturgical practice, a good fraction of them deal with science and astronomy. These include Chaucer's *Treatise on the Astrolabe* (first published 1399), descriptions of how to make quadrants and the navicula,[1] working luni-solar volvelles as well as the sundial description. Chaucer's *Treatise*.. is often regarded as the first scientific treatise in English and it may be the presence of this text that convinced the MS 123 scribe to produce an English version of the sundial text.

The volume is dated at c.1440 by means of several references within the individual texts and it is believed to have been written in the area around Chester by the dialect used in some of the English language texts. A note on one folio, physically quite close to the sundial one, links it to the Augustinian friary of Warrington.[2] Another note shows that the manuscript had been owned by one William Fitton of Gawsworth, Cheshire.[3] It was given to the University of Aberdeen in 1723 by Robertus Barclay of Urie (Urry).

The description of the sundial begins on f.66r in Latin. It is a fairly standard description with the incipit *Instrumentum per quod sciuntur hore diei per vmbram.* The same text is also known, for example, in the Bodeian Library MS Digby 29 ff. 118v-119r. The Aberdeen version runs to about one and a half pages and then uniquely continues in a different hand with a translation into English. An example of the text is shown in Fig. 1. The text continues to folio 67v and includes two diagrams, one of the finished dial (Fig. 2, f. 67r) and one of the construction method (Fig. 3) after the text on f. 68r. A transcription of the text, and a translation into more modern English, is shown in Fig. 4 (over page).

The basic method used to draw the dial is a simple geometric one which became widely used, which a number of variants, over the following two centuries. Sawyer has recently given a good description of these methods.[4] Fig. 5 gives a modern interpretation of the method in the manuscript, which provides a rather garbled account. It employs an equatorial circle, uniformly divided into hourly 15° segments, which is projected onto a tangent line. The key step is to determine the radius of this circle to be $\sin\varphi$, relative to that of its horizontal projection, to suit the latitude for which the dial is being designed. Mathematically, we require:

$$x = \arctan(\sin\varphi \tan h)$$

where x is the angle of the hour-line from the noon line, φ is the latitude and h is the hour angle.

The first step is to draw circle ABCD which will eventually become the chapter-ring of the dial and which is taken to have unit radius. The line EF is then drawn such that AEF = φ. At

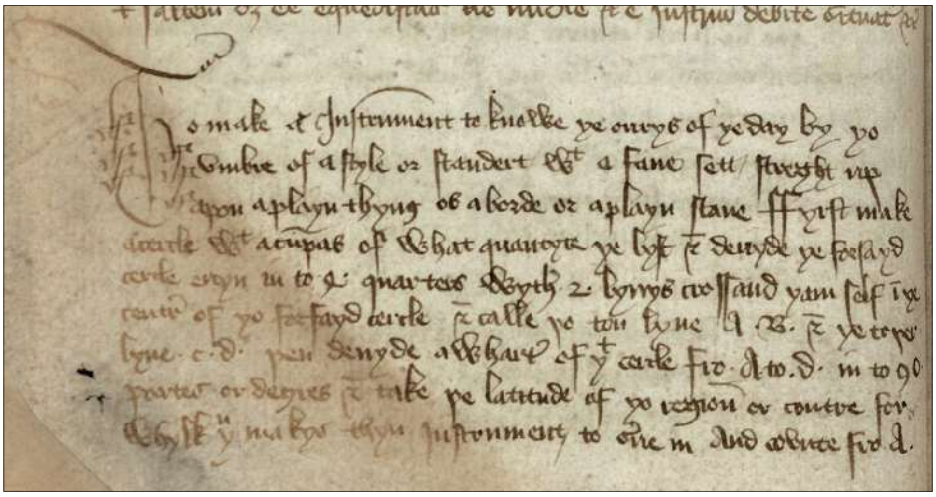


Fig. 1. Image of the English text from Aberdeen MS 123 f.66v. Copyright Aberdeen University Library.

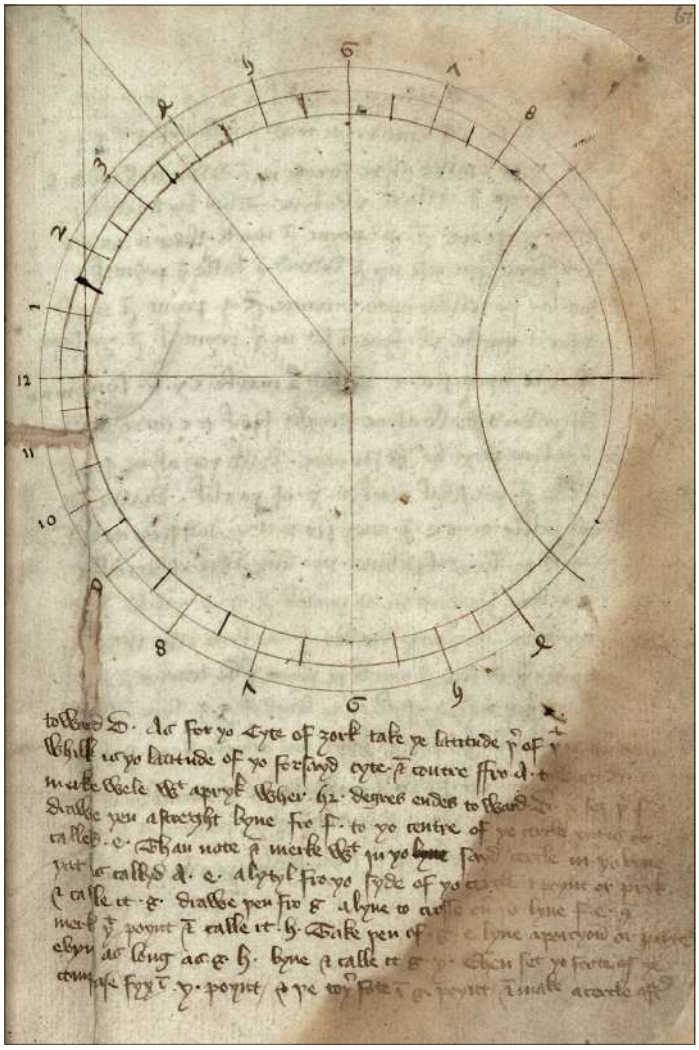


Fig. 2. Image of the dial drawing. Aberdeen MS 123 f.67r. Copyright Aberdeen University Library.

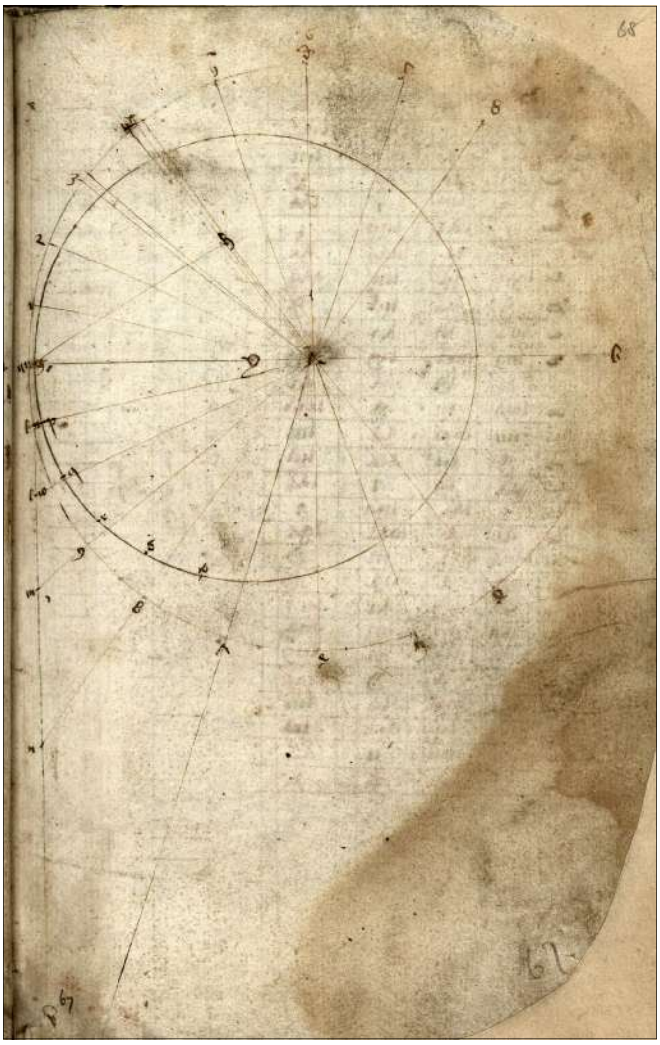


Fig. 3. Image of the construction method. Aberdeen MS 123 f.68r. Copyright Aberdeen University Library.

the time, laying out this angle without the benefit of a protractor would have been the most difficult part of the design, involving much halving of angles and trial-and-error stepping out with the dividers. By dropping the perpendicular AG to this line we define this distance as $\sin\varphi$ which can be transferred with compasses to AY to give the centre Y of the equatorial circle, tangential to the dial circle at A.

The equatorial circle is then divided into 15° increments ("*.24. euen pts*") such as p, q, r, s, t. Lines from centre Y through these point are drawn to meet the vertical tangent line at l, m, n etc. Then hour-lines from the dial centre E can be drawn to these points, fulfilling the required trigonometrical relationship. Note that these hour-lines are described with Roman numerals in the text but labelled with Arabic numerals, of medieval form, in the drawings.

This basic method of delineating the dial is a very standard one and leads automatically to a design with the origin in the centre of the dial-plate so that the 6am-6pm line forms a diameter. It was almost two centuries before the origin was moved towards the south of the dial-plate in order to make better use of the available space.

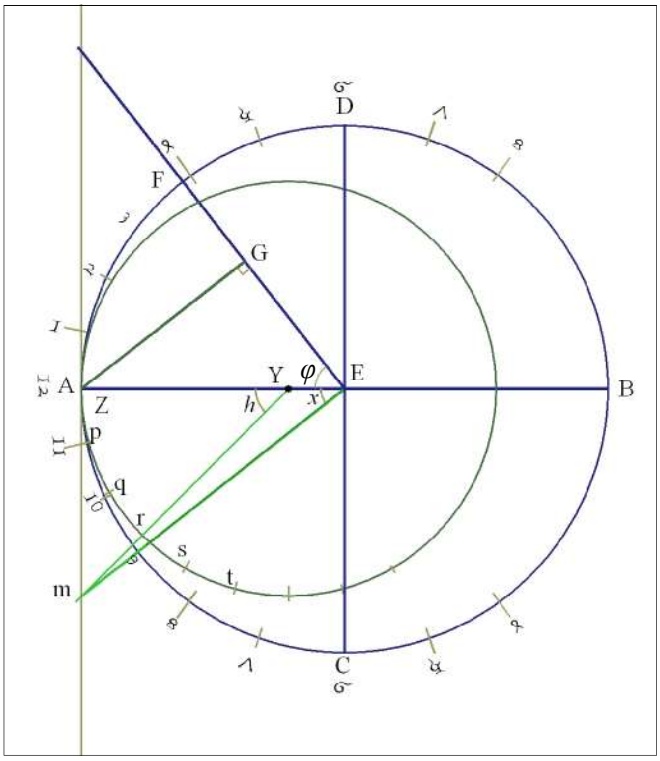


Fig. 5. Modern interpretation of the design method.

Transcription

[66v] To make an Instrument to knowe ye ourys of ye day by ye / umbre of a style or standert w^{t} a fane sett streght up / upon a playn thyng os a borde or a playn stane Fyrst make / a cercle w^{t} a cu[m]pas of what quantyte ye lyst & deuyde ye foesayd / cercle croyn in to 4. quarters wyth 2. lynys crossand yem self in ye / centr of ye forsayd cercle & calle ye tou lyne .A.B. & ye uther / lyne .c.d. þen deuyde a whart of ye cercle fro A to .D. in to 90 / partes or degres & take þe latitude of ye region or contre for / whylk y^{u} makyr thyn Instrument to one in And cobute fro A. / [67r] toward D. As for ye ?yte of z or l take ye latitude & of ye ..... / whilk is ye latitude of ye forsayd syte & contre Fro A towards D / merke wele wt a pryk wher 52. degres endes toward D. set ye ? / Drawe yen a streght lyne fro f. to ye centre of ye cercle / called .e. Then note & merk w^{t} ?u ye lyne sayd cercle in ye line / yat yo callyd .A.e. a lytyl fro ye syde of ye cercle ? poynt or pryk / & calle it .g. Draw then fro g a lyne to crosse .. a lyne f.c. & / merk y^{t} poynt & calle it .h. Take þen of g.e. lyne a peiryed or ..../ ebyn as long as.g.h. lyne & calle it g.y. Then set ye foote of ye / compase fyyi .y. poynt & ye toy fote in g. point & make a cercle aft? / [67v] that quantyte Deuyde then yor serkyl in to .24. euyn pts / y^{at} is to say yw [wth] aquarter in to .6. & calle those pts .p.q.r / s.t. then drawe alyne streght up & down acossand .A.B. / in g. point & calle it .y.b lyne. Then lay a rewlar / upon y centre & .p. poynt & merk wher it touches / y. b. lyne yat gose up & downd. & kalle y^{t} poynt .k. / Zet lay þy rewlar upon .y. centre & .q. poynt & merk / wher it touches .y.b. lyne & set in þ^{t} poynt .l. & ye same / way Do upon .v.s.t poynts & marke it y.? lyne m.n.o / Aftyrward draw alyne streght fro .k. to e centre & þ^{t} lyne ? / betokyns þe XI. ho^{s} be for none. Draw þen alyne fro l. / to e. & þat sthal be tokyn .X. of þe clok. Drawe ?t / alyne fro m. to e. & anoþr fro .n. to e. And fro o. to e. & / these .?. lynes b tokyns IX bm? & by? of ye clok & / t.e. lyne be to kyns 6? of ye clok & g.e.XII ho^{s} þat is / mydday Forsp.... drawe f.e. lyne owt whilst it / touche .y.b. lyne & merke þe poynt þ^{c} he touchys & set / þ^{t} .z. then make þy style of ye lengh of .g.z. lyne & set it / streght up in .g. poynt Knyt þen a threde fro þe style top / to a centre. Or if y^{u} wyl make a fayne of metal or of borde / mak it ebyra & playn & 3 cornerd of ye quanate of e.g.z. / trou ye umbra of þat schal schewe yo aways truh

Translation

[66v] To make an Instrument to know the hours of the day by the / shadow of a style or standard with a vane set vertically / upon a flat surface or a board or a plane surface. First make / a circle with a compass of whatever size you like & divide the foresaid / circle circumference in to 4 quarters with 2 lines crossing in the / centre of the foresaid circle & call the two lines **AB** & the top / line **CD**. Then divide the part of the circle from **A** to **D** in to 90 / parts or degrees & take the latitude of the region or country for / which you make the Instrument. And count from **A** / [67r] toward **D**. As for the height of arc take the latitude & of ye ...../ which is the latitude of the foresaid site & country. From **A** towards **D** mark well with a prick where 52 degrees ends toward **D**. Set the ?/ Draw then a straight line from **F** to the centre of the circle / called **E**. Then note & mark with ju? said circle in the line / that you called **AE** a little from the side of the circle ? point or prick / & call it **G**. Draw then from **G** a line to cross .. a line **FC** & / mark that point and call it **H**. Take then of **SE** line a peiryed? or ..../ ebyn? as long as line **EH** lyne & call it 8.y?. Then set the foot of the / compass fyyi .y. poynt & ye toy fote ? 8. point & make a circle aft? / [67v] that quantity. Divide then your circle in to 24 even points / that is to say with aquarter in to .6. & call those points **P, Q, R / S, T**. Then draw a line straight up & down across and **AB /** in 8 points & call it line **YB**. Then lay a ruler / upon the centre &.p. point & mark where it touches / line **YB** line that goes up & down & call that point **K**. / Next lay your ruler upon the centre **ZQ** point & mark / where it touches line **YB** line & set in that point l. And [in] the same / way do upon **V, S, T** points & mark it y.? line **M, N, O /** Afterward draw a line straight fqo.k. to **E** centre & that line ? / indicates the XI hour before noon. Draw then a line from **P /** to **E** & that shall indicate X o'clock. Drawe ?t / A line from **M** to **E** & another from **N** to **E**. And from **O** to ? & / these **M** lines indicate IX am & ?? of the & / **TE** line indicates 6? o'clock & the XII hours that is / Midday. Forsm.... draw line **FE** line out where it / touches line **XB** & mark the point which touches & set / the **Z** then make the style of the length of line **GZ** & set it / straight up at point **G**. Tie then a thread from the style top / to a centre. Or if you will make a vane of metal or of board / make it ebyra? & plane & 3 cornered of the size of **EGZ**. / Through the shadow of that shall show you aways true

Fig. 4. Transcription and translation of the English text from Aberdeen MS 123, ff.67v – 68r.
Note that the text in some places is difficult to decipher and thus this reading must be taken with some caution. The author would welcome further input from scholars familiar with 15th-century texts.

There are several features of the Aberdeen MS 123 text which are particularly noteworthy. The first is that the equatorial circle is drawn inside that of the actual dial, rather than externally tangential to it, as in the majority of the vertical dial (*horologium murale*) descriptions of the period. Geometrically, the two schemes are completely equivalent but the internal scheme has the advantage of saving space – and expensive vellum – but with the disadvantage of being less clear, with two sets of lines overlapping. A scribe would clearly copy the version of the text that he was presented with and not seek alternative layouts so this fact may provide a clue into the lineage of the text. Later writers developed the design method so that the extreme length of the tangent line for times approaching 6am and 6pm was not needed.[4]

A second feature is that the text is explicitly for a latitude of 52° and the diagram is drawn to this value. However, the latitudes of Chester and Warrington are both 53° 11′ so it must be that the original design was for a different location and it has been copied without modification. Since the latitude quoted for Oxford[5] at this period was 51° 50′, it seems very likely that the description may have originated there, or possibly at the nearby Benedictine monastery of St Albans.

A third noteworthy feature is that the first form of gnomon described uses a string (a *threde*) stretched from the origin to the top of a post on the noon mark. This strongly suggests that the designer had a portable dial, or one for indoor use, in mind rather than an outdoor pedestal design. Only as an alternative does he suggest a plate gnomon (a *streght fane*) in the form of a right-angled triangle.

The description is very much a theoretical one with no detailed discussion of the manufacturing methods. It is also notable that a subdivision to half-hours is shown on the final design but not described in detail. These marks could be constructed from 7.5° divisions of the equatorial circle though it is equally likely that they were drawn by dividing the hours by eye. The arc at the south of the finished dial, crossing the chapter ring at about 3am and 9pm, is unexplained – these times are beyond the earliest (latest) sunrise (sunset) times at this latitude.

The language of the text is interesting and quaint to modern eyes. Naturally, the spelling is rather variable (e.g. fane/ fayne, cercle/serkyl/zerk[l] etc.) being basically phonetic. One point worth noting is the use of two forms of the 'thorn' or 'th' character, initially a 'y' but later a 'þ'. Some abbreviations and omission signs are used which seem to indicate that the writer was mainly trained in Latin and was applying the same methods.

ACKNOWLEDGEMENTS

It is a pleasure to thank Kim Downie, University of Aberdeen Library, for providing copies of this manuscript. Catherine Eagleton (British Museum) is thanked for her encouragement as is Harry Wells for information on Warrington Friary.

REFERENCES & NOTES

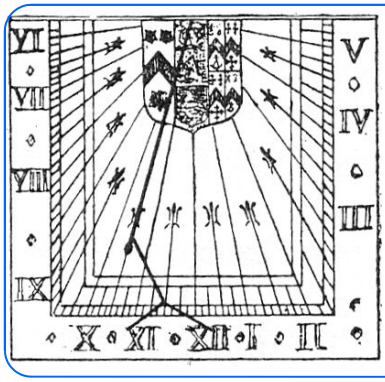
1. The MS 123 text for the navicula (the 'Little Ship of Venice', a rare, universal altitude dial which seems to be a medieval English development) can be found in C. Eagleton: *Monks, Manuscripts and Sundials: the Navicula in medieval England*, Brill Academic Publishers (2010). It was this book which first alerted me to the existence of the horizontal dial description.
2. H. Wells: *Warrington Friary – notes on a talk entitled The Austin Friars of Warrington,* Self-published (2000).
3. Two William Fittons of Gawsworth (c.1408-59 and c.1438-?), probably father and son, are recorded in the online records of The Church of Jesus Christ of Latter-day Saints.
4. F. Sawyer: 'Horizontal Layouts 1–4', *NASS Compendium*, 13 (2), 33-35 (March 2012).
5. See Note 14 of J. Davis: 'Robert Stikford's "De Umbris Versis et Extensis"', *BSS Bull.*, 23(iv), 24-28 (Dec 2010).

ANNEX – Warrington Friary

Warrington Friary was a house of Hermit Friars of St Austin, founded by William Fitz Almeric le Boteler. It was established by 1291. The boundaries of the Friary land are uncertain, but land grants suggest that the property was extensive. The Friary was suppressed in 1536 during the dissolution of the monastaries and granted to Thomas Holcroft in 1540. Holcroft sold it to John Cawdwell on the condition that the townspeople could still use the use Friary church (Jesus Church) and that he was allowed to remove the stone of any unroofed walls. This Church is mentioned again in around 1640, though how long it was used is uncertain. The last remaining structure was the arch of Friary gateway, which was demolished in the late 18th century.

The Prior of Warrington is known to have ordered a clock for the Priory sometime before 1400.[2] It did not live up to expectations and so its maker, Thomas Graver of Manchester, was sued to recover its cost of 100 shillings. Despite this failure, the interest in timekeeping at the Priory is clear.

The most famous incumbent at Warrington was Thomas Penketh (d.1487) whose entry in the Oxford DNB describes him as an Augustinian friar and theologian who studied theology at Oxford just before 1466. He later travelled to study in Padua, where he was appointed lector in metaphysics at the university. Although there is no known link between Penketh and Aberdeen MS 123, the association with Oxford and with international travel show that what might appear to be an insignificant provincial friary did indeed have connections to the European-wide academic scene.



Brasenose College Oxford

Originally made in 1719 for under £9, with the painting and gilding costing £7 7s. Drawn here by Robert Gunther in 1923.

It is SRN 0988, most recently recorded in 2000.