1 Sacred Astronomy? Beyond the Stars on a Whipple Astrolabe*

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It has occasionally been my privilege to act as a stand-in gallery attendant in the Whipple Museum. This has afforded precious opportunities to observe visitors, who seem not to feel my scrutiny as they explore the atmospheric main gallery. Almost invariably they wander clockwise. They may pause first at the horses' teeth or glass fungi. But they are guaranteed to stop, and to stare, at the astrolabes case.

Astrolabes seem to hold a fascination for museum visitors, even – perhaps especially – if they have no understanding of their workings. A mathematical instrument that is as beautiful as it is precise, a medieval astrolabe can be appreciated on multiple levels, scientific or artistic. This is not as anachronistic as it might appear: when they were made, too, astrolabes – at least the ones that survive in museum collections – were ornate status symbols as well as functional tools. Even so, it is often hard to imagine the contexts in which these devices were first designed and used. Behind glass, their three-dimensionality and mutability obscured by the fixed presentation of one face to the observer, they may epitomise the 'decontextualised commodities' deplored by Ludmilla Jordanova.[1] Even for those of us who study them, they seem to recede into mystery even as new methods of analysis allow us to get closer to them than ever before: as the newly delineated complexities of their long lives blur simple

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1 L. Jordanova, 'Objects of Knowledge: A Historical Perspective on Museums', in Peter Vergo (ed.), *The New Museology* (London: Reaktion, 1989), pp. 22–40, on p. 25.

ascription, or as once-prized historic objects turn out to be modern fakes.[2] It is thus perhaps not surprising that, at least until recently, approaches to astrolabes have been narrowly antiquarian.[3] Understanding the conditions and motivations of their use was seen as less important than seeking ever greater precision about the time and place of their production. Needless to say, in order to use an object to illuminate its context we first need to know where and when that context was. Yet, even when we lack certainty about their provenance, there remain ways that astrolabes can be understood and can help us to better understand the Middle Ages more generally.

This chapter focuses on one astrolabe in the Whipple Museum's collection, Wh.1264 (Figure 1.1), as a way of highlighting these issues. It is an object that has not been extensively studied: it is not clear when or how it came to be in the Whipple collection, and it was not included in the foundational catalogues of astrolabes.[4] Some studies have considered it, but mainly as a way of elucidating other instruments.[5] However, it has recently played a supporting role in a detailed treatment of another instrument in Cambridge, and it has been included in an extensive programme of metallurgical analysis carried out by John Davis.[6] Such new methods as X-ray fluorescence

2 B. Jardine, J. Nall, and J. Hyslop, 'More Than Mensing? Revisiting the Question of Fake Scientific Instruments', *Bulletin of the Scientific Instrument Society*, 132 (2017), pp. 22–9.

3 These were epitomised by R. T. Gunther in his *Astrolabes of the World* (Oxford: Oxford University Press, 1932); *Early Science in Oxford* (Oxford: Oxford University Press, 1923); and *Early Science in Cambridge* (Oxford: Oxford University Press, 1937). For the influence of such approaches on the early development of the Whipple Museum, see S. Falk, 'The Scholar as Craftsman: Derek de Solla Price and the Reconstruction of a Medieval Instrument', *Notes and Records of the Royal Society*, 68 (2014), pp. 111–34.

4 Gunther, *Astrolabes of the World*; D. J. Price, 'An International Checklist of Astrolabes', *Archives internationales d'histoire des sciences*, 32 (1955), pp. 243–63; and S. L. Gibbs, J. A. Henderson, and D. J. de Solla Price, *Computerized Checklist of Astrolabes* (New Haven: Yale University Press, 1973). It is included, with the briefest description, in David Bryden's catalogue of sundials at the Whipple Museum: D. J. Bryden, *The Whipple Museum of the History of Science, Catalogue 6: Sundials and Related Instruments* (Cambridge: Whipple Museum of the History of Science, 1988), no. 342.

5 O. Gingerich, 'Zoomorphic Astrolabes and the Introduction of Arabic Star Names into Europe', *Annals of the New York Academy of Sciences*, 500 (1987), pp. 89–104; and C. Eagleton, '"Chaucer's Own Astrolabe": Text, Image and Object', *Studies in History and Philosophy of Science Part A*, 38 (2007), pp. 303–26.

6 J. Davis and M. Lowne, 'An Early English Astrolabe at Gonville & Caius College, Cambridge, and Walter of Elveden's *Kalendarium*', *Journal for the History of Astronomy*, 46 (2015), pp. 257–90. I am grateful to J. Davis for sharing the results of his endeavours with me.

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Figure 1.1 Wh.1264, an English astrolabe, *c.* 1350. Image © Whipple Museum.

(XRF) analysis, diffraction analysis, and scanning radiography have the potential to revolutionise our understanding of instruments. Hard data about their chemical composition or metallic microstructure can, in combination with more traditional comparative techniques, support theories about their age, geographical origins, and methods of production, as well as testing old broad-brush dating tools such as precession data.[7]

Yet pinpointing the age and geographical origins of an astrolabe is problematic, for two contrasting reasons. First, these were never static objects. They moved freely across the national boundaries

7 In principle, the astrolabe rete and calendars should reflect the state of the skies at the time the astrolabe was made, and the position of the first point of Aries has often been used as an indication of this, but this approach is unreliable. See Gingerich, 'Zoomorphic Astrolabes and the Introduction of Arabic Star Names into Europe', p. 89; and G. L'Estrange Turner, 'A Critique of the Use of the First Point of Aries in Dating Astrolabes', in G. L'Estrange Turner, *Renaissance Astrolabes and Their Makers* (Aldershot: Ashgate, 2003), Part III, pp. 548–54.

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marked on modern maps – and as they moved, they changed. Parts of these instruments – always intended to be dismantled and reconfigured – were lost; new parts were added; new engravings were made, altering the purposes or appearance of the instruments. Some may almost be regarded as compilations, or as having been composed and later re-edited. When we talk of astrolabes having replacement parts we may picture insensitive Victorian curators, and indeed astrolabes in British museums contain their fair share of nineteenth-century brass. Yet we must reflect that parts were most likely to be lost or broken when the instruments were in most active use. XRF analysis would seem to support this, as we find different parts of instruments containing quite different – but still medieval – alloys. Secondly, a precise guess of a date and place of origin, or even ascribing an instrument to a named individual, may overlook the continuity of artistic and particularly scientific trends across time and context. Contemporary scholars were remarkably uninterested in the geographical or even religious origins of scientific instruments or ideas.[8]

Nevertheless, even within such broader trends we find local specificities. One example of this is the religious motivation for scientific inquiry. Links between Christianity and astronomy were long underestimated, and although no serious historian now subscribes to the idea of a 'warfare of science with theology', historians may still disagree about how far Christian faith inspired an understanding of nature, or was simply set aside by natural philosophers.[9] Astrolabes have a part to play in exploring such questions. Just as an image of an instrument might symbolise learning in an illuminated bible (Figure 1.2), so the inclusion of religious information on an astrolabe could allow its patron or maker to express his devotional preferences.[10] This need not have been in an explicitly religious setting like a monastery; it seems to have occurred as much on instruments

8 O. Pederson has shown how unconcerned commentators were with the nationality of Johannes de Sacrobosco. See O. Pederson, 'In Quest of Sacrobosco', *Journal for the History of Astronomy*, 16 (1985), pp. 175–220.

9 See A. D. White, *A History of the Warfare of Science with Theology in Christendom* (New York: Appleton, 1896). See also the debate between E. Grant and A. Cunningham in the pages of *Early Science and Medicine*, 5 (2000), pp. 258–300.

10 On devotional motivations for practising astronomy, see S. Falk, 'Improving Instruments: Equatoria, Astrolabes, and the Practices of Monastic Astronomy in Late Medieval England', unpublished PhD thesis, University of Cambridge (2016), pp. 13–41.

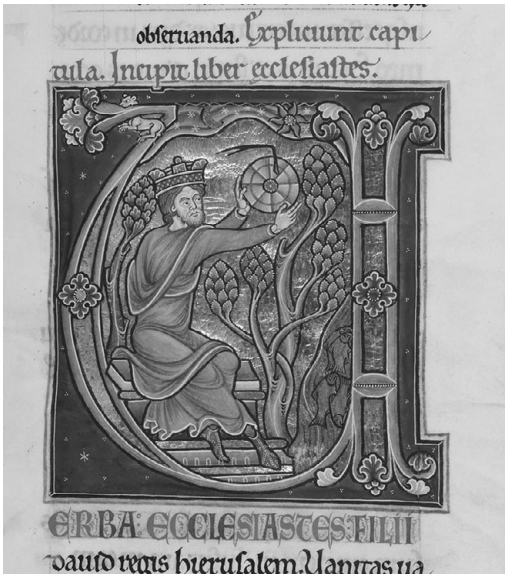

Figure 1.2 Solomon observing the stars, from a Franciscan Bible. The message here is ambiguous: the historiated initial adorns the opening to the Book of Ecclesiastes, in which the wise Solomon admonishes that 'in much wisdom is much grief: and he that increaseth knowledge increaseth sorrow' (1:18). Reproduced courtesy of the Bibliothèque Nationale de France (MS Latin 16745 (*c.* 1170–80), fol. 108).

made for lay patrons, and in any case the links between the larger monasteries and the universities and royal court were strong across the late medieval period.

The Whipple's English Astrolabe

Wh.1264 is an ideal object to show how such devotional preferences might be expressed. It has usually been dated to the late fourteenth century, and is among the larger Western astrolabes known from this period: its mater is 295 mm in diameter, and 40 mm thick; the entire instrument including its suspension ring and throne measures 348 mm in length. The mater was constructed by riveting a cast rim (with a depth of 5 mm) onto the backplate, with twenty-three regularly spaced pins that have been driven through the front. The throne is set into the rim and fixed in place with two rivets, though this joint has become a little loose. The throne is very small and plain: a round boss that is almost completely covered by the shackle; the bail is in the T–H form common to astrolabes of this period. The astrolabe is held together with a plain pin and horse, including three modern washers (one metal, two plastic) – it is not known when these were added. It has a double graduated rule atop the rete, and an alidade with pinhole sights at the back.

It was manufactured from a fairly typical medieval latten, an alloy of copper and zinc with smaller quantities of tin and lead. XRF analysis of the instrument by Davis shows that it contains an unusually low level of zinc (7.7 per cent) compared with other astrolabes of the

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period which are more likely to have 10–15 per cent.[11] The rete has slightly higher levels of zinc, showing how variable the smelting process could be, and the alidade, rule, and pin have significantly higher zinc levels (*c.* 20 per cent) which suggest these may be later replacement parts. The horse is certainly made of a modern brass.

There are no separate tympans for specific latitudes; the only stereographic projection is engraved within the womb of the mater. It is not labelled for a specific place or latitude, but the distance between the zenith and the celestial pole indicates that it was produced for use at latitude 52°. This corresponds to locations in central England where astronomy was extensively practised, such as the university of Oxford and monastery of St Albans; however, Davis and Lowne, connecting it with an astrolabe at Gonville & Caius College, have suggested that it may have been made for use at Norwich.[12] The almucantars, which mark celestial altitude, are drawn and labelled every two degrees: as closely spaced as, and more frequently labelled than, on any catalogued astrolabe. This would have made it exceptionally user-friendly when it came to finding the locations of stars. Yet this 600-year-old instrument was surely used in different ways at different times. Engraved and labelled among the almucantars with a finer tool and later script are the Great Houses, useful for astrology; much more crudely, hammered points just inside the rim were used to add the first few letters of the name of each month, as well as four dots in the shape of a diamond, twice between each month name and the next (Figure 1.3).

The absence of interchangeable tympans (plates) for different latitudes makes Wh.1264's origins and purpose harder to identify. The presence of modern washers to prevent the rete, rule, and alidade from rotating too loosely suggests that the astrolabe previously had tympans which have been lost. However, tympans must be held in place within the womb of the mater; this was usually accomplished by making the tympans with tangs that fit into a slot in the rim, though some later astrolabes instead had lugs in the rim and notches in the tympans. This astrolabe has neither system, and a stereographic projection is, somewhat unusually, engraved in the

11 Davis and Lowne, 'An Early English Astrolabe at Gonville & Caius College, Cambridge, and Walter of Elveden's *Kalendarium*', p. 280; and J. Davis, private correspondence, 6 April 2018.

12 Davis and Lowne, 'An Early English Astrolabe at Gonville & Caius College, Cambridge, and Walter of Elveden's *Kalendarium*', p. 257.

Figure 1.3 Detail from the womb of Wh.1264, showing the equator, almucantars, and unequal hours, and a finer Great House line (with corrected '6'). Note also the hammered-in month names and diamonds. Image © Whipple Museum.

womb, so it may be questioned whether it ever had separate tympans. In addition, the single stereographic projection has, unusually, neither a named location nor a latitude. These details would have been omissible if there was no need to distinguish between different projections; if, perhaps, its user had no plans to travel with it. On the other hand, if an astrolabe was intended for use at a single latitude, the mater could be reduced to a single plate, as we find on Wh.4552, a near neighbour in the Whipple's current display. The fact that Wh.1264 has a recessed womb surrounded by a rim suggests that it was at least intended to be equipped with tympans. In any case, astrolabes without tympans are rare, whereas it is relatively common for tympans to have been lost from astrolabes now on display in museums. Lacking any other evidence, we must assume that this is the case with this instrument. How the tympans would have been secured in place is not clear, though since the throne is a little loose it is possible that it was originally fitted differently, and that the refitted throne has filled a slot that was previously located just beneath, as is customary. Alternatively, perhaps the astrolabe is incomplete: its maker may have failed to fit the womb with lugs, just as he failed to mark the latitude; or, conceivably, he chose to add a rim for aesthetic reasons.

Tympans are not the only notable absence from this astrolabe. It is also missing any engraving within the top inner semicircle on the back (apart from a roughly scratched 'Hd'). In Western astrolabes

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from this period it is fairly common to see an unequal-hour scale there. John North has called the inclusion of these lines an 'empty ritual', noting how rarely the scales are accurately engraved or supplied with a counterpart giving solar positions; it might be added that such scales are usually unnecessary, since they are commonly also on the front of the astrolabe.[13] Their appearance on the back may indeed be ritualistic, reminding users of the astrolabe's timekeeping function and perhaps privileging that over its parallel astronomical uses. In this context, it is also notable that the rim of Wh.1264 is labelled with 360 degrees, rather than the twenty-four hours that were a common feature of Western astrolabes in this period.[14] One may, then, suggest that its maker was relatively uninterested in timekeeping functions. Needless to say, it can still be used to tell the time with some precision, during the day or night, at any season of the year. It has unequal-hour lines on the front, and the rule is graduated to allow conversion between equal and unequal hours, according to the midday solar altitude, at the latitude for which the astrolabe was made. The lack of an equal-hour scale on the rim certainly makes Wh.1264 less user-friendly for timekeeping, but even if the maker of this astrolabe was more interested in astronomical uses, or wanted to use the 360-degree scale on the rim to represent a conceptualisation of the cosmos as a geometrical entity, such intentions might not be reflected in the way it was used. Certainly, the 360-degree scale by no means precludes its use as a time-telling device.

Stars and Almucantars

It is possible to characterise the back of the astrolabe, with its calendar of feast days and surveyor's shadow square, as representing terrestrial things; the front, in contrast, carries the net of stars and so looks more directly towards the heavens. The rete has been considered by a few scholars who have sought to develop typologies of

13 J. North, 'Astrolabes and the Hour-Line Ritual', in J. North, *Stars, Minds and Fate: Essays in Ancient and Medieval Cosmology* (London: Hambledon, 1989), pp. 221–2, on p. 221. First published in *Journal for the History of Arabic Science*, 5 (1981), pp. 113–14.

14 The astrolabe illustrated in Chaucer's *Treatise* has the latter arrangement. See G. Chaucer, *A Treatise on the Astrolabe* (*c.* 1391), ed. S. Eisner (Norman: University of Oklahoma Press, 2002), pp. 142–3.

astrolabes according to their shapes, symbolism, and the stars they contain.[15] Wh.1264 fits into a group of astrolabes with quatrefoil and demi-quatrefoil motifs on their retes, which have been distinguished from other instruments whose retes are dominated by a Y-shape within the ecliptic circle. The latter group are sometimes characterised as 'Chaucerian' because the same Y-shape appears in illustrations within some early copies of the *Treatise on the Astrolabe*, but it is not clear whether the illustrations imitate the astrolabes, vice versa, or both in different cases.[16] Those astrolabes adorned with architectural decoration such as quatrefoils have been persuasively linked with similar examples of church architecture as a way of localising their production (or adaptation); such comparisons by themselves may be unconvincing, but can add important support to origins hypotheses based on other parts of the instruments.

The stars marked on astrolabe retes do not necessarily correlate closely with the decoration of their supporting framework. They have been analysed in terms of the selection of stars included, the positions given, and the names used. Gingerich has called the fourteenth century 'a key period in the transmission of Arabic star names into common English usage', and we certainly find these Arabic star names on Wh.1264.[17] (Many of these Arabic names, such as Altair and Vega, are still in common use today.) The lists of stars chosen were first systematically analysed as a series of 'types' by Paul Kunitzsch, and his Type VIII corresponds most closely to the Whipple rete.[18] This list, Kunitzsch demonstrates, combines one that appeared in Spain in the late tenth century and another compiled by John of London in 1246, in Paris. It contains forty-nine stars, forty-one of which appear on the rete of Wh.1264 (see Table 1.1).[19]

15 Gingerich, 'Zoomorphic Astrolabes and the Introduction of Arabic Star Names into Europe'; D. A. King, 'An Ordered List of European Astrolabes to *ca*. 1500', in D. A. King, *Astrolabes from Medieval Europe* (Farnham: Ashgate, 2011), p. xii; and J. Davis, 'Fit for a King: Decoding the Great Sloane Astrolabe and Other English Astrolabes with "Quatrefoil" Retes', *Medieval Encounters*, 23 (2017), pp. 311–54.

16 Eagleton, 'Chaucer's Own Astrolabe'; J. Bennett and G. Strano, 'The So-Called "Chaucer Astrolabe" from the Koelliker Collection, Milan', *Nuncius*, 29 (2014), 179–229.

17 Gingerich, 'Zoomorphic Astrolabes and the Introduction of Arabic Star Names into Europe', 96.

18 P. Kunitzsch, *Typen von Sternverzeichnissen in astronomischen Handschriften des zehnten bis vierzehnten Jahrhunderts* (Wiesbaden: Otto Harrassowitz, 1966).

19 An almost identical list of stars 'to be placed on the astrolabe' survives in an early-fourteenth-century collection of astronomical and astrological texts from the monastery of Bury St Edmunds: Cambridge University Library MS Add.6860, ff. 70v–71r.

TABLE 1.1 List of stars marked on rete of Wh.1264

Star Name on Wh.1264	Modern Name	Kunitzsch Type VIII Number
Mirak	β Andromedae	1
Batuchaythos	ζ Ceti	2
Cenok	α Arietis	4
Menkar	α Ceti	6
Algeneb	α Persei	7
Augetenar	τ Eridani	8
Aldeboram	α Tauri	9
Alhaok	α Aurigae	10
Rigil	β Orionis	11
Elgeuze	α Orionis	12
Alhabor	α Canis Majoris	13
[unlabelled pointer]	α Geminorum	14
Algomeiza	α Canis Minoris	15
Markeb	κ Velorum	16
[unlabelled pointer]	μ Ursae Majoris	17
Alfard	α Hydrae	19
Cor	α Leonis	20
[unnamed bird]	Corvus	22
Edub	α Ursae Majoris	23
Cauda	β Leonis	24
Algorab	γ Corvi	25
Alehimek	α Virginis	26
Benenaz	η Ursae Majoris	27
[unlabelled pointer]	? μ ≈ Lib 20, δ ≈ −18	–
Alramek	α Bootis	28
Elfeca [broken off][a]	α Coronae Borealis	29
Yed	δ Ophiuchi	31
Alacrab	α Scorpii	32
Alhawe	α Ophiuchi	33
Thaben	γ Draconis	34
Wega	α Lyrae	35
Althayr	α Aquilae	36
Delfin	ε Delphini	37
Aldigege	α Cygni	39
Aldera	α Cephei	42
Musida Equi	ε Pegasi	43
Denebalgedi	δ Capricorni	44
Cenok	δ Aquarii	45
Humerus Equi	β Pegasi	46
Alferas	α Andromedae	47
Denebchaytos	β Ceti	48
Skeder	α Cassiopeiae	49

[a] The pointer is broken, leaving only 'El'. Gingerich ('Zoomorphic Astrolabes and the Introduction of Arabic Star Names into Europe') noted this as Elfeca without further comment; perhaps the rete was broken after he studied it.

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Two stars are labelled Cenok. Four are unnamed, including one in the shape of a pretty bird resembling a song thrush, possibly intended to represent the constellation Corvus (the star Algorab, γ Corvi, is also shown and labelled).[20]

The zoomorphic pointer for Corvus made it unnecessary to engrave a name: the shape was its own label. Here zoomorphism served a mnemonic function, but elsewhere on astrolabes in this period it served an aesthetic one. Compared with some others of the period, most notably the Sloane astrolabe in the British Museum, Wh.1264's decoration is sparse, but a few other pointers do suggest zoomorphs. The Paris workshop of Jean Fusoris was later to popularise a sparser style, but the fourteenth century in England was clearly a period when astrolabe-makers were keen to display their aesthetic, as well as geometrical, skills.

Saints and Calendars

If we turn the astrolabe over, we encounter what might be termed the 'terrestrial' side of the astrolabe (Figure 1.4). This is mundane in two senses: features such as the shadow square highlight uses such as surveying, while the dual reference calendars make the astrolabe as much almanac as instrument. In decorative terms there is little to remark here, though it is notable that care has been taken over the names of the months and zodiac signs; the Gothic-style lettering here is considerably more elaborate than the simpler, more archaic capitals used for the star names on the rete. More worthy of comment are the circles of saints' names, feast dates, and dominical letters that form the inner rings of the Julian calendar. These are a relatively common feature of astrolabes produced in the fourteenth century; it seems calendrical functions became less important later.[21] Until very recently, no historian has given more than cursory consideration to the feast days featured on astrolabes.[22] But they are far from space-fillers: even small astrolabes from this period, such as Gonville &

20 See also Table 1 in Gingerich, 'Zoomorphic Astrolabes and the Introduction of Arabic Star Names into Europe'. Gingerich noted only two unlabelled stars, including the bird. One of the ones he omitted is identifiable as Kunitzsch 14 (α Geminorum, known as Razalgeuze). The other cannot be identified with any star in Kunitzsch's lists.

21 K. de Soysa, 'The Decline and Fall of the Astrolabe', unpublished M.Phil. essay, University of Cambridge (2000), pp. 7–8.

22 J. Davis has recently begun to rectify this. See, for example, J. Davis, 'Dating an Astrolabe from its Calendar Scales', *Bulletin of the Scientific Instrument Society*, 135 (2017), pp. 2–7.

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Figure 1.4 Detail from the back of Wh.1264, showing the calendar of feasts for March. Note the uncial-Gothic capital 'M'. Image © Whipple Museum.

Caius Astrolabe B, squeeze in a calendar with as many feasts as possible. It has been more than a century since the antiquarian and chancellor of the diocese of Carlisle Richard Saul Ferguson wrote that 'it is to be wished that some expert in hagiology would examine the . . . calendars [on English astrolabes] and endeavour to ascertain the principle of selection'.[23] The rest of this chapter represents a tentative initial answer to his plea. Feast-day calendars certainly have the capacity to impart valuable understanding not only of the instruments themselves, but of the society that produced them.

Examination of the calendars and analysis of their sources must start from an awareness that astrolabe-makers chose well-known feasts to fill almost all the twenty-four to forty-eight spaces on their instruments. This reflects the fact that in fourteenth-century England the date was more often reckoned with reference to saints' days than using the Roman system. Thus the majority of dates marked on the astrolabes are feasts celebrated throughout Christendom, and we should see their function on the astrolabe as a method of measuring the course of the year parallel to the twelve months and zodiac signs, quite apart from their devotional significance. Nevertheless, the variety that remains can tell us much about the influences and interests of astrolabe-makers.

Table 1.2 lists the feast days marked on Wh.1264, and compares them with ten other astrolabes attributed to fourteenth-century England. It is noteworthy that, of the eight dates that appear on all

23 R. S. Ferguson, 'On an Astrolabe Planisphere of English Make', *Archaeologia*, 52 (1890), pp. 75–89.

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TABLE 1.2 Comparative calendar of feast days on Wh.1264 and ten other astrolabes

Date	Dominical Letter	Feast Day[a]	English Translation and Notes	Others[b]
Ianuarius				
6	f	Ephia dñi	Epiphany	10
22	a	vincentus	Vincent of Saragossa (d. *c.* 304)	5
25	d	pauli	Paul	8
Februarius				
*	*	puriff[c]	Purification of Mary (Candlemas)	9
5	a	agathe	Agatha of Sicily (d. *c.* 251)	1
22	d	petri	Chair of St Peter	10
24	f	math	Matthias	7
Marcius				
2	e	cedde	Chad, bishop of the Mercians (d. 672)	3
12	a	gregor'	Gregory the Great	9
25	g	anñciacō ma	Feast of the Annunciation	10
Aprilis				
4	g[d]	ambrosii	Ambrose (d. 397)	9
23	a	georgii	George	4
25	c	marcii	Mark	10
Mayius				
1	b	phelip ia	Philip and James	6
3	d	crucis	Holy Cross (Finding)	7
19	f	dunst'	Dunstan (d. 988)	7
26	f	aug'	Augustine of Canterbury	7
Iunius				
11	a	barnab'	Barnabas	10
17	g	botulf'	Botulph (d. *c.* 680)	2
24	g	Johis bap	John the Baptist (Nativity)	8
29	e	petri	Peter (and Paul)	8
Julius				
7	f	thome	Translation of St Thomas of Canterbury	6
20	e	marga	Margaret of Antioch (d. 304)	6
22	g	magdal[e]	Mary Magdalene	4
25	c	Iacob	James	8
Augustus				
1	c	petri	St Peter in Chains	4
10	e	laur'	Lawrence of Rome (d. 258)	10
15	c	marie	Assumption of Mary	8
24	e	barth	Bartholomew	9
29	c	joh	John the Baptist (Beheading)	3
Septemb-				
8	f	marie	Mary (Nativity)	9
14	e	crucis	Feast of the Cross	7
21	e	mathei	Matthew	9
29	f	mich	Michael(mas)	8

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TABLE 1.2 (*cont.*)

Date	Dominical Letter	Feast Day[a]	English Translation and Notes	Others[b]
October				
9	b	dionisii	Denis (d. *c.* 250)	9
18	d	luce	Luke	10
28	g	simonis iude	Simon and Jude	10
Novemb-				
1	d	omni scōrum	All Saints	8
11	g	mart'	Martinmas (Martin of Tours, d. 397)	9
23	e	clem'	Clement of Rome (d. *c.* 98)	1
30	e	andi'	Andrew	4
December				
6	d	Nichol'	Nicholas	7
8	f	mar'	Immaculate Conception of Mary	5
13	d	lucie	Lucy	4
21	e	thom'	Thomas	9
25	b	Nat' d'	Feast of the Nativity	9

[a] The transcription of feast names is as close as possible to what we see on the astrolabe. However, I have expanded some common superscript abbreviations (-ri and -ru-).

[b] The number of other (possibly) English astrolabes on which this appears (out of ten). The others are (1) Oxford, Museum of the History of Science 47869, 'the Painswick astrolabe' (#299 in the 'International Checklist of Astrolabes' first compiled by Price in 1955); (2) Chicago, Adler Planetarium M-26 (#200 = #295); (3) Cambridge, Gonville & Caius College Astrolabe B (#301); (4) London, British Museum 1914, 0219.1 (#298); (5) British Museum SLMathInstr.54, 'The Sloane astrolabe' (#290); (6) British Museum 1909, 0617.1 (dated 1326) (#291); (7) Liège, Musée de la vie Wallonne (#457); (8) London, Science Museum, inv. no. 1880–26 (#293); (9) Innsbruck, Tiroler Landesmuseen Ferdinandeum (#2579); and (10) Astrolabe formerly in a Belgian private collection, present location unknown but included in Georges Baptiste (ed.), *La mesure du temps dans les collections belges: Catalogue et sélection des pièces* (Brussels: Generale Bankmaatschappij, 1984), p. 37 (#4518). I am grateful to John Davis for sharing images of nos. 7, 8, and 9, and providing invaluable information about no. 10. See also Davis, 'Fit for a King', pp. 337–9.

[c] No date or dominical letter is given (the date of this feast is 2 February). The day appears to have been written 'pufiff', and the first 'f' subsequently changed to an 'r'.

[d] This seems to be a mistake: the correct dominical letter would be 'c'.

[e] Written 'magdat', and subsequently corrected.

eleven instruments, seven commemorate people or events named in the Bible; the last, St Lawrence, was a third-century holy man venerated across Europe. How were the remaining feast days selected? As a fairly large astrolabe, Wh.1264 had room for forty-six, more than

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most other instruments. Even so, none of its feasts is unique to it. This is probably because astrolabe-makers adhered closely to a small number of calendars that circulated in fourteenth-century England.

The source of saints' days in this period was the Sarum calendar, part of the liturgy instituted by the bishops of Salisbury in the eleventh century. This was adopted as the calendar of daily use across England in the late thirteenth century, and astronomers who compiled their own calendars were generally faithful to it.[24] In the fourteenth century the most notable of these were Walter of Elveden and especially, later in the century, John Somer and Nicholas of Lynn. The last two were both cited by Chaucer in his *Treatise on the Astrolabe*. Somer's calendar survives in at least thirty-three complete and nine partial copies, while there are twenty-one of Nicholas's.[25] These calendars name feasts for almost every day of the year, so it is not surprising that almost all the feasts featured on the astrolabes examined for this study were listed by both Somer and Nicholas.

It is likely that such calendars provided important source material for these astrolabes, though the calendars of Somer and Nicholas themselves, which both begin in 1387, were probably produced after Wh.1264. An astronomical calendar such as this would have been useful not only to provide the basic data of feast days, but also to draw out the precisely aligned Roman and zodiacal calendars which together produce a solar equatorium. Indeed, Davis has shown that it may be possible to identify the calendrical source of an astrolabe by comparing their values of solar longitude.[26] However, when it comes to the saints' days it is hard to propose a single source. Autograph versions of the calendars of Walter, Somer, and Nicholas do not survive, and the extant copies vary somewhat in their calendrical coverage. Yet there were almost certainly some saints, such as Botulph or Chad, which appear on Wh.1264 and other astrolabes but were not included in the manuscript calendars.[27] Thus we can observe the makers of these astrolabes exercising a degree of personal choice.

24 N. Morgan, 'The Introduction of the Sarum Calendar into the Dioceses of England in the Thirteenth Century', in M. Prestwich, R. Britnell, and R. Frame (eds.), *Thirteenth Century England VIII: Proceedings of the Durham Conference 1999* (Woodbridge: Boydell, 2001), pp. 179–206, on p. 184.

25 L. Mooney (ed.), *The Kalendarium of John Somer* (composed 1380) (Athens: University of Georgia Press, 1998), p. 18; and S. Eisner (ed.), *The Kalendarium of Nicholas of Lynn* (completed 1386) (London: Scolar Press, 1980).

26 Davis, 'Dating an Astrolabe from its Calendar Scales'.

27 They do not appear in the base manuscripts chosen by their modern editors, only in later copies.

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Botulph and Chad were also originally absent from the Sarum calendar. Botulph's feast of 17 June was added to the calendar in many dioceses, but Chad, who had been bishop of the Mercians in the seventh century (and was a patron saint of astronomers), was unlikely to appear in calendars outside the dioceses of Coventry, Lichfield, and Lincoln until around 1400. The see of Lincoln included Oxford, where both Somer and Nicholas were active at the end of the fourteenth century, but it appears that neither astronomer chose to honour this local saint. It seems Somer was working fairly uncritically from the Sarum calendar: despite dedicating his *Kalendarium* to Sts Francis of Assisi, Anthony of Padua, and Louis of Toulouse, he did not include any of their feast days in the calendar itself.

So it is clear that some calendars, and perhaps some parts of every calendar, were populated indiscriminately with saints chosen from a standard list. Even so, the question of choice is crucial – and is often ignored by historians intent on proving the sources of astrolabe data. Beyond the almost ubiquitous fixed feasts, from Epiphany to Christmas, astrolabe-makers had a free choice of what saints to include; most astrolabes include at least one somewhat obscure feast, such as Scholastica or Perpetua, that is unique to that instrument.[28] On what basis did makers exercise this choice? The basic calendrical function, marking out the regular passing of days across the year for reference purposes, was certainly a consideration; it was evidently critical to the maker of Gonville & Caius College Astrolabe B (who may have been Walter of Elveden himself); that astrolabe's calendar marks a consistent two feasts per month.[29] The author of the British Museum's Sloane Astrolabe appears to have made a special effort to include feasts on the first day of the month, achieving this in six months by marking such obscure celebrations as the Translation of St Remigius, and St Egidius's (Giles's) day.[30] Beyond this, though, it must simply have come down to personal devotional preference. If the maker of the Caius astrolabe had only been concerned to mark

28 St Scholastica's day (10 February) appears only on the Painswick astrolabe; St Perpetua's day (7 March) appears only on Science Museum inv. no. 1880–26.

29 This is the persuasive identification of Davis and Lowne, 'An Early English Astrolabe at Gonville & Caius College, Cambridge, and Walter of Elveden's *Kalendarium*'.

30 These two feasts also appear on astrolabes closely associated with the Sloane: Liège MVW and Science Museum 1880–26 (St Remigius is only on the former). Davis has made a close study of these three astrolabes, and suggests that Giles was a saint of particular interest to Richard de Bury, who may well have commissioned the Sloane astrolabe (Davis, 'Fit for a King', p. 343).

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passing time, he would surely not have omitted Christmas; doing so left space in December for Nicholas and Thomas the Apostle. Thus the regime of two feasts each month did not prevent this astrolabist from making individual choices. Very few astrolabes (and none of our eleven) have a maker's name attached to them, so we cannot know whether they were more often made by the person who wished to use them, or commissioned from a skilled craftsman. However, since demand was, until the fifteenth century, insufficient to create a livelihood for professional makers, it is most probable that these astrolabes were the product of the personal choices of the first astronomers to use them.[31]

In all but one case, they exercised their choice with the inclusion of some English saints. Ten of the eleven astrolabes used in this study include at least three saints who were English, or had a particular following in this country.[32] Sts Dunstan, Augustine of Canterbury, Thomas of Canterbury, Margaret of Antioch (whose unusually strong cult led to the dedication of fifty-eight churches to her in Norfolk alone), and George all appear on at least five out of those ten.[33] Among the English saints represented less often are Alban, Aldhelm, Alphege, Botulph, Cuthbert, King Edmund, King Edward the Confessor, Frideswide, Guthlac, Hugh of Lincoln, and Swithin.

To draw some conclusions about how the astrolabe-makers chose their saints, we should consider what information, beyond lists in calendars, they would have had about them. Whether based in the monastery or the university, the makers of these astrolabes would

31 A. J. Turner, *Early Scientific Instruments: Europe 1400–1800* (London: Sotheby's, 1987), p. 27.

32 The exception is the Adler Planetarium's M-26. It was identified as English (*c.* 1250) by the Websters in their 1998 catalogue (R. Webster and M. Webster, *Western Astrolabes* (Chicago: Adler Planetarium, 1998), p. 40), but its first cataloguer, M. Engelmann, suggested it was 'probably French' and from around 1550 (M. Engelmann, *Sammlung Mensing: Altwissenschaftliche Instrumente: Katalog* (Amsterdam: Muller, 1924), p. 26). Its split personality is such that R. T. Gunther included it twice in his *Astrolabes of the World* (pp. 348, 472): once as a French 'astrological astrolabe' and once as a fourteenth-century English instrument. In a recent reassessment (J. Davis, 'A Royal English Medieval Astrolabe Made for Use in Northern Italy', *Journal for the History of Astronomy*, 48 (2017), pp. 3–32), J. Davis concludes that it is English, but made (and later modified) for use in continental Europe.

33 On Margaret of Antioch, see D. Farmer, *The Oxford Dictionary of Saints* (Oxford: Oxford University Press, 2003) and Davis and Lowne, 'An Early English Astrolabe at Gonville & Caius College, Cambridge, and Walter of Elveden's *Kalendarium*', p. 273. St Thomas Becket is generally represented by his translation on 7 July; only one astrolabe also gives his martyrdom on 29 December.

almost certainly have read saints' lives as part of their education. Indeed, it is likely that they would have written some hagiography themselves, as an exercise in grammar and rhetoric which helped keep hagiographical practices alive. English saints would have been frequent subjects of these hagiographies, one of whose purposes was to promote local saints and their shrines. Through hagiography the faithful were encouraged to learn from the lives of the saints, and to imitate their exemplary actions. If hagiographies were, as Heffernan explains, 'a catechetical tool much like the stained glass which surrounded and instructed the faithful in their participation at the liturgy', we can see these astrolabes fulfilling the same function: an aide-memoire that encouraged the devout astronomer to meditate on the saints in heaven as he looked to the sky.[34] If we accept a link between hagiographies and the astrolabes, it is hardly surprising to see Dunstan on so many of the latter: four hagiographies were written in barely more than 100 years after his death (d. 988); the last of these, by Eadmer, was much copied and rewritten.[35] Likewise, the popularity of the hagiographies of Martin of Tours, by Sulpicius Severus and later Gregory of Tours, made it almost inevitable that he would appear on ten of the eleven astrolabes (indeed three feature him twice, including his translation on 4 July as well as the more familiar November Martinmas festival).[36] It is also tempting to suggest that the special associations of certain saints would encourage astrolabe-makers to choose them. For example, an astronomer making an astrolabe for didactic purposes might include St Catherine, the patron of education and scholarship; indeed, she features on eight of the eleven astrolabes in our group. And a maker with sore eyes after painstakingly engraving azimuths and almucantars with perfect precision might be tempted to choose St Lucy, who appears on five of the eleven, because of her power to intercede on behalf of those suffering from visual problems.

The Whipple astrolabe, and four others in this group, provide evidence for the cult of a saint whose popularity grew exponentially in the fourteenth century: St George. Increasingly revered in the

34 T. J. Heffernan, *Sacred Biography: Saints and Their Biographers in the Middle Ages* (Oxford: Oxford University Press, 1988), p. 6.

35 E. van Houts, 'Review of A. J. Turner and B. J. Muir (eds.), *Eadmer of Canterbury: Lives and Miracles of Saints Oda, Dunstan, and Oswald*', *English Historical Review*, 123 (2008), pp. 1515–16.

36 On the cult of Martin, see T. F. X. Noble and T. Head, *Soldiers of Christ: Saints and Saints' Lives from Late Antiquity and the Early Middle Ages* (London: Sheed & Ward, 1995), p. xxvi.

West after he was associated with the First Crusaders' victory at Antioch in 1098, George became a symbol of chivalry across Christendom.[37] Edward I of England, who had himself taken the cross, was a devotee, and he invoked George's support for what he saw as his crusade against the Welsh dragon by having George's red cross stitched onto the bracers and pennoncels of his soldiers.[38] The success of his campaigns against the Welsh led him to honour St George in peacetime too: in 1285 he gave gold figures of George and Edward the Confessor to the shrine of George at Canterbury. Still, it was not until the reign of his grandson Edward III (1327–77) that George took on a role as protector of the whole English nation; it was confirmed by his installation as the patron of the new Order of the Garter, founded in the late 1340s. It is an open question how far people identified with the kingdom or nation in the High Middle Ages, but insofar as there was a sense of belonging to a nation, George was strongly associated with that national sense.[39]

Of course, loyalties could be much more local. Margaret of Antioch, featured on Wh.1264 and six other astrolabes of our group, has already been mentioned as a saint with a particular local following in Norfolk. Another is St Clement, whose feast on 23 November appears only on the Whipple instrument and Gonville & Caius Astrolabe B. In a recent article, Davis and Lowne note that twenty-two of the twenty-four feast days on Caius B also appear in Wh.1264's longer list. Suggesting a close relationship between the two instruments, they point out that the great church at Terrington St Clement in Norfolk was built and refounded in 1348 by Edmund Gonville, the founder of what would become Gonville & Caius College and an associate of Walter of Elveden.[40] Likewise, they posit a link between the slightly unusual appearance of the beheading of John the Baptist (29 August) on both instruments and the depiction of that event in the painted stone bosses of Norwich Cathedral cloisters. If such precise localisation is not a coincidence, we should hardly be surprised to find that we land on consecrated ground.

37 D. S. Fox, *Saint George: The Saint with Three Faces* (Windsor Forest: Kensal, 1983), p. 63.

38 J. Good, *The Cult of St George in Medieval England* (Woodbridge: Boydell, 2009), pp. 52–8.

39 Good, *The Cult of St George*, pp. 4–5.

40 Davis and Lowne, 'An Early English Astrolabe at Gonville & Caius College, Cambridge, and Walter of Elveden's *Kalendarium*', p. 274.

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Conclusions

It is clear that astrolabes played a complex role in medieval culture: not only did they perform a staggering variety of functions; they could also be objects of prestige, aids to spiritual contemplation, and even, in the case of Peter Abelard and Héloïse, function as a name for a child.[41] In the case of the Whipple astrolabe, it is hard to imagine a purpose other than practical. Its medium size, large enough for precision and stability, but not too large to hold at arm's length, makes it ideal for observations. Its iconography is relatively spare: instead of lavishing attention there, its maker has saved his energy for the engraving of closely spaced almucantars and precisely marked eccentric calendars. Its astrological functions appear to have been expanded by the later addition of Great Houses. All in all, it is an extremely user-friendly device. That does not preclude its employment as a teaching tool, either by its first or subsequent users, and, of course, it is likely that its user had some kind of devotional motivation for his astronomical observations, just as its maker would have exercised personal devotional preferences in his choice of saints.[42] For what it is worth, it is reasonable to call it English: at least, it was certainly made for an Englishman. And a date in the middle of the fourteenth century fits with the metallurgical analysis, quatrefoil tracing, and eccentric calendar, as well as the choices of saints.[43]

Recent studies have shown that a combination of contrasting analyses can yield new insights even into much-studied instruments. Even though astrolabes have always been popular with researchers, there is certainly scope for new approaches that combine technologically advanced methods such as XRF, or the use of computer-aided design tools to analyse the geometry of their engraving, with more traditional tools of assessment such as palaeography, iconography, and textual analysis. There is also plenty more to be said about the backs of astrolabes. These remain rather ignored in studies,

41 Astralabe [*sic*], or (Petrus) Astralabius, was born to the famous lovers *c.* 1117–18. See P. Abelard, *Historia Calamitatum*, ed. J. Monfrin (Paris: Vrin, 1962), p. 74; and *The Letters of Abelard and Heloise*, trans. B. Radice (Harmondsworth: Penguin, 1974), pp. 285–7.

42 J. Bennett has noted how, at least in the early-modern period, instruments that started as observational might become didactic. See J. Bennett, 'Early Modern Mathematical Instruments', *Isis*, 102 (2011), pp. 697–705, on p. 698.

43 Davis has suggested that eccentric calendars fell out of fashion in England in the mid-fourteenth century (Davis, 'Dating an Astrolabe from its Calendar Scales', p. 3).

and illustrated catalogues all too often picture only the front of instruments, making it harder to survey astrolabe backs without examining instruments in person or commissioning expensive new photography.[44]

Museum visitors sometimes suffer in the same way. While some museums are able to display astrolabes in freestanding cabinets, or make creative use of mirrors so that both sides are accessible, in most cases only one side can be seen, and curators perhaps understandably opt to display the more visually arresting front. If astrolabes like Wh.1264 are to be reassessed by researchers, this should feed into museum practice; but it should also take account of recent work in museology and instrument studies, starting with what Ken Arnold and Thomas Söderqvist have called 'a more forthright concern with [instruments'] immediate presence'.[45] This would not be to succumb to what Jordanova scorned as 'childish awe',[46] but, as W. David Kingery has argued, 'the warm emotional and aesthetic content of objects should share the spotlight with their cold practical and cognitive aspects in a holistic approach to material culture'.[47] A museum of the history of science is always likely to privilege the technology over its context, but it is vital to show that both are changed by their interaction. If museums were to permit a more active engagement with astrolabes in their context, it might encourage scholars to pay less attention to the astronomical theories they demonstrated, and more to the varied ways, and reasons why, they were commissioned, made, and used in the Middle Ages.

44 Falk, 'Improving Instruments', pp. 46–76. Some recent articles by Davis, cited above, have paid new attention to the neglected backs.

45 K. Arnold and T. Söderqvist, 'Medical Instruments in Museums: Immediate Impressions and Historical Meanings', *Isis*, 102 (2011), pp. 718–29, on p. 718.

46 Jordanova, 'Objects of Knowledge', p. 40.

47 W. D. Kingery (ed.), 'Introduction' to *Learning from Things: Method and Theory of Material Culture Studies* (Washington: Smithsonian Institution, 1996), pp. 1–15, on pp. 4–5.