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THE SCIENTIFIC INSTRUMENTS IN HOLBEIN'S *AMBASSADORS*: A RE-EXAMINATION*

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The scientific instruments depicted in Hans Holbein's *Double Portrait of Jean de Dinteville, the Bailly of Troyes and Georges de Selve, Bishop of Lavaur,* more commonly known by the slight misnomer of *The Ambassadors* (Fig. 35), have received considerable attention from scholars. Irregularities have been noted in the times the instruments appear to indicate, as well as 'inaccuracies' in their construction. The general assumption has been that these discrepancies are intentional, lending support to an interpretation of the painting as an allegorical commentary on the religious and political events in Europe during the 1530s. Unfortunately, most descriptions of the scientific instruments have been flawed because they rely too heavily on inadequate secondary literature.

The current state of knowledge about these scientific instruments has advanced only slightly since Mary Hervey's study of the painting, published in 1900.[1] Although there is much of value in her work, later scholars have not taken sufficient account of the author's modest admission that she did not possess the required expertise to make any judgements about the instruments, nor have they noticed her reluctance to draw any firm conclusions about them. It is Hervey's work, despite these limitations, that serves as the iconographic touchstone for the painting and it is her tentative suggestions that hold sway. The aim of this paper, then, is two-fold: to re-examine the scientific instruments depicted by Holbein and to see if such an analysis can shed any additional light on his artistic or iconographic intentions.

THE GLOBES

THE TERRESTRIAL GLOBE. Of the two globes depicted in *The Ambassadors,* the terrestrial one has provoked more interest. Efforts have mainly been directed towards identifying the author and the date or state of the woodcut prints used to create the twelve, lozenge-shaped gores that make up the covering of the globe. Hervey suggested that the cartographic source of the terrestrial globe was related to a facsimile set of twelve woodcut gores manufactured during the nineteenth century and believed to be based on a lost terrestrial globe of 1523 by Johannes Schöner (see Fig. 36).[2] In general, the

* We should like to thank Susan Foister and Martin Wyld of the National Gallery for allowing us to study the painting during its recent restoration and for providing detailed photographs of the instruments with the old repaintings removed.

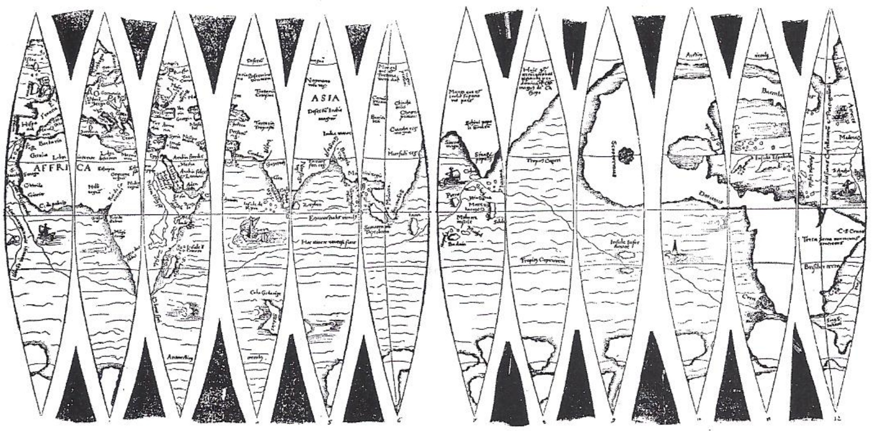
1. M. F. S. Hervey, *Holbein's 'Ambassadors': The Picture and the Men. An Historical Study,* London 1900.

2. Hervey (as in n. 1), pp. 210–18. The attribution to Schöner was first made in 1888 by C. H. Coote. See *Johann Schöner ... A Reproduction of his Globe of 1523 Long Lost,* ed. H. Stevens and C. H. Coote, London 1888. The facsimiles were published by the bookseller Ludwig Rosenthal during the 1880s. There are two copies in the National Maritime Museum in Greenwich

35. Hans Holbein, The Younger, *The Ambassadors*, 1533

attribution of the facsimile gores and, by extension, of the Holbein terrestrial globe to Schöner has slipped into the art historical literature on the painting without much notice of Hervey's warning that Adolf Eric Nordenskiöld, one of the pre-eminent nineteenth-century authorities on Renaissance cartography, had contested this attribution

(inv. no. GLB 0221 is a sheet of unmounted gores, and no. GLB 0033 is a set of mounted gores). There is a set of mounted facsimiles at the Yale University Library in New Haven, N.J., and another at the University Library in Helsinki; and unmounted sets exist in the British Library, the Österreichisches Nationalbibliothek in Vienna and the Bibliothèque Nationale in Paris (for references see A. D. Baynes-Cope, 'The Investigation of a Group of Globes', *Imago mundi*, XXXIII, 1981, pp. 9–19). In addition, there is a set of facsimile gores in the collection of Dr Rudolf Schmidt in Vienna. For an illustration, see Christie's exhibition catalogue, *The World in Your Hands*, London 1994, p. 22.



36. Sheet of unmounted facsimile gores for a terrestrial globe (c. 1880)

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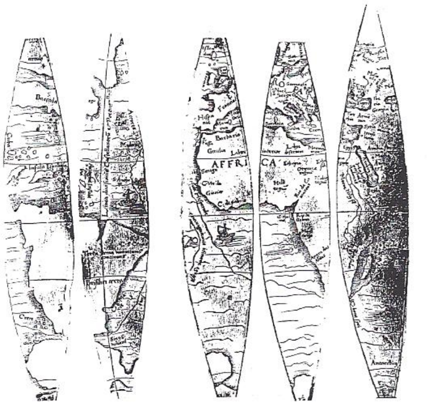
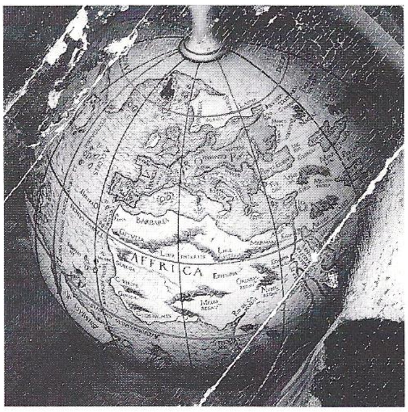
quite strongly.[3] Nordenskiöld argued that the Holbein globe could not have been based on an original terrestrial globe by Schöner for simple cartographic reasons.[4] Comparing the cartographic features of Schöner's terrestrial globes of 1515, 1520 and 1533, he noted certain fundamental discrepancies between the changing state of Schöner's cartographic knowledge and that conveyed by the author of the globe from which the nineteenth-century facsimiles—and, presumably, Holbein's globe—were copied. In particular, he pointed out differences in the western coastlines of North and South America and the introduction of the Pacific Ocean in the facsimile gores. Like many of his contemporaries, after 1523, when the results of Magellan's circumnavigation of the earth became known, Schöner appears to have believed that the Pacific Ocean was a large bay, with North America linked to Asia by a continuous land mass running from about 15°N latitude northwards to the pole.[5] The fact that the facsimile gores show a fully formed Pacific Ocean, in Nordenskiöld's view, eliminated the possibility that they were copied from a prototype by Schöner's hand.

3. See Hervey (as in n. 1), p. 211. The suggestion that these facsimiles are 'fakes' (see S. Foister, A. Roy and M. Wyld, *Making and Meaning: Holbein's 'Ambassadors'*, exhib. cat., National Gallery, London 1997, esp. p. 101 n. 19) is misleading. Furthermore, the proposal that the terrestrial globe used by Holbein might have been a manuscript original does not accord with the clear pictorial evidence (ibid.).

4. See A. E. Nordenskiöld, *Facsimile-Atlas to the Early History of Cartography, with Reproductions of the Most Important Maps printed in the XV and XVI Centuries*, English tr. J. A. Ekelöf and C. R. Markham, Stockholm 1889, repr. New York 1973, pp. 82–3 and pl. 40. Nordenskiöld believed that the Holbein globe was based on an original by the Nuremberg instrument-maker Georg Hartmann. At present, however, only three sets of globe gores can be securely attributed to Georg Hartmann, all of which post-date the painting by at least five years. For information and reproductions see P. van der Krogt, 'The Globe Gores in the Nicolai Collection', *Der Globusfreund*, XXXIII–XXXIV, 1989, pp. 99–116 (nos 3–5).

5. An attribution to Schöner is also dismissed by H. Harisse in *The Discovery of North America*, London and Paris 1892 (repr. Amsterdam 1961), pp. 519–28.





37a. (left) Sheet of unmounted gores for a terrestrial globe, 1556–60. New York, Public Library
37b. (right) Rotated detail of the terrestrial globe from Fig. 35 (during restoration)

In *The Ambassadors*, the western half of the globe is obscured. Most observers have supposed that, since the eastern hemispheres of the facsimile gores are so close to the visible eastern hemisphere of Holbein's terrestrial globe, the far side of his globe must also be similar and, therefore, the obscured half must include a depiction of the Pacific Ocean. Were this so, one would have to agree with Nordenskiöld that a terrestrial globe by Schöner is very unlikely to have been the original model for Holbein's globe.[6]

More recent evidence published by Baynes-Cope, however, might serve to undermine Nordenskïold's thesis. In his study of the nineteenth-century Schöner facsimiles, Baynes-Cope uncovered the only known, 'original' sixteenth-century version of these gores. Preserved in the New York Public Library, they are printed on paper bearing watermarks associated with the city of Nuremberg and can be dated to sometime between 1556 and 1560 (Fig. 37a).[7] Although these particular impressions obviously post-date Holbein's painting, they provide a somewhat clearer notion of what the 'original' set of gores of a lost Schöner prototype might have looked like.

A close examination of the cartography of the New York gores and of Holbein's terrestrial globe reveals that, contrary to scholarly opinion, Holbein's globe is far from identical to either the New York gores or their nineteenth-century copies. For example, in Holbein's globe (Fig. 37b) there are mountain ridges drawn in Europe and Africa

6. Not surprisingly, the current attribution of the globe among cartographers and art historians is usually rather vague and non-committal (such as, 'Anonymous, possibly from Nuremberg'). See e.g. R. W. Shirley, *The Mapping of the World. Early Printed World Maps 1472–1700*, London 1984, repr. London 1987, pp. 66–8.

7. See Baynes-Cope (as in n. 2), esp. p. 13; and E. L. Yonge, *A Catalogue of Early Globes. Made Prior to 1850 and Conserved in the United States*, New York 1968, p. 95.

that are not present in the New York copy. Another point worth mentioning is that the labels on Holbein's globe are nearly all written in majuscule. The labels on the New York Library gores (and the related nineteenth-century facsimiles) have initial capital letters, but the rest of the label is written in lower case.[8] Hervey suggested that the anomaly was the result of Holbein's intervention; but there are a number of other differences that are surely not due to artistic invention. For example, the label for 'TROPIC[US] CANCRI' is placed to the west of the continent of Africa; whereas, in the New York gores it appears to the west of the Americas. The label for the equator is not only spelled differently in the two exemplars (the New York label reads 'Equinoccialis circul[us]' and Holbein's 'AEQUINOCCIALIS CIRCUL[US]'), but is also placed in different locations (it appears below Africa in Holbein's globe and beneath India in the New York gores). And, as Hervey had previously noted, Holbein's version lacks the track showing Magellan's circumnavigation of the globe, which is included in the New York gores.[9]

What these small but significant differences show is that the New York version of the gores was printed from newly cut woodblocks and is not merely a later edition of the original gores depicted in Holbein's globe. This fact explains the absence of mountain ridges in the New York copy, as well as the absence of Magellan's track in the Holbein globe. Moreover, when the path of Magellan's voyage was introduced into the map by a later copyist, the positions of the labels for the equator and the Tropic of Cancer would have had to be changed because the track runs precisely through the locations where the labels had been placed in the earlier version of the gores. The form of the lettering was most likely changed at the same time. This new interpretation of the relation between the model of Holbein's globe and the New York gores reopens the possibility that the obscured hemisphere in Holbein's globe might be quite dissimilar to the New York gores and that it might have a depiction of the Pacific Ocean.

Although Holbein's globe is certainly drawn from a printed exemplar, its surface has been 'personalised' by the addition of the town of Polisy in manuscript to the map of France.[10] The appearance of this unusual feature led Hervey to the town of Polisy itself and her consequent discovery of the identity of the two figures in the painting. We know from an inventory of 1589 that the painting was hung at the château in the *'grand'salle'* [*sic*] of the first floor, but there are no records indicating when it left England for France.[11] Most commentators have assumed that it accompanied de Dinteville when he returned to his native France in November 1533, although he was posted to England three further times in his career—in 1535, 1536 and 1537.[12] Whatever the case, it seems likely that *The Ambassadors* was probably commissioned

8. See Hervey (as in n. 1), p. 212.

9. Ibid. Another difference is that the label 'BRISILICI R.' is painted on the equator near the northern coast of South America in Holbein's globe, while 'Brisilici terra' is shown below the Tropic of Capricorn in the New York gores.

10. See Hervey (as in n. 1), p. 212. One point that has not been commented on, however, is the fact that, since the terrestrial globe has been depicted upside-down, the town of Polisy has been misplaced so that it lies to the north-east (and not the south-east) of Paris.

11. The 1589 inventory records 'Ung Grand tableau ou sont en puintz les feuz Sieurs de Polisy & dauxerre'. See *Making and Meaning* (as in n. 3), p. 101 nn. 19, 31.

12. See Hervey (as in n. 1), pp. 66–98, 100–3, 105–7, 108–10 respectively.

specifically for the château at Polisy. If this is true, it raises a series of intriguing questions about the intended viewers of the painting, which, by extension, might serve to focus future enquiry concerning its iconography and overall 'meaning' towards France and away from England.

THE CELESTIAL GLOBE. The second globe in the painting has received less attention and, consequently, there has been less speculation on its manufacture. Hervey claimed, simply, that 'it is not known from what original this globe was copied'.[13] Recent research into the production of celestial globes during the first decades of the sixteenth century, however, allows us to conclude that Johannes Schöner is definitely the author of Holbein's celestial globe.

Like its terrestrial counterpart, the celestial globe in *The Ambassadors* was copied from one whose surface decoration was constructed from twelve paper woodcut gores. The medium of the original blocks can be determined by the shape of the stars depicted on the globe. According to the system introduced by Ptolemy in the first century, astronomers most often classified the brightness of a star according to six varying magnitudes.[14] In drawings or in copper-engraved prints, the variation in magnitude is expressed pictorially with different star-like symbols. The less responsive nature of wood, however, meant that stellar markings were reduced to only two magnitudes. In Albrecht Dürer's woodcut celestial planispheres of 1515, for example, the majority of the stars are marked with simple circles, and only a few of the brightest stars are set apart with a six-point starry symbol (Fig. 38).[15] The reduced markings of the stars in the celestial globe in *The Ambassadors* are a sure sign, therefore, that the original globe was covered with woodcut gores. As with the Dürer planispheres, most of the stars on Holbein's celestial globe are indicated by simple circles, and a select number of the brighter stars are marked with starry symbols: the bright star in *Corona Borealis* (α CrB), in *Lyra* (α Lyr), in *Cygnus* (α Cyg) and in the square of *Pegasus* (α Peg, β Peg, γ Peg and α And). Johannes Schöner is the only globemaker practising during the early sixteenth century known to have produced woodcut celestial globe gores.[16]

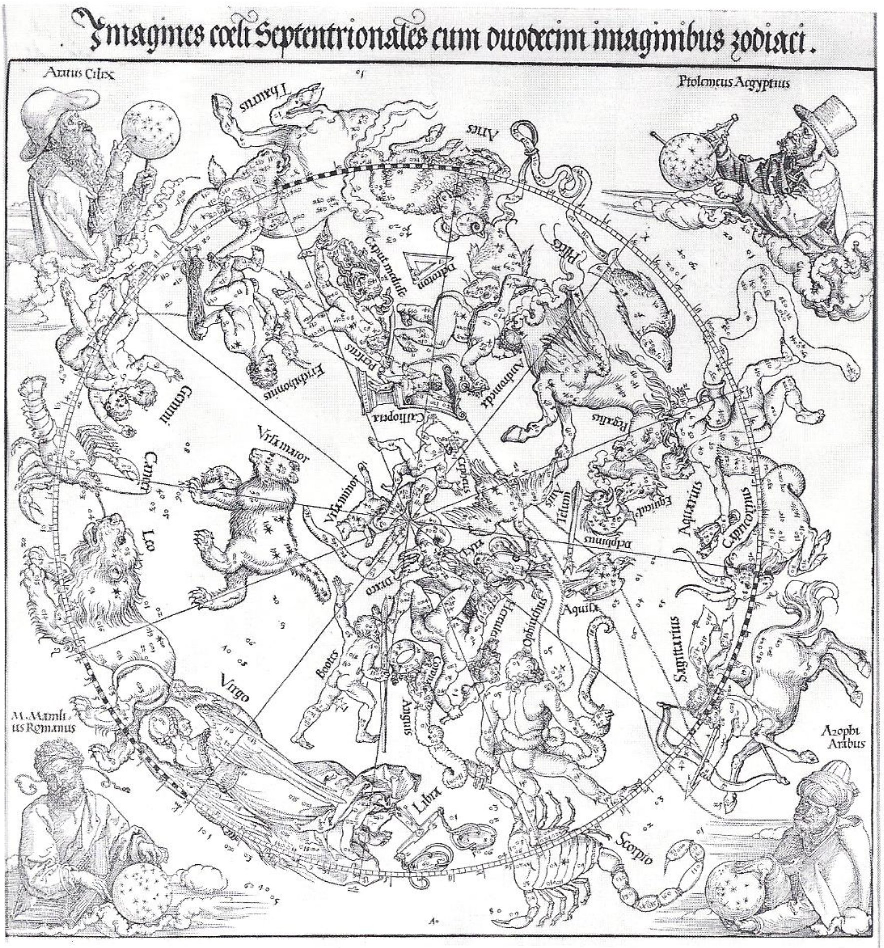
Additional comparisons between Holbein's celestial globe and Schöner's work all support the idea that the celestial globe used by Holbein was made by Schöner. Four sets of Schöner's celestial globe gores are known. Two were discovered at Wolfegg

13. Ibid., p. 210.

14. See Claudius Ptolemaeus, *Syntaxis mathematica*, VII.4. For an English translation see *Ptolemy's Almagest*, tr. and annotated by G. J. Toomer, London 1984, pp. 16, 339.

15. Dürer's map is frequently described in the literature. For the astronomical/astrological importance of the drawing of the map, see W. Voss, 'Eine Himmelskarte vom Jahre 1503 mit den Wahrzeichen des Wiener Poetenkollegiums als Vorlage Albrecht Dürers', *Jahrbuch der Preussichen Kunstsammlungen*, LXIV, 1943, pp. 89–150; F. Saxl, *Verzeichnis astrologischer und mythologishcher illustrierter Handschriften des lateinischen Mittelalters. Die Handschriften der National-Bibliothek in Wien*, Heidelberg 1927, pp. 19–40. See D. J. Warner, *The Sky Explored: Celestial Cartography 1500–1800*, New York 1979, pp. 71–5. It is tempting to suggest that this difficulty in differentiating the star magnitudes was the impetus towards using copper-plate engraving for celestial globe gores.

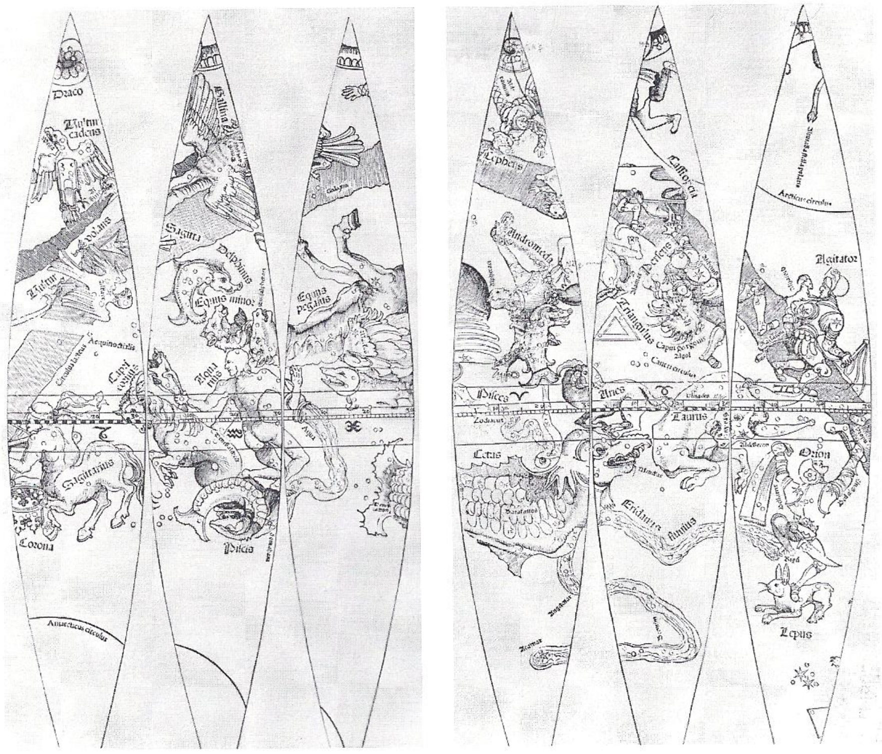
16. Schöner is known to have produced celestial woodcut globes from 1515 onwards. For additional information see K. Pilz, *600 Jahre Astronomie in Nürnberg*, Nuremberg 1977, p. 182; and P. van der Krogt, *Globi Neerlandici: The Production of Globes in the Low Countries*, tr. E. Daverman, Utrecht 1993, pp. 30–3.



38. Albrecht Dürer, Conrad Heinfogel and Johann Stabius, *Northern Celestial Hemisphere*, 1515.

Castle, in a collection of maps once owned by Schöner.[17] Both these sets of gores are incomplete and may have been early proofs. One seems to have been discarded as it was used as part of the binding material for the maps; and the other lacks the lines of

17. The gores form part of the Wolfegger Sammelband in the collection of the late Count Max Willibald, Fürst zu Waldburg-Wolfegg. The volume was discovered by Josef Fischer, S.J., in the library of Wolfegg Castle in 1901. For additional information see J. Fischer and Fr. R. von Wieser, *Die älteste Karte mit dem Namen Amerika aus dem Jahre 1507 und die Carta marina aus dem Jahre 1516 des M. Waldseemüller (Ilacomilus)*, Innsbruck 1903, pp. 1–5. We should like to acknowledge the kindness of the late Count Max



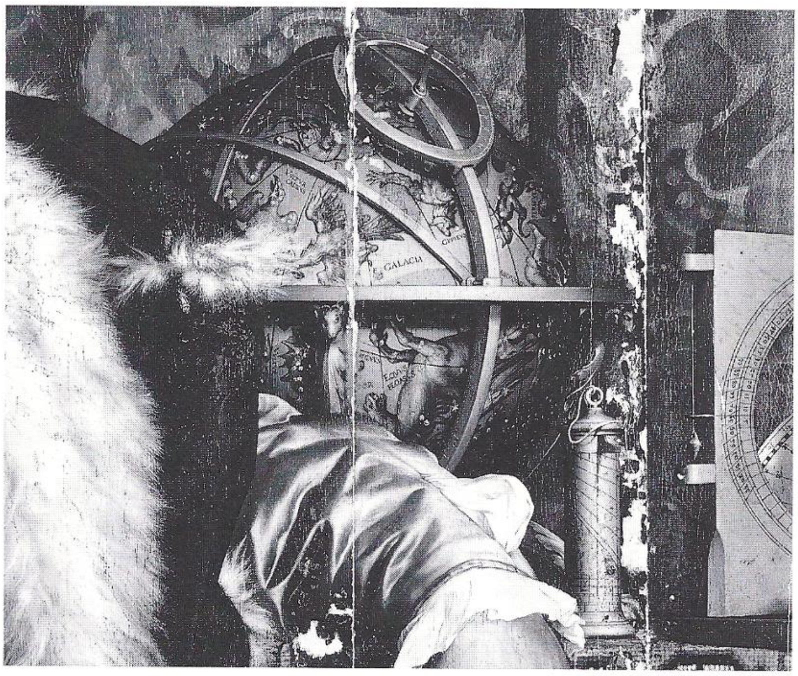
39. Johannes Schöner, unmounted gores for a celestial globe, c. 1515
a. (left) the constellations of *Cygnus* (labelled *Gallina*), *Pegasus* and the Milky Way (labelled *Galaxia*)
b. (right) the constellations of *Andromeda, Cassiopeia* and *Perseus*

the equator and the tropics (Fig. 39),[18] although labels are included for these circles. The third and fourth sets have been mounted on globes of approximately 28 centimetres in diameter, on stands which bear the dates 1534 and 1535.[19] Although there are minor differences among the four versions, in most respects there is agreement between them. All were printed from woodblocks, and all conform to the Schöner-type

Willibald, Fürst zu Waldburg-Wolfegg for allowing us to study the gores in the Wolfegg Sammelband, and to thank the foundation Kunstsammlungen der Fürsten zu Waldburg-Wolfegg for permission to publish reproductions of them.

18. For reproductions of an example of both sets of gores see E. Harris, 'The Waldseemüller World Map: A Typographic Appraisal', *Imago mundi*, XXXVII, 1985, pp. 30–53, fig. 6.

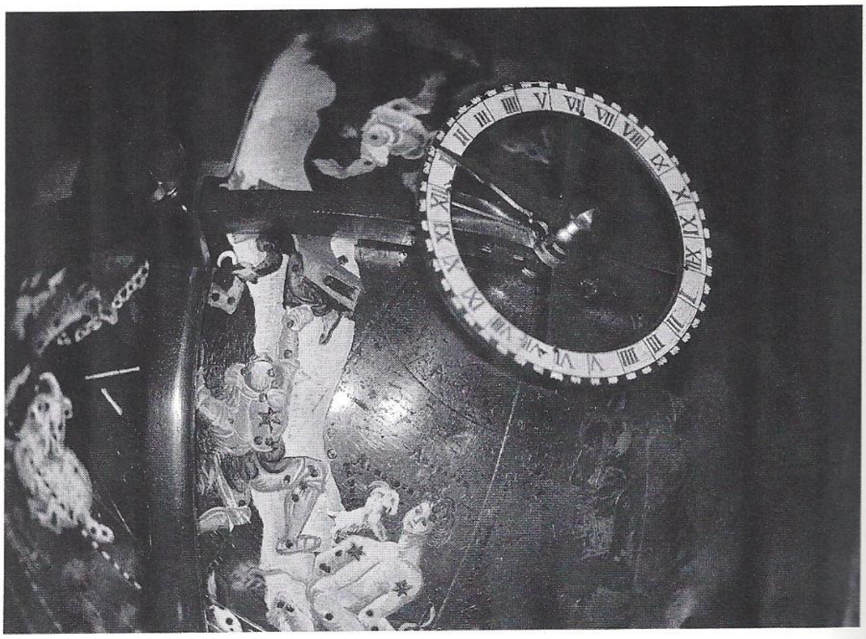
19. The globe whose stand is dated 1534 is in the Herzogin Anna Amalia Bibliothek in Weimar; for a description see the entry by E. Dekker in *Focus Behaim Globus*, exhib. cat. (Nuremberg, Germanisches Nationalmuseum), Nuremberg 1992, II, pp. 524–5, no. I.22.a. The other globe is in the Science Museum in London; for a reproduction see *The World in Your Hands* (as in n. 2), p. 20.



40. Detail of the celestial globe from Fig. 35 (during restoration)

style and iconography for the constellations. If one compares the stars and the figures depicted in the gores with those on the surface of the celestial globe in Holbein's painting (Fig. 40), the resemblance is striking. The globe in *The Ambassadors* shows ten constellations very clearly—*Hercules, Draco, Lyra, Cygnus, Delphinus, Pegasus, Cepheus, Cassiopeia, Andromeda* and *Perseus*—a sufficient number to preserve several telling details which can be used to tie the globe specifically to Schöner. On all of the Schöner gores, for example, the outstretched hand of *Perseus* is empty (traditionally, Perseus holds the *caput Medusa* in one hand and his sword in the other—as in Dürer's 1515 star chart [Fig. 38]). For the sixteenth century, this detail is unique to Schöner's work, and it reappears in Holbein's celestial globe. Similarly, in Schöner's work, *Cassiopeia* sits on a very tall throne with an object shaped like a sickle and a spiked crown on her head. On the celestial globe in *The Ambassadors*, the spiky crown, sickle-shaped implement and the unappealing visage are all faithfully portrayed. Another constellation which ties Holbein's globe to Schöner's original gores is the figure of *Cygnus*, the swan, depicted as a hen.[20]

20. For further information regarding the depiction of *Cygnus* as a hen see nn. 27–9 below.



41. Celestial globe, copied from a globe by Johannes Schöner, forming the central part of a planetary clock restored by Oronce Fine, c. 1525–50. Paris, Bibliothèque Sainte-Geneviève

Yet the similarity between Schöner's globe gores and Holbein's celestial globe breaks down when it comes to the labelling of the constellations. As can be seen in Appendix I below, the constellation names agree with Schöner's unmounted gores of 1515; but all of Holbein's labels use capital letters for these names (as one sees in Schöner's 1535 globes), while the 1515 gores use a combination of lower and upper case letters. This is not the sort of intervention one would expect from an artist copying a globe. A very similar use of capital letters is seen on the globe set on top of a planetary clock modified by Oronce Fine in 1553 (Fig. 41).[21] This 'Paris globe' is generally believed to date from c. 1550, but stylistic comparisons with other globes suggests that a date of c. 1525 is more likely. It is so close to the 1515 Schöner gores that only they could have been the cartographic source.[22] For example, the 'Paris globe' depicts

21. See D. Hillard and E. Poulle, 'Oronce Fine et l'horloge planétaire de la Bibliothèque Sainte-Geneviève', *Bibliothèque d'humanisme et Renaissance*, XXXIII, 1971, pp. 311–34.

22. The celestial globe is described in detail by M. Destombes, 'Oronce Finé et son globe céleste de 1553', *Actes du XIIe Congrès International d'Histoire des Sciences, Paris 1968*, Paris 1971, X, A, pp. 41–50 [repr. in *Marcel Destombes (1905–1983): Selected Contributions to the History of Cartography and Scientific Instruments*, ed. G. Schilder, P. van der Krogt and S. de Clerq, Utrecht 1987, pp. 391–400]. Destombes makes the unexpected (and unfounded) suggestion that the globe should be attributed to Fine himself (p. 396).

only two magnitudes of stars; *Perseus* and *Cassiopeia* follow the Schöner model; and one of the *Gemini* in the Paris globe holds the extremely rare attribute of a violin—following Schöner's iconographic formula.[23] Indeed, when compared with Holbein's celestial globe, the Paris globe provides an exact match in most respects. The similarity between the two gives added strength to the suggestion that there was another version of Schöner's gores that postdates his 1515 set and that this lost globe served as the model for both the Paris globe and for Holbein's rendering.[24]

Having suggested a more likely provenance for Holbein's celestial globe, it is worth examining some of the assumptions that have been proposed concerning its iconography. In her study, Hervey drew attention to the figure of a chicken or rooster, near to which appears the label 'GALACIA'. She believed that this figure represented 'the cock, a very ancient device of France'.[25] More recently, J. D. North has described the figure as 'the constellation Cygnus marked as "Galacia", looking distinctly cock-like, and symbolising France'.[26] Both scholars argue that Holbein positioned the celestial globe in order to highlight the bird, which symbolises the homeland of the 'ambassadors'. The identification of the cock as a symbol of France is certainly common, and the possibility that Holbein situated the globe in order to highlight the French origin of the painting's patron can not be denied. Nevertheless, the arguments which have been used to support this interpretation rest on two significant misunderstandings.

The constellation of *Cygnus*, the swan, has a rather tortured iconographic history due to a series of mistakes made by over-zealous translators in a number of languages. When the constellation reappears in the Latin West via the Arabic translations of Ptolemy's *Syntaxis mathematica*, it does so in a number of peculiar disguises: as a swan (the text generally describes the bird as 'olor' or 'avis'); as a lily ('lilium'); and as a hen ('gallina').[27] The illustrations of *Cygnus* during the fourteenth, fifteenth and sixteenth centuries vary equally widely, showing the constellation as a nondescript flying bird, a bird posed according to a heraldic formula with its wings outstretched and its claws drawn up towards its body, a rooster, and a hen with a brood of small chicks (Fig. 42).[28] Further contaminations in the iconography of *Cygnus* occur due to a confusion between

23. For a reproduction of the *Gemini* on Schöner's globe see E. Dekker and P. van der Krogt, *Globes from the Western World*, London 1993, p. 28, pl. 5.

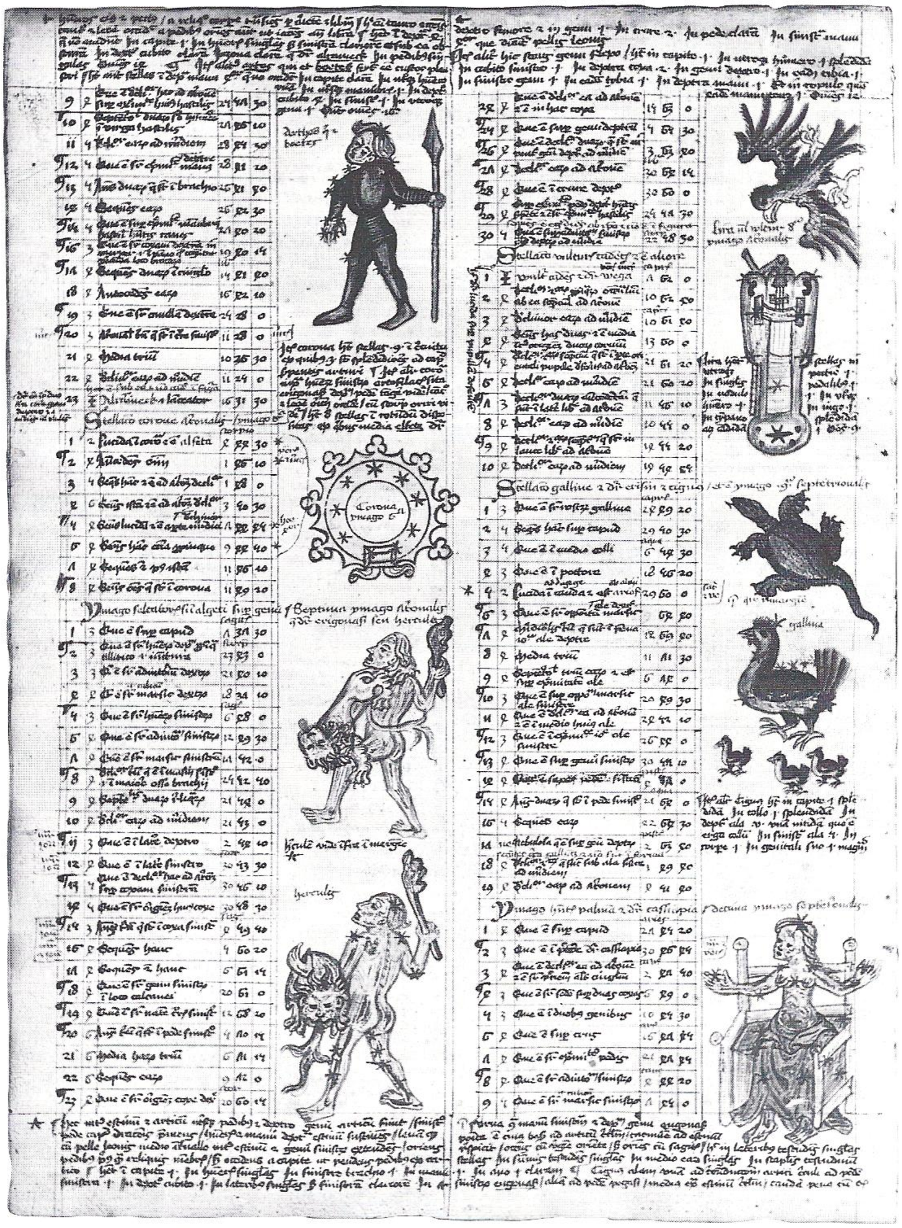
24. It is possible that the Wolfegg Sammelband gores (Fig. 39) were test-pieces, or proofs of an edition that was never printed. In which case, there would be only two versions of the globes: (1) the example used in the Holbein painting and in the Paris globe; and (2) the mounted copies in London and Weimar, in which the style of the lettering has been changed.

25. See Hervey (as in n. 1), p. 210: 'Astrology apart, however, the central position is awarded to "Galacia", the cock, a very ancient device of France ... It seems to symbolize the onslaught of France upon her foes, and their ultimate downfall and flight'.

26. See J. D. North, 'Nicholas Kratzer: The King's Astronomer', *Science and History: Studies in Honour of Edward Rosen*, ed. E. Hilfstein et al. (Studia Copernicana, XVI), Ossolineum 1978, pp. 205–34; repr. in J. D. North, *Stars, Minds and Fate: Essays in Ancient and Medieval Cosmology*, London 1989, pp. 373–400 (see esp. p. 393).

27. For additional information see L. Ideler, *Untersuchungen über der Ursprung und die Bedeutung der Sternnamen. Ein Beytrag zur Geschichte des gestirnten Himmels*, Berlin 1809, pp. 74–6; and K. Lippincott, 'The Astrological Vault of the *Camera di Griselda* from Roccabianca', this *Journal*, XLVIII, 1985, pp. 43–70, esp. p. 51 and pl. 12a, b (illustrating the Roccabianca vault and the 15th-century manuscript, Vatican City, Biblioteca Apostolica Vaticana MS Urb. lat. 1399, fol. 36^{r}).

28. More than half the illustrations of the Latin manuscripts related to Ptolemy's stellar tables show



42. *Cygnus* as *Gallina* with chicks, with three versions of *Lyra* above and *Cassiopeia* below. Fifteenth century. Vatican City, Biblioteca Apostolica Vaticana MS Pal. lat. 1368, folio 51v

this constellation and the stellar asterism of the *Pleiades*, which is also sometimes represented as a hen with chicks, as well as with the nearby constellations of *Lyra* and *Aquila*.[29] For example, there is a peculiar development in which the image of the turtle's shell of Mercury's lyre (for *Lyra*) contaminates the iconography of *Cygnus* so that the constellation is shown as a shell-less turtle—looking remarkably like an overweight mouse.

In his 1515 gores, however, Schöner illustrates *Cygnus* as a heraldic rooster and clearly labels it as 'GALLINA'. The idea that Holbein, when he wrote 'GALACIA', might have either made a mistake in the transcription of *gallina* or was making a pun on *Gallia*, overlooks the fact that the label on his globe actually belongs to another, adjacent structure, namely, the Milky Way or, as it was most commonly known during the Renaissance, *Galaxia*—the Galaxy. In Schöner's gores, for example, the Milky Way is labelled as 'Galaxia'. Strictly speaking, therefore, the hen appears on the celestial globe primarily as an iconographic variant of the constellation *Cygnus*, while the label 'GALACIA' belongs to the Milky Way. This is not to deny the possibility that the figure itself has been highlighted in order to make a punning reference to France; but it is important to note that nothing on the surface of the globe has been manipulated in order to do so.

As a celestial globe could be used to solve certain astrological problems, Hervey's suggestion that the one depicted by Holbein has been positioned in such a way that it records a specific time and date seems plausible.[30] Indeed, many scholars, following Hervey's lead, have argued that the time and date recorded by the globe are essential to any true understanding of the painting. Yet, while it is true that semi-circles of position on a globe can be used to determine the boundaries of the zodiacal houses, the orientation of Holbein's celestial globe has been misunderstood. The meridian ring of the globe has a scale, as was common during the period, that is numbered twice: once for the angular distance from the north pole (counting 0° to 90° from the pole) and once for the latitude (counting 90° to 0° from the pole). The horizon ring of the globe intersects the scale of the meridian ring at 42° counted from the north pole and 48° counted from the equator. Since the latitude of a location on Earth equals the angle between the local horizon and the northern celestial pole, we can see that

Cygnus as a hen or rooster. See Lippincott (as in n. 27), p. 51.

29. The illustrations in the stellar tables found in the 15th-century manuscript of Prosdocimo de' Beldomandi's *Opere* (Oxford, Bodleian Library MS Can. misc. 54, fol. 51^{v}) show *Cygnus* in four variations: as a hen eating grain; as a heraldic cock; as the *Pleiades* (seven young girls); and as six fish. Two other 15th-century stellar tables (Vienna, Österreichische Nationalbibliothek MS lat. 5318 and Catania, Biblioteca Comunale MS 87 [int. 87]) also illustrate a text that reads: 'stellatio crisin [*sic*] et est volans et iam vocatur gallina et crisin [*sic*] quasi redolens ut lilium ab yrco', with pictures of heraldic birds and the seven *Pleiades*. (Somewhat different forms of the text are cited by Ideler, as in n. 27, pp. 74–5.) For additional information on the confusion between *Cygnus* and the *Pleiades* see A. Le Boeuffle, *Le Noms latins d'astres et de constellations*, Paris 1977, p. 124. Since, as seen above, *Cygnus* is also described as 'volans', it is often confused with *Aquila*, which is also referred to as 'vultur volans'. For the confusion between *Lyra* and *Cygnus* see Lippincott (as in n. 27), p. 51 n. 43. The description of this constellation as a 'Lyre Bird' (see *Making and Meaning*, as in n. 3, p. 36) is without precedent—ancient or modern.

30. See Hervey (as in n. 1), p. 210.

Holbein's celestial globe has been set to indicate the terrestrial latitude of 42°N, which, according to contemporary tables, was the latitude of Rome.[31] This small piece of information is important as it undermines any suggestion that the globe in Holbein's painting has been positioned in order to indicate a date that is particularly significant with regard to a sojourn of 'the Ambassadors' in London. The globe is not set to reflect a London sky. It reflects a sky over Rome. In trying to interpret this fact, one might argue that a reference to Rome and, by implication, the Vatican, was included as an allusion to the primacy of the Catholic Church. Alternatively, it is possible that whoever set the globe in its stand inadvertently used the complementary scale on the meridian ring. If this is the case, then the intended latitude was 48°N—the latitude of Paris and, more importantly, of de Dinteville's home town of Polisy. Either way, the positioning of the celestial globe further undermines the idea that the iconography of *The Ambassadors* is wholly concerned with sixteenth-century English politics.

The time that the globe represents can be reckoned by consulting the hour circle, which encompasses the north pole of the globe. The hand is set for the afternoon or *post meridiem*, and reads precisely 2 hours and 40 minutes p.m.[32] Another significant feature that helps to determine the date for which the globe is set is the constellation of *Pegasus*, which is positioned just below the line of the horizon, with the star α Peg barely emerging from beneath the meridian ring. By combining these various factors, one can determine that the celestial globe in *The Ambassadors* represents the afternoon sky of 12 July (old style) at 2:40 p.m. (see Appendix II). Whether or not this fact is significant has yet to be proved; but it is unlikely that the globe refers to the horoscope of either of the sitters, as de Dinteville was born on 21 September 1504 and de Selve is said by Hervey to have been 'born in the winter or early spring of 1508–09, probably January or February'.[33]

THE DIALS

There are four dialling instruments depicted in *The Ambassadors*: (from left to right) a pillar or shepherd's dial; a universal equinoctial dial (disassembled into two parts); a horary quadrant with straight hour lines; and a polyhedral dial. Most of the dials are shown with the shadow of their pointers (gnomons) falling on a particular spot on the time-scales of the instruments. Although *The Ambassadors* displays the interior of a room,

31. In Johannes Stöffler's treatise, *Elucidatio fabricae ususque astrolabii*, Paris 1568, p. 10^r (in the 'Tabula regionum'), the latitude for Rome is listed as 42°. Although the 1568 edition is a late version of the text, the information in the tables remains unaltered from the first edition of 1513. The suggestion that Holbein could have relied on a drawing or engraving as the basis for his celestial globe (see *Making and Meaning*, as in n. 3, p. 37) underestimates the intricacies involved in pictorially re-orienting a two-dimensional rendering of a globe to depict a specific latitude setting.

32. The scale of the hour circle is twice 0–12 hours, which means that when the pointer is on 12 it can indicate either noon or midnight. When the hand points from the north pole towards the zenith—as it does in the Holbein painting—the 12 should be read as indicating noon.

33. See Hervey (as in n. 1), pp. 36, 143. North's suggestion, that the globe might reflect the birth of the future Queen Elizabeth I (7 September 1533), seems equally unlikely. See North (as in n. 26), p. 393 n. 89. Unfortunately, many of North's suggestions (see below, p. 125 n. *) were reiterated by L. Jardine, *Worldly Goods: A New History of the Renaissance*, London 1996, p. 428.

and the question of how a sundial might function in such a setting has never been addressed, most scholars believe that the times depicted by the various dials are, somehow, significant to and consistent with the overall meaning of the painting. By examining each of the dials in detail, the problems inherent in this proposal become slightly more clear.

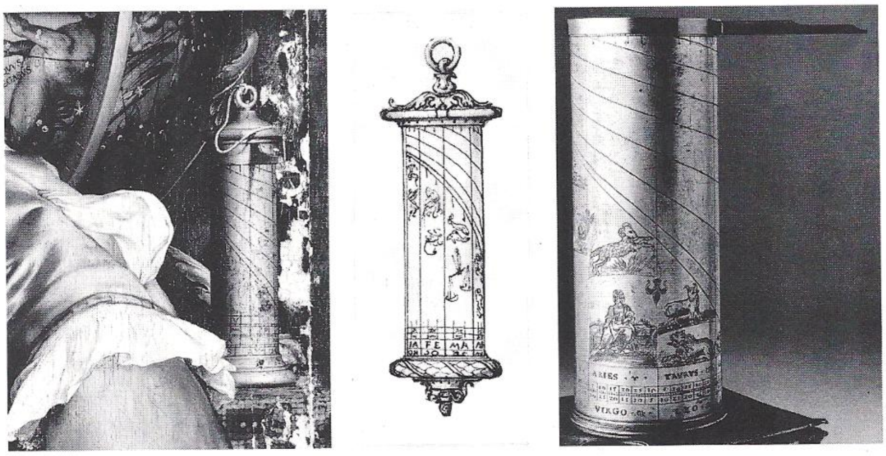
THE PILLAR DIAL. The simplest of the group is the pillar dial, named after its pillar-like shape. This instrument is also known as a cylinder dial, chilinder, shepherd's dial, a poke dial (because it was often small enough to be carried in one's pocket) and a *horologium viatorum* (Fig. 43a).[34] The cylinder of the dial is hollow, the bell-shaped cap can be removed, the protruding gnomon (or pointer) detached and slipped into the body, and the cap repositioned to stop the gnomon from falling out. Along the bottom, there is a grid representing the path of the sun along the zodiac throughout the course of the year, and the curving lines along the body of the dial echo the curving arc of the sun's shadow at the same hours for different times of the year. In Holbein's painting, two small figurative drawings of the zodiacal signs of *Aries* and *Virgo* can be seen, placed above two symbols or glyphs for these signs. If it were possible to turn the dial, no doubt one would see ten other zodiacal signs paired so that their arrangement is symmetrical with respect to the solstitial colures. The same applies to the calendar scale beneath these signs. Thus, starting from the winter solstitial colure, *Capricorn* is paired with *Sagittarius*, *Aquarius* with *Scorpio*, *Pisces* with *Libra*, *Aries* with *Virgo*, *Taurus* with *Leo* and *Gemini* with *Cancer*. From *Capricorn* to *Gemini*, the signs are arranged and the scale is numbered from left to right; from *Cancer* to *Sagittarius*, both the signs and the scale are ordered in the opposite direction. This change reflects the fact that the apparent motion of the sun from summer to winter (*Cancer* to *Sagittarius*) is the reverse of that from winter to summer (from *Capricorn* to *Gemini*).

Whereas most pillar dials do not bear figurative decoration, these sorts of illustration are by no means rare. One might cite Holbein's own drawing of a pillar dial in which the signs of the zodiac are illustrated with small figurative drawings arranged in pairs: *Capricorn/Sagittarius*, *Aquarius/Scorpio*, *Pisces/Libra* and *Aries/Virgo* (Fig. 43b).[35] A further example, the gilt brass dial from Augsburg, dated c. 1550, in the Science Museum in London (Fig. 43c), is also pictorially quite similar to Holbein's dial.[36]

34. For additional information about pillar dials see L. Thorndike, 'Of the Cylinder called the Horologe of Travelers', *Isis*, XIII, 1929–30, pp. 51–2; C. Kren, 'The Traveler's Dial in the Middle Ages: The Chilinder', *Technology and Culture*, XVIII, 1977, pp. 419–35; A. J. Turner, 'Sun-dials: History and Classification', *History of Science*, XXVII, 1989, pp. 303–18; A. A. Mills, 'Note: Altitude Sundials for Seasonal and Equal Hours', *Annals of Science*, LIII, 1996, pp. 75–84, esp. p. 83, fig. 8; and M. Arnaldi and K. Schaldach, 'A Roman Cylinder Dial: Witness to a Forgotten Tradition', *Journal of the History of Astronomy*, XXVIII, 1997, pp. 107–17. A similar, but not identical, pillar dial appears in Holbein's *Portrait of Nicolaus Kratzer* on the shelf mounted on the wall behind the sitter (see Fig. 45 and the discussion of other 'shared' dials below).

35. London, British Museum, inv. no. 5308-148. See J. Rowlands, *Drawings by German Artists and Artists from German-Speaking Regions of Europe in the Department of Prints and Drawings in the British Museum. The Fifteenth Century, and the Sixteenth Century by Artists born before 1530*, London 1993, I (catalogue), p. 158, and II (plates), pl. 220, no. 35.

36. London, Science Museum, inv. no. 1883-124. We thank Neil Brown and Giles Hudson for their assistance in securing a photograph of this dial. Also



43a. (left) Detail of the pillar dial from Fig. 35 (during restoration)
43b. (centre) Hans Holbein, The Younger, drawing of a pillar dial. London, British Museum
43c. (right) Gilt brass pillar sundial from Augsburg, c. 1550. London, Science Museum

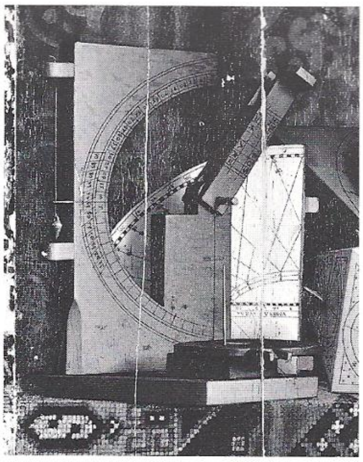
Although there have been suggestions as to what date and time might be indicated by the dial, two insurmountable obstacles stand in the way of a definitive reading. A pillar dial needs to be set so that its gnomon lines up vertically with the sign in which the sun is located at that particular time of year. The gnomon in Holbein's painting is placed for a date coinciding with the sun's position at either the end of *Aries* / beginning of *Taurus* or the beginning of *Virgo* / end of *Leo*—that is, either for the date 10 April or 15 August respectively. But with a pillar dial, unlike a globe, there is no way of knowing which of these two dates might be the right one.[37] Notionally, that information is held only by the person who set the dial.

A second curiosity of the pillar dial is the manner in which the shadow of the gnomon falls on the cylindrical surface of the dial. Time-reckoning with a pillar dial is possible only when the gnomon is directed towards the sun, so that the shadow falls absolutely parallel with the body of the instrument. In Holbein's painting, not only does the shadow fall obliquely across the body of the dial but the tip of the shadow seems to curl as it falls down the length of the body. It is a nice visual conceit that serves to heighten the sense of the dial's curved surface; but, unfortunately, it also defies the laws of optics. It could be said that the end of the shadow falls on the line that indicates either 9:00 a.m. or 3:00 p.m.;[38] however, it would be impossible to argue with any

worth mentioning is the 16th-century brass pillar dial in the Germanisches Nationalmuseum, inv. no. WI 34. For a reproduction see the entry by 'J.W.' (Johannes Willers) in *Focus Behaim Globus* (as in n. 19), II, p. 616, no. 1.100.

37. North (as in n. 26), p. 393 n. 89, is incorrect in his statement that the pillar dial has been set for the vernal equinox (that is, around 10 March).

38. Dickes offers the bizarre suggestion that the dial is actually reading 10:30 p.m. See W. F. Dickes,



44. Detail of the dismantled universal equinoctial dial with the horary quadrant behind it, from Fig. 35 (during restoration)

conviction that this sundial is recording the natural phenomena of a particular time of day. If Holbein meant to indicate a specific time, he has done so only by undermining an essential principle of how dials work.

THE UNIVERSAL EQUINOCTIAL DIAL. To our knowledge, there is only one scholar who has managed to decipher the mechanics of this dial (Fig. 44). Peter Drinkwater was the first to recognise that the dial in *The Ambassadors* is made up of two parts that have not been re-assembled.[39] The part of the dial that is shown vertically, with its plumb line steady along one side, has two scales which serve for adjusting the dial to a particular geographical latitude. What is missing, however, is the dial itself, or the circular piece which can be seen lying flat on the table in front, skewered by some sort of 'letter, bill or copy spike'.[40] The same instrument reappears in Holbein's *Portrait of Nicolaus Kratzer*—still mysteriously dismantled—with the body of the dial perched on the shelf

Holbein's Celebrated Picture, now called 'The Ambassadors' shown to be a Memorial to the Treaty of Nuremberg, 1523; and to Portray those Princely Brothers, Counts Palatine of the Rhine, Otto Henry (The Magnanimous) and Philipp (Defender of Vienna), who shared the Government of the Duchy of Neuberg, and dying, closed the 'Elder Churfurst Line', London 1903, esp. p. 26).

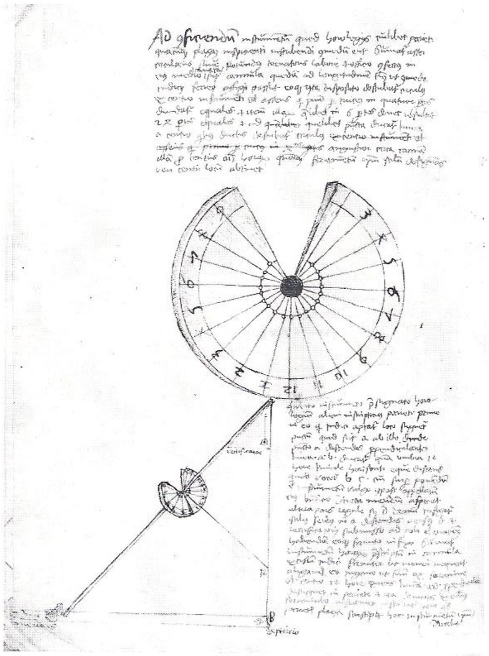
39. See P. I. Drinkwater, *The Sundials of Nicholas Kratzer*, Shipton-on-Stour 1993, esp. pp. 7–9. Previous scholars, unaware of the dial's dismantled state, have been at a loss to explain how it might work; see e.g. E. Zinner, *Deutsche und niederländische astronomische Instrumente des 11.-18. Jahrhunderts*, Munich 1956 (enlarged edition Munich 1967 with a reprint of the 2nd edition in 1979), p. 210; M. Bobinger, *Alt-Augsburger Kompaßmacher. Sonnen-, Mond- und Sternuhren. Astronomische und mathematische Geräte. Räderuhren*, Augsburg 1969, p. 77; and North (as in n. 26), p. 392. The passages concerning this dial in *Making and Meaning* (as in n. 3), pp. 35–6, show no understanding of Drinkwater's descriptions or arguments, although his articles are cited.

40. See Drinkwater (as in n. 39), p. 7.

45. Hans Holbein, The Younger, *Portrait of Nicolaus Kratzer*, after 1528

behind Kratzer and the dial skewered again on the table in from of him (Fig. 45).[41] In order to function, the circular piece slides on to the pivoted, square arm of the main body and intersects with the curving arc of its scale; and, when the dial is correctly assembled, it functions as a universal equinoctial dial, or an equinoctial dial that is usable at all latitudes. In principle, the time is found by the shadow of the appropriate edge of the square arm of the dial plate. Its disassembled state indicates, however, that it is not intended to tell the 'time'.

41. The difference between the two dials are minor. For example, in the *Portrait of Nicolaus Kratzer*, the other side of the body is depicted. The original version of this painting is in the Louvre (inv. no. 1343) and is dated 1528. There is a close, near-contemporary copy in the National Portrait Gallery (inv. no. NPG 5254). For additional information see P. Ganz, *The Paintings of Hans Holbein*, London 1950, p. 233, pl. 85, cat. no. 48; or J. Rowlands, *Holbein. The Paintings of Hans Holbein the Younger. Complete Edition*, Oxford 1985, pp. 134–35, colour plate 19 and pl. 59, cat. no. 30.



46. Oxford, Corpus Christi College Library MS 152, fol. 10v. A universal equinoctial dial used as a 'dial-maker'

Two pressing questions remain. First, why is the dial shown disassembled? And second, is the dial of Kratzer's own invention?

In Holbein's *Portrait of Kratzer*, the sitter is shown with an unfinished dial in his hand. One possible reading of this image is that it has been included as an 'attribute', used to convey Kratzer's devotion to the art of making dials. The inclusion of the disassembled equinoctial dial in the painting certainly supports this idea. It does not explain, however, why the disassembled equinoctial dial reappears in *The Ambassadors*, unless perhaps one assumes that Holbein was unaware of how this dial worked and thought that the way he had painted it in his portrait of Kratzer indicated the form in which it was intended to be used. Another possibility is that the dial may be disassembled to show it being employed in the laying out of the other dials, such as the pillar dial and the horary quadrant.[42] The fact that the basic principles underlying the design of equinoctial dials made them suitable for laying out other dials was well known to Kratzer. On folio 10r of his notebooks, preserved in the library of Corpus Christi College, Oxford, there is a drawing of an instrument which looks like an equinoctial dial set on a sliding indicator (Fig. 46). The noon mark of the dial lies in the north-south plane

42. See Drinkwater (as in n. 39), p. 9, n. 3.

47. Universal equinoctial dial used as a 'dial-maker' from a mining compass. German, c. 1600. Prague, National Technical Museum

of the meridian and, at the base of the instrument, is a small diptych dial, which echoes the larger dial's structure.

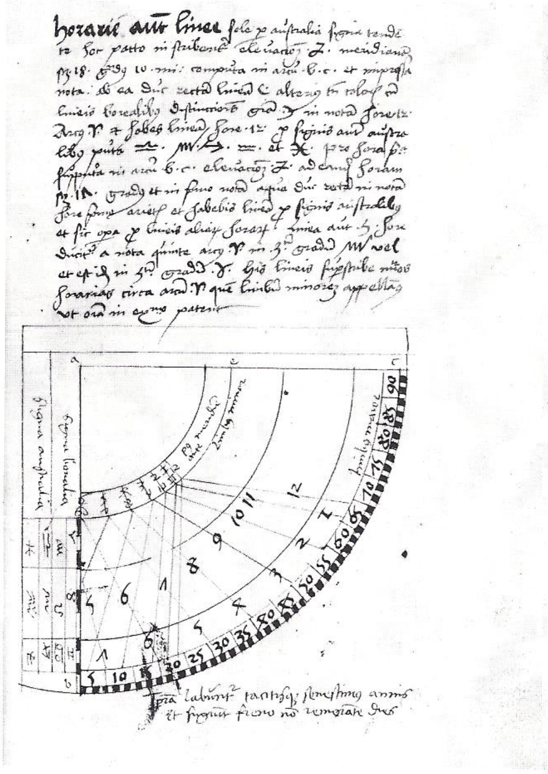
Whatever Holbein's intentions in depicting the equinoctial dial, it is certain that constructions of this sort were not unique to Kratzer. A similar instrument, for instance, is illustrated in the decorative engravings on the underside of the case of a German mining compass dating from about 1600 in the National Technical Museum in Prague (Fig. 47).[43] Beyond this, there were more elaborate ways of using an equinoctial dial to construct other dials than the simple device recorded in Kratzer's notebook. With the help of the sight attached to the upper end of the square arm and the pivotal peg at its bottom end, the sun could be sighted and its altitude measured at any latitude and for any time of day during the year. In this way, it was possible to collect all the information necessary to calibrate time-telling devices.

THE HORARY QUADRANT. The quadrant shown in *The Ambassadors* has two sights on its vertical side and a graduated border, with hour lines marked by Arabic numerals along the inner limb and Roman numerals along the outer limb (Fig. 44). Inside the inner border, there is a so-called 'shadow square', labelled 'VMBRA VERSA'. Drinkwater correctly identified this instrument as a horary quadrant with straight lines, also known as the *horarium bilimbatum*.[44] The horary quadrant with straight lines seems to have been developed during the first quarter of the sixteenth century.[45] It appears on an

43. Inv. no. 24,961. For a description and illustration of the dial see Z. Horský and O. Škopová, *Astronomy Gnomonics. A Catalogue of the Instruments of the 15th to the 19th Centuries in the Collections of the National Technical Museum, Prague,* Prague 1968, esp. p. 152 (no. 168) and pl. XLIII.

44. See Drinkwater (as in n. 39), p. 11. Curiously, North identified the instrument as a meteoroscope, a quadrant used for making trigonometric calculations. See J. D. North, 'Werner, Apian Blagrave and the Meteoroscope', *British Journal for the History of Science,* III, 1966, pp. 55–65; and idem (as in n. 26), p. 390 n. 2. The quadrant in *The Ambassadors* is clearly an observing instrument (witness the presence of the sights) and not a calculating instrument.

45. During the Middle Ages, there were essentially two types of quadrant in use: the *quadrans vetus* and the *quadrans novus.* A systematic study of the development of the quadrant has yet to be written, but a discussion of the *quadrans vetus* appears in R. Lorch, 'A Note on the Horary Quadrant', *Journal for the History of Arabic Science,* V, 1981, pp. 115–20; and there is a discussion of the *quadrans novus* in E. Dekker, 'An Unrecorded Medieval Astrolabe Quadrant of c. 1300', *Annals of Science,* LII, 1995, pp. 1–47.



48. Oxford, Corpus Christi College Library MS 152, folio 92r. A horary quadrant with straight lines

exceptional navigational chart drawn by the Spaniard Diego Ribero in 1529,[46] but was first published by Sebastian Münster in 1531 and by Oronce Fine in Paris in 1532.[47] A rough drawing of a similar horary quadrant manufactured for the latitude of approximately 47° appears among Kratzer's sketches in Oxford, Corpus Christi College Library MS 152, folio 92r (Fig. 48).[48]

In *The Ambassadors*, the horary quadrant has been set on its side and, therefore, does not appear as a scientific instrument in use. Moreover, the quadrant seems to have its sights on the 'wrong' side. By reading the varying sets of scales, one can see

46. For a reproduction see Shirley (as in n. 6), pp. XXIV–XXV, pl. 6.

47. See S. Münster, *Compositio horologiorum*, Basle 1531; and O. Fine, *Protomathesis. Opus varium...*, Paris 1532. An attractive later version of such a dial by Christoph Schissler, dated 1599, is preserved in the Museo di Storia della Scienza in Florence; for an illustration see *Storia delle scienze. I: Gli strumenti*, ed. G. L'E. Turner, Turin 1991, p. 204.

48. The similarity was first noticed by Drinkwater (as in n. 39), p. 11.

that the sights are set into the straight side from which the scales begin their numbering (i.e., where the graduation of the scales starts with 0°). In order to use the scales and hour lines as shown on this face of the quadrant, the sights would have to be on the other vertical side of the instrument, or on the straight side, that is, the side upon which the instrument rests. One explanation is that the sights visible in Holbein's dial are actually intended for use with a set of hour lines and scales on the reverse side of quadrant. As several contemporary diallists advocate using both sides of a quadrant to experiment with different types of dialling methods, such a solution seems possible.[49] The horary quadrant with straight lines is latitude dependent; but the intersections of the hour lines with the scale on the outer limb of the quadrant is not sufficiently well drawn in *The Ambassadors* to determine the latitude for which this instrument was intended.

THE POLYHEDRAL DIAL. The most remarkable of the dials in Holbein's *Ambassadors* is the polyhedral dial placed on the front edge of the table between the two sitters (Fig. 49). The dial is clearly depicted with three of its sides prominently displayed, each of which contains a gnomon whose shadow falls directly on the surface of a legible scale. Of all the instruments, the polyhedral dial seems to provide the best prospect for the representation of a specific time within the painting. Unfortunately, however, like all the other instruments in *The Ambassadors*, the polyhedral dial, while revealing quite a bit of information, does not tell the time.

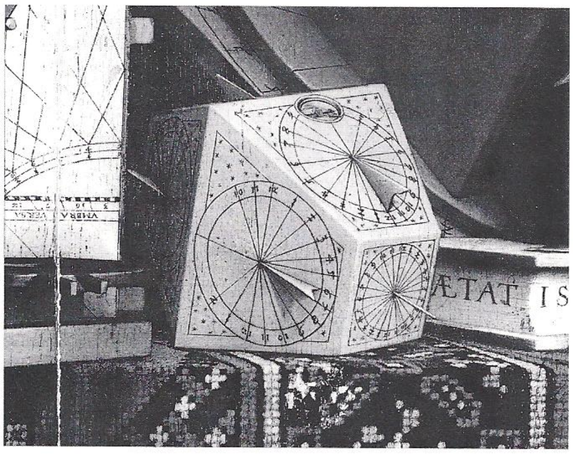
In general, multi-facetted sundials (of which polyhedral dials form a sub-set) are masterworks, scientific instruments designed to show off the skill of their makers. Multi-facetted dials are not uncommon. Indeed, two such dials have been associated with the hand of Nicolaus Kratzer, the putative owner of many of the instruments included in *The Ambassadors*: a brass multi-facetted dial bearing the arms of Cardinal Wolsey for the latitude of 51°N in the History of Science Museum in Oxford;[50] and the so-called 'Acton Court Polyhedral Sundial', which is signed 'NK' and dated 1520.[51]

There are several aspects of the Holbein's polyhedral dial, however, that are problematic. For instance, the times 'told' by the three visible faces of the dial seem to differ. The dial with the pin gnomon and the upper sloping surface of the dial (with an inset compass) both read 10:30, whereas the shadow on the face of the dial on the left-hand side of the instrument clearly points to 9:30. This discrepancy raises two questions: are the different illuminated sides of Holbein's dial meant to be read together; and do the various dials all record time using the same or different hour-systems? In order to

49. We are most grateful for this suggestion, made by Peter Drinkwater in a private communication.

50. For an illustration and descriptions see L. Evans, 'On a Portable Sundial of Gilt Brass made for Cardinal Wolsey', *Archaeologia*, LVII, 1901, pp. 331–4; North (as in n. 26), pp. 387–8; P. Pattenden, *Sundials at an Oxford College*, Oxford 1979, esp. pp. 14–15; and W. Hackman, 'Nicholas Kratzer: The King's Astronomer and Renaissance Instrument-Maker', in *Henry VIII: A European Court in England*, ed. D. Starkey, London 1991, esp. pp. 70–3 (V.15).

51. See G. S. J. White, 'A Stone Polyhedral Sundial dated 1520, Attributed to Nicholas Kratzer and Found at Iron Acton Court, near Bristol', *Antiquaries Journal*, LXVII, 1987, pp. 372–3; and *Henry VIII* (as in. n. 50), p. 124 (VIII.1).

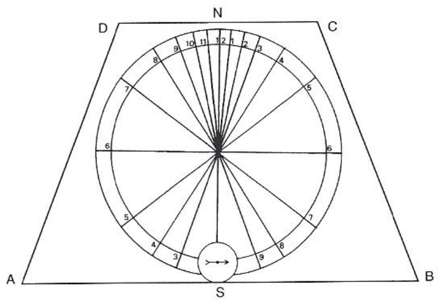


49. Detail of the polyhedral dial from Fig. 35 (during restoration)

answer either of these questions, it is necessary to examine the way in which the dial has been constructed.

The first feature to note is how the hour lines on the foremost, square surface of the dial (the face with the pin gnomon at its centre, closest to the viewer) are arranged. The even spacing of the lines, similar to the manner in which the hours on a clock-face are arranged, in combination with a pin gnomon set perpendicular to the dial's surface, reveal that this dial is to be used as a simple equinoctial dial when the surface is placed parallel to the equatorial plane. This means that, in order for this face of Holbein's polyhedral dial to work, it must be set so that the central axis of the truncated pyramids is aligned with the pin gnomon pointing towards the north pole. Further, the hour line for 12 o'clock must lie true to the plane of the local meridian. Once the dial is properly set up in this fashion, each of the styles, or edges of the gnomons, of the dial's other faces will also lie parallel to the north-south polar axis, that is, parallel to the pin gnomon of the square equinoctial face. This fact tells us that Holbein's dials are each telling the time in equal hours (or *horae communes*).

Whereas the lines themselves all seem to demonstrate a similar splay, the numbering of the lines differs between the visible sides. On the top plane (with the compass), the number 12 sits at the top of the gnomon. On the dial facing left, the number 6 sits at the top of the gnomon and two figures of 12 appear attached to hour lines perpendicular to the gnomon. In other words, between the two faces, the numbering has shifted by 90°. This is exactly what one would expect if the dial faces are to be used simultaneously to tell the time on the different planes. For, when the dial is properly set up, the gnomon of the square equinoctial dial and the gnomon plane of the dial with the compass are parallel to the meridian plane through the north-south direction and the north pole. In contrast, the gnomon planes of the dial faces adjacent to the one with the compass are parallel to the plane through the east-west line and the north



50. Diagram showing the correct splay of the hour-lines for the uppermost surface of the polyhedral dial and depicting the placement of the compass needle as it ought to have been shown in *The Ambassadors* (© E. DEKKER)

pole. Since the 12-hour line is always located in the meridian plane, it coincides with the orientation of the gnomon on the square equinoctial dial and the gnomon plane on the dial with the compass; however, on the dial faces adjacent to the one with the compass, this line is perpendicular to the orientation of the gnomon plane. As the numbering on the two visible adjacent sides confirms, this multi-facetted dial has been constructed so that, when it is properly set up, all dials tell the same time—regardless of their relative orientation to the sun.

Another feature of the polyhedral dial was uncovered only during the painting's recent restoration. When all traces of over-painting had been removed, the small compass in the dial's upper surface suddenly became more legible. One can now see that its pointer is set so that it runs more or less horizontally within the picture plane or perpendicular to the direction in which the dial's gnomons are set. Were further evidence needed, this fact proves beyond doubt that the dial is not 'telling' the time, as the first step towards orienting a dial in order to read the time is to set the gnomons parallel to the polar axis. The compass pointer clearly shows that the north-south axis of Holbein's studio runs along the length of the table; hence the dial is placed with its gnomons sitting east-west. None of its surfaces, therefore, could possibly be recording a specific time.

In addition to its orientation, there is something else wrong with the polyhedral dial.[52] It appears that the splay of hour lines on the side planes does not agree with the basic rules of plane dialling. The splay of hour lines depends on the angle between the dial plane and the polar axis. In an equinoctial dial, this angle is—by definition—90°, and that is why the splay on the top plane of the dial is evenly spaced, like the hour markings on the face of a clock. When the angle between the plane and the polar axis decreases, the splay changes. For the side planes of the polyhedral dial in Holbein's painting, for example, the hour lines should be more heavily grouped towards the tip of the gnomon (Fig. 50).[53] The fact that the side planes are marked with evenly splayed

52. The following explanation is based on that of Drinkwater (as in n. 39), but the authors wish to thank him for additional information he has offered to us both orally and by letter.

hour lines reveals that, clever as it might be in inspiration, in practice the dial would not work. The same, of course, applies to the polyhedral dial depicted in the *Portrait of Nicolaus Kratzer* (Fig. 45).[54]

THE TORQUETUM. The torquetum, at the far right of the painting (Fig. 51), is an interesting instrument for Holbein to have included in his composition. The body of the instrument is slightly obscured from the viewer; nevertheless, its structure is clear.

The origins and use of the torquetum are still a matter of debate. We possess two medieval descriptions: one written by Franco of Poland, dated 1284; and a sketchier account supplied by Bernard of Verdun, which, although undated, was probably written sometime during the second half of the thirteenth century.[55] It has been impossible to determine which of these two accounts is the earlier. Nor has it been possible to confirm or deny the supposition that the torquetum is an instrument of Arabic origin, beyond an assertion by the fifteenth-century astronomer Johannes Regiomontanus associating the instrument with the twelfth-century astronomer from Seville, Jābir ibn Aflah, known to the Latin West as 'Geber'.[56] There is no evidence that the torquetum originated in the Arabic world; indeed, even the Arabic sources are surprisingly mute

53. The orientation of the polar axis is fixed by the pin gnomon on the top plane. Since the side of the square base of the truncated pyramid is roughly twice the length of the lines forming the top side, one can calculate that the side planes are inclined from the polar axis by an angle close to 21°. This is consistent with the small angle of the gnomons of the side planes.

54. The suggestion that this dial has been 'designed for North Africa' (see *Making and Meaning*, as in n. 3, p. 35) is based on the observation that the inclination of the dial corresponds with a southerly latitude, but fails to account for the fact that the splay of hour lines would render the dial useless at such a latitude. Had the splay been correct, the dial could have been used at any latitude. All that is needed is an accessory for setting the pin gnomon in the meridian plane, directed towards the north pole. It is worth pointing out that the image of a 'compas' mentioned in Jean de Dinteville's letter to his brother François of 23 May 1533, an instrument over which he claims to be puzzled, was not a magnetic compass (as suggested in *Making and Meaning*, as in n. 3, p. 35), but a sundial ('Je vous prie m'envoyer le portraict du compas auvale duquel m'avez escript; car je suis bien empesché à comprendre la façon de laquelle il est fait'; cited by Hervey, as in n. 1, p. 80). The term compass (or *Kompasz*) is regularly used from about 1480 onwards to refer to a portable sundial containing a compass. In particular, Schöner, Apian and Münster used the word with this connotation. This sort of term would, of course, include diptych dials, cruciform dials or polyhedral dials, such as we see in *The Ambassadors*. For a discussion see P. Gouk, *The Ivory Sundials of Nuremberg, 1500–1700*, Cambridge 1988, p. 9.

55. For additional information see R. T. Gunther, *Early Science in Oxford*, Oxford 1923, II, pp. 35–6 and 370–5; L. Thorndike, 'Franco de Polonia and the Turquet', *Isis*, XXXVI, 1945–6, pp. 6–7; E. Poulle, 'Bernard de Verdun et le turquet', *Isis*, LV, 1964, pp. 200–8. The first printed description, largely based on the account of Franco of Poland, was published by the Carthusian monk Gregor Reisch, in his *Margarita philosophica*, Strasbourg 1512. For a reproduction of the woodcut illustrating Reisch's instrument see J. Bennett and D. Bertoloni Meli, *Sphaera mundi: Astronomy Books 1478–1600. A 50th Anniversary Exhibition at the Whipple Museum of the History of Science*, Cambridge 1995, p. 46, fig. 47.

56. See R. P. Lorch, 'The Astronomical Instruments of Jābir ibn Aflah and the Torquetum', *Centaurus*, XX, 1976, pp. 11–34, esp. p. 32. Lorch's study clarifies what Hartmann had suspected in 1919: 'Soll sich der Hinweis Regiomontans auf dieses [Jābir's astronomical instrument] als die Urform des Torquetums beziehen so muss das Instrument in der Zwischenzeit erheblich umgestallet worden sein' (see J. Hartmann, 'Die astronomischen Instrumenten des Kardinals Nikolaus Cusanus', *Abhändlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen, Math.-Phys. Klasse*, n.s. x.6, 1919, pp. 3–56, esp. 9–10). We should like to thank Richard Lorch for his correspondence concerning our questions about the torquetum.

on the topic. Weak support for an Arabic origin of the instrument comes from the fact that the earliest Latin form of the name, *turquetus*, was later translated into the German *Türkengerät*, indicating that the instrument was believed to have come to the Latin West via the 'Turks'.[57]

There are also disagreements about how the instrument was used. One school of thought (following Emmanuel Poulle) maintains that the torquetum is not a genuine observational instrument, but instead 'a mechanical solution to simultaneous readings of co-ordinates in the three principal planes to which they refer: the equitorial, the ecliptical and the horizontal'.[58] In contrast, Zinner and Lorch consider the torquetum to be an instrument specifically designed to meet the demands of Ptolemaic astronomy and its concentration on the determination of the position of a star or planet in terms of its ecliptical longitude and latitude.[59] This is why the torquetum has a disc representing the ecliptical plane; and why the two sighting vanes, or alidades, move parallel or perpendicular to this plane. In order to obtain ecliptical measurements by direct observation, however, the astronomer needs to correct, or rectify, the instrument to take account of the daily equatorial movement of the sky above the observer's local horizon. Hence, the torquetum has another disc representing the equatorial plane, which is constructed so that it can be turned (*torquere*) in order to adjust the ecliptical plane to the night sky. It is this essential function of the torquetum that was noticed by Regiomontanus and helps to explain why he changed its name from *turquetus* to the more descriptive *torquetum*.[60]

Most early notations on the use of the torquetum seem to support the view that the primary purpose of the instrument was observational. For example, Franco of Poland recommends the torquetum for finding the positions of the stars and planets and for verifying the Toledan Tables—updated versions of the stellar tables found in Ptolemy's *Almagest*.[61] Both of these tasks are observational. The French astronomer John of Murs, writing in 1318, mentions the torquetum in his defence of the reliability of observational astronomy.[62] Peter of Limoges claims to have used it for his observations of the comet of 1299, and that of 1301, now known as 'Halley's Comet'.[63] Paolo Toscanelli

57. See Zinner (as in n. 39), p. 177. Lorch, in a private communication, has claimed that there is no ground for this belief. See also Poulle (as in n. 55), p. 204: 'On sait que le terme même de turquet est resté inexpliqué, les étymologies qui ont été proposées relévent de la fantasie'.

58. '... une solution méchanique aux lectures simultans des coordonnées dans les trois plans principaux auxquels elles sont rapportées, l'equitorial, l'écliptique et l'horizontal.' E. Poulle, *Les Instruments astronomiques du moyen âge*, Paris 1967 (repr. Oxford 1983), p. 33. See also idem (as in n. 55), p. 205. We have been unable to find any record predating 1530 that supports Poulle's idea that the instrument can be or was used in a number of co-ordinate systems; nor does he provide any such evidence in his own publications. Nevertheless, his opinion reappears in a number of works; see e.g. O. Pedersen, 'Astronomy', in D. C. Lindberg, *Science in the Middle Ages*, Chicago 1978, pp. 322–3. See also n. 66 below.

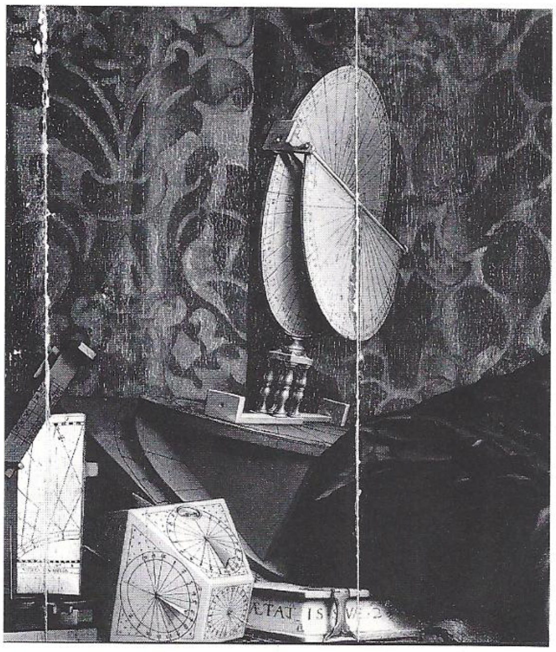
59. See Zinner (as in n. 39), pp. 177–83; and Lorch (as in n. 56).

60. See Poulle (as in n. 55), p. 203; and Zinner (as in n. 39), p. 177.

61. See Gunther (as in n. 55), pp. 374–5. On the Toledan Tables see G. J. Toomer, 'A Survey of the Toledan Tables', *Osiris*, XV, 1968, pp. 5–174.

62. See L. Thorndike, *A History of Magic and Experimental Science*, New York 1934, III, pp. 295–6, citing Paris, Bibliothèque Nationale MS 7281, fol. 160r. It is not clear from the text cited whether John used the torquetum himself.

63. See L. Thorndike, 'Peter of Limoges and the Comet of 1299', *Isis*, XXXVI, 1945, pp. 3–6; idem,



51. Detail of the torquetum from Fig. 35 (during restoration)

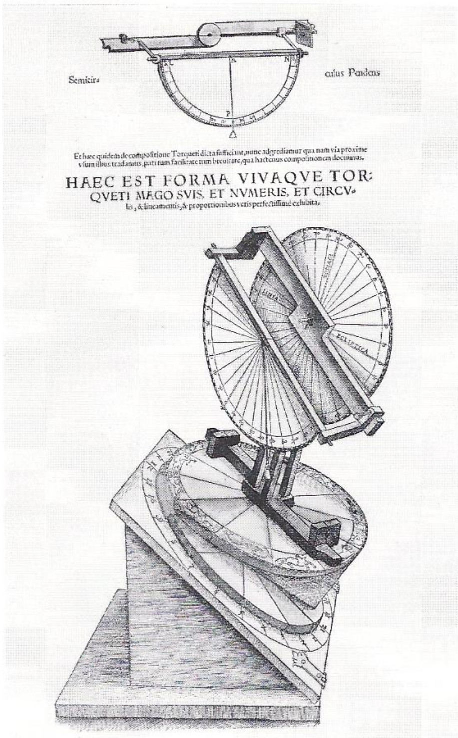
used the torquetum for another appearance of Halley's Comet in 1456.[64] In 1524, Johannes Schöner also built himself a torquetum, using it for the appearance of Halley's Comet in 1531.[65] Finally, it seems possible that Peter Apian used a torquetum among other instruments for his observations of the comets of 1531, 1532 and 1533, as they coincide so closely with the publication of his treatise on the torquetum in 1533.[66]

Latin Treatises on Comets between 1238 and 1368 AD, Chicago 1950, pp. 196–207; D. K. Yeomans, *Comets: A Chronological History of Observation, Science, Myth and Folklore*, New York 1991, pp. 24–6.

64. See Yeomans (as in n. 63), pp. 24–6.

65. In a letter from Schöner to Willibald Pirckheimer, dated 31 January 1524, he writes: 'das ich itz zu den Canonibus Joannis de Monte Regio uber dz Torquet auch mache fabricam solchs torquets, welchs gar ain schon loblich instrumentum in astronomia ist' (see H. G. Klemm, *Der fränkische Mathematicus Johann Schöner (1477–1547) und seine Kirchehrenbacher Briefe an den Nürnberger Patrizier Willibald Pirckheimer*, Erlangen 1991, p. 51). For Schöner's observation and publication of Halley's Comet see his *Coniectur odder ab nemliche außlegung Joannis Schöners uber den Cometen so im Augstmonat des M.D.XXXj. jars erschinen ist…*, Nuremberg 1531; and K. Pilz, *600 Jahre Astronomie in Nürnberg*, Nuremberg 1977, p. 190. Schöner's torquetum is illustrated in his edition of *Scripta M. Ioannis Regiomontani, de torqueto…*, Nuremberg 1544. For a reproduction see Bennett and Bertoloni Meli (as in n. 55), p. 31, fig. 30.

66. The instrument is described and illustrated in Apian's edition of Joannes Werner's work, *Introductio geographica Petri Apiani in doctissimas Verneri annotationes*, Ingolstadt 1533. It also appears in a number of other works by Apian, including his *Astronomicum*



52. Illustration of a torquetum from Apian's *Astronomicum Caesareum*, Ingolstadt 1540

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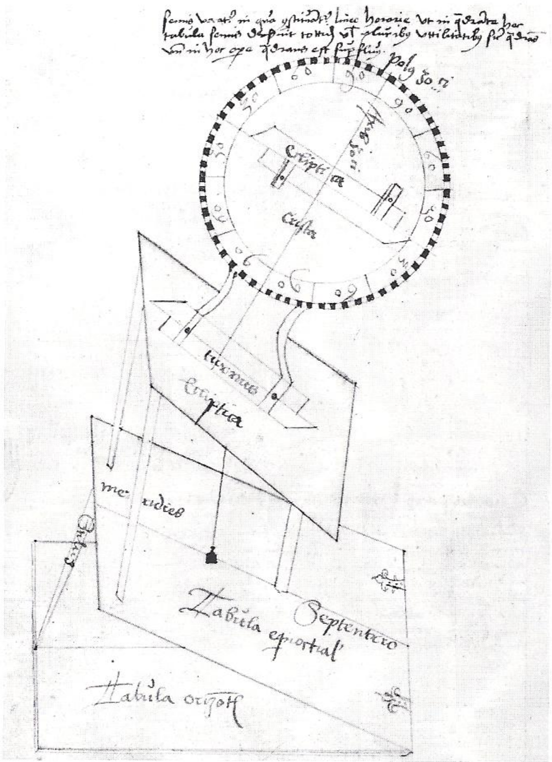
The misunderstandings about the original purpose of the torquetum seem to derive from the fact that, during the middle years of the sixteenth century, a number of structural changes were made to the design. The most important modifications were introduced by the instrument-maker Erasmus Habermel, whose alterations allowed the astronomer to make observations relative to all three of the torquetum's scales—

Caesareum, Ingolstadt 1540. Of course, it is impossible to say for certain whether Apian used a torquetum himself. He seems to have used a cross-staff for his observations of the comet of 1532, following the example of Regiomontanus, who had observed the 1472 comet with such an instrument. See D. Wattenberg, 'Johannes Regiomontanus und die astronomischen Instrumente seiner Zeit', in *Regiomontanus Studien*, ed. G. Hamann (Sitzungsberichte der Österreichischen Akademie der Wissenschaften, CCCLXIV), 1980, pp. 354–5, esp. 357. Note that Apian's drawing clearly shows that the instrument can be adjusted for the latitude of place. There are hinges connecting the equatorial plane to the horizontal plane. There are no such hinges, however, connecting the ecliptical plane to the equatorial plane (the angle between the two planes is constant). Therefore, it seems unlikely that the instrument could have been used to measure in any co-ordinate system other than the ecliptical one.



53. Oxford, Corpus Christi College Library MS 152, folio 251^{v}. A torquetum

horizontal, equatorial and ecliptical.[67] Habermel's design tends to obscure the fact that the original construction of the torquetum did not allow for observations relative to all three co-ordinate systems. Holbein's instrument, for example, is the most basic sort imaginable: an equatorial plane, with a simple hour scale, is fixed at an angle to a horizontal plane and the scale marked on the ecliptical plane shows the signs of the zodiac without corresponding numbers. These features are almost identical to the illustrations in Apian's treatise on the torquetum (Fig. 52).

Kratzer illustrates a torquetum in his Corpus Christi notebooks (Fig. 53);[68] but at first glance it is difficult to imagine an instrument identical to or derived from that drawing serving as the basis for the highly finished torquetum in *The Ambassadors*.

67. See Zinner (as in n. 39), p. 182. As Zinner notes, these changes turned the torquetum into a universal instrument (i.e. one suitable for a range of non-astronomical observations, such as surveying).

68. Oxford, Corpus Christi College Library MS 152, fol. 251^{v}.

Several important features of the torquetum appear to be missing or misunderstood in Kratzer's drawing, such as a movable equatorial disc carrying the ecliptical disc. One detail, however, does suggest that both his and Apian's image derive from the same source—the hinge used to connect the horizontal plane to the equinoctial plane is nearly identical in both. We know that Kratzer spent some time in a Carthusian monastery in Maurbach, near Vienna, around 1515, where he appears to have copied much of the contents of his notebooks, as is claimed in the note which opens the first folio of the collection.[69] Examination of the contents of the manuscript shows it to be a compilation of texts, primarily by astronomers of the previous generation, such as Peurbach and Regiomontanus.[70] It is not only possible, therefore, but highly likely that a number of similar astronomical compilations were circulating throughout Germany and the Low Countries during the period, fuelling the explosion of publications on the construction of scientific instruments, by such authors as Münster, Apian, Schöner and Fine, which occurred in the early sixteenth century.

Nevertheless, the sorts of structural problem evident in Kratzer's drawing suggest that he did not have sufficient information to construct a working model of a torquetum for Holbein to copy prior to the appearance of Apian's treatise in England soon after it was published in 1533.[71] Kratzer, who had encountered the torquetum through his copy of the Maurbach manuscript, must have seized upon Apian's illustration, rapidly had a rudimentary version of the instrument constructed and passed it to Holbein to include in *The Ambassadors*. It seems unlikely that the illustration itself served as the model, since the differences in design, minor as they are, indicate that he used a real instrument.[72] Reconsidered from this point of view, the depiction of the torquetum in Holbein's *Ambassadors* is an important signpost marking a specific step forward in the history and dissemination of scientific learning during the Renaissance. And, from a patron's perspective, having an up-to-date torquetum in his portrait was an indication of first-hand acquaintance with the cutting edge of European scientific thought.

As certain key areas of Holbein's torquetum are obscured or too dramatically foreshortened to read, it is impossible to fix the time of day or the date for which the

69. 'Complura ex veterato libro monisteriae [*sic*] charthusae Maurbach 2 miliaria a Vienna austriae ego nicolaus kracerus extripsi [*sic*]'. The folio (the first recto numbered 1, which follows the flysheet and two unnumbered folios) is reproduced in O. Pächt, 'Holbein and Kratzer as Collaborators', *Burlington Magazine*, LXXXIV, 1944, pp. 133–9, esp. pl. IIIa; and is transcribed by North (as in n. 26), p. 388; and by Pattenden (as in n. 50), p. 72.

70. See North (as in n. 26), p. 388; and Pattenden (as in n. 50), p. 72.

71. Book trade between the Continent and England was exceedingly brisk during the period, with certain prestigious volumes appearing in England virtually days after they were published abroad. For a discussion of the volume this trade see J. Roberts, 'Importing Books for Oxford, 1500–1640', in *Books and Collectors, 1200–1700: Essays presented to Andrew Watson*, ed. J. P. Carley and C. G. C. Tite, London 1997, pp. 317–33. We thank J. B. Trapp for this reference.

72. For example, the design of the ecliptical alidade is different. Furthermore, the change in the pillars supporting the altitude semicircle and the altitude disc (as well as the some of the decorative details on the sights for the latitude disc) all suggest modifications introduced by a carpenter, rather than an instrument-designer or a painter. Also, the change in orientation relative to the viewer argues in favour of there having been a three-dimensional model available.

instrument is rectified. Nor is it possible to determine the angle between the horizon (the table) and the first inclined plane (the equatorial plane). This angle could have revealed the local latitude of the observer. The only detail worth recording is that the alidade, or sighting limb, on the latitude plate points to an object with an ecliptical latitude of about 17·5° and a height above the horizon of about 7·5° If this sight was, in fact, meant to be pointing at something, it could not be the sun, the moon or any planet, since these all move within the ecliptical plane (that is, within 5° of the sun's apparent path). It is, however, possible for a comet or a star to appear at higher ecliptical latitudes. Of the comets observed in Europe between 1531 and 1533, only Halley's Comet of 1531 meets the specific criteria: it was observed in August, when the sun was in *Leo*, at an ecliptical latitude of about 17·5°; and it appeared near the eastern horizon at a height of about 7·5° just before sunrise. Nevertheless, having noted this, the notion that the position of the torquetum in Holbein's *Ambassadors* celebrates the passing of Halley's Comet two years previously—given the disposition of the other instruments in the painting—seems tenuous, at best.

CONCLUSION

Our re-examination of the scientific instruments in *The Ambassadors* has yielded the following observations:

First, strictly speaking, none of the dials in the painting depicts a scientific instrument 'displaying' time. It could be argued that Holbein has created a series of references in the painting to indicate some specific 'iconographically significant' time. If so:

(1) the celestial globe shows 2:40 p.m. on 12 July (old style);
(2) the pillar dial shows 9:00 a.m. or 3:00 p.m. on either 10 April or 15 August;
(3) the polyhedral dial shows 9:30 a.m. or 10:30 a.m. *horae communes*; and
(4) less plausibly, the torquetum might indicate the period of visibility of Halley's Comet in 1531.

Second, all of the instruments in the painting, with the exception of the pillar dial, are of new and innovative design. The globes and the torquetum are 'state of the art' instruments. The polyhedral dial and the universal equinoctial dial (or dial-maker) are also relatively experimental in their design. Furthermore, these new instruments are all specifically German in their manufacture: one of the globes is connected with certainty to Schöner; the second globe can be traced to Nuremberg; the torquetum is linked to Apian in Ingolstadt; and the universal equinoctial dial can be associated with earlier designs found on German instruments. It seems safe to say that if a contemporary viewer would have received any obvious message from this particular selection, it would be that the instruments were new, quite expensive, and German.

Third, the next step must be to explore the nature and extent of Nicholas Kratzer's possible role. The general trend in the critical literature on *The Ambassadors* has been to assume that the errors and inaccuracies in the instruments were introduced by Holbein himself.[73] All that we know about Holbein from his other work indicates that he was meticulous in the rendering of details; and there is no reason to suppose that he was any less careful in his depictions of the scientific instruments in *The Ambassadors*. The texts and the scientific instruments associated with Kratzer's hand, however, reveal a fair amount of inconsistency and error. Admittedly, the great dial formerly in the orchard of Corpus Christi College, Oxford, seems to have been well laid-out;[74] but the three sides of the Acton polyhedral dial are incorrectly plotted; the Wolsey dial is (to quote Drinkwater) 'adequate rather than fine';[75] and the polyhedral dial represented by Holbein in both *The Ambassadors* and the *Portrait of Nicholas Kratzer* is constructed so that it could never function properly, regardless of latitude. It might seem petty to spend time trying to determine who was responsible for the fact that some of the instruments in *The Ambassadors* appear to have been badly constructed. On the other hand, such a search falls within the genre of art historical enquiry into the complex relationship between parton, artist and the so-called 'humanist advisor'. In this context, understanding Kratzer's role in the construction of *The Ambassadors* is not so different from trying to isolate the contributions of Poliziano, Guarino, Borghini or Caro in some of the great artistic programmes of the Italian Renaissance.

Finally, if one considers that *The Ambassadors* was commissioned specifically to hang at de Dinteville's château at Polisy, it might be time to re-evaluate the painting's status as a jewel of early Tudor painting. The artist was German (and so, conceivably, was the iconographic advisor), and most of the items which form the still life at the centre of the composition are of German manufacture. The patron was French (reportedly loathing his stay in England),[76] and the painting itself was designed to hang in a building situated just a few miles from the king's estates in Fontainebleau. Whatever the 'meaning' of *The Ambassadors* might be, we have perhaps been looking for it in the wrong place.

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The Royal Observatory Greenwich

73. For example (quoted from one of the text panels for the exhibition *Making and Meaning*): '... the inaccuracies in some of Holbein's depictions suggest that he [Kratzer] was not directly concerned and that Holbein may have been working from drawings rather than from actual instruments'.

74. For the Corpus Christi dial see Drinkwater (as in n. 39), p. 6; North (as in n. 26), p. 386–7; and Pattenden (as in n. 50) , pp. 21–4.

75. Drinkwater (as in n. 39), p. 7.

76. See *Making and Meaning* (as in n. 3), p. 16.

Appendix I: Nomenclature of the Constellations

The Ambassadors' globe, 1533	Paris globe, c. 1525	Schöner's gores, c. 1515	Schöner's globes, c. 1535
DRACO		Draco	DRACO
VVLTVR CADENS	VVLTVR CADENS	Vultur cadens	LYRA
VVLTVR V[OLANS]	VVLTVR VOLANS	Vultur volans	AQUILA
[DEL]PHINVS		Delphinus	DELPHINUS
EQVVS PEGASVS	EQVVS PEGASVS	Equus Pegasus	PEGASUS
CEPHEVS		Cepheus	CEPHEVS
[CAS]SIOPEIA		Cassiopeia	CASSIEPEA
ANDROMEDA		Andromeda	ANDROMEDA
PERSEVS	PERSEVS	Perseus	PERSEVS

Appendix II: The Day of the Year as Portrayed in the Celestial Globe

The day of the year for which a globe has been rectified can be found in the following way:

1. Note the time on the hour circle. In the case of the globe in the *Ambassadors*, the hand on the hour circle indicates that it has been 2 hours and 40 minutes since the sun culminated in the south (or, since it was noon).

2. Find the difference in culmination between the sun and a chosen star. In the painting, the star α Peg has just emerged from under the north side of the meridian ring. This means that it culminated about 12 hours previously and that the sun had culminated 9 hours and 20 minutes later than α Peg.

3. Find the degree of the ecliptic in which the sun is placed and look up the date in a contemporary set of tables. A difference in culmination time equals a difference in right ascension. The right ascension of α Peg on Schöner's globe (for the epoch 1500) is 340°. The right ascension of the sun is then found by converting the difference in time (9 hours and 20 minutes) into degrees (140°). Since the sun lags behind α Peg, this number is added to 340. A full circle is 360°, so this figure is subtracted from the total of 480°, thereby revealing that the celestial globe in *The Ambassadors* has been rectified for a day on which the right ascension of the sun was equal to 120°. The right ascension of the sun is 120° during midsummer, when the sun is located in the sign of *Cancer* at 28°. By using the tables provided in Stöffler for 1501, we find that this day is 12 July (old style).*

* See Stöffler (as in n. 31), fol. 46r under *Tabula veri motus verificata ad An. Christi. MDI.* This date does not coincide with that provided by North (as in n. 26, p. 393 n. 89), who claims that 'the celestial globe is very roughly set for the autumnal equinox with the sign of Scorpius rising'. On 12 July, the sign of *Scorpio* is indeed rising at 2:40 p.m. (the time indicated by the hour circle). Had the globe been set for the autumnal equinox, however, the sign of *Scorpio* would have risen four hours earlier, at 10:40 a.m. Furthermore, at the autumnal equinox, the sun is located at the first point of the zodiacal sign of *Libra* and its right ascension is 180°. So, had the globe been set for the autumnal equinox, the sun would culminate 13 hours and 20 minutes after α Peg. This means that the hour-circle would be showing 10:40 a.m. when α Peg was emerging from underneath the meridian ring. It is not.