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Ptolemy and the Origins of Linear Perspective

Atti del convegno internazionale di studi: la prospettiva rinascimentale, Milan 1977, ed. Marisa Dalai-Emiliani (Florence: Centro Di, 1980), pp. 403-407.

To account for the (re-) discovery of Renaissance linear perspective there exist at least five explanations: 1) a change in 'world view[1]; 2) workshop practice[2]; 3) architectural tradition using ground plan/elevation methods[3]; 4) surveying[4] and 5) cartography.[5] The purpose of this paper is to reconsider briefly the importance of cartography and suggest the importance of a sixth context; astronomy which introduced the use of planisphere and astrolabe.

Ptolemy in his *Geography* discussed three projection methods. If these were significant in the Renaissance one would expect to find careful attention to the diagrams illustrating these methods. Examination of *Codex Urbinas Graecus 82*[6] --to cite one important example - reveals, however, that the diagram for methods one (fig. 1) and two (fig. *2)* are not elaborately produced and that the diagram for method three is omitted entirely.

To question that geography was responsible for the discovery of perspective is not to deny, however, that there existed close links between cartography and perspective in the latter fifteenth and sixteenth centuries: cf, for example, Leonardo's sketches (fig. 3); Dürer's woodcut for the *1525* edition of Ptolemy's *Geography* - albeit the principles here relate primarily to astronomy; Christoforo Sorte, who was active in geography as well as perspective or Egnazio Dante, editor of Vignola's *Due regole della prospettiva (1583),* who also produced maps of Perugia and later of all the papal states. A passage from Accolti's *Lo inganno degli 'occhi (1625, p. 125)* is particularly interesting for this, theme - although we must beware of *post hoc ergo propter hoc* arguments:

> whence if we wish to constitute a measure or a scale as the geographers say in order to be able to measure any and every member of the said drwaing, we shall do it in this way most easily and most expeditely, also without needing to use other instruments of quandrants with scales of heights and similar mathematical instruments.[7]

Hence for Accolti there were obvious links between cartography and geography. How these links developed, what their connection was, in turn, with topography and surveying deserve future attention.

Concerning the origins of perspective Doesschate[8] alluded to another influence: astronomy. A regular planisphere[9] such as that described by Ptolemy imagines the eye (fig. 4) to be at the south pole, uses the equator as picture plane and projects onto it the tropics of Cancer and Capricorn plus the ecliptic. Here one has the three basic elements of linear perspective: eye at a fixed point, picture plane and object.
The astrolabe is one step more complex. It begins with the same projection as the planisphere, which may be termed the standard point of view. It then adds projection of latitudes (almucanthars) and longitudes (azimuths) relative to the viewer's position (fig. 5).

Hence it combines systematically two points of view: one "standard", the other apparent. This, it is suggested, marks an important step in the abstraction process necessary for the

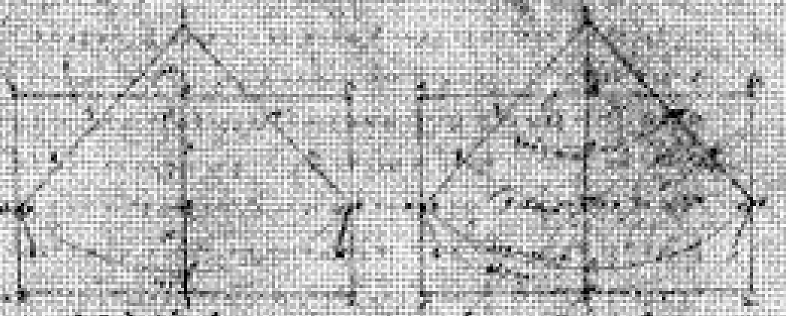
discovery of linear perspective which, it will be recalled, also combines systematically two distinct points of view: usually ground-plan/elevation, but in fact any two points of view at right angles to one another, e. g. frontal plus lateral etc.

Evidence of close links between astronomy and perspective abounds. Brunelleschi, the discoverer of perspective cooperated with Paolo dal Pozzo Toscanelli in constructing an astronomical clock in Santa Maria del Fiore. Uccello, famous for annoying his wife in bed with his greater love for perspective, was also concerned with astronomical clocks.[10] Alberti,[11] Melozzo da Forli,[12] Dürer[13] were active in both perspective studies and astronomy.

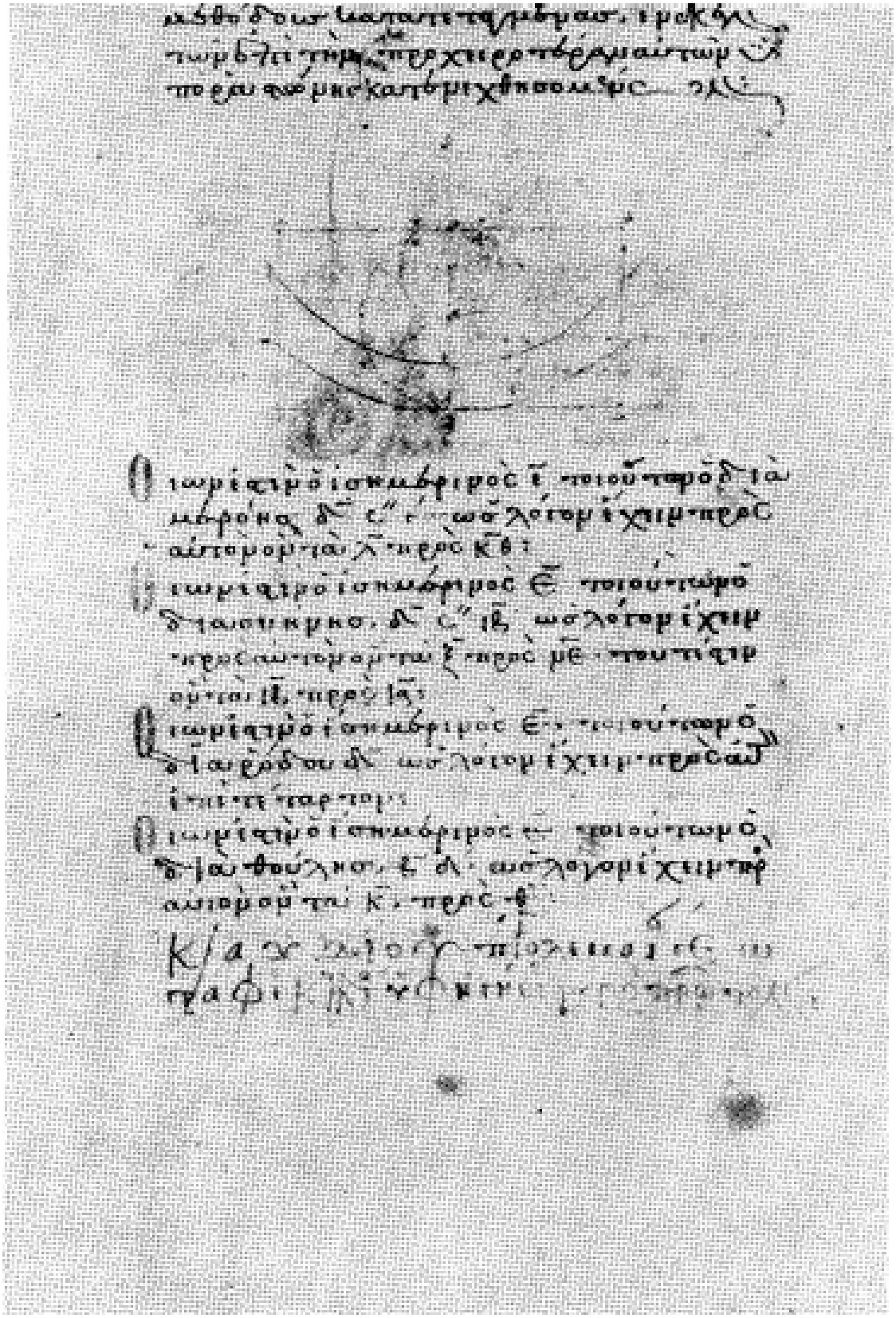
In Gregor Reisch's *Margarita Philosophica* (eg. editions of *1512, 1515)* Pélerin's treatise on linear perspective is found between a treatise on architecture and one on astrolabe construction. Commandino's edition of the planisphere of Ptolemy *(1552)* contains a commentary that is a treatise of perspective. Commandino also wrote on analemmas and sundials. D. Barbaro dedicated book VI of his *Pratica della prospettiva (1568)* to the construction of the planisphere and book IX to a universal horological instrument. Egnazio Danti, active in perspective matters *(1583)* was also responsible for placing an astronomical quadrant and aequinoctial armillary sphere on Santa Maria Novella *(1580-90).* In addition he wrote on the astrolabe in Italian *(1569, 1578),* on the use of the armillary sphere *(1573),* and furnished editions of the *Sphaera Mundi* of Sacro Bosco *(1571)* and of the Sphere of Proclus *(1573).* In the seventeenth century one merely needs to look at Aguilonius *(1613),* Accolti *(1625),* Kircher *(1646)* or Maignan *(1646)* to see that the interdependency of the two traditions became more obvious with time.

The visual evidence is equally striking, a woodcut by Wohlgemut shows painting and astronomy together (fig. 7). Artists show, moreover, a considerable interest in representing the armillary sphere with care; Taddeo Gaddi,[14] Petrus Christus,[15] Botticelli,[16] Carpaccio,'[17] Joos v. Wasserhove[18]" and Honthorst[19] may be mentioned as examples, or Leonardo who actually demonstrates how such instruments may be drawn. Whence it would seem that the question of Ptolemy's influence is to be answered by attention to the tradition of astronomy rather than geography.

If we return for a moment to the early days of astronomy, it becomes clear, however, that astronomy and geography were traditionally linked. From our school days we are all familiar with the ingenious method used by Erastothenes in determining the values of latitude (and longitude) on which were based his geographical researches: using the difference in the sun's shadow between Siene and Alexandria and so on. The romance of the story tends to obscure its essential lesson: that geography in Antiquity was entirely dependent on astronomy and specifically that branch involving shadow projections. Such projections were dis cussed both in Euclid's *Elements* and *Optics* and served, moreover as the starting point for the analemma (cf. Vitruvius IX, 7).
The point that interests us is the interconnection of fields; shadow projection linked astronomy, geography, optics, and topography; a tradition continued by Ptolemy, through Alhazen, Witelo and Levi ben Gerson, inventor of the "Jacob's staff" for surveying, which he combined, in turn, with the camera obscura for astronomical study. Gregor Reisch's *Margarita philosophica (1504)* shows us that all these disciplines were sometimes classed under geometry (fig. 6). But then comparison with other illustrations of these disciplines (cf. Wohlgemut, fig. 7 or J. Amman in the *Catalogus gloriae mundi)* reminds us that their categories were much more fluid than our own. Whence we may conclude that the context of perspective is to be found amongst the many offspring of mother geometry and in particular her daughter, astronomy.



Λοιπὸν δ' ἐν ὑποκειμένου τοῦ προχείρου τῆς τῶν κα-
τατασσομένων τόπων παρασημειώσεως
ποιησόμεθα καὶ λεπτὸν κανόνιον μόνον ἴσον τῷ
μήκει τῇ ηζ ἢ τῇ ηθ μονῆς· καὶ ἐκπολί-
σαντες αὐτὸ περὶ τὸ η ὥστε παραλλ-
ηλομένου καθ' ὅλον τὸ μῆκος τῆς καταγραφῆς
ἐφαρμόζειν ἀκριβῶς τῇ ἑτέρᾳ τῶν
παραλλήλων τῶν μεσημβρινῶν [illegible]
θέσεως· διαιροῦμεν τὸ κατὰ μέσον τοῦ πολ-
λαπλασιασμοῦ ἀπὸ τῆς [illegible] τῶν
τοῦ τῆς [illegible] εἰς τὰ βόρεια
[illegible] τμήματα ρλ· [illegible]
τῇ ηθ μονῇ τμήματα ριε· καὶ παρα-
σημειωσόμεθα τοὺς ἀριθμοὺς ἀπὸ
κατὰ τὸν ἰσημερινὸν τὸ μὲν ποιούμενοι
τὴν ἀρχήν, [illegible] καὶ τοὺς [illegible]
δεῖ ἐπιγράφειν· ἵνα μὴ τὸν [illegible] καταγραφῆς
μεσημβρινὸν θεῖσα [illegible] τὰ
τμήματα [illegible] καὶ παρασημει-
ούμενοι, συγχωνεύων ταῖς θέσεσι [illegible]
αὐτῶν [illegible] γράφομεν· [illegible]
[illegible] καὶ τὸν ἰσημερινὸν [illegible]
[illegible] καὶ [illegible] ρπ μοίρας καὶ [illegible]
τοὺς ἀριθμοὺς ἀπὸ [illegible]
[illegible] μεσημβρινὸν ἀρχήν [illegible] παρεισόμ-
ενοι τὴν τοῦ κανονίου [illegible]
[illegible] τοῦ μήκους [illegible] καὶ [illegible]



1 Illustration of Ptolemy's first projection method from C. Ptolemaei, *Geographiae Codex Urbinas Grae*cus 82, Fol. 10 (9)r - Lib. I C. 24 (23) 3-10.

2. Illustration of Ptolemy'S second projection method from C. Ptolemaei, *Geographiae Codex Urbinas Grae*cus 82, Fol I I (10)r - Lib. I C. 24 (23) 17-22.

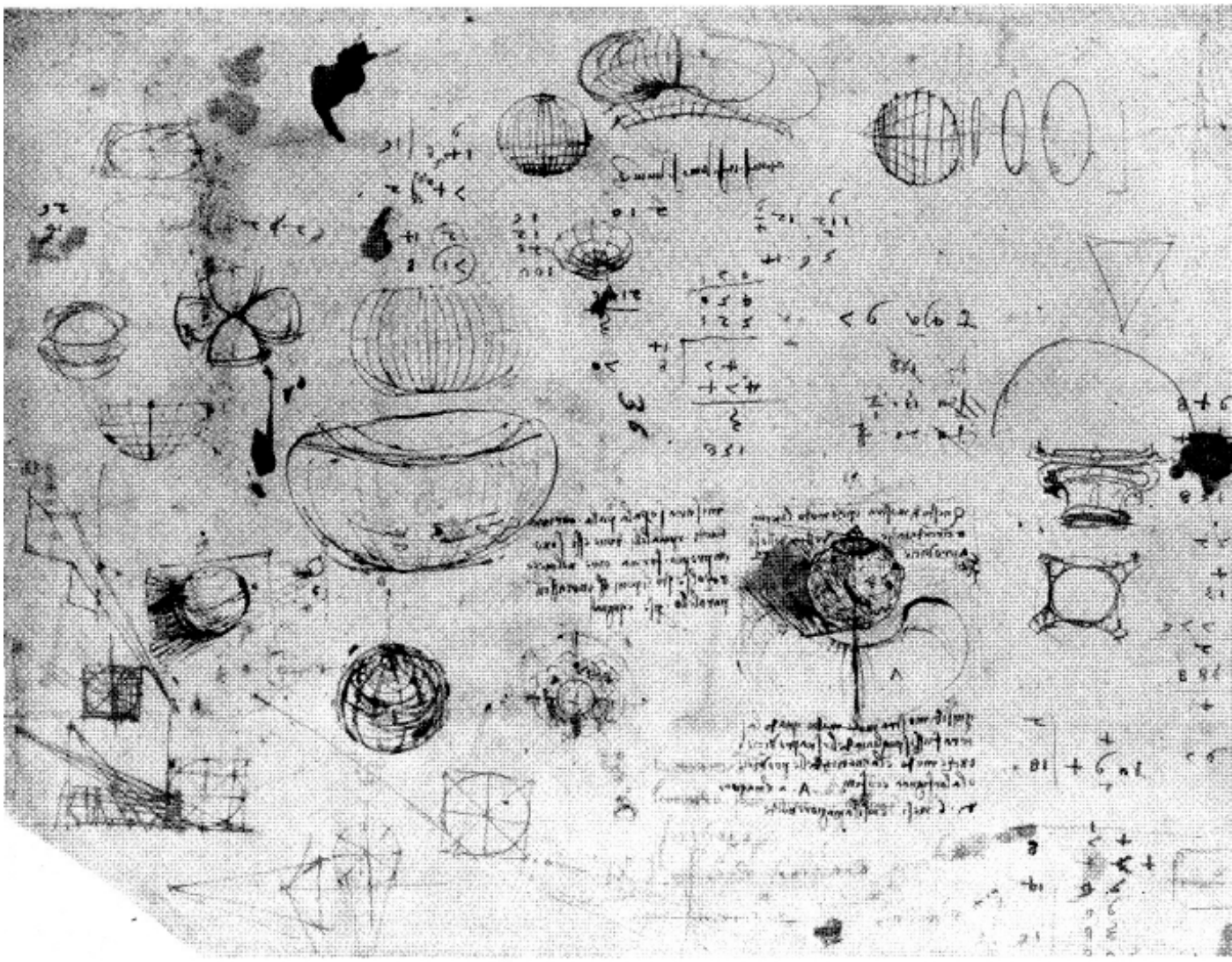
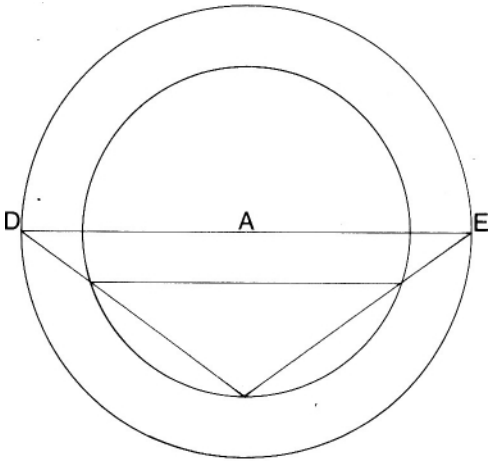
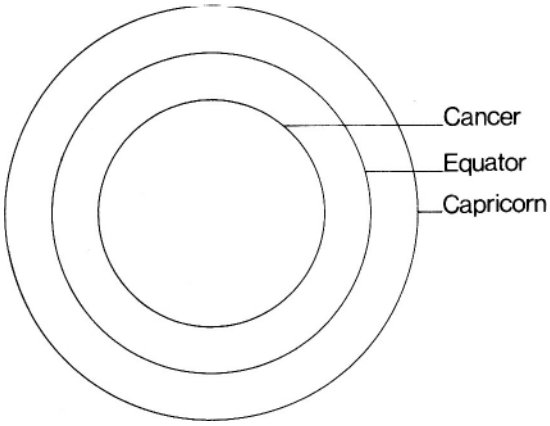


Figure 3. Illustration of cartographic projection problems from Leonardo da Vinci, Il *Codice Atlantico*. Edizione in facsimile dopo il restauro dell'ex originale conservato nella Biblioteca Ambrosiana di Milano... Firenze: Barbèra 1973 e sgg. vol. VI, Fol. 521°.



4. Illustration of projection principles in ordinary planisphere.

In similar fashion the tropic of Capricorn is projected to the equator. With centre A and radius DE another circle is then drawn corresponding to the topic of Cancer.



If the circles for Cancer (step 3) and Capricorn (step 4) are now combined, one has the three familiar circles of the regular planisphere and astrolabe,

5. Illustration of Moorish/ Gothic Astrolabe (c. 1300) in the National Maritime Museum, Greenwich.

Figure 6. G. Reisch: Geometry in *Margarita Philosophica* (Strassburg, 1504), Pvi.

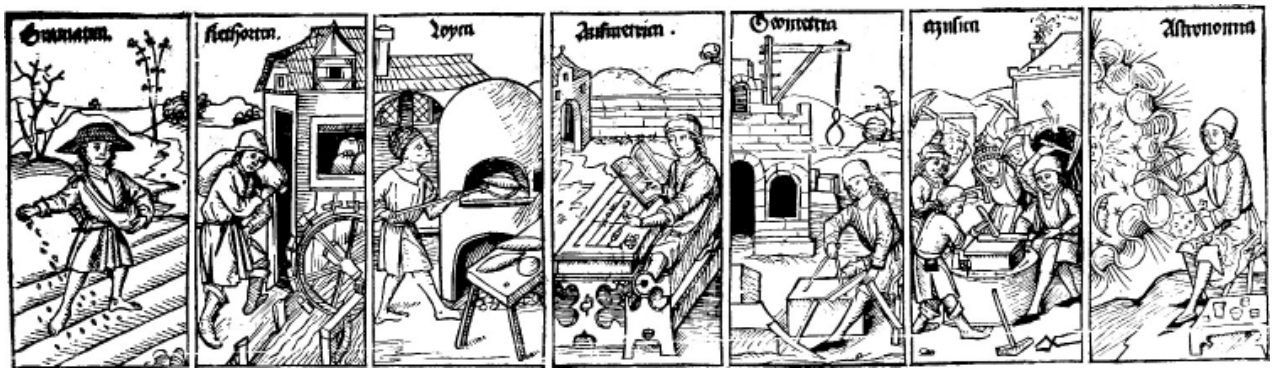


Figure 7. M. Wohlgemut: Woodcut showing *Liberal Arts*, Nürnberg, 1493 (note link between astronomy and painting).

Acknowledgements
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Notes

1 1) E. Panofsky, *Die Perspektive als symbolische Form,Vorträge der Bibliothek Warburg* 1924-25, Leipzig 1927.

[2] R. Klein, *Pomponius Gauricus on Perspective,* The Art Bulletin, XLIII, Sept. 1961, pp. 211-29.

[3] R. Krautheimer, *Lorenzo Ghiberti,* Princeton 1956.

[4] H. Brockhaus, ed., *De Sculptura von P. Gauricus,* Leipzig 1886; J. Gadol, *Leon Battista Alberti,* Chicago 1969.

[5] S. Edgerton Jr., *The Renaissance Rediscovery of Linear Perspective,* New York, 1975. cf. review: *Art Bulletin, July* 1977, pp. 281-82.

[6] C. Ptolemaei, *Geographiae Codex Urbinas. Graecus 82. Phototypice depictus consilio et opera curatorum Biblioteca Vaticanae* Lugduni Batavorum: Bríll; Lipsiae: Harrassowitz, 1932. 4 pt. (Codices e Vaticanis selecti, vol. 19).

[7] onde se vorremo constituire una misura o scala, come dicono i Geografi da poter misurar ogni, & membro del sudetto Disegno, faremo in questo modo per il più facile, & espedito; anche per non haver a metter mano ad altri instrumenti de quadranti di scale altimetri e si fatti matematici instrumenti...

[8] G. ten Doesschate, *Perspective, Fundamentals, Controversials, History,* Nieuwkoop 1964.

[9] J. D. North, *The Astrolabe,* Scientific American, New York, vol. 230 (no. 1), 1974, pp. 9G-106; for more detailed discussion see: R. T. Gunther, *Astrolabes of the world,* London, Holland Press 1932, new edition, *ibid.,* 1976.

[10] G. Poggi, *Paolo Uccello e l'orologio di S. Maria del Fiore,* Miscellanea di storia dell'arte in onore di G. P. Supino, Firenze 1933, pp. 324 ff.

[11] L. Vagnetti, *Considerazioni sui Ludi Matematici,* Omaggio ad Alberti. Studi e Documenti di architettura n. I, Firenze: Teorema Edizioni 1971, pp. 217-219.

[12] W. Bode, *Die Astronomie von Melozzo da Forlí,* Jahrbuch der preussischen Kunstsammlungen, Berlin, VIII, 1887, pp. 235-236.

[13] E. Weiß, *Albrecht Dürers geographiische, astronomische und astrologische Tafeln,* Jahrbuch der kunsthistorischen Sammlungen, Wien, VII, 1898, pp. 207-220.

[14] Taddeo Gaddi: so called Fresco of a *"Virtue"* (1332-38), Baroncelli Chapel, Santa Croce, Florence.

[15] Petrus Christus, *St. Jerome,* Detroit, Institúte of Fine Arts.

[16] Sandro Botticelli, *St. Augustine,* Refectory of Ognissanti, Florence; Botticelli (follower), Reverse of *Portrait of lady: An angel holding an armillary sphere,* National Gallery, London, no. 2082.

[17] Vittore Carpaccio, *Vision of St. Augustine* also called: *St. Jerome,* Scuola di San Giorgio, Venice.

[18] J. van Wassethove, *Astronomia,* formerly in Kgl. Galerie Berlin, cat. no. 54. A.

[19] G. Honthorst, Apollo *and Diana,* Hampton Court. This collection has another fine example illustrating an armillary sphere: Florentine School: *Lady with Lap Dog.,*