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**FROM GRID TO PROJECTED GRID:
ORIENTAL CARPETS AND THE DEVELOPMENT OF LINEAR PERSPECTIVE**

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This paper addresses a significant topic that seems to have escaped notice in studies of the development of linear perspective in the fifteenth century, a subject that is otherwise so well studied in the annals of scholarship concerning Western European painting.¹ Oriental carpets, that is, carpets imported into the West from Spain and the East, often appear in Western European paintings (figs. 1-6), where their representation is treated with exceptional care in the rendering of colors, patterns, and details of form.² The role of carpets depicted in such paintings has been described variously as lending an aura of opulence, exoticism, luxury, wealth, or status; more often, discussion of them is omitted entirely. Visually, they serve to highlight particular space by drawing attention either to an important personage, whether standing or seated, or to a location where significant action is depicted.

In the scholarly literature, although such paintings themselves are often taken to illustrate significant steps in the evolution of contemporary critical thinking about representation of the spatial dimension, the carpets, if referenced at all, are treated simply as accessory objects the placement of which underscores ambience.³ The evidence presented in this paper may lead us to alternative interpretations that link the representation of carpets to the development of linear perspective (figs. 7-8).

The gist of the argument rests upon correlate notions that linear perspective in two dimensions represents space mathematically by means of a projected grid (fig. 8), and that carpets bear patterns that are grid-based, as well as having an underlying orthogonal grid of interlacing warp and weft. The argument, however, is not based on just the coincidence of the presence of grids, but rather depends upon the significance of grids in the histories of both mathematics and the arts in the Islamic world and the pivotal role of the fifteenth century, which is increasingly recognized as a temporal nexus in the cultural

¹ Among what became standard Western studies in the twentieth century of the development of linear perspective are Erwin Panofsky, *Perspective as Symbolic Form*, tr. Christopher S. Wood (New York, Zone Books, ©1991) (originally published in German as “Die Perspektive als ‘symbolische Form,’” in *Vorträge der Bibliothek Warburg 1924-1925* [Leipzig and Berlin, 1927]), and Samuel Y. Edgerton, Jr., *The Renaissance Rediscovery of Linear Perspective* (New York, Basic Books, 1975).

² John Mills, *Carpets in Paintings* (London, National Gallery of Art [1983]); see also Donald King and David Sylvester, *The Eastern Carpet in the Western World: From the 15th to the 17th Century* (London, Arts Council of Great Britain, 1983). For images, see Lauren Arnold, *The Carpet Index: The Oriental Carpet in Early Renaissance Painting*, <http://www.flickr.com/photos/26911776@N06/collections/72157607280464750/>, accessed 12 November 2010, which is divided into three sections: Carpets pre-1420, Renaissance Carpets 1420 through 1540, Reformation Carpets 1540 to 1555 [sic]. A symposium in London devoted to the study of “Carpets of the Mediterranean Countries, 1450-1550 was held as part of the 4th International Conference on Oriental Carpets (1983) and resulted in the publication of *Oriental Carpet & Textiles Studies II: Carpets of the Mediterranean Countries 1400-1600*, ed. Robert Pinner and Walter B. Denny (London, Hali Publications, 1986). See also Rosamond E. Mack, *Bazaar to Piazza: Islamic Trade and Italian Art, 1100-1600* (Berkeley and Los Angeles, University of California Press, c2002), especially ch. 4, “Carpets,” pp. 73-93. A useful synthetic overview of the subject is provided by “Oriental Carpets in Western European Painting,” at http://en.wikipedia.org/wiki/Oriental_carpets_in_Renaissance_painting (accessed 14 November 2010).

³ Using what he calls Islamic carpets represented in European paintings as a leitmotif, David Carrier, *A World Art History and Its Objects* (University Park PA, Pennsylvania State University Press, 2008) attempts to justify a world history of art, based upon interactions of different cultural traditions. My gratitude to John Rapko for bringing this to my attention in his review of Carrier’s work published in the *British Journal of Aesthetics*, vol. 50, no. 2 (2010), pp. 209-212.

encounters that contributed to the development of Renaissance arts, sciences, and ideas.⁴ More specifically, it is suggested that carpets themselves provided artists with an established visual depiction of measured space in two dimensions that could facilitate the conceptualization of three-dimensional space by means of projection. That is, by drawing a projection of the modules of the grid that structures the patterns of Oriental carpets, an artist could convey the illusion of three-dimensional space on a two-dimensional picture plane.



Figure 1, left. *Atelier, François Clouet, middle of the 16th century, Henry II (1519-1559).* (http://en.wikipedia.org/wiki/File:Clouet_atelier_Henri_II_Roi_de_France.jpg, accessed 1 December 2010). He married Catherine de' Medici in 1533 and was King of France from 1547 until his death. Note that the carpet, depicted as parallel to the picture plane (i.e. vertical) is represented here in an archaizing style.

Figure 2, right. *Master of Saint Giles, Mass of Saint Giles, c.1500, oak, National Gallery, London.*

According to the scholarly paradigm current today in the West, theoretical understanding of linear perspective was first articulated in Alberti's treatise, *De pictura*, published in Florence in 1435.⁵ Studies of the origins of linear perspective in European painting tend to focus on contemporary and subsequent developments in artists' treatment of the spatial dimension, with attention especially devoted to mathematical principles that underlie the representation of three-dimensional objects in three-dimensional

⁴ See George Saliba, *Islamic Science and the Making of the European Renaissance* (Cambridge, MIT Press, 2007); for significance of the 15th century in Islamic arts, see Gülrü Necipoglu, *The Topkapi Scroll: Geometry and Ornament in Islamic Architecture* (Santa Monica CA, Getty Center for the History of Art and the Humanities, 1995).

⁵ *De Pictura, On Painting* by Leon Battista Alberti (1435), tr. Cecil Grayson with an introduction and notes by Martin Kemp (London, Penguin, 1991 [c1972]); Kemp's commentary includes an excellent list of further readings.

space, as exemplified particularly by architectural space.⁶ It is the work of Brunelleschi, in particular, that is credited with the earliest consistent visual expressions of the principles of linear perspective that were later articulated by Alberti in a book dedicated to this very person and his friends, who were also close friends of Alberti.⁷ The traditional paradigm offers an analysis that is dependent upon then new European understandings of optics and perception in the Renaissance, and applications of these newly understood principles are particularly focused on the depiction of human beings and objects that are represented as if perceived in three-dimensional space.



Figure 3. Pedro Berruguete, (Spanish), late 15th century, Annunciation Panel, Sta. Maria de Mileflores, Burgos, Spain.

Often still considered as unique to the Renaissance, the innovation of representing three-dimensional space with a reasonable degree of mathematical accuracy in the two-dimensional picture plane, and its reflections in treatises of the Renaissance, is now recognized as being quite specifically dependent upon earlier treatises on optics written in Arabic by Ibn al Haytham (Alhazen), Latin translations of which were in circulation in Spain and elsewhere in the fifteenth century.⁸ Belting argues that the development of linear perspective could not have happened without the body of Arabic literature pertinent to the development of optics as a scientific field of study in Islamic realms (and its translation into Latin).

⁶ As described and treated, for example, by both Panofsky (1927) and Edgerton (1975). It should also be noted that Alberti was himself an architect. Almost all of Martin Kemp, *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat* (New Haven and London, 1990) deals with architecture and the representation of architecture in painting.

⁷ A chronological outline of the history of linear perspective based on the Western paradigm is presented by Edgerton (1975), pp. xv-vii; throughout the book there is a temporal focus on the earliest appearance of linear perspective in painting in the work of Brunelleschi as early as 1425, which was subsequently articulated in the treatise by Alberti (1435).

⁸ Hans Belting, "Double Perspective: Arab Mathematics and Renaissance Art," *Third Text Asia*, Issue 2, Spring 2009, pp. 15-21. See also Hans Belting, *Alhazen, Brunelleschi, and Western Philosophy* (Munich, 2008). The important contributions of Alhazen (Ibn al-Haytham) to Renaissance understandings are also described by David C. Lindberg, *Theories of Vision from Alkindi to Kepler* (Chicago, 1976), but touched upon only briefly by Kemp (1990). For further relevant discussion, see Nader El-Bizri, "A Philosophical Perspective on Alhazen's *Optics*," *Arabic Sciences and Philosophy* 15 (2005), pp. 189-218.



Figure 4, left. Andrea del Verrocchio, c.1476, *Madonna with Saints John the Baptist and Donatus*, oil on panel (altarpiece), Cathedral of Pistoia, Cappella del Sacramento.



Figure 5, right. Hans Holbein the Younger, 1533, *The Ambassadors*, oil on oak, National Gallery, London. ([www.en.wikipedia.org/wiki/The_Ambassadors_\(Holbein\)](http://www.en.wikipedia.org/wiki/The_Ambassadors_(Holbein)), accessed 1 October 2010).

Within studies addressing the development of linear perspective in the fifteenth century, scant attention has been drawn to the significance of the depiction of Oriental carpets in relation to representation of the spatial dimension. To address the topic from this new vantage point is both simple and complicated. While the focus of most studies has been on human form and objects within architectural contexts, the carpet, in contrast, offers an example of a three-dimensional object, the perception of which is as a flat surface – planar and two-dimensional in appearance. Almost as a counterpoint, the pattern of the carpet draws one’s vision to a place within the painting, attracting both the artist’s and the viewer’s attention to that place.



Figure 6. Unknown artist, *Somerset House Conference*, 1604, oil on canvas, National Portrait Gallery, London. (<http://www.npg.org.uk/collections/search/portrait/mw00166/The-Somerset-House-Conference-1604>, accessed 29 November 2010).

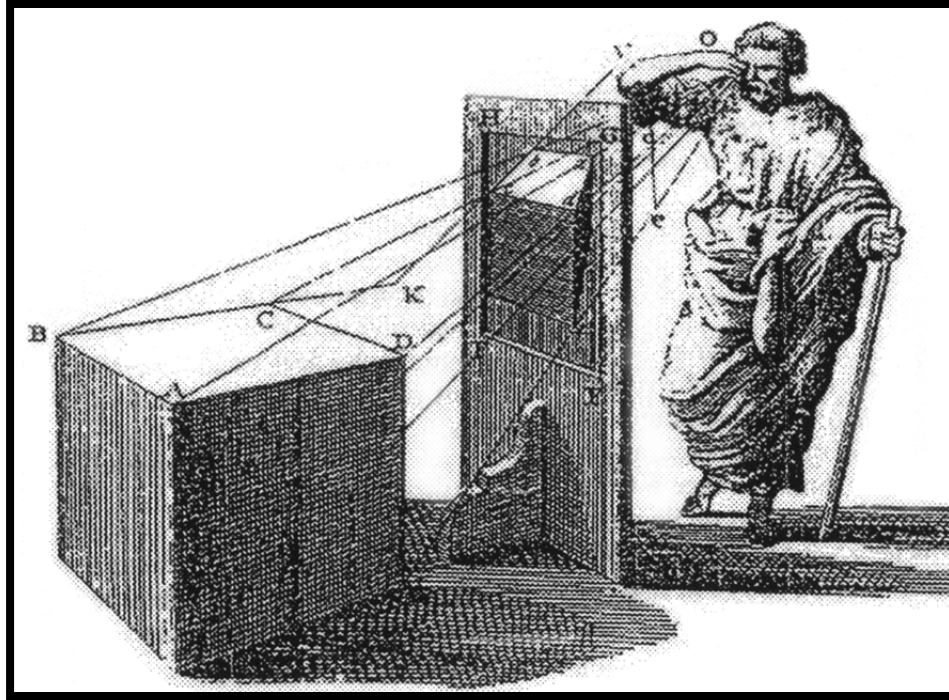


Figure 7. Drawing illustrating Alberti's descriptive methods of constructing linear perspective.
(<http://gallery.cabri.com/en/persp.html>, accessed 30 November 2010).

Carpets depicted in European paintings exemplify what we have come to call the “Oriental carpet.”⁹ But this begs the question – just what is an “Oriental carpet”? If one thinks about it, the term itself is oxymoronic, for no one ever produced one. The word “Oriental” hints at an outsider’s perspective, for the “Orient” was located to the east (of Europe). If it is referential at all, it offers a reference to something beyond, a place in the distance, not local. What would have been produced locally was “a carpet,” not an “Oriental carpet,” which must be recognized as a cultural construct of the West. A carpet would have been produced on a loom, which is a structure designed to hold warps (a set of parallel yarns) taut. By that means, a weft (transverse yarn) could be introduced and interlaced with the warps as weaving progressed. After several passes of the weft, supplementary yarns would be introduced to the emerging fabric structure, and these yarns would be colored, and wrapped around adjacent warps, so as to produce a pile. Thus, the resulting fabric is three-dimensional in structure, having length (warps), width (wefts) and depth (pile).¹⁰ And it would have been called a carpet, *hali*, or *qali*, or whatever word was prevalent in the local language of the person who wove it. Well then, where were Oriental carpets made? In lands that were once upon a time called the Orient (in Europe) – lands mostly east of the Bosphorus that divides the Orient from the Occident (Europe). [Not the Orient of the farther east of the last century]. So, what is meant when we say the “Orient” of the “Oriental carpet,” is Turkey, Iran, Central Asia, lands of traditional rug-weaving cultures where sheep-rearing was the staple of the economy. But we must expand this ecologically-defined geographic are to include culturally Spain in the 15th century, where many carpets were produced in the tradition of those we know (later) from Turkey and Turkmenistan, among other

⁹ See Carol Bier, “Mathematical Aspects of Oriental Carpets,” *Symmetry: Culture and Science* (Budapest), 12/1-2 (2001), pp. 67-77, available electronically through the Ethnomathematics Digital Library (2004).

¹⁰ For illustrations of pile-woven structures, see <http://mathforum.org/geometry/rugs/carpets/knots.html> (accessed 29 November 2010); the standard reference for description of structure and process is May H. Beattie, “On the Making of Carpets,” reprinted in King and Sylvester (1983), pp.106-109. See also, Carol Bier, “Approaches to Understanding Oriental Carpets,” *Arts of Asia*, vol. 26, no. 1 (1996), pp. 66-81.

traditions, and Egypt in the 15th century, where a unique geometric style developed in the context of Mamluk art and architecture.¹¹

Now carpets, being woven on a loom -- often a quite broad loom -- on which a set of warps had been strung up, have a particular underlying structure that forms a grid, the grid being created by the interlacing of warps and wefts. The loom's function, as mentioned above, is straightforward enough -- simply to hold the warps parallel and taut. Whether a ground loom, which is horizontal, or an upright loom, which is vertical, the warps comprise the longitudinal elements and they run parallel to one another. And the wefts, typically, interlace with the warps, becoming the transverse elements as weaving progresses. And the so-called knots -- which create the pile of the carpet -- are little cut segments of supplementary wefts of different colors that have been introduced singly and wrapped around a warp or warps above a row, or rows, of weft, as weaving progresses, and then cut to form tufts that jut out and rise above the surface, obscuring the underlying grid structure of interlaced warp and weft. If the colored yarns of the pile are inserted and wrapped, as they typically are, in counted and repeated sequences -- say 1-2-3-4-4-3-2-1, or double red-double blue-single yellow-double blue-single white, and repeated in some manner (as for example, in the same sequence, or the same sequence reversed), the sequentially wrapped colored yarns will create a pattern that is perceived on the surface of the carpet. And the weaver is at liberty to play with repeated sequences of color and form so as to create patterns of interest and excitement, achieving beautiful rhythms and intricate geometries, producing a conceptual infinity that is often made visually finite when bounded on all sides by surrounding borders. So the carpet, in effect, although three-dimensional in its structure, is intended to be seen as a two-dimensional surface that is a plane, and flat, but intricately patterned.¹² For some reason that we don't entirely understand, patterning is what characterizes all carpets in all traditional weaving cultures -- perhaps it can be attributed on the one hand to a flight from boredom -- imagine how boring it would be to insert knot after knot of a single color (or no color). Or perhaps at times and in particular circumstances it is a devotional exercise -- but that would be the subject of a different paper. Here I seek to focus attention on carpets both as woven objects in three dimensions and their representation as two-dimensional on the picture plane in European paintings, and to demonstrate their possible relationship to the development of linear perspective.

Given that carpets are relatively flat objects -- a pliable plane, as Jack Larsen likes to say, and that their patterning, no matter how complex, was intended to be viewed as two-dimensional, the linking of carpets to the representation of three-dimensional space would seem to be paradoxical. But the relationship may actually find a basis in historical reality.

Carpets produced in the "Orient" in the fifteenth century and perhaps earlier, were imported into an emerging early modern Europe from lands to the east.¹³ When they appear in early European paintings (fifteenth century and earlier), they are depicted as flat objects, often conforming to the vertical surface of the picture plane, while in the same paintings the depictions of human beings, architecture, furniture and objects may show early efforts to describe pictorial space, representing the architecture, furniture, and objects depicted to suggest they exist in three-dimensional space. In contrast, when carpets are included in later European paintings (sixteenth century and later), they tend to be depicted using the same artistic principles used to depict other objects and three-dimensional forms represented within the two-dimensional picture plane (figs. 5-6), and conforming to a mathematically derived treatment of space based on the projected grid (fig. 8).

¹¹ For a map of carpet-weaving regions of the world, see Carol Bier, "Symmetry and Pattern: The Art of Oriental Carpets," at <http://mathforum.org/geometry/rugs/carpets/map.html> (accessed 29 November 2010).

¹² Carol Bier, "Choices and Constraints: Pattern Formation in Oriental Carpets," *Forma (Journal of the Society for Science on Form, Japan)* (2000) v.15, no.2, pp.127-32 [Proceedings of the 2nd Intl Katachi U Symmetry Symposium (Tsukuba, 1999), Pt 3]. See also, Bier (2001).

¹³ See John Mills, "The Coming of the Carpet to the West," in King & Sylvester (1983), pp. 11-23.

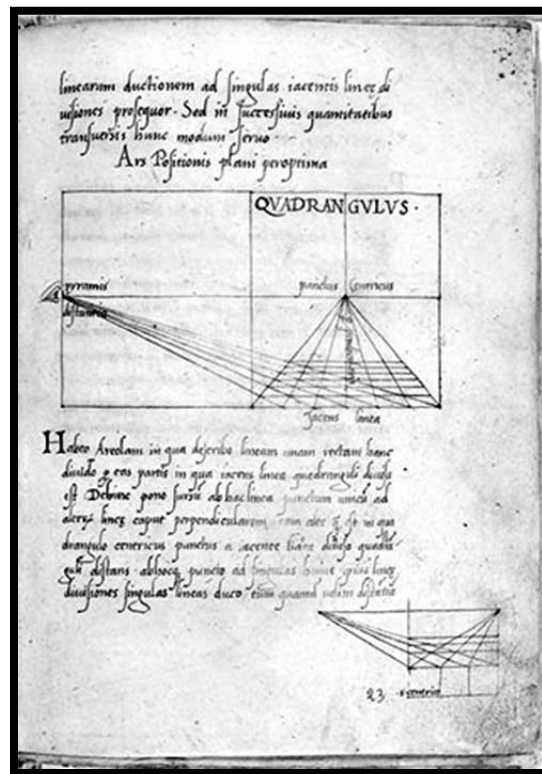


Figure 8. Leon Battista Alberti, Illustration from a 1518 edition of *De Pictura et Elementa*, paper codex, Lucca, Biblioteca Governativa, Ms. 1448, ff. 23r-v. (<http://brunelleschi.imss.fi.it/mediciscienze/emed.asp?c=70019>, accessed 29 November 2010).

This paper presents an interpretation based upon comparative observations of representations of carpets in European paintings, in which the carpets represented are either from Spain or in styles that influenced the production of carpets in Spain.¹⁴ The interpretation presented also rests upon an understanding of the unique underlying grid of a carpet, considered in relation to grids that are fundamental to the structure of patterns in Islamic art in the fifteenth century.¹⁵ As for carpets represented in European paintings and in Spain, the issues are not clear-cut, and nor are the attributions of the carpets represented.¹⁶ Preliminary study of the representations of carpets in paintings suggests that different conceptualizations of space often exist in the same painting in the fifteenth century, whereas in later centuries, there seems to be a greater consistency in the representation of the spatial dimension, in which carpets as well as other objects are depicted as if existing in three-dimensional space. Compare, for example, the following two representations: the carpet on which Henry II, King of France, is shown standing (fig. 1), which is depicted in an archaizing style oriented horizontally but in a plane parallel to the vertical picture plane, and, in contrast, the carpet shown draped over a table (fig. 5) in a painting by Hans Holbein the Younger in 1533. The carpet in the Holbein painting is rendered more naturalistically (by Western standards), as if draped over the horizontal surface of the table, with loose folds extending below the tabletop. The style of

¹⁴ Research for this paper was inspired by the preparation of a chapter on Spanish carpets for the catalogue of an exhibition under development by the Philadelphia Museum of Art on the “Crown of Aragon,” organized by Carl Strehlke, a project currently on hold.

¹⁵ Necipoglu (1995) offers an outstanding study of the role of grids used to structure such patterns in Islamic art.

¹⁶ The identification of carpets represented in paintings and difficulties of attribution was recognized already by Mills’ early study, *Carpets in Paintings* (1983); new attributions continue to be offered, as for example, by Walter B. Denny, *The Classical Tradition in Anatolian Carpets*, The Textile Museum, Washington, DC, 2002, pp. 50-53.

the carpet represented in these two paintings is referred to in the literature of carpet studies as “Large-Patterned Holbein,” characterized by large octagons set within squares that distinguish the large, square grid-based pattern.¹⁷ Further comparisons within *The Ambassadors* are worth mentioning – the function of the carpet is not simply to cover the table; it also serves as the dividing line that differentiates the arts of antiquity (below) and those of the (then) modern period (above, set upon the carpet) – the instruments of scientific accuracy. The viewer’s perception is also manipulated exceptionally in this painting by the artist’s representing a human skull that is visibly skewed by anamorphosis – a distorted projection that appears normal when viewed from a different angle, and which may be “corrected” by a mirror or lens. This intended distortion contrasts significantly with the play of light and shadow, indicating projections or recesses in the folds along the side of the carpet that extends below the edge of the table.

In the *Mass at St. Giles*, c. 1500 (fig. 2), another “Large-Pattern Holbein” carpet, similar in style, is oriented on the diagonal as if on a plane that appears to intersect the picture plane. This method of depiction is parallel to that of one of the earliest depictions of carpets, painted in fresco at the Papal Palace in Avignon dating from 1344-46.¹⁸ In the St. Giles painting, despite the hint of a spatial dimension conveyed by the shadows of drapery and converging lines of other planes depicted in the painting, the outlines of the carpets pattern show minimal convergence. In both St. Giles and Avignon, diagonal lines, folds, shadows, and outlines contribute to a sense of the spatial dimension by means of several simultaneous conceptualizations of space, none of which incorporate linear perspective.

The historical circumstances pertaining to the context of Berruguete’s *Annunciation* (fig. 3), however, are especially revealing to the sources of linear perspective in Spanish painting. Having travelled to Italy to study painting, Berruguete returned to Spain in 1489 and died in 1503. His earlier work reflected a Spanish interpretation of Flemish style, but his later work is described as having been profoundly influenced by his study in Italy where the Florentine Renaissance use of linear perspective was in full swing; on his return to Spain, he paid particular attention to the rendering of perspective through the spatial illusionism of tiled anterooms and thereby contributed to the development of the Castilian Renaissance.¹⁹ His *Annunciation* in Burgos shows an exceptionally early example of a carpet and its pattern depicted with a projected grid. Along with the converging grid lines of the floor tiles, the carpet clearly is used to structure space, providing an illusion of depth through the projection of its pattern, which is itself in turn structured by a rectangular grid.

Consistency in representation of the spatial dimension is more prevalent in later periods, both in Spain and in northern Europe. In an English painting depicting the Somerset House Conference, held on the 19th of August 1604 (fig. 6), note the representation of the carpet spread on the table. The painting illustrates the scene of the peace treaty established by Spain (represented by the individuals seated on the left) and England (represented by individuals seated to the right), who are facing each other across the table covered by a Turkish carpet – a type called “Small-Patterned Holbein,” which was also produced in Spain in the fifteenth century.²⁰ In this painting, the rectangular grid-based pattern shows converging lines in the warp direction, corresponding with the recession of space towards a vanishing point in the distance. Situated along the same converging lines are the edges of the table as well as the two rows of gentlemen

¹⁷ Denny (2002), pp. 29-31 and *passim*. The earliest known extant example of this type of carpet was discovered in 1973 in the Great Mosque at Divrigi and is attributed to the 13th century (Denny 2002, pp. 22-23 and p. 29). We do not know what such carpets were called in their original cultural contexts, nor in the European contexts of their depictions in painting; current terminology in the carpet literature offers terms of convenience, associated with the names of European painters, but not restricted in their representation to those individual artists.

¹⁸ See King & Sylvester (1983), p. 11 (fig. 2); also, <http://www.flickr.com/photos/26911776@N06/3852851098/>, accessed 6 December 2010.

¹⁹ Jonathan Brown, *The Golden Age of Painting in Spain* (New Haven and London, Yale University Press, 1991), pp. 12-14.

²⁰ Denny (2002), pp. 29-31 and *passim*.

seated at the table, which is reinforced by the diagonally aligned backs of the chairs at the front. Visible grids also appear in the leaded glass windows at the far end of the table, which one supposes is considerably reduced in size to suggest the illusion of distance.

Reconsidering possibilities for the origins and development of linear perspective, Richard Talbot illustrates various means of constructing the illusion of space that does not rely upon the principles established by Alberti.²¹ He relates such efforts to spatial experimentation, as generated by checkered floor patterns, tiling, and decorative pavements, as well as by coffered ceilings. Typical of such work on the origins and development of perspective, Talbot makes no reference to carpets and the grids that structure their patterns, which could be used similarly to generate a projected grid to represent the spatial dimension. In a rare mention of carpets in the context of spatial representation, Lauren Arnold notes one instance where the visual prominence of the carpet in the Pistoia altarpiece painted by Verrocchio (fig. 4), may perhaps contribute to and substantiate the interpretation of Verrocchio's "attention to nuances of space...[and] implicit geometries of viewing angles and distance points," as referred to by Patricia Lee Rubin and Alison Wright in their study of "Artists and Workshops," without direct reference to the carpet.²²

Although Alberti specifically refers to "equidistant and collinear qualities" and the "method of dividing up the pavement...we shall call composition" (Alberti, tr. Grayson 1991, pp. 48-49 and 58), it is equally apparent that stairs, tiles, and coffered ceilings served to structure space in the picture plane. Similarly, the grids that structure patterns in Oriental carpets provided a unit of measure for the proportional illusionistic treatment of the spatial dimension by means of a projected grid to depict the visual effect of receding space. The development of linear perspective can be tracked to demonstrate the use of carpets in this manner based on how they appear over time in Western European paintings to convey both place and a sense of space.

Expressive of the traditions of Islamic art that rely upon grids for patterning, Oriental carpets in Europe may indeed have contributed to the development of linear perspective in the subtle shift from square grid to projected grid in the depiction of the spatial dimension.

²¹ Richard Talbot, "Speculations on the Origin of Linear Perspective," *Nexus Network Journal*, vol. 5, no. 1 (Spring 2003), pp. 64-98, an online journal available at <http://www.nexusjournal.com/Talbot-pt01.html> (accessed 29 November 2010).

²² Lauren Arnold, *Circa 1440 Blog*, circa1440.blogspot.com, n. 11 (accessed 29 November 2010), quoting Patricia Lee Rubin and Alison Wright, *Renaissance Florence: Art of the 1470s* (National Gallery, London, 1999), p. 95.