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Original Paper

Frontispiece. 'The Annunciation' by Masolino (c. 1430).

Masolino da Panicale:

A Neglected Innovator of Renaissance Perspective

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On tend désormais à voir en Masolino un innovateur en matière de perspective, proche en particulier des principes formulés par la suite par Alberti, et l'on admet aujourd'hui que la complexité de son espace pictural est une donnée stylistique digne de considération et historiquement significante.

Daniel Arasse (1980)

[One will tend from now on to see Masolino as an innovator in the matter of perspective, adhering in particular to the principles formulated thereafter by Alberti, and accept today that the complexity of its pictorial space is a stylistic bequest worthy of consideration and historically significant.]

Abstract

The painter Masaccio has received the lion's share of the credit for developing the basic perspective construction that dominated the painting style of the Early-to-High Renaissance period, based on the geometric insights of the architect Filippo Brunelleschi and the mathematician Paolo Toscanelli. Close examination of the artworks of the period reveal that this misapprehension was based on a critical misattribution of many of the works supporting his claim from their true author, Masolino da Panicale. The two artists are well established as working closely together, with Masolino being the senior by 18 years. But Giorgio Vasari, whose 'Lives of the Artists' is the sole source for most of our knowledge of Renaissance painters, attributed the entire Brancacci Chapel works to Masaccio (with some finished by Filippino Lippi), while listing its profound influence on two dozen of the most famous painters of the Renaissance. Indeed, art historians have developed the notion that Masaccio not only taught perspective to his older collaborator, but "must have" provided the sketches for works painted by Masolino after his (Masaccio's) early death. A review of the current attributions of several of the Brancacci and other works to Masolino, and an analysis of the accuracy and consistency of the perspective construction in them, in comparison with the relative inconsistency of the actual Masaccio examples, leads to a reversal of the canard that the younger artist played a dominant role, indicates in fact that Masolino was the true master of accurate perspective for three-dimensional compositions, and that it was his array of strikingly original spatial constructions that influenced artists for the rest of the fifteenth century. These included not only the classic central one-point construction, but extreme examples of shifted one-point and even accurate two-point perspective. This impressive analytic capability is contrasted with the demonstrably intuitive approach to perspective construction by an array of contemporaries who have variously been proposed as key figures in the introduction of geometric perspective.

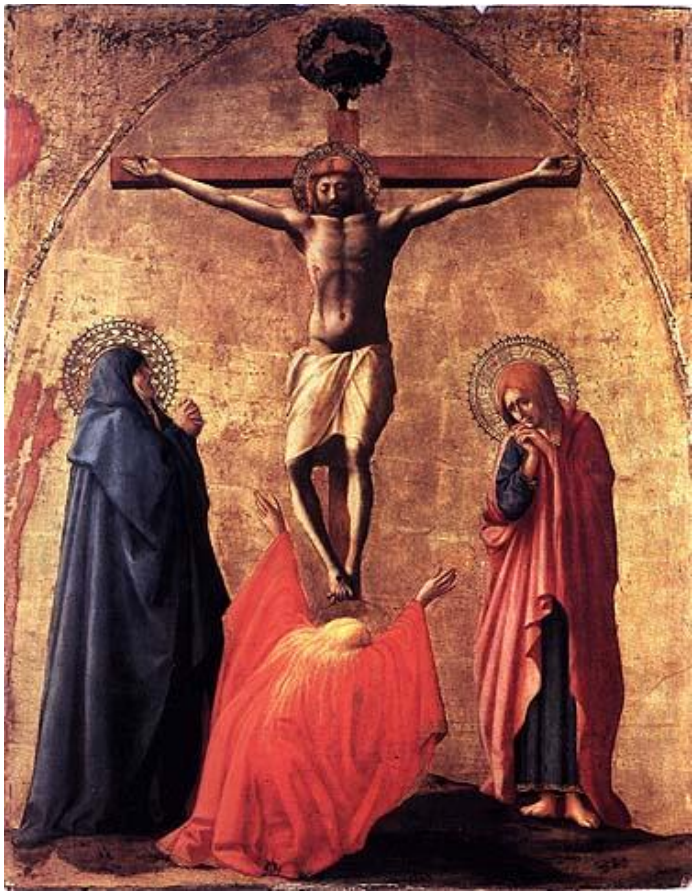


Fig. 1. 'The Crucifixion' by Masaccio (1426). Although this work exemplifies the dramatic figuration on which Masaccio's reputation is based, the background shows no hint of perspective construction at this late date, two years before his death.

1. Masaccio and Masolino

Recognized as one of the community of Florentine artists who founded the Italian Renaissance, Masolino da Panicale (Thomaso di Cristoforo Fini, 1383-c.1440) was renowned for his delicacy of style and aesthetic modeling of his figures. Vasari, for example, "found his style very different from that of his predecessors, for he endowed his figures with majesty, and made the draperies soft, falling in elegant folds." However, he is generally regarded as a minor player in the history of perspective, despite his long association with one of its recognized innovators, Masaccio (Tommaso di Giovanni di Simone Guidi, 1401-1428). As generally told, accurate perspective was introduced in Florence by the architect Filippo Brunelleschi (1377-1446), with the great flourish of perspective renditions of two classic Florentine buildings. The first surviving paintings in accurate perspective have been considered those of Masaccio, Masolino's younger collaborator. Masaccio seemed to project a vigour into all he touched, electrifying the era with dramatic depictions of the biblical stories, despite his early death at the age of only 27. Much of his work was painted in close collaboration with Masolino, but such is his reputation that he is generally credited with most of the innovation of their joint work, especially in regard to perspective.

Closer examination of Masaccio's work reveals that perspective was not such a dominant theme as may be generally assumed. As late as 1426 he was painting altarpieces completely devoid of perspective elements (Fig. 1). His main claim to perspective precedence rests on three of the frescos in the Brancacci Chapel and on the 'Holy Trinity' in the adjacent Church of Santa Maria Novella, painted in the year of his death. The latter work has, indeed been subjected to intensive geometric analysis (Field, 1997), revealing that the perspective construction, though sophisticated, is far from flawless. As the present analysis will show, all its projective features can be found in earlier Masolino paintings. The same is true of the other Masaccio frescos in the Brancacci Chapel.

Fig. 2. Masolino's portrait of St Peter (from 'St Peter Preaching', 1426, Brancacci Chapel, Florence) facing the portrait of Masolino from Vasari's 'Life of Masolino' (1568).

By way of introduction, Fig. 2 shows the portrait of Masolino from Vasari's 'Lives', expressing his self-confident and visionary demeanour as ton of the pre-eminent artists of his era. This is coupled with one of his several depictions of St Peter from the Brancacci Chapel in the Church of the Carmine in Florence, which appears to be a cryptic self-portrait of the artist.

There are two reasons that Masaccio seems to have received the major credit for the introduction of perspective to painting. Although the younger partner of Masolino, he had the more dynamic and evocative style, which was appreciated by Renaissance biographers such as Vasari (1550). More

recently, although the dating of his works used to place them earlier than those of Masolino, current scholarship has progressively retarded his works while advancing those of Masolino (e.g., Joannides, 1993). The result is the creeping anachronism of Masaccio being credited with the invention of perspective in frescos postdating by as much as five years the occurrence of accurate perspective in paintings by his mentor, Masolino. Before considering the issue of precedence, let us take an overview of Masolino's contributions to spatial representation.

Fig. 3. Detail of Masolino's 'St. Peter Healing the Cripple' (1425), showing foreshortening of the cripple's legs, vivid shadows, accurate perspective and Renaissance cultural elegance.

Vasari gives Masolino considerable credit for his perspective skill, while withholding the ultimate accolade: "If he had been a perfect designer . . .he would have been numbered among the greatest, for his works are executed with grace, in a noble style, with beautiful and harmonious colouring *and considerable power and relief in design*, though this is not absolutely perfect." (my italics). These skills are exemplified in the detail of 'St. Peter Healing the Cripple' in Fig. 3, from his work in the Brancacci Chapel. Grace is indeed characteristic of the figures. Masolino employs an interesting use of light that is reminiscent of the vividness of Netherlandish art of the period, combining sharp shadows of the pebbles on the ground with softer shadows from the figures at a greater distance from the ground, diffusing the penumbras of these long shadows. The depth effect is so strong that the pebbles almost look like water droplets on the page. Vasari, for instance, says that Masolino "achieved many difficult foreshortenings admirably, such as, for instance, as the poor man who is asking alms of St. Peter, his leg thrust out behind him, so that by means of the shadows on the colouring and the outline of the design he actually appears to be kicking the wall." Moreover, in current attribution, Masolino painted as many as twenty frescos in vivid perspective, a far greater output than his vaunted protégé. Analyzed in detail, one can find minor geometric imperfections in some of these paintings, but the perspective depth in some of them is nevertheless startling, as shown in the Frontispiece, for example. One has to agree that Vasari's assessment of Masolino's skills stands the test of time.

A **B**

Fig. 4. A. Detail of Masolino's 'St. Christopher,' (1435) with Jesus holding the globe of the earth. B. The 1968 NASA 'Earthrise' photograph of the actual appearance of Earth in space.

Despite the restrained grace of his style, it should be emphasized that Masolino's established works evince many examples of audacious creativity in their composition. He was one of the earliest exponents of pronounced foreshortening (Fig. 3), a technique that became greatly valued in the succeeding century. Even his earliest Madonnas are notable for the boldness of their poses, in contrast to late *Trecento* conventions. His later work includes a remarkable depiction of the globe of the earth, half a century before the era of voyages of discovery typified by Columbus' expedition (Fig. 4).

Fig. 5. Detail from Masolino's 'Fantasy Hungarian landscape' (1435, Palazzo Branda, Castiglione Olona) evincing a rich imagination of mountainous citadels supposedly inspired by the Hungarian city of Veszprem through which he had travelled.

And in one of his last paintings, Masolino embarks on a full-scale landscape punctuated by Utopian communities that is almost worthy of the imagination of Hieronymous Bosch (Fig. 5). Such examples argue against the stereotype of Masolino as a reticent traditionalist, filling in the figuration of Masaccio's breakthrough inventions. It is clear that the two were at least well-matched collaborators.

2. Masolino's Perspective Innovations

Let us, then, take a closer look at Masolino's oeuvre with particular reference to his use of perspective. As many have observed, issues of perspective are susceptible to a geometric treatment that takes us beyond areas of aesthetic judgement to more objective criteria of evaluation. This approach is compatible with my own background in vision science, which does not provide for an informed evaluation of the art historical determination of chronology, for example. Nevertheless, chronology plays a key role in the evaluation of the intellectual contributions to an era such as the Renaissance. The creative idea is necessarily attributed to the one who did it first, since the succeeding artists could so easily copy the concept once introduced. To address this need, the present approach is simply to accept the most current estimate of the dates of particular paintings, with the conclusions dependent on the accuracy of such chronology.

Fig. 6. The 'Miracle of the Snow' that occurred at the foundation of the church of Santa Maria Maggiore, Rome; left: as depicted by a Duecento mosiacist and right: by Masolino da Panicale (1423). (The mosaic was occluded at lower right by an ornament, which has been greyed out for clarity.) The overall similarity of the compositions is striking, except that Masolino inserted clouds and perspective scenes of Rome in place of the Duecento angels and strange blanket of snowflakes.

With these caveats in mind, the record indicates that Masolino's early works up to about 1420 consist of a series of Madonnas and similar works, well-characterized by Vasari's historical description, on backgrounds of plain gold leaf. He then ventured into a number of related altarpieces with a change of style that involved the addition of structured backgrounds that required some sort of perspective construction. This approach to ecclesiastical painting was not new; it had been practiced for over a

century by artists such as Giotto, the Lorenzetti brothers and Taddeo Gaddi, with an elaboration of the mediaeval conventions of incoherent local perspective. In the Trecento, each object in the scene had an acceptable perspective, but relations among them were still often incoherent and spatially disturbing. What was new in Masolino's paintings was not the interest in spatial structure but the fact that it was suddenly rendered in accurate perspective unified throughout the scene.

Before considering the perspective of the Santa Maria Maggiore altarpiece (Fig. 6, right), it is of interest to consider its history. The sad state of Rome in the early 1400s was due to the Great Schism of the West, with a succession of antipopes laying claim to the papacy. The city was occupied by General Sforza Attendolo of the kingdom of Naples, and was in an advanced state of ruin, famine and sickness, with very few, starving inhabitants. Eventually, Pope Martin V was elected in Konstanz, Germany, by the Council of Konstanz after two years of negotiations, and made his way slowly to Rome with a final stop in Florence for about a year. With the help of the Florentines, Martin came to an understanding with the famous condottiere Bracco di Montone, who had gained mastery over half of central Italy. The pope allowed him to retain the cities of Perugia, Assisi, Todi and Jesi as vicar of the church, whereupon Bracci ceded all his other conquests to papal control. Pope Martin V finally arrived in Rome on 28 September, 1420. He immediately set to work establishing order and restoring the dilapidated churches, palaces, bridges, and other public structures. For this reconstruction he engaged some famous masters of the Tuscan school, and thus laid the foundation for the Roman Renaissance.

Principal of those masters was Masolino da Panicale, who was selected for the prime commission of the altarpiece of Santa Maria Maggiore, probably the most venerable church in Rome at that time. Masolino, then, should not be regarded as one among a bevy of artists of the period, but as the most exalted of the group, chosen for the most prestigious commission in the whole of Rome, the altarpiece of the venerable basilica of which Martin was the patron. For this commission Masolino followed the theme laid down by his predecessors in a mosaic of the same event, as may be seen in Fig. 6, left.

As if to highlight its significance at this point in history, Masolino employed a historic innovation in the medium used in this altarpiece – oil paint. The snow in the ground-plan of the church has a soft, full appearance that analysis reveals to have been conveyed by pigment dissolved in linseed oil. This discovery is described by Strehlke and Forsinini (2004) in the following terms: "what may be the most remarkable use of a paint, whose appearance and handling are utterly unlike anything seen elsewhere in early quattrocento painting . . . is strange in a picture of this early date. It more than anywhere else suggests that [Masolino] was aware of what the oil medium might be able to achieve." It thus appears that it was Masolino who was the first known artist to employ the lustrous medium of oil paint to artworks, a decade or so before Jan van Eyck (who is generally attributed with that discovery).

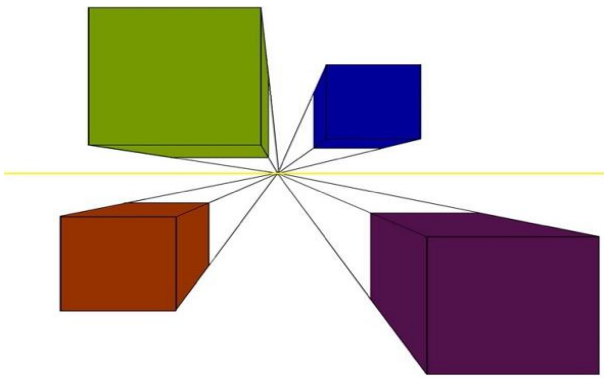


Fig. 7. The one-point perspective construction, with convergence of the receding horizontals at the horizon.

To evaluate perspective accuracy, one needs to have a clear understanding of the rules of perspective, three of which will be relevant to the present discussion. One is the rule of the central vanishing point. If we imagine a canvas set up before the scene to be painted, all edges receding from the (at a right angle to it) will project to lines in the picture converging toward a single, central vanishing point (Fig. 7). This is the familiar one-point construction, which applies to a scene where one set of edges recedes from the canvas to this central vanishing point, while all other edges are parallel to the surface of the canvas and project to the picture without distortion. In Fig. 7, these parallel edges are the edges of the square sides of each cube that are facing us, and therefore project as square.

Fig. 8. Detail of Masolino's 'Foundation of the Church of Santa Maria Maggiore' (1423), showing the accurate convergence to a central vanishing point.

For correct perspective, the vanishing point should be directly in line with the viewer's eye location (normal to the canvas plane), at its geometric center of projection. Thus, the use of a displaced vanishing point, either vertically or laterally, will result in incorrect perspective geometry if the picture is viewed centrally. Conversely, the perspective with a central vanishing point will be incorrect if

viewed from a displaced position, as in the typical view of frescos such as Leonardo's 'Last Supper' on a high wall of the refectory of Santa Maria delle Grazie, Milan, or the Masolino fresco to be discussed in Fig. 12. In fact, although virtually all of Italian Renaissance frescos are composed with a central vanishing point, the vast majority of them cannot be viewed with the eye in the correct location due to their height above the ground and other restrictions of the church architecture. In this sense, all such paintings exemplify Panofsky's concept of "perspective as symbolic form", in that the perspective conventions are employed to give a sense of the spatial layout of the scenes depicted without adhering to the requirements of a full virtual reality geometry. Instead, they seem to rely on Kubovy's (1988) robustness principle that the viewer can project themselves to the center of projection in space before the painting. It remains, however, unclear to what extent they can achieve the full stereoscopic sense of the depicted space from their displaced position.

The second rule applies to other lines or edges at various angles in the ground plane, or parallel to the ground plane (not shown in Fig. 7). All edges parallel to the ground plane will have a vanishing point at the same level as the central vanishing point. In fact, all these vanishing points will be in the line of the horizon (yellow line in Fig. 7). The third rule is that the single vanishing point of the one-point construction may be shifted to any point in the picture. This shifted vanishing point construction has been used extensively, both during and since the Renaissance. However, it should be appreciated that, in true optical projection, the vanishing point is always directly in front of the viewer. If the vanishing point is shifted away from the centre of the picture to the left or right, this implies that the viewer has shifted in a parallel fashion to view the scene from this displaced left or right position. The shifted perspective is thus only strictly correct if viewed from such a shifted position, which seems particularly uncomfortable in the typical case of shifting it all the way to the edge of the painting.

With the rules in hand, we may examine Masolino's paintings for the accuracy of their perspective. The 'Foundation of the Church of Santa Maria Maggiore' shows the Pope Liberius using a hoe to delineate the ground plan of the new basilica in Rome (Fig. 8). In the background to the left and right are two ornate buildings. All the parallels of the two background buildings and of the apse of the ground plan share a common receding axis, and should therefore adhere to a common vanishing point. It is a pleasure to find that such a vanishing point can be found at the center of the painting, despite the wide separation of these three structures from each other. Notice in particular the accurate convergence within the cornice moldings on both buildings to a mutual vanishing point. The snow clouds also show an appropriate degree of convergence, although it is difficult to assess their geometry with any accuracy. The alignment of the clouds, of course, should not be expected to converge to the same vanishing point unless their recession was at the same angle as the faces of the buildings. But their haphazard arrangement does not permit a rigorous evaluation of the linear perspective construction. There would be no reason to have a coincidence of the three vanishing points unless the painter was clearly aware of its geometric necessity. On present chronology, this is the first known painting rendered in accurate one-point perspective.

In fact, this painting was singled out by Vasari for particular praise in his Life of Masaccio: "He also made many panels in distemper, which have been all lost or destroyed in the troublous times of Rome; one being in the Church of S. Maria Maggiore, in a little chapel near the sacristy, … with the portrait from nature of Pope Martin, who is tracing out the foundations of that church with a hoe, and beside him the Emperor Sigismund II [facing us at the rear of the foundation plan]. Michelangelo and I were one day examining this work, when he praised it much, and then added that these men were alive in Masaccio's time." Despite its location in the wrong Life, its attribution to Masolino looks sound, because all the faces of the many participants have a delicacy and form that is characteristic of Masolino's style throughout his career, and are quite inconsistent with Masaccio's rugged physiognomies.

Despite the accuracy of the convergence on all sides to a single vanishing point, however, one might note that it is located well below the horizon in the background, so Masolino had evidently not yet realised the need for the vanishing-point lines to converge exactly at the horizon. (One might argue that the horizon should be below the hilltops, but in fact this church was sited on the Esquiline hill, the largest of the seven hills of Rome, so the topographical eye-line should be at the tops of the hills.)

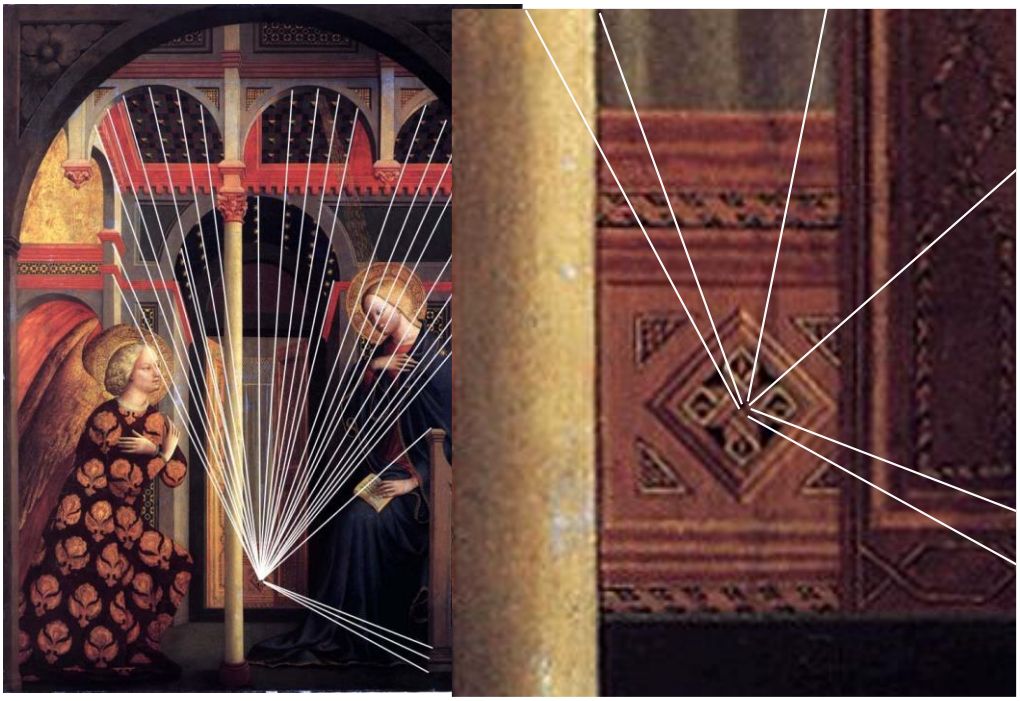
A smaller panel on the same altarpiece depicts the dual event of St. Julian being deceived by the devil outside his dwelling and decapitating his parents as a result on the inside (Fig. 9). The style again points clearly to Masolino as the artist. The local construction lines are strongly inscribed in this treatment, implying a great attention to the issue of perspective. Such attention may have been required because of the striking offset of the vanishing point well to the right of the center in this composition. These construction lines make it very clear that every single receding line adheres accurately to the displaced vanishing point, even those all the way to the left edge of the elongated frame of this predella.

Fig. 9. Masolino's 'St. Julian Deceived by the Devil' (1423), showing the accurate displaced vanishing point.

It should be emphasized that here, as in the 'Foundation', the likelihood of all such construction lines converging to as single vanishing point if guided solely by intuition is extremely low (as exemplified by Gentile da Fabriano's 'Presentation at the Temple' from the same year, which has a wild assortment of vanishing points scattered over a large area, despite the relative success of its intuitive perspective construction; see Fig. 21). Convergence of three or four lines to a single vanishing point may be regarded as a happy accident, but when the numbers reach 10 or 12, the statistical probabilities become so small that a guiding intelligence must be assumed. The conclusion from the analysis is that Masolino appears to have been the first to develop the accurate displaced vanishing-point construction that became a staple of the later *Quattrocento*, with such practitioners as Fra Angelico, Fra Carnevale, Carpaccio and Mantegna.

A further example of Masolino's grasp of perspective is provided by the Goldman 'Annunciation' (Fig. 10), which is currently dated to 1424. Although this painting has been attributed to other artists such as Uccello in the past, it is now generally accepted as Masolino's work (Joannides, 1993). Here the announcement is played out in front of an archway with an elaborate vaulted ceiling construction. At the base of the arch is an 'Knot of Solomon' emblem with a clearly defined centre, forming a deep three-dimensional design of spiral elements. Projection lines indicate that this emblem precisely marks

the central vanishing point, not only for the lines of stars inside the arch but for the entire ceiling above it. Moreover, the same vanishing point serves for the Madonna's throne the right and (less accurately) for the architectural features to the left. All horizontals throughout the depth and range of the picture are therefore integrated into this single vanishing point, which Masolino can be interpreted as triumphantly identifying with this striking Knot of Solomon to corroborate his discovery. No other cases of such a specific accentuation of a vanishing point are known, although approached in such rare examples such as the 'Last Supper' of Leonardo da Vinci, where he seems to use the vanishing point to emphasize the central figure of Jesus in the composition.



A **B**

Fig. 10. A. Masolino's 'Annunciation' (1424), with its fully integrated 3D vanishing-point construction from rearground to foreground. B. Detail with outlined perspective construction showing how it converges to the 'knot of Solomon' emblem in the doorway.

The only objects set at an angle to the receding lines perpendicular to the picture plane are the half-open doors within the central archway. The tops of these doors are at two different angles to the picture plane, and therefore by our second rule their horizontals should converge to two different vanishing points. Such a construction poses a difficult problem within the framework of one-point perspective, and one might well have expected Masolino to have employed the intuitive approximation that is typical of most Renaissance examples. It is somewhat of a surprise, therefore, to find that both the door outlines and their inset panels converge to accurate lateral vanishing points. More to the point, both vanishing points are exactly at the level of the central vanishing point defined by the bulk of the composition. Somehow, Masolino was up to the challenge of this oblique construction, which evaded most artists for the next century or more.

The collaboration between the two Thomas's (for both of the names Masolino and Masaccio are diminutives of Tommaso) was expressed in their best-known works, the frescos in the Brancacci chapel. Here again the panel that is most clearly identified with Masolino, the double scene of miracles of St. Peter detailed in Fig. 3, has the strongest perspective construction of any of the panels (Fig. 12). Although the ground plane is a rock-strewn earthen floor, almost all the receding horizontals in the

buildings around the piazza conform accurately to a single vanishing point. This is the more remarkable because the structures span the visible depth range, from the front edge of the picture to the narrow streets in the far background (where the convergence requirements are close to parallel). In the words of White (1957), "Here is the joy of space creation largely for itself – exuberant exploitation of a new-found power." Again, only someone with a thorough commitment to the principle of central convergence could have achieved this global level of uniformity. As shown in Fig. 12, one can find as many as 24 horizontals that converge to an accurate vanishing point at the figures' eye level, although four other lines deviate from this centre by a small amount. As other early *Quattrocento* works show, the probability of finding this degree of convergence on the basis of intuitive construction alone is so small as to be negligible.

Fig. 11. Distance-point convergence for the diagonals in the ceiling (white lines) to the horizon line (yellow line) defined by the central vanishing point of Fig. 10. The turquoise lines show the oblique convergence of the two doors in the background, which are at different 3D angles from the ceiling diagonals, to the same horizon line.

This focal work was in fact the pinnacle of array of works in the Brancacci Chapel, which inspired Vasari to extreme heights of hyperbole:

"… and there still are therein some heads so lifelike and so beautiful, that it may truly be said that no master of that age approached so nearly as this man did to the moderns. His labors therefore deserve infinite praise, and above all because he gave form in his art to the beautiful manner of our times.

And that this is true is proved by the fact that all the most celebrated sculptors and painters, who have lived from his day to our own, have become excellent and famous by exercising themselves and studying in this chapel; namely, Fra Giovanni da Fiesole, Fra Filippo [Lippi], Filippino [Lippi], who finished it, Alesso Baldovinetti, Andrea dal Castagno, Andrea del Verrocchio, Domenico del Ghirlandaio, Sandro di Botticello, Leonardo da Vinci, Pietro Perugino, Fra Bartolommeo di San Marco, Mariotto Albertinelli, and the most divine Michelangelo Buonarroti; likewise Raffaello da Urbino, who owed to this chapel the beginning of his beautiful manner, Granaccio, Lorenzo di Credi, Ridolfo del Ghirlandaio, Andrea del Sarto, Rosso [Fiorentini], Franciabigio, Baccio Bandinelli, Alonso Spagnuolo, Jacopo da Pontormo, Pierino del Vaga, and Toto del Nunziata; and in short, all those who have sought to learn that art have ever gone to this chapel to learn and to grasp the precepts and the rules for good

work from the figures of Masaccio [and Masolino, as presently attributed].” This is an astounding scope of influence across the spectrum of art history for the two early Renaissance partners.

Fig. 12. Masolino’s ‘St. Peter Healing a Cripple and the Raising of Tabitha’ (1425). Note the almost perfect convergence of the vanishing points for receding horizontals from all parts of the composition, from the front of the scene (white construction lines) all the way to streets in the far distance (black construction lines).

The intensive collaboration between the two Thomases is also evident in one of the Brancacci works most firmly attributed to Masaccio – ‘The Tribute Money’ (upper panel of Fig. 13). Most of the figures have the distinctive cast of Masaccio’s rough-hewn sculptural style. The perspective construction also is often cited as a prime example of Masaccio’s skill. It is noteworthy, therefore, that the style of the central figures in this panel are consonant with those of Masolino rather than Masaccio, as seen in his fresco (Fig. 12). The lower panels of Fig. 13 shows details of the many of the heads in the ‘Tribute Money’. It is clear that these are close matches to the figures of Jesus and St. Peter in ‘The Tribute Money’. Those of the central group of the Apostles (with Jesus occluded) are typical of Masaccio’s style, with woolly ringletted hair, rounded brows, uncomprehending expressions and somewhat hunched shoulders. A similar description applies to the figures of St Peter and the Tax Collector in the separate vignette on the right. The three central figures of St Peter, Jesus and St Thomas, on the other hand (central group of three faces in Fig. 13, lower panel) are strongly reminiscent of those in Masolino’s fresco. Evidently, Masolino was the one to have painted these key elements in the composition.

It has sometimes been suggested that Masaccio was working on this picture at the time of his death, and that Masolino came back to complete the faces of the principal figures later. Partially painted pictures of the period suggest that this order of events is unlikely, and that the principal figures were usually painted first. This fact suggests that alternative scenario that Masolino, the senior artist by some 18 years, and well-established painter in the papal employ in Rome, was the dominant exponent of this panel. Perhaps he painted the central figures and then had Masaccio, as the junior partner, complete the accompanying group of apostles. This order of completion would make a better fit with the seniority of the two painters, providing a much different insight into their relative skills than that promulgated by Vasari writing more than a century later.

This brings us to the issue of the perspective of the building at right in ‘The Tribute Money’. The general consensus is that Masaccio was the one to bring perspective technique to the partnership, but there is very little evidence to support this claim. In fact, the examples cited so far show that Masolino painted many accurate perspective pictures long before any by Masaccio are known. Masolino,

therefore, may well have provided the background building here, too, leaving the junior Masaccio to exhibit his famous figuration skills. Interestingly, the vanishing point in 'The Tribute Money' falls well to the right of the head of Jesus (white lines in Fig. 13), contrary to the common conception that it demarcates the head location. Whether vanishing points were intentionally aligned with key elements of the composition (Arasse, 1980) is an interesting issue to be taken up after more examples have been discussed.

Fig. 13. Upper panel: 'The Tribute Money' (1427, Brancacci Chapel). The linear perspective portion is indicated by the dashed lozenge. Lower panels: details of the heads of the figures. Left: a selection of the group of apostles, with the tax collector, evincing Masaccio's typical rough-cast faces and woolly hair. The three central figures of the story, Peter, Jesus and Thomas, have a more square-jawed, alert look typical of Masolino, while the duo in the vignette at right are back to the Masaccio physiognomy.

The second major collaboration between the two artists was in the decoration of the Santa Caterina Chapel the Basilica of San Clemente, close to the Coliseum in Rome. This commission began in 1428, the year that Masaccio died, so his degree of involvement in the effort is unclear. He is typically given an influential role in the series based on the strength of the perspective in many of the panels (Fig. 14). However, as we have seen, current dating suggests that it was Masolino who had the advanced sense of perspective while Masaccio contributed the human emotions and figuration in the large 'Crucifixion' panel (not shown here). This arrangement makes rather more sense of their extended collaboration, since one can imagine the senior Masolino setting to work in defining the layout of the composition and the positioning of the figures, while his young collaborator developed his expressive style in elaborating the more emotive characters of the drama. It is generally agreed, for example, that the expressive poses of the Roman soldier and Mary Magdalene in the San Clemente 'Crucifixion' are likely to be the work of Masaccio. On the other hand, the majority of the panel decoration of the left wall illustrating the life of St. Catherine retains the more restrained style of figuration associated with Masolino (Fig. 12). He evidently seized the opportunity to develop this complete sequence with gusto,

developing a series of panels of the trials of St. Catherine of Alexandria with perspective backgrounds so vivid that they tend to overpower the action.

Now that we can establish Masolino's earlier proficiency with perspective, there are no grounds for attributing any of these panels to Masaccio. Indeed, the architecture in each panel, particularly the 'Miracle of St Catherine' in the lower central panel, has a formal simplicity and grace that is resonant with Masolino's style of figuration. It is incompatible with the classical 'Roman Forum' style that is characteristic of Masaccio's 'Holy Trinity'. On stylistic grounds, one would immediately categorize these two works as by different artists. Since the 'Holy Trinity' is firmly associated with Masaccio, it follows that Masolino must have been the one to paint the St. Catherine series.

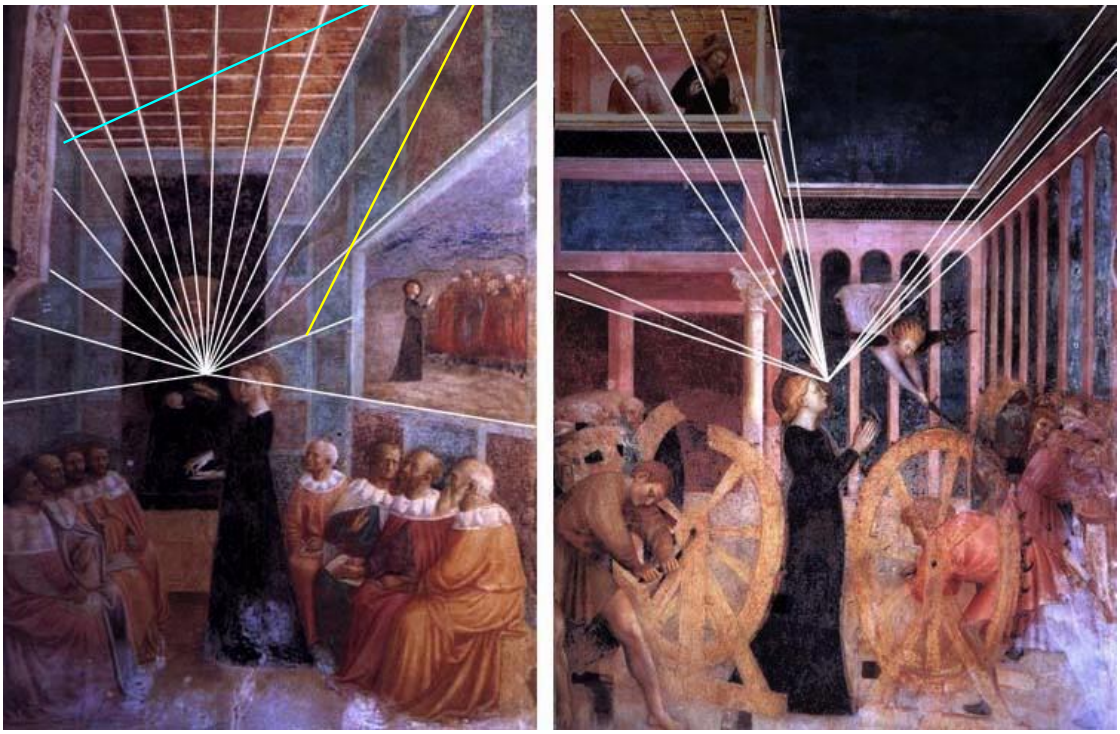
Fig. 14. The St. Catherine cycle of five panels exhibiting Masolino's creative use of perspective to enhance the story of the saint's powers of persuasion.

Given that the St. Catherine series is the work of Masolino, we can immediately see just how involved he was with the background structure at this time. This is clearly a man intoxicated with perspective, even to the detriment of the balance of the compositions - in the view of some critics. In several scenes, the perspective is so strong as to almost crowd out the action. The panelling, the arcade, and the dome of the Pantheon are vivid explorations of a variety of three-dimensional structures. Masolino seems to be reaching into his toolkit for a range of effects with which to establish that he is a master of this new

medium on a par with his junior collaborator, who had just completed his chef d'oeuvre in the Santa Maria Novella.

3. The Question of Technique

One issue that has gained recent currency is the extent to which Renaissance artists might have used optical devices to aid them in the new discoveries of accurate depth rendering. The main candidate for such a device at this point in history would be the *camera obscura*, a means for projecting the image of a scene onto a wall inside a darkened room. The geometry of the perspective gives us an important tool to evaluate such speculations; an artist using such a device would be likely to avoid major errors in the construction by virtue of the fact that they would be able to make measurements for any part of the perspective that they did not understand well. Before considering the perspective construction in this light, however, we should consider the plausibility of the use of a *camera obscura* in the ecclesiastical settings in which the art of the early *Quattrocento* was engendered. There are a number of problems with this concept.



A **B**

Fig. 15. Two panels with accurate central convergence throughout each scene, from 'The Miracle of St. Catharine' by Masolino (1430).

First is the issue of the light. The *camera obscura* requires a high level of light for its operation, and was consequently used for astronomical observations of the sun's path. Inside a church, the light levels are severely restricted, as is the directionality of the light path. There are only a few special circumstances where appropriate lighting conditions would have been available for a particular mural location. Next is the issue of scale. The *camera obscura* was generally used on a scale from a few centimetres to a metre or so. To employ it for projecting to wall panels on the order of 10 metres on a side is far more demanding, requiring even higher light levels to provide a perceptible image. This requirement in turn would imply the need for extensive curtaining to darken this large volume sufficiently to maximize the image visibility. And finally, there is the issue of the object represented.

The *camera obscura* can only project objects in a real scene, but the artist is constrained to paint the biblical events for which the church has commissioned him. He would therefore have to build at least a skeleton structure of the scene in question to generate the three-dimensional model for the desired scene. This construction would have been particularly demanding for the more extreme perspectives, because those are the ones that depict the longest reaches of physical space.

While not impossible to achieve, the entire enterprise of the *camera obscura* is something that would tend to appeal far more to an engineer than an artist. How much simpler it would be just to understand a few rules of projection and make some measurements with a stretched string on the wet plaster of the fresco wall. So if the *camera obscura* was used, it would have to have been at the expense of a great deal of effort to construct the apparatus (and to carry it all from one assignment to the next), and to the detriment of conceptualization of the optical requirements. The difficulty of this enterprise just adds one more reason to doubt that the *camera obscura* could have been used by Masolino in his seminal work.

With this contrast in mind, we may consider the perspective construction employed by Masolino at this time. The real test of an understanding of the spatial construction of perspective is not the flat plane of a tiled floor or *pavimento*, but the three-dimensional construction of an architectural scene with convergence from all sides. Masolino attempts this feat in the multicoloured panelling of the room in which St. Catherine stuns the assembled elders with the philosophical power of her answers to their interrogation (Fig. 15, left). The walls are panelled on three sides and, to have an accurate perspective construction, all orthogonals should adhere to a single vanishing point. Just as in his 1423 altarpiece, Masolino achieves this integration with near-perfect accuracy throughout the entire composition.

The second feature that should be integrated is the recession of the transversals (parallel to the picture plane) on all three walls. Here Masolino evidently runs into problems, because the width of the panelling is greater in the right wall than on the ceiling. He does not seem to have realized that the rules that apply to horizontal surfaces, with the oblique vanishing points on the horizon, apply also to vertical surfaces, with the oblique vanishing points in vertical alignment. This *lacuna* is not as strange as it may sound, since as much as 200 years later the proficient geometer Vredemann de Vries would still be illustrating the idea that all vanishing points should fall on the horizon, even for non-horizontal objects (Kemp, 1990). It is highly credible, then, that Masolino, as the first to apply rules of convergence, would retain a misunderstanding of the vertical recession behavior.

Paradoxically, the very error in the vertical aspect assures us that he had understood the other rules of convergence, for no such error would have been made if Masolino had employed a device such as a *camera obscura* for his perspective construction. There are two possibilities consistent with the use of such an optical instrument. One is that the construction would be loally consistent, whether or not the painter had any understanding of the rules of projection. The second is that the *camera obscura* was used for one part of the scene (such as the ceiling in Fig. 15A), but could not be used for another because the appropriate structure was not available for projection. In this case, the added region (such as the right wall in Fig. 15A) would be generally discrepant in construction. However, the fact that its vanishing point is accurately integrated with that of the ceiling suggests that Masolino was fully aware of the central convergence rule, but had not come to terms with the rule of equal recession of the transversals on the wall and the ceiling.

The counterpoint between Masolino's accuracy of the central vanishing point and his ineptness in handling the transversals sheds an interesting light on the derivation of his technique. It is well established that Brunelleschi was a master of the *costruzione legittima*, an architecturally-based method of constructing perspective from the projection of plan and elevation that required no knowledge of vanishing points (Vasari, 1550; Gioseffi, 1957; Sinisgalli, 1998). With this laborious method, one would obtain equal accuracy in the orthogonals and transversals, so that either both would be accurate or neither would be accurate. The discrepancy in accuracy between the two line directions thus implies

that Masolino was using the central vanishing point as a short-cut to the full construction, and either not bothering with, or not realizing, the need for the same kind of geometric scheme for coordinating the transversals. As shown by the alignment of the cyan line in Fig. 15A with the intersections of the ceiling beams, the recession of the transversals on the ceiling is essentially perfect, as indeed can be achieved by the use of such an oblique line in their construction. The problem is with the wall transversals (e.g., yellow line in Fig. 15A), for which no diagonal can be found that will pass through all the required corners. This lapse suggests that Masolino had not thought through the application of the oblique transversal construction for vertical surfaces, whereas its use was well-known for horizontal tile floors throughout much of the previous century (Field, 1997).

Fig. 16. Masolino's decoration of the Castiglione Olona (1435), showing the welter of colour and action with which he covers the walls.

The martyrdom of St. Catherine in Fig. 15B is an active composition in which the angel is destroying the wheels to which the saint was to be bound. St Catherine herself, on the other hand, is immobile at the centre, praying for release from her trials. This statuesque pose is interestingly echoed by the portentous architecture of the surrounding colonnade, to which her gaze is directed. The link between the saint and the architecture is emphasized by its perspective construction, which has its vanishing point just in front her eye. Despite claims that this is a common theme of Renaissance composition

(Arasse, 1980), such co-location with a narrative motif is actually a rarity in any period of art. Indeed, this example is the first known use of the idea, although even here the coincidence is not exact, so it remains unclear to what degree it was intended. As illustrated in Figs. 8-15A, even Masolino seldom used this device, typically placing the vanishing point at some nondescript location in the background. Note, however, that the vanishing point itself is again used with great accuracy in Fig. 15B, in that all four parallels within the pediment at right converge to the vanishing point. As in his previous work, Masolino did not just align the overall structure correctly. He took care to provide uniform convergence for each separate element of the molding. There should be no doubt, therefore, that the central vanishing point was fully comprehended.

In general then, the decoration of the Santa Caterina Chapel represents a masterpiece of this compelling artist, a proving ground for his new tool of perspective depth, and testament to his evolution from the decorative emphasis of the International Style to a true Renaissance 'modernism' in the open structure of the compositions and the bold fresh coloration.

Fig. 17. Masolino's 'Feast of Herod' (1436) in the Castiglione Olona. The dramatic perspective construction with accurate convergence to a central vanishing point (white lines) tends to overpower the action of the presentation of the decapitated head of John the Baptist by Salomé to her mother (at lower right).

The success at San Clemente was soon followed by an even more ambitious project, the renovation of the Castiglione Olona (Fig. 16). Here Masolino swathes the vault of the church with a riot of color beyond anything that had been conceived in the art of the time. Surely the Castiglione Olona must be regarded as Masolino's 'Sistine Chapel', the *chef d'oeuvre* of his career, despite its severe state of decay. The dominant theme of the compositions relies on depth, although much of it is pastoral and atmospheric, rather than the linear perspective of the San Clemente periodA dramatic example is afforded by Masolino's 'Feast of Herod' (1436), shown in Fig. 17. In the words of John White (1957), "In the whole of the first half of the fifteenth century there is nothing that can match the exuberance of the 'Feast of Herod' . . . Such a clear, uninterrupted sweep of architecture from the foreground inwards

to such depth had never been attempted until this time." This receding arcade bears a strong resemblance to the architecture of Brunelleschi's Foundling Hospital in Florence, which had been completed in the preceding decade. It is certain the Masolino would have been familiar with this edifice, the finest example of the contemporary architecture in his home town of Florence at that time. It therefore seems plausible that Masolino became entranced with the perceptual effects of this receding vista and was inspired to use it to enhance his subsequent composition.

In summary, both the earlier and the later work of Masolino underline his devotion to perspective, in the form of accurate one-point constructions, both central and displaced. In this, the Italian Renaissance followed him, employing almost exclusively the one-point and displaced one-point formats. Given the absence of both constructions before they are found in Masolino's compositions, and the fulsome encomium by Vasari of the widespread influence of the Brancacci Chapel, it is hard to imagine that these highly accessible works were not pivotal in the dissemination of the concept of perspective representation.

4. Two-Point Perspective

One of the only accurate two-point constructions of the Italian Renaissance is a painting from the late Quattrocento of Christ healing a lunatic (Fig. 18), brought to light by Bernard Berenson (and now in the Philadelphia Museum of Art) but of vexed attribution. The action is dominated by an elaborately arched edifice with its corner protruding towards us, in dramatic angular perspective. While other paintings of this era may depict an object with oblique sides, this work seems to be the only extant painting from the fifteenth century where the entire composition is based on the two-point construction. It is all the more remarkable, then, that the perspectival convergence is completely accurate. All the lines, from whatever depth both outside and inside the building, converge to either the left or right vanishing point, as appropriate. Whoever painted this painting indubitably had a full understanding of two-point perspective, perhaps for the first time in history.

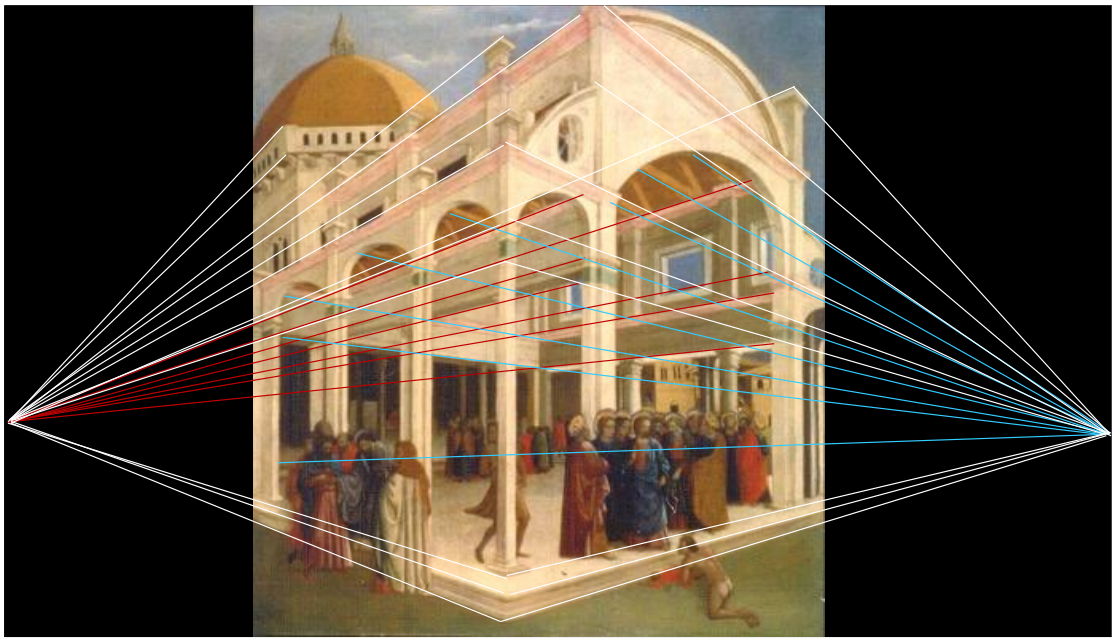


Fig. 18. Painting of 'Christ Healing a Lunatic' of uncertain attribution, but employing what was likely the first use of accurate two-point perspective. White lines: left and right obliques from external building structures. Red lines: left obliques from internal building structures. Blue lines: right obliques from internal building structures.

It has been difficult to identify this artist, however. Berenson attributed the extant painting to Andrea di Giusto, but it is interesting that Parronchi considered it to be a copy of an ‘exercise’ by Masolino, now lost. In fact, there are good grounds for assuming that it is the picture of Jesus healing the madman attributed to by Vasari to Masaccio: “He [Masaccio] was very zealous at his labours, and a marvellous master of the difficulties of perspective, as it is seen in a story painted by him with small figures, which is today in the house of Ridolfo del Ghirlandajo. In this story, besides a Christ who is delivering the man possessed by a devil, there are very beautiful buildings in perspective, drawn in a manner that they show at one and the same time both the inside and the outside, by reason of his having chosen the point of view, not of the front, but over the corner, as being more difficult.” In other words, Vasari is describing a painting of Christ healing the lunatic located in a cutaway building in oblique, or two-point, perspective, of which this is almost certainly the only known example. Given Vasari’s extensive confusion between attributions to this pair of co-workers, there is little doubt that he made the same error in this case. The figures are entirely reminiscent of Masolino’s work, and there is curious difficulty with the slanting arches that is evident in his well-established work. If Parronchi’s attribution could be believed, it would imply that Masolino not only introduced the one-point and displaced one-point constructions, but went on to develop the rigorous two-point geometry also.

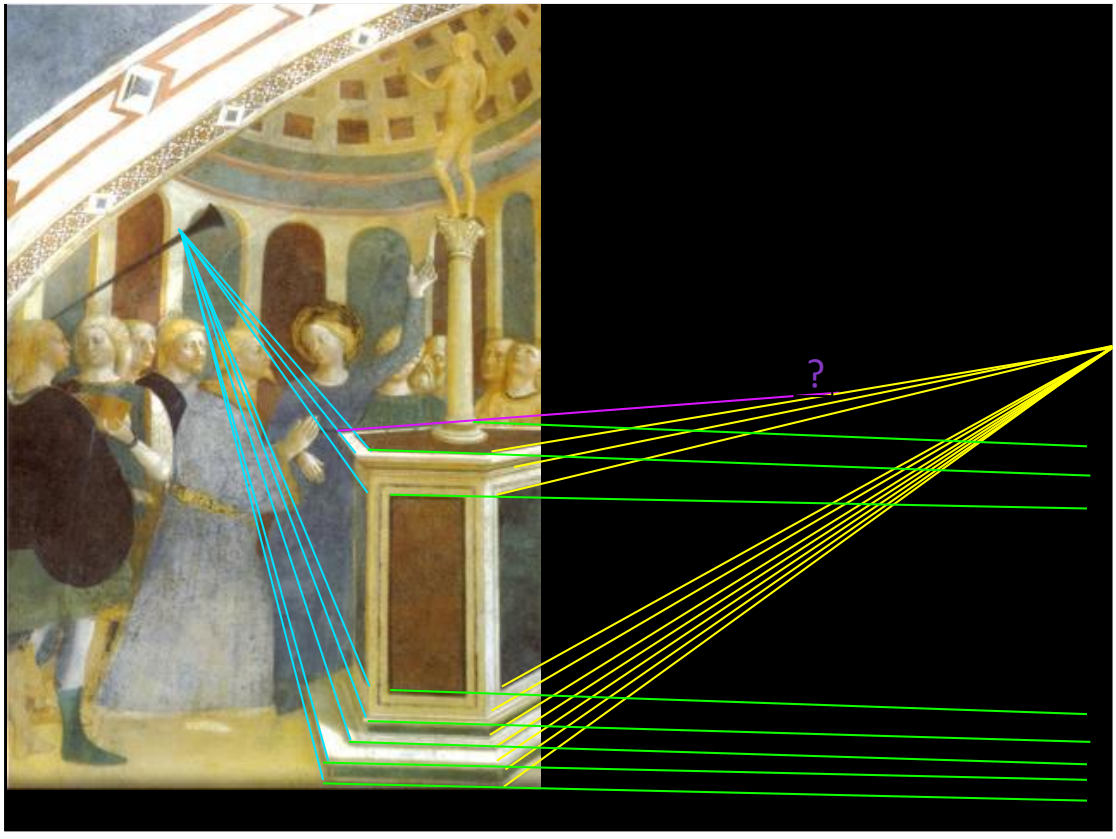


Fig. 19. Perspective construction for hexagon plinth in the San Clemente panel: ‘St Catherine Refusing to Worship Idols’ by Masolino (1428-31).

Putting the capstone on the analysis of Masolino’s innovative capabilities in rendering perspective is the construction of the oblique hexagonal plinth in the upper left-hand panel of the San Clemente chapel of Fig. 14. This construction is essentially unique in the history of Renaissance painting. Although there were later examples of simple plinth structures, and hexagonal and polygonal temple structures (see Fig. 21), they were universally symmetrical, and were only accurately constructed

towards the end of the 15th century. Masolino, on the other hand, produces an almost perfect ***oblique*** construction, with all the edges of the two major oblique sides converging to two accurate vanishing points from the top to the bottom and for the two sides of the decorative molding around the plinth (Fig. 19). The front side even appears to be slightly angled so as to converge to a distant vanishing point far outside of the picture frame (green lines in Fig. 19), rather than being simply parallel. The only deviations from this accurate three-point construction are that of the upper back edge, which seems to have been visually estimated rather than measured for the precise angle (magenta line in Fig. 19), and that Masolino seemed to have been unaware that the oblique vanishing points should all lie on the same horizon line.

5. Summary

Masolino's contributions to the art of perspective, both in his own work and his apparent influence on Masaccio (who stole much of his thunder) must be considered as great as any in the history of art. His accomplishment is recognized in a quote from Vasari on the painter of the Goldman 'Annunciation', which is an example of that same error of attribution between the two Thomases. Of this Annunciation, Vasari says that:

> "there is an alcove drawn in perspective; it is very beautiful because, in addition to the construction of the lines, which is perfect, he employed the technique of fading the colours to become fainter and fainter until they can no longer be distinguished; in this he really showed his understanding of perspective depth."

Although Vasari is highlighting the fidelity of the aerial perspective in this quote, he gives full recognition to the linear perspective construction in this painting, ironically misattributed to Masaccio. As we have seen, this painting is now generally attributed to Masolino on stylistic grounds. The confusion between the 'two Thomases' may be so deep that it is ultimately impossible to unravel their individual contributions. But, at the least, Masolino is emerging from the shadow of his protégé as a major force in the introduction of true perspective to the Renaissance mind.

6. Comparisons with Contemporary Artists.

Having established Masolino's early proficiency with perspective, the key question is how innovative was this technique? His first perspective painting, currently attributed to 1423, falls in a period when other artists who used perspective were also active, notably Fabriano, Donatello and Uccello. Both Donatello and Uccello worked in Ghiberti's Florentine workshop at the time that Masolino was developing perspective, so if they had understood its principles, they could have been the ones to have explained it to Masolino. Since there are no records of the conversations among the artists of that time, we have to rely on the evidence of the pictures themselves. If other artists were aware of the principle of the central vanishing point, they would certainly have used this powerful innovation themselves. We may then examine the works of these artists to determine from their construction whether these artists understood the perspective construction in the period when it was first used by Masolino, or whether their constructions betray weaknesses implying a more intuitive approach to perspective without a clear understanding of its geometry. But before evaluating the works of these artists, we need to examine the role of the architect Brunelleschi, who played such a significant part in the cultural life of Florence at the turn of the 15th century.

It has generally been assumed, based on the descriptions of Manetti and Vasari in the 15th and 16th centuries, respectively, that Brunelleschi was the first person to understand the geometry of perspective. Despite the prevalence of this idea, it has been incisively re-evaluated by Kubovy (1986), who examines Brunelleschi's personality through his manipulations to achieve the commission for completing the dome of the Cathedral in Florence. Brunelleschi was quite secretive about his methods and refused to submit a plan for spanning the dome. Instead, he challenged all the other contenders to

make an egg stand on one end. When they failed to rise to the challenge, he simply broke the end of the egg to make it stand stably. Despite the competitors' protestations that he had cheated on his own challenge, Brunelleschi was awarded the commission.

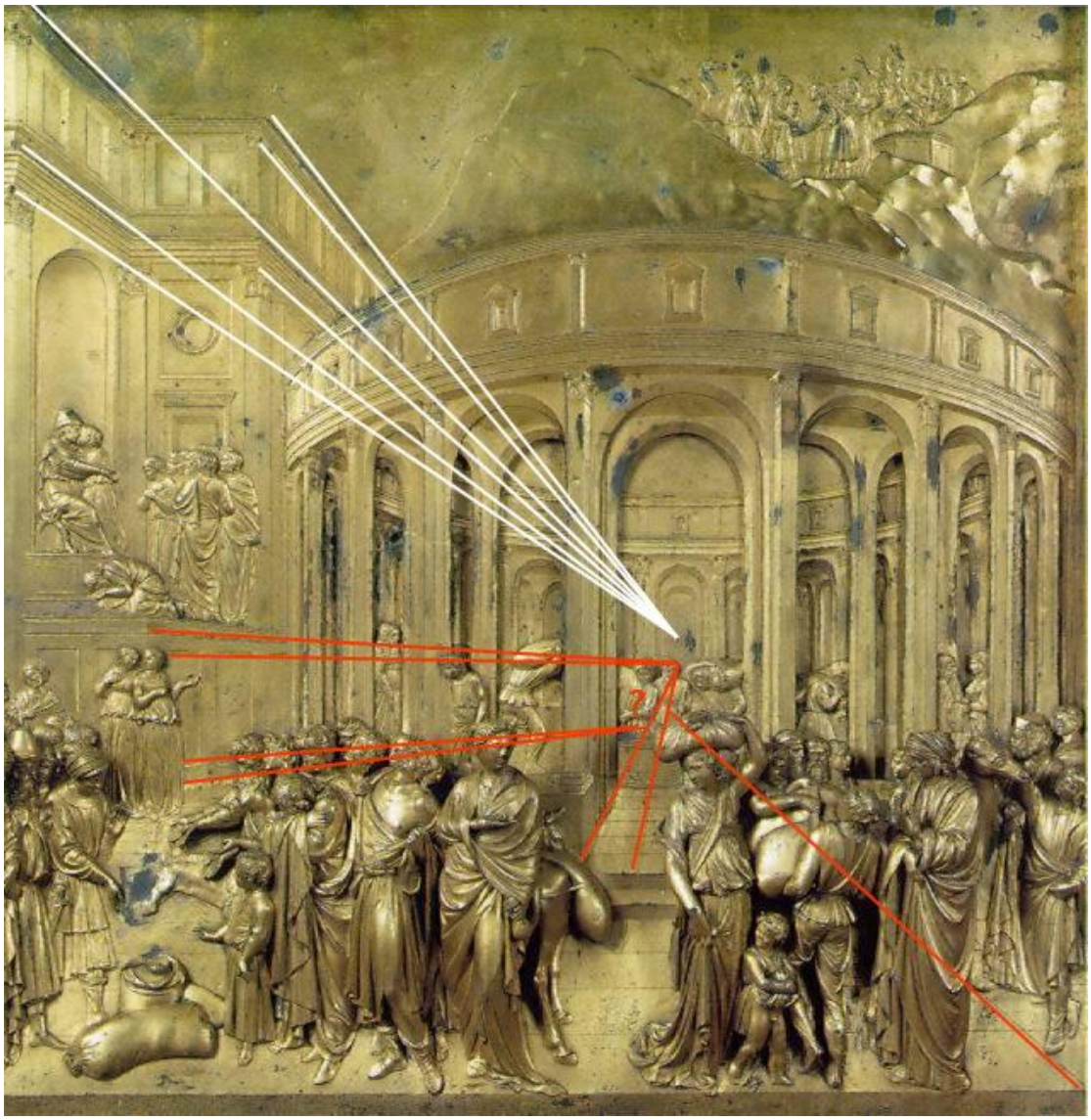


Fig. 20. 'The Story of Joseph' (1425-52), bronze casting from the 'Gates of Paradise' Baptistry doors by Ghiberti. The converging lines from various regions of the composition fail to meet at a single vanishing point.

Kubovy uses this incident to illustrate Brunelleschi's powers of persuasion and flair for showmanship, but also to infer that he was perhaps more of an intuitive, hands-on problem solver than an analytic intellect. If he had worked the problem out analytically, it seems that he would have not had to resort to an irrelevant challenge to get the best of his competitors for the commission. By inference, then, the fact that it was Brunelleschi who was the first to demonstrate perspective some time in the early 1400s does not necessarily mean that understood the principles of perspective. As Arnheim (1986) makes clear, "Nothing in Manetti's description of Brunelleschi's procedure suggests that it involved any geometric construction or indeed required it." He may, for example, have understood how to use a *camera obscura* to project an image accurately onto a panel and trace its outlines. In fact, Parronchi

(1964) proposes that he hung a mirror on the door of the Duomo facing the Baptistry and traced the outlines of the Baptistry image that he saw on the mirror surface While such a procedure requires ingenuity, it does not imply a knowledge of the vanishing-point construction, or any other geometric means of generating perspective for imaginary scenes. Only that the construction lines need to be traced from a fixed standpoint. The fact the both the perspective panels that Brunelleschi was described as demonstrating were depictions of the local architecture of Florence, rather than the imaginary edifices of Masolino's storytelling, is consistent with such a lack of knowledge.

Another dehiscence in the Brunelleschi story is the fact that he is widely attributed as promulgating the concept of the central vanishing point of one-point perspective, although this detail is entirely based on supposition from 20th century sources (Edgerton, 1976; Kemp, 1990). Renaissance historians such as his biographer Manetti merely mention that he understood the principles of perspective in the generic terms of diminution with distance, without any specification of the requisite geometry. However, on Manetti's description, both panels were constructed with only oblique angles of recession. Remarkably, there were no features in either scene to require the central convergence of one-point perspective. None. These oblique configurations would have made it difficult for Brunelleschi to understand the one-point construction in relation to these compositions. Moreover, the vanishing points for the two-point construction of the main Baptistry panel were as much as two feet beyond the sides of the panel. Although this is not an insurmountable difficulty, it raises yet another barrier to the process of understanding the construction of vanishing points.

To evaluate the claim of Brunelleschi's influence, we may examine the art of the immediately succeeding period, the second quarter of the 15th century. The main artistic figures of that era are familiar in art history. Gentile di Fabriano was the most famous artist of the time, travelling around northern Italy executing commissions for all the richest churches and noblemen. Lorenzo Ghiberti had established a workshop in Florence that was engaged on casting the ornate doors of the Baptistry and the Duomo through the entire first half of the century. Many of the Florentine artists of the time were employed by this workshop in various capacities, including Donatello, Uccello, Masolino, Masaccio and Fra Lippo Lippi. And Leon Battista Alberti was a fellow architect who had moved from Rome to Florence and who wrote the first manual of perspective technique. If Brunelleschi had understood the principles of perspective and communicated them to his fellow artists, this group, within which he was working on a daily basis to design the Foundling Hospital and cap the dome of the Duomo, would be the ones to show the influence of his powerful new ideas.

The 'Gates of Paradise' doors of the Baptistry showcase the finest set of cast panels of the Renaissance, and represent the zenith of the work of Ghiberti and his collaborators. Compared with the north doors of the Baptistry, which had been cast between 1403 and 1424, the 'Gates of Paradise' doors on the east entrance (1425-52) reveal a marked change in style, providing insight into the general understanding of perspective in the years following Brunelleschi's demonstrations. Several of the panels feature innovative perspective backdrops, supporting the idea that there had been a renewed awareness of the power of perspective, perhaps attributable to Brunelleschi. On the other hand, these panels clearly reveal that the designer(s) were unconcerned with strict adherence to a central vanishing point. One of the most impressive is shown in Fig. 20. While the buildings at the left rear converge appropriately, the plinth below them and the floor edges meet only approximately to the same general region. It seems most unlikely that the designers would be casual about the layout of the design for this auspicious religious and cultural icon, which took a quarter of a century to complete, when just a few minutes work could have ensured its correctness for posterity. One is led to the conclusion that the designers of this panel did not appreciate the importance of adhering to a central vanishing point for the whole space, or else they would have ensured that this construction was used. It follows, therefore, that this particular issue had not been explained to them by Brunelleschi, or anyone else. This example again underlines Brunelleschi's lack of influence in the adoption of one-point perspective. Finally, although

Masolino was involved in Ghiberti's workshop and knew the rules of central perspective by this time, it appears that he was a casual assistant involved with finish work, and was not party to the designs of the master.

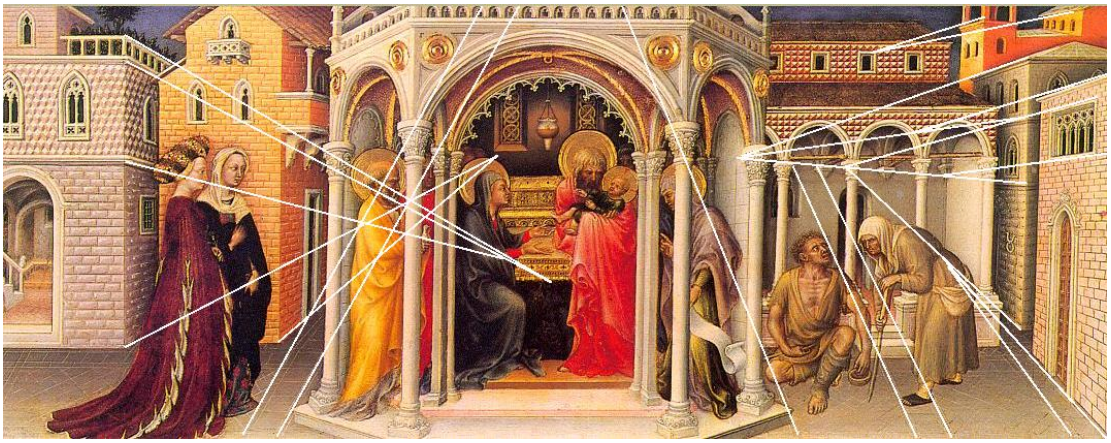


Fig. 21. 'Presentation at the Temple' by Gentile di Fabriano (1423), with sample lines of convergence in this highly spatial composition. Note that their convergence to vanishing points is haphazard and broadly distributed, although all should meet at a single point at the centre of the picture.

The painting of the period that most resembles the description of Brunelleschi's 'Baptistry' demonstration panel is the 'Presentation of the Virgin' (Fig. 21) painted by Gentile di Fabriano (*c.*1370-1427). It has a central octagonal building set in a Renaissance piazza, with great emphasis laid on the perspective construction in which the action is taking place. The picture is dated to 1423, one of the first known paintings in the years after Brunelleschi's demonstration. The evidence all points to the idea that Fabriano was following Brunelleschi's lead in the use of perspective. The perspective effects are dramatic, and we could well imagine that Renaissance observers would be impressed by the power of the depth evocation in this picture, especially if viewed under the peepshow viewing conditions set up by Brunelleschi. Fabriano has made clever use of recession and shading to maximize the perspective illusion of this scene.

However, as the construction lines make very clear, Fabriano did not have the least idea that receding orthogonals should converge to a central vanishing point. All the white construction lines in Fig. 21 should converge to a central point at the level of the horizon, about where the lamp is on the wall in the Temple. But the walls to left and right overconverge to meet before reaching the centre, while the orthogonals in the floor tiles underconverge so as not to meet until way above the top of the picture. Even within the single surface of the receding wall at right, the convergence is far from accurate, with some lines remaining parallel and others converging steeply. Although the overall effect is perceptually adequate, the is no question that Fabriano was completely unaware of the principles of central projection (although he is clear on the basic principle that straight lines in space must project to straight lines in the picture). If, indeed, Fabriano had based his panel on Brunelleschi's vivid demonstration, it is evident that nothing of the geometry of perspective had been communicated between them, perhaps the most famous architect and artist of their day, respectively.

Fabriano's wild assortment of convergence points is in strong contrast to Masolino's accurate constructions of the same year, as illustrated in Figs. 8-19. Not only does Masolino use a unified central vanishing point (for all but a few stray edges), his lateral vanishing points are well-coordinated to fall on the same horizon lines as the central ones. It is particularly noteworthy that this rule for lateral vanishing points was not employed by Masaccio for the distance points in the 'Holy Trinity' (Field, 1997). The recession of the arches in the barrel vault of the ceiling of that painting is a difficult

construction that has not been fully explained. Analysis reveals, however, that its recession is not coordinated with the main vanishing point, indicating that Masaccio had not fully understood the construction that Masolino had perfected. This comparative analysis suggests the need to revise the view that Masaccio developed the art of perspective in conjunction with Brunelleschi, while Masolino was a holdover from the International Style of delicate figuration. Instead, the Goldman Annunciation' of Fig. 11 shows that Masolino was capable of elaborate perspective structures – coffered, curved and oblique – and was at least an equal contributor to this development of three-dimensional representation in architectural scenes.

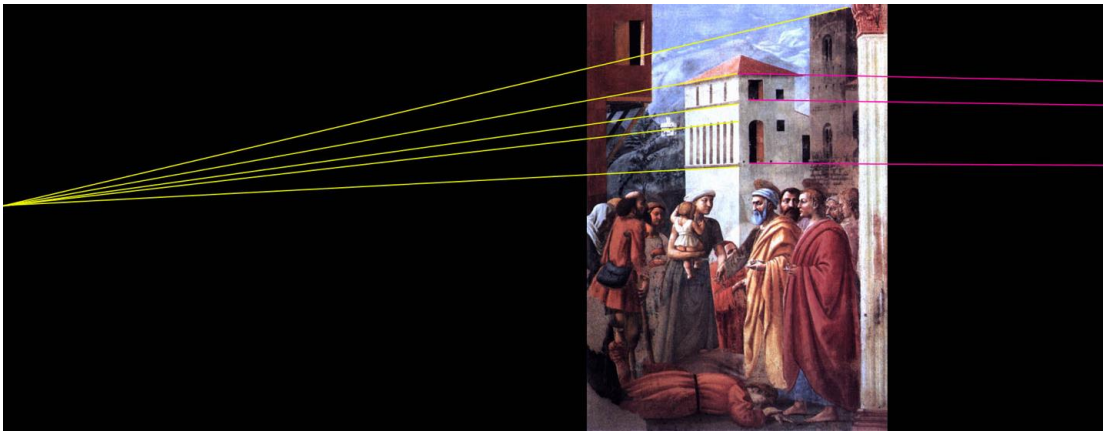


Fig. 22. Detail of Masaccio's 'Distribution of the Goods' (1425) from the Brancacci Chapel. Although the left side of the white building shows convergence to the left, horizontals on the right side are almost parallel, without the required convergence to the right if this building was intended to be square. The same asymmetry is evident in the overhanging structure at the right of the picture. Evidently Masaccio was employing the concept of a single vanishing point.

In this connection, it is interesting to speculate whether the archway of the Goldman 'Annunciation' was the inspiration for arch of the chapel in Masaccio's 'Holy Trinity'. Rather than learning perspective from Brunelleschi, this similarity of structures may suggest that Masaccio was borrowing from his meticulous mentor, enhancing it with his characteristic flair. Conversely, none of Masaccio's known work bears any resemblance to the reconstructions of two perspective panels of scenes in Florence with which Brunelleschi had caused such excitement. As already discussed, it appears from Manetti's descriptions that both of Brunelleschi's panels were painted in two-point perspective, without a central vanishing point (White, 1953). Masaccio never used the two-point construction, even in the rare cases where he showed buildings with a vanishing point shifted from the central placement. In these cases, he followed the almost universal Renaissance convention of setting the edges of the nearer side of the building parallel, as in the standard one-point construction (Fig. 22). If he was deriving his knowledge of perspective from working with Brunelleschi, as some have suggested (Field, 1997), it would seem inevitable that he would employ Brunelleschi's approach to perspective. Thus, the idea that Masaccio might have been assisted in the construction by Brunelleschi seems implausible based on our knowledge of Brunelleschi's work with two-point perspective.

. Another artist credited with early contributions to perspective geometry, Donatello (Donato di Betto Bardi, 1379-1466), deserves comparison with Masolino. His silver panel depicting the 'Dance of Salomé at the Feast of Herod' (Fig. 17), dated to the same period as Masolino's early work, between 1423 and 1427, employs a dramatic perspective staging for the action that is commonly cited as evidence that Donatello had initiated the art of true perspective. Unfortunately, Kemp's (1990) careful geometric analysis reveals the use of at least two distinct vanishing points for the receding horizontals.

Donatello's perspective is consistent only locally and, therefore, does not extend beyond the level of understanding of the Lorenzetti brothers eighty years earlier.

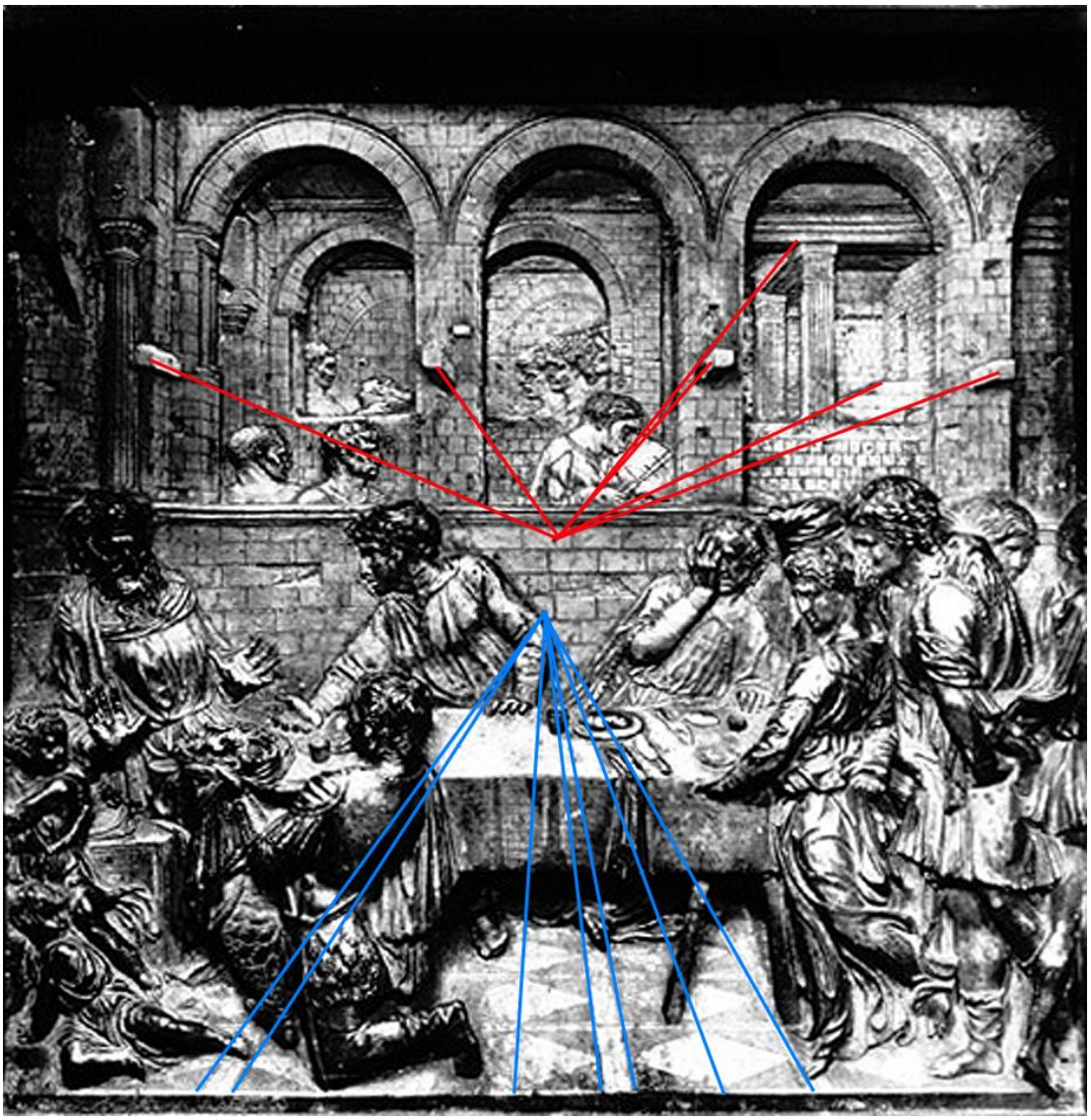


Fig. 23. Donatello's 'Dance of Salomé at the Feast of Herod', lauded for its dramatic evocation of perspective, actually employs at least two distinct vanishing points. In this respect, it shows no conceptual advance over the perspective constructions of the early *Trecento,* from which it appears that Donatello drew inspiration.

Donatello is often credited with the first use of an accurate central vanishing point, in the 'St. George and the Dragon' predella to his superb statue of St. George (1404). The archway at the right does indeed seem to be accurately constructed. However, as the Donatello's 'Feast of Herod' shows, accurate convergence in one region was not matched in other regions of his compositions. In fact, in numerous strong perspective constructions throughout his life, Donatello never integrated the perspective from all regions of the scene to a single point. Despite the fact that he was working well into the second half of the *Quattrocento*, Donatello does not seem to have understood the need for a unified central vanishing point. Since the St George predella has perspective elements in only one structure at right, it provides insufficient evidence that Donatello had initiated the concept of the unified vanishing point

There is no question that Donatello was a keen exponent of perspective. He continued to use it boldly in paintings and silver panels throughout his long career, notably in the altarpiece of San Antonio, Padua (1447-9). But careful reconstruction, as in Fig. 23, reveals that accurate convergence is never achieved in any of his works. His perspective, though vividly rendered, remains intuitive and approximate (Kemp, 1990). This lack of consummation is subject to two interpretations. Either Donatello did not understand the principles of perspective, but did his best with acute observation, or he understood them well enough but elected to approximate them rather than employ an accurate construction because it seemed sufficient to his purpose. The latter argument is often made by art historians but it seems to be refuted by direct testimony by the artist, who is reported by Vasari to have complained to Uccello, "Ah Paolo, this perspective of yours makes you neglect what we know for what we don't know. These things are no use except for marquetry." In other words, Donatello had no patience for the intricacies of geometric perspective. Nevertheless, it would seem odd for him to relinquish the convenience of the one-point construction that could be measured out in a few minutes for the design of a work that was to be beaten or cast for an important social or religious occasion.

As another example, Donatello is supposed to have been a senior member of a team that made key contributions to the design of the Baptistry doors that occupied the major efforts of Ghiberti's workshop for more than a quarter of a century (1425-1452). Here again the perspective of the panels is approximate rather than exact. Surely, if he and the other members of the group had understood the geometry of perspective, they would have taken the trouble to ensure that the orthogonals for this major commission at the heart of the Florentine artistic efflorescence had the correct convergence? It seems clear that the general understanding of perspective in the time of Brunelleschi and Donatello in the first half of the 15th century was at the rudimentary level actually specified by Manetti's words at the time. They understood the need for the convergence to smaller angles with increasing distance, but were probably unaware of the need for coherent vanishing points for parallel edges across the whole of the scene. To this extent, it seems that perspective geometry of these artists had advanced little over the best of the 14th century, Giotto and Duccio, the Lorenzettis, Gaddi and Daddi (as represented by Fig. 21).

The work of Donatello and Masaccio also gives us interesting insight into Brunelleschi's thinking. According to Vasari:

> "When Donatello was a young man, esteemed as a sculptor, Brunelleschi began to converse with him, and such an affection sprang up between them that it seemed as if they could not live without each other. Brunelleschi, who was capable of many things, was held also by those versed such matters to be a good architect. He also studied perspective, and taught it to his friend Masaccio."
>
> Author trans. after George Bull

One may expect, therefore, that the paintings of Donatello and Masaccio would represent Brunelleschi's state of knowledge of perspective. Since both artists began producing perspective works around the year 1425, this co-development tends to validate Parronchi's dating of the development of the concepts among these three artists. As previously discussed, Masaccio's work before that date shows no evidence of an interest in perspective. Donatello, indeed, employed only approximate convergence of perspective lines throughout his long life, and even Masaccio's 'Trinity' shows many minor inaccuracies. These approximations are most easily attributable to a view of proportional convergence from a near plane to a far plane, avoiding the need to project to a specific vanishing point that captured infinity on the canvas (or stucco). Only Masolino, with his Gordian emblem marking the global vanishing point in the 1424 Goldman 'Annunciation' (see Fig. 10), evinces awareness of the significance of this perspective fulcrum.

Our final candidate for an early rival to Masolino is Uccello (Paolo di Dono, 1397-1475). This artist was besotted with the intricacies of perspective, and Vasari remarks that his wife used to say that "he would sit studying perspective all night, and when she called him to come to bed he would answer, 'Oh, what a sweet thing is this perspective'". Nevertheless, his friend Donatello was aware that he had "abandoned the certain for the uncertain", so it is evident that Uccello was still struggling with some aspects of perspective construction. In view of his reputation as an early innovator of perspective, it comes as somewhat of a surprise to note that that the perspective construction of his mid-career version of 'St. George and the Dragon' is still at the *Trecento* level (Fig. 24). In this undeniably charming composition, Uccello goes to some trouble to define the perspective of the formal ornamental beds, enhancing the surreal quality of the fact that the lady has the dragon on a leash. Often cited as an example of Uccello's interest in perspective, the convergence location by the construction lines in Fig. 24 reveal that the only vanishing point is well below the horizon, and is applicable only to the foreground flower beds. All the other beds are constructed in a kind of *parallel* perspective that bears no relation either to the foreground beds or to the horizon. Conceivably, Uccello intended this distortion to enhance the surreal quality of the composition, but he has very few works from which his perspectival abilities can be judged. The dramatic structure of his 'Noah's Flood', for example, is well known to have more than one central vanishing point (Kemp, 1990).

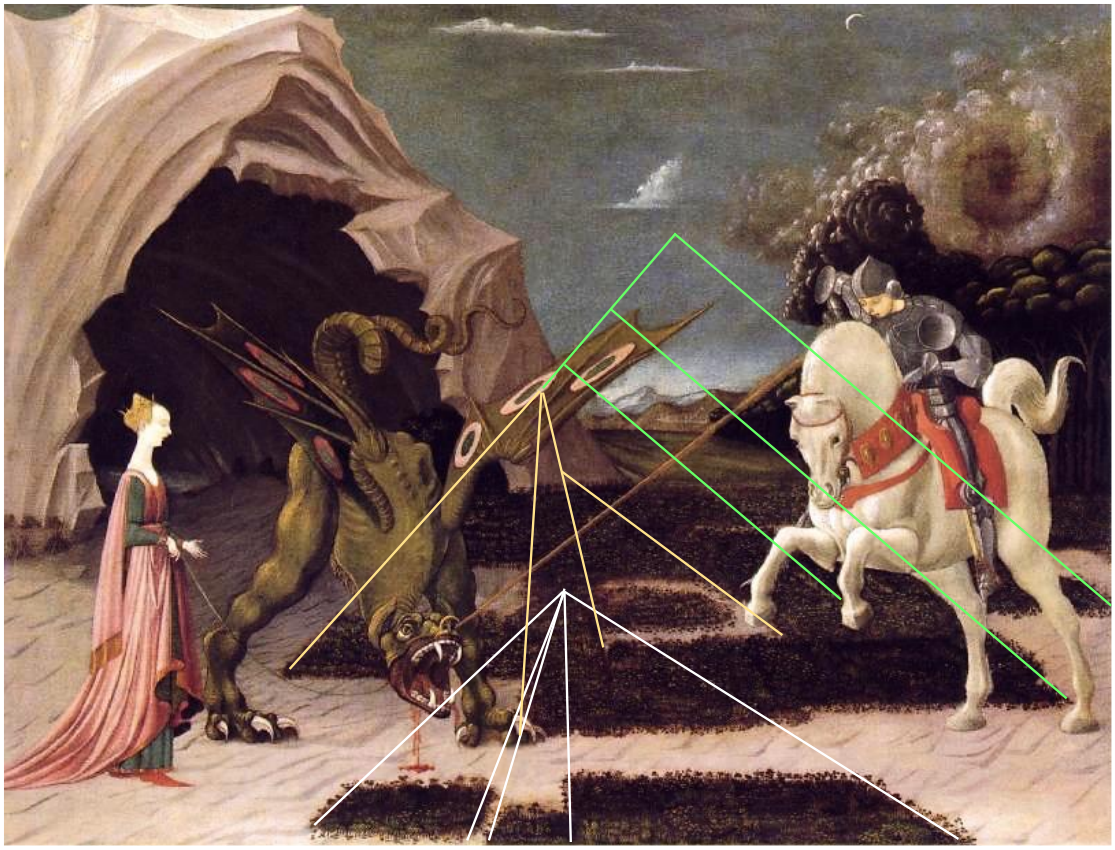


Fig. 24. 'St. George and the Dragon' by Uccello (1455-60)

Uccello's attributed study of a chalice, though famed for its perspective accuracy, may be shown to be entirely in parallel (isometric) perspective, with no converging lines. While this is an acceptable convention in architectural practice, it does little to assure us of Uccello's competence with classic 1-point perspective convergence. In any case, most of Uccello's work dates to well beyond the period

of Masolino's early work, so any claim he may have to being an innovator of perspective is invalidated by the late dating of his efforts to the second half of the 15th century. Even his earliest surviving attempts at perspective construction are dated after Masolino's death. Despite the interest his creative approach to the perspective problem may hold, it is clear that Uccello was not one of the originators of accurate one-point perspective construction.

Whatever one may suppose of their intentions, it is clear that the hard evidence of the perspective geometry does not lend any support to the idea that the geometry of central convergence was understood by either Donatello or Uccello, and by extension, by Brunelleschi. The first written specification of this principle was in Alberti's '*De Pictura'* (1435). Here again, Alberti has been credited with a full understanding of the perspective construction on the basis of quite slender evidence. He certainly bases his construction on the concept of a central vanishing point, and describes what is known as the '*costruzione legittima'* [standard construction]. However, the details of Alberti's exposition focus on the measurement of the projection from a physical scene, such as a floor tiling, onto a picture plane represented by a translucent sheet of muslin. He describes how to mark off the recession of the transversals in terms of their height on the sheet by physical measurement, and how to "check" the construction with an oblique line passing through the intersections. His books are supposed to have gone through multiple printings and been in widespread use in the workshops of the artists and artisans of the 1400s. But there is no mention of the convergence to lateral vanishing points that would account for Brunelleschi's constructions, or indeed of the requirement of a uniform convergence to a single vanishing point for all lines perpendicular to the picture plane. In both this and the next available treatise, by Piero della Francesca in 1475, the emphasis is on the laborious measurements of each perspective line from the geometric construction. The insight of the use of the central or oblique lateral vanishing points as a construction shorthand is lacking.

7. Conclusion

The approach of this treatment is to focus on the evidence of surviving paintings rather than interpretation of the words of historical accounts, since those words are ambiguous as to the detail of issues such as perspective construction. Such analysis leads to the position that the first person for whom there is evidence of a clear understanding of the concept of a central vanishing point was Masolino da Panicale, who painted a large number of perspective works between 1423 and his death in about 1440. Since Masaccio is well-established to have been his protégé, it seems most likely that Masolino communicated the basic concepts of perspective to Masaccio, and that their works seeded the perspective explosion that characterized the remainder of the *Quattrocento*.

It may be that Brunelleschi's innovative role involved communication if the geometry of perspective to Masolino, but this is rendered less likely by the fact that Brunelleschi reportedly only two-point perspective constructions, while those of Masolino and Masaccio are almost exclusively one-point. Moreover, the procedure that Brunelleschi used was described by his biographer, Manetti, as tracing the outlines of the scene on a (translucent) muslin stretched across a doorway, which would not require any knowledge of the geometry of perspective projection, only an awareness that it had to be done with care and precision from a stable viewing point in order to get the correct effect. If indeed Brunelleschi had explained perspective geometry to his contemporaries, one would therefore expect that the two-point construction would have figured in their works. But almost all known perspective constructions of the era (with the exception of those illustrated in Figs. 18 & 19, and of Fra Angelico discussed in the following) are based on the one-point scheme. The output of Ghiberti's workshop, which was the most likely venue for Brunelleschi's interaction with his contemporaries, does not even adhere to an accurate one-point construction. It therefore seems more probable that Brunelleschi kept the details his constructions to himself and had little influence on the understanding of perspective geometry at the time.

Since Masolino's work can now be seen to have inaugurated one-point perspective, it is more likely that his paintings, which adorned some of the most notable churches in Florence, Rome, and several towns around Northern Italy, were the source of the one-point preoccupation of subsequent Renaissance artists. The accessibility of his dramatic compositions could hardly fail to have excited notice among the subsequent generation of artists, such as Donatello, Fra Angelico, Fra Lippo Lippi, Fra Carnivale, Mantegna, Uccello, Leonardo da Vinci, Piero della Francesca and even Raphael, all of whom were deeply imbued with the perspective construction. This characterization is made explicit in the earlier quote by Vasari, emphasizing how much the works in the Brancacci Chapel by Masolino and Masaccio had a profound influence on this subsequent generation of artists. Masolino's predominant role in this cultural transmission is, however, largely neglected because Vasari mistakenly identified the whole fresco series to the younger artist alone.

This influence seems to have extended to the shifted one-point construction, which is evident in some of Masolino's earliest work and was a favourite of Fra Angelico (Note). There is also the interesting possibility that Masolino developed the two-point perspective construction, based on the contentious attribution of the rare example of a two-point painting of the 15th century to Masolino ('Christ Healing a Lunatic', Fig. 18). This painting did not seem to have had the same influence on other artists (despite the fact that this painting was prominently displayed in the house of the famous artist, Ridolfo Ghirlandaio), since the earliest Italian paintings with accurate two-point construction did not reappear until the eighteenth century. Nevertheless, it is astounding to find that Masolino is given virtually no recognition in popular accounts for his role in promulgating the perspective approach to space representation that is characteristic of the Renaissance. It is to be hoped that the analysis presented here will act to promote a reconsideration of the significant achievements of this neglected artist.

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Note

Fra Angelico (Guido di Pietro), known more recently as Beato Angelico, made extensive use of the oblique perspective construction in works such as 'Apostle Peter Preaching', a predella for the Linaioli Tabernacle (1433, Museo San Marco, Florence). However, detailed analysis shows that it is an intuitive construction with only haphazard adherence to consistent oblique vanishing points.