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Understanding Errors in Perspective

Dominique Raynaud¹

Summary. This paper examines the question of error in perspective from the viewpoint of the painter, not the spectator. This distinction significantly modifies the way in which perspective is approached for one must view it with the eye of the painter or the architect who constructed it. The perspective is therefore judged in terms of the methods used by its creator, which is to say in terms of the goals he set himself and the means at his disposal in order to achieve them. We then explain the "good reasons" the Renaissance painters had to consent to the three main types of error in perspective: "accidental errors" (type I), "ad hoc errors" (type II) and "systematic errors" (type III).

Keywords. Perspective, errors, social consent, subjective- and cognitive rationality.

[...] The evaluation of perspective correctness is often based on a feeling of "uneasiness" experienced when looking at certain paintings. Let us examine *The Wedding at Cana* that Duccio di Buoninsegna painted around 1311. The "uneasiness" here comes from the fact that the table top is tilted to such an angle that we half expect the plates and cutlery to slide off the tablecloth at any moment ... Whatever the significance of this typification — which would seem both rapid and effective — it is necessary to acknowledge that this judgement comes from the eye of the spectator for he alone feels this "uneasiness", and it is he again who expects to see the objects slide off... According to an Antique distinction, this refers to what was known as an "aesthetic evaluation"² ($\alpha i\sigma \theta \alpha' v \rho \alpha i$ meaning "to feel" in Greek). However,

¹ Université Pierre-Mendès-France, BP 47, 38040 Grenoble, dominique.raynaud@upmf-grenoble.fr. This chapter is adapted from D. Raynaud, *L'Hypothèse d'Oxford. Essai sur les origines de la perspective*. Paris, Presses Universitaires de France, 1998, pp. 26-27 and 49-120. Translation: Sally Brown.

² Erwin Panofsky (1975) often proposes this type of aesthetic evaluation: "The objects represented seem, for the most part, to glide above the paving rather than to rest upon it"; "The floor, with quadrangular motifs, [...] gives the effect of a rug held halfway up"; "The objects, for example on [...] the table of The Last Supper, do not seem to be inside the space [...]"; "The picture plane, rising up as it does in the centre of the space, seems to stretch across it in order to pass in front. Indeed, due to the short distance, it even seems to surround the spectator standing

alongside this sensorial characterisation of painting, another one — which I would like to develop here — is possible. It is one based on a "poietic evaluation" (ποιέω meaning "to make" in Greek). This distinction significantly modifies the way in which perspective is approached for one must view it with the eye of the painter or the architect who constructed it. Such or such a perspective is therefore judged in terms of the methods used by its creator, which is to say in terms of the goals he set himself and the means at his disposal in order to achieve them. Alongside an aesthetic sociology, a poietic one could emerge, one whose very basis is grounded in the criticism that it justifiably makes of the former: if western painting has undergone a transformation, it is not because the eye of the spectator has changed, but because this same eye has trained itself to appreciate works of art that the hand of the painter has constructed differently. [...] To say that the perspectives of the Renaissance are "correct" is no more satisfying than to assert the "falseness" of medieval representations. From a technical point of view, the various errors in perspective are also constructions — they are the result of operations which are false but which are operations nonetheless. The only question which deserves to be asked in all such cases and whatever the apparent correctness, is "How are these perspectives constructed?" Let us first examine three types of error frequently made by painters: "accidental errors" (type I), "ad hoc errors" (type II) and "systematic errors" (type III).

Type I errors. From an operating point of view, the accidental error is characterised by the fact that it is not concerned with any logico-semantic network. For example, an isolated vanishing line which unintentionally slips off at an angle, should only be interpreted as an accidental mistake. However, if it leads to an area where other vanishing lines converge, it could be an example of a type II or a type III error.

Type II errors. The ad hoc error is a conscious one whose existence can be understood from a practical point of view. For example, when paving squares are interrupted by one or two steps, it is worthwhile drawing a unique perspective network on the floor, and altering the vanishing lines at the steps so that the error is no longer obvious. In this case, the error is not

before the painting" (1975: 119, 119, 122, 136-137 respectively, my italics). Panofsky mentions that this feeling of correctness is socially constructed, which suggests that one can only begin to evaluate a perspective by questioning the presuppositions which form the background to axiological evaluation.

incomprehensible for it obeys an instrumental pattern of logic which does not allow itself to resort to measures which are not in keeping with the desired objective.

Type III errors. The systematic error can be distinguished from the previous two by the fact that it is part of a coherent logico-semantic network based upon an acceptance of certain rules of construction or principles of organisation. Let us consider *Madonna and Child* by Fra Filippo Lippi, painted around 1452. The vanishing lines converge at two centric points which coincide with the Virgin's two eyes. Here we are clearly faced with a systematic error for we can imagine that the painter saw a relation between the eye and the vanishing point. This could have been the artistic expression of a binocular system of vision as laid out in Medieval texts (Raynaud 1998, 2003). Each time an error can be categorised as a type III error, we must view it in terms of the sociological analysis of false beliefs proposed by Boudon (1990) who highlights Pareto's words: "Logic tries to discover why a thought process is false whereas sociology tries to discover why it is so frequently adhered to". What are the reasons for painters' adherence to such or such a system of rules? Furthermore, is there one, unanimous consent about the rules of linear perspective or are there several consents which follow the divisions between the various artistic schools and workshops?

The question "How are perspectives constructed?" enables us to reconsider the procedure for the analysis of paintings. To construct a "correct" perspective, in terms of linear perspective, is to carry out a twofold sequence of operations: the first consists in analysing the *orthogonal lines*, which is to say those whose direction is parallel to that of the viewer's gaze and which will become *vanishing lines* in a perspective view. The second consists in analysing the *transversal lines* which are perpendicular to the viewer's gaze. The orthogonals force the painter to fix a vanishing point (unique in one-point perspective). The transversals force the painter to choose a method of *foreshortening* which will determine the diminishing spaces between the transversals (usually those which are the receding horizontals of the floor plane).

Since Panofsky's research, historians of perspective have often seen the positioning of the centric point as being more important than the various methods of foreshortening, so much so that their evaluation of a painting's precision is almost exclusively based on an examination of the system of vanishing lines. An analysis of the methods of foreshortening is nevertheless

necessary in order to evaluate to what extent painters subscribed to the rules of perspective.

Methods of foreshortening

If the use of orthogonal lines leaves little room for constructive imagination, the same cannot be said for the use of transversal lines. Concerning the question of diminishing spaces, Renaissance painters proposed a wide range of empirical solutions.

How is one to represent horizontal lines which are perpendicular to the viewer's gaze? On the floor plane, the spacing of the transversal lines is regular since the paving squares are of the same dimension. This is not so in a perspective view and most painters subscribed to the idea that the further away the squares are, the smaller they should seem to the naked eye. However, which rule of diminution were they applying? They were not able to resort to the theory of perspective for this was only invented by mathematicians in the 17th century. Such knowledge being unavailable³ at the time, they therefore came up with various tactics in order to give to perspective the only thing they had ever known: the *qualitative principle* of foreshortening apparent size according to distance, a principle which appears in all of the Medieval treatises on optics⁴. The *quantitative translation* of this qualitative principle could

³ This situation of a heuristic search for solutions in a context of limited information certainly evokes the experiments of Tversky and Kahneman (1973) concerning the solving of problems of probability by individuals unfamiliar with mathematics. Let us not forget that most of the concepts of perspective, beginning with the basic "vanishing point", were unknown in Renaissance times (for instance, Alberti speaks of a "punctum centricus", not yet of a "punctum concursus"). This conceptualisation thanks to 17th century mathematicians, such as Guidobaldo del Monte, who began to study methods of projection (Kemp, 1985; Field, 1997). Throughout the rest of this text, which is concerned with the paintings of the quattrocento, the technical terms "vanishing point", "distance point", "transversal lines", etc. are inappropriate. One must nevertheless resign oneself to the naming of those lines and points present in the working drawings. I have therefore kept these terms which have an *indexing function* rather than a *semantic function*.

⁴ Here is a sample: "Aequales magnitudines inaequaliter expositae inaequales apparent et maior semper ea quae propius oculum adjacet" (Euclide, *Optica*, sup. V). "Magnitudo uera uisibilis percipitur ex comparatione basis anguli et longitudine pyramidis opticae" (Ibn al-Haytham, *De aspectibus*, II, 38). "Eadem res distans facit paruum angulum in oculo quae faceret magnum quando est propinqua" (Bacon, *Opus maius*, V, II, III, 3). "Comprehensionem quantitatis ex comprehensione procedere pyramidis radiosae et basis comparatione ad quantitatem anguli et longitudinem distantiae" (Pecham, *Perspectiva communis*, I, 74). "Aequalium et

therefore adopt one of several different routes. In his inventory of the methods used by painters, Panofsky (1976: 229, 232) distinguishes (with the exception of Accolti's method which he does not mention) a series of constructive methods which all give approximately the same geometric results yet which seem to translate the stages of an operating simplification. We can find: (a) Brunelleschi's (hypothetical) method (1413); (b) Alberti's section of the visual pyramid, sometimes called *costruzione legittima* (1435); (c) Vignola's distance point method and tracing of oblique lines (published posthumously in 1583); Viator's simplified distance point method and tracing of the diagonal line (1505); (e) Pietro Accolti's reduced distance points method (1625). [...] The analysis of paintings cannot, however, be based on this inventory. One problem must first be solved: Despite its accuracy, Panofsky's inventory is one of *true* methods. It is quite possible, therefore, that it does not contain all of them and it must be completed by a rational examination of all the possibilities.

Imagine finding yourself in a room paved with identical rectangular tiles. Now, open a door in such a way that it crosses a tile diagonally. You will notice that the door is lined up diagonally with *all* the tiles and — as trivial as it may seem — that this diagonal line is a *straight* one. What you have just experienced is also true for painting. For perspective to be "correct", the tiles' diagonal line must be straight⁵. Otherwise, every door which were to open diagonally would be askew, which is materially impossible. This rule was often ignored and two main types of error can be highlighted: either the "diagonal" becomes concave or it becomes convex. Add to this the case of a true perspective where the diagonal remains straight and one has a range of three possibilities.

aequidistantium magnitudinum inaequaliter ab uisu distantium propinquior semper maior uidetur, non tamen proportionaliter suis distantiis uidetur" (Witelo, *Optica*, IV, 25). "Infralle cose dequal grandeza quella chessara piu distante dallochio si dimossterra di minore figura" (Leonardo da Vinci, MS. *SKMII*, fol. 63 r.)

⁵ Alberti verified the correctness of the perspective layout by using this property but he was unaware that the diagonals should converge at a distance point: "Qui quidem quam recte descripti sint inditio erit, si una eademque recta continuata linea in picto pauimento coadiunctorum quadrangulorum diameter sit. Est quidem apud mathematicos diameter quadranguli recta quaedam linea ab angulo ad sibi oppositum angulum ducta, quae in duas partes quadrangulum diuidat ita ut ex quadrangulo duos triangulos fit" (*De pictura*, I, 20).

1) Methods of correct foreshortening

Here we can find the whole range of foreshortening methods giving rise to *straight diagonals*. The spacing between the horizontal lines diminishes correctly as one approaches the vanishing point. The first perspective method known in written form, that of Alberti (*De pictura*, 1435) is to be found here. The so-called "intersection of visual pyramid" consists first in forming a pencil of visual rays linking the eye to each of the paving divisions. The "visual pyramid" is then cut by the picture plane: this intersection will fix the height of each of the receding transversal lines. The originality of this method is that the side view and the perspective view are drawn on the same sheet so that the intersection points of the visual pyramid can be more easily transfered.

2) Methods of under-foreshortening

Foreshortening can also generate *concave diagonals*. In this case, the spacing between the horizontal lines does not diminish rapidly enough on approaching the vanishing point. Let us first mention the "zero degree" of foreshortening which consists in drawing equidistant transversal lines. This method is only used in a few paintings which have shallow visual field (such as *Death of the Saint* by Simone Martini, *Confession of the New-born Child* by Donatello, *Last Supper* by Andrea del Castagno, etc.) The error here is understandable for diminishing spaces would have necessitated an extravagant procedure considering the lack of depth (Type II ad hoc error). [...]

In this category we can also find the so-called diminution by a 1/3. Panofsky wrote "If one were to go by Alberti, the deceptive habit of mechanically reducing each strip of paving to a third of the size of the previous strip still held sway at that time" (1975: 147). Alberti did in fact mention this painters' *ratio vitiosa* (*De pictura*, I, 19), before applying his own method. [...] There are alternatives to this error. The vertical line traced from the vanishing point (F), divides the central square at 1/2 (Lorenzetti), 1/3 (van Eyck), or 1/4 (Brunelleschi, Ghiberti). One can nevertheless understand the unity of these constructions. Because it is justified in operating terms, the division of the central square falls into the domain of type III systematic errors. Two constructions have been used.



Figure 1

The first (*Figure 1*) consists in using the space of the triangle (A_0B_0F) in order to trace the receding transversals. From point (A_0), located on the same vertical as vanishing point (F), trace a diagonal with the set square. This diagonal intercepts the first vanishing line (B_0F) at (B_1). From this point, trace a horizontal line (A_1B_1), which will determine point (A_1) on the vertical line (A_0F). Then translate the set square in order to trace a parallel to (A_0B_1) from (A_1). This line will intercept the point (B_2) which, in turn, will fix the height of the second horizontal (A_2B_2) and so on and so forth until the horizon. This method of under-foreshortening produces concave diagonals. Why was such an error accepted by painters such as Lorenzetti, Rogier van der Weyden or Carpaccio? Perhaps because, for the Renaissance man, brought up on *abaco*⁶, such proportional representation called to mind the "Golden Rule" whereby

$$a:b = c:d$$

Let us return to the perspective view and let us call: A_iB_i and A_iA_j the apparent width and height of a square. The application of the Golden Rule gives us:

$$A_0B_0: A_0A_1 = A_1B_1: A_1A_2 = ... = A_iB_i: A_iA_i = ... = A_mB_m: A_mA_n.$$

⁶ Other connections between the *abacus* — a term from the Middle Ages which encompasses arithmetic and algebra — and perspective have been proposed by Judith V. Field (1997), in order to understand the construction methods of Piero della Francesca.

This relation means that the proportional ratio between the heights, from the first to the last interval, can be directly estimated with the naked eye. Thus, in comparison with the foreshortening that a linear perspective would produce, the first intervals $(A_0A_1 \dots)$ are too short and the last $(\dots A_mA_n)$ are too long. Here the error comes from an overestimation of identity. Is it not convenient to suppose that if the ratio *a:b* applies to the first intervals, then (because all the squares are identical) this should also be true for the last ones? Despite the fact that linear perspective does not tolerate the construction of intervals by set square, painters had sound reason to believe in the validity of this empirical rule.



Figure 2

Other paintings which reveal under-foreshortening cannot be associated with the previous method. Let us suppose that the vertical line traced from the vanishing point (F) divides the first square at 1/4 (*Figure 2*). In order to create the spacing of the transversal lines, the height of the first square can be fixed arbitrarily by tracing the straight line (A₀P). This line intercepts the first vanishing line (B₀F) at (B₁). From this point, trace the first horizontal (A₁B₁). This horizontal line intercepts the vertical line (A₀F) at (A₁). Then trace from this point the diagonal (A₁P) which will determine the point (B₂) by intersection with the vanishing line (B₀F). The point (B₂) will now fix the height of the second horizontal (A₂B₂) and so on and so forth until the horizon. Compared to the previous system of construction, the diagonals are no longer parallel. They converge at point (P) which is situated above the horizon⁷. [...] This is why all

⁷ This construction point (P), which foreshadows the "distance point" of linear perspective as codified in the 17th century, seems indeed to have been used by painters since it is usually to be found in a place which stands out from the architectural decor. We can find it: at the corner of a pilaster (Brunelleschi), on the edge of a

the intervals (A_0A_1) , (A_1A_2) , (A_2A_3) ... are longer than those which would normally produce exact perspective foreshortening. This method of under-foreshortening is quite frequent, particularly in the works of Brunelleschi, Ghiberti, Jan van Eyck or Rogier van der Weyden.

If painters followed these two (erroneous) methods, it was mainly because they allow one to represent intervals which diminish the closer they are to the horizon. Considering the knowledge which was available during the quattrocento, the goal of a *qualitative representation* of diminishing spaces was thereby achieved.

3) Methods of over-foreshortening

Finally, foreshortening can result in a network of *convex diagonals*. In this case the spaces between the horizontal lines diminishes too rapidly as one approaches the vanishing line.





One is faced with over-foreshortening (*Figure 3*) when the point of convergence (P) of lines (A_0B_1) , (A_1B_2) ..., as previously constructed, is situated lower than the horizon line. In this case, the series having as intervals (A_0A_1) , (A_1A_2) , (A_2A_3) ... tends to a limit (A_n) at the height of (P). In a linear perspective, this point of convergence (P) should correspond to a "distance point" on the horizon. However, since (P) is situated below the horizon — and assuming that the paving is drawn to infinity —, there will always be an empty space between this limit and the true horizon. Here the opposite effect is produced to that of under-foreshortening: the intervals (A_0A_1) , (A_1A_2) , (A_2A_3) ... are too short compared to those which an exact perspective

building (Ghiberti), on the shoulder of a figure (Donatello).

foreshortening would produce.

This type of diminution is not very common in the corpus (Donatello, Masaccio), and painters' preference for the under-foreshortening methods mentioned above can be easily explained: despite being false, they allowed one to fill the entire space between (A_0) and (F), something that over-shortening methods do not permit. [...]

Examination of paintings

The aforementioned cases of over-foreshortening, foreshortening and underforeshortening are exclusive categories. When attempting to locate these constructions in the Renaissance's most representative pictorial works of art, one is struck by the fact that few of them reveal correct diminution. A few late works do however exist, such as *Christ's Flagellation* by Piero della Francesca's or *The Reflection* by the Master of the Barberini Panels (both ca. 1450). Most paintings, however, depart from the rules of linear perspective.

It is generally agreed that Filippo Brunelleschi (1377-1446) played a major role in the setting up of this new system of representation and yet only one perspective view is attributed to him — *Healing of the Possessed* (ca.1425) — to be found at the Louvre's Département des Objets d'Art (*Plate 1*). Should we accept the opinion of Parronchi (1958: 16) for whom "if one looks carefully, the perspective construction of the buildings on this plateau quickly reveals the mathematical precision on which the law of proportions concerning 'diminutions' and 'augmentations' is built"? We notice that the vertical line going through (F) divides the paving stones in the central axis at 1/4. Since the network of diagonal lines on the floor is concave, and point (D/4) is situated above the horizon, we are faced with an example of underforeshortening. As paradoxical as this may seem, the supposed inventor of linear perspective here uses a construction which departs from the rules of correct diminution.

Let us now examine the work of Lorenzo Ghiberti (1381-1455). Critics have often supposed that Brunelleschi or Alberti had an advisory role in the bas-reliefs of the San Giovanni baptistery doors in Florence (1437). Thus, Krautheimer says "In the *Isaac* and *Joseph* panels, Ghiberti applied *verbatim* the construction perspective that Alberti had exposed in his text on painting" (1956: 251). John White is of the same opinion: "Here, the paving in perspective, whose construction is henceforth exact, allows the figures to evolve on a platform which conforms to the new scientific principles" (1992: 172). [...] When studying the method of diminution used by Ghiberti, you will notice that these opinions are dubious. The squares situated on the central axis are, as with Brunelleschi's plateau, shifted back by 1/4 compared with the vertical line traced from the vanishing point (F). As the series of diagonals on the floor are concave, the system used is one of under-foreshortening. In fact, contrary to Kemp's analysis (1990: 25), the lateral point of convergence, both in *Isaac (Plate 2)* and in *Joseph*, is situated above the horizon. These are not accidental errors for the construction is the same in both panels. One must therefore abstain from believing that Ghiberti indulges in a "strict use of artificial perspective" (White, 1992: 162).

Let us now turn to the work of Donatello (1386-1466) whose talent was praised by Cristoforo Landino with the following words: "Donato [...] was a great imitator of the Ancients and knew a great deal about perspective" (in Panofsky, 1976: 70). Certain historians agree upon the exactness of his perspective layouts. For example, concerning *Feast of Herod*, Darr and Bonsanti (1986) state: "He constructed an architecture painted according to the rules of the two point perspective which had just been codified by Leonbattista Alberti in his *De pictura* of 1435" (1986: 141). The fact that the network of diagonals on the floor is concave proves that Donatello used an under-foreshortening which departed from the rules of linear perspective. Moreover, this is not simply an occasional error on his part for in the first *Feast of Herod* (Plate 3), carved between 1427-1429, Donatello again resorts to under-foreshortening: the point (D/6) is clearly situated beneath the horizon. [...]

Was Vasari right in attributing "the perfection of this art [of perspective]" to Paolo Uccello (1397-1475)? He wrote: "Paolo devoted himself, without respite, to the most difficult artistic research; he perfected the method of constructing perspective by the intersection of lines traced, using floor plans and elevations of buildings, to the very summits of cornices and rooftops. After fixing the point of view of the eye higher or lower, according to his desire, he foreshortened them and made them diminish towards the vanishing point. Trace a working drawing of *Holocaust (Plate 4*), which is part of *Profanation of the Host* predella kept at the Palazzo

ducale d'Urbino (1465-1469). [...] The network of diagonals is a concave structure. One must therefore refute Kemp's judgement (1990: 39) and admit that Paolo Uccello used underforeshortening.

It is common practice to place the young Masaccio in Brunelleschi's wake. It is true that they were together in Rome and that their age difference easily leads one to imagine a masterdisciple relationship. But is this true when considering the use of perspective? [...] Study Trinity fresco at Santa Maria Novella (Plate 5) painted between 1425-1427. Look at Vasari's commentary in the Vite: "At Santa Maria Novella [...] there is something even more beautiful than the figures: it is a barrel vault, drawn in perspective and divided into coffers filled with rosaces whose proportions decrease with foreshortening so that the wall appears to be hollowed out". Panofsky believes that this work of Masaccio's reveals a "completely precise and unified construction" (1975: 147). Parronchi considers that "Masaccio's Trinity at Santa Maria Novella, which is a work of genius and well ahead of its time" is an example of the strict translation of the rules of perspective (1957: 7). White agrees: "The painter proposes an architectural foreshortening in line with the principles of artificial perspective. The diminution of the coffers is calculated with precision" (1992: 146). An over-sophisticated system has recently been proposed in order to explain this construction⁸ (Aiken, 1995). However, let us reconstruct the perspective of the coffers by transfering the points of the vault (a, b, c) on to the plane (a', b', c'), then tracing the grid resulting from the intersection of these new vanishing lines with the transversals. We notice that the network of diagonals is a convex one, which implies the use of over-foreshortening. The point (D/2) is situated halfway between the horizon and the coffered vault. Therefore, Field is right in saying that: "There are serious [...] departures from mathematical correctness in Masaccio's Trinity fresco" (1997: 72). Besides, The

⁸ Jane Aiken postulates that Masaccio constructed the diminution of the vault ribs using astrolabe and

stereographic projection. Nevertheless, it is questionable how much the orthographic and stereographic projections of the astronomers were "readily available sources to Masaccio and Brunelleschi" (1995: 173). First, the length and complexity of this construction proves an obvious lack of proportion between means and ends, so much so that one could wonder whether so sophisticated a technique has ever been used. Secondly, if Renaissance painters and architects like Brunelleschi or Masaccio were that erudite, one could wonder why they claimed so vehemently to be artists. The reason is obvious: they had neither the status nor the income of those who trained at the Faculty of Liberal Arts.

Holy Trinity is not the only work of Masaccio's to depart from the rules of linear perspective: the *Desco da parto* at Berlin's Gemäldegalerie shows a network of convex diagonals with a convergence point situated halfway between the floor and the horizon line. Here we have another example of over-foreshortening.

These brief notes concerning a few of the quattrocento's greatest artists allow us to draw a simple — if not surprising — conclusion: among the Italian paintings of the first half of the quattrocento, not a single one applied the rules of linear perspective to the letter, not even those of Brunelleschi, the supposed inventor of *perspectiva artificialis*. The first example of a strict application of linear perspective is by Piero della Francesca around 1450. Against this hyper-critical analysis of the use of perspective one could therefore say that the rules of linear perspective were applied from Piero della Francesca onwards and, as such, our demonstration should continue on until after the 15th century. It is not for us to embark upon such a task, yet it is possible to show that the homogeneity of pictorial practices is still over estimated. The reconstruction *ex post facto* of a number of paintings from that era shows that, if the Academies played a role in the diffusion of perspective methods, they did not completely standardize the operations used by painters. I shall only propose one example which proves that the rules of perspective were not always followed after 1450.

The extremely architectured work of Vittore Carpaccio (1460-1526) has been the object of evaluations of correctness which can be compared to those concerning the works of the quattrocento. Should we therefore accept the judgement according to which: "The geometric and perspective precision of the town planner and the architect is characteristic of Carpaccio's way of thinking"? (Sgarbi, 1979: 17). Consider, for example, *Birth of the Virgin (Plate 6)*, which is part of the *Albanian Cycle* of 1504. [...] Apart from the fact that the system of vanishing lines does not converge towards a unique vanishing point, Carpaccio's method of diminution is also erroneous. By tracing the diagonals of the squares we obtain a concave network which quickly reveals this construction to be an example of under-foreshortening. The vertical line traced from the vanishing point (1) divides the axial squares at ¹/₄. The fact that the oblique lines (CD ... EF) remain parallel shows that Carpaccio used a method of under-foreshortening whereby the diagonals are constructed by translation of the set square. This is, I admit, a selected example of transgression of the laws of perspective, but it is not certain that Carpaccio was the only 16th century painter to display such independance concerning the rules of perspective. [...]

Conclusions

Let us leave aside the working drawings and step back for a moment. The study of operating methods over a period of two centuries (1297-1504) allows us to make several general conclusions. The history of perspective, put together through the examination of constructive procedures, is made up of three key moments: 1) Giotto was the first to use a correct method of diminishing intervals; 2) Brunellschi created a perspective representation based on the postulate of monocular vision, but he used a false method of diminution; 3) Piero della Francesca used both a unique vanishing point and a correct method of diminution. However, this history obviously has rather a strange link with the question of truth or falsehood. Uniquely in terms of the foreshortening of intervals, it was Giotto's workshop (*Jesus among the Doctors*) and Simone Martini (*Funeral of the Saint*) who practised true perspective around 1315-1317. Brunelleschi, Ghiberti, Uccello, Fra' Angelico, Donatello and Masaccio practised it wrongly a century and a half later.

With regard to the supposed affinities between artists, it is apparent that the community of architects, painters and sculpteurs of the quattrocento were not united in their adherence to the rules of linear perspective. A comparison of the foreshortening methods shows that no true unity of conception existed. Each artist used a construction which he believed to be right, without there being any real sharing of knowledge. Moreover, if Ghiberti and Masaccio showed signs of a certain operating stability, the same cannot be said of Donatello or Ucello who tried several different constructive systems. [...] *In Renaissance times, perspective was not unique but multifarious*. This could be seen as a reply to the question of uniformity of operating practices voiced by Marisa Dalai Emiliani: "[During the quattrocento] are we faced with the application of one, unique discipline or rather of a discontinuity, of variations or mutations to such an extent that we could speak of a 'personal' use of perspective on the part of each

individual artist?" (1990:17). The quattrocento's perspectives are thus characterised by a series of "uncoordinated initiatives" which is exactly what sociologists have observed in most developing social movements. This analysis of perspective methods also wonders why the human mind is so reluctant to conceive that artistic movements could exist other than in the form of social groups with uniform behaviour. Here, perhaps, we should see the final vestiges of influence of the concept of *Kunstwollen*⁹.

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⁹ Panofsky already recognised the problems raised by the use of this holistic notion. He wrote: "The term *Kunstwollen* usually refers artistic phenomena in their entirety, to the artworks of a whole era [...] whereas the term 'artistic intention' is more often used to characterise an individual work of art" (1975 : 200).

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Illustrations

Plate 1. — Brunelleschi, *Healing of the Possessed*, ca. 1425. Carved silver plate (7 x 11 cm). Paris: Musée du Louvre, Département des Objets d'Art.

Plate 2. — Ghiberti, Isaac, 1437. Carved and gilded bronze plate (79 x 79 cm). Florence: San Giovanni Baptistry.

Plate 3. — Donatello, Feast of Herod, 1427-29. Gilded bronze plate (60 x 60 cm). Sienna: San Giovanni Baptistry.

Plate 4. — Ucello, *Profanation of the Host: Holocaust*, 1465-69. Tempera on wood (42 x 361 cm). Urbino: Palazzo Ducale.

Plate 5. — Masaccio, Trinity, 1425-27. Mural fresco and tempera (667 x 317 cm). Florence: S. Maria Novella.

Plate 6. — Carpaccio, Birth of the Virgin, 1504. Oil on canvas (126 x 129 cm). Bergamo: Accademia Carrara.