Branko Mitrović

NELSON GOODMAN'S ARGUMENTS AGAINST PERSPECTIVE—A GEOMETRICAL ANALYSIS

For the past fifty yeas few books by English-speaking philosophers have exercised a greater influence on art- and architectural history than Nelson Goodman's *Languages of Art*.[1] Having come out in 1968, the book was an important contribution to the rise of cultural relativism that subsequently came to dominate the English-speaking humanities for decades. Goodman adopted the view (previously advocated by Ernst Gombrich in his 1960 book *Art and Illusion*) that "there is no innocent eye" and that the totality of an individual's perception is predetermined by and a result of that person's conceptual framework.[2] Unlike Gombrich, however, Goodman inferred that, since our conceptual frameworks derive from the cultures we live in, all we can know and perceive is a result of our cultural background; he consequently argued that reality itself was but a cultural construct.[3] According to this view, there are no facts that constitute the world independently of human cognitive apparatus. Reality is not there to be discovered. Rather, reality, including everything we perceive, is itself constituted by one's conceptual framework, and the conceptual framework ultimately results from membership of a culture.[4] In other words, reality is formless; our cultural background slices it, one could say, into units that are comprehensible to us because of our membership of a given culture. Since, following Gombrich, there is no innocent eye and we can perceive only what we already know about, Goodman infers that our perception too is fully determined by our membership of a culture.[5]

The rejection of both perspective and the idea view some visual representations represent *non-conventionally*, by simply showing objects the way they look like, was the necessary preliminary step in Goodman's formulation of his argument. The radical cultural-constructivist position that Goodman advocated could not allow the view that a perspectival drawing (or a realist painting) represents an object by simply resembling it—for instance, by delivering a similar bundle of light rays that one would receive when looking at the object. Accepting that this is possible would mean that our interaction with reality is sometimes not mediated by our background. It would mean that (in some cases at least) our perception of similarities between things is not based on our membership of a culture. For Goodman, the similarity that we perceive between perspectival drawings (or realist paintings) and the things they represent, derives from social conventions. In his view, this similarity is independent of the geometry of light rays. In other words, resemblance between a cat and a drawing of a cat is nothing less conventional than the use of the word "cat" to refer to a cat. According to Goodman, *every* representation is conventional; the fact that we perceive perspectival images as similar to the objects they represent is a result of cultural inculcation.[6] Like every other mean of communication, perspectival images need to be *read* and this skill is acquired. (14)

In order to make this argument, however, Goodman had to show that the geometrical rules for the construction of perspectival images are arbitrary and do not depend on the geometry of light rays. The opening section of *Languages of*

Art states a number of geometrical arguments that attempt to prove this. Although Goodman's entire argument hinges on the geometrical validity of his analysis and although its validity has been occasionally contested, no systematic analysis of his arguments has been published so far.[7] The lack of a systematic review of Goodman's geometrical arguments is remarkable, considering the wide (and sometimes critical) attention that his book received as well as the wide influence it exercised.[8] My paper is intended to fill this gap, by providing a systematic analysis of Goodman's arguments that pertain to the geometry of perspective. The paper will present a comprehensive analysis of Goodman's errors and define conceptual misunderstandings that generated them.

Light and its geometry

By the time Goodman came to articulate his position, the idea that the ability to comprehend perspectival images is a social, cultural convention was an old one. Its most famous formulation goes back to the early 1920s and Erwin Panofsky's essay "Perspective as a Symbolic Form."[9] Panofsky argued that the discovery of the geometrical construction of perspective in the early Renaissance was a result of a new understanding of space; before the Renaissance, Panofsky claimed, space was not conceived of as homogenous. In Panofsky's view, the geometrical construction of perspective as it is normally defined for a flat surface, cannot account of natural human vision. The image that light rays produce on the human retina is formed on a semi-spherical surface and, in Panofsky's view, the very image that we see has consequently to follow the curvature of this surface. He argued consequently, that our vision corresponds to curvilinear perspective; insofar as the rules of perspective are defined for a flat surface, in Panofsky's view, they are unrelated to how we actually see. The implication is that our ability to read perspectival images must be an acquired skill that the individuals who grow up in western civilization learn by living in their culture.

The obvious answer to this argument is that we do not see the retinal image, we see things in front of us. [10] A perspectival image endeavors to replicate the bundle of light rays that would reach our eyes if the objects that it represents were in front of our eyes. At the same time, not all light rays are equally important. Those light rays that arrive from the contours of objects define their shapes; a perspectival image that strives to represent a certain disposition of shapes will primarily strive to replicate the light rays that would reach the eye from the lineaments of these shapes. It is consequently the understanding that a perspectival image represents by virtue of producing a bundle of light rays that would reach the eyes from the object represented, that Goodman's attack on perspective needed to defeat. Goodman has two available strategies. He can point out that non-conventional representation, based on delivering an equivalent bundle of light rays is simply impossible: that in order to recognize what a certain bundle of light rays represents, merely perceiving such a bundle of light rays is not enough. This argument pertains to the *ambiguity* of perspectival representations and I will discuss it in the final section of this paper. Another approach, targeted by all other arguments Goodman formulates is geometrical: Goodman must show that rules for the standard and geometrical construction of perspectival drawings do not correspond to the actual geometry of light.

Before analyzing Goodman's arguments, let us start by considering what actually happens when a perspectival drawing is constructed. Consider a typical situation presented in **figure 1**.

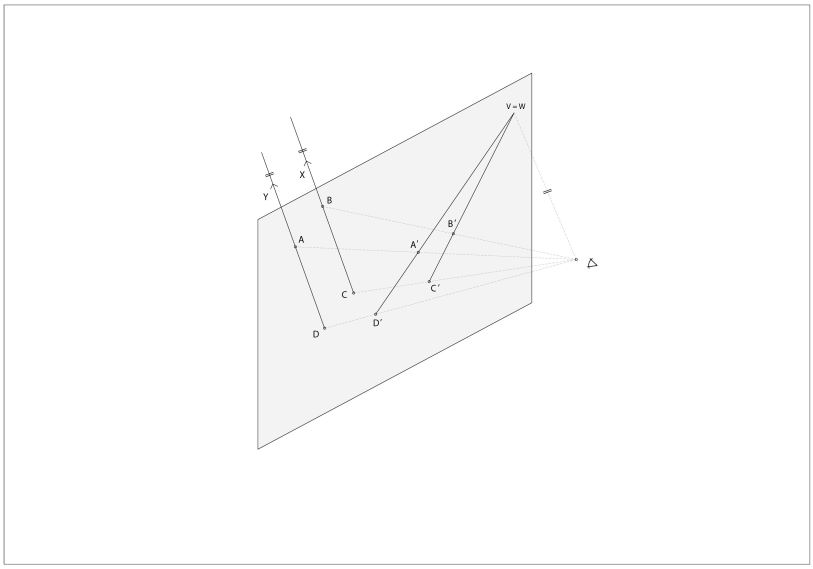

Fig. 1

Let O be the position of the eye and let AD be a line seen through a glass panel. A' and D' are then the points of the intersection of lines OA and OD with the glass plane. In other words, if one looks at AD through the glass plane and draws on the plane what one sees, one will draw A'D'. Similarly, any point Y on AD has a picture Y' on the glass plane, which is the intersection of the plane and OY. Now imagine AD extended beyond A and imagine that Y travels along this extension to new positions Y_1, Y_2, Y_3, …etc. The pictures of these points on the glass plane are Y_1', Y_2', Y_3', …etc. The further Y travels from A, the more parallel OY becomes with the line AD. When Y vanishes in infinity, the line OY will be parallel with AD; at that moment, the picture of Y on the glass plane will be the point of intersection of the plane and the line from O that is parallel with the line AD. Let us name 'V' that point. Consider now another line BC, parallel with AD. Again, the picture of this line on the glass plane will be B'C'. Let now X be a point that travels along the extension of BC to infinity. Like in the case of the point Y, the line OX will gradually become more and more parallel to the line defined by the points B and C. Ultimately, when X vanishes in infinity, OX will be parallel with the line BC. But since AD and BC are parallel with each other, and since there can be only one line through a given point (the position of the eye) that is parallel with both of them, it follows that when X vanishes in infinity, W, the intersection of OX and the glass plane will be also V. V is the *vanishing point* for all the lines in the glass plane that are the pictures of lines parallel with AB and CD. We thus reach the general principle that in a perspectival drawing *any set of parallel lines appears to vanish in the direction of a line that goes through the eye and is parallel to these given lines.* Various geometrical rules for the construction of perspectival drawings, the use of vanishing points and so on, explain how to construct on a piece of paper the drawing that would be created by looking at an object through a glass plane and drawing on the glass plane the contours of the object.

Taking all this into account, it is also important to relativize the idea that the glass plane, or the plane of the picture that replicates the drawing made on

glass, has to be a plane surface. A perspectival representation need not be a flat plane, or a plane at all. A perpsectival representation of any object can be any disposition of objects that would deliver to the eye, when seen from at least one point in space, an identical disposition of light rays to the object it is representing. (Ultimately thus understood, a physical model is a kind of perspectival representation as well.) Perspectival images are just two-dimensional members of a wider family.

Goodman's geometrical arguments

Goodman's main target is thus the idea that a perspectival drawing represents by delivering the same bundle of light rays as the object(s) it represents, that "identity in pattern of light rays must constitute identity of appearance." (12)

His first argument pertains to the positioning of the eye point in relation to the picture plane. A perspectival picture is indeed constructed in accordance to the position of the eye. Goodman says that "the picture must be viewed through a peephole, face on, from a certain distance, with one eye closed and other motionless." (12) Such conditions are abnormal, he says; it is known from physiology that an eye that would be fixed that way would not be able to see. This statement pertains to the fact that the eye is indeed never stationary, that it moves in so-called "saccadic movements."[11] We believe that our vision is continuous, but it is not; the eye sees by performing a series of jumps ("saccade fixations"). A saccadic movement of the eye takes between one two-hundredth and one twelfth of a second. The eye then makes a short pause (say, a quarter of a second) and then performs another saccadic movement. During the saccadic movement the eye is blind; what we see, we see in the moments between these movements. However, the important point is that the movement of the eye does not disturb perpectival perception as long as the center of rotation of the eye coincides with the center of perspective.[12] The point is precisely that a perspectival drawing delivers a bundle of light rays that matches the one that would arrive from the objects the perspectival drawing represents. The eye has its way how it performs its job—while operating with the equivalent bundle of light can only result in an equivalent perception, whatever the eye does. It would be quite different if the head turned, because then the direction of sight changes and the eye receives a different bundle of light rays.

This brings us to another implication of Goodman's complaint that a perspectival drawing requires a stationary eye. Consider, for instance, what happens if a perspectival drawing is viewed from a position different than the one for which it was constructed. A way to answer this question is to draw another perspectival drawing that would provide us with the bundle of light rays equivalent to the one arriving to the eye at the new vantage point. **(fig. 2)**

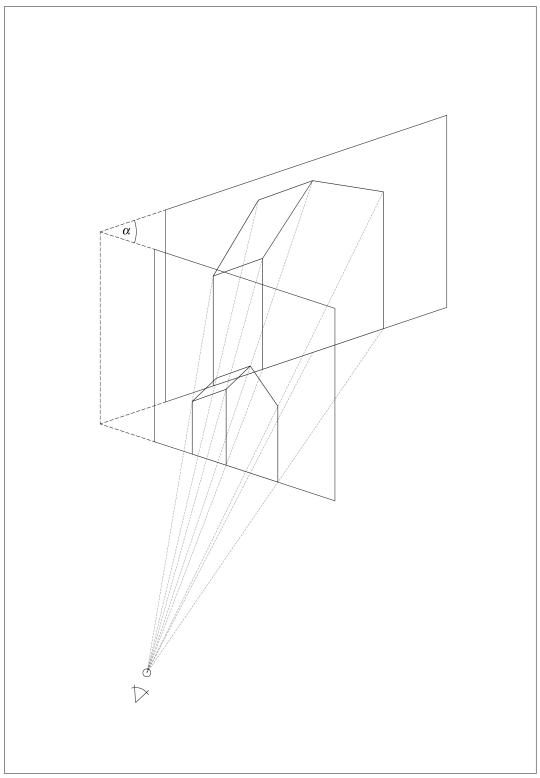

Fig. 2

Imagine thus having placed a glass plane between the eye and the original perspectival drawing seen askew. The result would be new perspectival drawing on the glass plane. Let O be the new vantage point and let AB be a line on the original drawing whose vanishing point is V. **(fig. 3)** Then the pictures of A, B and V on the new glass plane will be A', B' and V'. While the distance between A', B' and V' will be different from the one in the original drawing (it will depend on the angle between the original drawing and the new glass plane), the three points will still have to be colinear. And this applies to every line of the original drawing and its vanishing point. In other words, the new drawing on the glass plane will be a perspectival drawing, though, depending on the angle between the original drawing and the glass plane, the proportions and relative sizes of the objects represented will be different.[13] If the angle becomes too big, the original drawing may become unrecognizable, as it is the case with various anamorphic representations.

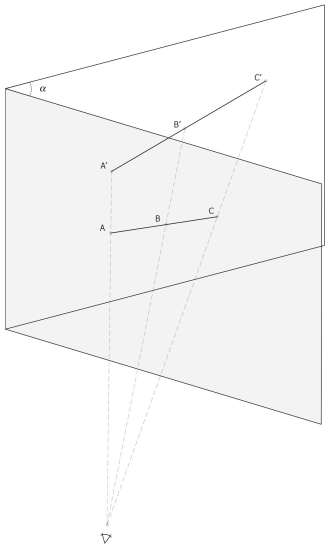

Fig. 3

Goodman's remaining geometrical arguments directly derive from a failure to understand the fact that a geometrically constructed perspectival drawing is an equivalent of a drawing that one would produce when looking through a glass plane and drawing on it what is seen through it. Goodman thus argues that "a picture is viewed face on at a distance of six feet while the cathedral represented has to be looked at, from, say, and angle of 45° to its facade and at a distance of two hundred feet." (13) Obviously, a geometrically constructed drawing has to account for this; very often geometrical drawings do represent buildings seen at an angle. In fact, as mentioned, a drawing itself need not be constructed to be seen orthogonally nor does it have to be on a plane. Similarly, Goodman argues that

> By the pictorial rules [of the geometrical construction of perspective] railroad tracks running outward from the eye are drawn converging, but telephone poles (or the edges of a facade) running upward from the eye are drawn parallel. By the 'laws of geometry' the poles should be also drawn converging.

which is obvious nonsense. If poles are parallel with the imaginary glass plane, then they will have to be parallel and not converging in the drawing. The same will actually happen with railway lines if they are seen from above and the imaginary glass plane/picture plane is placed parallel with them.

This same misunderstanding of the relationship between the imaginary glass plane and picture plane motivates Goodman's final, "conclusive" argument. **Figure 4** shows a drawing equivalent to the one he has presented in the book.

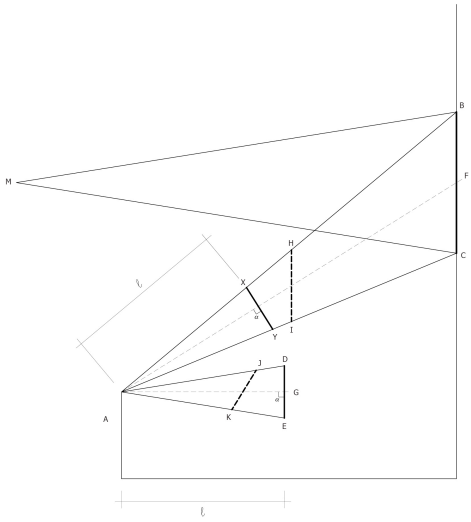

Fig. 4
The observer's eye is at a; b,c is the facade of a high building while d,e is the picture of the facade. He then points out that picture and the facade are parallel but the angles at which they are seen are different. Consequently, he explores whether a picture positioned at hi or jk would provide the same bundle of light rays as the one the eye receives from the facade. This question is the wrong one to ask. The geometrical construction of perspective does not work so that one has a ready drawing and then goes around looking how to position it so that it conveys the same bundle of light rays as the one existing at a given place. Rather, one decides from the beginning about the angle at which the drawing is going to be perceived (normally, but not necessarily, this angle is orthogonal on the line of sight) and the position from which the object represented (in this case the building) would be seen. One then imagines a glass plane between the object and the eye placed at the same angle and at the same distance as the plane of the picture (XY in the **figure 4**). The geometrical construction of the perspectival drawing should produce the same drawing as the one we would draw on the glass plane, if we drew on it what we see through it. This last example clearly illustrates that Goodman never properly grasped the functioning of perspectival the drawings as imaginary replications of drawings that would be drawn on a glass plane placed between the object represented and the eye.

Ambiguity of perspective
It has been mentioned that Goodman has another argument against perspective that is potentially much more damaging. This argument was well-known in the 1960s when *Languages of Art* came out. The important point is that in order to recognize what a certain bundle of light represents, mere perceiving that bundle

of light rays is not enough. The important problem with perspectival representations is that they are *ambiguous.* A single perspectival image can always be taken to stand for an infinite number of different three-dimensional shapes. Ultimately, every drawing consists of lines; while every line in a perspectival drawing may stand for a single line in three-dimensional space, it can also represent any number of disconnected lines that are merely appear to be a single line when observed from a specific viewpoint. **(Fig. 5)**

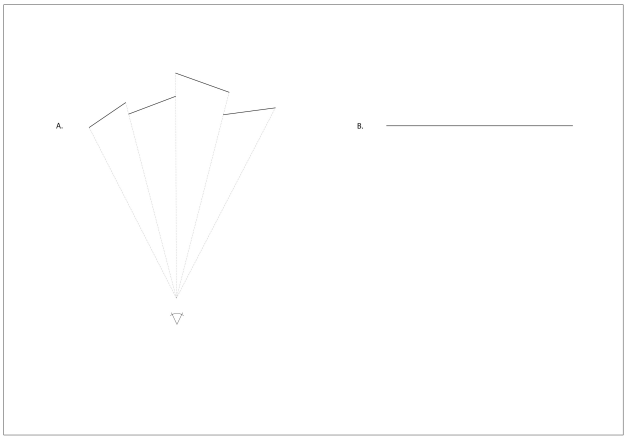

Fig. 5

In a widely discussed experiment Adelbert Ames constructed a criss-cross of disconnected wires in a room, that, when seen through a peephole, were perceived as a chair.[14] Although wires were disconnected, hanging in the air and certainly did not form a chair, their endpoints were placed to coincide perspectivally when seen through the peephole. The implication is that when perceiving any perspectival picture, that same image may have been generated by an infinite number of different spatial dispositions of objects. Yet, the human mind chooses one possible interpretation as the right one. Goodman points out that

> ...the rays yielded by the picture under the specified conditions match not only those yielded by the object in question from a given distance and angle but also those yielded by any multitude of other objects from other distances and angles. (11-12)

While for Goodman this meant that the capacity to interpret perspectival images was culturally inculcated, Ernst Gombrich, who defended the transcultural validity of perspective, regarded the ambiguity of perspectival representations as a confirmation of his thesis that perception is inseparable from conceptualization. From his point of view, when looking through the peephole in Ames' experiment, people saw a chair because their brain organized their perception according to the available concept (chair). It was the availability of the concept that explained the subjects' interpretation of the disposition of wires they perceived.[15]

Modern psychological explanation of this phenomenon, however, does not follow Goodman's or Gombrich's view. After all, one can form a definite three-dimensional interpretation of a two-dimensional image even when it is impossible to associate a specific concept with what one sees. Subsequent research has provided a different explanation of the way we derive our

awareness of three-dimensional dispositions of objects from two-dimensional images. The point is not that the brain relies on available concepts; rather, it relies on specific rules or constraints when interpreting a two-dimensional image three-dimensionally.[16] One such rule, for instance, is that the brain will always interprete a straight line in an image as a three-dimensional straight line (although it may actually consist of a number of disconnected lines that only appear to be in continuation of each other). Similarly, when the ends of two lines coincide in an image, they are interpreted as coinciding three-dimensionally (which explains why subjects perceived Ames' disconnected wires as connected). Further on, elements near each other in an image are interpreted as nearby three-dimensionally (even though they often may not be). It is the rules and constraints of this kind that determine the interpretation of our retinal image and provide us with knowledge about the spatial disposition of objects around us. A substantial body of modern psychological research indicates that the early stages of human vision are independent of concepts we operate with; the idea that "there is no innocent eye" is by this time considered as "1950s psychology."[17]

Conclusion

The efforts of a number of twentieth-century scholars, such as Panofsky or Goodman, to reject perspective as a transcultural mode of visual presentation are a remarkable aspect of twentieth century intellectual history. Their views were accepted and regarded as valid results, at the time when there were plenty of scholars who could have pointed out that they were based on invalid reasoning. In the case of Goodman, the entire argument of his book was built upon the assumption that every similarity must be conventional—and that consequently perspectival images to not operate by delivering an equivalent bundle of light as the object represented. In spite of the huge influence of his book, the arguments in favor of this thesis, were based on an elementary miscomprehension of how perspectival representation functions.

[1] Nelson Goodman, *Languages of Art: an Approach to a Theory of Symbols*, Indianapolis: Hackett Publishing Company, Inc., 1968. All citations according to the second edition, 1968.
[2] Ernst Gombrich, *Art and Illusion. A Study of Psychology of Pictorial Representation*, London: Phaidon 1960. For a survey of Gombich's views in the context of the relativist and social-constructivist metaphysics that came to dominate the intellectual life of the English speaking world after the 1970s, see Branko Mitrović, "A Defence of Light. Ernst Gombrich, the Innocent Eye and Seeing in Perspective", *Journal of Art Historiography*, 3 (2010).
[3] See in particular his subsequent book: Nelson Goodman, *Ways of Worldmaking*, Hassocks: The Harvester Press, 1978: "Not only motion, derivation, weighting, order, but even reality is relative." (20)
[4] He thus expects that his views will be "irritating those fundamentalists who know very well that facts are found not made, that facts constitute the one and only real world, and that knowledge consists of believing the facts." Ibid., 91.
[5] "The catch here, as Ernst Gombrich insists, is that there is no innocent eye. The eye always comes ancient to its work, obsessed by its own past and by old and new insinuations of the ear, no, nose tongue, fingers, heart and brain. ... Not only how but what it seen is regulated by need and prejudice. It selects, rejects, organizes, discriminates, ass(7)ociates, classifies, analyzes, constructs. ... The myths of the innocent eye and of the absolute given are unholy accomplices. Both derive from and foster the idea of knowing as a processing of raw material as being discoverable either through purification rites of by methodological disinterpretation. But reception and interpretation are not separable operations; they are thoroughly interdependent. ... what has been received and what has been done to it cannot be distinguished within the finished product. (9) A picture never merely represents x, but rather represents x as a man or represents x to be a mountain, or represents *the fact that x is* a melon." Goodman, *Languages*, 6-9.
[6] "Just here, I think, lies the touchstone of realism: not in quantity of information but in how easily it issues. And this depends upon how stereotyped the mode of representation is, upon how commonplace the labels and their uses have become. Realism is relative, determined by the system of representation for a given culture or person at a given time. ... Realistic representation, in brief, depends not upon imitation or illusion or information but upon inculcation. Almost any picture may represent almost anything; that is, given picture and object there is usually a system of representation, a plan of correlation, under which the picture represents the object. How correct the picture is under that system depends upon how accurate is the information about the object that is obtained by reading the picture according to that system. But how literal or realistic the picture is depends upon how standard the system is. IF representation is a matter of choice and correctness a matter of information, realism is a matter of habit." Ibid., 36-38.
[7] For partial discussions see: David Carrier, 'Perspective as a Convention: On the Views of Nelson Goodman and Ernst Gombrich', *Leonardo*, 13 (1980), 283-287. (See also the subsequent exchange, *Leonardo*, 14: 1. (1981), 86-87.) David Topper 'On the Fidelity of Pictures: A Critique of Goodman's Disjunction of Perspective and Realism', *Philosophia*, 14, 1-2 (1984) 187-197. Michael Kubovy: *The Psychology of Perspective and Renaissance Art*, Cambridge: Cambridge University Press, 1986, 122-126.
[8] For reviews of Goodman's *Languages of Art see* B. C. O'Neill, '*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman', *The Philosophical Quarterly*, 21: 85, October 1971, 361-372; Wolfgang M. Zucker, 'Languages of Art, an Approach to a Theory of Symbols by Nelson Goodman', *The Art Bulletin*, 52: 2, June 1970, 223-224; Monroe C. Beardsley, 'Languages of Art: An Approach to a Theory of Symbols by Nelson Goodman', *Philosophy of Science*, 37: 3, September 1970, 458-463; Daniel Rigney, '*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman', *Contemporary Sociology*, 8: 2, March 1979, 319-320; Annette Barnes, '*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman' *Perspectives of New Music*, 9: 2, Spring-Summer 1971, 330-340; Christiana M. Smith, 'Symbolic Systems, Cognitive Efficacy, and Aesthetic Education. *Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman', *Journal of Aesthetic Education*, 3: 4, October 1969, 123-136; Nicholas Wolterstorff, '*Languages of Art*', *The Journal of Aesthetics and Art Criticism*', 34: 4, Summer 1976, 491-496; Michael Thompson, '*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman; *Laws of Form* by C. Spencer Brown', *Leonardo*, 7: 2, Spring 1974, 175-176.
[9] Erwin Panofsky, *Die Perspektive als symbolische Form* in Fritz Saxl, ed., *Vorträge der Bibliothek Warburg 1924-1925*, Leipzig and Berlin 1927. Cited according to the reprint in Erwin Panofsky,

Deutschsprachige Aufsätze, Karen Michels and Martin Warnke, eds., Berlin, Akademie Verlag 1998, vol. 2, 664-757.

[10]For this argument, see Genesius Ten Doesschate, *Perspective, Fundamentals, Controversials*, History Nieuwkoop: B de Graaf, 1964, 46-56, esp. 49 and also Maurice Henri Léonard Pirenne, *Optics, Painting & Photography*, Cambridge: Cambridge University Press 1970, 148-149.

[11] A good description of the implications of saccadic movements for human vision is in George McConkie: "On the role of and control of eye movements in reading" in Paul Kolers; Ernst Merald and Herman Bouma (eds.): *Processing of Visual Language*, New York: Plenum Press, 1979. 37-48. George McConkie, and David Zola: "Is visual information integrated across successive fixations in reading", *Perception and Psychophysics*, 25 (1979) 221-224.

[12] Doesschate, *Perspective*, 67.

[13] This is a purely geometrical account of the perception of perspectival drawings under angle. However, in the psychology of perception there exists a substantial literature on the problem. See in particular Dejan Todorović, "Geometric and perceptual effects of the location of the observer vantage point for linear-perspective images", *Perception*, 34 (2005), 521-544. Idem: "Is pictorial perception robust? The effect of theobserver vantage point on the perceived depth structure of linear perspective images," *Perception*, 37 (2008), 106-125. Idem: "The effect of the observer vantage point on perceived distortions in linear perspective images", *Attention, Perception, Psychophysics*, 71 (2009), 183-193.

[14] For a description of these experiments see Ittelson, *The Ames Demonstrations*.

[15] Gombrich, "Western Painting" 15-17.

[16] For a systematic presentation of these rules, see Donald Hoffman, *Visual Intelligence*, New York: Norton, 1998.

[17] See Zenon Pylyshyn, "Is vision continuous with cognition? The case for cognitive impenetrability of visual perception," *Behavioural and Brain Sciences*, 22 (1999), 341-423. Idem: *Seeing and Visualizing. It's not what you think.* Cambridge, Mass.: MIT Press, 2006.