There is perhaps no invention more closely associated with the Renaissance than that of linear or pictorial perspective. Voicing the most advanced ideas of his time, Leonardo da Vinci (1452–1519) said that perspective is “the signpost and gateway” without which nothing “can be done well in the matter of painting.”

While many have celebrated perspective as one of the crowning achievements of the Renaissance, this technical invention has also had its detractors. Most fifteenth-century artists and thinkers, for example, believed that painters’ geometry was directly analogous to optical vision as it was then understood. But cognitive and perceptual theorists long ago rejected this comparison, arguing that sight is a far more complex and multifaceted phenomenon than perspective’s reliance on a single point of view would suggest. Social theorists have also criticized one-point perspective, albeit for different reasons. They point out that while it has been hailed for having created a universal, humanist point of view, in actuality perspective posited an elite and literate viewer whose class, gender, and intellectual background were always already encoded in the technique’s geometry and application. Some post-Cartesian philosophers have also rejected perspective’s apparent reduction of the body to a visual apparatus. They question the mind/body distinctions and epistemological over-valuations of sight to which perspective has contributed. Some art historians have argued that the focus on perspective has created an Italian-centric bias in the discipline that overlooks many other contemporaneous theories of optics and representation, such as those exhibited in northern Renaissance art, for instance, or in non-European cultures. Others have pointed out that perspective became the arid foundation of a banal academic practice that was first challenged by modernist...
avant-garde movements and then irrevocably deconstructed by post-modernist theoretical practice. Perspective is therefore a conundrum. On the one hand it is associated with the lasting ingenuity and sagacity of the Renaissance and on the other with false ideologies, pre-modern philosophical complacencies, and a legacy of rigid representational formalism.

However, from its inception perspective has been a contested and heterogeneous set of theories, practices, and expectations. After centuries of debate we still do not know precisely what perspective signified in the minds of those who invented and used it. Perspective became a powerful medium for experimentation precisely because it encompassed contrasting modes of inquiry. On the one hand, it advanced theories of both optics and geometry. On the other, it was used in the service of increasingly more sophisticated illusions intended to deceive and delight the senses. Perspective thus has always embodied antithetical statements about the nature of optics, reality, and human knowledge.

In many respects, the study of perspective was merely one segment of a broader concern with vision and opticality that spread through Europe in the sixteenth century. Understanding how we see was thought to be paramount to understanding what we see. As speculations about the relationship between the senses and perception increased, artists, engineers, and natural philosophers constructed drawing machines, lens-based apparatuses, and other optical instruments that could demonstrate various theories and advance knowledge about vision. Perspective, as it was promulgated in various treatises and in practice, constituted a discourse on vision that intersected with but did not necessarily dominate these others types of investigation. However, because it was an expression of both geometric and representational ideals, perspective also stood apart from other forms of inquiry. As a technique employed to render illusions, perspective was always a paradox: that is, it was partly an experimental science, but also partly a hallucinatory aid.

In a famous illustration (Figure 2.1) that appears at the end of his treatise on proportion, *Underweysung der Messung* (Nuremberg, 1525), the German artist Albrecht Dürer (1471–1528) depicts a drawing machine used to trace the points of convergence between a lute, an intersecting plane, and a hypothetical, ideal viewpoint. This one condensed image asserts that by applying the rational principles of Euclidean optical theory and geometry to painting, artists could recreate a rationalized three-dimensional world on a two-dimensional surface. The machine’s end product would have been illusionistic: e.g., the resulting image would have engaged the viewer in a visual game of *trompe l’œil*. But in the sixteenth century, this kind of machine was also understood to demonstrate certain truths about vision and geometry and to connect representation to nature in an unprecedented way.

It is noteworthy, however, that Dürer’s image also indicates how even the most rational applications of perspective reveal basic epistemological inconsistencies between theory and practice. Two men are shown manipulating Dürer's machine. One man holds a string that is fixed by a pin to a back wall, and he uses it to mark various points on the lute. The other squeezes into the small space between the pin and the apparatus in order to mark where the string crosses through the hinged window. This picture shows us that while the construction of illusions depends on the embodied view of both the artist and the viewer, the ideal projected viewpoint
of perspective is abstract, disembodied, and mathematical. Dürer’s technicians give form to an ideal scenario, but they also stand outside that scenario’s projection. The image presents us with a conflict between two kinds of viewpoint. One is archetypal and transcendent, and the other is heterogeneous and corporeal. One constitutes a generic, universal paradigm, and the other a complex, contingent variable.

A HISTORY OF PERSPECTIVE AS A PRACTICE

While Dürer’s was the first printed treatise to depict artists actually using perspective, it was the Italian humanist Leon Battista Alberti (1404–72) who initially described the principles on which Dürer’s ideas and pictures were based. In his work On Painting (the first version was written in Latin in 1435, and the second in Italian in 1436), Alberti linked medieval optical geometry directly to the new practices of representation that he saw emerging before him in Florence. Like many other fifteenth-century Florentines such as the artists Donatello (1386–1466), Masaccio (1401–28) and Filippo Brunelleschi (1377–1446), Alberti drew on optical geometry as it had been developed in Greek and Arabic thought. In the Renaissance, medieval optical geometry was known as perspectiva. Fifteenth-century artists redefined this word, fashioning it as a modern technique for viewing, measuring, and, above all,
representing the world. Eventually artists and theorists such as Leonardo would come to distinguish between *perspectiva naturalis* (the optics of natural vision) and *perspectiva artificialis* (artificial or painterly perspective), but the two fields were understood to constitute interrelated branches of knowledge.

While the painter Masaccio produced the earliest true painted perspective (*The Holy Trinity* in Santa Maria Novella, 1426–27), it was Brunelleschi, the Florentine architect and sculptor, who is credited with having produced the methodological foundations for this new artistic technique. Around 1413, Brunelleschi used a combination of architectural surveying techniques and workshop practices to produce a small, foreshortened painting of the Florentine baptistery as if seen from the Duomo, the city’s cathedral. He then set up a now-famous experiment in which he attached the painting to an apparatus with a mirror. The viewer was invited to look through a small hole in the back of the painting from which he (the viewer of a public spectacle in Florence at this time would invariably have been male) would then see reflected both the picture of the baptistery and his own eye peeping out. With this experiment, Brunelleschi sought to prove that the image achieved a convincing illusion because it was organized around a central visual ray, a concept that probably derived from the work of Alhazen (965–c. 1039), an Arabic natural philosopher who wrote extensively on optics. In his biography of Brunelleschi written before 1489, Antonio Manetti (1423–97) described Brunelleschi’s approach. His account provides an insight into what fifteenth-century artists and theorists expected from perspective:

> [Brunelleschi] propounded and realized what painters today call perspective, since it forms part of that science which, in effect, consists of setting down properly and rationally the reductions and enlargements of near and distant objects as perceived by the eye of man: buildings, plains, mountains, places of every sort and location, with figures and objects in correct proportion to the distance in which they are shown. He originated the rule that is essential to whatever has been accomplished since his time in that area.²

But the details of Brunelleschi’s experiment remain murky: the painting itself has never been found and most of what is known about it comes only from Manetti’s description. While informative, Manetti’s account lacks the necessary precision to recreate the panel experiment exactly as it was or to determine the precise technique or even epistemological framework used to obtain the image. Did Brunelleschi set out to prove a correlation between optics and painting? Or did he produce a convincing illusion of the baptistery using mechanical methods that themselves were not based on theoretical ideas about vision? Was it only later that he had an epiphany that caused him to connect his method to the theory of the central ray?

The principles of perspective were not clarified until Alberti expressed them in written form. Beginning his treatise on painting with a long description of mathematical entities such as lines and points, Alberti defined vision as a double pyramid intersected by a plane. This “visual pyramid,” he observes, is anchored by a central ray (the “prince of rays”) that provides the clearest focus of sight. Within the pyramid, angles of vision diminish proportionally and thus “quantities” in the visual field can
be measured by triangulation. Alberti probably drew this notion from Euclid’s *Optics*, which was widely circulated in fifteenth-century Italy.3

Establishing a base in optical geometry, Alberti then describes how to begin a composition. Stating that a painting “the intersection of a visual pyramid at a given distance, with a fixed centre and certain position of lights, represented artistically with lines and colours on a given surface,”4 Alberti instructs the reader to draw a rectangle and imagine it as the intersection. The visual pyramid would then pass hypothetically through this two-dimensional plane. He then directs the reader to draw a single horizontal line within this rectangle (the picture’s assumed horizon) and mark a point in the middle. This point represents the prince of rays piercing the center. To determine the proportional quantities of vision, Alberti creates a costruzione d’aiuto, a diagram designed to help the artist establish the proper diminution of receding planes. This additional diagram appears to be directly based on Euclid’s eleventh proposition in the *Optics*, which states that those intersections representing the horizontal segments that are farthest away will appear both higher in the visual field and progressively shorter in length. Transferred to the picture plane, this means that those planes that are intended to be perceived as further from the viewer should be higher on the two-dimensional surface and shorter in width. Thus Alberti invents a mechanism known as the “distance point,” transposing Euclid’s proposition into a formula for rationalizing the spatial relationship between the viewpoint and the pictorial field. This peripheral point mathematically determines the proportional distance between the viewer and the receding planes of the picture.

Throughout his treatise, Alberti deliberately places optical geometry and painting on equal footing (although he is also careful to maintain a distinction between them). The two dedications to the Italian version of the book reveal a great deal about Alberti’s motives for making this comparison. The first dedication is in the form of a letter to Brunelleschi, and in it Alberti favorably contrasts the achievements of Brunelleschi and other Florentine artists with those of the ancient artists of Greece and Rome who were known through Pliny’s *Natural History* and other sources. He concludes by asking Brunelleschi to review the manuscript and offer corrections. As Anthony Grafton points out, in doing this, Alberti identifies Brunelleschi “as a man of learning” and intimates that the relationship between the two men is “one of scholar and scholar.”5 Alberti therefore represents Brunelleschi as an equal and as someone whose success as an engineer and architect was due in great part to his intellect. The second dedication is to Gian Francesco Gonzaga (1395–1444), the Marquis of Mantua. In it, Alberti alludes to the prince’s pleasure in the liberal arts and he offers *De pictura* as fodder for the prince’s “customary pursuit of letters.” Representing painting in this light, Alberti suggests that it be considered the result of intellect rather than learned skill. Alberti’s treatise is one of the first works of literature to draw a correlation between the visual arts and the seven liberal arts (grammar, logic, rhetoric, arithmetic, geometry, music, and astronomy), thereby distinguishing painting from the artisanal practices or mechanical arts with which it customarily had been associated. In addition, Alberti uses rhetorical devices and narratives drawn from ancient sources, emulating the Greco-Roman body of literature and philosophy that had increasingly become the hallmark of a classical education and a demonstration of erudition in fifteenth-century Florence. Thus, by
employing various strategies, Alberti allies painting to other intellectual pursuits and makes a persuasive case for elevating the status of visual art.

What was the historical impact of Alberti’s strategy? In promoting perspective as evidence of the artist’s intellect, Alberti made the remarkable and highly original claim that a certain kind of naturalistic representation should be seen as a form of inquiry about the world on a par with other forms of natural philosophy. In *De pictura*, the science of optics was transformed into a theory of painting, but painting in turn became a theory of optics or rather a proposition about how and what we see. As Leonardo had made clear, the invention of perspective heralded a new era in which painting could be seen as a proposition about vision and the order of nature. With its perfected, geometric understructure and its idealized viewpoint, perspective was thus ultimate evidence of the human ability to command knowledge of the world.

This characterization of painting informed Renaissance debates concerning the relative merits of the different arts. Enthralled by Horace’s simile from the *Ars poetica*, “Ut pictura poesis” (“as is painting, so is poetry”), Renaissance artists and humanists argued over the meaning of imitation and the power of painting versus poetry to invoke the presence of what was absent. Leonardo, for instance, insisted that painting had more power than poetry to make nature present to the mind of man and this was due in part to the sheer force of vision. In the notes for his incomplete treatise on painting, he observes that the eye is the window of the soul and “is the primary means by which the sensus communis of the brain may most fully and magnificently contemplate the infinite works of nature . . .”6 For Leonardo, the eye is the most rational of senses, the “prince of mathematics,” and paintings that employ the principles of perspectiva are a direct reflection of the eye’s singular reflective power.7 Painting is exceptionally adept at rendering visible the most elemental truths of nature precisely because of its connection to the eye.

After Alberti, scholars and artists incorporated perspective into various mathematical fields: the technique figured prominently in discussions of conics, the Platonic solids, and cartographic and astronomical projections. But most texts dealing with perspective were also concerned with issues of visual representation and the ordering of space. Alberti’s text was neither illustrated with diagrams (a fact that has caused no end of consternation and speculation among art historians), nor printed until much later (the Latin version was first printed in Basle in 1540 and the Italian version was not published until 1847). But there were two other important fifteenth-century treatises on painting – one by Piero della Francesca (c. 1420–92) and the other by Leonardo, both of which were illustrated. Piero completed *De prospectiva pingendi* sometime in the early 1480s. He extended and clarified much of Alberti’s text, but also added substantial portions on mathematics and geometry and provided a series of original, detailed diagrams.8 Although finished in the late fifteenth century, Piero’s manuscript did not appear in printed form until much later. Leonardo left his treatise unfinished and it did not appear in print until more than a century after his death, although even then in an abridged and dubiously organized form. Leonardo’s speculations were particularly formative for the epistemological claims that were eventually made on behalf of perspective, and his diagrams were among the most useful for explaining the new technique (for instance, his diagrams of the distance point illuminate Alberti’s otherwise somewhat confusing explanations). Nevertheless,
his ideas, buried as they were in his notebooks, only filtered out through the comments, observations, and plagiarisms of later authors.

The first printed treatise devoted entirely to perspective, *De artificialis perspectiva*, did not appear until 1505. It was the work of the Canon of Toul, Jean Pélerin (c. 1435–1524), who published under his Latin name, Viator (“voyager”). While most of the treatise’s illustrations depict stage-like settings that are proffered as templates for artists and scene designers, there are also a few geometric diagrams. Unfortunately, these are accompanied by only a short and uninformative text. In contrast to Alberti, Piero, and Leonardo, Viator provides only a rudimentary rationalization of his method, barely correlating it to optics or geometry. In short, he does not offer anything like Alberti’s mathematical and philosophical justification, nor does he make a plea to elevate the status of art.

Instead Viator’s diagrams reflect common workshop methods that are often referred to as dual or bifocal constructions. A famous example of bifocalism appears in the Sienese artist Pietro Lorenzetti’s *Birth of the Virgin* (1335–42). In this painting there are incised lines from two lateral points on either side of the frame. An intersecting grid created by these two sets of lines was used to construct the *pavimenti* (tiles) that appear on the floor. Using a method called *tiers points* (three point), Viator expanded on this bifocal technique. In his treatise he employs a centric and two lateral points to construct tiled floors and obliquely angled buildings. His method thus has far more in common with late medieval workshop practices than it does with the more intellectualized theory of Alberti. In fact, most artists and even many of the great theorists of perspective employed similar techniques. In his 1536 edition of Vitruvius, Giovan Battista Caporali (c. 1476–c. 1560) states that Leonardo once said that he preferred to construct perspectives “with two centers, or rather vanishing points.” 9 Although not based on any suppositions about vision or geometry, bifocal practices may have evolved into the theory of the distance point elaborated by later commentators. Thus perspective may have been the result of a complex interweaving of workshop practices and theoretical musings.

Following Viator, a number of treatises on painting and related subjects such as proportion, architecture, geometry, and scene design were published in increasing numbers; between 1500 and 1700 roughly 90 books on these topics (many with multiple editions) were printed throughout Europe.10 All dealt with perspective in one form or another. The proliferation of printed texts – written in many different voices and often to very different ends – reveals how the topic became a voluble and suggestive avenue for thinking about a host of problems.

As mentioned, Dürer published one of the earliest treatments of perspective in a book devoted to proportion. Dürer made two visits to Venice, where he absorbed Italian approaches, and it is clear that perspective held a particular attraction for him. During his second stay in Italy (1505–10/11) he traveled to Bologna. His reason for this trip is recorded in a letter he wrote to his close friend, the Nuremburg humanist Willibald Pirckheimer: “I shall be finished here in another ten days. Then I shall ride to Bologna in order to learn more about the secret art of perspective, which someone there is willing to teach me.” 11 His contact in Bologna was most likely Luca Pacioli (1445–1517), the celebrated mathematician and Franciscan friar who lectured at various universities throughout Italy and then was invited to the
Sforza court in Milan. Pacioli knew and plagiarized the work of Piero della Francesca, and he also met Leonardo in Milan. In fact, Leonardo provided illustrations of the Platonic solids for Pacioli’s *De divina proportione* (Venice, 1494), a treatise on solid geometry and proportion. Dürer was therefore apprenticing himself to a well-known mathematician who was in turn connected to some of the great Renaissance masters of perspective. Pacioli’s treatise underscored the “divine” and mystical nature of proportion and mathematics, and similar associations may have at times adhered to perspective geometry. It also seemed to be an esoteric and even slightly occult kind of knowledge, which may be why Dürer deemed it “secret.”

Nevertheless, it was not too secret to be published in manuals for painters. Dürer’s reasons for producing a treatise on proportion and for embracing the art of perspective were similar to those of Alberti. He claimed that painting required the highest of human faculties and that it was based on unequivocal intellectual foundations. Following the publication of Dürer’s manual, Nuremberg became one of the major printing sites for treatises devoted to problems of proportion and representing complex bodies. From 1543 to 1571 Nuremberg produced works by Augustin Hirschvogel (1503–53), Lorenz Stoer (c. 1540–1620), Wenzel Jamnitzer (1508–85), and Hans Lencker (1523–85). Conceived along Dürer’s model, these treatises focused on the varied articulation of regular and semi-regular solids and firmly correlated perspective with geometry. At the same time, they were filled with increasingly intricate and beautiful illustrations that made the books expensive objects intended for literate, humanist audiences and book collectors.

In sixteenth-century Italy the study of perspective evolved in a slightly different direction. From early on, Italian writers forged a link between painting, architecture, and mathematics. One of the earliest Italian works on perspective was devoted to architecture and scene design. This was Sebastiano Serlio’s *Il primo libro d’architettura* (Paris, 1545). Serlio’s text was the Renaissance answer to Vitruvius’ *Ten Books on Architecture* in that he established a set of surveying and representational techniques that would come to define architectural practice for ensuing centuries. But it was two other works printed in this period that established perspective as a distinct discourse with its own language and paradigms. These were *La pratica della perspettiva* (Venice, 1569) by the Venetian patrician Daniele Barbaro (1513–70) and *Le due regole della prospettiva pratica* (Rome, 1583) by the architect Jacopo Barozzi da Vignola (1507–73), which was edited, annotated, and printed posthumously by the mathematician Egnazio Danti (1536–86).

One of Barbaro’s most important contributions was to show the relation between Ptolemy’s astronomical projection and perspective. As with many mathematicians of his period, Barbaro was fascinated with Ptolemy’s system of projection for the night sky or planisphere. According to Barbaro, the Ptolemaic planisphere “appears to me to be founded on perspective, [and thus] it seems reasonable to devote a part of my work to the practice of such a beautiful invention.” In fact, it has been argued that Ptolemy’s geographic system for depicting the *mappa mundi* (map of the earth), which was based on a single point of visual projection, may have even provided a model for early theorists of perspective such as Brunelleschi. But Barbaro’s treatise also marries contemporary solid geometry to painterly perspective. Like Dürer he provides techniques for measuring and foreshortening complex, multi-sided objects,
but he also connects his constructions to Euclidean principles. According to Barbaro, sight is the sense that allows for judgment, and Euclid’s theorems make this clear. Vision arbitrates the proportions that appear in nature. Barbaro compares sight to the camera obscura (an enclosed darkened box with a pinhole that projects a reverse and upside-down image of what is outside) but only in so far as it demonstrates how the eye determines proportion and diminution. As Martin Kemp has pointed out, in equating vision and proportion Barbaro espouses the idea that works of art are best when they “mirror the geometrical structure behind natural forms.”

Barbaro thus furnishes the reader with a full-fledged justification for certain types of representation based on geometrical projection.

On the other hand, Vignola’s *Le due regole* tied together all previous speculations and was addressed equally to painters, architects, and mathematicians. Expanding greatly on projective theories of perspective, Vignola provided vividly illustrated explanations of the relation between the viewer’s space, the picture plane, and the vanishing point. His remarkable diagrams of two alternative “rules” for perspective demonstrate how to correlate an architectural ground plan to a distance point construction. Danti, his editor, also provided a running commentary on Vignola’s text, updating the mathematics, interjecting new discoveries, and illustrating new drawing machines and techniques. In short, Vignola and Danti identified and defined a new area of inquiry that was neither solely mathematics, nor architecture, nor painting, but a hybrid of all three: namely, perspective.

Later in the century, however, perspective fell increasingly into the domain of professional and amateur mathematicians such as Federigo Commandino (1509–75) and Guidobaldo del Monte (1545–1607). In *Ptolomaei planisphaerium* (Venice, 1558) and *Claudii Ptolomaei liber de analemmate* (Rome, 1563), Commandino used perspective as the basis for exploring Ptolemaic astronomical, conical, and orthographic projections. Guidobaldo’s *Perspectivae libri sex* (Pesaro, 1600) moved perspective toward projective geometry, a field that would be fully realized by the French mathematician Girard Desargues in the 1630s. At this point, perspective became subject to a difficult and abstruse mathematics that went far beyond the demands of painted or built illusions. In fact, by the end of the sixteenth century the study of perspective had begun to split into two areas of inquiry. On the one hand it served as the basis for a more and more sophisticated and abstracted geometry of projection, and on the other it became incorporated into a series of formulaic representational and projective techniques for artists and architects.

**THE SELF-CRITIQUING ART**

Even before it began to split into differing areas of inquiry, perspective was a catalyst for analytic reappraisals and self-reflexive critiques. As early as the beginning of the sixteenth century, perspective was associated with the vainglorious presumptiveness of both Renaissance science and art. Dürer’s famous print *Melencolia I* (1514) represents a nascent expression of these sentiments (Figure 2.2). As an embodiment of the saturnine artistic temperament, Dürer’s winged female figure sits glumly, chin in hand, contemplating the ineffective instruments of inspiration that surround her.
One of these is a shaded polyhedron, of the sort that appeared regularly in perspective treatises. But Dürer purposefully rendered this complex object incorrectly. Thus it can be interpreted as a symbol of geometry and proportion that nevertheless attests to a disjunction between divine and human creativity. Along with the mysterious panel of numbers, the compass, and other symbols, the polyhedron imbues the entire

Figure 2.2 Albrecht Dürer. Melancholia I (1514). Davison Art Center, Wesleyan University.

One of these is a shaded polyhedron, of the sort that appeared regularly in perspective treatises. But Dürer purposefully rendered this complex object incorrectly. Thus it can be interpreted as a symbol of geometry and proportion that nevertheless attests to a disjunction between divine and human creativity. Along with the mysterious panel of numbers, the compass, and other symbols, the polyhedron imbues the entire
engraving with a sense of misapprehension and inadequacy. This image testifies to the contradictions, doubts, and insecurities of Renaissance natural philosophy and artistic ingenuity.

But perspectivists also came to incorporate these doubts into the very fabric of their practice. For instance, from the late fifteenth century on, artists were aware of a form of perspective that was initially used to produce “secret” images that only became recognizable from sidelong or hidden viewpoints. Virtually from the moment it was first invented, artists recognized that perspective could be used to create highly skewed views. Precipitously foreshortened works such as Andrea Mantegna’s (1431–1506) Dead Christ of 1480–90 fell just shy of a disorienting distortion. While Mantegna’s painting underscores the doctrine of transubstantiation by making it seem as though Christ’s severely raked body is being offered to the viewer on an altar, other artists, including Leonardo, used similar raked perspectives to produce trick images of less gravity. Since the seventeenth century, these have been labeled “anamorphic.” Before this, other labels were used to identify this type of distortion. Gian Paolo Lomazzo (1538–1600), for example, used the term “prospettiva inversa” (reverse perspective), while Jean-François Niceron (1613–46) coined the phrase “la perspective curieuse.”

A typical use of anamorphosis can be found in engravings produced by the German printer Erhard Schon (1491–1542), who was a student of Dürer’s. These inexpensive prints, called Vexierbilder or “puzzle pictures,” concealed portraits and, in some cases, erotic and scatological images. But anamorphosis also found an outlet in at least one “high art” example: The French Ambassadors by Hans Holbein the Younger (1497/8–1543) painted in 1533 (Figure 2.3). This double portrait of Jean de Dinteville and Georges de Selve, two French ambassadors to the court of Henry VIII, places them in the interior of Westminster Abbey (the elaborate inlaid pavement alludes to the location). They flank a table with two shelves that hold musical and scientific instruments. Among the objects we see a lute, a case of flutes, a German hymnal, terrestrial and celestial globes, quadrants, sundials, a torquetum (used to determine the motions of celestial bodies), and a mathematics textbook. Attesting to the two Frenchmen’s varied intellectual pastimes, this array of objects represents the mathematical interests that would have been characteristic of the educated upper classes: geometry, astronomy, arithmetic, and music. In front of this solemn portrait is a strange, floating object that seems suspended in mid-air. Neither fully part of the painting, nor of the viewer’s space, the image becomes recognizable only when seen from the right side of the painting and from very close to the painted surface. At a viewpoint along the picture’s edge, this amorphous shape resolves into a leering skull.

In northern Renaissance painting, particularly in the developing genre of still life, the skull was a conventional symbol of vanitas or memento mori. It is probably included in Holbein’s painting as an intentional contrast to the highly detailed instruments between the two men. The point is underscored by the presence of a small crucifix on the upper left of the painting that is only partially concealed by the rich green fabric of a curtain. Scientific knowledge is juxtaposed against the truth of divine revelation, and the skull tips the scales against the former as it reminds the viewer of the vanity and hubris of human endeavors.
But the skull is not simply another iconographic symbol. Through its distortion, it subverts the portrait’s seemingly linear, rational organization. It contradicts the technically virtuosic, foreshortened pavement and the table’s perfect diminution. At the same time it challenges the two men’s capacity to measure and rationalize space through mathematics. But, of course, all this is done on purpose. In anamorphosis, perspective is turned on itself in a prevaricating game of contravention. Holbein’s painting intentionally reveals perspective’s paradoxical nature: the world is available to us geometrically and mathematically, but only in so far as we embrace the illusions through which this reality is conveyed.

Figure 2.3 Hans Holbein the Younger (1497–1543). *The Ambassadors*, 1533. The Art Archive/The National Gallery, London/Eileen Tweedy.
In a lecture given in 1938, the German philosopher Martin Heidegger (1889–1976) asserted that “the fundamental event of the modern age is the conquest of the world as picture.” The image that epitomizes Heidegger’s “world picture” is the window, a metaphor first employed by Alberti in On Painting: “First of all, on the surface on which I am going to paint, I draw a rectangle of whatever size I want, which I regard as an open window through which the subject to be painted is seen . . .”

While we might assume that the idea of a world-picture or world-view is universal – a foundational characteristic of any historical age or place – Heidegger argued against this notion. He insisted that rather than simply shifting in kind from one age to another (for example, the often-repeated trope that a medieval “world picture” gave way to a “modern” one), it was the very idea of a “world picture” that distinguished the modern age from all those that preceded it. For Heidegger, the “world picture” did not carry positive connotations. Instead, he saw it as the erroneous legacy of the European Enlightenment, particularly as demonstrated in Cartesian thought.

René Descartes had postulated that our understanding of the world is constituted by and in our mental pictures of it and we, as self-understanding human beings, consume these pictures from a singular and irreducible vantage point (that of the Cartesian cogito or subject). Because of its inherent relation to the mind, sight is the sense that connects our inner being with the world outside. It sorts out and makes clear all of our other perceptions. Fifteenth- and sixteenth-century painting and artistic theory provided a model for how this idea of mind and sight might work. The perspective picture seems to posit a homogeneous, infinite, and occurrent space with a rationalized, central point of view. It reduces the world to extended matter and represents sight as the locus of knowledge. One might say that the “perspective” picture’s convergence with Cartesianism produced a “way of seeing” that united vision to enlightenment. The problem for Heidegger was that this “way of seeing” ignored other (phenomenological) aspects of what he called “being-in-the-world” and thus it sustained an inherently fallacious association between seeing and knowing.

Heidegger’s is one of the most powerful philosophical critiques of the perspective “window” as a world-picture. But as art historian James Elkins has pointed out, while Renaissance notions of perspectiva naturalis were metaphorically unified around the image of the window, in practice, the geometry of perspective was disassociated almost completely from any type of optical framing. Over time, the idea of the “window” has been consistently misconstrued as a technical image intended to imply the transparency of the picture plane itself. And yet for Alberti, the enclosure of the painting was a stage set intended to serve as an appropriate backdrop to the imaginative istoria or narrative constructed by the artist. A painting did not need to reflect the outside world; rather it needed to create a whole new world within the frame. But if the goal of perspective in painting was not necessarily to provide an exact similitude of nature in an empirical sense, then how do we explain the persistent historical interpretation of perspective as an objective portrait of reality and human vision?
Grappling with twentieth-century perceptual psychology, the art historian E. H. Gombrich (1909–2001) argued in *Art and Illusion* (1960) that perspective was the result of a series of experiments in perception: what he called “schema-matching.” Fifteenth-century artists and viewers employed a form of visual testing of reality. That is, they consistently matched what they saw to what they represented, replacing old visual schemas with newer and more salient versions. Perspective, he observes, was a result of this comparative testing. Of course, there are a number of problems with this idea, not the least of which is that the “realism” attributed to perspective was contested even in the fifteenth century (one of the most famous examples is the “curvilinear” debate concerning whether perspective should reflect the lateral distortions that occur in regular vision). Testing perceived reality against our representations of it may be a human physiological and psychological trait, but it cannot account for why a given picture of reality is acceptable in some instances or at a given moment in time, but not at others. To be fair, Gombrich took some pains to argue that while some might view the tendency to test as universal, the resulting pictures are not. Thus, one society or culture’s version of a match between reality and representation does not necessarily have to be the same as another’s, even if schema-matching is the underlying mechanism at work. Gombrich opened up an important debate about the contingent and contextual nature of what is perceived as “real” or “natural” in any given culture or time period. Nevertheless, the notion of schema-matching could never account for why certain versions of pictorial reality took hold over others at any given place in any given time.

In contrast, in *Painting and Experience in Fifteenth Century Italy*, the art historian Michael Baxandall offers one of the most impressive attempts to explain why perspective took hold as the preferred method of representing reality in Renaissance Florence. Rather than focus on the reception of medieval optics, Baxandall explores how a given group of people with similar economic and social interests could and did develop a shared visual language that combined elements of geometry and mathematics with certain conventions of representation. In a chapter famously titled “The Period Eye,” Baxandall outlined a series of skills and expectations that were shared by the literate and political classes in fifteenth-century Florence. Given that the city’s economy was based on banking and mercantile interests, arithmetic and geometry were fundamental rather than extraneous adaptive skills. Counting, measuring, weighing, and gauging were all necessary to an economy based on cloth production, trade, monetary lending, and the calculation of interest. Baxandall suggests that one reason perspective melded with these interests is precisely because it was a representational practice built on the evocation of geometric and volumetric solids and numerically determinable relationships of distance. He does not argue that the one defined or caused the other, but rather that Florentine art developed concurrently with a set of skills that themselves were deemed necessary to the smooth ordering and management of Florence’s fortunes. The talent for visual judgment was highly prized in Florentine culture (the ability to gauge or assess a volume or weight by “eye”), and perspective relied on this and other conventional skills for reading and recognizing particular patterns. As Baxandall points out, the successful evaluation of an image during any historical period depends on the “interpreting skills one happens to possess, the categories, the model patterns and the habits of
Thus in Renaissance Florence the new visual language of diagrams and geometric figures fulfilled a particular demand for a certain type of transparency in transactions. Florentines adapted a set of interpretive skills that relied on visual acuity to ascertain what was “true” or “honest.” Perspective seemed not only to meet this requirement but also demonstrated that this acuity could be given pictorial form — that a particular style of seeing could itself be made visible.

Baxandall explains the social and economic conditions that made it possible for perspective to be accepted as an expression of pictorial reality at a given moment of time in a particular place. But his analysis does not account for how and why perspective continued to be a primary trope for human understanding and empirical inquiry even after its central axioms had long been abandoned and its connection to some version of visual “reality” dismantled. That Heidegger would feel compelled to critique the perspectival “world picture” as late as 1938 is testament to the tenacious power of the geometric view. The art historian Erwin Panofsky contended with this problem in his seminal essay of 1927, “Perspective as Symbolic Form.”

Indebted to the philosophy of Ernst Cassirer, Panofsky argued that perspective must be seen as a peculiar form of symbolic thinking about human interpretations of the world. Cassirer endorsed the notion that art, literature, geometric proofs, and other forms of representation are symbolic forms through which humans mediate their encounters with the given world. Symbolic forms are not imitations of reality. Rather they are imaginative representations of human encounters with reality. As Michael Ann Holly puts it, for Cassirer a “symbolic form is neither the world nor the source of thinking about the world but is, instead, a representation of the process of human creativity.”

For Panofsky, perspective operates along these lines. It is not an exercise in verisimilitude: it isn’t isomorphic with either the world as it exists or as it is seen. Nor can it be said to be a “correct” evocation, in pictorial terms, of space. Humans experience space as a lived phenomenon, but the space posited by perspective is artificial: it is geometric, static, and ideal. For Panofsky, perspective must instead be understood as a mythical and conventional structure, one that symbolizes a particular way of thinking about space. Perspective does not show us how we already see but rather shows us how to see. And in this case, what we see is an expression of space that evokes mathematically consistent continuities and extensions. In short, perspective allows humans to conceive of infinity in mathematical and geometric terms. Herein lies its claim on our imagination. Perspective engendered one of the most powerfully consistent ways of seeing the world, one that still exerts a pull on human imaginative faculties. As Patrick Heelan argues, the perspective grid, once it was granted authority, implied “the notion that reality itself is pictorial.”

Of course, it is precisely this view of perspective that Heidegger rejected. And yet, questions about the nature and meaning of perspective were present at its birth and were debated throughout the Renaissance by artists themselves. Because of its historical complexity and its many philosophical and cultural associations, perspective has never neatly fitted with any particular model of interpretation nor with any attempts to correlate it strictly with objectivity, naturalism, or even with the operations of vision itself. Perspective was expected to tread a fine line between science and convention, holding together unstable and often incommensurable ideas.
about illusion, geometry, and vision. That it repeatedly failed to do so only made it
more fascinating to a Renaissance audience.

NOTES

2 Antonio di Tucci Manetti, *The Life of Brunelleschi*, ed. and trans. Howard Saalman and
3 David Lindberg suggests that Alberti would have been familiar with Euclid through a
Latin version of the *Optics* that was widely circulated in the early fifteenth century. David
Lindberg, *Theories of Vision from Al-Kindi to Kepler* (Chicago and London: University of
4 Leon Battista Alberti, *On Painting and On Sculpture. The Latin Texts of De Pictura and
De Statua*, edited with translation, introduction and notes by Cecil Grayson (London,
& Wang, 2000), p. 76.
7 On the other hand, Leonardo rejected the monocural model of vision posited by one-
point perspective, and also argued at times in favor of curvilinear perspective on the basis
that a curved surface more closely approximated the conditions of actual vision. For a
discussion of the problems and myths surrounding the issue of curvilinear perspective in
the Renaissance, see chapter 5, “Curved Foundations,” in James Elkins, *The Poetics of
8 Piero is an interesting case precisely because not only was he a painter of great note, but
he was also a highly accomplished mathematician who wrote two textbooks on
mathematics; the *Trattato d’abaco* (a treatise on calculation) and the *Libellus de quinque
corporibus regularibus* (a treatise on the five regular bodies of geometry). See J. V. Field,
*The Invention of Infinity: Mathematics and Art in the Renaissance* (Oxford: Oxford University
Press, 1997).
9 “[I] n our time Leonardo da Vinci of Florence, with whom we have spoken about this
perspective, . . . affirms that he does it, more than the others with two centres, or rather
vanishing points.” Presumably this is a reference to bifocal construction. Caporali as
et Renaissance* 25 (1963), p. 70.
10 For a comprehensive bibliography of these books and their respective editions, see Luigi
Vanetti, *De naturali et artificiali perspective – bibliografia ragionata delle fonti teoriche e delle
ricerca di storia della prospettiva; contributo all’omaggio della conoscenza di un’idea razionale,
nei suoi sviluppi da Euclide a Gaspard Monge*, Studi e documenti di architettura 9–10
(Florence, 1979). Although interest in perspective was born in fifteenth-century Italy,
the sixteenth century witnessed its spread throughout Europe, with German, French,
and Dutch authors contributing to the discourse.
11 The letter itself is dated to October 13, 1506. Citation of the letter with translation is
provided in Albrecht Dürer, *The Painter’s Manual*, trans. and with commentary by Walter
12 Daniele Barbaro, *La Pratica della perspettiva* (Venice, 1569), p. 163, as trans. by Martin


15 The term “anamorphosis” was derived from the Greek *ana* meaning “again” or “back” and *morphē* meaning “form,” and was coined by the Jesuit Gaspar Schott (1608–1666) in 1657, more than a century after it was initially illustrated in perspective treatises (both Barbaro and Danti discuss it). See Book III “Magia anamorphotica” of Gaspar Schott’s *Magia universalis* (Wurzburg, 1657), pp. 101–69.


18 The Latin text is as follows: “Principio in superficie pingenda quam amplum lebeat quadrangulum recorem angulorum inscribo, quod quidem mihi pro aperta finestra est ex qua historia contueatur . . .”, in Alberti, *On Painting and On Sculpture*, p. 55.


21 According to Heidegger, “We call it the ‘perspective,’ the track of foresight. Thus we shall see not only that being is not understood in an indeterminate way, but that the determinate understanding of being moves in a certain pre-determined perspective . . . We have become immersed (not to say lost) in this perspective, this line of sight which sustains and guides our understanding of being.” Heidegger, *An Introduction to Metaphysics*, trans. R. Manheim (New York: Doubleday, 1961), p. 99. In Heidegger’s view, Descartes and those who followed him avoided the most important question of how or in what way we come to be in the world. Knowledge, for Descartes, preceded being, and for Heidegger this constituted a perversion of the correct order of interrogation. Thus, the perspectival picture with its Cartesian “point of view” would be an entirely inadequate metaphor for either being or understanding precisely because it posits an epistemological solution to an ontological question (it tells us how we see without asking why we see).

22 Elkins, *The Poetics of Perspective*, pp. 46–52. Elkins distinguishes between, on the one hand, what he calls “optical” metaphors associated with the classical rhetorical tradition adopted by Renaissance writers like Alberti and, on the other hand, the geometric training necessary to construct perspective. While the window was an adept metaphor, it in no way conveyed the actual practices of perspective.

23 According to Joseph Masheck, the window had only ever been intended by Alberti as “a trope, and a signal of the essentially fictive poetics of painting.” See Masheck, “Alberti’s ‘Window’: Art-historiographic Notes on an Antimodernist Misprision,” *Art Journal*, spring 1991, p. 35.


SUGGESTIONS FOR FURTHER READING

Primary sources

Secondary sources