

Introduction

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This book is about the development of optics and perspective between the fifteenth and seventeenth centuries. It intervenes in two distinct historiographies: firstly, the history of perspective, an interdisciplinary field of study, to which primarily art historians and historians of science have contributed, and which developed in the wake of Erwin Panofsky's foundational study *Perspective as Symbolic Form* (1927); and secondly, the history of optics, a sub-field within the history of science, of which the contours have been outlined in David Lindberg's classic study of the history of optics *Theories of Vision. From al-Kindi to Kepler* (1976).¹ Both fields of study come with their defining experiments and canonical texts. For Panofsky, Filippo Brunelleschi's peephole and panel experiments in front of the Baptistery and the Palazzo Vecchio in early fifteenth-century Florence marked the invention of linear perspective. He cast Brunelleschi's invention as pointing forward to the first codification of perspectival procedures in Leon Battista Alberti's *On Painting*, a method of construction which, based on nineteenth-century German scholarship, Panofsky elevated to the status of 'costruzione legittima'. Lindberg, in his turn, considered the medieval texts of Roger Bacon, John Pecham, and Witelo as the canon of optics (or *perspectiva*, foremost to be defined as a theory of vision) connecting the reception of Ibn al-Haytham (known as Alhacen) with the work of Johannes Kepler at the beginning of the seventeenth century.

Panofsky wrote *Perspective as Symbolic Form* at a time when scholarship on the history of optics, and medieval optics and the reception of Alhacen in particular, was still largely non-existent. However, more is at hand in the separation of the histories of optics and perspective than simply ignorance, which can be remedied by the progress of scholarship. Looked at from the other side of the divide, Lindberg discussed perspective as an impoverished application of optical theory with no development of its own and very little consequence for the route taken by the discipline of optics. More recent scholarship in the history of optics by Gérard Simon and A. Mark Smith is more attentive to perspective and art and disagrees with Lindberg's embracement of continuity of optics from Antiquity to Kepler,

¹ Erwin Panofsky, *Perspective as Symbolic Form*, trans. by Christopher S. Wood (New York: Zone Books, 1997); David C. Lindberg, *Theories of Vision. From al-Kindi to Kepler* (Chicago: University of Chicago Press, 1976). I have discussed the historiography in Sven Dupré, 'The Historiography of Perspective and "Reflexy-Const" in Netherlandish Art', *Nederlands Kunsthistorisch Jaarboek*, 61 (2011), 35–60.

while leaving Lindberg's basic assumption of a well-defined separation between optics and perspective intact.² Panofsky's own position in *Perspective as Symbolic Form* is rather ambivalent: while he recognizes the multiplicity of perspectives, especially ancient and modern ones, as well as different ways of constructing perspective, the one often more natural than the other, there are equally numerous passages in the book in which he privileges the *costruzione legittima* and a teleological view separating the histories of optics and perspective. Remarkably, despite his own ambivalence, Panofsky's most whiggish definition of perspective still haunts present-day scholarship on the history of perspective. Most recently, Hans Belting even revived Panofsky's notion of perspective as 'symbolic form', implying that it was 'expressive' of Renaissance culture.³ While Ibn al-Haytham plays a crucial role for Belting, the argument hinges on a problematically essentialist definition of two cultures, as well as an equally problematic separation of optics and perspective.

Recent scholarship in the history of perspective has more strongly embedded the rise of perspective in the history of optics. In *L'Hypothèse d'Oxford* (1998) Dominique Raynaud attributed the highest importance to optics, a well-developed discipline in the Middle Ages in the hands of the Franciscans Robert Grosseteste, Roger Bacon and John Pecham, as a body of knowledge available to the artisans and craftsmen inventing linear perspective. And in a more recent book, Raynaud showed why, given the importance of the diffusion of Franciscan optics to the rise of perspective, it emerged in central Italy (rather than Oxford, the cradle of Franciscan optics, or the medieval Islamic world).⁴ Most recently, Pietro Roccasecca proposed a new reading of Alberti's *On Painting*, replacing Panofsky's interpretation of Alberti's perspective as *costruzione legittima* with an emphasis on the importance of Alhacen's optics to Alberti's perspective.⁵

Most importantly, these studies have downplayed the significance of the invention of perspective as a singular moment in the hands of one individual (Brunelleschi). Contrary to Panofsky's elevation of Alberti's perspective as the *costruzione legittima*, it has been shown, on the basis of the study of the material practices of painters in imitating and representing the

² A. Mark Smith, *From Sight to Light: The Passage from Ancient to Modern Optics* (Chicago: University of Chicago Press, 2014); Gérard Simon, *Archéologie de la Vision: L'optique, le corps, la peinture* (Paris: Editions du Seuil, 2003).

³ Hans Belting, *Florence and Baghdad: Renaissance Art and Arab Science*, trans. by Deborah Lucas Schneider (Cambridge, Mass.: Belknap Press of Harvard University Press, 2011).

⁴ Dominique Raynaud, *L'hypothèse d'Oxford. Essai sur les origines de la perspective* (Paris: Presses universitaires de France, 1998); Dominique Raynaud, *Optics and the Rise of Perspective: A Study in Network Knowledge Diffusion* (Oxford: The Bardwell Press, 2014).

⁵ Pietro Roccasecca, *Filosofi, oratori e pittori. Una nuova lettura del De Pictura di Leon Battista Alberti* (Rome, Campisano Editore, 2016).

effects of light and space, that Renaissance artists used several, sometimes incompatible techniques to create the illusion of three dimensions on a two-dimensional surface.⁶ Moreover, Renaissance authors on perspective used several concepts and aspects of perspective in the most diverse ways rather than working towards a Cartesian conceptualisation of space.⁷ Several central concepts and theorems, most notably that of the vanishing point, were only acquired in the late sixteenth and early seventeenth centuries; they should not be projected back into the early fifteenth century and the work of Brunelleschi and Alberti. In short, essentialist and teleological tendencies have coloured the historiography of perspective in the last century following Panofsky's *Perspective as Symbolic Form*. Instead, the point of departure of this book is the recognition of the polysemy of perspective, that is, the plurality of meanings of perspective, building on the ground-breaking work of Raynaud and Roccasceca already mentioned, of Filippo Camerota's on 'prospettiva aedificandi', and that of Jeanne Peiffer on 'Messung'.⁸

To say that this book is about perspective might be as confusing as it is to state that it is about the history of optics. Both optics and perspective come with present-day associations as well as connotations emerging from the historiographies in which optics and perspective have been clearly separated. If we want to avoid these confusing associations and connotations, we could write that it is about *perspectiva*, which is a period term used interchangeably for texts, things and thoughts which today we would classify, without hesitation, as either optics or perspective. It is *perspectiva* which we have, for ease, translated as 'perspective' in the title of this book. There is, unfortunately, no less ambiguous term in English.

To bring forward the polysemy of perspective, this book treats the history of *perspectiva* in terms of practices, a conglomerate of material, social, literary and reproductive practices, through which knowledge claims in perspective were produced, promoted, legitimated and circulated in and through a variety of sites and institutions. The ways optical knowledge was used by different groups in different places (such as the university classroom, the anatomist's dissection table, the goldsmith's workshop, and the astronomer's observatory) defined the meanings of Renaissance perspective. As this period was characterized by

⁶ Pietro Roccasceca, 'Gentile da Fabriano, A Miracle of Saint Nicholas: A Rigorous Nonperspective Spatial Representation', *Center: Record of Activities and Research Reports, National Gallery of Art, Washington*, 21 (2001), 126–30; Pietro Roccasceca, 'Not Albertian', *Center: Record of Activities and Research Reports, National Gallery of Art, Washington*, 22 (2002), 167–69.

⁷ James Elkins, *The Poetics of Perspective* (Ithaca: Cornell University Press, 1994).

⁸ Filippo Camerota, *La prospettiva del Rinascimento : Arte, architettura, scienza* (Verona : Electa, 2006); Jeanne Peiffer, 'Projections Embodied in Technical Drawings: Dürer and his Followers', in *Picturing Machines 1400-1700*, ed. by Wolfgang Lefèvre, (Cambridge, Mass.: The MIT Press, 2004), pp. 245–75.

widespread ‘optical literacy’, perspective was defined in different ways in different places and sites by various groups of practitioners.

This book aims to reveal the polysemy of perspective by focusing on three different aspects of perspective as practice. Section 1 focuses on different sites in which perspective is practiced. It aims to elucidate not only the widespread optical literacy of the period, but especially the site-dependent meanings of *perspectiva*. Most interestingly, sites such as the theatre, the instrument maker’s workshop and the courtly garden were home to practices of perspective which have remained on the margin, or even completely invisible, in the historiographies of optics and perspective. Other sites have been privileged in scholarship, and among those the astronomical observatory in particular has received ample attention. It has been shown that astronomy, and its connection to understandings of the physics of rays in optics, was important to Renaissance image theories.⁹ Even more to the point, most recently, Raz Chen-Morris argued that Kepler’s optics is fundamentally providing the epistemological foundations of his astronomical research program as well as a response to widely shared anxieties about vision and knowledge in Renaissance culture.¹⁰ True knowledge is gained not by direct access to the world via the sense of sight but by artificially construed observation – that is, by measuring shadows in the camera obscura – Kepler maintains, according to Chen-Morris. As an important site of observation, the astronomical observatory is the prime locus in which the epistemological implications of perspective were considered. However, precisely because it has received so much attention, this book does not include a chapter specifically devoted to the astronomical observatory and shifts attention to the sites which have remained more marginal in scholarship. This is not to say that the anxieties about the instability of vision and knowledge, which Stuart Clark has argued preoccupied the period between 1430 and 1670, are not present in any of the other sites than astronomical observatories.¹¹ This is most certainly not the case given the ubiquity of these anxieties, but the question which this book raises is a different one: in what ways do the plurality of sites make a difference to our understanding of the polysemy of perspective?

The first site to be discussed is that of the *trecento* urban piazza in Marvin Trachtenberg’s contribution to this book. Architectural site planning was shaped by a set of

⁹ Mary Quinlan-McGrath, *Influences: Art, Optics, and Astrology in the Italian Renaissance* (Chicago: University of Chicago Press, 2013).

¹⁰ Raz Chen-Morris, *Measuring Shadows: Kepler’s Optics of Invisibility* (University Park, Pennsylvania: Penn State University Press, 2016).

¹¹ Stuart Clark, *Vanities of the Eye: Vision in Early Modern European Culture* (Oxford: Oxford University Press, 2007).

Euclidean-Vitruvian optical principles, and the urban piazza was laid out, according to Trachtenberg, to create particular points of view following these principles.

The two following chapters examine the artisanal workshop. On the basis of an analysis of a variety of practices of working emeralds and of knowing their optical properties, Marjolijn Bol shows that the artisanal workshop was a site of knowledge of light and colour, thereby focusing on domains of *perspectiva* different from the geometry of vision adopted by Brunelleschi and Alberti. Bol also shows how this knowledge reached scholars and natural philosophers, who applied it in the material refurbishing of their studies. More important to the central argument of this book, Bol's chapter defies the historiographical demarcation between optics and perspective and brings to the fore the aspects of perspective which a focus on scholarship on geometry, sight and projective space had obscured. In the next chapter, Samuel Gessner focuses on a different type of workshop, not that of the jeweller, goldsmith or painter discussed by Bol, but of the mathematical instrument maker, namely, Ieremias Arsenius. Well-connected to highly placed patrons as well as circles of mathematicians, such as Gemma Frisius and Gerard Mercator, Gessner shows how the Arsenius workshop and the circles connected to it, employed an understanding of perspective which included 'planisphaeric' or 'stereographic' projection used for the design of instruments.

The following chapters in this section consider three different sites: the anatomy theatre, the courtly theatre, and the courtly garden. In opposition to the historiography of optics following Lindberg, as discussed above, in which the role of anatomists in the development of visual theory is downplayed, and geometry is privileged, Tawrin Baker shows how, over the course of the sixteenth century, the anatomy theatre at the University of Padua became the site of dissemination, disputation and teaching of an approach to visual theory integrating ocular anatomy, mathematical optics and natural philosophy. In Jaime Cuenca's chapter we move to another type of theatre, the aristocratic theatre in which perspective was applied to scenery on stage. Cuenca shows how perspective in the courtly theatre had a political function. He traces how the privileged point of view in the perspectival theatre became identified with the prince's seat, and how perspective again lost its political significance in the eighteenth century. Finally, the site of perspective at the centre of Juliet Odgers' attention is the courtly garden. Odgers discusses the design of the Sayes Court garden near London by the seventeenth-century English polymath and member of the Royal Society, John Evelyn. In line with Gessner's discussion of the meaning of perspective employed in the mathematical instrument maker's workshop, Odgers shows that Evelyn's garden is home to a

practice in which perspective is embedded in the broader field of the projective mathematical arts.

Section 2 deals with writing as one of the most important practices of *perspectiva*. The chapters in this section concentrate on textual carriers and vehicles of the transmission of *perspectiva* and on how textual transmission entails appropriation resulting in changing meanings of *perspectiva*. Challenging essentialist definitions of Western linear perspective as compared with the image cultures of the Islamic East, Elaheh Kheirandish looks at the transmission of key concepts and aspects of perspective in a variety of textual sources in Arabic and Persian to bring out various practices of perspective in the Islamic Middle Ages.

In his chapter, A. Mark Smith points to the importance of extra-textual conduits of transmission of *perspectiva*. By the mid-thirteenth century the association of *perspectiva* with optics was firmly established, that is, two centuries before it also became connected with linear perspective in the canonical texts of medieval optics already mentioned. They were disseminated in academic milieus via university teaching in the European Middle Ages. However, as A. Mark Smith argues, oral transmission of optical knowledge via literary texts, such as most famously Dante's 'Divine Comedy', often read out loud to an audience of listeners, and especially in church sermons, resulted in a widespread optical literacy.

The next three chapters in section 1 discuss more specific texts, instantiating kinds of writing or genres, and how these textual vehicles of transmission shaped ideas of optics. Dominique Raynaud argues for the existence of a textual source for Leonardo's theory of the penumbra, thereby focusing on a field within perspective – the science of shadows – which has traditionally remained outside the scope of studies of the transmission of optics. Since the source was originally in Arabic, though known to Leonardo through a fourteenth-century Latin translation, Raynaud's chapter highlights the role of translation in the transmission of optical knowledge. Sven Dupré discusses different types of text, recipes and secrets, in his contribution to this book. Through books of secrets, flooding the print market in the sixteenth century, optical knowledge travelled more easily and widely than ever before. These secrets also re-packaged the experiential basis of optical knowledge and changed the meaning of optics. Breaking up optical texts, secrets led to new conceptual possibilities as well as the idea that optics was primarily about the manipulation of instruments to create visual effects. Finally, a notebook of the Spanish mid-sixteenth-century architect Hernan Ruiz II is the object of analysis in Jose Calvo Lopez's chapter. Offering a space for experimentation, the notebook shows various practices of perspective at work in visualising architecture.

Section 3 focuses on the practices of drawing, painting and constructing. Chapters in this section take the visual problems painters, draughtsmen and gardeners face as their point of departure and bring out the differences between codifications of *perspectiva* and practice. These constructional problems, and how they connect to bodies of optical knowledge, rather than the epistemological implications of perspectival art, are the centre of attention in this book. Firstly, there were a variety of non-Albertian constructions to create the illusion of space, as exemplified in the first three chapters of this section.

Filippo Camerota revisits a locus classicus in the historiography, Massaccio's *Trinity* fresco. In contrast to its traditional place in the historiography, Camerota shows that Massaccio did not apply the 'costruzione legittima' but instead applied the constructive tools available in the mathematical culture of the *abaco* tradition. Nevertheless, as Pietro Roccasecca points out in his chapter re-interpreting the perspective codified in Alberti's 'On Painting', perspective entailed a broader engagement with Alhacen's visual theory. Finally, even a painter of the mathematical accomplishment of Piero della Francesca deviated from the rigorous application of geometry if needed, as J.V. Field argues.

Secondly, other types of optical knowledge and experience were as important to artists as the geometry of perspective, as we will already have seen in Bol's chapter. In this section, Field shows how important knowledge of shadows and the reflection and refraction of light was to Piero's painting. In a similar vein, Paul Hills argues that Venetian painting around 1500 was the result of a practice of perspective paying special attention to light. Hill's chapter in this book scrutinizes the singular importance of Luca Pacioli for this practice of perspective. According to Hills, Pacioli's understanding of proportion is in agreement with the geometry and modulation of colour found in Venetian paintings around 1500, perhaps most apparent in works by Giovanni Bellini. Thus, taken together, these chapters show that other domains of *perspectiva* were important to painters. Nor was perspective constrained to the two-dimensional plane, which is obvious from the meaning of perspective and its uses in the context of mathematical instrument design and garden construction in the chapters by Gessner and Odgers, respectively.

In the final chapter of this book Georges Farhat continues this line of inquiry. Based on an analysis of André Le Nôtre's design of the Grand Canal of Versailles, Farhat argues that a specific appropriation of optical knowledge was at work there, which he calls 'topographic perspective', a practice which included the construction of optical devices, visual alignment and the application of anamorphic schemes. The garden is perhaps the best site to show that in the early modern period perspective was not tied to two-dimensional

graphic representation. Thus, garden design underscores the polysemy of perspective central to this book.