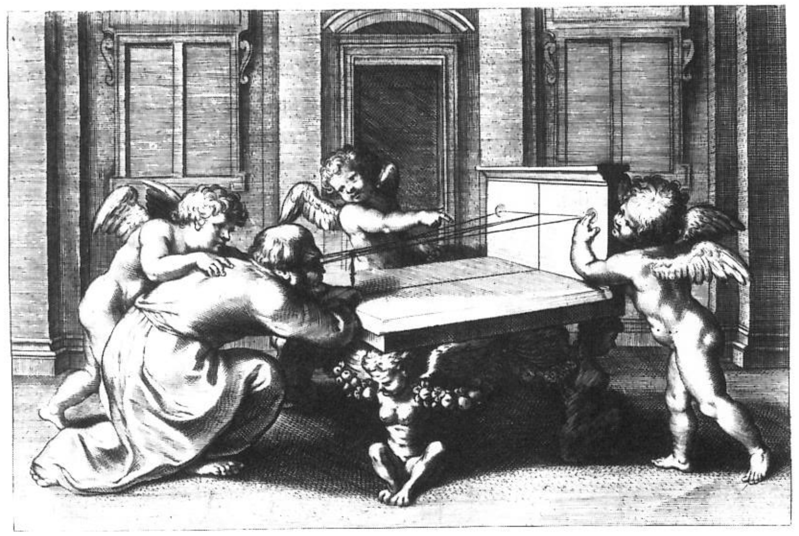
Martin Kemp

THE SCIENCE OF ART



Optical themes in western art from Brunelleschi to Seurat

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CHAPTER III

Linear perspective from Rubens to Turner

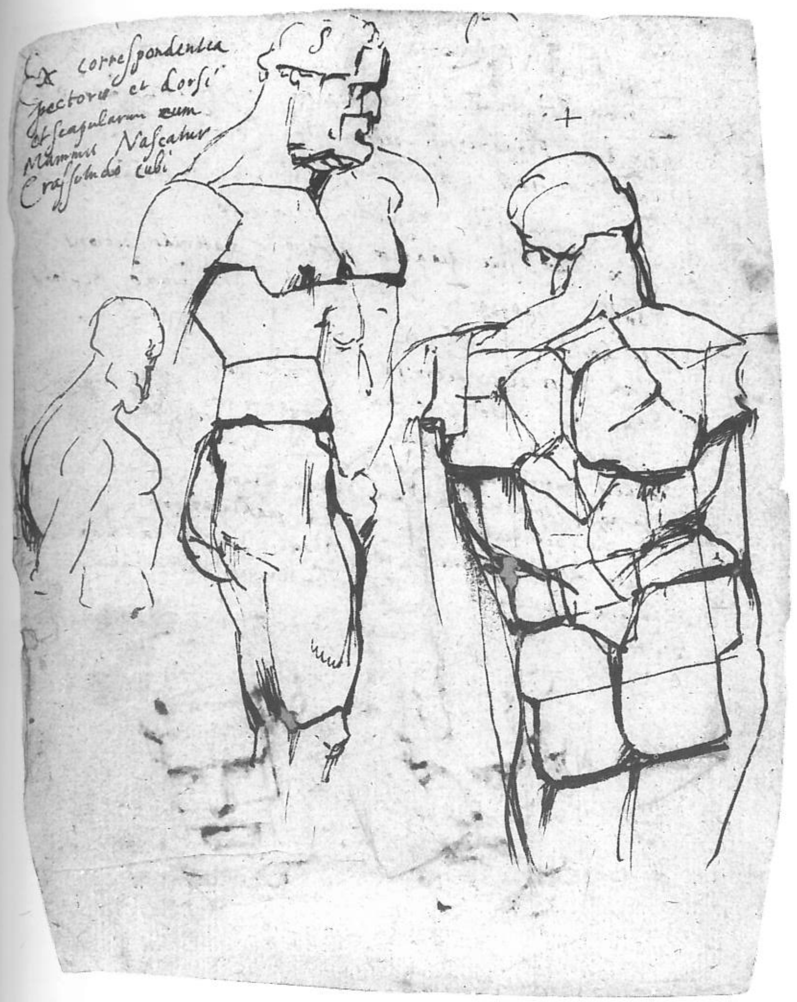
The absorption of geometrical perspective into mathematical science, with the concomitant emphasis on the general case and underlying theorems, worked against the provision of ready formulas for achieving pictorial effects. The drawing apart of geometrical and pictorial perspective was partly a consequence of the greater technical difficulty of the geometry—though I do not think its difficulty should be exaggerated—but it was more profoundly based on a difference in intention. This difference meant that the relationship between pictorial practice and perspectival theory would necessarily be different from that during the Piero della Francesca era. Even for an artist concerned with perspectival demonstration, the relationship would now be closer to that between an engineering technology and a pure science. We have already seen one manifestation of the changed relationship between visual science and painting in the interchange between Galileo and Cigoli, but this does not provide a model for other such relationships. Indeed, I believe one factor which will emerge from this chapter is that there is no single or even predominant model after 1600. Particular aspects of Dutch and French art will on occasion move close to the earlier direct correspondence between perspectival theory and pictorial practice, but such episodes do not provide the norm, In Italy perspectival techniques in art reached a peak of illusionistic complexity in theory and practice, but were based on an underlying science little more complex than that of the *quattrocento*. For many intelligent and even overtly intellectual painters, perspective became a kind of five-finger exercise—an essential grounding for technique but one which should be so much a natural part of an artist's skill and judgement that it is not an apparent part of the finished performance. Henceforth, overt demonstrations of perspectival learning were only to be occasioned by special circumstances or by the special proclivities of the artists and patrons involved.

It is to acknowledge this new situation that I have chosen to begin this chapter with two major artists of high intelligence who experienced close contact with optical learning at an advanced level, who possessed a profound sense of the intellectual foundations of their art, and yet whose paintings are almost devoid of conscious displays of constructional geometry. The two artists are Peter Paul Rubens and Diego Velázquez.

I should perhaps say at the outset that 'Rubens and optical science' is not the non-subject it might appear to be, given the popular image of the great Flemish master. However, there is no denying that it is a topic which faces grave problems of evidence. The notebooks and more formal manuscripts which contained his theoretical precepts have almost entirely vanished. His famous 'pocket book' exists only in a few scattered sheets and some records by later hands, including Van Dyck's.[1] The discourse on colours to be discussed in a later chapter is no longer traceable. And a book which contained 'observations on optics, symmetry, proportions, anatomy, architecture, and investigations of efficient causes and motions drawn from the descriptions of the poets and the demonstrations of the painters'—which was known to G.B. Bellori and Roger de Piles—has likewise vanished.[2] His voluminous correspondence provides only hints of this side of Rubens—mainly references in letters to Nicolas-Claude Fabri de Peiresc, the Parisian collector and intellectual. These concern such matters as a perpetual motion machine devised by the painter and various Archimedean questions of weight and motion.[3] Few of Rubens's extant drawings betray his activities in scientific or theoretical fields. One of the rare exceptions is a surviving excerpt from his pocket book, which analyses the structure of the Farnese Hercules according to cubes in the *quadratura* manner (pl. 193). He argues that the cube is inherent in the construction of massively robust male figures, while the circle pertains more properly to female anatomy. The triangle corresponds to robust thoraxes or in a more attentuated form to the extremities of the body.[4] This is hardly the evidence, however, on which to erect a scientific theory of art for Rubens. We may in any case believe that such design criteria were implicit rather than actual when he came to portray the contrast between masculine strength and female beauty (pl. 192).

There is, fortunately, a more solidly documented episode which allows us better to judge Rubens's stance. This was his involvement with François d'Aguilon (Aguilonius) in the production of a substantial book on optical science. Aguilonius was Rector of the Jesuit Maison Professe at Antwerp, and Rubens had become a member of the Grand Sodality of the Annunciation at the Maison.[5] The text of Aguilonius's trea-

192. Peter Paul Rubens, Samson and Delilah, *c.*1610, London, National Gallery.



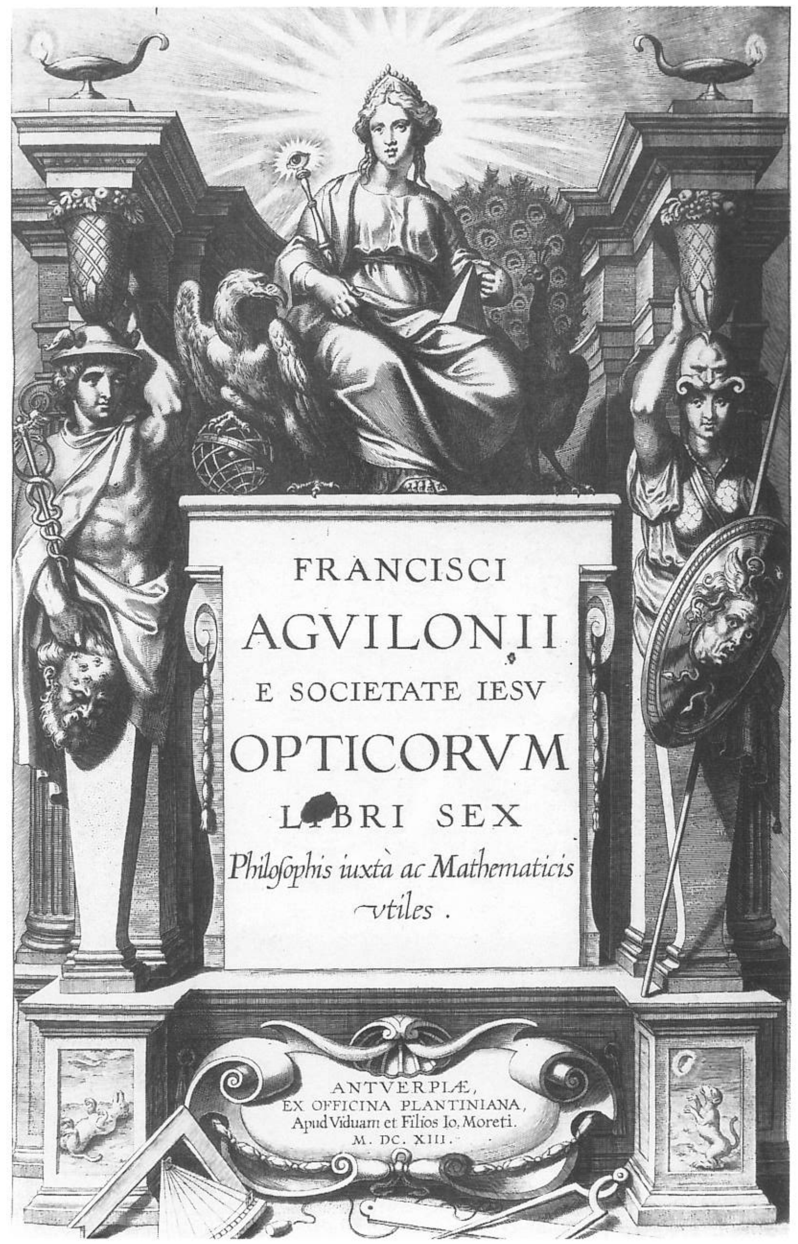
193. Geometrical analysis of the figure of *Hercules* by Peter Paul Rubens, London, Courtauld Institute, Princes Gate Collection, MS Johnson, no. 427v.

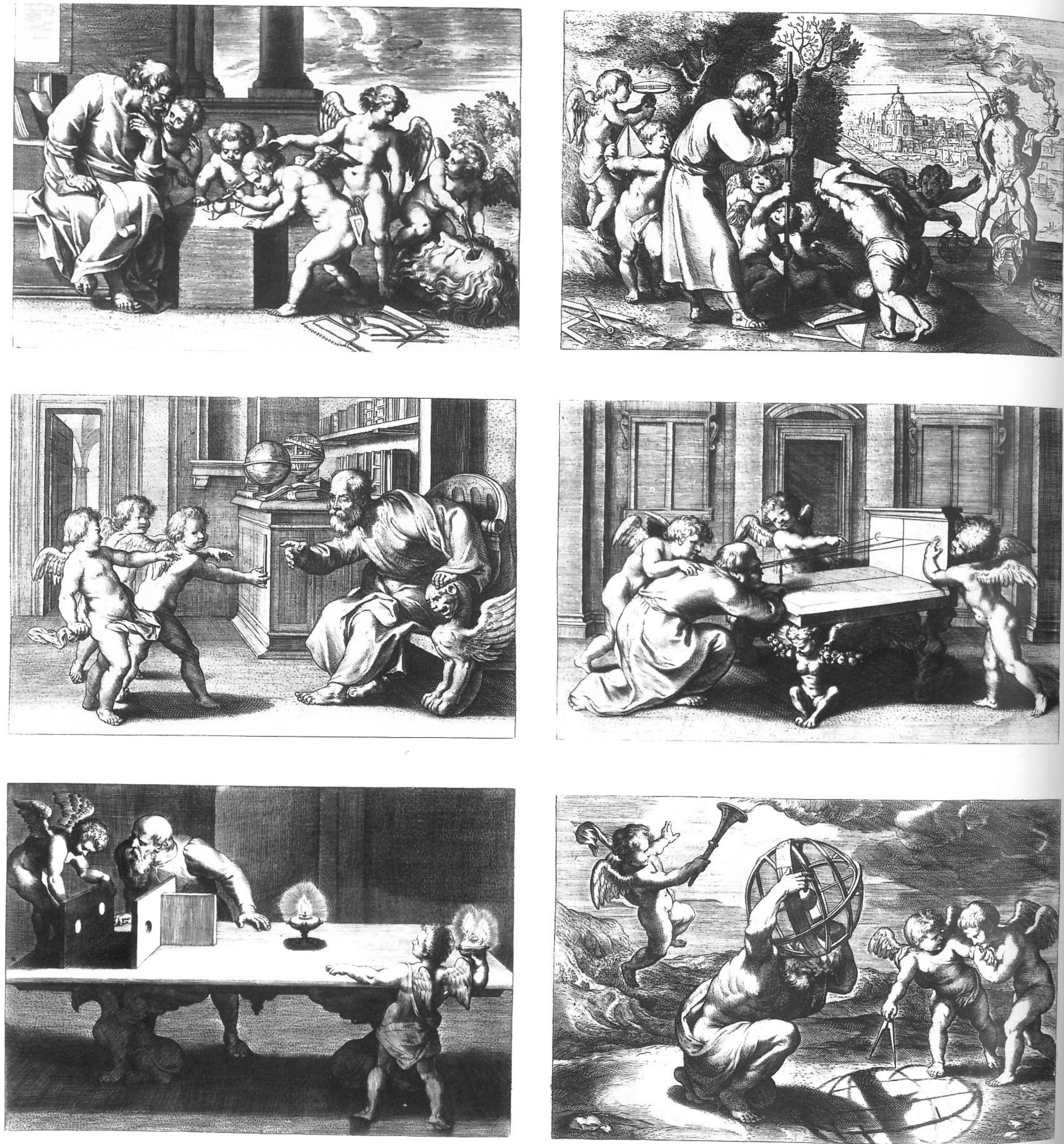
tise, the *Opticorum libri sex*, was approved by the censor in 1611 and was published in 1613 with seven illustrations by Rubens skilfully engraved by Theodore Galle.[6] The treatise represents an intelligent, highly lucid and fundamentally conservative synthesis of various threads in classical, mediaeval and Renaissance science. It is not without its subtle observations, original touches and—as we will see—a nice sense of experimental procedures, but Aguilonius's intellectual stance is circumscribed by the defined parameters of traditional optics rather than venturing into the more revolutionary territories of Kepler, Galileo and Descartes.

Rubens's main title page (pl. 194) provides a series of ingenious references to the alliance of vision and reason. There are some obvious details—the disembodied eye shining forth, the visual pyramid on Juno's knee, the celestial sphere and the optical-geometrical instruments—together with some less obvious, mythological references. Mercury with the many-eyed head of Argus, for example, refers to a visual allegory. Mercury, acting on Juno's orders, had lulled Argus's watchful eyes to sleep before decapitating him. The 'hundred' eyes were scattered by Juno across the tails of her attendant peacocks.[7] According to Macrobius, who is quoted by Aguilonius, Argus's eyes signify the starry sky which is extinguished by the radiant sun (Mercury) at each dawn.[8] In the next chapter we will see a related painting of this story by Rubens from this period (colour plate III).

The title page on its own would suggest no more than an illustrator's job well and professionally done. However, the vignettes which Rubens provided for the individual title pages of each of the six books (pl. 195) show such a complex and knowing relationship to the text as to leave no doubt that Rubens's intellectual involvement was considerable. The vignettes range from compositions which exhibit clever if

194. Peter Paul Rubens, Title page from F. Aguilonius's, *Opticorum libri sex*, Antwerp, 1613, engraved by Theodore Galle.





195. Peter Paul Rubens, Six vignettes from F. Aguilonius's, *Opticorum libri sex*, engraved by Theodore Galle.

general relationships to the book in question to those which make quite specific references to the arguments in the text. I will list them in an order which corresponds roughly to increasing specificity to the text:

Book I, 'On the Organ, Object and Nature of Sight', illustrates the dissection of the conveniently large eye of a cyclops, in keeping with Aguilonius's insistence on accurate knowledge of the eye's structure. He demonstrated his awareness of advanced anatomical investigation of the eye, but his view of its physiology remained essentially traditional and made no reference to Kepler's concept of a 'picture' on the retina.

Book II, 'On the Visual Ray and the Horopter', displays a range of surveying instruments in action, including a staff used for the optical measurement of the Colossus of Rhodes. These complement Aguilonius's discussion of Euclidian angles as the foundation of visual judgement.

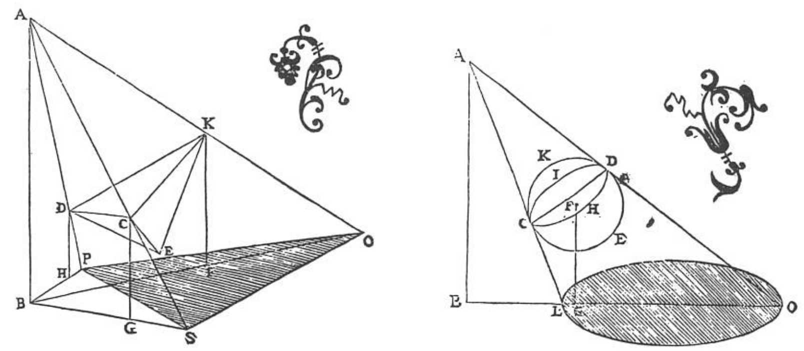
Book VI, 'On Projection' shows a rough-and-ready means of projecting a celestial sphere onto a plane surface. Aguilonius acknowledged Commandino's works on orthograpic and stereographic projection and looked towards Guidobaldo for the related science of cast shadows (pl. 196).[9]

Book IV, 'On Misleading Appearances', which deals with the apparently transformed shapes of objects viewed from different angles etc., is illustrated by reference to the parallax phenomenon. The illustration shows how an object is seen in two different places relative to the background when viewed by each eye in succession. Parallax was also a key concept in the astronomical measurement of distances.

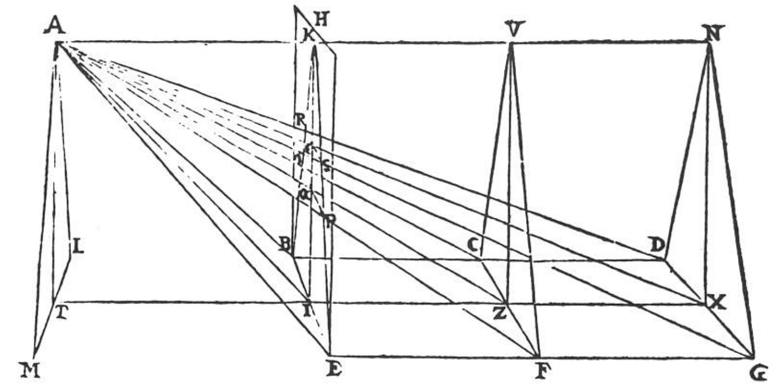
Book III, 'On the Cognition of Common Objects', represents a 'humorous experiment' described in the text, in which the author points out how difficult it is to reach out with certainty to touch a small object using one eye alone.[10]

Book V, 'On Light and Shadow', is the most interesting experimentally, and depicts one of two set-ups devised by Aguilonius to show that the relationship between the strengths of light sources and their diminution over distance does not simply stand in inverse ratio.[11] If a light twice the strength is placed at twice the distance from the receptive surface, it will still exceed in brightness the original light at the original distance. The result of this experiment goes against common expectation and, I suspect, would have perturbed Leonardo who believed that the uniformly pyramidal law applied in all such cases of the diminution of the powers of nature. The law at work here, as we now know, is the inverse square law, which is so widely used in astronomical calculations of distances.

What relation does all this bear to art in general and to Rubens's painting in particular? In the next chapter we will attempt to answer this question with respect to colour, which is the last of Aguilonius's four parts of painting—contour, light, shade and colour.[12] The author does treat scenographic (artistic) perspective effectively and succinctly in Book VI. He



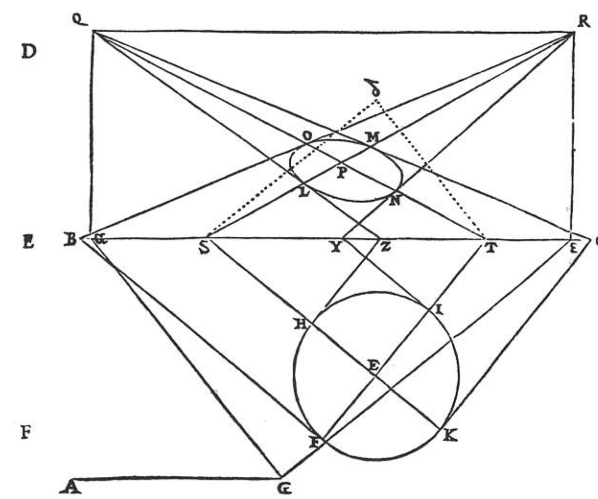
196. Projection of the shadows of a pyramid and sphere from point sources of light, from Franciscus Aguilonius's *Opticorum libri sex*, Antwerp, 1613.



197. Demonstration of the *punctum concursus* for parallel lines perpendicular to the picture plane from Aguilonius's *Opticorum*. . ..

TA—observer H—picture plane

Points on the parallel lines BCD and EFG are joined to A. The '*punctum concursus*' is at K.



198. Perspective projection of a circle using the points of convergence for lines at a given angle, from Aguilonius's *Opticorum*. . ..

The basic procedure as in Guidobaldo, pl. 173.

provides a clear outline of the basic points in Guidobaldo's treatise, including neatly designed diagrams of the convergence of parallel lines perpendicular to the picture plane and the construction of a circle in projection using the theorem of the *punctum concursus* (pls. 197–8). Such diagrams are fine for

199. Peter Paul Rubens, *The Gonzaga Adoring the Trinity*, central fragments of a dismembered altarpiece, 1604–5, Mantua, Palazzo Ducale.

demonstrating the geometrical principles at work, but do not readily serve the needs of pictorial construction.

There can be no doubt that Rubens was intellectually equipped to understand the text and he was too intelligent to have dismissed Aguilonius's visual science as irrelevant. But neither was he concerned to use such knowledge or techniques in a direct or mechanical manner in his paintings. Relatively early in his career when he was in the service of the Gonzaga at Mantua, he had been faced with the challenge of a large-scale composition in an architectural setting to be viewed from a low viewpoint. The result was his painting of 1604–5 for the Church of Sta. Trinità showing the Gonzaga family adoring the Trinity (pl. 199), now sadly mutilated as a series of dispersed and incomplete fragments.[13] What survives of the central part of the scene shows that he did not fail to take up the illusionistic challenge of Giulio Romano's example in Mantua, and more specifically the challenge of Cristoforo Sorte's lost scheme which used Solomonic columns. However, his architectural setting for all its apparent rationality is more in the nature of 'painter's architecture' than a precisely projected geometrical illusion of a logical structure in the central Italian manner. He took his lead in this from Titian and from Veronese's normal procedure as a decorator (though not as in the Villa Barbaro) in which perspectival suggestion is used to evoke an artistically flexible space of a predominantly non-geometrical kind. A functioning understanding of perspective provides the artist with the means to bend it suggestively to particular ends. This remained Rubens's position with respect to linear perspective throughout his career.

However, it is worth remembering that the measurement of distance comprises only a small portion of Aguilonius's visual science, just as in the works of Alhazen and Witelo. There is much else in Aguilonius's book that could have inspired Rubens in his study of light and colour. His vignette for Book V displays his sensitivity to Aguilonius's treatment of light and shade. It is not unreasonable to look for some reflection of this in Rubens's paintings. For example, the *Samson and Delilah* (pl. 192), which dates from this period, contains a deliberately contrived set of complex light effects emanating from four independent sources: two braziers, one candle and one taper. This is more complex in ambition and effect than the earlier *tenebroso* pictures he had painted in the fashionable vein, and makes great play with the varied effects of different intensities of light on various colours and textures—ranging from matt absorption to gleaming reflection and from stony depth to luminous refraction (in the glass carafes). One observation is particularly in keeping with the tenor of Aguilonius's treatise. The old maid who holds the candle above the central incident of the cutting of Samson's hair cups her other hand behind the candle in such a way as to enable her to see *past* the candle to the covert operation itself. If the glare fell directly into her eye it would obscure the view behind it—an 'experiment' we can all perform with a light bulb. The maid's gesture is thus more subtly 'optical' than the simple shading gesture which had appeared in Rubens's earlier paintings in a stock manner.[14] As we will see in the next chapter, he also made a related observation on the simultaneous contrast of light and shade which is directly based on Aguilonius.

I do not wish to imply that Rubens was in these respects a visual scientist in the manner of some of his Renaissance predecessors, but that his literacy in such matters informed his practice in a deeply integrated and yet non-dogmatic manner. He had, I should like to propose, reached the position which Lomazzo implicitly attributed to Michelangelo—the state in which his basic learning and controlled scrutiny of natural effects was so much a natural part of his creative equipment that he could act with secure judgement in transcending the rigid prescriptions of a particular theory.

To some degree Velázquez appears to have stood in an analogous position, though the model of his particular relationship between optical learning and pictorial practice was rather different. In the popular and scholarly images of Velázquez, science is unlikely to enter into consideration at all. Yet we have more impressive evidence of his access to the exact sciences than for any other painter of the seventeenth century. On his death in 1660, inventories were drawn up of the contents of the suite of rooms he occuped in the Alcázar Palace in Madrid. These contained a library of 154 volumes.[15] His holdings were relatively thin in fiction, poetry and religion, but remarkably rich in the books which we have already encountered in the first chapters. Looking down the inventory in order we find (with their inventory numbers): Luca Pacioli's *Summa d'aritmetica*. . . (2); Aguilonius's book (8); Dürer's treatise on proportion (11); Witelo on optics (13); Serlio on architecture (16); Benedetti's treatise on the gnomon (17); Zuccaro's *Idea*. . . (30); Cousin's treatise on perspective (35); a Spanish translation of Euclid's books on optics and catoptrics (49); Daniele Barbaro on perspective (50); Tartaglia's *Works* in Italian (56); Euclid's *Catoptrics*, in Italian (78); Guidobaldo

201. Diego Velàzquez, *Las Meninas*, 1656, Madrid, Prado.

tainers, is the precociously poised Infanta Margarita, daughter of Philip IV and Queen Mariana, whose reflections are elusively but unquestionably visible in the mirror at the centre of the rear wall. A flight of stairs is visible through the open door and across a relatively short vestibule. The man on the stairs holds open a further door. The glances of no less than six of the figures are directed through the picture plane and into our space. The strong implication of all this is that the subject of their attention is the Royal presence itself, and that the King and Queen are shortly to progress through the room to the short staircase at the far end. The corollary is that the painting on which Velázquez is engaged depicts the Royal couple. Are these implications supported by a more precisely spatial analysis of the setting?

The perspectival clues are less blatant than they might be in an Italian Renaissance painting, but they are definite enough. The vanishing point lies close to the central point of the door opening (pl. 203). The visual axis thus runs asymmetrically down the room along a line between two of the doors. The painter's own position in the picture can be determined as straddling the central axis of the room. Given the viewing axis, the centrally-placed mirror cannot but reflect a relatively narrow vista which lies almost exclusively to the left of the central axis. The line of vision from the mirror would almost certainly have been intercepted by the large canvas. The painting would, therefore, represent a double portrait of the King and Queen. This interpretation corresponds to that of Palomino and is confirmed by the pictorial device of a red curtain visible in the mirror reflection. Velázquez would not have required advanced optical planning to achieve this effect, but simply his first-hand knowledge of what was visible in the room from a certain standpoint and what was (or would be) reflected in that mirror. However, if he has followed optical logic, it seems that the depicted figures must have been somewhat larger than life size, in that the viewing distance is doubled by the mirror reflection.

Given the clues within the painting and our knowledge of the setting, we can legitimately ask if Velásquez has precisely recreated the view according to optical principles. Let us for the moment suppose that he has used perspectival geometry, and see where this will take us.[26]

We can determine units corresponding to squares in the ground plan using the width of the end wall as the side length. These show that the picture plan is stationed somewhat more than three-and-one-quarter units from the rear wall (at IJ in pl. 203) and must therefore be nearly if not precisely coincident with the plane of the opposite wall of the room. However, this would not be consistent with the scales of the uprights canvas (which can be judged to be about three meters high and *Las Meninas* itself, which is over three meters tall. To produce the proper scaling, the picture plane would need to be located at PP in pl. 202.[27] I interpret this discrepancy to mean that there was probably not a directly geometrical relationship between the setting and the perspective of the painting. The setting and the painting would therefore stand in a different relationship from that in the standard construction.

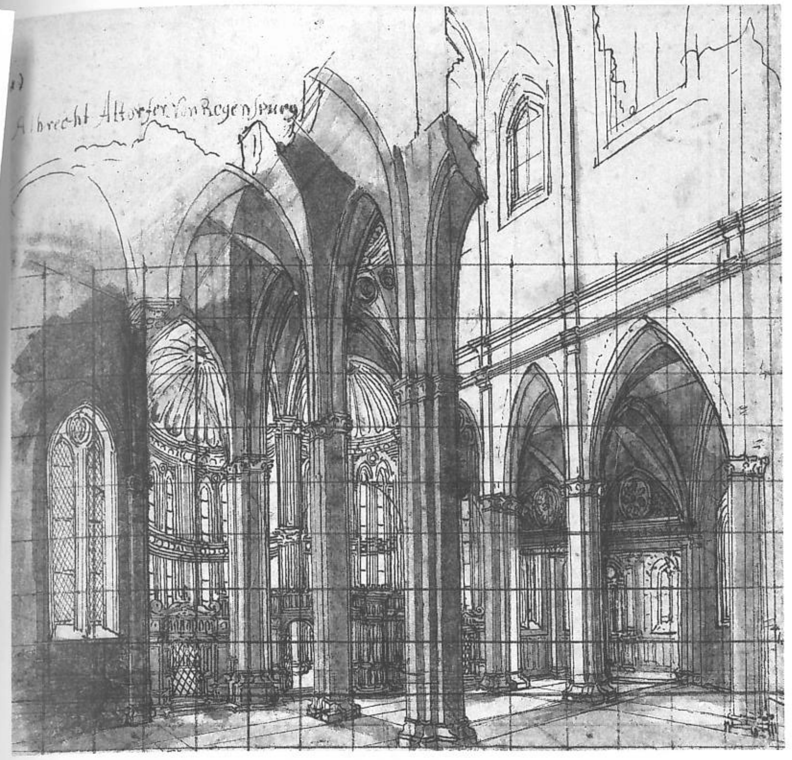
In the light of this, I should like to suggest a design procedure as follows. Velázquez took his basic view of the room as framed by the upright edges of the door from point E. This would mean that the plane of the door aperture acted as the Albertian 'window', a concept with which he would have been well familiar from the treatises by Alberti and his successors. This view was directly recorded 'by eye', either in a rough sketch or less probably in the underdrawing on the canvas itself. It was organised in the picture itself using a standard construction of orthogonals converging on the vanishing point, but without a precise scaling of all the architectural forms in depth in the Piero manner. The figures would have then been added 'by eye' to create the desired impression.

If this is anywhere near the truth, it would mean a procedure very different from the perspectival calculations of Colonna and Mitelli. Given Velázquez's access to perspective science, this would represent a conscious choice. According to this interpretation he would be openly challenging the perceptual limitations of the Italians' geometrical mechanics. They had painted 'a little black boy going down a staircase looking like a real one' using the traditional techniques of the illusionist decorators. By contrast, Velázquez's man on the staircase is conjured up through complex interplays of tone, colour, definition and scale. The bright patch of wall silhouetting the distant man—which optically draws the wall towards the spectator—and the more ghostly *sfumato* of the reflection in the mirror are to my mind quite deliberately juxtaposed. This is just one instance of Velázquez's desire, manifested throughout the painting, to give a wider sense of the subtle processes of vision and how they can be magically evoked or paralleled in the medium of paint than was possible with the drier mechanisms of linear perspective and geometrical shadow projection. No painting was ever more concerned with 'looking'—on the part of the painter, the figures in the painting and the spectator. Velázquez's art is a special kind of window on the world—or a perceptual mirror of nature—or perhaps even more literally in this instance his personal door to the subtle delights of natural vision and painted illusion.

Velázquez and Rubens indicate in their respective ways that artists of high intelligence who were urgently concerned at this time with questions of visual representation could set their understanding of perspective into a broader context of seeing and representation. In as far as many of the optical effects to which they turned fall into the subjective category—that is to say, they were based on their appearance to the viewer rather than theoretical constructs—we will not be surprised that their visual solutions differ in detail. Similar questions of seeing and representation in relation to the science of art are posed even more directly by the art of many of their contemporaries in Holland, who were regularly involved in the business of precise architectural and topographical description in a way which Rubens and Velázquez were not.

OPTICAL GEOMETRY IN DUTCH ART OF THE SEVENTEENTH CENTURY

The flowering of easel painting in the seven United Provinces—the territories in the Northern Netherlands which had



204. Albrecht Altdorfer, *Study of a Ruined Church*, *c.*1520, Berlin, Staatliche Museen, Kupferstichkabinett.

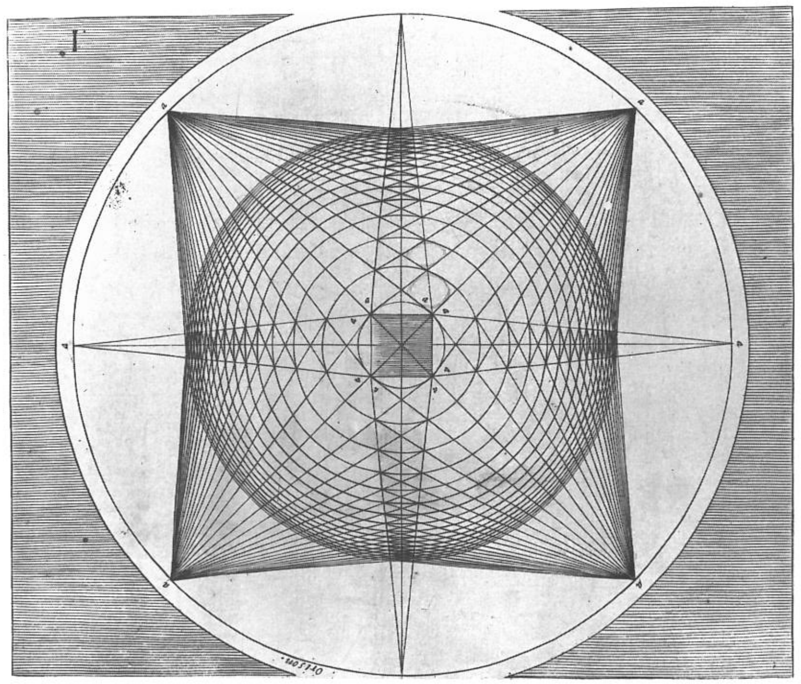
been effectively freed from Spanish domination in 1609—is nowhere more remarkably seen than in the burst of perspectival painting which occurred from about 1630 onwards. This was directly linked to a striking group of illustrated texts. The character of Dutch perspectival art, above all the painting of townscapes, church and domestic interiors, was locked into contemporary thought and society in a way which is not so coherently apparent in most of the other episodes in the story we are telling. Perhaps only fifteenth-century Florence and sixteenth-century Nuremberg are in any way comparable in the earlier periods. Amongst the contemporary and successive episodes, only French art and theory of this same period offers anything like as responsive a picture—but without the internal coherence which characterises Dutch art, thought, technology and society.

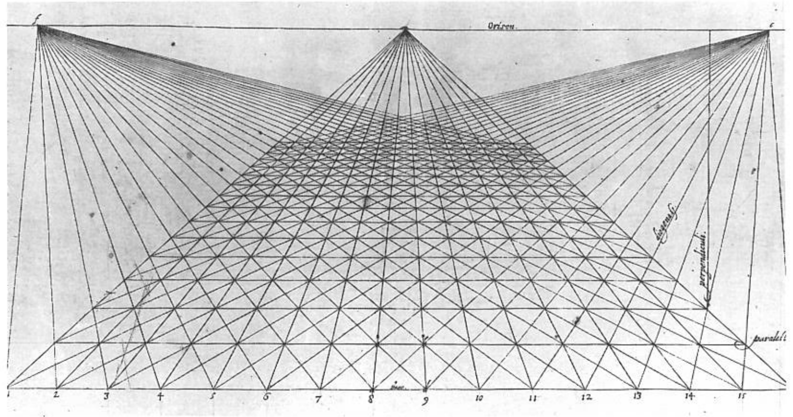
To understand the nature of Dutch painting at this time it is necessary to take account of the powerful tradition of Northern and most specifically Netherlandish naturalism from the fifteenth century. As characterised by its leading figure, Jan van Eyck, this tradition had developed a high level of effectiveness in the empirical rendering of space, in concert with the kind of particularising light we noted in Dürer's art. Some idea of what could be accomplished when this tradition was allied with Italian techniques has already been provided by Dürer himself. There are comparable hints of this potential in the work of other major painters. Albrecht Altdorfer, probably shortly before 1520, made a very remarkable study of a partially ruined Gothic church (pl. 204), using a lateral-point system similar to that of Viator to achieve an effect of angled space which virtually seems to belong two centuries later.[28] However, when perspectival techniques were taken up in a wholesale manner by Netherlandish artists in the sixteenth century it was as part of the whole baggage of the Italianate style. In the hands of painters like Mabuse and van Orley, perspective was not so much married with the native tradition as imposed upon it, as an elaborate and virtuoso part of the *all'antica* vision to which so many Northerners were converted at that time.

To some extent the dominant Dutch pespectivist of the latter part of the century, Hans (or Jan) Vredeman de Vries, is a representative figure of the Italianate phase of Northern art, but he also genuinely leads us into the era in which Dutch artists were to achieve their individual contributions to the systematic portrayal of space. Hans Vredeman was a painter, graphic artist and architectural designer who pursued a peripatetic career around Europe, comparable to that of many mobile artists during this period, and worked for a while at the illustrious court of Rudolf II in Prague.[29] His major significance was as an indefatigable producer of books of engraved designs portraying architecture, ornamental motifs, fountains, gardens and most notably perspective. These designs emerged in a steady stream from 1560 to 1604. His drawings and his *Scenographiae sive perspectivae* of 1560 show that he had acquired a competent grasp of the rudiments of spatial construction during the late 1550s and was already capable of exploiting perspectival effects with an unusually lively imagination.[30] His finest book, his two-part *Perspective* which was published in 1604–5, stands at the climax of his long career as a practising artist and educative designer.[31]

In more than one sense, Vredeman is the first natural heir to

205. Orbital diagram of the visual field, from Hans Vredeman de Vries's *Perspective*, The Hague and Leiden, 1604–5.



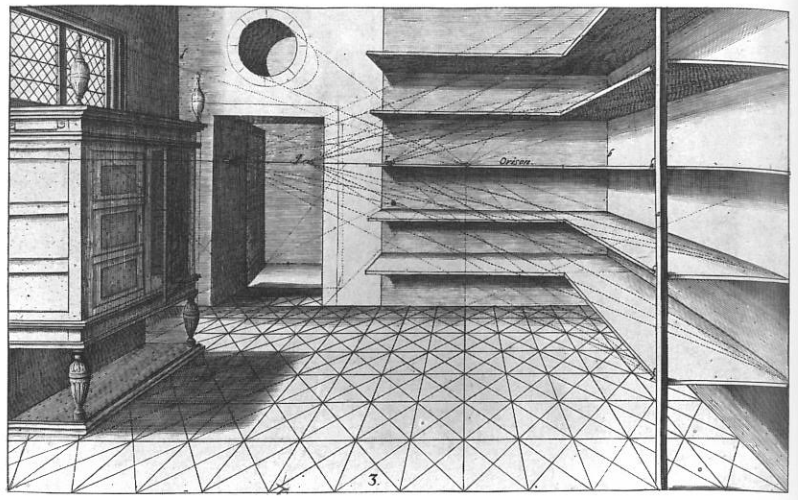


206. Basic perspective construction using two 'distance points' from Vredeman de Vries's *Perspective*.

f, c—distance points

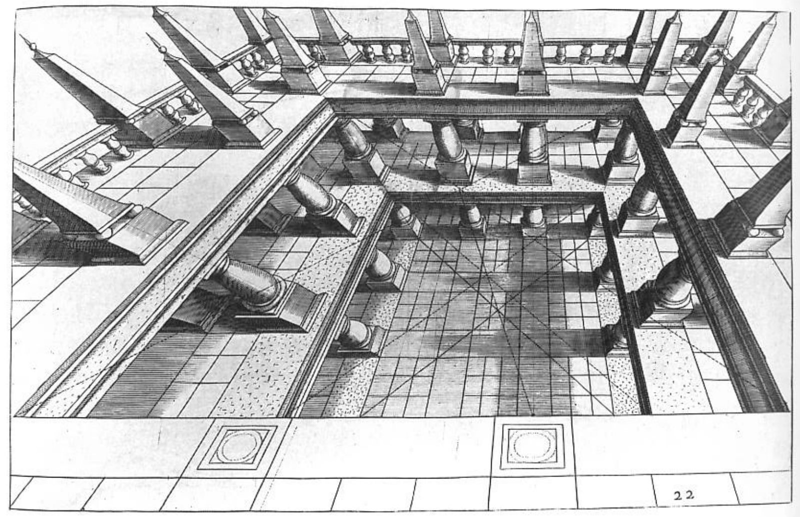
Viator. Like his predecessor, he provides can unfailingly inventive series of demonstrations of perspective in action, with brief commentaries and little overt display of constructional geometry. In his first diagram (pl. 205) he may be directly taking up one of Viator's themes, in that he illustrates the motion of the axis of sight as the eye rotates. The result in his case is an orbital diagram of successive pyramids with curved horizontals rather than Viator's straight horizon. Vredeman's second diagram shows the arrangement which corresponds to a static viewpoint (pl. 206), and this familiar scheme provides the basis for his subsequent constructions. Although he cites Dürer as the greatest master of precise perspective, his actual constructions seem to owe more to Viator, Serlio, Cousin or one of the other *tiers points* specialists.

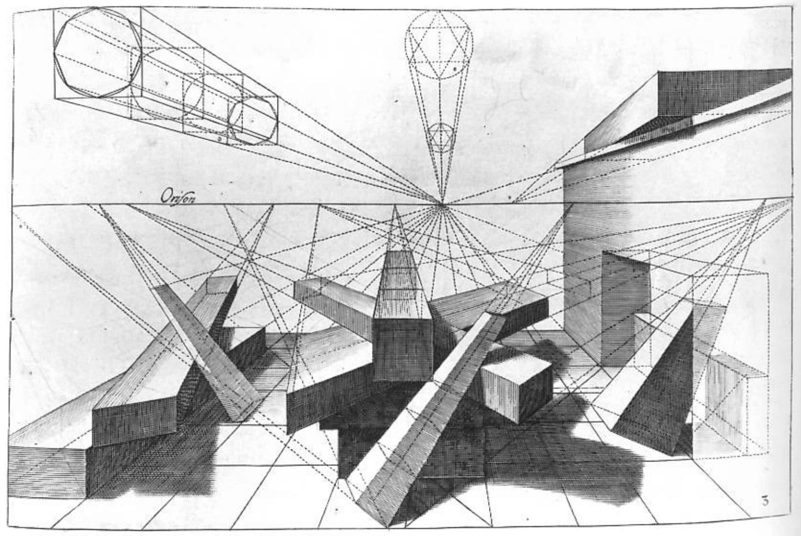
The more than seventy demonstrations in the two parts of his *Perspective* provide a fertile series of variations on architectural themes. There are at least some signs of strain as his geometrical techniques prove inadequate for some of the more complex problems he has set himself, particularly those involving regular curves. Relatively orthodox designs based on canonical boxes of space (pl. 207) are followed by some eye-catching variants (pl. 208) in which architectural forms are portrayed at odd angles from such close viewpoints that the effects are those of anamorphic images which assume undistorted appearance only when viewed from a particular position. Occasionally his geometrical shortcomings are apparent, as in the third plate of the second part (pl. 209), in which some of the forms are clearly characterised as truncated pyramids parallel to the picture plane and yet still neatly converge at the horizon level as if subject to parallel diminution. Not suprisingly some of the designs relate directly to his own pictorial practice. He is known to have devised lost schemes of illusionistic decoration.[32] His vault perspectives (pl. 210) pay clear homage to the Italian tradition in this respect. Of his few surviving paintings, the majority exploit complex fantasies on Italianate themes of the kind he illustrates in a number of the plates (pl. 211).[33] Perhaps most significantly for the future, he also applied perspectival techniques to the portrayal of con-

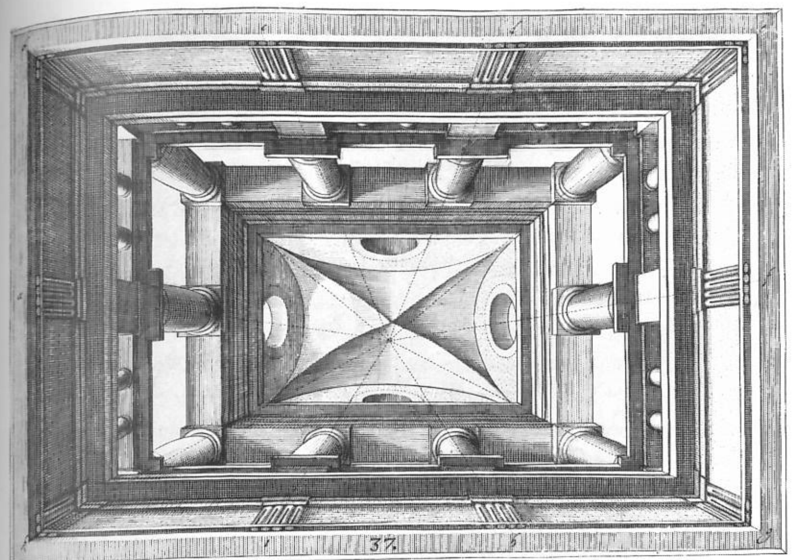


207–9. Perspectival projections from Vredeman de Vries's *Perspective*:

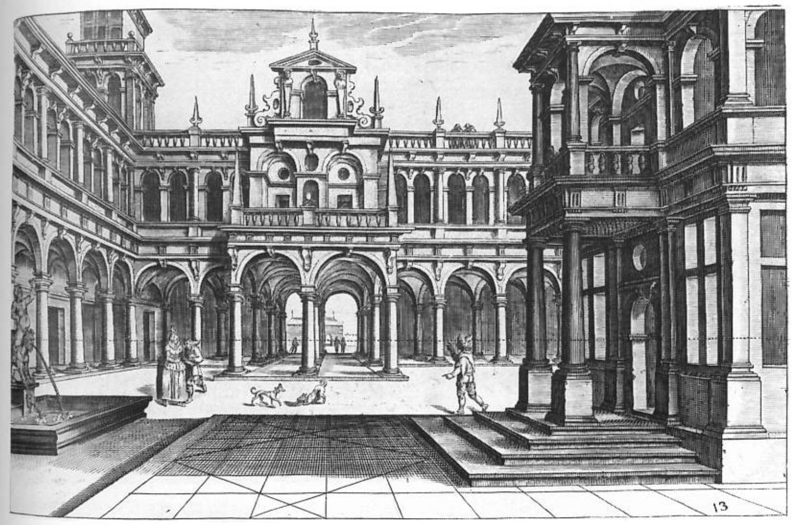
(above) Interior. r, g, f—alternative 'vanishing points'
(below) A tiered loggia.
(bottom) Geometrical bodies.

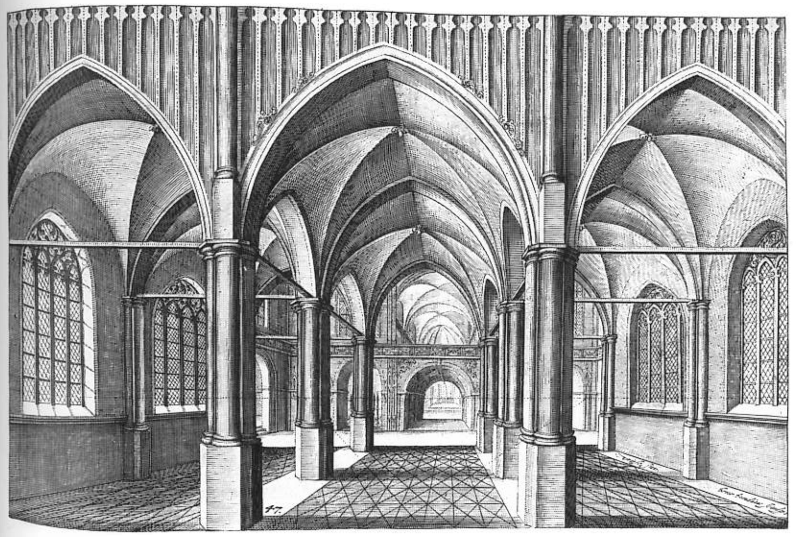






210–12. Perspectival projections from Vredeman de Vries's *Perspective*:
(above) An open loggia for an illusionistic ceiling.
(below) View of an Italianate palace courtyard with figures.
(bottom) View of the interior of a Gothic church.

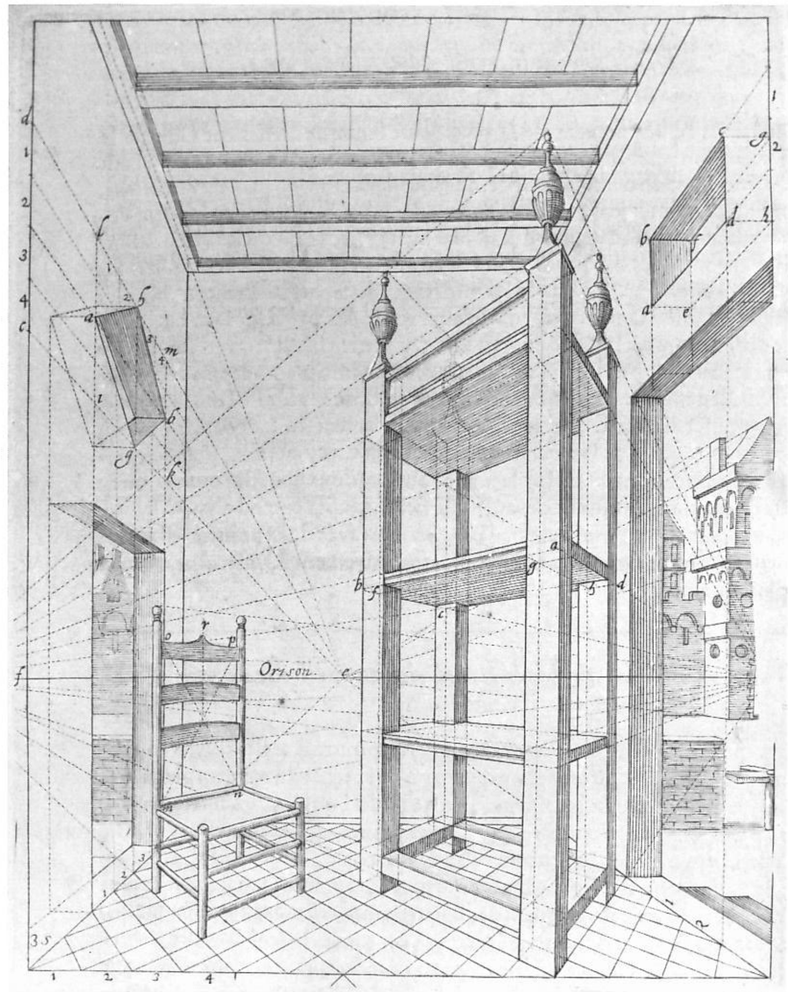


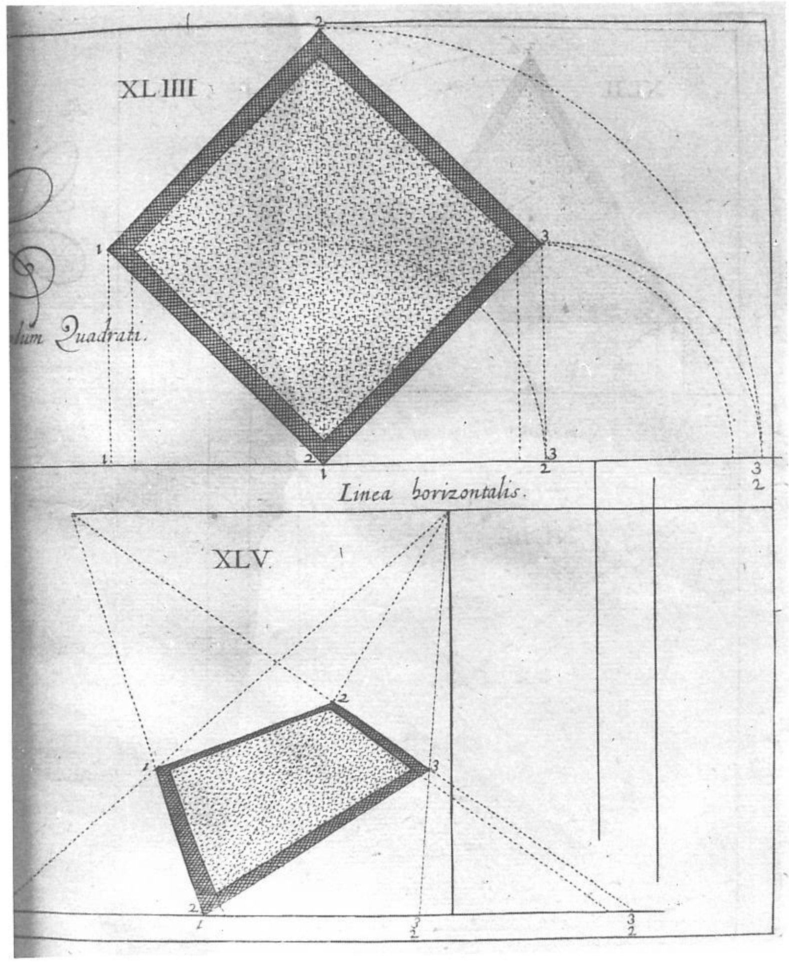


vincing Gothic structures (pl. 212). During the 1590s he made a number of paintings of the interiors of actual mediaeval churches.[34] In this aspect of his practice he had apparently been preceded by Hendrick van Steenwyck the Elder, who had painted a perspective of the interior of Aachen cathedral as early as 1573.[35]

During the later part of the sixteenth and earlier part of the seventeenth centuries, architectural painting in the Vredeman de Vries manner, ranging from entertaining fantasies (with or without narrative subjects) to more sober portrayals of actual or credible monuents, continued as a conspicuous sub-genre in Netherlandish art. The full range would often be embraced by individual artists, for example the van Steenwycks, the Neefs and Bartolomeus van Bassen.[36] Vredeman's direct influence on this practice appears to have been considerable. His influence on the theoretical literature was equally significant. His immediate heir was Hendrik Hondius, a pupil who became a print-maker, publisher, expert on fortifications and author. In addition to publishing successive editions of Samuel Marolois's writings on perspective and related subjects, for which he utilised illustrations by Vredeman and himself, he wrote a popular treatise on his own account, his *Institutio artis perspecti-*

213. Perspective projection of an interior with objects, from Hendrik Hondius's *Institutio artis perspectivae*, The Hague, 1622.

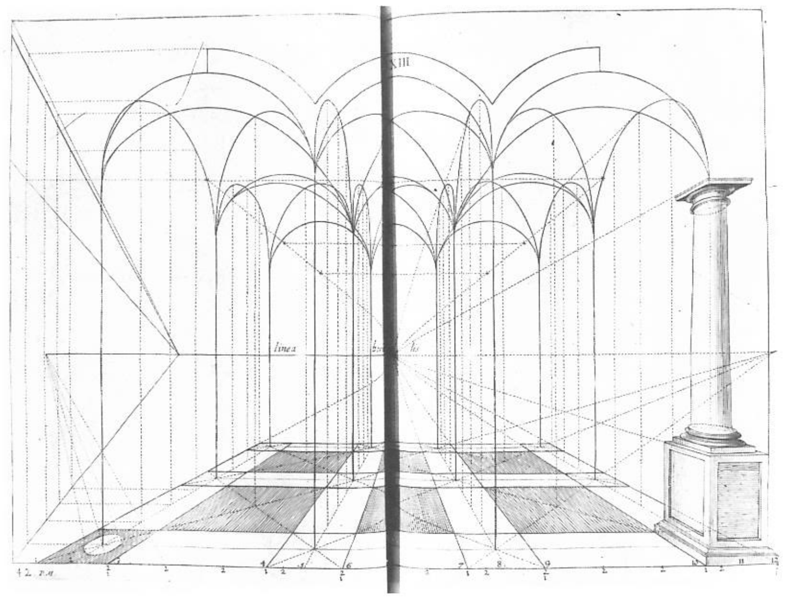




214. Perspective projection of a square using the distance point, from Samuel Marolois's *Opera mathematica*, Amsterdam, 1628.

Procedure essentially as in pl. 155.

215. Perspective projection of a loggia, from Marolois's *Opera mathematica*.



vae (issued in French as *Instruction en la science de perspective*). His book provides a series of neatly conceived demonstrations of perspective in its abstract and applied forms (pl. 213) and gives an original if brief analysis of the upwards convergence of tall verticals to a '*contre-poinct*' when viewed with a plane tilted slightly towards the spectator.[37]

Marolois, a mathematician and fortification designer (in the manner with which we are familiar), provided the standard treatment of mathematical perspective for Dutch painters and served in large measure to make the Italian mathematicians' projective techniques accessible to artists of intellectual inclination. The numerous editions of his work suggest that there was no lack of interest in his methods. His treatise on perspective first appeared in his *Opera mathematica ou oeuvres mathematiques traictons de geometrie, perspective, architecture, et fortification* in 1614.[38] Not surprisingly, in the setting of a compendium of mathematical sciences, his approach to the subject is thoroughly geometrical in nature. He insists that the artist should not naively represent 'what the eye receives' but should found his representation on the principles of projection onto a plane surface which intersects the lines of light. In answer to the claim that the painter should follow the natural phenomena of vision with respect to lateral and upwards recessions, he argues that the resulting images will violate 'natural reason'. The geometry of projection (*scenographia*) will produce a demonstrably accurate record of optical fact on the surface of the picture, and this itself will be subject to the rules of natural vision (*optica*).[39]

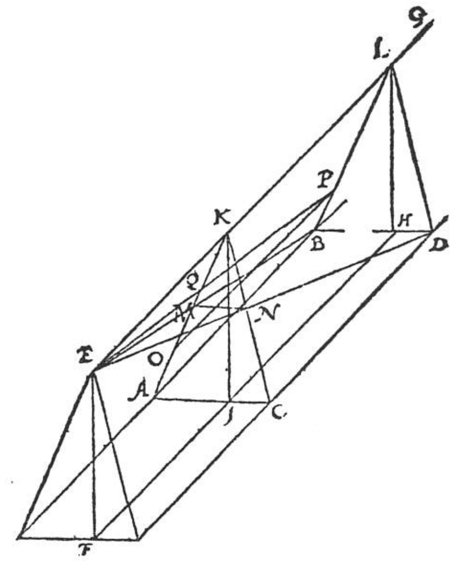
As we might expect he is much concerned with the perspective of geometrical bodies in the Italian manner and he provides basic instructions which are akin to those of Danti-Vignola (pls. 214–15). He also follows Vignola in providing some reasonably accessible demonstrations of projection in three dimensions and paying a good deal of attention to neatly conceived 'machines' for the obtaining of proper projections (as will be seen in Chapter IV). The mathematical yet practical tenor of his treatise is consistent with the publications by other Dutch theorists, most notably Salomon de Caus, whose *La Perspective, avec la raison des ombres miroirs* was published in London in 1612, and Simon Stevin, whom we will meet when we look at Saenredam's church interiors.[40]

Most studies of Dutch art have paid little attention to the relationship between such geometrical theories and pictorial practice. There has been a general sense that the naturalism of Dutch art is largely indepenent of geometrical theorising.[41] More specific beliefs have been expressed to the effect that such 'Italianate' mathematics are radically incompatible with the naturally descriptive vision of Dutch art. It is true that we should not automatically regard the mathematical theorists as representing the typical face of Dutch art—it could simply be the case that the mathematically-minded theorists were inclined to put their thoughts down on paper, while the 'empiricists' were not. However, all the indications are that the books served a very real need and were hugely successful. Marolois's treatise re-appeared in 1616, 1628, 1629, 1630, 1638, 1639, 1644, 1651 and 1662, adorned with illustrations by Hondius and incorporating plates from Vredeman de Vries.[42] The mathematical aspects were re-edited by Albert Girard, a mathematician-engineer of some significance, who was also the editor of texts by Stevin.[43] Hondius's own compendium sold sufficiently well to warrant a number of editions in a short space of time.[44] All this, to my mind, is symptomatic of an avid interest in perspective in the United Provinces, an interest which fully expressed itself in pictorial form–not in pictures which imitate the Italian mode but in representations which find a new way of expressing the geometry of perspective within the framework of the direct scrutiny of nature. The way in which Dutch artists from about 1630 succeed in integrating perspective with the direct portrayal of real structures may be seen as the realisation of one of the potentialities of Brunelleschi's original invention, a potentiality which had remained largely dormant.

The diverse levels and wide range of approaches to 'natural mathematics' in Dutch art make it difficult to know where best to begin. Perhaps it would be wise to begin where the detailed evidence is strongest. This, happily, is also where the art is at its most compelling. I am referring to the architectural paintings of Pieter Saenredam. Even without close analysis and without any knowledge of their creator's background, his paintings speak a language of consummately measured control in every respect. When we choose to undertake close analysis of particular paintings and investigate his known interests we will find that this impression is amply confirmed.

We are fortunate in knowing the contents of his library immediately after his death.[45] His collection consisted of over three hundred books—an outstanding total at this time for anyone in any walk of life. Amongst these is a coherent group of texts on pure and applied geometry and related arts. He owned three Euclids, including the first Dutch translation (1606), Dürer's treatises on proportion and measurement, and a Dutch edition of the *Mathematical Works* of Frans van Schooten, one of the teachers of the great Christian Huygens.[46] Perhaps the most interesting set of texts from our point of view are the treatises by Simon Stevin. He possessed Stevin's works on land-metering, architecture, and the military sciences—engineering, logistics and manoeuvres.[47] Stevin is an interesting and important figure, who will require closer attention in our efforts to understand Saenredam in particular and Dutch perspective art in general.

Stevin was a mathematician-engineer whose researches in pure science were deeply informed by his practical activities in the service of Prince Maurice of Nassau, the leader of the United Provinces.[48] He was involved in geometry, algebra, arithmetic (pioneering a system of decimals), dynamics and statics, almost all branches of engineering and the theory of music. Not altogether unexpectedly, he published a treatise on perspective in 1605.[49] His approach to perspective belongs in the Commandino-Benedetti-Guidobaldo tradition, and his main demonstrations are uncompromisingly geometrical in nature (pls. 216–17). He also took up the essentially non-pictorial problem of the rotation of the picture plane into the ground plane, formulating one of the basic theorems of homology.[50] However, he does show some of Marolois's sensitivity to the needs of practitioners. His treatise was occa-

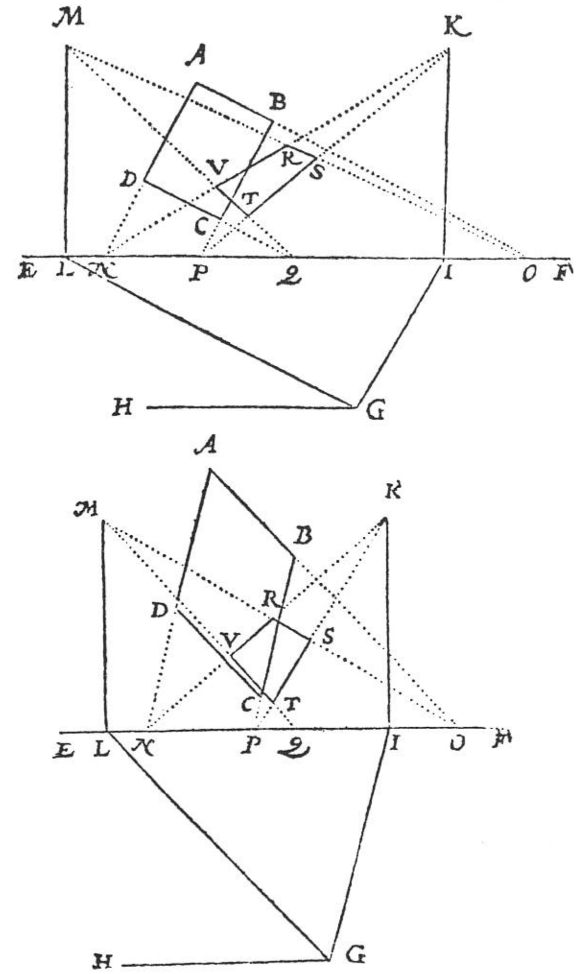


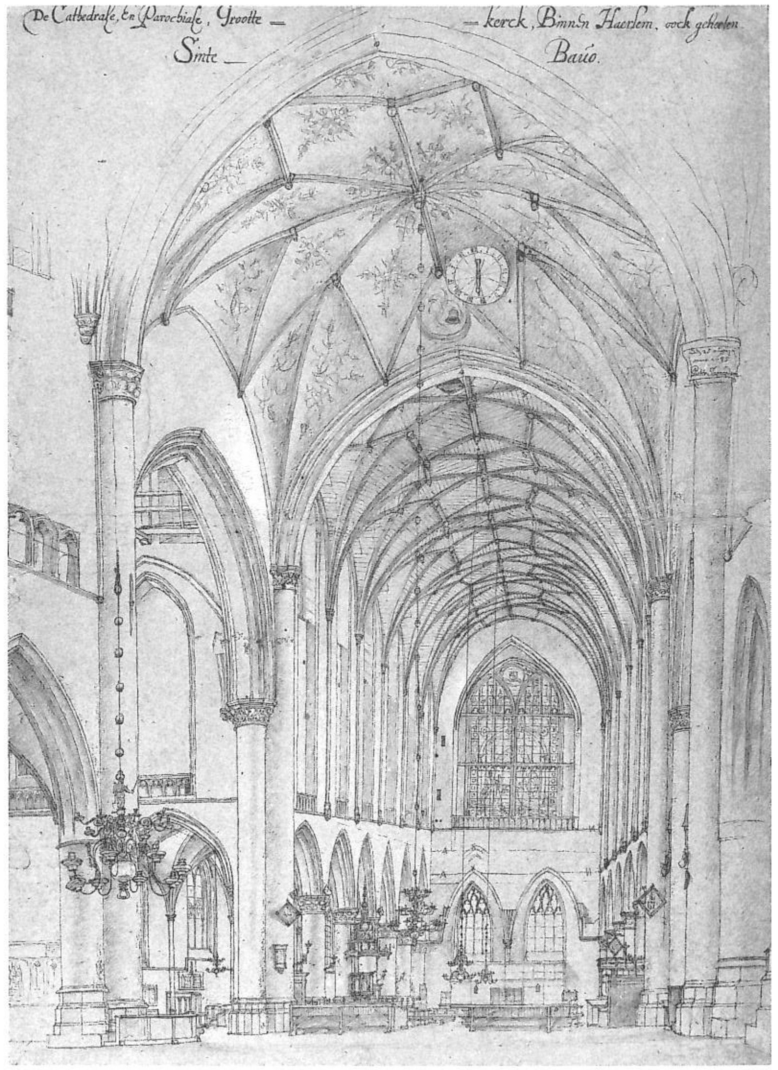
216. Demonstration of the 'vanishing point' for parallel lines, from Simon Stevin's *De Deursichtighe*, Lieden, 1605.

FE—observer AC—base of picture plane
AB and CE—parallel lines projected to AM and CN
K—'vanishing point'

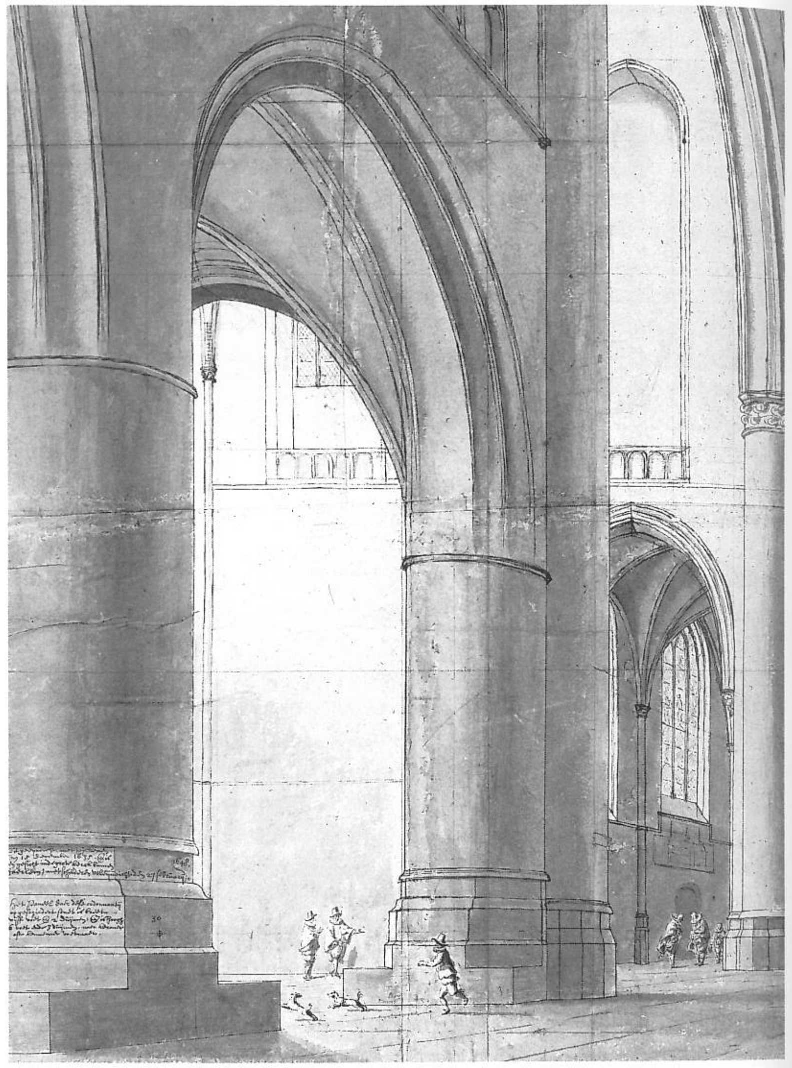
217. Perspective projection of rectangle and a parallelogram, from Stevin's *Der Deursichtighe*.

The basic procedure as in Guidobaldo, pl. 172.





218. Pieter Saenredam, *Study of the Interior of St. Bavo's Looking West*, 1635, Haarlem, Municipal Archives.



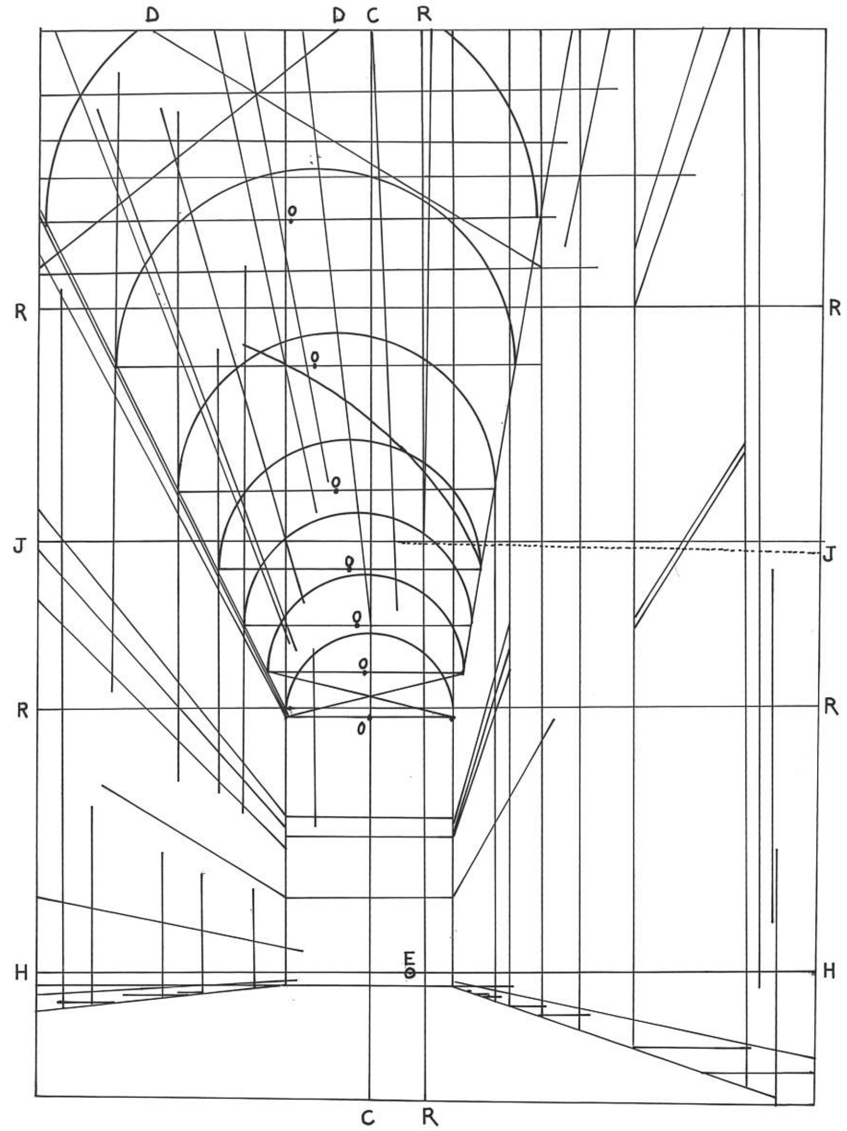
219. Pieter Saenredam, *Lower Left Portion of the Construction Drawing for the Interior of St. Bavo's*, 1635, Haarlem Municipal Archives.

sioned by the desire of Prince Maurice to understand the principles of pictorial representation—'wishing to design exactly the perspective of any given figure with knowledge of causes and mathematical proof'.[51] Stevin accordingly provides 'abridgements' of his geometrical techniques for artists—albeit rather abstract abridgements—and illustrates a Dürer-like perspective machine.[52]

Stevin's work as a whole is deeply characteristic of Dutch activities—scientific and practical—at this time. The close allegiance he forged between abstract mathematics and technical practice, drawing the pure sciences away from their metaphysical base and uniting them with concrete procedures, is altogether typical of Dutch science.[53] Stevin and his fellow mathematicians were concerned with an astonishing range of applied skills and technologies—fortifications, guns, ships, canals, navigation, windmills, cranes, modes of transport, timepieces, surveying, accounting, banking and, certainly not least, the optical instruments such as the telescope and microscope that were being exploited to revolutionise the visual data of science. No less characteristic was the self-conscious 'Dutchness' of the total enterprise. Stevin wrote fervently about the intellectual power and practicality of the Dutch language, which thus became a vital tool in the triumph of the moderns over the revered ancients.[54] All this activity was taking place in consciously new kind of society in which the properties of order were seen from both within and without as manifestations of the Dutch genius for functional rationality.

With respect to the geometrical particulars, the technical precision and the generality of outlook, Saenredam's art is a high manifestation of these Dutch ideals. He is the first artist who turns exclusively to the unwavering scrutiny of Dutch buildings. Each on-the-spot drawing is typically inscribed in an obsessive manner with particulars of when and where it was made and often with details of when it was translated into a painting, which sometimes did not occur until years later.[55]

220. Pieter Saenredam, *Lower Right Portion of the Construction Drawing for the Interior of St. Bavo's*, 1635, New York, Ian Woodner Family Collection.



221. Transcription of the more readily visible lines in the graphite underdrawing in the construction drawing for Saenredam's *Interior of St. Bavo's* (pl. 220).

E—'eye point' (or vanishing point)
CC—vertical line through centre of end wall
DD—diagonals for the construction of the vault
RR—squaring lines in reddish ink
HH—horizon
JJ—join in the pieces of paper

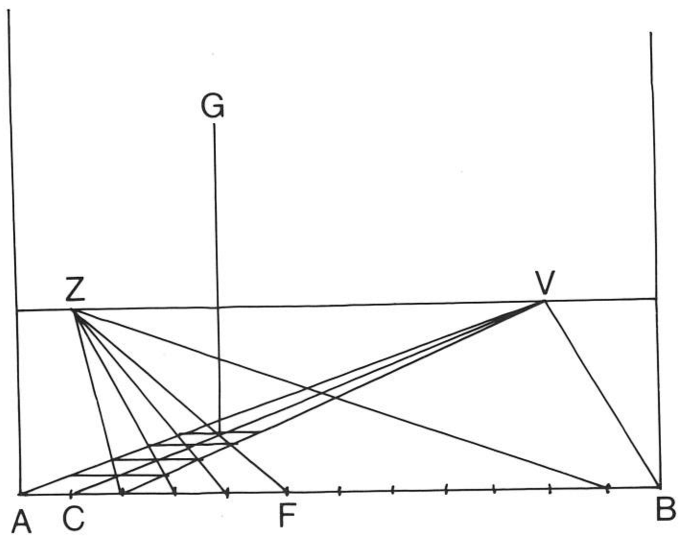
Thus the illustrated drawing of the 'Great Church' of St. Bavo's Haarlem, looking through the crossing to the West end (pl. 218), is inscribed 'On 25 August year 1635, Pieter Saenredam' on the capital of the rightmost pier.[56] It is as if Saenredam's presence has become part of the fabric of the building. In the more highly-finished construction drawing which grew out of this study (pls. 219–20), he wrote on the base of the leftmost pier, in the manner of a graffito: 'finished drawing this on the 15 December 1635. And is a view in the great church of Haarlem the painting finished on 27 February 1648. The panel on which this construction (*ordonnantij*) was painted is five feet and two inches wide and 6 feet and 3 inches high. After *kermer* or *kennemer* footmeasurement'. In the resulting painting (pl. 222) the inscription is set amongst other graffiti on the same pier base: 'This is the Cathedral great church of Haarlem, in Holland. Pieter Saenredam, finished painting this, the 27 February 1648'. We know that this obsession with precision was reflected in his taking precise measurements of at least some of the buildings he was to portray. Some of his drawings record actual dimensions and others bear a linear scale along the base of the perspective construction.[57]

When we look at this particular construction drawing in detail we find ample evidence of the level of precise planning involved. A complex armature of drawn lines (pl. 221) underlies the architectural forms modelled in pen and wash.[58] He has not only noted his 'eye point' as he calls it—i.e. the vanishing point—but he has also recorded the position of the one distance point which lies within the construction itself. This is marked by a crossed circle on the base of the leftmost pier and its distance from the central axis, '30' Dutch feet, duly noted. This point would have provided one means for controlling the scale of all forms into the depth of the painting (pl. 223). The relative dimensions of breadth and height in the end wall are so

222. Pieter Saenredam, *Interior of St. Bavo's Looking West*, 1648, Edinburgh, National Galleries of Scotland.

223. Demonstration of the use of the 'distance point'.

V—'eye point' (or vanishing point)
Z—'distance point'
CV—orthogonal marking the axis of a colonnade
AB—scale along the base of the picture
ZF—diagonal intersecting CV at a depth of 4 units
G—a vertical of 8 units erected on CV at a depth of four units



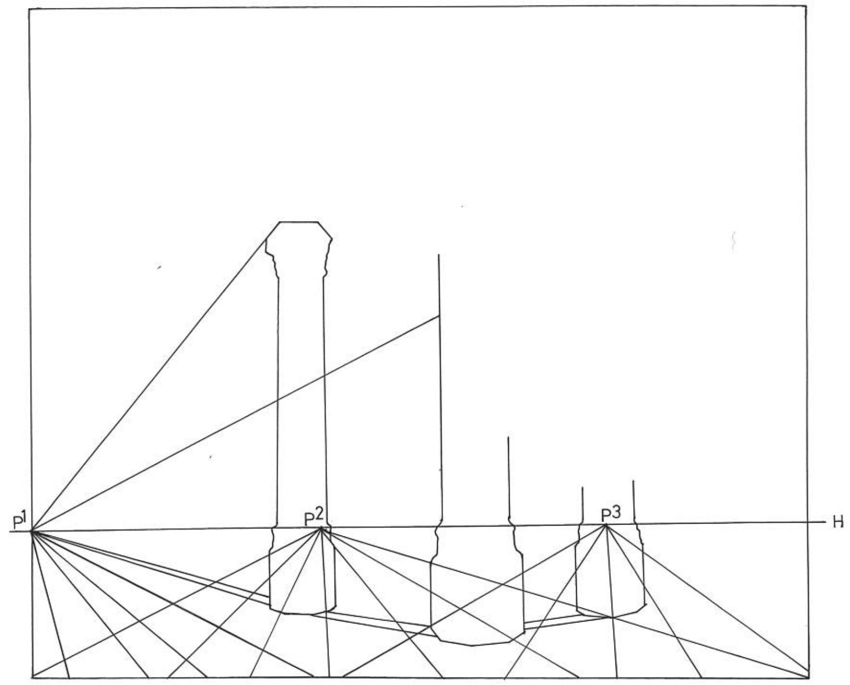
accurate as to suggest that this has served as a stable point of proportional reference.[59]

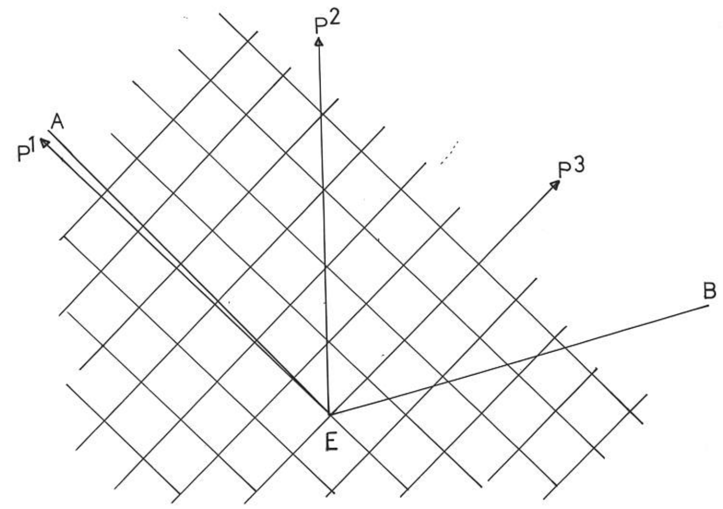
All this effort of constructional precision does not result in a painting which is drily mechanical. This is partly a result of his marvellously subtle use of light, as he traces the nuances of diffused radiance throughout the space, but it is also a consequence of a particular kind of visual magic which is built into the linear structure of the picture itself. His fascination with the geometrical transformation of shapes when projected onto a plane surface—a fascination which was nourished by his knowledge of three-dimensional geometry—clearly influences his choice of viewpoint and visual angle. The subsequent exercise of projectional geometry remains continually responsive during the design procedures to his dual sense of the subjective effect of the seen object and the physical properties of the drawings and paintings on flat surfaces in particular media. It can be shown that he has perceptibly stretched the vault over the nave and the crossing to create the desired effect of verticality.[60] This is accomplished in the context of the peculiarly tensile equilibrium of the linear design on the surface of the panel. If any part of the cobweb of tense visual threads were to be severed, we feel that the whole delicate armature would shatter into discrete filaments.

The particular procedure adopted for this design is not precisely the same as that for his other paintings. His design process was continually responsive to the special needs of each individual case.[61] Indeed, the visual and technical range within the apparently limiting confines of his chosen genre is astonishing. What this painting does share with all his mature works is the *level* of precise planning and degree of perspectival acumen which went into its construction. It also shares one inviolate technical feature, namely his steadfast allegiance to the parallel alignment of the picture plane with one of the predominant planes of his subject—in this instance the plane running parallel to the end wall, the lateral walls of the transepts and the transverse faces of the pier bases. This dogged planarity is an expression of his desire to retain a clear sense of the projection of forms in terms of their *transformed shape* on a plane surface, in a manner analogous to the geometrical demonstration of Stevin.[62]

Other Dutch artists in the direct or indirect succession of Saenredam adopted a variety of solutions which departed to a greater or lesser degree from his sense of plane projection. The most perspectively adventurous solutions were those developed by Delft artists in 1750 and shortly thereafter, above all by Gerard Houckgeest and Emanuel de Witte.[63] Almost simultaneously these two artists turned to the depiction of real church interiors, usually with angular viewpoints which create a quite different sense of Gothic space from that of Saenredam. Houckgeest's *Interior of the New Church at Delft of* 1651 (pl. 224), showing the tomb of William the Silent—a subject whose popularity is explained by its status as a focus for Dutch patriotic feeling—gives an idea of their approach at its most virtuosic. The extraordinarily wide angle of view, which can be calculated as close to 120°, picks up three converging systems in the diagonally-orientated tiles, two corresponding to the sides of tiles and one passing along the diagonal axis (pls.

224. Gerard Houckgeest, *Interior of the New Church at Delft with the Tomb of William the Silent*, 1651, The Hague, Mauritshuis.





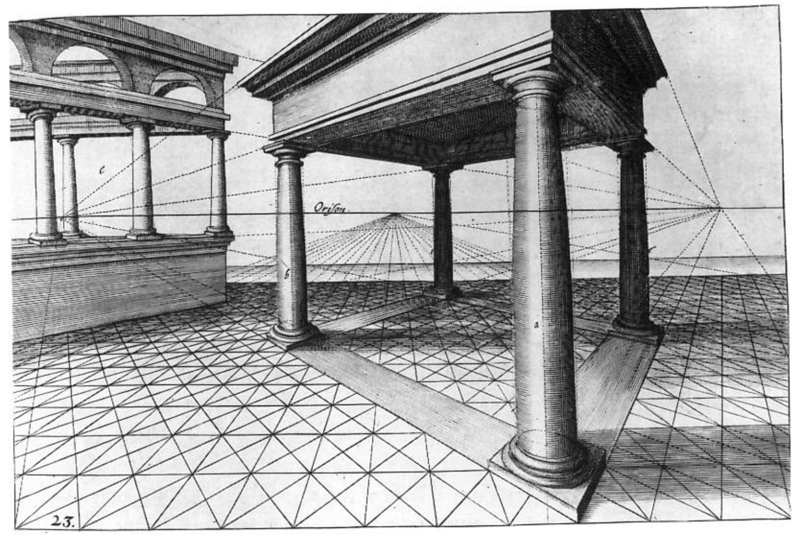
225. Perspective analysis of Gerard Houckgeest's *Interior of the New Church at Delft*.

P^1—point of convergence of orthogonals of floor tiles looking down the aisle
P^2—point of convergence of diagonals of the floor tiles
P^3—point of convergence of the orthogonals looking across the choir
H—horizon

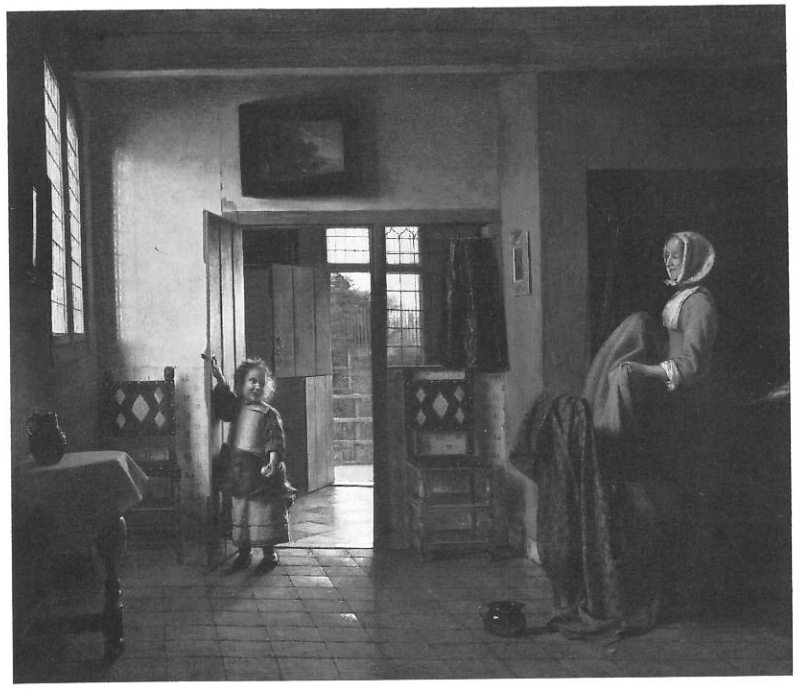
226. Demonstration of the viewing angles in Houckgeest's *Interior of the New Church at Delft*.

E—observer
P^1, P^2, P^3 as in pl. 225
AB—visual angle

227. Perspectival representation of architectural forms under an angle in excess of 90°, from Vredeman de Vries's *Perspective*.



225–6). The basis for this type of construction was very probably the wide-angle illustrations of forms in Vredeman de Vries's *Perspective* (pl. 227), though Houckgeest has used the system for quite different visual effects. He has brilliantly suggested the almost bewildering variety of spatial configurations with a Gothic church, particularly in a formally complex area like the ambulatory. Narrow slivers of upright space, sharply angled vistas, fractured occlusions of remoter objects and dynamic rhythms of clustered lines create a new species of optical variety without losing the sense of an organic whole. Probably only Altdorfer (pl. 204) had earlier approached this effect. In other paintings by Houckgeest and de Witte similarly unconventional vistas are complemented by a special attention to irregular patches of light and shade which contribute yet more optical complexity to paintings in which the artists seem



228. Pieter de Hooch, *The Bedroom*, c.1660, Washington, National Gallery of Art, Widener Collection.

deliberately to be stretching irregularity as far as it will go before it collapses into spatial incoherence.[64]

The painting of domestic interiors, which occupied a no less prominent part of the careers of other Dutch artists, also yields a rich crop of perspectival effects, though none with the overtly mathematicising quality of Saenredam. Often it was simply a case of the basic construction of a tiled floor and the converging orthogonals of wall and ceiling being used in a routine way with greater or lesser care to provide the desired space for the subject. Within the *oeuvres* of some painters, Jan Steen for example, it is possible to find both careful schemes of precise perspective and casual constructions which indicate little concern with accuracy.[65] Others, such as Pieter de Hooch, Jan Vermeer and Samuel van Hoogstraten, exhibit a consistently high level of care for exact construction. Of these painters, Vermeer presents the most striking visual and intellectual challenge. However, I think it is impossible to discuss the optical qualities of his art without a fuller understanding of instrumental systems for the imitation of nature. I am, therefore, postponing an analysis of his paintings until the next chapter. I am adopting the same procedure for Carel Fabritius. This is one instance—I hope the only conspicuous instance—in which my chosen division of the material creates real difficulties, but the many other advantages seem to outweigh this one major dislocation. That this should occur with Dutch art may itself eventually say something about the visual qualities of that art.

For the moment Pieter de Hooch will serve to exemplify Dutch painting of domestic interiors at the highest level (pl. 228). Whenever he wished to describe one of his typically enticing series of intimate glimpses through a succession of domestic spaces, he almost invariably used canonical perspective in foreground to establish the pace of the recession.[66] This even applies to exterior pavements composed from rougher tiles or bricks of varied sizes. Equally characteristically, the constructional geometry is endowed with a kind of homely irregularity—perhaps we should call it a sense of humanity—through the use of differently orientated patterns in the secondary spaces, and not uncommonly by the portrayal of tiles of different size and shape from those in the foreground. To this is added the optical variety of broken patches of illumination, both direct and reflected, together with the sheen of polished floors, which not infrequently masks the linear patterns as the light glances from surfaces at a low angle in the deeper portions of the space.[67] Perspective is thus exploited with a control which would win the respect of an Alberti, but it is subtly subverted by other ocular effects in a way which would have unsettled an Italian's sense of geometrical integrity.

These techniques provided the Dutch artists with the means to create illusionistic decorations on their own terms. As with Vredeman de Vries's work in this field, disproportionately small numbers of such illusions, painted in and for specific domestic settings, have survived. One exception is the compelling illusion of three successive rooms painted by Hoogstraten on his visit to Britain in 1662. His 'perspective', as it was called, was located at an early date at the end of one of the cross-axes in the country house of Dyrham Park in Gloucestershire (pl. 229).[68] That such illusionistic decorations were thought to be capable of sustaining comparison with the devices of the Italian illusionists is indicated by Hoogstraten himself, who follows his admiring reference to Giulio Romano's frescoes at Mantua with an account of Fabritius's optical art and his own perspective boxes.[69] His surviving perspective box (pls. 408–9) will be discussed in the next chapter, but the reader might like to refer forward to the illustrations for additional confirmation of the kind of visual challenge Hoogstraten was capable of mounting.

Hoogstraten's own treatise on painting, his *Inleyding tot de Hooge Schoole der Schilderkonst* (perhaps best translated as 'Introduction to the High School of Painting') is in many ways a curious concoction and rests uneasily with much of his own pictorial practice. It is organised in nine books, each dedicated to one of the Muses, and is predominantly larded with generous helpings of derivative humanist learning which serve to emphasise the high intellectual and social status of painting. He provides no technical exposition of perspective, simply referring the reader to Dürer, Vredeman de Vries, Marolois, Guidobaldo and Desargues.[70] His general remarks on optics do not suggest an attitude very different from that of Marolois or even Stevin, and he professes an open admiration for Alberti's treatise.

> The art of painting is a science for representing all the ideas or notions which the whole of visible nature is able to produce and for deceiving the eye with drawing and colour. . . . I say that a painter whose work it is to fool the sense of sight also must have so much understanding of the nature of things that he thoroughly understands the means by which the eyes are deceived.[71]

229. Samuel van Hoogstraten, *Perspective Illusion*, 1662, Gloucestershire, Dyrham Park, the National Trust.

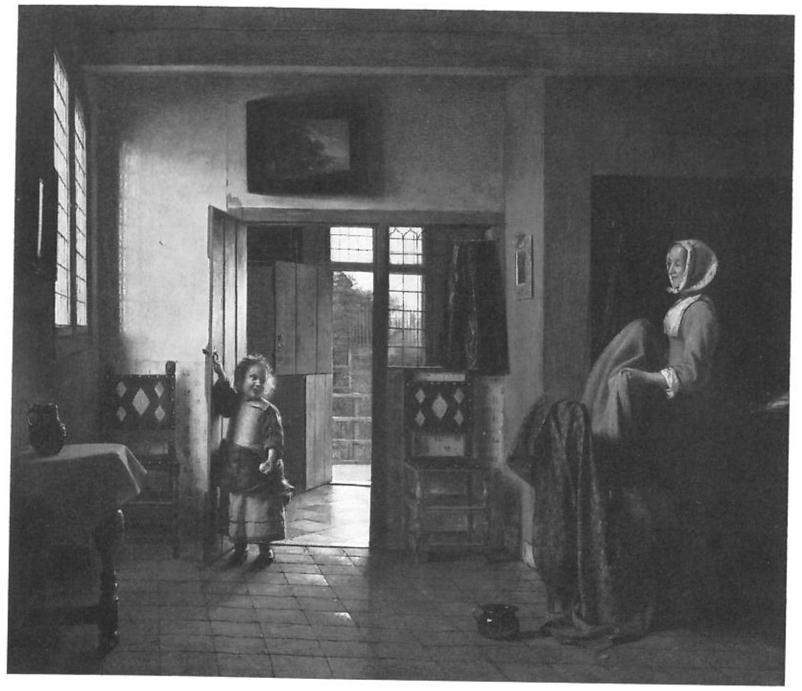
Like Aguilonius and his great Swedish contemporary, Scheferus, he is well aware that scenographic perspective is only a very limited case within the whole science of optical phenomena, but this does not lead him to suggest a fundamental revision to the available means at the painter's disposal.[72] Where he does show an individual flavour is in his wholehearted placing of illusion in the service of natural representation. His attention to light effects, which he discusses before he makes his brief comments on perspective, is consistent with this emphasis, and had been foreshadowed to some extent by Salomon de Caus's lively demonstrations of cast shadows in domestic interiors.[73]

The actual optical ideas in all the Dutch treatises were deeply conservative. Hoogstraten, like Marolois, still advocated an extramission theory of sight, and there is not the slightest glimpse of the new ideas on the mechanism of the eye pioneered by Kepler and extended by Descartes. Kepler's concept that 'vision is brought about by a picture of the thing seen being formed on the concave surface of the retina'—that 'the retina is painted with the coloured rays of visible things'—seems to offer a tempting parallel to the optical veracity of Dutch art.[74] Unfortunately, there is no evidence that such an identification was made. Indeed Kepler's theory on its own terms—set within his mathematical investigation of astronomical optics and placed in the service of his elaborately Platonising cosmology—offered the artist nothing new that he could immediately use.[75] Indeed, certain features of his theory, such as the 180° viewing angle, would simply have caused unwanted problems in an area which was already complicated enough.

The optical-perspectival features of Dutch art represent a complex alliance of traditionally Aristotelian optics, geometrical theory, standard workshop techniques and Eyckian naturalism with the empirical and applied tenor of Dutch thought at this time. The ingredients and proportions in this compound naturally differed for different artists, but there seems to be nothing in theory or in practice which cannot be encompassed by this interpretative model. There is much to be done in illustrating and refining this model—and we will ourselves be approaching it from a different angle in a later chapter—but I do not at present see any reason to look beyond it.

THE FRENCH PERSPECTIVE WARS

The matching span of fifty years or so in France from 1630, which saw the foundation of the most potent of all the early academies of art, may not unreasonably be considered as the golden age of the perspective treatise. It was certainly the prime period for vicious battles over questions of perspectival ethics. The disputes reached levels of personal bitterness which make the Bassi-Tibaldi altercation seem quite restrained. The story of these years, both as a human tale of factional rivalries within the artistic profession, and as an account of colliding aesthetic values, is not the first or last episode we are encountering in this study which is worth a book in itself. The sheer quantity of primary sources is formidable.



228. Pieter de Hooch, *The Bedroom*, *c.*1660, Washington, National Gallery of Art, Widener Collection.

deliberately to be stretching irregularity as far as it will go before it collapses into spatial incoherence.[64]

The painting of domestic interiors, which occupied a no less prominent part of the careers of other Dutch artists, also yields a rich crop of perspectival effects, though none with the overtly mathematicising quality of Saenredam. Often it was simply a case of the basic construction of a tiled floor and the converging orthogonals of wall and ceiling being used in a routine way with greater or lesser care to provide the desired space for the subject. Within the *oeuvres* of some painters, Jan Steen for example, it is possible to find both careful schemes of precise perspective and casual constructions which indicate little concern with accuracy.[65] Others, such as Pieter de Hooch, Jan Vermeer and Samuel van Hoogstraten, exhibit a consistently high level of care for exact construction. Of these painters, Vermeer presents the most striking visual and intellectual challenge. However, I think it is impossible to discuss the optical qualities of his art without a fuller understanding of instrumental systems for the imitation of nature. I am, therefore, postponing an analysis of his paintings until the next chapter. I am adopting the same procedure for Carel Fabritius. This is one instance—I hope the only conspicuous instance—in which my chosen division of the material creates real difficulties, but the many other advantages seem to outweigh this one major dislocation. That this should occur with Dutch art may itself eventually say something about the visual qualities of that art.

For the moment Pieter de Hooch will serve to exemplify Dutch painting of domestic interiors at the highest level (pl. 228). Whenever he wished to describe one of his typically enticing series of intimate glimpses through a succession of domestic spaces, he almost invariably used canonical perspective in foreground to establish the pace of the recession.[66] This even applies to exterior pavements composed from rougher tiles or bricks of varied sizes. Equally characteristically, the constructional geometry is endowed with a kind of homely irregularity—perhaps we should call it a sense of humanity—through the use of differently orientated patterns in the secondary spaces, and not uncommonly by the portrayal of tiles of different size and shape from those in the foreground. To this is added the optical variety of broken patches of illumination, both direct and reflected, together with the sheen of polished floors, which not infrequently masks the linear patterns as the light glances from surfaces at a low angle in the deeper portions of the space.[67] Perspective is thus exploited with a control which would win the respect of an Alberti, but it is subtly subverted by other ocular effects in a way which would have unsettled an Italian's sense of geometrical integrity.

These techniques provided the Dutch artists with the means to create illusionistic decorations on their own terms. As with Vredeman de Vries's work in this field, disproportionately small numbers of such illusions, painted in and for specific domestic settings, have survived. One exception is the compelling illusion of three successive rooms painted by Hoogstraten on his visit to Britain in 1662. His 'perspective', as it was called, was located at an early date at the end of one of the cross-axes in the country house of Dyrham Park in Gloucestershire (pl. 229).[68] That such illusionistic decorations were thought to be capable of sustaining comparison with the devices of the Italian illusionists is indicated by Hoogstraten himself, who follows his admiring reference to Giulio Romano's frescoes at Mantua with an account of Fabritius's optical art and his own perspective boxes.[69] His surviving perspective box (pls. 408–9) will be discussed in the next chapter, but the reader might like to refer forward to the illustrations for additional confirmation of the kind of visual challenge Hoogstraten was capable of mounting.

Hoogstraten's own treatise on painting, his *Inleyding tot de Hooge Schoole der Schilderkonst* (perhaps best translated as 'Introduction to the High School of Painting') is in many ways a curious concoction and rests uneasily with much of his own pictorial practice. It is organised in nine books, each dedicated to one of the Muses, and is predominantly larded with generous helpings of derivative humanist learning which serve to emphasise the high intellectual and social status of painting. He provides no technical exposition of perspective, simply referring the reader to Dürer, Vredeman de Vries, Marolois, Guidobaldo and Desargues.[70] His general remarks on optics do not suggest an attitude very different from that of Marolois or even Stevin, and he professes an open admiration for Alberti's treatise.

> The art of painting is a science for representing all the ideas or notions which the whole of visible nature is able to produce and for deceiving the eye with drawing and colour. . . . I say that a painter whose work it is to fool the sense of sight also must have so much understanding of the nature of things that he thoroughly understands the means by which the eyes are deceived.[71]

229. Samuel van Hoogstraten, *Perspective Illusion*, 1662, Gloucestershire, Dyrham Park, the National Trust.

Like Aguilonius and his great Swedish contemporary, Schefferus, he is well aware that scenographic perspective is only a very limited case within the whole science of optical phenomena, but this does not lead him to suggest a fundamental revision to the available means at the painter's disposal.[72] Where he does show an individual flavour is in his wholehearted placing of illusion in the service of natural representation. His attention to light effects, which he discusses before he makes his brief comments on perspective, is consistent with this emphasis, and had been foreshadowed to some extent by Salomon de Caus's lively demonstrations of cast shadows in domestic interiors.[73]

The actual optical ideas in all the Dutch treatises were deeply conservative. Hoogstraten, like Marolois, still advocated an extramission theory of sight, and there is not the slightest glimpse of the new ideas on the mechanism of the eye pioneered by Kepler and extended by Descartes. Kepler's concept that 'vision is brought about by a picture of the thing seen being formed on the concave surface of the retina'—that 'the retina is painted with the coloured rays of visible things'—seems to offer a tempting parallel to the optical veracity of Dutch art.[74] Unfortunately, there is no evidence that such an identification was made. Indeed Kepler's theory on its own terms—set within his mathematical investigation of astronomical optics and placed in the service of his elaborately Platonising cosmology—offered the artist nothing new that he could immediately use.[75] Indeed, certain features of his theory, such as the 180° viewing angle, would simply have caused unwanted problems in an area which was already complicated enough.

The optical-perspectival features of Dutch art represent a complex alliance of traditionally Aristotelian optics, geometrical theory, standard workshop techniques and Eyckian naturalism with the empirical and applied tenor of Dutch thought at this time. The ingredients and proportions in this compound naturally differed for different artists, but there seems to be nothing in theory or in practice which cannot be encompassed by this interpretative model. There is much to be done in illustrating and refining this model—and we will ourselves be approaching it from a different angle in a later chapter—but I do not at present see any reason to look beyond it.

THE FRENCH PERSPECTIVE WARS

The matching span of fifty years or so in France from 1630, which saw the foundation of the most potent of all the early academies of art, may not unreasonably be considered as the golden age of the perspective treatise. It was certainly the prime period for vicious battles over questions of perspectival ethics. The disputes reached levels of personal bitterness which make the Bassi-Tibaldi altercation seem quite restrained. The story of these years, both as a human tale of factional rivalries within the artistic profession, and as an account of colliding aesthetic values, is not the first or last episode we are encountering in this study which is worth a book in itself. The sheer quantity of primary sources is formidable.