

DAVID HOCKNEY, SECRET KNOWLEDGE, PUB. 1990
& HUDSON, 2000.



My Great Wall allowed me to see, with one sweep of the eye, what art historians have long recognized as a shift towards ever greater naturalism from the fifteenth century to the nineteenth. But what was immediately apparent, surrounded by so many images, was that this was not a gradual process – the optical look arrived suddenly, and was immediately coherent and complete.

I know from experience that the methods artists use (materials, tools, techniques, insights) have a profound, direct and instant influence on the nature of the work they produce. The sudden change I could see suggested to me a technical innovation rather than a new way of looking that then led to a progressive development of drawing skills. We know of one such innovation in the early fifteenth century – the invention of analytical linear perspective. This provided artists with a technique for depicting recession in space, with objects and figures scaled just as they would appear to the eye from a single point. But linear perspective does not allow you to paint patterns following folds, nor shine on armour. Optical aids would, but it is commonly assumed that the technology and knowledge did not exist until much later.

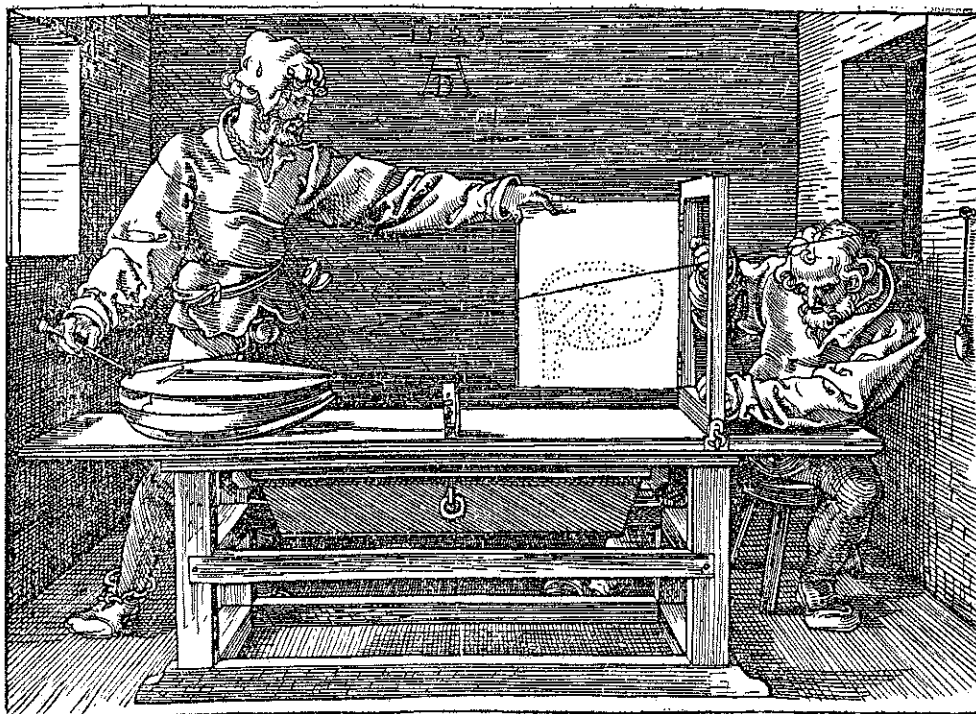


These two pictures are of the same subject – the Pope with attendants. The one on the left was painted around 1475 by Melozzo da Forlì. It is clearly of the mathematical school, with its space and architecture rendered according to the laws of linear perspective. It shows no obvious evidence of optics; I show it only as a contrast with the work opposite. Raphael's 1518–19 portrait of Leo X seems of a completely different order. It was said that people gasped when they saw it – 'a realistic marvel', 'amazing verisimilitude', etc. Andrea del Sarto said that making a copy of it was the hardest thing he'd ever done. Look at the Pope's clothes, for instance: they are depicted 'naturalistically' and with convincing volume. The space, on the other hand, seems unreal and enclosed, and it has a dark background, features I was beginning to notice in other suspected 'optical' works, too. That the standing



attendants are the same height as the sitting Pope is odd – they should be taller than him – but could be accounted for by the use of optics: 'Just bob down a bit', photographers say (the Pope may, of course, be sitting on a raised throne). Yet the real interest is what he is holding: a magnifying glass. It shows that Raphael was at least aware of lenses (though not that he knew how to use them). He would have wanted to make as vivid a portrait as he could. As a professional painter, he had a job to do and would have used all the tools at his disposal, including, if he thought they would help, lenses. He would not think 'I'm a great artist at the height of the Renaissance who should disdain such methods.'





Some of the most difficult things to paint with linear perspective are curved objects such as lutes. Dürer's famous woodcut of 1525 suggests that some artists used technical aids to help them. Dürer was a prodigy, a great draughtsman, yet he also had a keen interest in technology. Here he shows how a piece of string is attached to a point on the wall, representing the observer's viewpoint. The string is then connected to a point on the lute and its position is recorded by moving two other strings stretched across a wooden frame and then marking where these meet on a hinged screen. This is repeated until there are enough points on the screen to construct the shape of the lute. It is a difficult process, one that requires two men.

Now look at Caravaggio's painting of around 1595. These two pictures were among the first I brought together to ask a question. Could Caravaggio really have used Dürer's method to paint that incredibly foreshortened lute (he left no drawings), and how about the violin on the table, and the music that follows the curve of the page so perfectly? It would be very difficult to do these things with a drawing machine, and would take a very long time. Was it just divine skill, or could he have used optics?

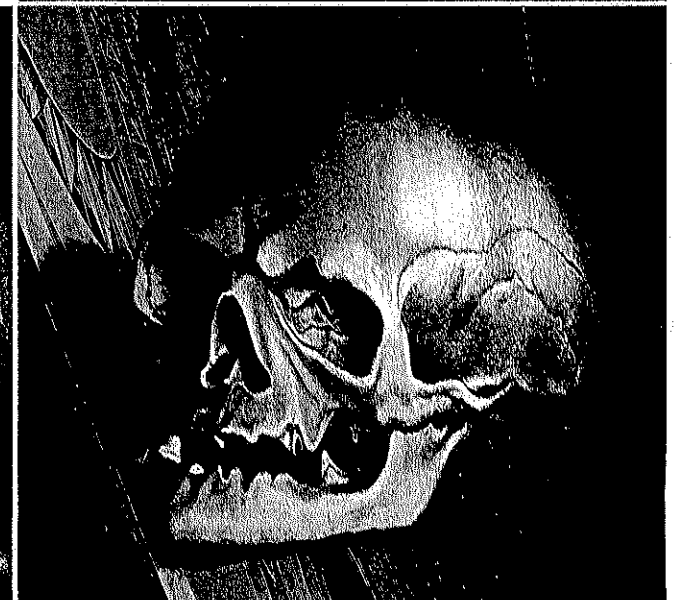
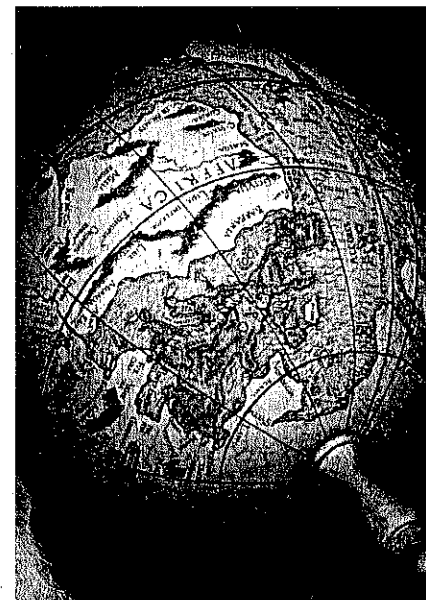
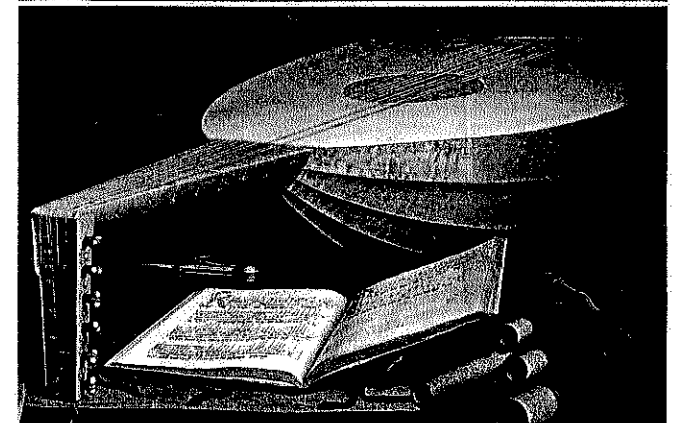




Caravaggio painted his lute-player seventy years after Dürer's woodcut, and, of course, the technology of drawing machines may have moved on in that time. But were such machines already out of date in 1525? Was Dürer depicting an earlier and now obsolete method of drawing ellipses and curves in perspective? Hans Holbein's *The Ambassadors* (above) was painted in 1533, just eight years after Dürer's print. It is filled with curved and spherical objects, all of which would have been difficult to eyeball, and yet all of them are marvellously 'accurate' in their foreshortening. Holbein *could* have used Dürer's machine to paint the lute on the bottom shelf, which is shown in much simpler foreshortening

than Caravaggio's, and from a similar angle to that in Dürer's print, but look at the other curved objects. The celestial globe on the top shelf, for example, is perfect in its rendering. The patterns on the curtain behind and on the tablecloth are utterly believable as they follow the folds. The lines of longitude and latitude on the terrestrial globe on the bottom shelf trace the curvature of the sphere precisely, as does the word 'AFRICA'. And the musical score is accurately depicted on the curved pages of the open book. That alone would have been near impossible to paint using Dürer's machine. It would have been possible, however, to use a lens to project an image of the book and the other three-dimensional objects onto a flat surface and trace the now two-dimensional, projected shapes.

The strange form in the foreground is a distorted skull – Holbein has stretched it. Such distortion can be achieved by tilting the surface onto which you project an image. I produced the detail of the skull below by squeezing it back into shape on a computer. It looks very 'real'. Is this not a clue that Holbein used optical tools?

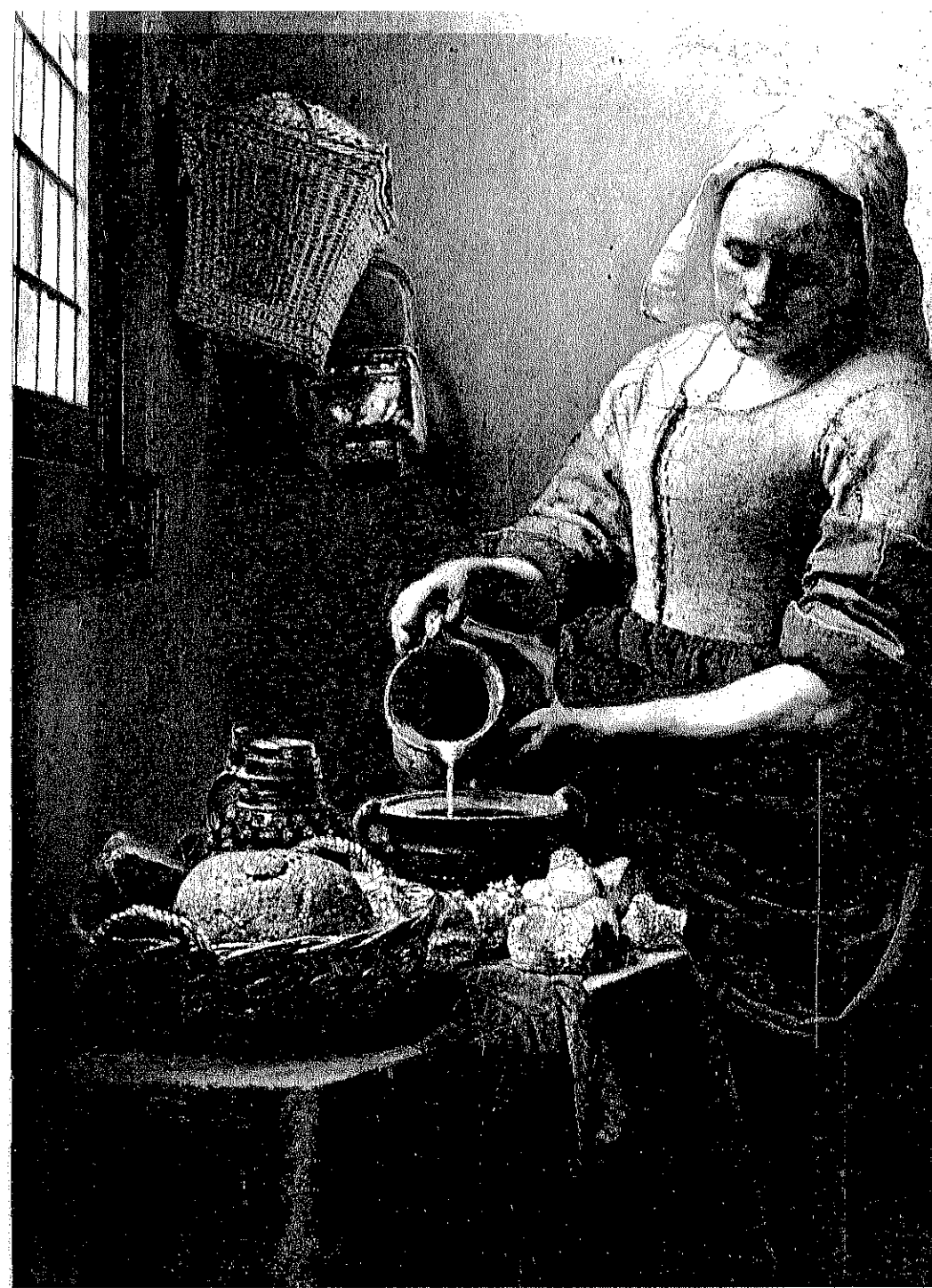




It is now generally accepted that Vermeer, working about fifty years after Caravaggio, not only had knowledge of optical instruments but also used them in some way in his painting. (Van Leeuwenhoek, the great microscopist and lensmaker, was a neighbour of his and executor of his will.) Much of the evidence is within the paintings themselves. Vermeer seems to have been delighted by the optical effects of the lens and tried to re-create them on the canvas. Foreground objects and figures are sometimes very large; some things are painted in soft focus, or out of focus altogether. In this painting of a milkmaid, for example, the basket in the foreground is out of focus compared with the basket hanging up behind, a distortion Vermeer would not have seen with the naked eye. Nor could he have rendered the 'halo' effect of out-of-focus highlights, seen here on the basket, the bread, the tankard and the jug, unless he had seen it! So, this was a starting-point: Vermeer was an artist who had used optics – his paintings demonstrate as much.

I would like to point out here that this is Vermeer's most solid figure. She has a greater presence than his ladies. Could this be because she is a servant (one of the so-called 'low-life' subjects of many early optical painters) and so wouldn't have been able to complain, 'Oh I have a headache, I need to lie down now', which 'ladies' would have been able to get away with?

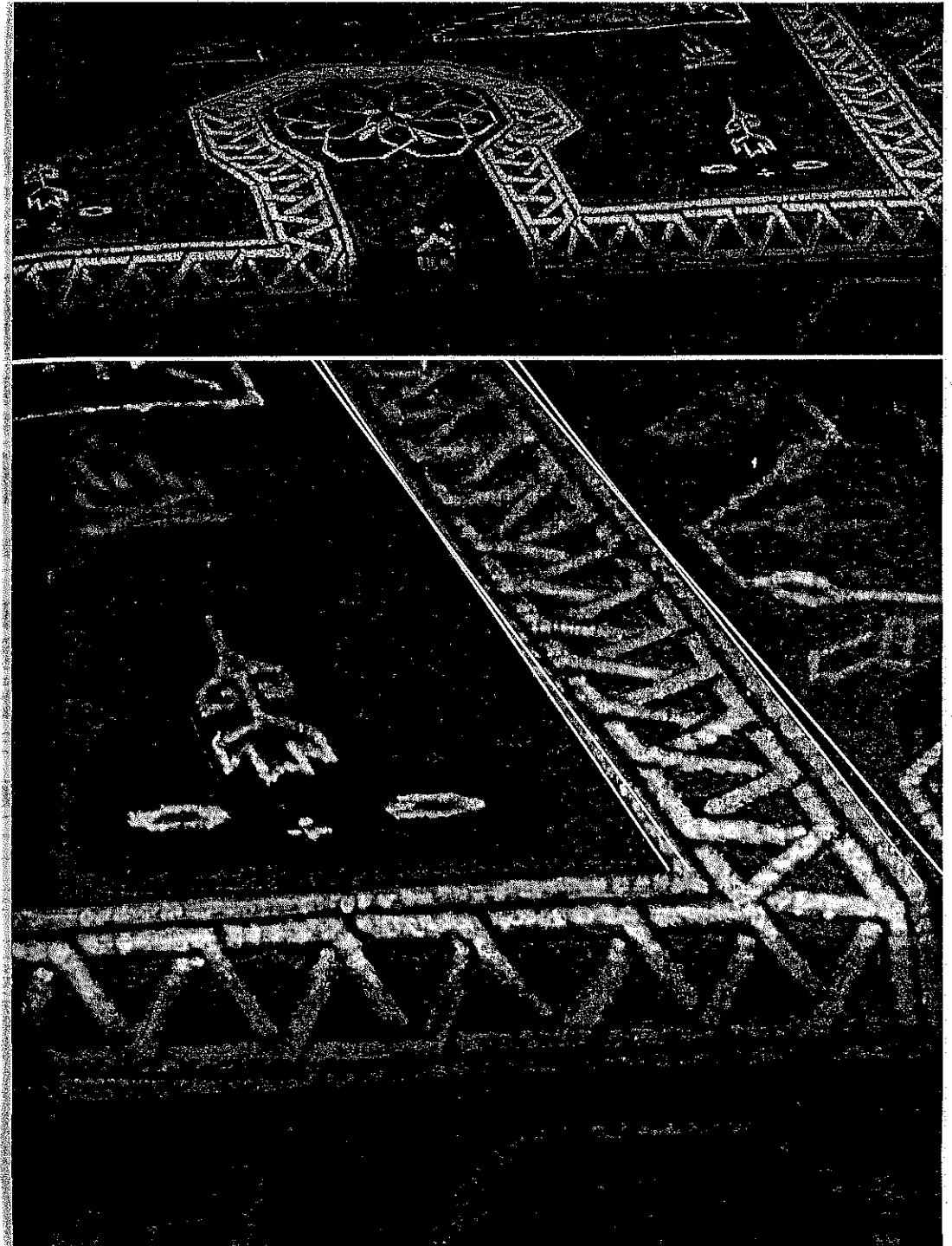
c. 1658–60 Johannes Vermeer >





1543 Lorenzo Lotto

One of the paintings on my wall was *Husband and Wife* by Lotto. I noticed that the top of the 'keyhole' pattern on the oriental carpet clearly goes out of focus (words which would have had little meaning before optics). The human eye would not see it like this, but a lens would. I showed this to Charles Falco, an optical scientist, and he pointed out that there are at least two vanishing points in the picture. This can be seen most clearly on the detail of the border opposite. Had linear perspective been used, the pattern would have receded in a straight line, the single vanishing point corresponding to a single viewpoint. But halfway back there is a kink in the pattern and it carries on in a slightly different direction. Charles reasoned that Lotto had set up a lens to project the pattern but discovered that it could not all be in focus at the same time. He had to refocus to do the back part of the carpet. But refocusing has a side effect – it changes the magnification. The difference would be only slight on the narrow border, but the pattern in the centre, being five times broader, would have changed five times as much, too much to ignore. The solution was to paint it out of focus. For Charles, these effects are 'optical artefacts', and are solid scientific evidence of the use of optics.





1532 Hans Holbein

Here's another carpet I found whose perspective seems wrong. The pattern in the left-hand corner seems 'true', but as you move back towards the letter, the table begins to loom up; and at the bottom right, it unexpectedly drops away, as if its corner has been chopped off. Also, we seem to be looking down on the box of coins left teetering on the edge from a different angle than the table itself. Again, these distortions suggest the use of a lens not geometry, and this a decade before Lorenzo Lotto.

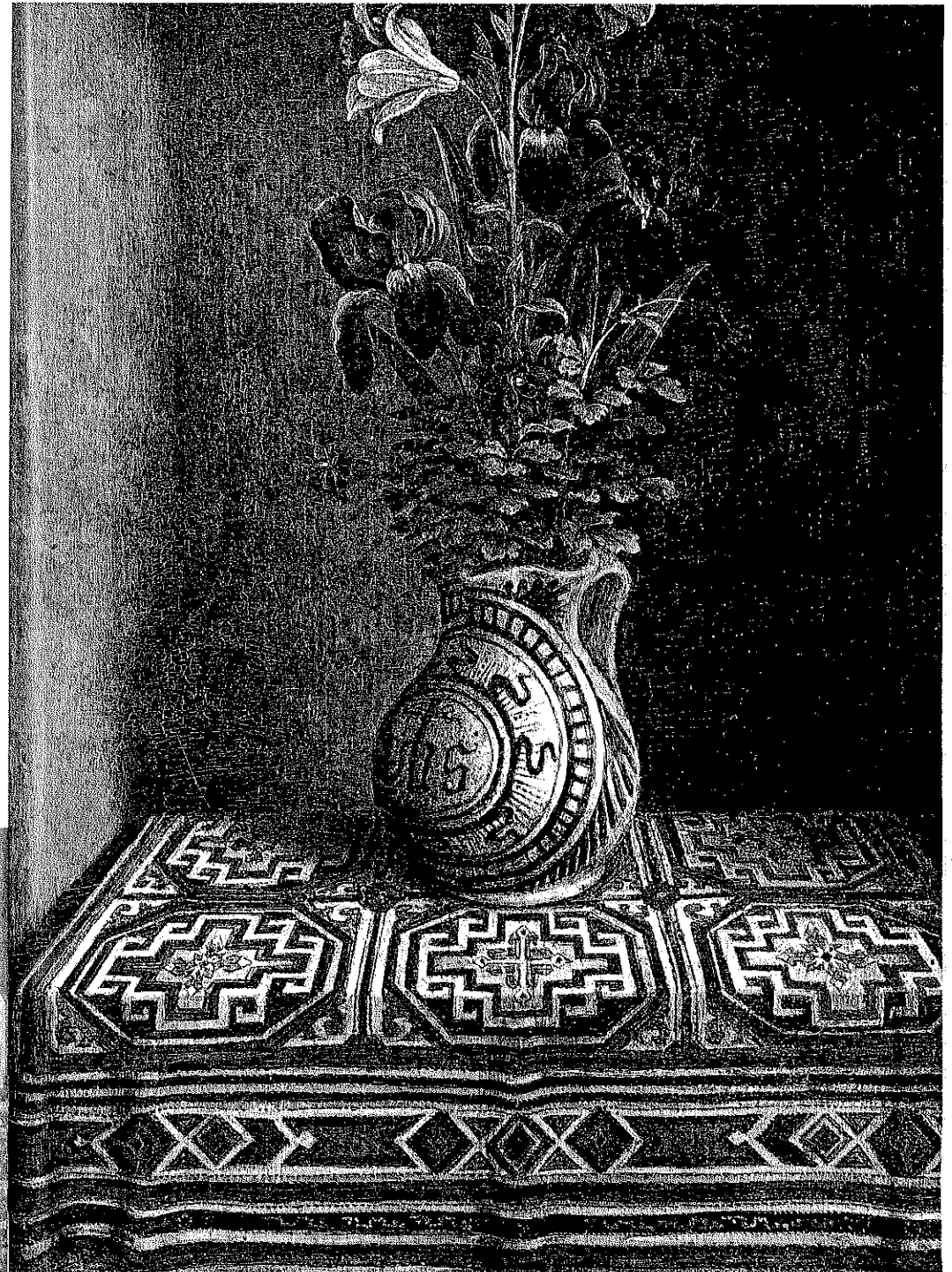
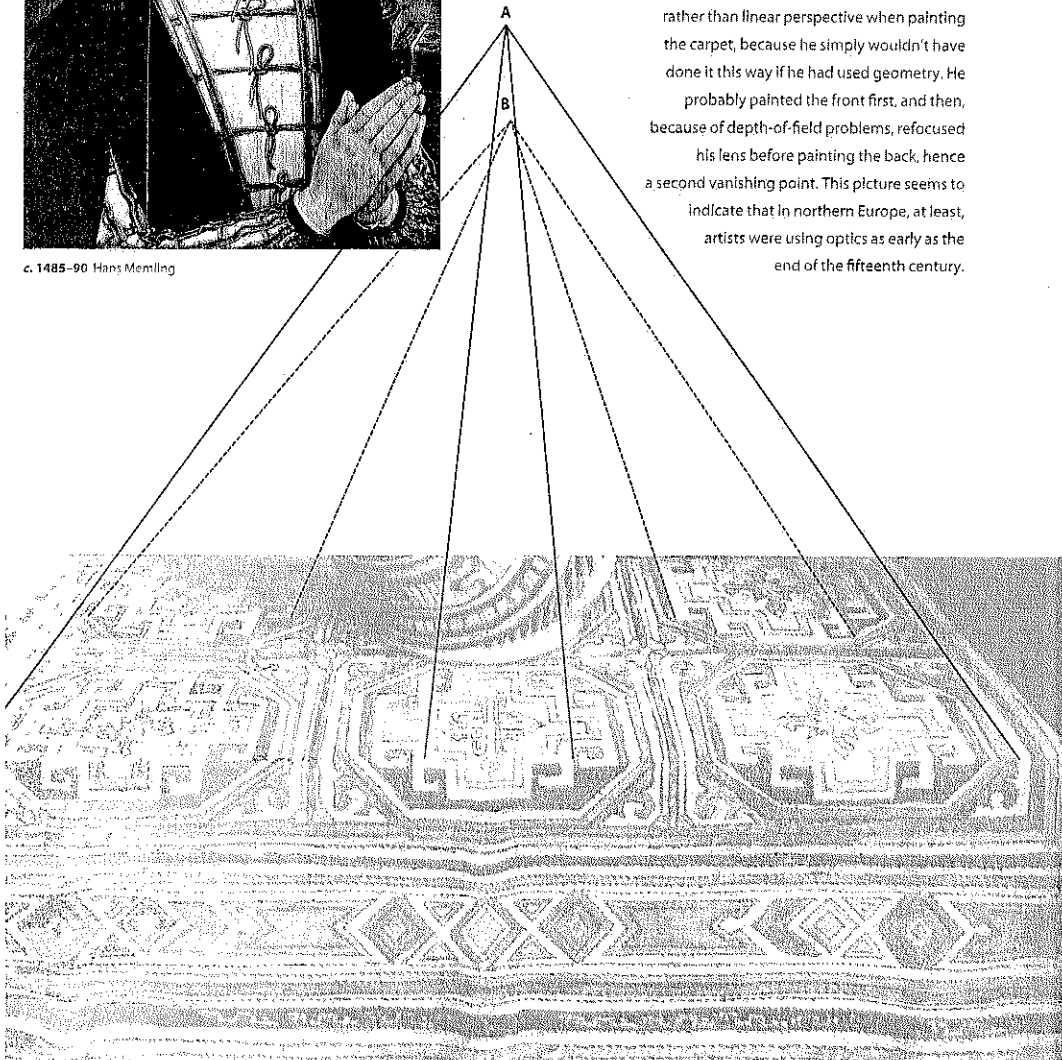




c. 1485–90 Hans Memling

More than fifty years before Lotto's *Husband and Wife* (and thirty years before Raphael was in Rome working on his portrait of the Pope), Hans Memling painted these flowers onto the back of the portrait shown on the left. It, too, contains an oriental carpet where a change of perspective can be seen on its pattern: the half of the carpet in front of the jug has a different vanishing point (A) from the half behind (B).

This suggests that Memling, like Lotto and Holbein, had used some kind of optical device rather than linear perspective when painting the carpet, because he simply wouldn't have done it this way if he had used geometry. He probably painted the front first, and then, because of depth-of-field problems, refocused his lens before painting the back, hence a second vanishing point. This picture seems to indicate that in northern Europe, at least, artists were using optics as early as the end of the fifteenth century.





1300 Giotto



c. 1365 Unknown Austrian



c. 1425 Masolino da Panicale



c. 1430 Robert Campin

Finding evidence of the use of optics in northern Europe in the late fifteenth century made me look more closely at early Flemish painting. On my wall a sudden, dramatic change stood out.

Here are four portraits painted 130 years apart. Giotto's of 1300 certainly has an interesting expression in the face. Sixty-five years later an unknown artist makes a portrait of Rudolf IV of Austria – like Giotto's, it is awkward. By 1425, in Italy, Masolino has more order in the face; the turban seems to follow the form of the head and looks as though it fits properly. But just five years later, in Flanders, something happens. Robert Campin's face looks startlingly 'modern'; it could be someone from today. There is clear lighting – notice the shadow under the nose – suggesting a strong source of light; the folds in the turban aren't awkward; the man's small double chin is seen clearly; and the mouth and

eyes are far more related, giving an intensity to his appearance. This painting has a totally different 'look'.

Of course, the medium is different. Campin's portrait is one of the earliest uses of oil tempera, which makes the blending of colour much easier. Yet it is the new 'look' that interests us here, a look that is radically different from Giotto's (compare his faces on the next page against those of Dieric Bouts). By itself, oil paint is not enough to explain this change. Something else is in play.

The only other faces that compare with the Campin are the ones by Masaccio in the Brancacci Chapel in Florence, which date from 1422. They certainly have individuality and could have been done by the same method, though the fresco technique hides this. Nevertheless, the dates are almost the same – the big change occurred some time around 1420–30.



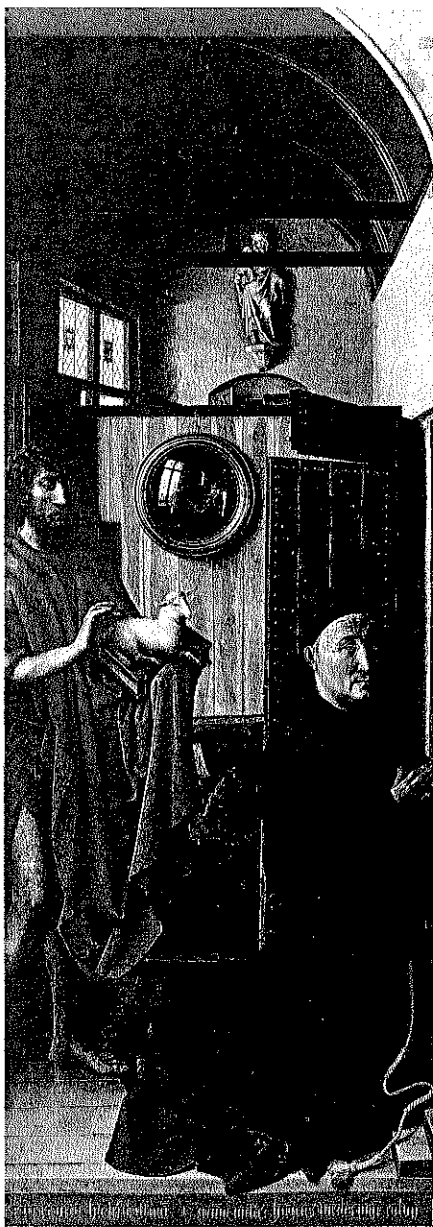
To emphasize again what happened within the space of just a few years, compare these two pictures, one painted in Florence in 1423, the other in Bruges around 1436. Gentile da Fabriano's fabrics are elaborate but do not follow the form convincingly – they are essentially flat. Van Eyck's Chancellor Rolin wears similarly heavy clothes, and they are equally elaborate – look at the highlights in the gold thread. But unlike da Fabriano's fabrics, they have convincing folds and give the impression that a real person is wearing them. Like Robert Campin's man in a red turban, the portrait of the Chancellor is also much more individualistic and 'modern' than any of the faces in the Gentile da Fabriano. Notice, too, the 'accurate' architectural reliefs behind him.

Having at first observed only that painting at the end of the Renaissance was much more naturalistic than it had been at the beginning, now we can be much more specific: the change to greater naturalism occurred suddenly in the late 1420s or early 1430s in Flanders. Could this have been down to optics? What other explanation could there be? Why would artists like Campin and van Eyck suddenly start producing far more modern, 'photographic-looking' pictures? We are familiar today with images projected through a lens. A camera works because an image of the 'real world' is projected onto film. Had Campin and van Eyck seen the world projected in this way?

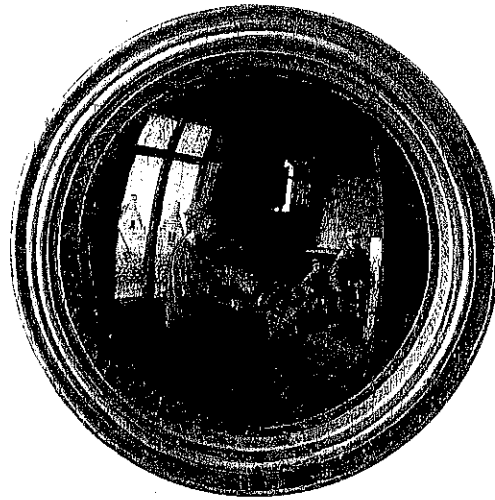


< 1423 Gentile da Fabriano

c. 1436 Jan van Eyck >



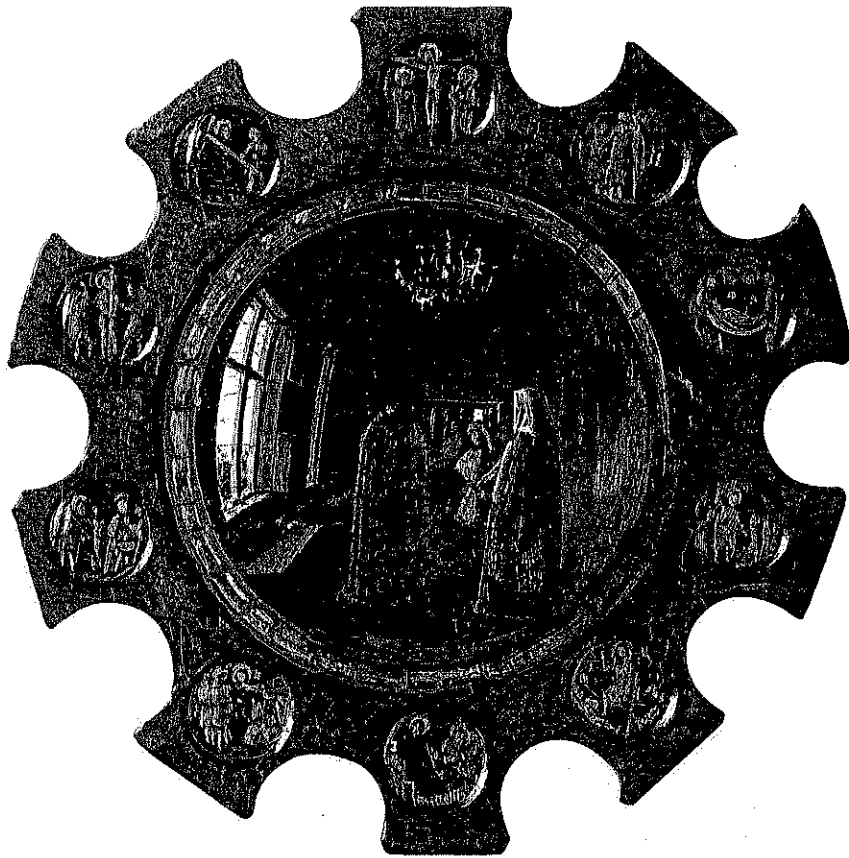
1438 Robert Campin



I can be certain that Robert Campin and Jan van Eyck knew about mirrors and lenses – the two basic elements of the modern camera – for they painted some in several of their pictures of the 1430s (and, at that time, painters and mirror-makers were both members of the same guild). In the Campin, the mirror is **convex** (easier to make than a flat mirror); and in the van Eyck, Canon van der Paele holds a pair of spectacles. Lenses and mirrors were still rare then, and artists would have been fascinated by the strange effects they produced. As people who made images, they must have been amazed that whole figures, even whole rooms, could be seen in just a small convex mirror. Surely it is no coincidence that such mirrors arrived in painting at the same time as greater individuality appeared in portraiture.

1436 Jan van Eyck >





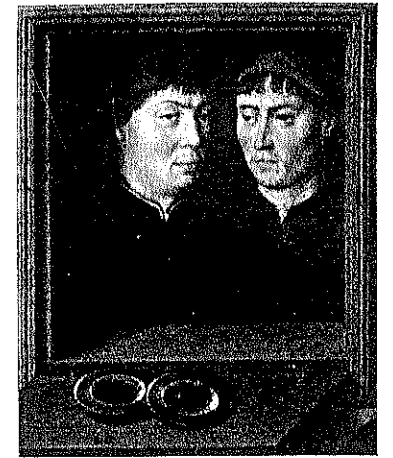
This is van Eyck's *Arnolfini Wedding* of 1434. I have admired the picture longer than any other in this book, and have gone back to look at the real one again and again. There is the convex mirror again. If you were to reverse the silvering, and then turn it round, this would be all the optical equipment you would need for the meticulous and natural-looking detail in the picture. The chandelier has always fascinated me. It was done without any detailed underdrawing or corrections (it's the only object in the picture to have been painted like that), amazing for such a complicated foreshortened form. Van Eyck could have hung the panel upside down next to the viewing hole and painted it directly, following the forms he could see on the surface. Notice how the chandelier is seen head on (not from below, as you would expect). This is the effect you would expect with a mirror-lens, which must be level with the objects you want to draw or paint. It would have been a superb subject to show off his skills. Artists think of these things.





This Last Supper scene is the central panel of an altarpiece painted by Dieric Bouts between 1464 and 1468. Just like in the *Arnolfini Wedding*, the chandelier is seen head on, not from below as you'd expect. And look at the faces. Not only do they have their own individuality, but they, too, are all seen head on like the chandelier. Some of the figures seem unrelated to each other, and some models appear to have been used more than once. I am sure that each element in the painting – each face, each object – was drawn separately with a mirror-lens and the hole-in-the-wall method, using a window just like the one on the back wall, and then pieced together on the panel. In effect, it's a collage. Bouts has managed to construct the painting so beautifully that we accept its marvellous space as a believable unit. The effect, though, is to bring everything (even distance) close to the picture plane.

My own polaroid collages have the same effect. Every single photograph was taken close to the subject, and then put together to make an attempt at space. Many windows. Many windows.





This Nativity scene by the Netherlandish painter Hugo van der Goes was commissioned around 1473 by Tommaso Portinari, agent for the Medici bank in Bruges. When it was sent to Florence in the 1480s, it was widely admired and had an immediate influence. The intense realism of individual features confirms close observation of small details (notice the shepherds' hands, for instance), and yet the space seems 'unreal'. It is noticeable, much more than in Bouts's enclosed interior, that the composition has not been constructed according to the laws of single-point linear perspective but has instead many different viewpoints, many different

windows onto the world – it has a 'multiwindow' perspective. We see each figure straight on, regardless of where they are in the scene, even those on the distant mountains. There are also dramatic differences in scale (or magnification) – just compare the shepherds to the right of the Virgin with the angels beside them. The kneeling man on the left is Portinari himself. His head was actually painted on a separate support and stuck onto the panel later. We can be sure that that particular window, at least, was done separately from the rest of the picture and so has a different viewpoint.

now it might seem outrageous to compare these two pictures, but it is only in their spatial structures that I am drawing parallels. Van Eyck's *Ghent Altarpiece* (1432) has the wonderful feeling of great depth when seen in the original, the swirling colours (not reproducible here) playing an important part in this, but when you look at the painting in the flesh you do notice that everything is seen close up, brought up against the picture plane. It is not like the depiction of space in, say, Piero della Francesca – think of the *Flagellation* (see page 125).

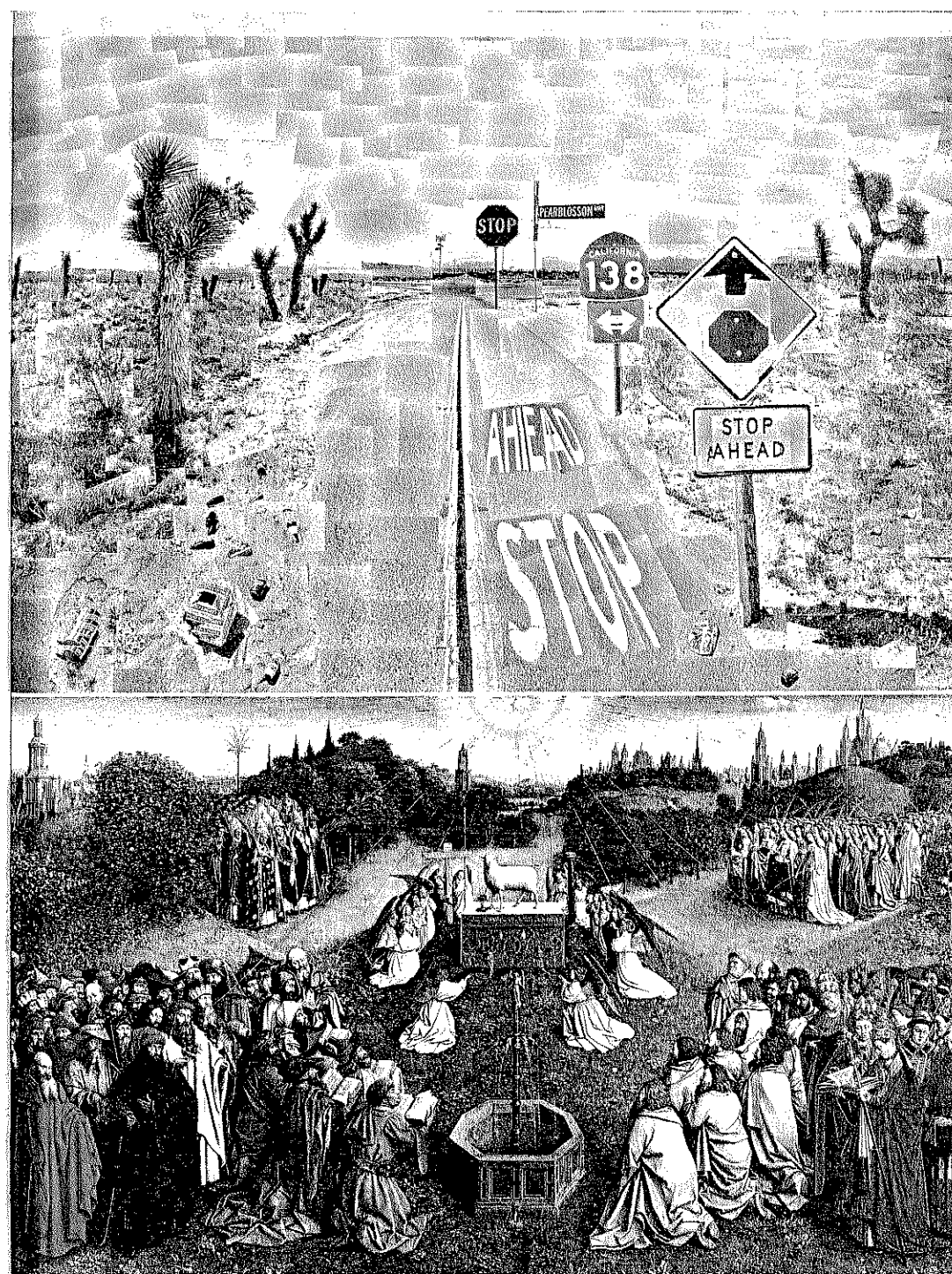
In the eighteenth century, some commentators thought that the altarpiece was an example of 'wrong perspective' – it didn't follow the rules – and yet the sense of depth is always there. We look straight on at the Lamb of God, and we move on when looking at the fountain. The left and right groups in the foreground are seen from the front, with a slight rise of viewpoint towards the centre. The crowds in the middle distance are seen head on, with very beautiful details of bushes and plants seen from the front, again head on. The angels on the ground but their lovely shapes also suggest flying. The rays of the sun radiate out as though the sun were the painting's vanishing point (infinity), yet a 'V' shape rises from the bottom of the picture to contradict this. It is a miraculous composition, and which we move from viewpoint to viewpoint. It is not intuitive at all, as it is sometimes described, but a highly sophisticated construction that is deeply satisfying spatially.

My own construction of *Pearblossom Highway* suggested to me how this sense of both closeness to everything yet at the same time depth could be achieved. Multiple viewpoints create a bigger space than can be achieved by one. Our bodies may

accept one central viewpoint, but our mind's eye moves around close to everything, except the far horizon, which has to be near the top of the picture.

Although *Pearblossom Highway* looks like it has a central fixed viewpoint, none of the photographs that make it up were taken from what could be called 'outside' the picture. I moved about the landscape, slowly constructing it from different viewpoints. The stop sign was taken head on, indeed from a ladder, the words 'STOP AHEAD' on the ground were seen from above (using a tall ladder), and everything was brought together by 'drawing' to create a feeling of wideness and depth, but at the same time everything was also brought up to the picture plane.

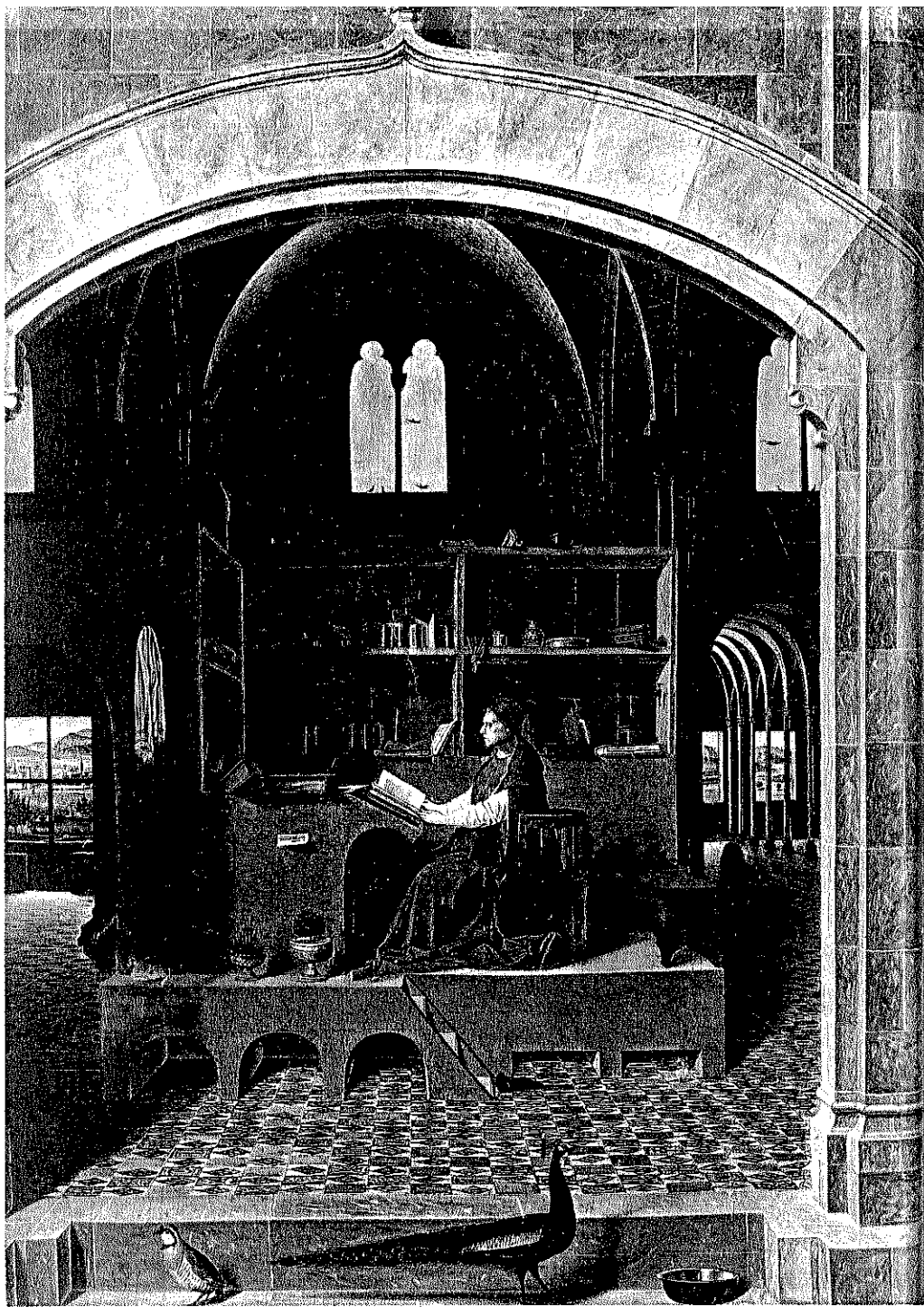
Is this the effect of the montage technique? What is known of van Eyck's methods is that he made lots of drawings of various elements and then 'drew' the whole painting out in detail from them. In making the drawings, everything would be close to him, alterations of scale being made from an intuitive but amazingly knowledgeable geometry. The farther away a crowd is the smaller it seems, yet there is no loss of detail (I scrutinized this painting with binoculars the last time I was in Ghent). We marvel at the 'realistic details', partly caused by use of shadows, yet the source of light seems an even one, certainly not coming from the sun. My point is that multiple viewpoints (many, many windows) have a similar distancing effect on a two-dimensional surface as a bird's-eye view, but that this is contradicted in the details. *The Ghent Altarpiece* is a magnificent construction of wide and deep space that pulls us in. We are outside it only for a few moments.



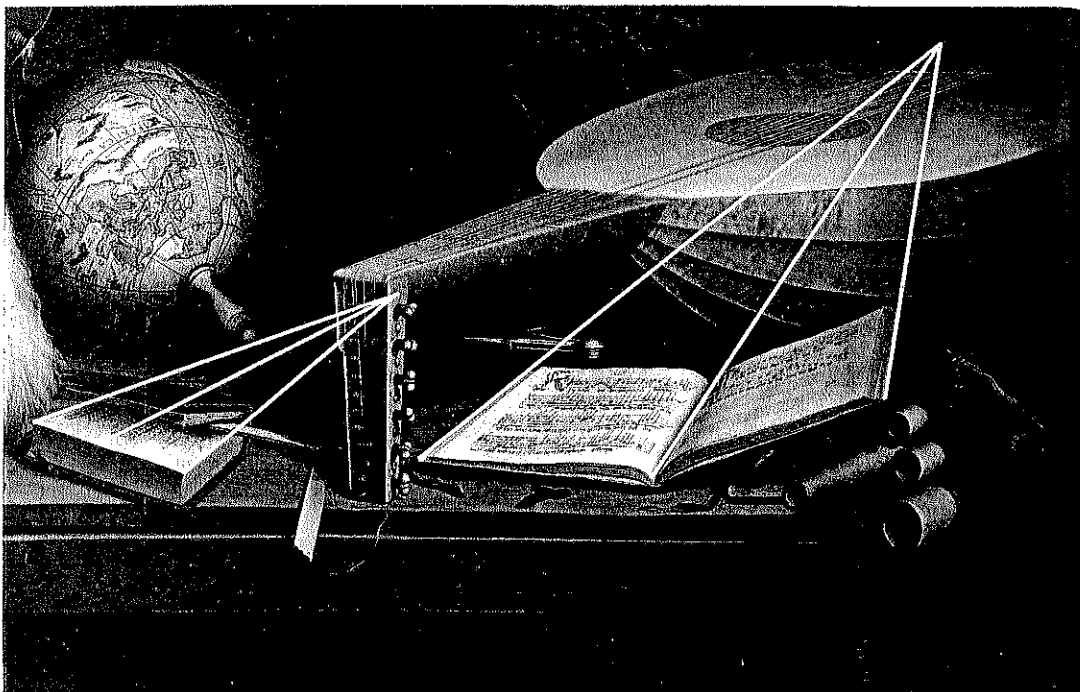


To see the completely different kinds of space you get with single-point linear perspective and 'multiwindow' perspective look at these two depictions of the Last Supper. You feel with Andrea del Castagno's 1447–9 version (*above*) that the action is taking place in a coherent space. This is because our viewing position is fixed; we see everything from the same point: the floor is seen from above, the table and disciples from straight on, and the ceiling from below. However, the painting also points to one of the limitations of linear perspective: because it is concerned with creating the illusion of depth, not of depicting everything equally,

the artist has had to use a friezelike composition to show each of the figures, otherwise they wouldn't all be visible. Suppose you take a photograph of friends at a dinner party – unless you ask some of them to lean forward or back (an indecorous pose for a saint), you won't see them all. Bouts's multiwindow perspective, on the other hand, allows us to see everything in equal measure, because we are constantly moving – or floating – from one part of the painting to the next, never still. Though quite different, both pictures are beautiful depictions of very sophisticated spaces.

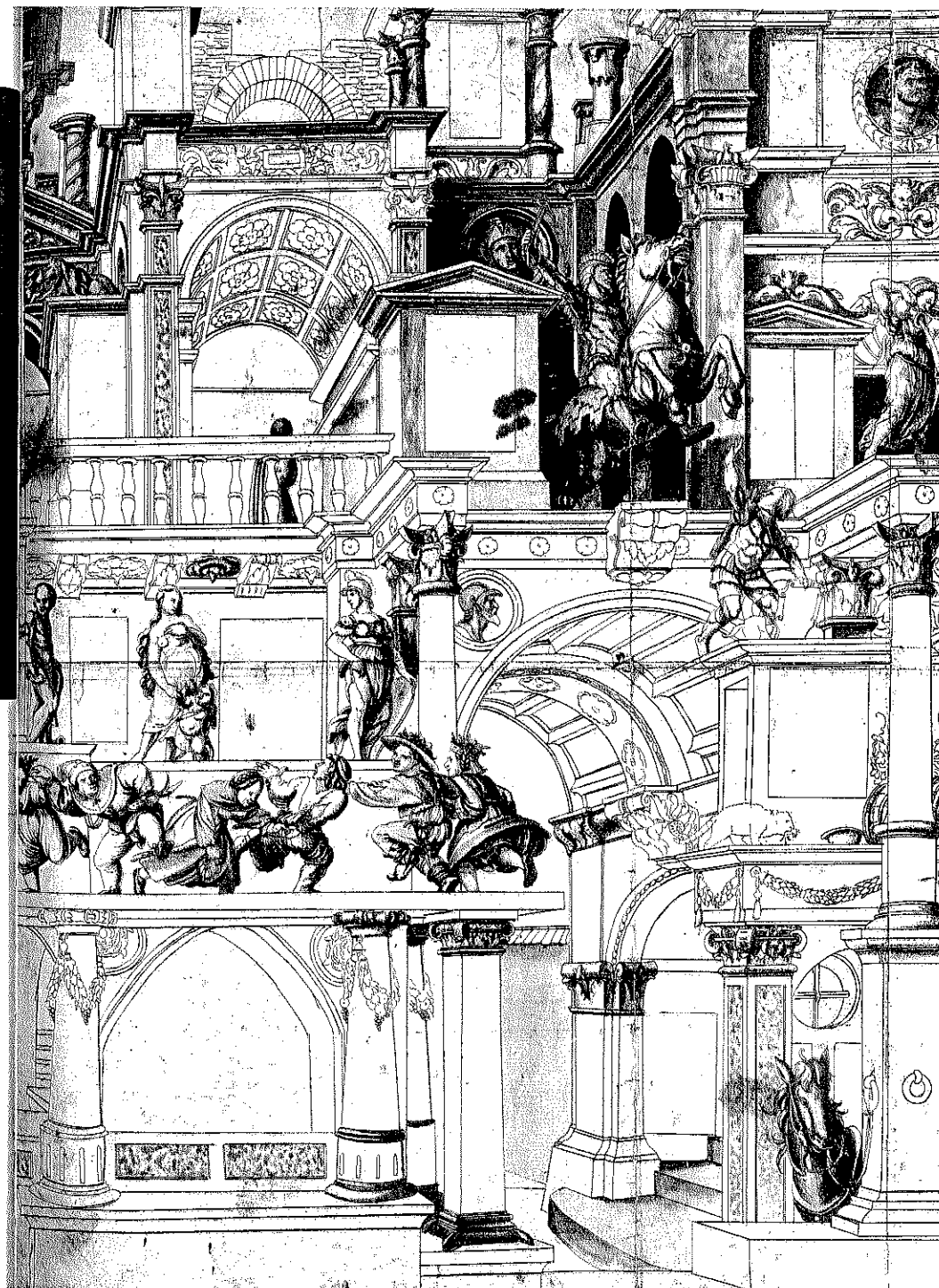


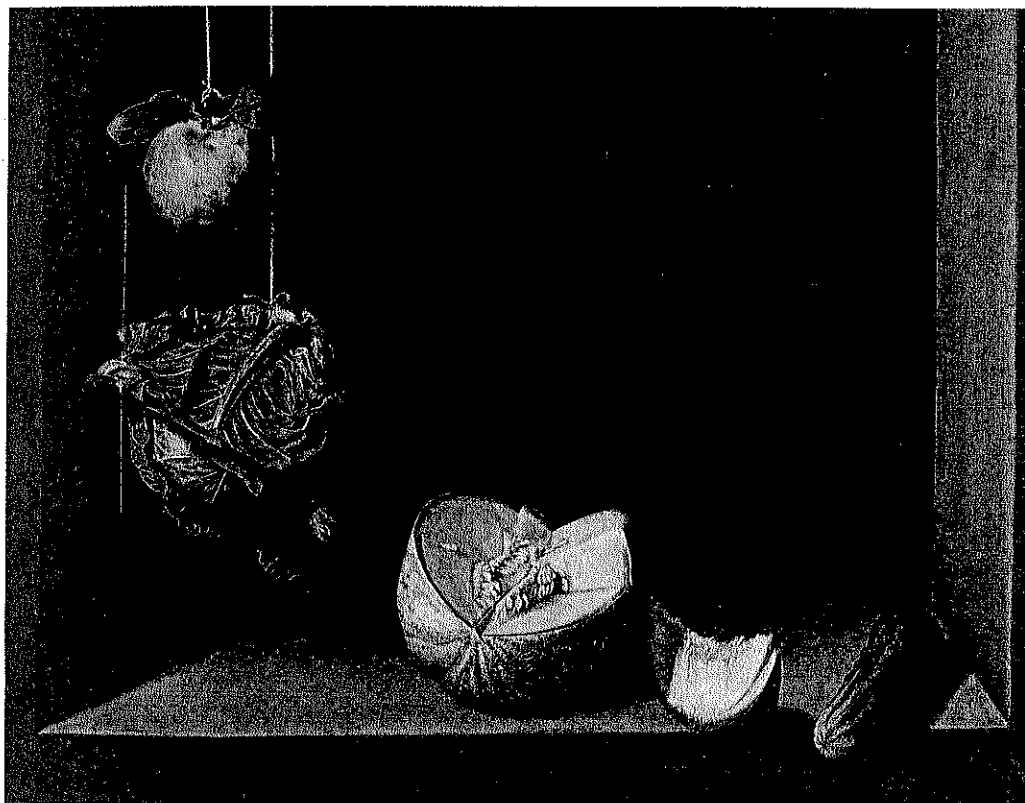
Antonello da Messina is traditionally credited with the introduction of oil painting to Italy from the north. He may have seen a van Eyck painting in Naples, or he may have actually gone to Flanders. He certainly discovered some of van Eyck's methods – could the mirror-lens have been among them? This painting of St. Jerome in his study of c. 1460–5 was regarded as being 'very Netherlandish' at the time. It certainly seems to combine the new northern techniques with Italian concerns. The strong shadows, for instance, are unusual in Italian painting of this time, but could be explained by the lighting needed for the mirror-lens. The room itself is drawn according to Alberti's linear perspective but the objects within it aren't – they are all seen head on. Many windows within one window?



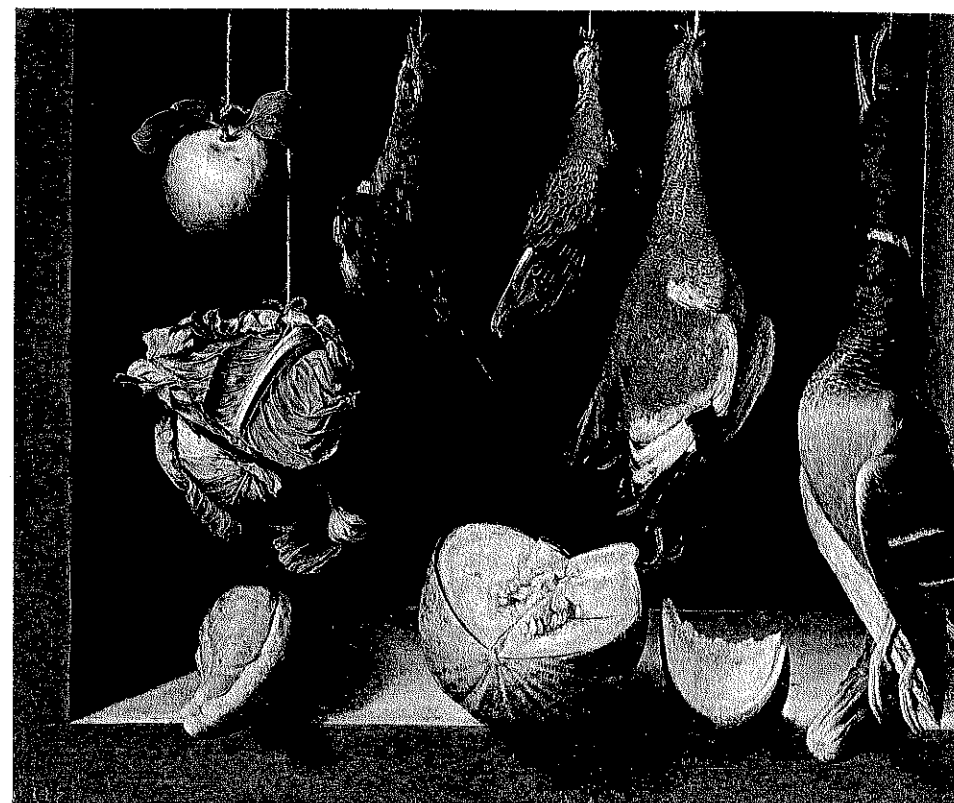
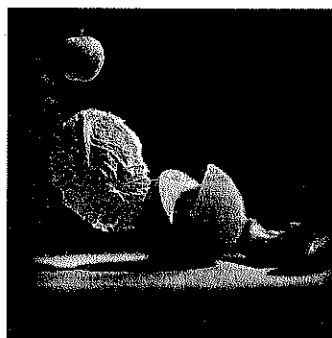
That Holbein understood and used Alberti's perspective is clear in this copy of one of his drawings from c. 1520 (*opposite*). Yet in the above detail from his *Ambassadors* we have what seems to be a collage construction. It is clear that the two books have vanishing points at different levels, which in analytical perspective means different eye levels. This indicates that they were seen at different times and from different viewpoints. Was the painting constructed using a mirror-lens? The globe seems to suggest this: it is incredibly 'accurate' in its spherical surface, which is very difficult to do convincingly.

It's true we do not notice these two vanishing points easily, but there must be a reason when as knowledgeable an artist as Holbein defies the conventions. They can be explained rationally by the mirror-lens collage technique.





Juan Sánchez Cotán painted this still life in 1602. The setting itself – a small window with a ledge – suggests our hole-in-the-wall technique, as does the lighting. How long would the cabbage look like that with such a strong light on it? How long would the cut melon (the lute of the fruit world) stay like that without decaying? Not very long, that's for sure, certainly not long enough for Cotán to have eyeballed it so precisely. Cotán's is a beautiful painting with a lovely, satisfying, yet simple composition. The curve formed by the objects has been commented on before, and sometimes given a religious interpretation. But

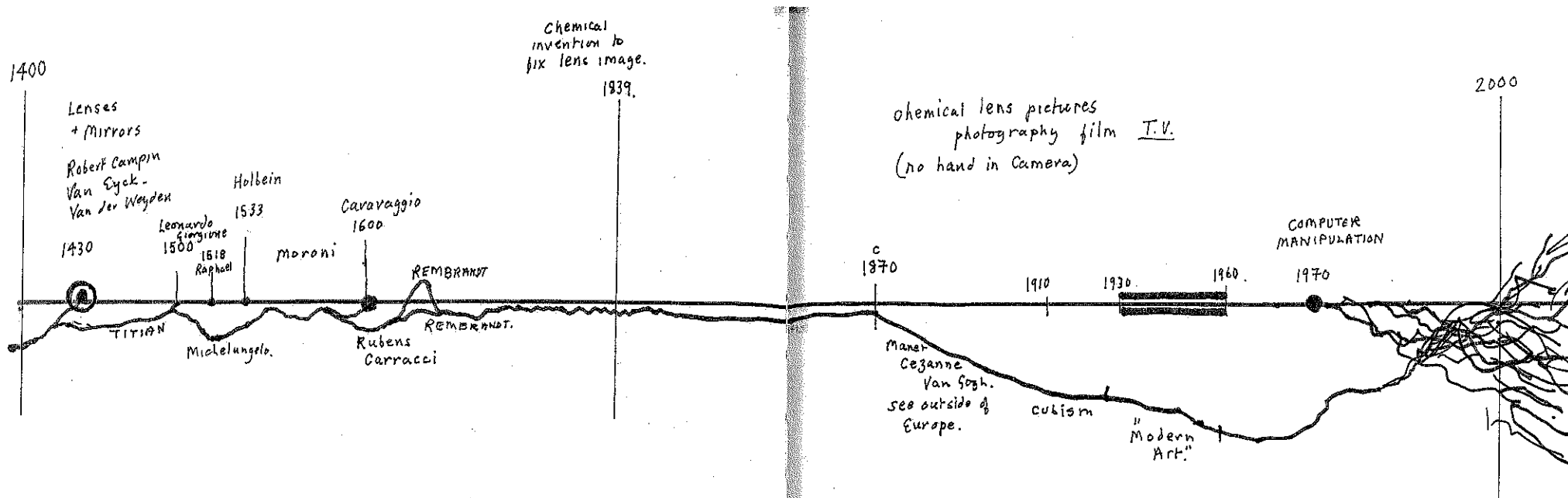


I would suggest that the objects are all on the same plane because of the depth-of-field problems I discussed and illustrated on the previous page. Now look at the second version of Cotán's still life, also painted in 1602. The composition is identical except for the addition of game and the vegetable in the bottom-left corner. The quince, cabbage, melon and cucumber are all in exactly the same place as in the first version. Could Cotán have used his mirror-lens as an epidiascope to make this copy, as I think van Eyck had done with the portrait of Cardinal Albergati almost two centuries earlier (see pages 78–9)?



There are many unanswered questions, and this book can be no more than an introduction to a vast subject. Though I have no doubt that the central thesis is correct, there is certainly more to be uncovered, and this could have an impact on the story as I have outlined it here. For example, I have identified the first use of optics as having been in Flanders about 1430 – there is solid evidence. Nevertheless, I am troubled by Masaccio, working in Florence a decade or two earlier. His portraits are less meticulously painted than van Eyck's, but this could be attributed to his medium, fresco. They do, however, have a similar look, and Masaccio was the first Italian painter to give faces in a crowd a true individuality (as in the Flemish crowds).

The end of the story (which has not, of course, ended yet) is also problematical. We know that the advent of chemical photography had a profound impact on painting – that it sparked a revolution against the optical image (Impressionism, Cubism). There is now a new technological revolution in the making of images. What effect will that have?



This is my attempt at explaining what I think has happened. The red line is the lens-based image, the green is the 'eyeballing' tradition. Before 1430, the red should perhaps be pink, partly because we can't be sure that this was the very first appearance of optics in painting, and partly because mirrors and lenses definitely existed before this – their effects may have been known to some artists.

I am suggesting that at moments in its history the green line was close to the red, influenced by what artists observed through the lens. The first of these moments was around 1430 in Flanders. Other artists saw the results and were immediately affected. The influence of the new art spread. The knowledge of how to do it became the subject of much rumour among guild craftsmen. Slowly, word got out, but, apart from some exceptions (Antonello da Messina, for instance), the 'secret' was more or less contained in northern Europe. But then Hugo van der Goes's *Portinari Altarpiece* is sent to Florence in the 1480s, and we begin to see increasing evidence of optics in Italian art.

By 1500 Leonardo is writing about the camera obscura. Certain artists like Giorgione and Raphael begin to experiment with optics, while others such as Michelangelo prefer to stick to eyeballing. By Caravaggio's time, mirrors and lenses have been around for at least 170 years, and scientists such as Giambattista della Porta are instructing artists on how to use them. Suddenly, there is an amazing burst of naturalism.

For four centuries, eyeballing closely follows the lens. This is not to suggest that all artists were using lenses, only that they were all trying, to various extents and with differing results, to emulate the naturalistic effects – the 'look', the 'looking like' – of lens-based images. Sometimes certain sensitive individuals, such as Rembrandt, cross the line, transcending mere naturalism to produce paintings that not only depict exterior reality but also reveal inner 'truths'. Throughout, however, they continue to follow the example of the optical.

Then comes the invention that fixes the lens image with chemicals (photography), doing away with the need for the artist's hand altogether. The lens now spreads much faster than before, but at first photography is still restricted to the relatively wealthy. Within twenty-five years or so, however, its impact has made itself felt much more widely. Vanguard painting now wants to distinguish itself from the lens and so steers the green line sharply away from the red. This is the birth of modern art. Awkwardness returns. Advanced painters begin to look outside Europe and towards the art of the Far East, which offers alternative ways of seeing.

But the lens, carried on by photography (and academic painters), remains dominant, eventually to become film and television. The gap widens, Cubism being the first style of painting to suggest a new way of representing the world far removed from the lens' veracity. Around 1930, though, the red line gets thicker. Movies are now everywhere – the most vivid depiction of reality possible, it was thought. This is the period when modern art suffers its most serious attacks, especially from the great tyrants – Hitler, Stalin, Mao – who all demand lens-based pictures and use them to consolidate their power. It is also the period of the world's bloodiest conflicts, way beyond anything previously known. Are these things connected? Certainly, control of the media was essential for the slaughter.

In the 1970s the computer arrives and changes the lens picture. (Technology always seems to have an effect on depiction.) Computer manipulation means that it's no longer possible to believe that a photograph represents a specific object in a specific place at a specific time – to believe that it is objective and 'true'. The special position, even legal position, that photography once had has gone. (Manipulate – 'to use the hand'.) The hand has returned to lens-based images. The computer has brought the photograph closer to drawing and painting once again. Its software uses terms like 'palette', 'brush', 'pencil' and 'paintbox'. So where are we now? Do the lines criss-cross, or jumble up?