CHAPTER 15

Demonstrating some core ideas

Introductory

As already explained, the rules of linear perspective were developed by Renaissance artists as aids to image-construction. This chapter starts the process of showing ways in which they can be used as a guide to looking. For this purpose a sound understanding of the core ideas that underpin them is necessary. Although many books attempt to provide this by referring to different examples of perspective constructions, using a variety of diagrams, they never really show how these relate (or fail to relate) how we see in the real world. My approach is very different. Eschewing diagrams it uses participatory demonstrations using real world props. In addition to revealing the basis for the standard rules, these provide a fascinating introduction to some of the seeming anomalies of visual experience..

Few people would disagree with anyone who tells them that objects appear to get smaller as they recede into the distance. This phenomenon is one of two core ideas behind of the laws of linear perspective, as taught in art schools. The other is the influence of the eye-line. If these were all that mattered, there would be a great deal less to write about in this chapter. However they are far from being so. The reason is not only that the crucial role of the picture plane, as the third variable, is too often neglected, in the interests of simplicity. Even more important for the approach presented in this chapter, is the fact that appearances can be dramatically influenced by the constancies of size, orientation and shape, as well as by the context in which they occur. This is because the context dependent, constancy phenomena, push appearances in different, often opposite directions to those predicted by the laws of linear perspective as usually taught. The resulting confusion can cause all sorts of problems for those who seek to make use of them when attempting to make accurate drawings from observation. This chapter shows how interactive demonstrations can be used to help people understand the reasons why. Subsequent chapters both continue this process and suggest many practical ways of using the knowledge that will be made available..

Through the tracing glass.

When explaining linear perspective to students at my *Painting School*, I make use one of the two large windows in the studio (*Figure 1).* As the photograph shows, it is divided down the centre into two halves, each containing twelve panes of glass, separated by five approximately horizontal, wooden bars. It is surprising just how much can be learnt from opening and closing it.

Figure 1 : One of the windows of the studio at Montmiral

The idea behind the procedure I propose for the first interactive demonstration is at least as old as Leonardo da Vinci. A framed pane of glass (henceforward called the "*tracing-glass*") is clamped to an easel and placed about four paces in front of the window (that is to say about two-thirds of the way across the studio floor). Care is taken to check that the *tracing-glass* is vertical, so that its surface and that of the window are parallel with each other: It is also important that the students' line of vision is perpendicular to both the *tracing-glass* and the *window*. Once these preliminaries are taken care of, the next step is to establish the students' *eye-line* (often called the *horizon line* in traditional perspective diagrams). As the studio floor is horizontal, the easiest way of getting them to do this is to asking them to stand up against the window, a manoeuvre which usually brings their eyes within the proximity of the second window bar from the bottom. Where necessary they are asked to stand on the height-correcting wooden plank or, if this is not feasible, a piece of masking tape is stretched horizontally across the window functioning as a substitute window bar. From now on the bar or tape established in these ways will be referred to as the "*eye-line bar*".

The students' first task is to trace the *eye-line bar* on the *tracing-glass* as accurately as possible, using a felt-tip pen with which they have been supplied. This usually proves surprisingly difficult and forcibly demonstrates the importance of:

- Keeping the head still.
- Closing an eye.

The slightest movement and everything gets dramatically out of kilter and, consequently, the students are straightaway faced with the fundamental lesson that *everything in linear perspective depends on the three-part relationship between the eye,* the *picture-plane* (in this case, the tracing-glass plane) and the *object being represented*.

Stepping back

The students' are now asked to answer a question about the change in the apparent size of an object when the viewing-distance is *increased*. To help them with their answer, they are requested to retreat a few of paces backwards from the *tracing-glass* while still looking through it to the *eye-line bar*. From their new vantage point they are asked to say whether it now appears *smaller* or *bigger* than before. Almost without exception, students have been surprised to discover that, to their perception, it has dramatically *increased in its size*. The evidence of their eyes being so very clear, it is possible to propose a first provisional law of linear perspective which gives much pause for thought:

(1) The greater the viewing distance, the larger its size.

Since this is not at all what books and teachers usually say, an explanation is required. Some students are quick to grasp what has happened. They realise that the window-bar has not expanded at all. It merely looks bigger relative to the tracing-glass which, being situated nearer than the window, has diminished in its measured size the faster of the two. Since vision is governed entirely by relativities, the extent of the window-bar relative to the tracing-glass is what the students see. The measured length of *window-bar image* on the glass or on the retina is irrelevant. This is why in this case perception is so little influenced by the fact that its measured length does indeed decrease with increases in viewing distance.

The discrepancy between the facts of *visual experience* and the facts of *physical measurement* can be startlingly great, providing yet another example of how the rules of physics and the rules of visual perception are by no means the same thing. This was the *watershed insight* of the *Eighteenth Century* psychologists of perception, who discovered *induced colour* and the various *constancies,* including *size constancy*.[1] The explanation of this last mentioned phenomenon as it applies to the demonstration being described is that the students' eye/brains, when focusing attention on the tracing-glass, will have taken it out of context (the first stage of all analytic looking) and stretched or squashed it so that it fills the *visual-analytic space* within the analytic processing part of their brains.[2] As this is always the same size and as the same squashing or stretching will occur at all viewing distances, this means that the experienced size will remain constant. What the students will be aware of is changes in the relativities within the tracing-glass. Accordingly, as far the students' eye/brains are concerned, the *window-bar,* which is now seen as stretching right across the tracing-glass, really does get longer.

Perceptual distortions due to *size constancy* operating differently in different parts of a scene can cause much difficulty for artists. For example, they might want to compare the height of a person framed by two tree trunks and their outstretched branches with that of someone that is out in the open with no equivalent framework. In this case, if the images on the retina are the same size, the person between the tree trunks is likely to appear to be larger than the one that is not.

Lessons so far

At this juncture it is worth pausing to reflect on basic lessons already provided by the demonstrations, for two key ideas have been introduced:

1 *"What Scientists can Learn from Artists", Chapters 13 & 15*

2 "What Scientists can Learn from Artists", Chapter 15

- All linear perspective is based on relativities between the eye, the tracing-glass (the equivalent of picture surface) and the object being drawn.
- Appearances can be deceptive.

If we could immediately grasp the full significance of these two statements, there would be no need for what follows in this chapter and the next. However, since many of the ramifications are far from self-evident, it is well worth pointing them out separately. This is done with the help of the tracing tasks to which we come next.

The opening window

As just explained, the first tracing of the *eye-line bar,* done when the window was closed, came out as a horizontal straight line. When it is has been completed, the window is opened a small amount and students are asked to make a second tracing with the window in its new position. As might be expected, the traced line will be shorter than before. Assuming that their eye position and level and have been kept constant, the two tracings will have common starting point on the hinge side and be exactly on top of one another. This means that the shorter line will be obscured by the longer one. To make its end point clear the students are asked to mark it with a short vertical stroke of the pen. The window is now opened progressively, a step at a time, with the result that the tracings of the eye-line bar gets shorter and shorter, until the window's edge is pointing towards the student, at which moment the eye-line bar disappears from view.

The same process, is then repeated a number of times, first with the top bar of the window, then with the bar above the eye-line bar and, finally, with the bottom bar. In all these latter cases, the traced images not only become shorter as the window opens, but also slope more and more steeply. A regular pattern emerges:

- When tracing window bars that are on the eye-line, the traced lines remain horizontal.
- When tracing window bars that are *above* the eye-line bar, the traced lines slope in one direction.
- When tracing window bars that are *below* the eye-line bar the traced lines slope in the opposite direction.
- The lines that are relatively *further removed* from the eye-line bar slope more acutely than the ones nearer to it.

Figure 2 illustrates these outcomes. There should be no surprises, except for those who have never quite convinced themselves that the rules of linear perspective have any connection with reality (not such a rare phenomenon as some might suppose).

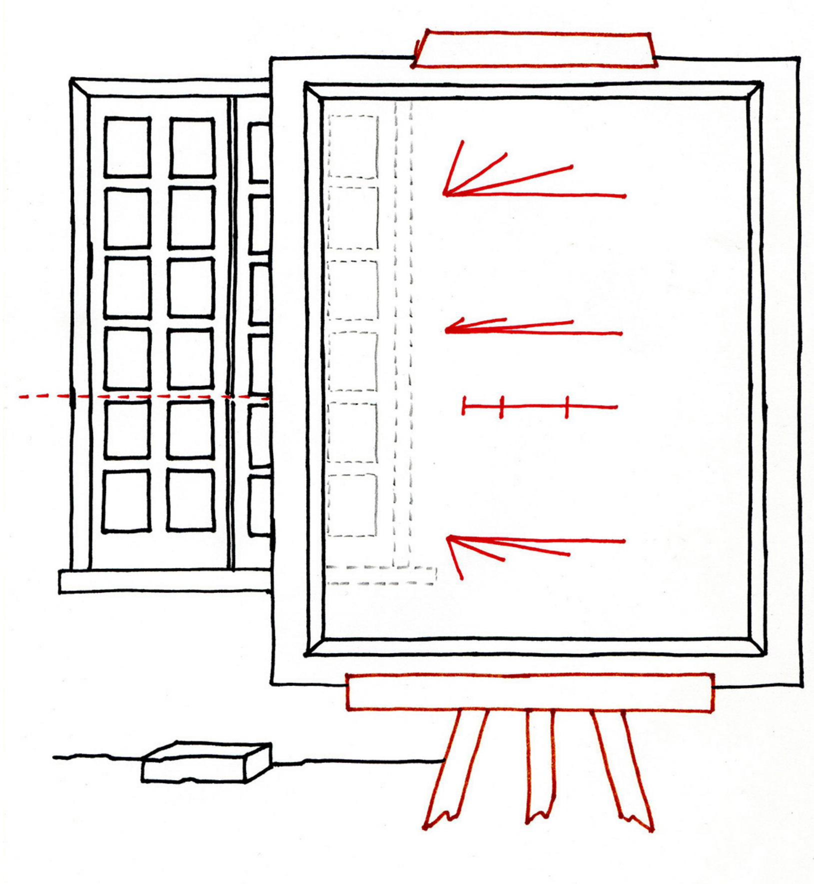

Figure 2 : The finished tracings on the tracing-glass

The next surprise

The next unexpected discovery comes after moving the tracing-glass, complete with the tracings on it, nearer the window, until a position is reached at which the line which formerly corresponded to the top bar of the window is now seen as superimposed upon the bar immediately above the eye-line bar. Meanwhile, the eye-line bar, just because it is on the eye-line, remains at the same height (although, of course, it appears as being a great deal longer)

As before, the window is opened a step at a time and once again the students are asked to make a sequence of tracings of the bars as they now appear. As should be expected, the different tracings of the *eye-line bar* are all horizontal. The surprise reveals itself when it becomes apparent that the progression of orientations of the lines representing the upper bar, exactly correspond to the progressions that was earlier revealed in the sequence of tracings relating to the top bar (*Figure 2*). Thus, from this demonstration seems to come a second provisional law of linear perspective:

(2) The rate of change in the slope of lines is related to the size of the image drawn on the glass and not to that of the object being traced.

Can we trust this conclusion? To answer this question, we need to take a look out of the window.

Out of the window

According to the law just stated, the smaller the image, the less noticeable will be the slopes. Indeed, in the case of very small images, they may not be evident at all. The reason for looking out of the window is to look for a way of demonstrating that this is the case.

It so happens that half a mile away, down below, in the valley of the river Vère, can be seen the château of *Corduries*. Having pointed out this imposing building to the students, they are asked to make a tracing of it on the tracing-glass. Virtually everyone is astonished at the size this turns out to be. Though, due to size constancy, the château takes up a large place in their visual awareness, its traced image turns out to be very small indeed (maybe a quarter of an inch in height). Moreover, not surprisingly in view of the rule just learnt, its tiny size ensures that all the actually horizontal edges on the château, have been traced as being horizontal and also, consequently, as parallel to one another. There are no angles at the corners of rectangular surfaces with the result that horizontal edges which meet at corners are drawn as straight lines. To the surprise of many, there is no apparent effect of recession towards any vanishing point.

If this is true of the tracings, what about the image of the château on the retina? Students regularly assume that there should be some degree of linear convergence towards a vanishing point and, experience shows that if they had not used the tracing glass, they would have almost certainly drawn lines converging towards a posited horizon. It is often only when faced with their mini-tracings that they realise that there is no sign of any such tendency to be found in them.

A practical problem and alternative solutions

This lack of visible evidence creates a practical difficulty. Few people, when painting a château in its countryside setting, want to make its image a mere quarter of an inch high. They usually want to make it much bigger (say, at the very least, two and a half inches). The problem arises because, according to the second provisional law of linear perspective (just explained), a two-and-a-half inch high image is large enough to ensure that:

- Horizontal edges, which are physically parallel on the building, will be seen as *converging towards a vanishing point.*
- Horizontal edges that intersect at the corners where walls join will be seen as *meeting at either obtuse or acute angles*.

So there's the rub. Students who want their two and a half inches high image of the château to look right, will have to draw angular relations which they cannot actually see. And how could they do that?

Many might conclude, as do most of my new students, that they would have to resort to some kind of linear perspective constructions complete with the extrapolations of the lines representing edges converging at vanishing points. If they had read the last chapter, they might well suspect that doing so would be no easy matter. And they would be right. Indeed, in the case of depicting the château from the studio window, it would be well-nigh impossible. To make the desired constructions, students would have to start by measuring not only the distance between their eye and the château (half a kilometre or so away) but also the heights of its walls and their angles relative to their line of sight. They would, then, need to construct an imaginary picture-plane somewhere in space between the studio window and the château.… There is no need to go on, the implications of adopting the linear perspective-construction route are already too mind-boggling to contemplate. On the face of it, the situation might seem hopeless and guesswork, the only option left,

However, there is an alternative solution, which does not depend on linear perspective constructions in any way. It is extremely simple to implement and, with a bit of thought, can be deduced from the findings of the tracing-glass demonstration. Remember, the three variables: the position of the eye, the placing of the tracing-glass and the location of the object being traced. Also, remember the first rule, namely, the greater the distance, the bigger the object.

If the penny doesn't drop immediately, a two-and-a-half inch square can be drawn on the tracing-glass (which is still by the window). Students can then be asked to look at the château through it: first, from close to the viewing-glass, to remind them that from there its image only takes up a tiny corner of the rectangle and, then, from the other side of the room, from where it looks a great deal bigger. Indeed, with a minimum of trial and error, it can be made to fit exactly the delineated square (or any other square of any other size).

This being the case, what seemed like the problem of drawing the chateau in correct perspective ceases to be one. All that the students have to do is to draw "*what they see*" (that is to say, the château without converging edges), at the scale they choose (five inches high, if they like) and, then, *look at the result from an appropriate distance,* which will be several paces from the picture-surface. The exact position will be determined by the rule that the larger the image, the further will be the required viewing distance. When the picture is looked at from this distance it will be in correct perspective. From there sloping edges and angled junctions would be wrong.

From this demonstration we discover a third basic principle:

(3) The distance between the viewer and the picture surface is one of the fundamental variables of linear perspective.

What Renaissance artists understood

All this was well understood by the *Renaissance artists* who saw the possibility of using linear perspective constructions to control picture-viewing distance. They believed that viewers could be:

- Drawn into the picture as participators, until they could almost smell the dung in the stable or recoil from the blood dripping from fresh wounds.
- Pushed away from depicted events (such as the birth, baptism or crucifixion of Jesus) so that they would find themselves viewing matters from a respectful or contemplative distance.

Such, at least, was their hope. However, it would seem that they were a little over optimistic, as can be deduced from the behaviour of people looking at paintings in galleries. In my experience, it is very rare indeed to see anyone moving backwards and forwards in front of a *Renaissance painting* in an effort to find the right viewing-distance. Rather, a constant distance seems to be preferred, often one from which the labels giving information about the picture can be easily read!

To ram home the point, students are now shown two illustrations which exaggerate the effect of viewing distance on appearance to such an extent that all will be aware both of an abnormality and of its disturbing quality. *Figure 3* comes from Ernst Gombrich's famous book *Art and Illusion*[3] and shows a photograph in which the linear perspective is so exaggerated that it looks impossible. However, if the photograph is held right up against the eye, we find that from this very close up viewing point (which is the equivalent of the camera's eye view) the image has become plausible (although it will be seriously out of focus).

Figure 3: A close up photograph of man holding pool ball

3 Gombrich, E.H. 1960, *Art and Illusion: A Study in the Psychology of Pictorial Representation,* Phaidon.

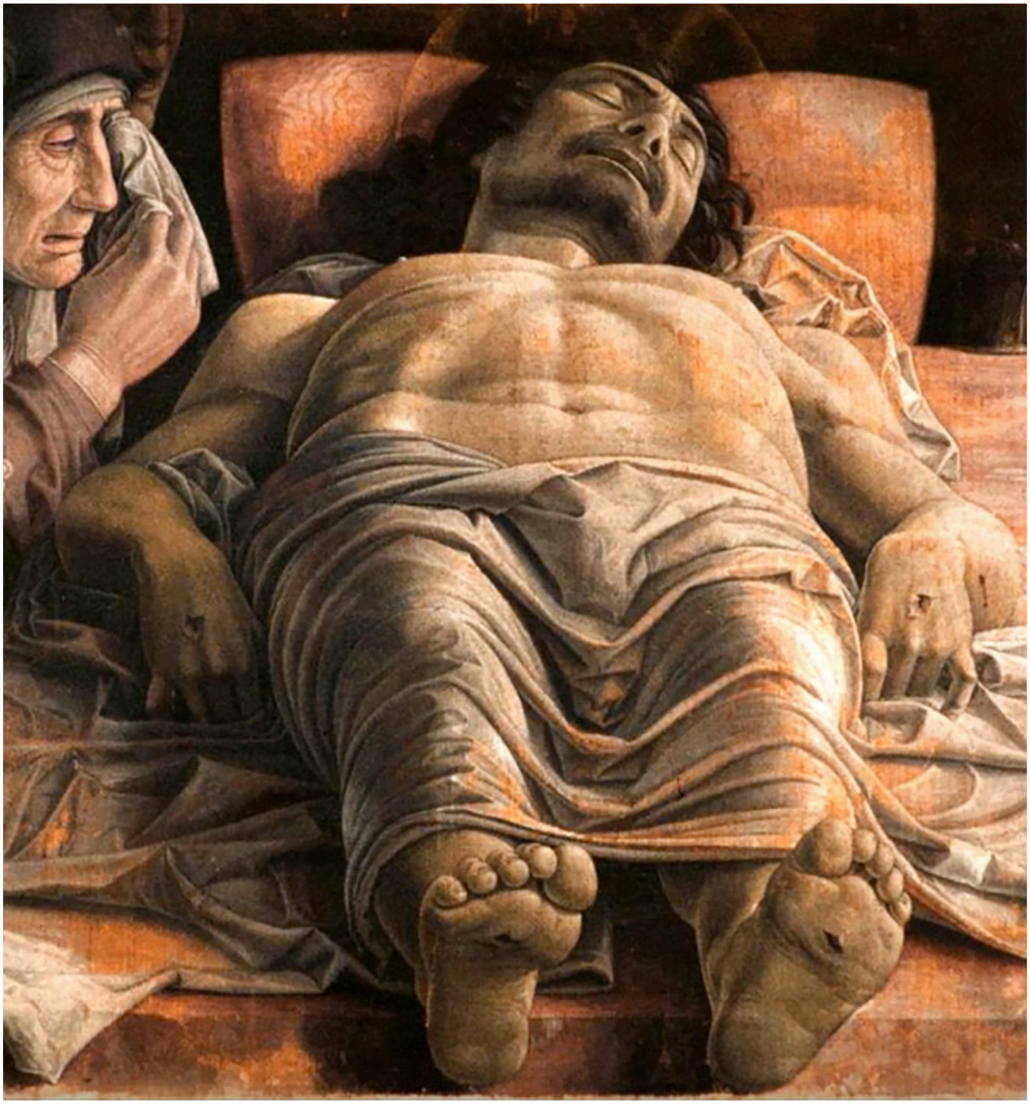

Figure 4: Mantegna's Christ in heavy foreshortening

In contrast *Figure 4* shows Mantegna's famous foreshortened figure of Christ. When looked at from book-reading distance (that is to say, well within an arm's length), the head looks far too big. However, when looked at from the other side of a large room, such as the big Studio of the Painting School, [4] it will come right (or very nearly so), before the viewer's very eyes.

The opening window as a conceptual tool

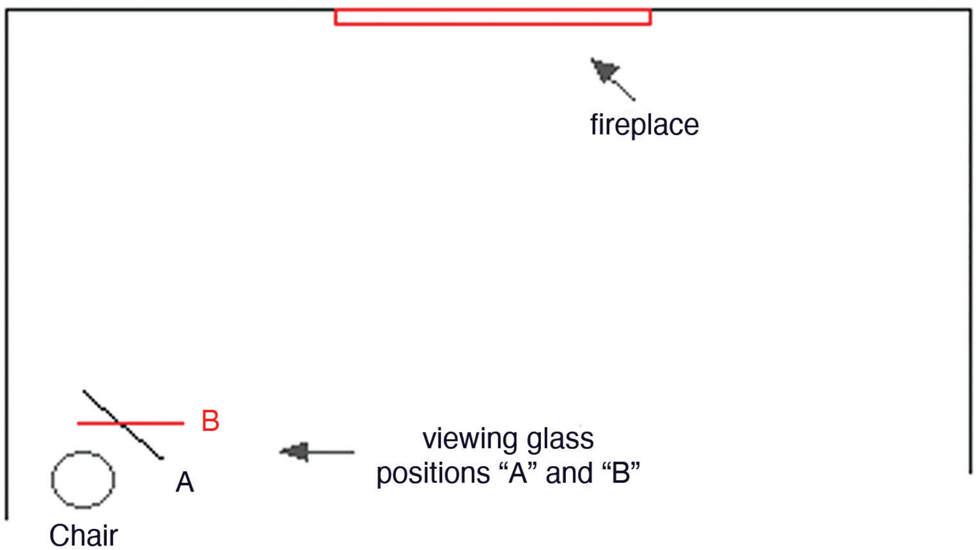

Figure 5 : Moving the easel, instead of the window

It is now time to return briefly to the device of the opening window. *Figure 5* illustrates an alternative way of producing an identical set of tracings to those illustrated in *Figure 2*. Instead of moving the window, the students move themselves to a sequence of different viewing points (represented by the numbers 1 to 4), making tracings from each of them. This equivalence between two ways of producing the same result has fundamentally important implications. It tells us that any window (door, wall or other rectangular surface), no matter from what angle it is viewed, can be imagined in terms of the concepts learnt from the progressively-opening-window: *One way of thinking will cover all contingencies*.[5]

Horizontal surfaces

At this point some students may raise an objection, "*What about horizontal*

4 Approximately ten metres

5 See grids for a left hand and a right hand window in *Appendix A*

surfaces, such as table-tops or roads, receding into the distance?" The answer is that these obey the same principles and can be dealt with by imagining the opening window as being hinged at the bottom or the top, like a trap door. The only complicating factor is the need for a vertical eye-line, which, instead of remaining horizontal (as with the opening window) stays vertical whatever the slope of the opening trap door. But the ramifications of this seeming complication is best left until the next chapter.

Changes in the orientation of the picture plane.

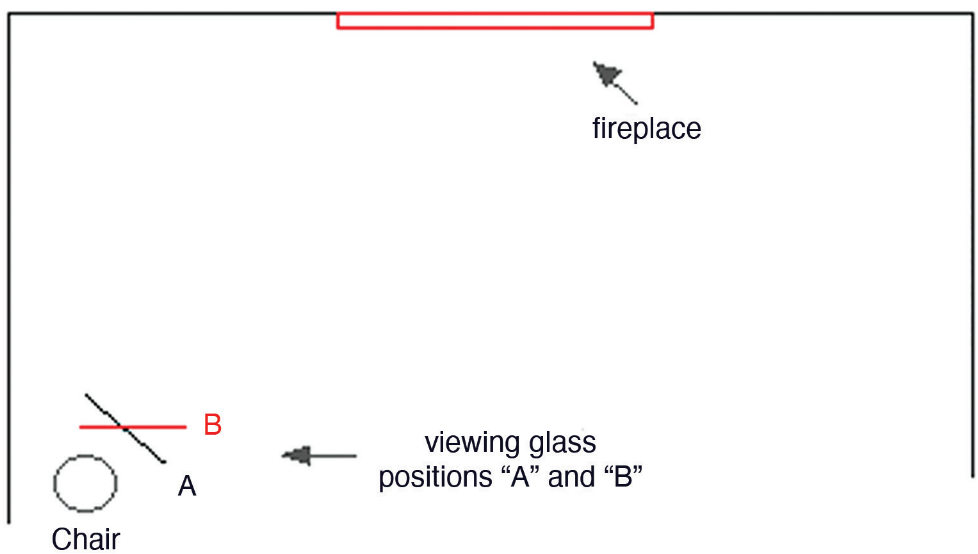

Figure 6: Two orientations of the viewing-glass ("A" & "B")

Finally, before going outside to demonstrate ways in which the concept of the opening-window can be used with actual buildings and walls, it is important to confront one more issue. What happens when the viewing-glass is not perpendicular to the line of vision? As one way of answering this question, students are asked to do two tracings of the studio fireplace. The viewing-position chosen is the same for both tracings, being several paces back from the fireplace and several paces to the left of it, such that one end of the mantelpiece is very clearly nearer than the other, as illustrated in *Figure 6*. From this viewpoint, as shown in *Figure 7*, the rules of linear perspective are clearly illustrated. Or are they?

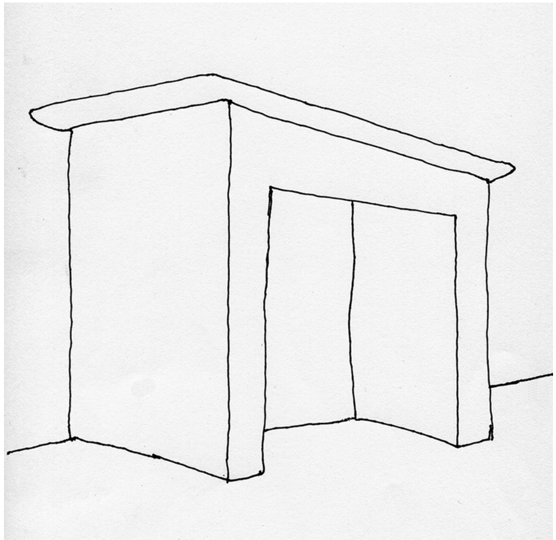

Figure 7 : Viewing glass position "A"'- Normal perspective.

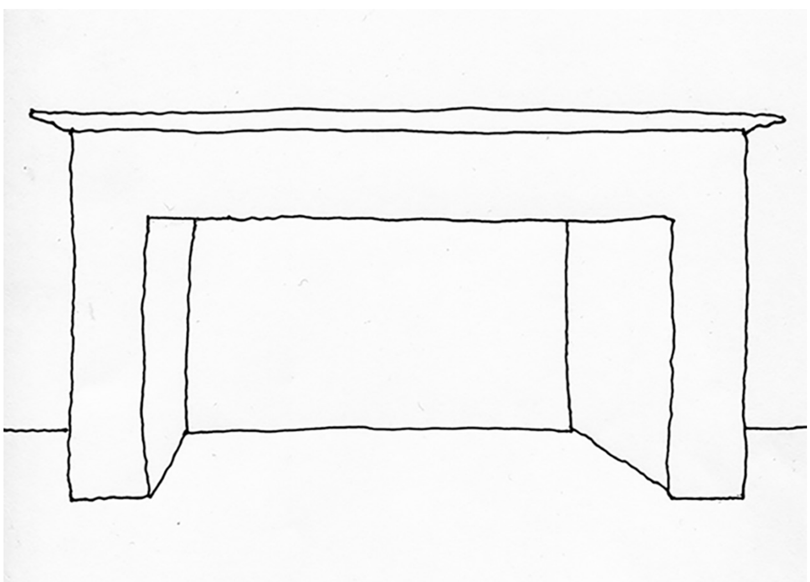

Figure 8 : Viewing glass position "B".

The question is needed because Figure 8 is also a tracing from the same viewing position. How can this be? What has changed to bring about such a very different result? Let me explain.

The first tracing is made in the normal fashion, with the tracing-glass perpendicular to the student's line of sight (position 'A'). The view through the glass will be correspond to *Figure 7.* It is not necessary to ask for a complete tracing, just the two outer verticals joined by the underside of the mantelpiece will do. When it is finished, students are asked to join the base of the verticals in their tracing. The outcome is a *trapezoid*. This is expected by everyone since it is the archetypal outcome for a rectangle in recession, showing the nearer side of the fireplace being higher than far side.

For the second tracing (which proves slightly more awkward to do) the viewing-glass is placed horizontal to the line of the fireplace (position 'B' in *Figure 6*). This time the view through the glass corresponds to *Figure 8* and the traced shape that emerges is a *rectangle.* It is an outcome that often surprises students for there is absolutely no sign of the linear perspective recession that most of them seem to expect.

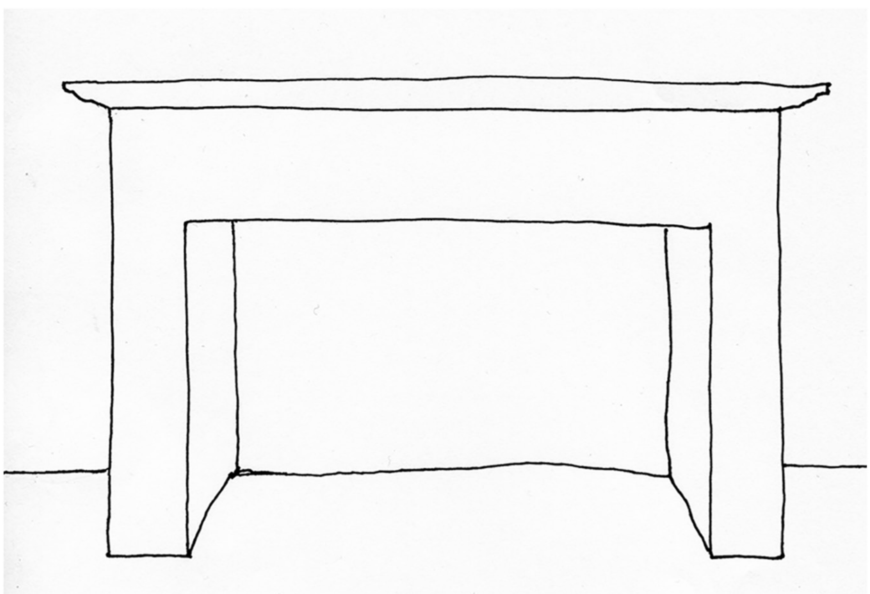

Figure 9 :Front view - Normal viewing.

Another seeming anomaly arises when the completed image is compared with a tracing made from directly in front of the fireplace. Clearly there is a big difference. This is that in *Figure 8* the receding walls to the left and right of the fireplace are of different widths, whereas, as illustrated in *Figure 9,* in the actual view from in front of the fireplace, they are equal.

Does this mean that the image in *Figure 8* is wrong? That answer depends on where the viewer stands. If it is viewed from directly in front, "*Yes, it does look wrong"*. However if looked at from the direction from which it was originally drawn with the orientation of the picture-surface corresponding to position 'B' in *Figure 6*, everything falls into place. From this vantage point the relativities between eye, picture surface and fireplace are as they should be.

From this demonstration a fourth law can be deduced:

(4) The orientation of the picture surface and the direction from which it is viewed need to be taken into account when making drawings from observation.

Implications

Without denying the truth of the well known rule that the retinal image of objects gets smaller with increases of distance from the viewer, we have discovered that this is far from necessarily what we perceive as being the case. Size constancy can reverse our expectations. Not only can it stop objects from appearing to get smaller but also, when allied to context effects, it can cause them to do the opposite, such that they can actually appear to get larger, often much larger.

In summary, without drawing a single traditional linear perspective diagram with its horizon and its vanishing points, we have already learnt a great deal about the subject. The next chapter, once more without recourse to traditional constructions, we can learn a lot more by investigating how the principles that we have identified can be made use of when we analyse scenes with a view to drawing them.