On Perspective

An Introductory Essay

By

Peter Goll

Preface

On Perspective is a revision of an essay published in letterpress by Dan Humphrey at the Chilkat Press, Haines Alaska in 1980, for students at the University of Alaska, Juneau. This revision was prepared digitally in 2020 for students of Renaissance drawing theory at the Port Townsend School of Art and revised further in 2021.

It is based on four lectures by Robert Beverly Hale as he delivered them twice a year to his daytime classes at the Art Students League of New York from 1977 to 1980. Additional material was given by Peter Hopkins, a League lecturer and taken from the works cited.

Perspective drawing was developed from the use of three architect's elevations – the top view or plan, the side view and the front view. With these, architects and builders can reproduce solid forms accurately.

Adding a fixed observer's point of sight to the three elevation drawings allows one to measure or estimate the changes in appearance of objects as they change position in space or change their orientation (aspect).

Perspective is an element of drawing. Robert Hale summarized: To draw a form one must know that it exists, come to a conclusion as to its shape, determine its position and aspect, manage its proportions, light the form, and understand the drawing system you are using, which may be perspective.

It is the artist's choice whether to use these elements of drawing to represent a natural object or simply to compose visual elements drawn for any artistic intent. Regardless of intent, when drawing forms, imagining the top view and side view of an object- as one draws the front view - provides specific information that answers the practical drawing questions of line direction and the location of points on the canvas.

Understanding the relationship between image and substance is not only a method of drawing and architecture, it also informs a philosophy of life based on truth and clear comprehension of the nature and language of appearances and specifically their distinction from solid matter.

Hale was an abstract artist, a trained architect who taught formal drawing theory. He viewed anatomy and perspective as part of the artist's vocabulary like the consistent behavior of light and line over various types of forms. He saw drawing systems as tools to increase the power to tell a story rather than as a limitation on content.

Developing a sense of mass to inform each line and tone is a powerful skill, aided by tools like reference planes, visual rays and elevations. These allow clear rationalization of the changes in appearance that occur with each movement of the eye or the subject. Upon this traditional framework for describing three dimensions, two rules will find any point or line direction in a perspective drawing.

The goal of this essay is to facilitate freehand drawing. Any measured drawing practice is to that end.

1. Reference Planes

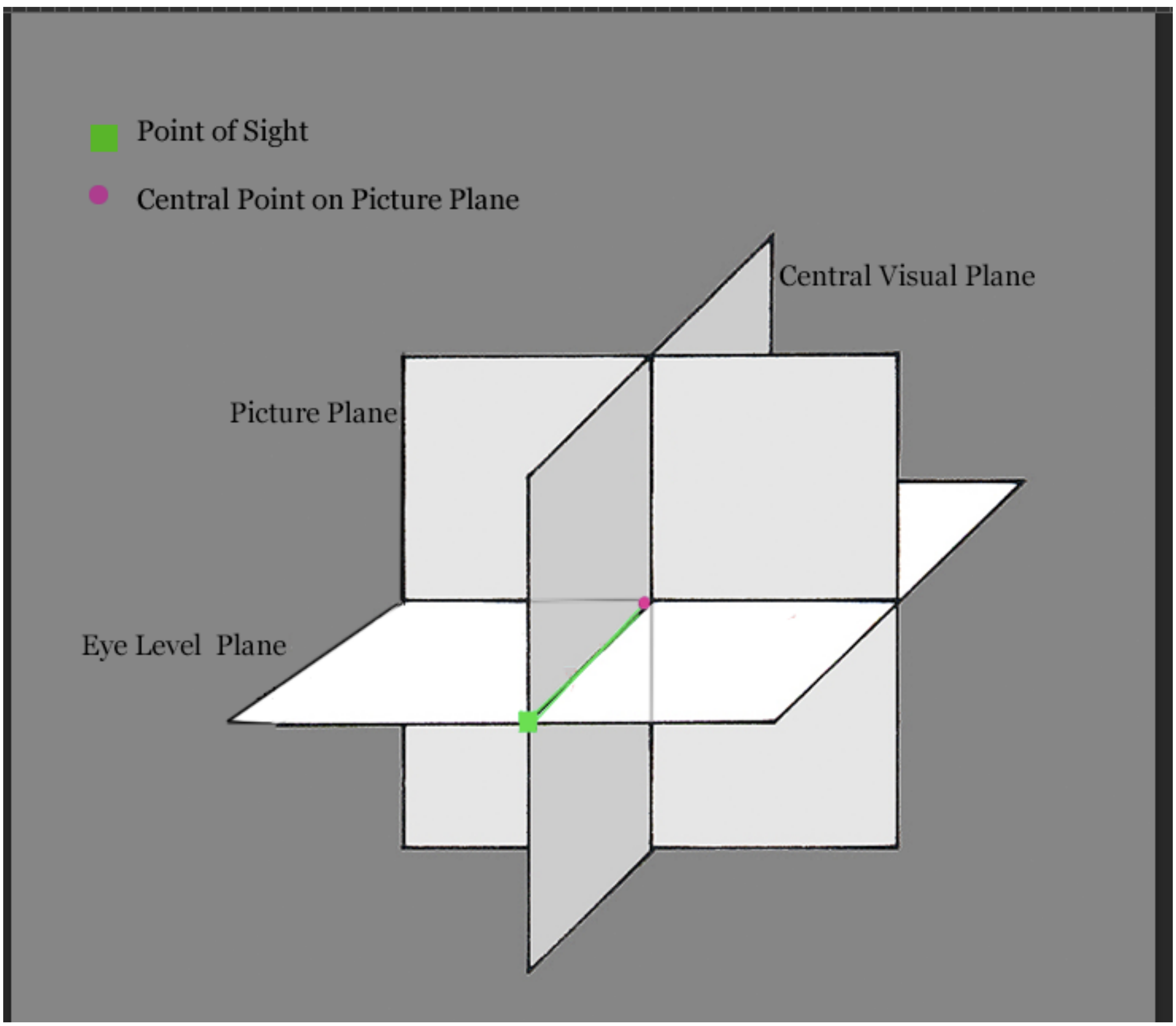
Drawing is often a matter of using visual conventions to describe three-dimensional objects on a flat surface called a picture plane.

Perspective drawing describes the appearance of objects seen from a single point of sight, that is from a particular perspective.

The reference planes for drawing are at right angles to one another. They are used for measuring along three dimensions, height, width and depth.

They are also used to measure the relationship between an object and an observer, measured in three dimensions, referred to in drawing as: height, width and depth.

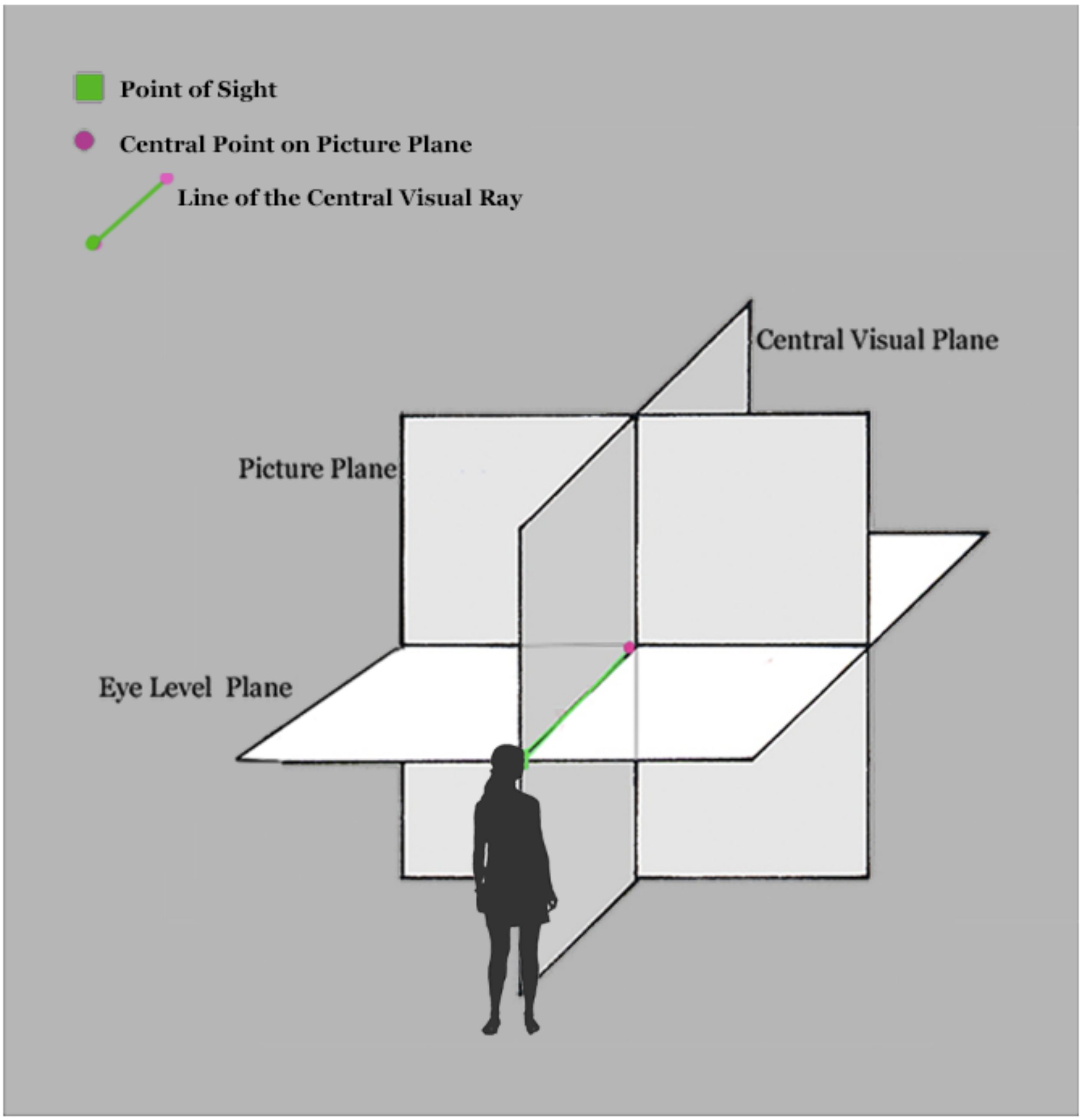
Fig. 1.



The three reference planes are called the Picture Plane, the Central Visual Plane and the Eye-Level Plane.

The reference planes for perspective are based upon a **Central Visual Ray** – a line from an observer's point of sight. The Picture Plane is *perpendicular* to that central visual ray.

Fig. 2. Reference Planes



2. Vocabulary

Some terms used in drawing are defined below. As each of these terms has fewer than three dimensions, so all of these terms are imaginary. In real life, artists use thick marks and blobs, referred to as lines or points, to represent these abstract concepts. (Fig. 3)

Aspect describes the tilt of the object's long axis and its rotation around that axis: the object's tilt and rotation are measured against the reference planes.

Position is defined as the location of an object in space, as measured against the reference planes.

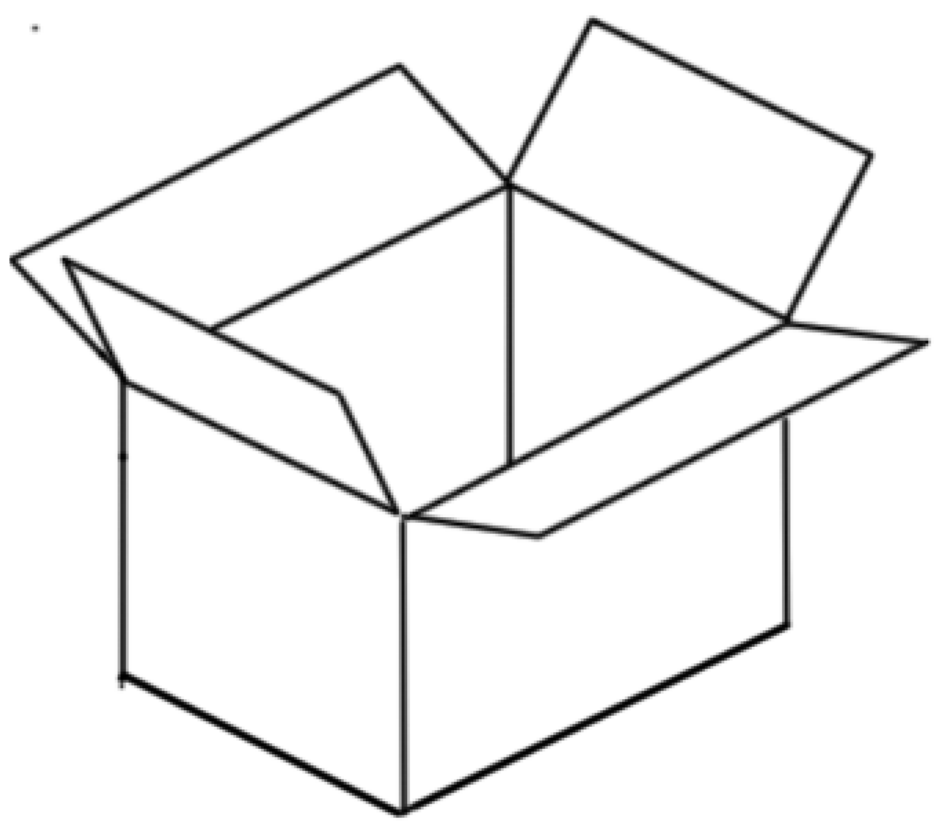
Points have no dimensions, only location. A line seen on end appears as a point.

Lines have only one dimension: length. A line may represent a plane on end. Artists draw lines to show the meeting of planes. A projected line from a point is called a ray.

Planes have only two dimensions: length and width. They represent the idea of a surface. Fig. 3 shows an open rectangular box, bounded by imaginary lines. The lines show where planes meet.

The outlines show the meeting of the planes that can be seen and planes we cannot see. Additional lines show where other planes meet, and so indicate where lighting will change.

Fig. 3



Vertical and Horizontal, Above and Below, Up and Down, Left and Right

Horizontal and Vertical are lines of direction imagined in relation to the earth. (Fig. 4.)

Vertical is a line running towards the center of the earth.

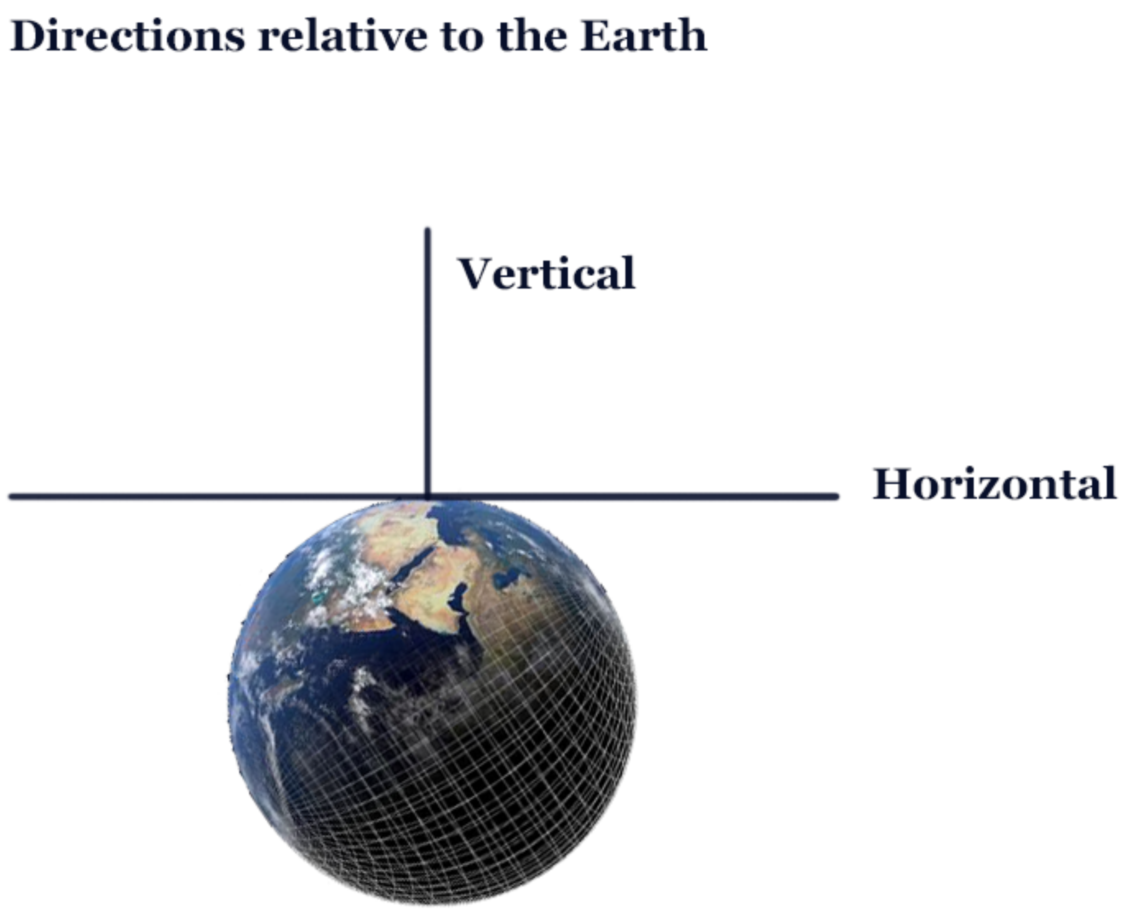
Horizontal is perpendicular to it, parallel with the visible horizon.

When we stand straight upright and look straight ahead on earth, neither up nor down, the eye level plane and the horizon plane coincide.

Looking straight ahead is the "common" way of viewing pictures and of viewing the world, and so it is called a "normal" perspective.

The horizon line is the eye-level plane seen on end.

Fig. 4.



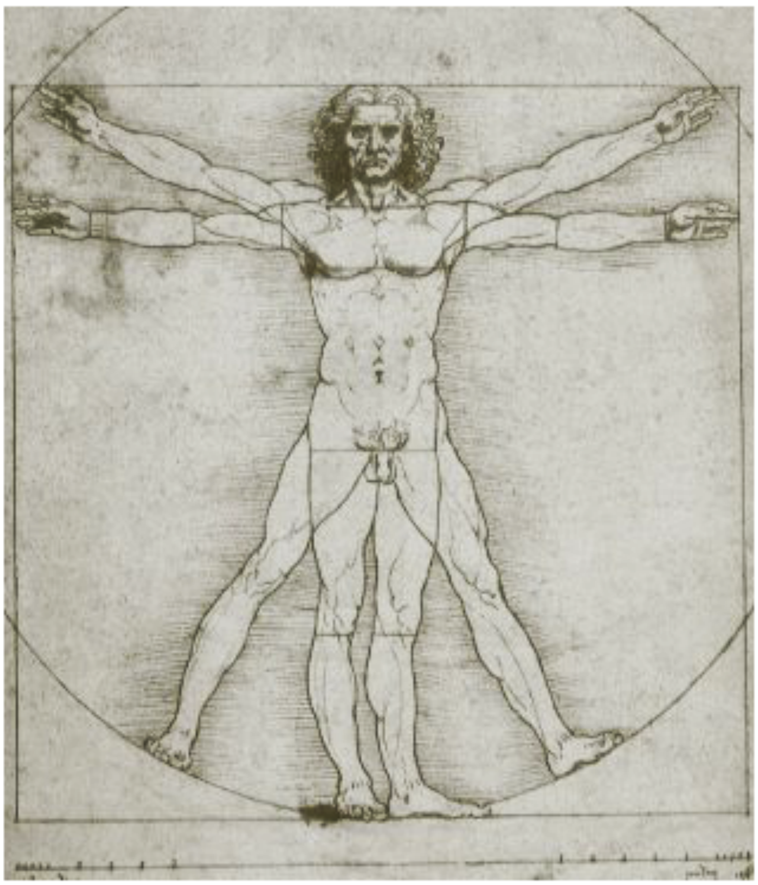
Above and Below, and Left and Right are directions imagined relative to an observer's personal sense of orientation in space.

On the perspective reference planes, distances to left and right of center or above and below the eye level plane will be measured on the picture plane.

When used in anatomical descriptions (Fig. 5) the words reflect measurements from the point of view of the body.

Fig. 5

Above



Below

Left and Right sides of one's body are named according to the person's own orientation when facing forward. Medical specimens are described in the same way.

Left

Right

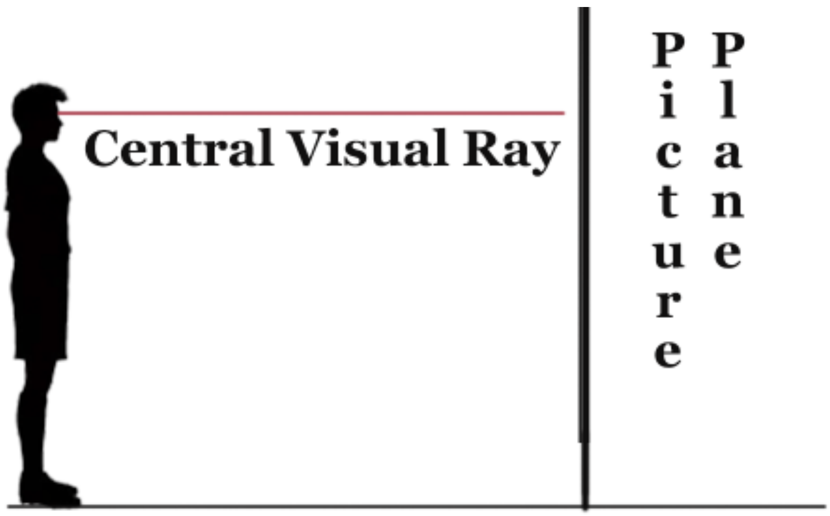
Fig. 6

Up and Down, besides being used commonly in relation to personal orientation or distance from the earth, also is used to indicate direction of movement along the *y-axis* in geometry and along the *height line* in a drawing.

A **Visual Ray** is an *imaginary line* from an observer's point of sight to a point on an object.

The **Picture Plane** is perpendicular to the central visual ray.

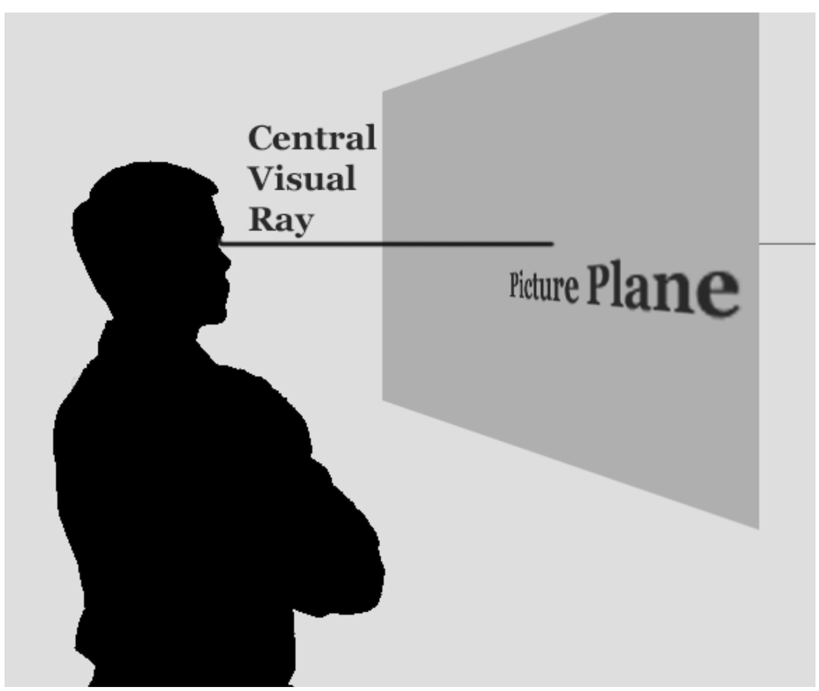
Fig. 7.



The picture plane, defined as perpendicular to the central visual ray, moves constantly with any change in the observer's direction of sight.

A discussion of the impact of eye movement on reference planes is found here.

Fig. 8.



<u>Locating Points in a Picture:</u> *Once familiar with the use of reference planes in thinking about the aspect and position of form, one can locate the points on a drawing by ascertaining where a visual ray from the point of sight to the point on the object pierces the picture plane. That will be the location of the point in the drawing. The artist invents the location of the picture plane. It is imaginary. The ability to imagine it comes from practice with reference planes.*

Fig. 9

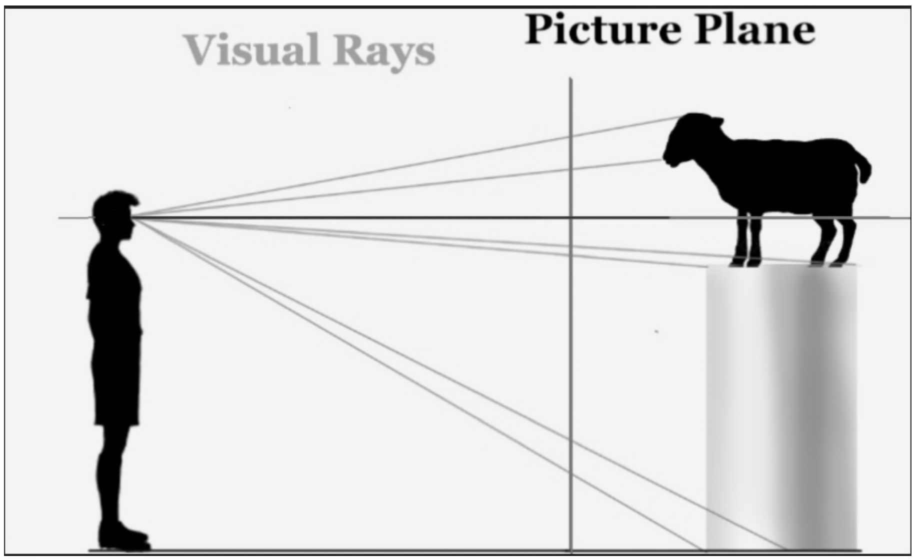
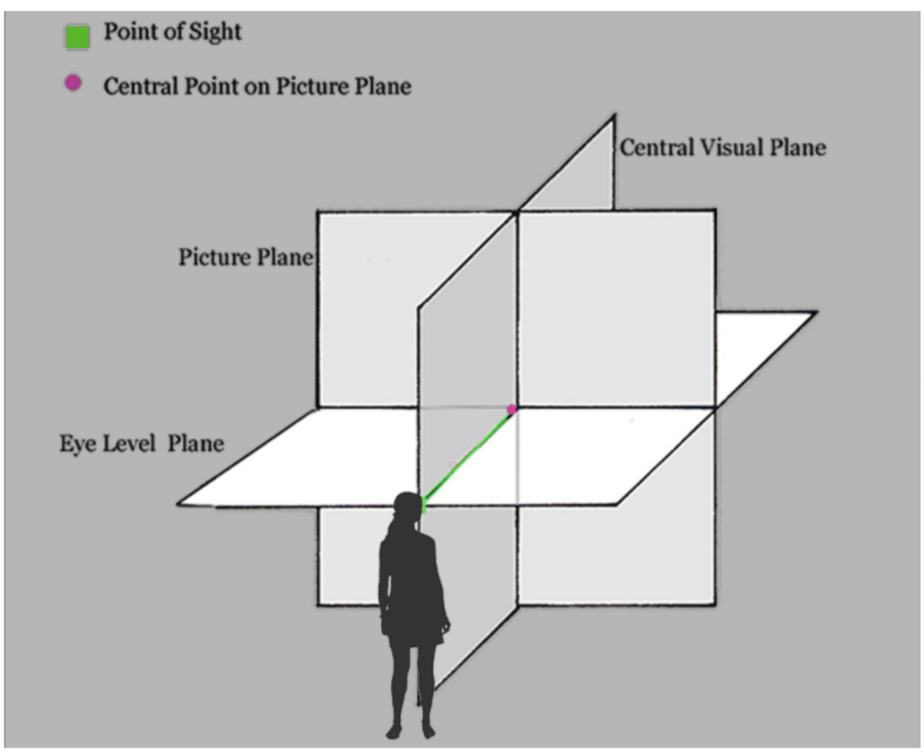


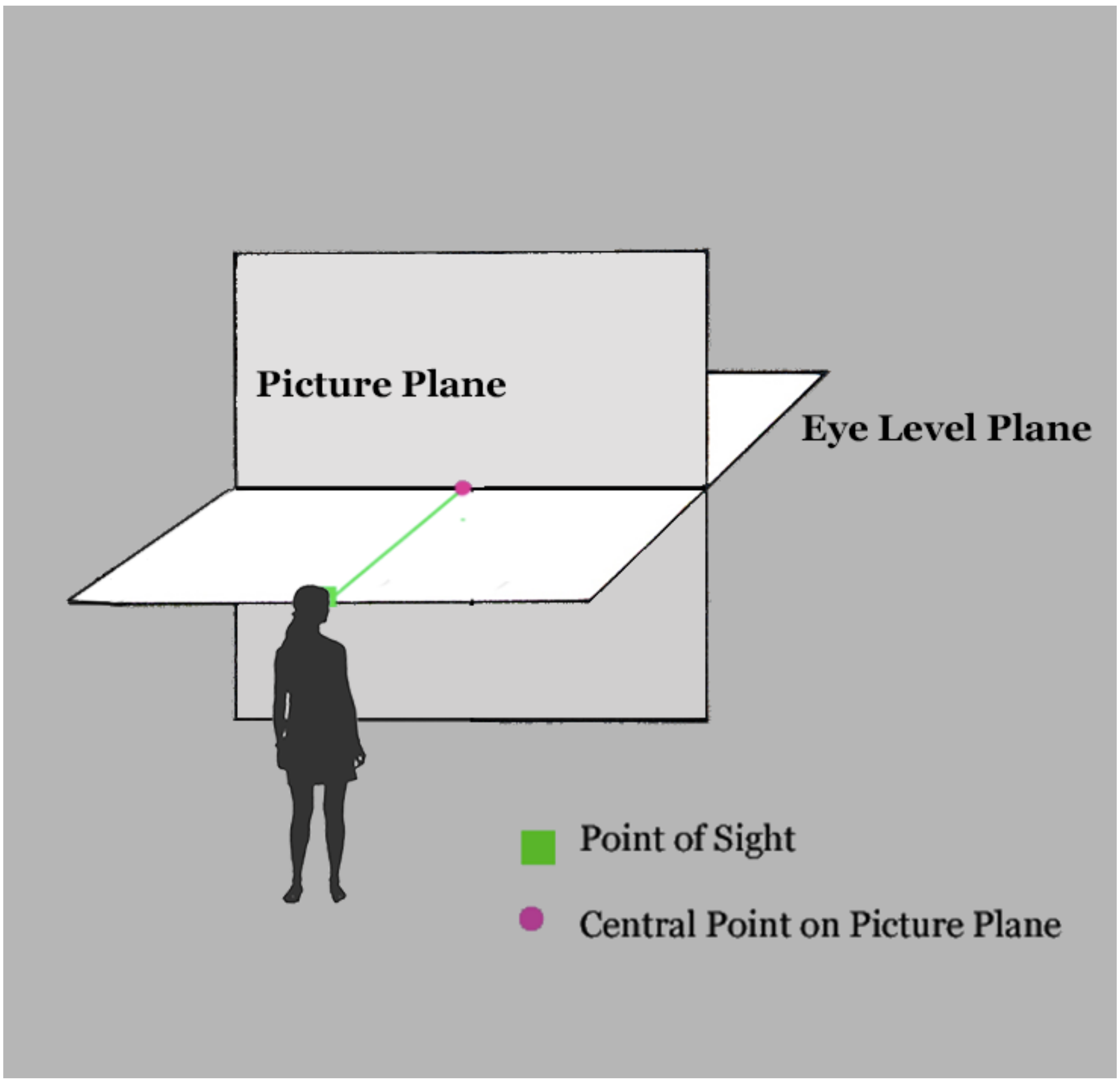
Fig. 10



3. Three Reference Planes and Architectural Elevations

The Eye Level Plane is on eye level. It is perpendicular to the picture plane. If standing on earth looking straight ahead, it is the same as the horizon plane. Where the eye-level plane and picture plane intersect, the eye level plane would be drawn as a horizontal line on the picture plane.

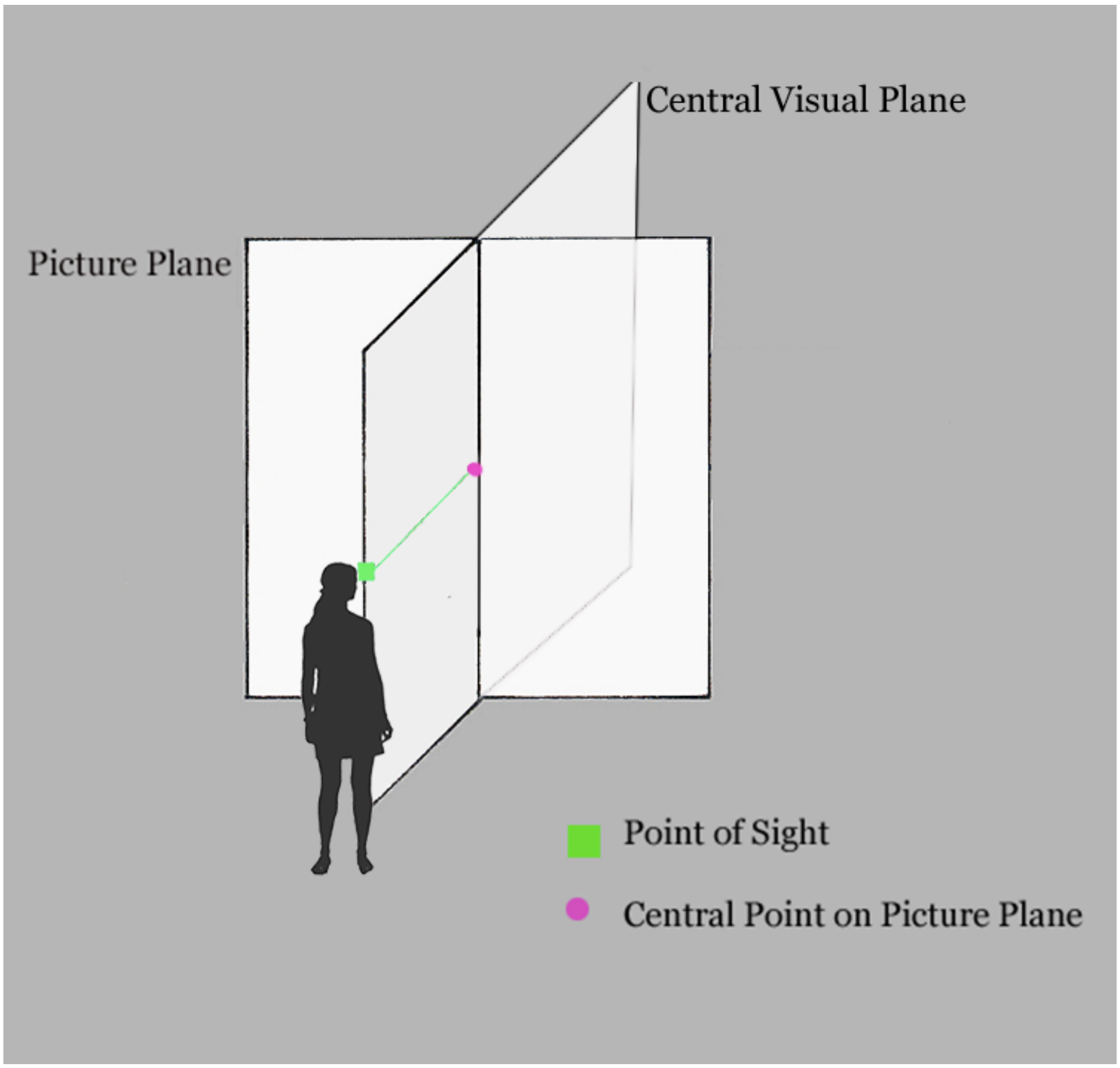
Fig. 11.



The Central Visual Plane is perpendicular to the picture plane and to the eye level plane.

Where it intersects the picture plane, the vertical line marks visual center of the picture plane.

Fig. 12

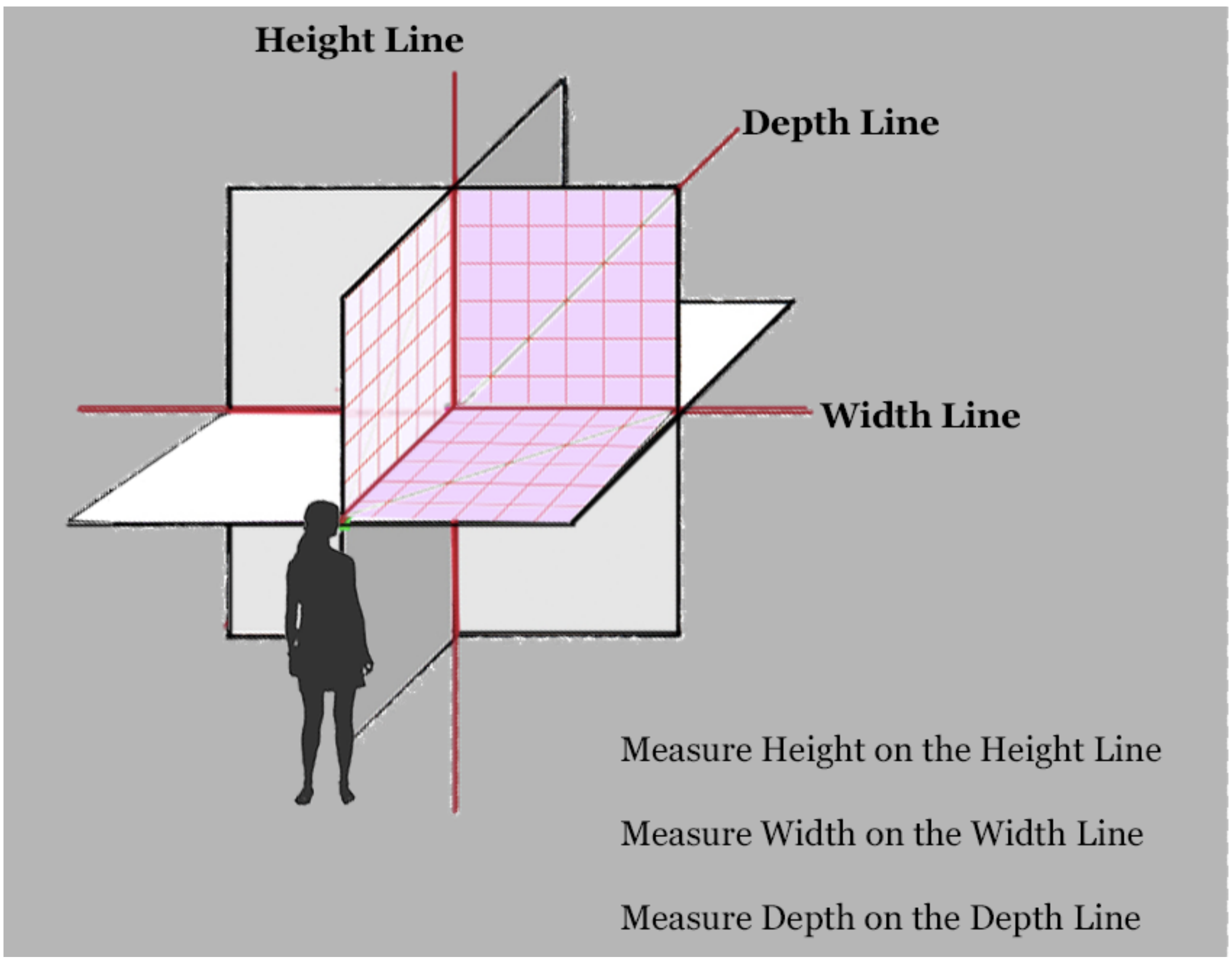


Line Systems

Lines indicating height, width and depth are created by the meeting of the three reference planes.

By measuring along the height, width and depth lines on the reference planes, an artist can locate any object in space in relation to a fixed point of sight.

Fig. 13



Plans and Elevations – The Reference Planes Drawn in Orthographic Projection

Views of the reference planes from the top, side and front are called elevations.

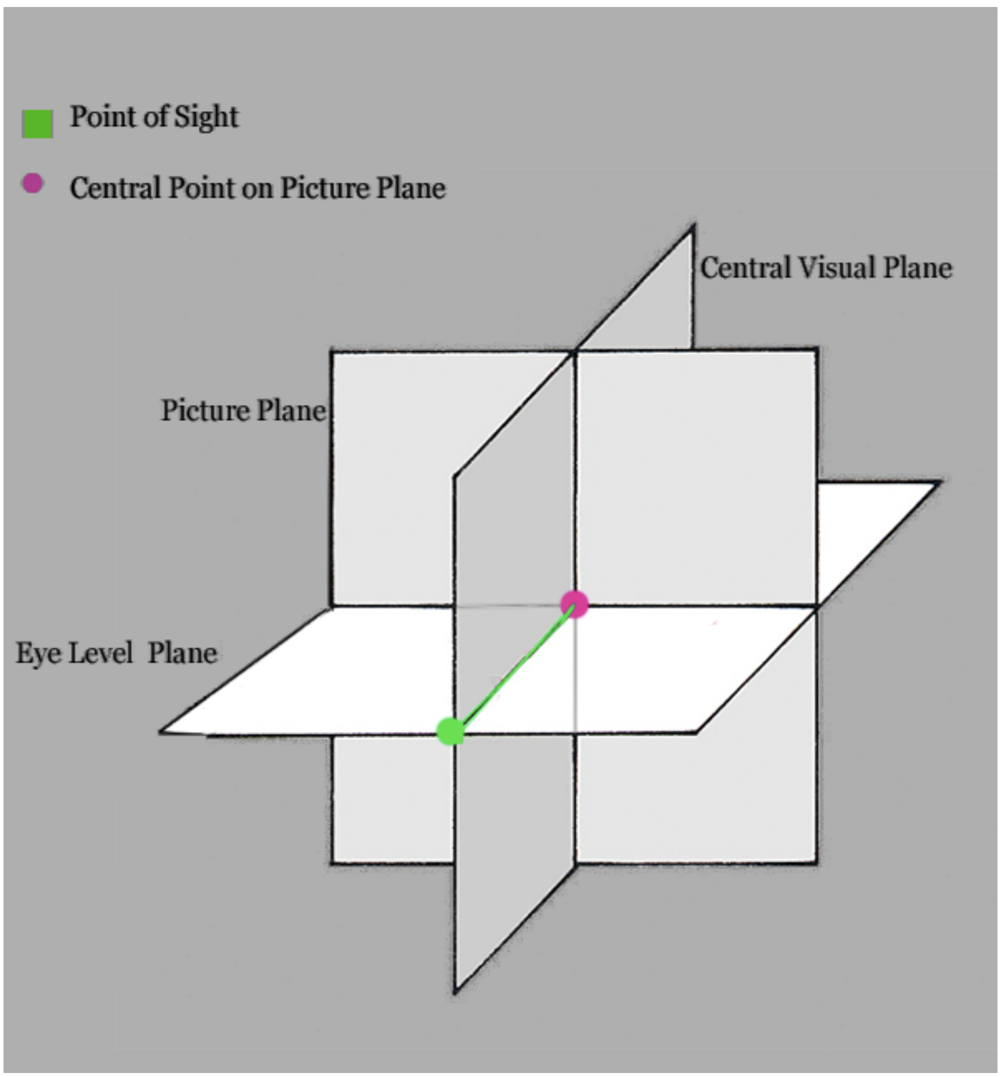
The top elevation is the plan. The side view is called the side elevation. The front view is called the front elevation.

It was by the use of these three *measured* views that Renaissance engineering of all kinds developed.

Subsequently, with the inclusion of an observer's point of sight, artist-architect-theoreticians like Brunelleschi, Leonardo, Alberti and Durer developed the science of perspective and transformed Western art.

This is a familiar view of the reference planes, with the point of sight indicated in green and the central point on the picture plane as shown in red in Figure 14.

Fig. 14.



Picture Plane as a Front Elevation.

Imagining ourselves at an infinite distance, an orthographic view of the picture plane will be called the front elevation.

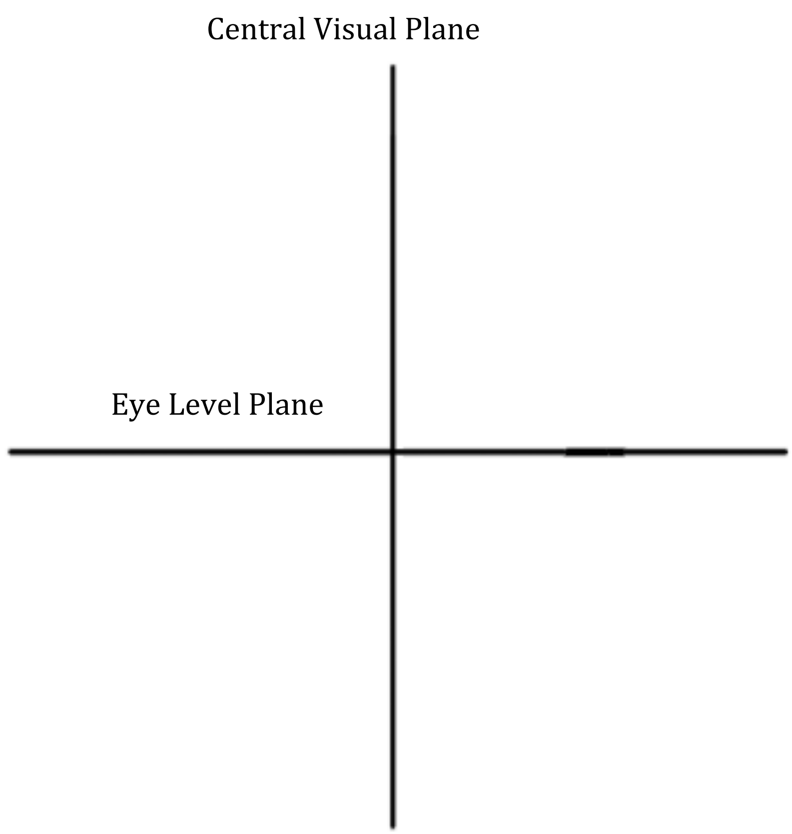
The central visual plane, will be seen as a plane on end, and appear as a vertical line. It is the height line.

The eye level plane on end appears as the horizon line. It is the width line.

We can locate points on the front elevation by measuring their distances from the eye level and center lines. These are the axes on which architects draw a measured front elevation, and from which the artist can construct a perspective picture.

Fig. 14a

The Front Elevation.



Orthographic Views and Parallel Visual Rays

The front view of our reference planes shown above represents the "edge" of the central visual plane and the edge of the eye-level plane, each seen on end from an imagined distance infinitely far and viewed from a single direction.

In Figure 15, the open-faced cube is seen on the front view, in orthographic projection.

The red lines on the adjacent side view show the imaginary parallel visual rays striking the cube.

Only the inside back of the open cube and the edges of the four open sides of the cube are "seen" by these parallel visual rays. They are drawn as a square around the back plane.

Perspective drawings in Fig. 16 depend on a fixed point of sight. As the point of sight approaches the cube, visual rays strike the inside top, bottom and sides. As the point of sight approaches further, more of the sides are seen compared to the back surface. As the point of sight recedes to infinity, less of the top, bottom and sides are seen, until only the square of the facing edges remains.

Fig. 15. **Parallel Visual Rays** Side View Front View

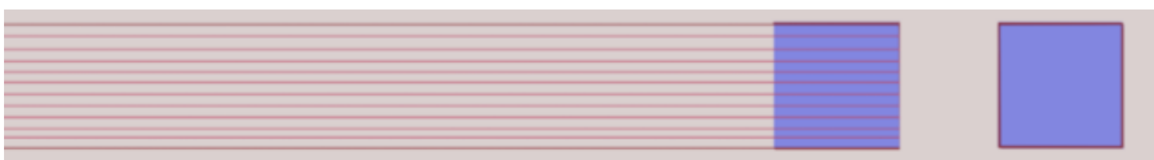
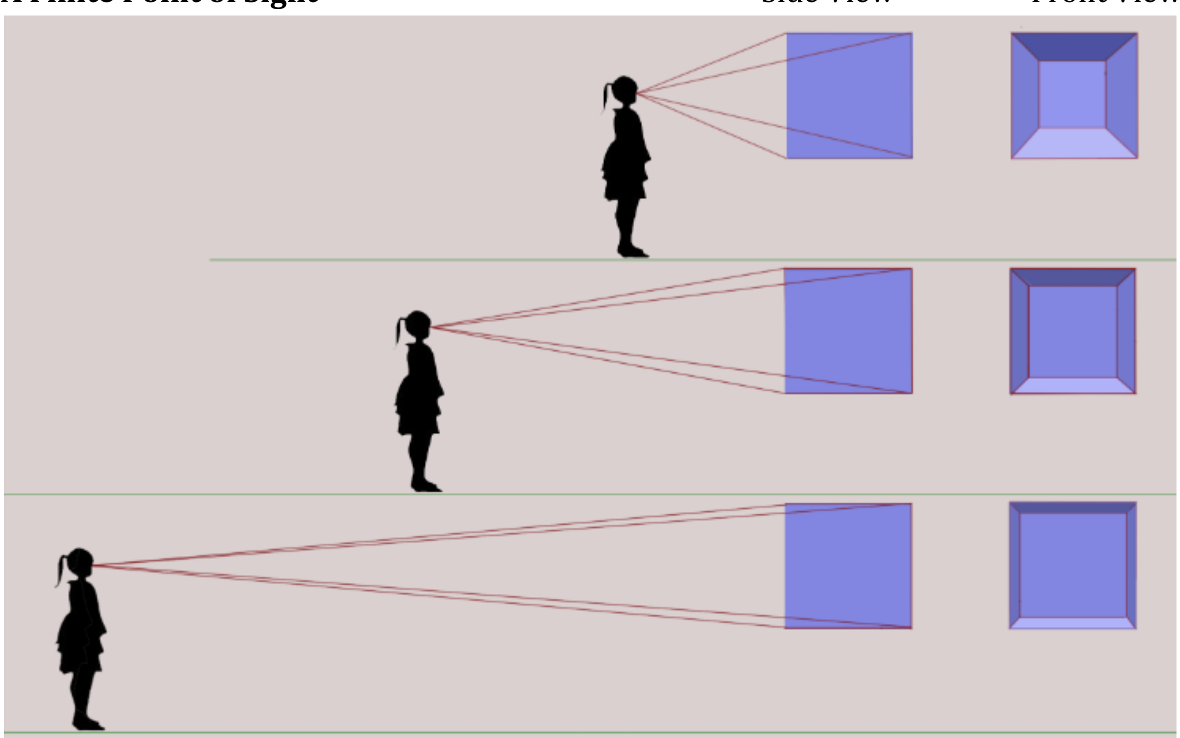


Fig. 16. **A Finite Point of Sight** Side View Front View

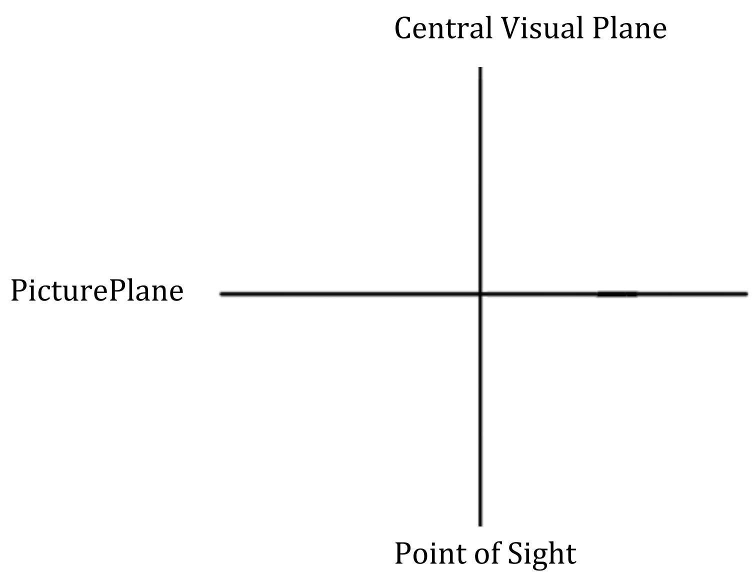


The Plan.

The Plan is the top view of the reference planes using orthographic projection. It is an imaginary view looking down on the eye level plane from an infinite distance.

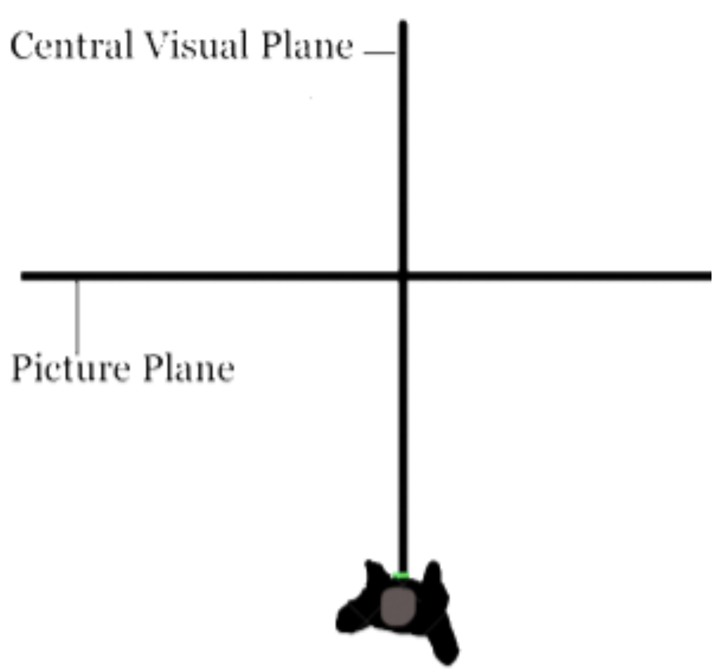
Objects may be located on the plan by measuring their depth from the observer along the central visual plane, or their position to left and right of center on the width line, here representing the picture plane seen here on end.

Fig. 17.



Here is an image of a plan with an observer added for clarification.

Fig. 18



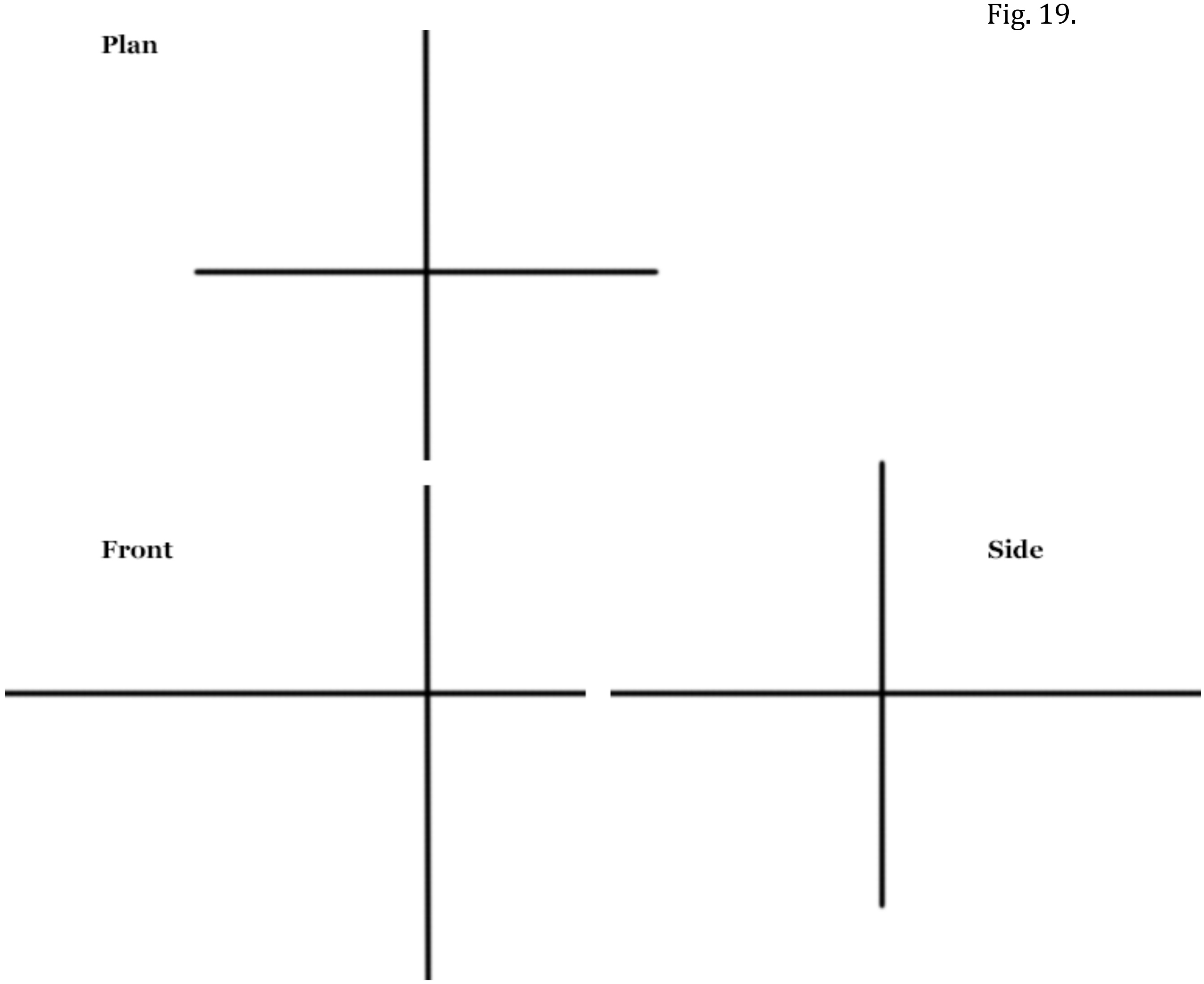
Using reference planes and measuring along the height, width and depth lines, we can locate objects in space relative to an observer.

To develop a perspective drawing, front elevation, the plan and the side elevation are displayed together.

This allows height measurements from the side elevation and width measurements from the plan to be combined and transferred to the front view.

The plan, side and front elevations are shown together below for the transfer of measurements to the front view.

Fig. 19.



The central visual plane and picture plane are lines in the plan.

The picture plane and the eye level plane are lines in the side elevation.

The central visual plane and eye level plane are lines in the front elevation – the picture plane.

Front Elevation and Projection of Parallel Visual Rays

Figure19 illustrates the meaning of using parallel visual rays for measuring; that is: using orthographic projection to create a front elevation.

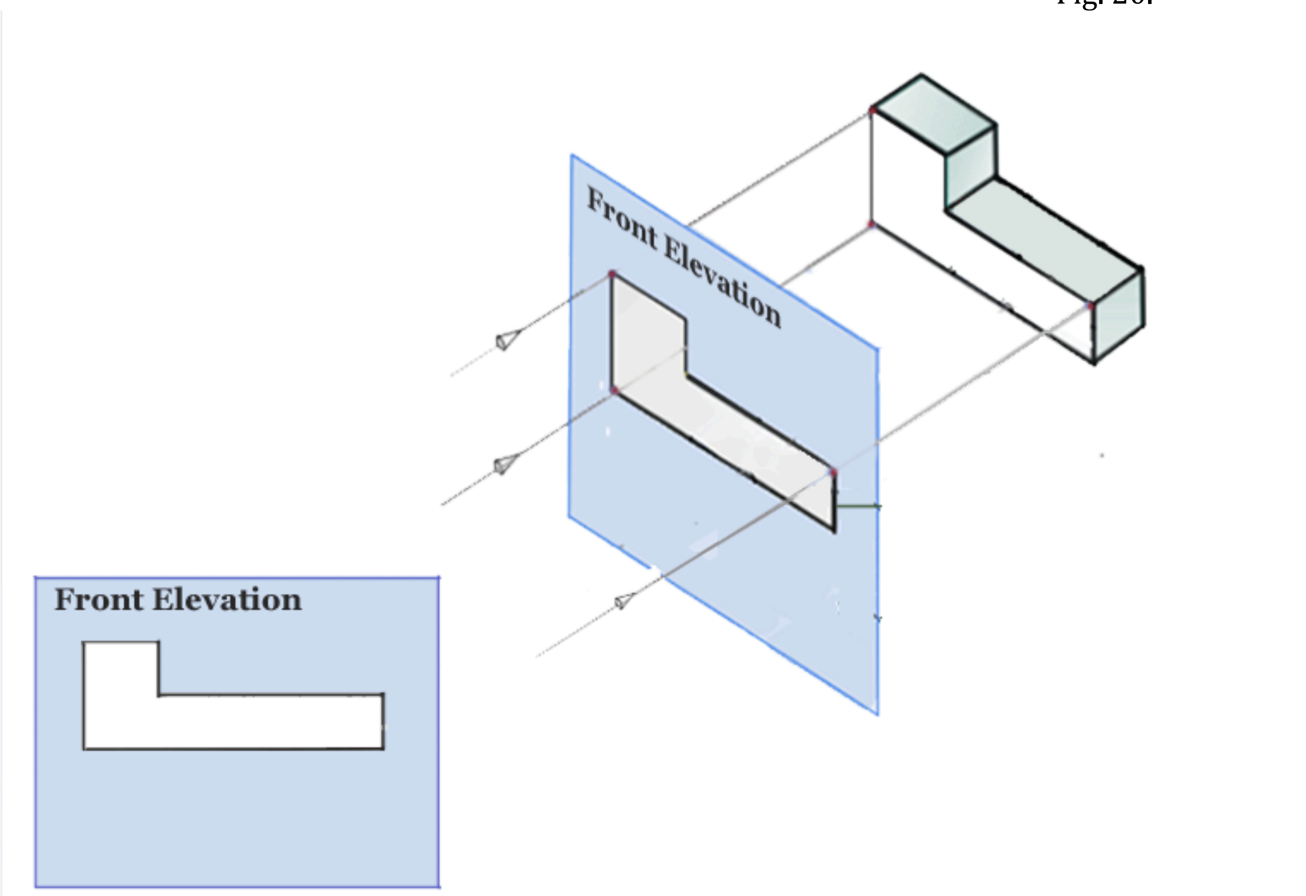
The stencil shown below is being used to measure a front elevation.

The stencil could be against the object itself allowing a direct tracing for this front elevation. Objects against the picture plane can be directly measured in this way.

Or as shown below, the stencil can be held away from the object, and with *parallel rays,* the object could still be measured accurately.

The front elevation derived is shown in the lower right.

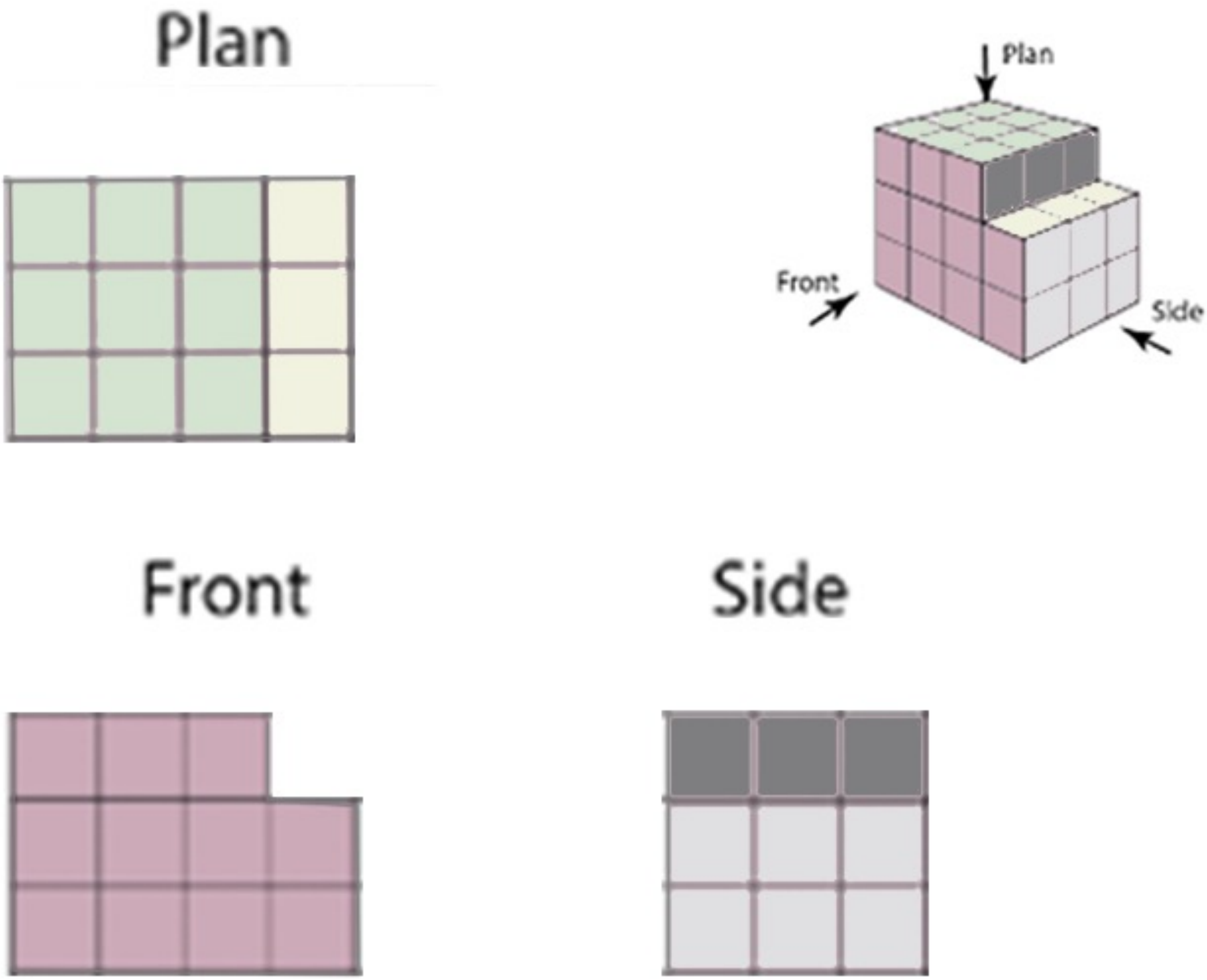
Fig. 20.



Three Elevations

Combining the front and side elevations and the plan allows accurate description of the true shape of an object. Figure 21 below illustrates how a block could be reproduced exactly from three drawings.

Fig. 21



Creating a Front Elevation from Plan and Side Elevations:

The distance of the object to the left or to the right of the central visual plane is measured on the plan.

The height above or below eye level plane is measured on the side elevation.

The distance of the object from the picture plane is read on both plan and side elevations.

Below is a cube and a set of reference planes. The plan (upper figure) shows the cube to be slightly rotated in relation to the picture plane.

We see that it lies upon on the eye level plane, by referring to the side elevation. From the side elevation, we see that the cube is not tilted.

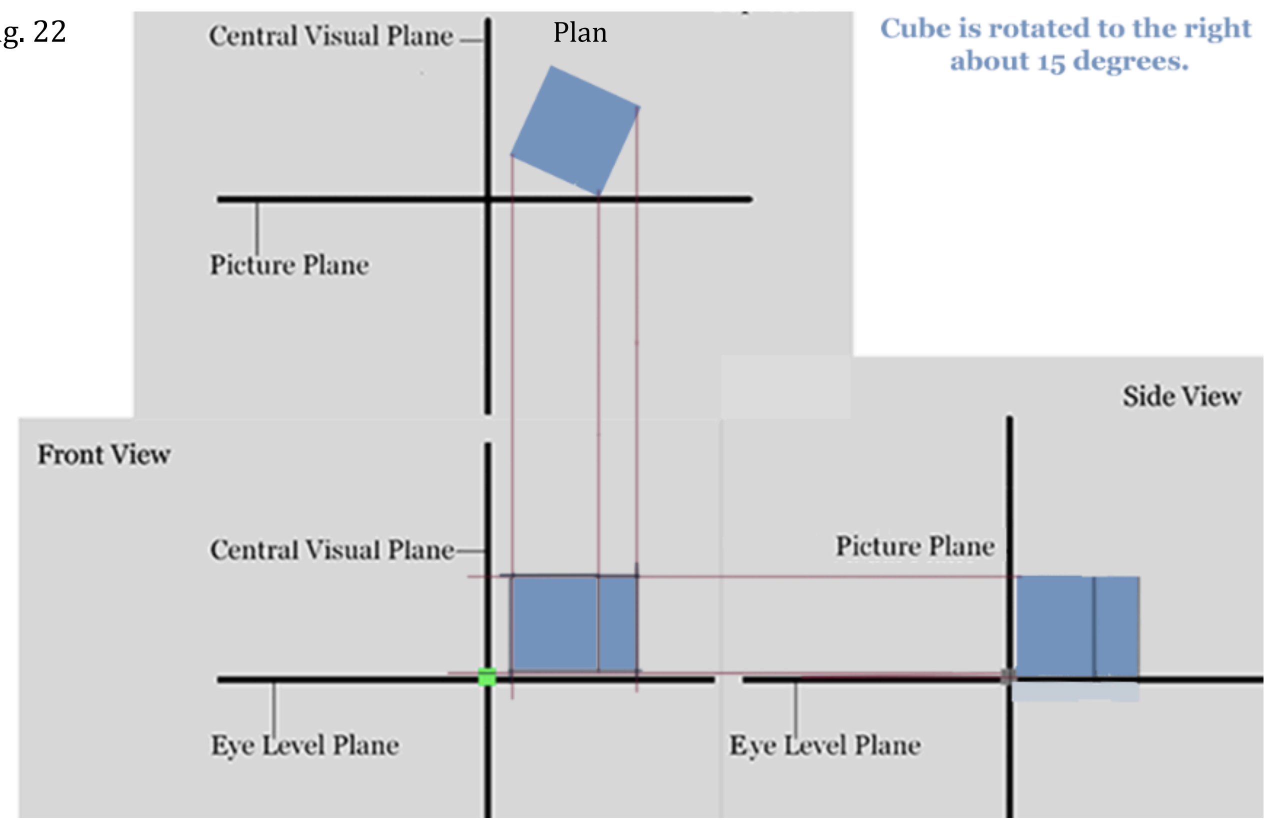
The plan shows that the cube's position is slightly to the right of the central visual plane.

This measured front view, an orthographic drawing of the front of the cube, is the front elevation. No observer point or perspective view has yet been considered.

The front elevation was constructed by using the red construction lines drawn across and down from the other two elevations. The elevations give the true relative dimensions of the object in space in relation to the reference planes.

We will use the plan and side elevation to construct perspective front views.

Fig. 22



Aspect and Position - Measuring Position and Aspect using Architectural Elevations

To draw a form in perspective the artist must know that it exists, come to a conclusion as to its shape, and determine its position and aspect.

The reference planes permit us to measure both position and aspect.

Aspect describes the tilt of the object's long axis and its rotation around that axis, measured against the reference planes.

Position is the location of an object in space in reference to an observer, as measured against the reference planes.

The axes represent the central visual and eye level plane where they intersect with the picture plane and provide the height and width lines of measurement.

A plan and side elevation of a cube.

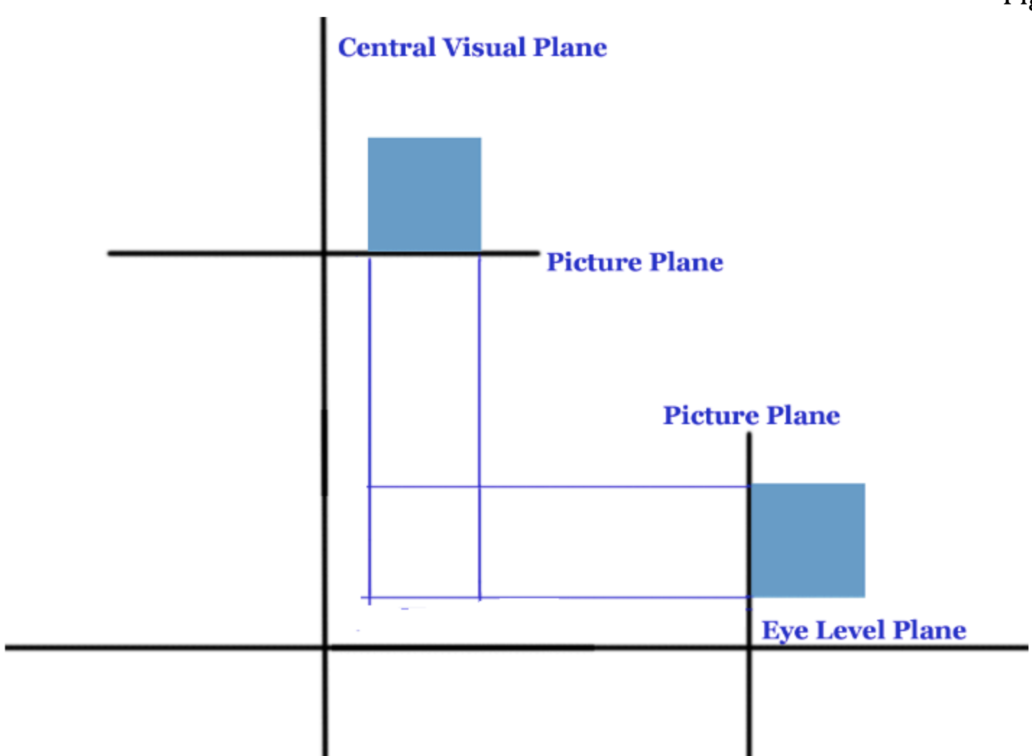
The four boundaries of the front of the cube are located by measuring from the top and side views.

The side elevation and plan explain both the aspect and position of the cube in Figure 23.

Aspect: The cube is placed at right angles to the picture plane and to the central visual plane.

Position and Size: The cube is 2 units square; it is located 1 unit to the right of the central visual plane, and 1 unit above the eye level plane.

Fig. 23



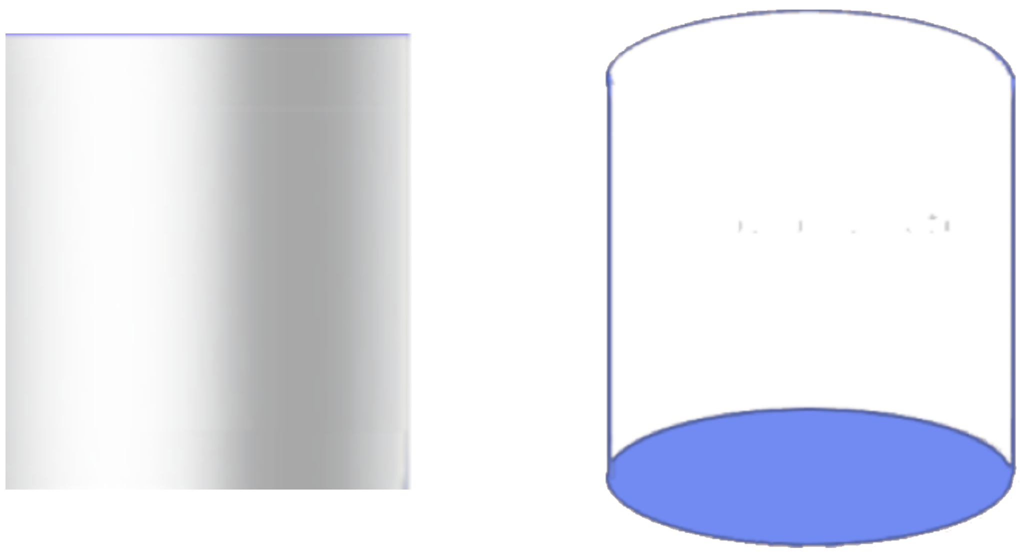
<u>4. Position and Aspect</u>

Point of View: Above and Below

Changes in aspect and position of an object in relation to an observer change the appearance of that object.

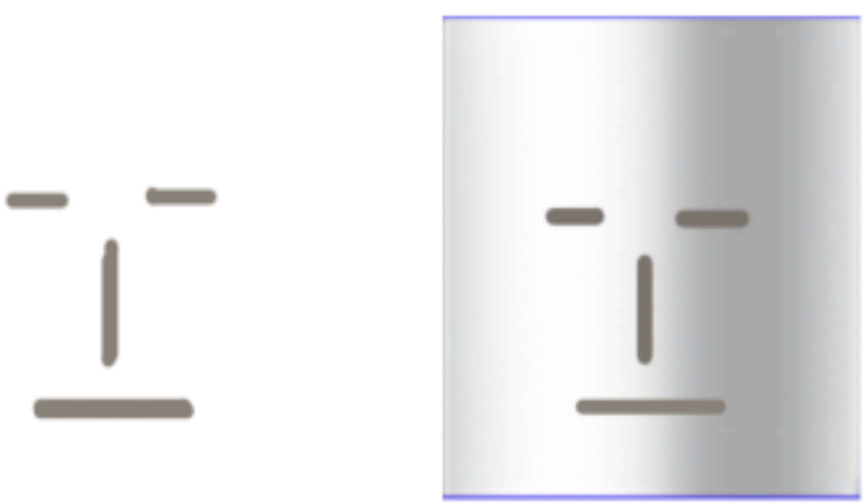
On the left is a front elevation of a cylinder. The top and bottom are circular and flat. Lines around the cylinder would appear as straight lines in the front elevation. However, on the right image of a cylinder seen from below, a straight line around the top and bottom edges of the cylinder will follow the curve of its surface.

Fig. 24



If straight lines representing the features, are drawn as straight lines on the front elevation of the cylinder as in Figure 25 they will retain their appearance.

Fig. 24



When the same lines are drawn on the cylinder seen from below, they follow the curve of a line around the form as it would be seen from below.

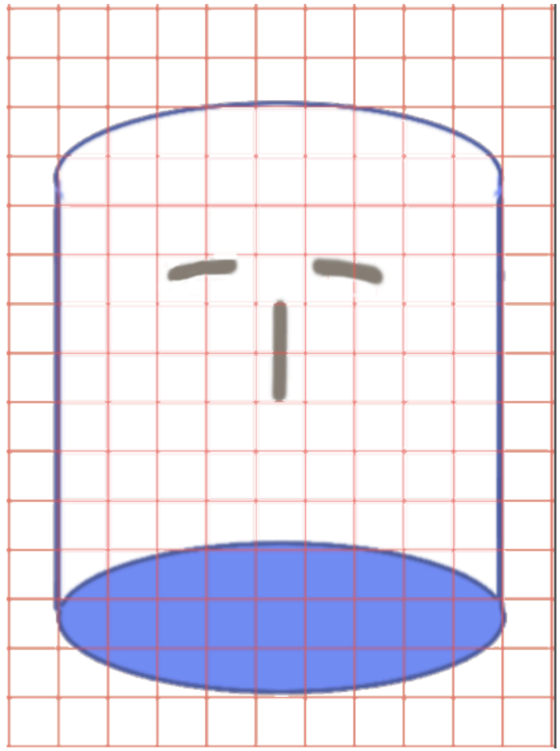
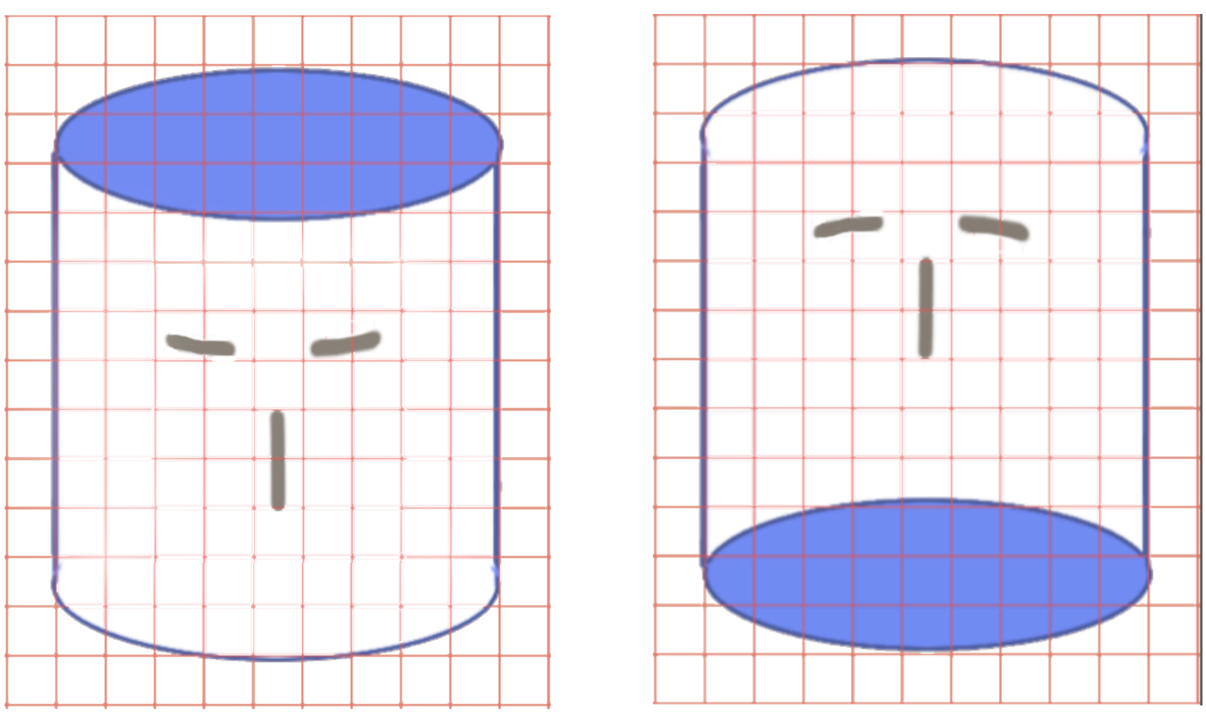


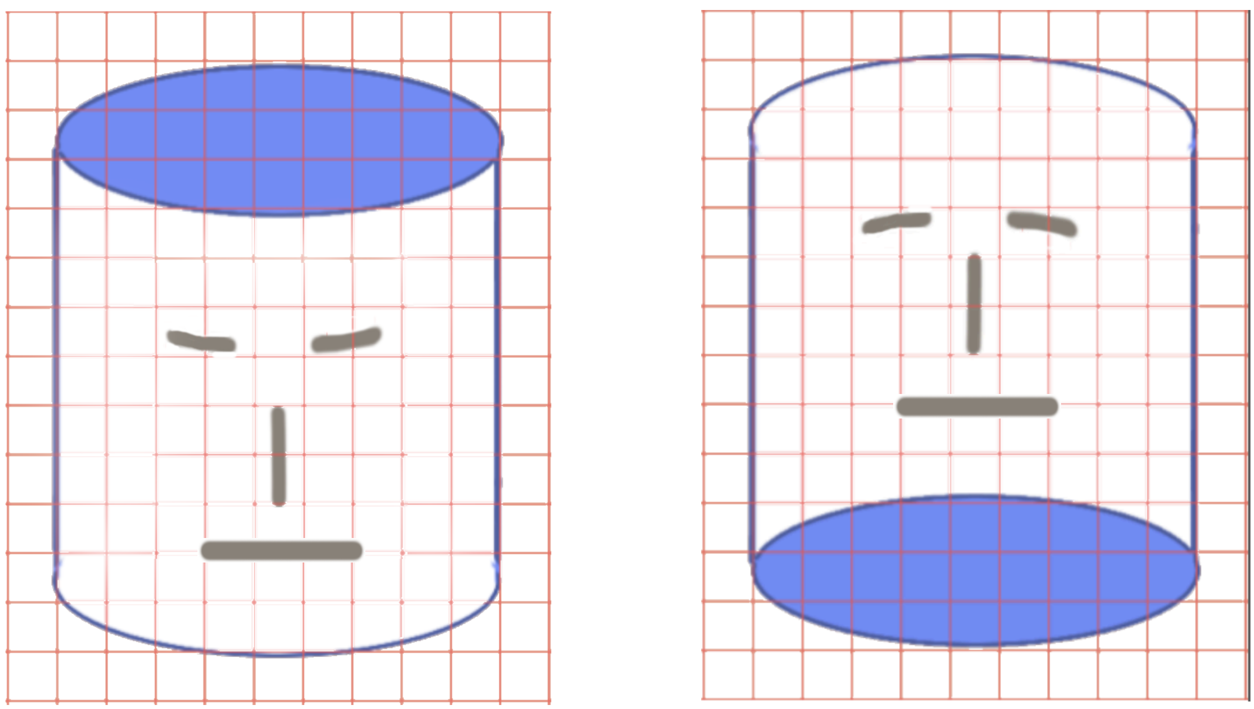
Fig. 25

Fig. 27 shows the straight "feature" lines drawn on the curved surface of a cylinder, imagined first from above and then from below for comparison.



If one uses the same straight line for the mouth, Figure 28 shows two very different appearances.

Fig. 27



The image will appear to have a sadder face on the left and a happier one on the right.

The reason is that an observer knows from early experience that the line of the mouth will follow the shape of the form over which it travels, *as do all straight lines over curved forms.*

Our brains interpret details on a mass in terms of the larger mass on which they lie, and not independently of it.

Concentration on detail over underlying form may indicate what interests the artist, but does give a good representation of what is being observed.

One recognizes a person at distances that preclude observation of facial features; and the beginner's habit of concentrating on the most interesting or erotic features, while of use for caricature or humor, seldom reproduces the actual appearance of the model.

Lines and visible planes change with changes of Aspect and Position.

When seen from above in relation to an observer, how does the artist assess *the relative measurements* of the visible top and side planes on this cylinder – for example, located below the eye level? How does the artist calculate the amount of apparent curvature of top and bottom or of any line around the cylinder? The answers to these questions are found in the side elevation. The cylinder looks like Figure 29 in a front and side elevation.

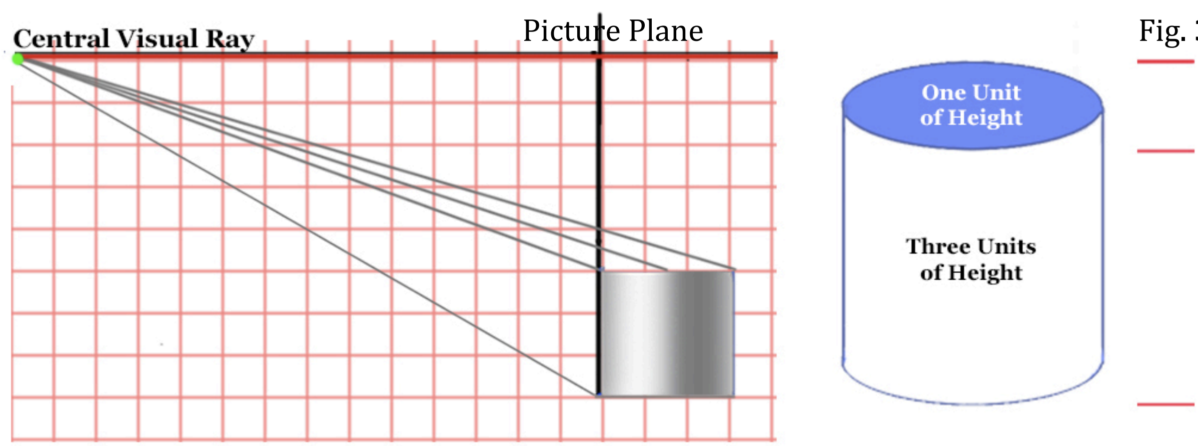
Fig. 29

Below is the side elevation showing the cylinder below eye level. To the right, is the one-point perspective drawing derived from this elevation. It gives an example of how point of sight is used by an artist to assess both relative vertical measurements of the drawing and the curvature of lines around the form.

In the freehand sketch below, the observer distance and the size of the cylinder are drawn in their true relation. The point where the visual rays cross the picture plane in the side elevation give the height of that point on the front view.

In this sketch, the cylinder is placed against the picture plane. The relative *approximate* visible amounts of the cylinder's front and top planes are measured on the vertical picture plane, and then are copied in scale to the drawing to right of the side elevation. *This exercise empowers the artist to approximate these relationships.*

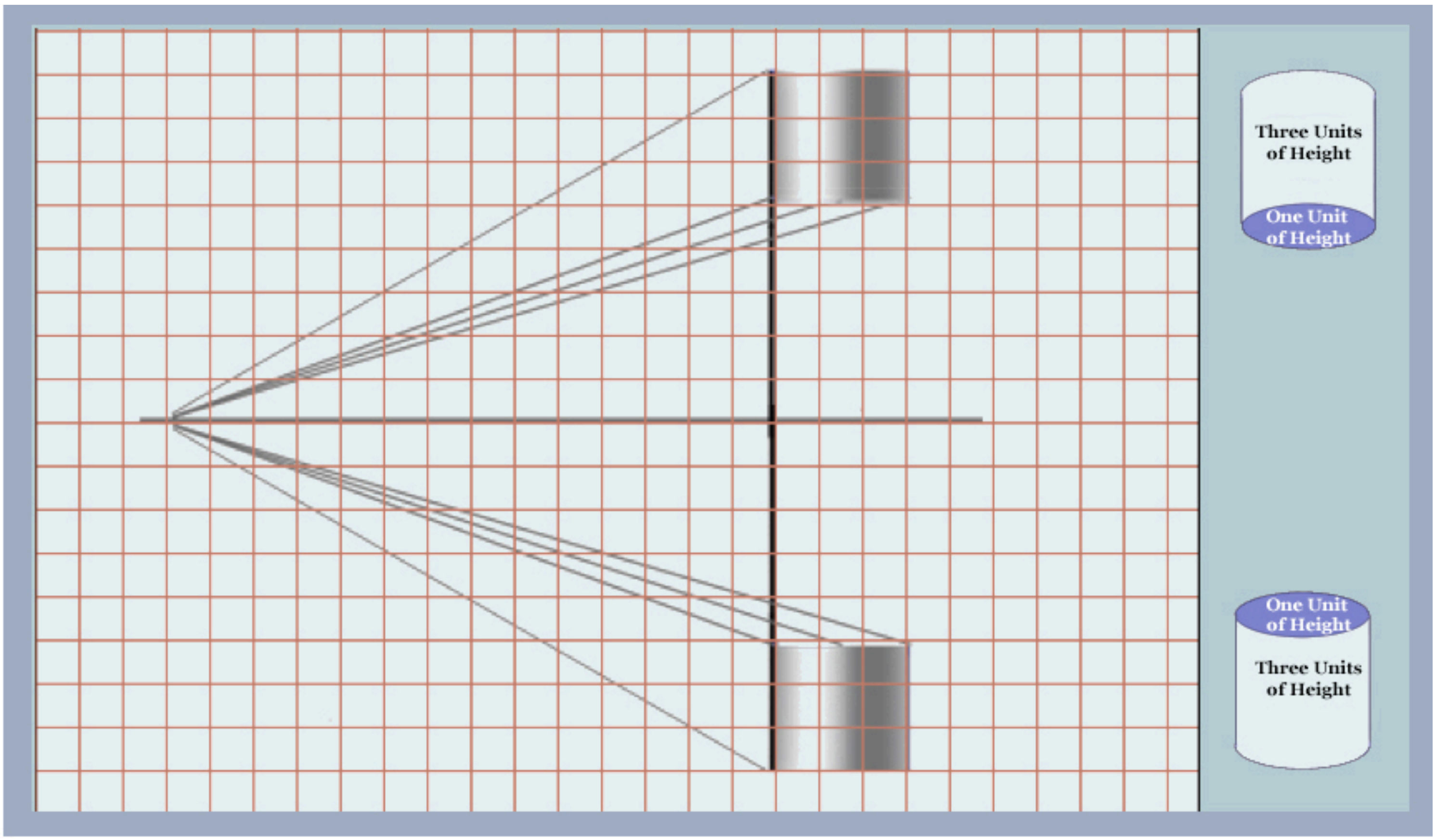
Fig. 30



The same relative measurements and curves apply to these cylinders, whether they are equally above or below the observer.

To the left are side elevations and to the right are the related one-point perspective drawings.

Fig. 31



A Cylinder from Below in Oblique Projection.

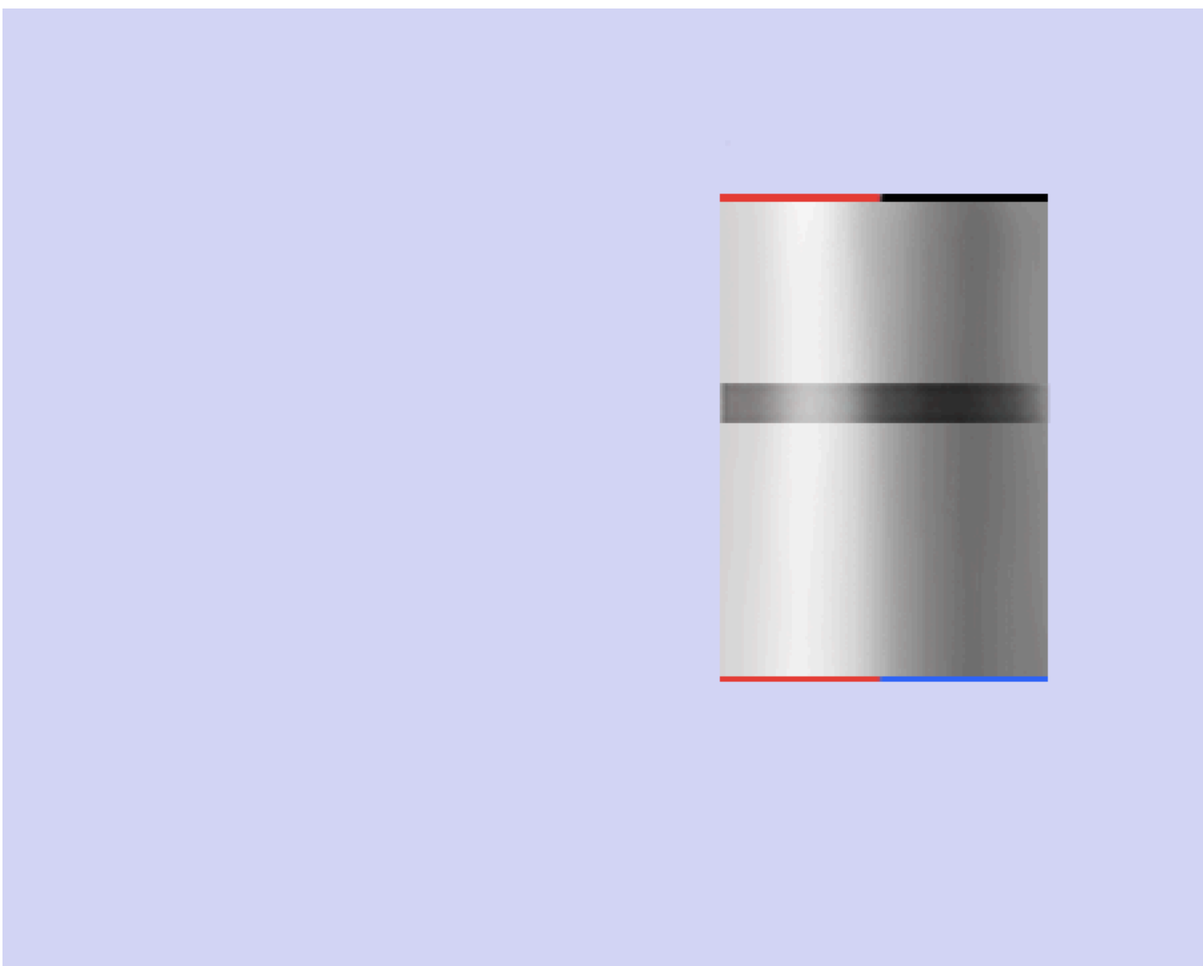
Oblique projection uses parallel visual rays at an angle to the picture plane as shown below. It offers a simple way to assess the impact of aspect and position in appearance.

Without considering the perspective created by a fixed point of sight, the artist can still estimate the effect of views from above or below by using this simple drawing system that measures with parallel visual rays.

This cylinder's aspect is imagined to be vertical in relation to the reference planes.

This is a side view of a cylinder in orthographic projection: A side elevation.

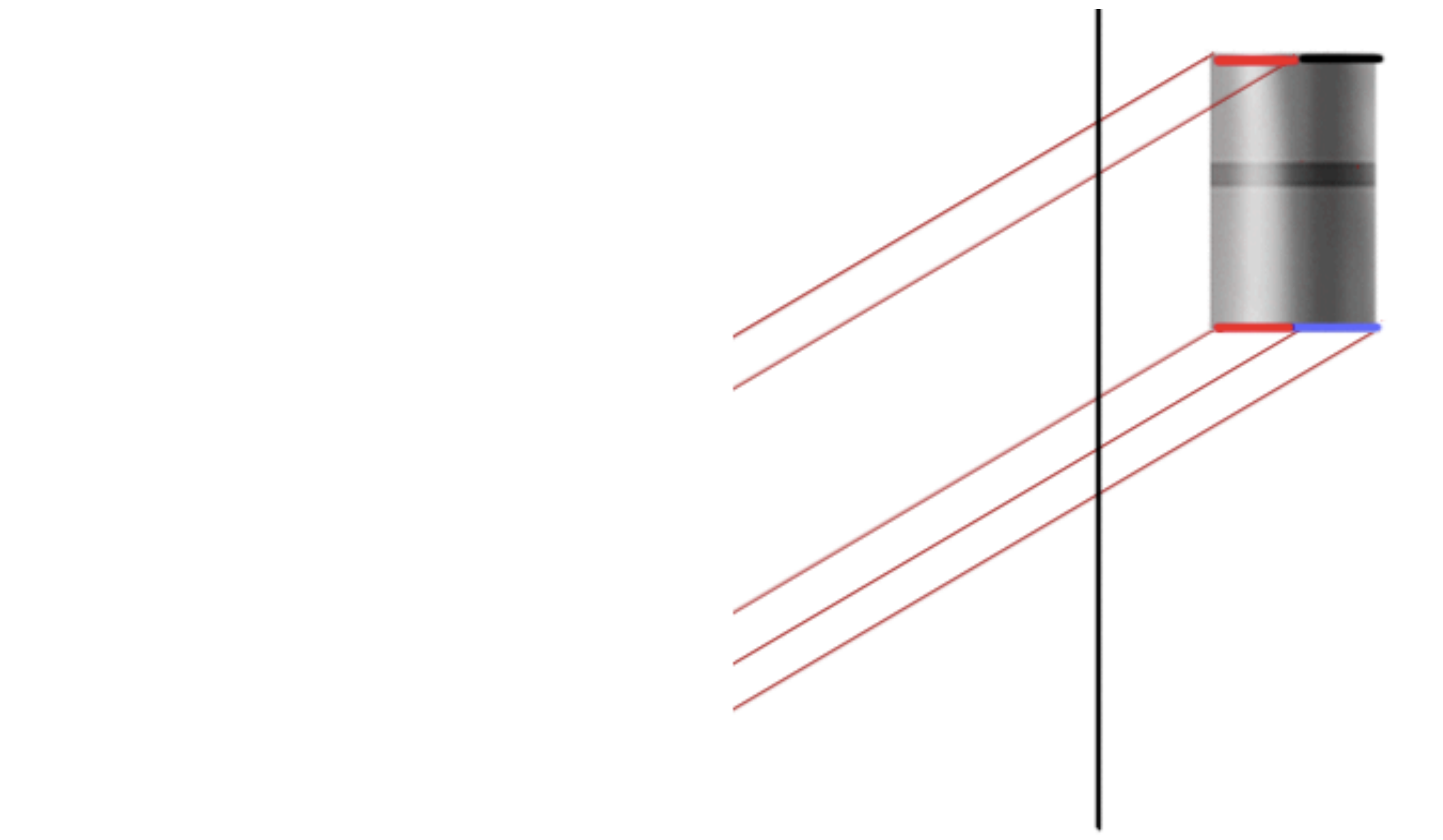
Fig. 32



Below is an illustration of oblique projection. Imagine a picture plane and parallel visual rays striking the cylinder obliquely at an angle from below. It is a simple way to consider the change in appearance when an object is thought of as above the observer.
It does not represent the human visual experience, but is useful for estimation and understanding of aspect and position.

The cylinder is imagined to be vertical, and from a very far theoretical distance is observed from below in Figure 33.

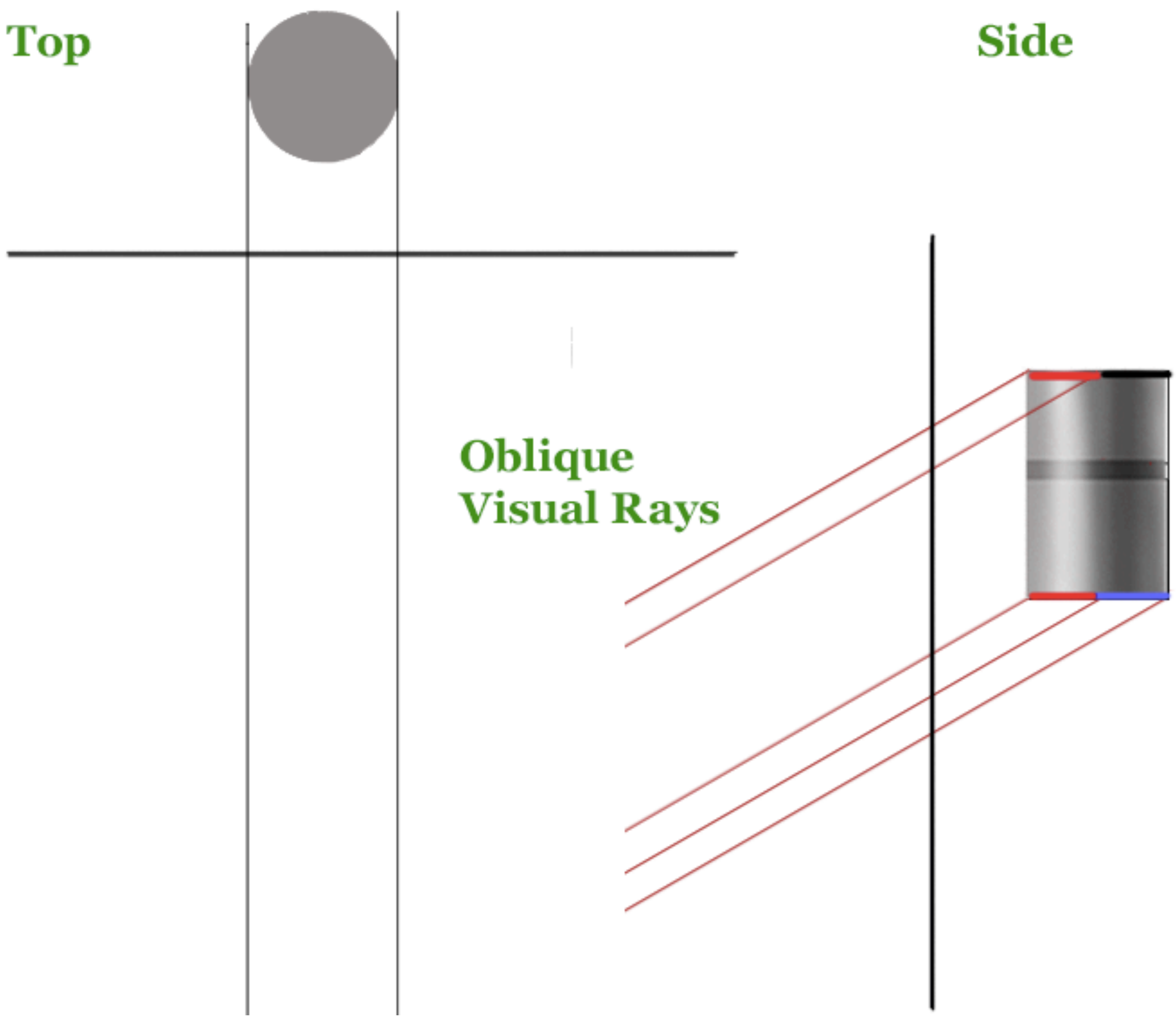
Fig. 33



To make a rough drawing, the plan is used to measure the diameter of the cylinder's top plane in Figure 34.

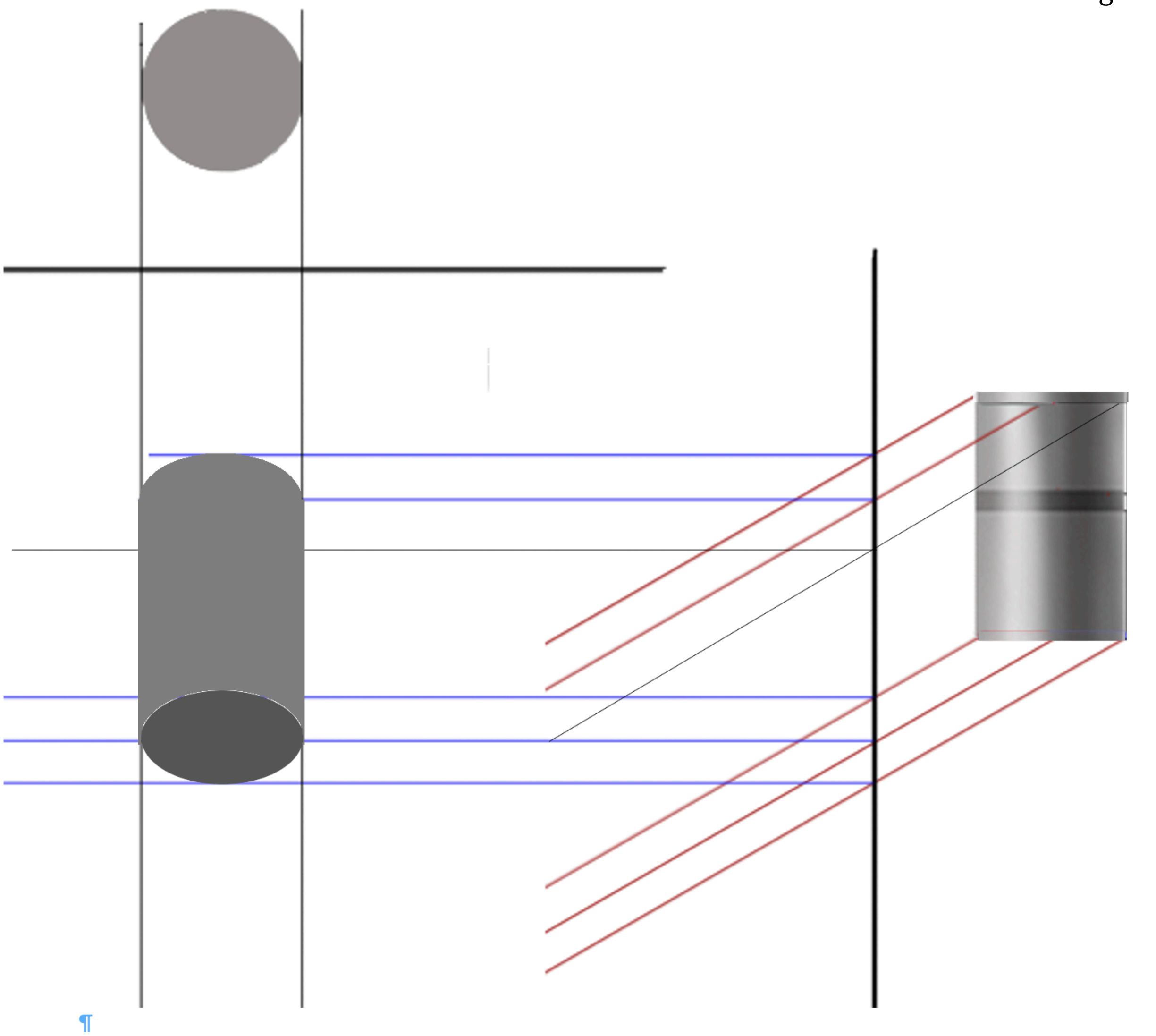
This image of the plan and side elevation together shows the angle of the parallel visual rays that strike the cylinder on the side elevation, and define the width of the cylinder from the top view, the plan.

Fig. 34



From the side elevation, the artist notes where the oblique parallel visual rays from below to points on the object cross the picture plane, and transfers those point to the front view as in Figure 35.

Fig. 35

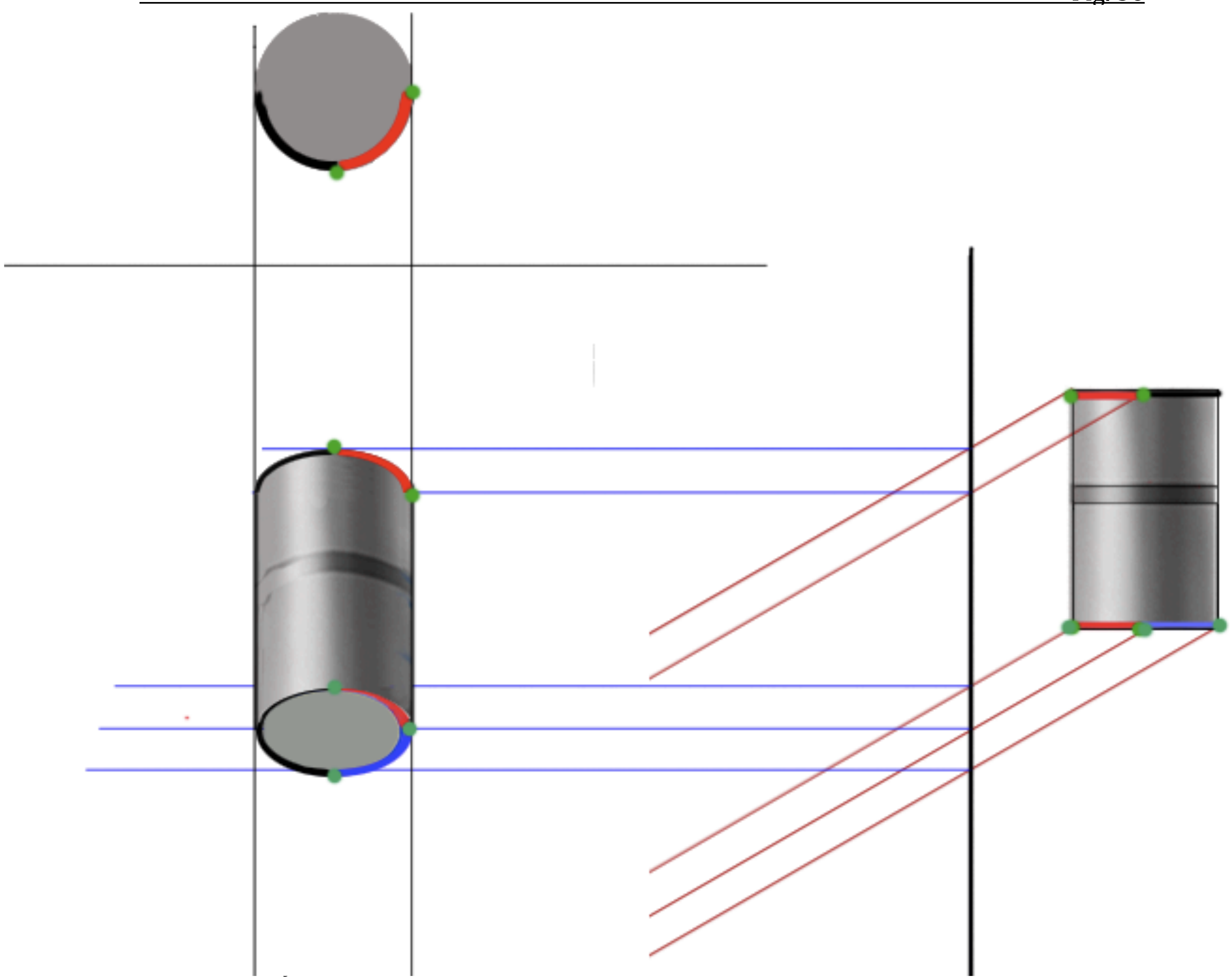


It is clear that the observer will not see any of the top of the cylinder, will see the bottom circular surface as an ellipse, and indicates the relationship between the vertical measurements in the picture of the front and bottom planes, To further illustrate the relationship between point of view and appearance, the edges of the top and bottom of the cylinder have been colored for reference in Figure 36. Practice with these drawings enables their freehand application.

Points on the portions of an object visible from the front can be understood and either measured or estimated from the plan and side elevations.

The cylinder is only an example. Any object may be rationalized using the same methods. Artists use simple forms such as cylinders and especially rectangular solids like cubes to enclose complex objects and thereby inform the drawing of lines and tones over the enclosed forms.

Fig. 36



In the examples above, reference planes were used to measure the change in appearance caused by change in the position of an object in relation to an observer.

Cylinders were used as examples, and imagined to be parallel to the picture plane. In the first case in Figures 30 and 31, the illustrations used a fixed point of sight, and so were in perspective.

In the second example - Figures 33 to 36 - parallel visual rays were used at an angle to a picture plane to create an oblique projection – a common drawing system to measure the change in the visible relative portions of top and side caused by a change in location. In both cases, the cylinder's long axis was parallel to the picture plane.

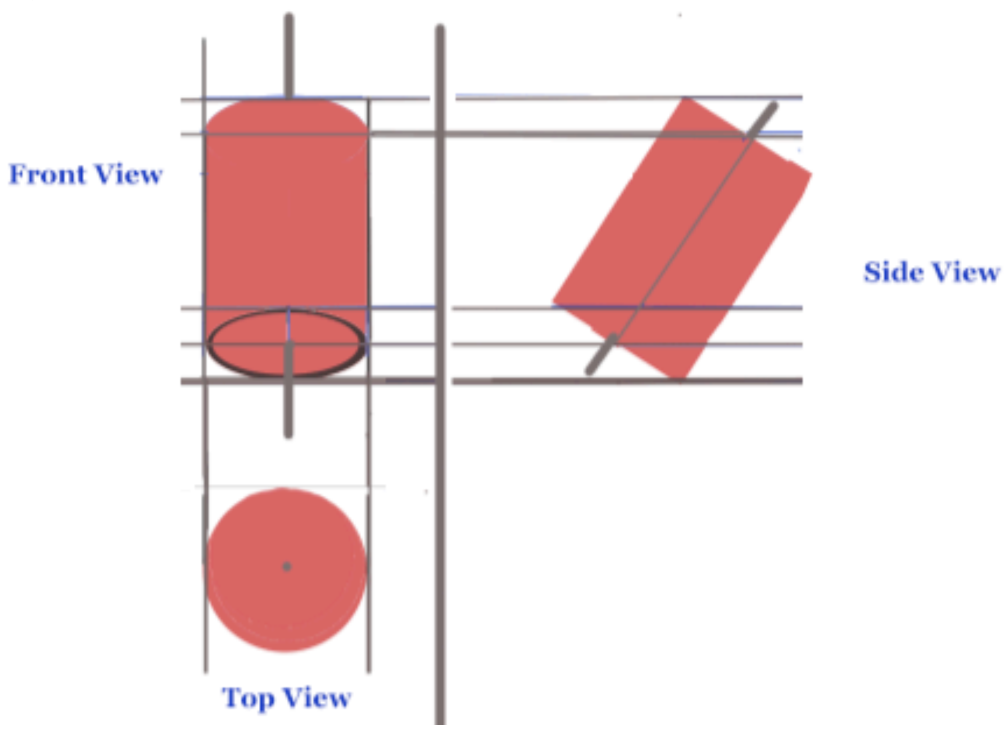
Figure 37 tilts the cylinder altering its *aspect* in relation to the reference planes. It shows the effect of a *change in aspect*. Parallel visual rays are used, perpendicular to the picture plane.

This orthographic projection allows easy estimation of the change in appearance of an object when its tilt is altered.

The artist measures the degree of tilt on the side elevation and transfers the points at which the visual rays pierce the picture plane to the front view.

The limited use of parallel visual rays: The use of parallel visual rays informs the artist and facilitates drawing, but does not reproduce the visual experience. Furthermore, drawing systems such as orthographic and oblique projection do not indicate whether it is the object's special orientation or the observer's point of view that causes a particular visual effect. That information is provided by the use of "traditional" perspective with its use of a fixed horizontal eye level, a vertical central visual plane and by the use of "vanishing points", all of which are discussed in the next section.

Fig. 37



4. Perspective

The purpose of the following material is to provide exercises that will train the artist to estimate the location of points and line directions in freehand drawing.

With plans and elevations clearly understood, the artist can measure at first, and later estimate the changes in appearance that result from various points of site. Perspective is a construction that offers an *approximation* of a human point of view.

While the system works for any central visual ray from a fixed point of sight, "normal" perspective is understood to have a horizontal eye level and vertical central visual plane, while "unusual" perspectives might be based on an eye level plane that is not parallel to the horizon and perpendicular to the vertical. An example of unusual perspective would be a view of the street from a rooftop.

The Two Rules

To locate any point or find the direction of any line in a perspective drawing, these two rules are sufficient.

Rule 1. *To find the vanishing point of any line, imagine a visual ray from the point of sight parallel to that line, and ascertain where it pierces the picture plane.*

Rule 2. *To locate any point on an object in the perspective drawing, imagine a visual ray from the point of sight to the point on the object itself, and ascertain where it pierces the picture plane.*

The rules below are several convenient special cases of these two, used to gain familiarity with the medium. They are used in the text below to help the artist get started. They are:

Lines Parallel to picture plane

3. Any point or line *on* the picture plane is drawn as in the front elevation.

4. All lines *parallel* to the picture plane retain their directions, angles and their relative lengths as found in the front elevation.

Vanishing Points.

6. Parallel lines all vanish at the same point.

7. A line parallel to the eye level plane will vanish on the eye level plane.

8. The Diagonal Vanishing Point is as far from the central Point as the observer is from the picture plane.

5. One-point Perspective

All perspective drawings are based on the three architectural orthographic views: the plan, the front elevation and the side elevation.

The perspective drawing will replace the front elevation, and will use measurements derived from the plan and side views.

Masses drawn in perspective may be imagined encased in rectangular solids. The artist studies the appearance of such solids from different perspectives to understand changes in the enclosed masses. Cubes are used for illustration purposes.

In one-point perspective, one surface of the cube is parallel to the picture plane, and its four receding edges are perpendicular to the picture plane. Rules may be used to make the one-point perspective drawing.

Rule 3 and Rule 4 are used to draw the *front face of the cube* in perspective as shown below.

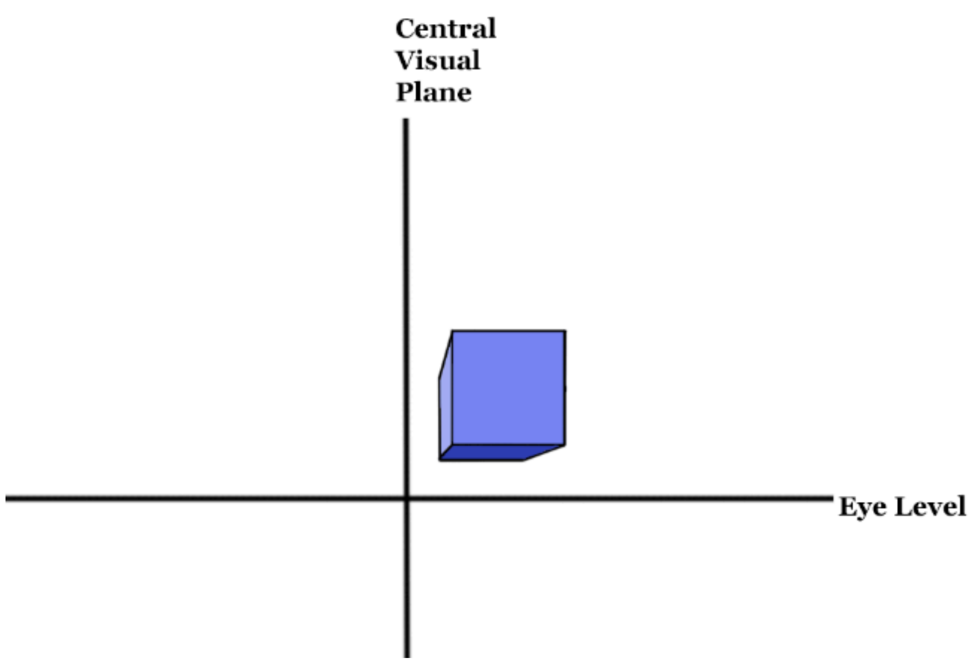
Rule 3. Any point or line *on* the picture plane is drawn as in the front elevation.

Rule 4. All lines *parallel* to the picture plane retain their directions, angles and their relative lengths as found in the front elevation.

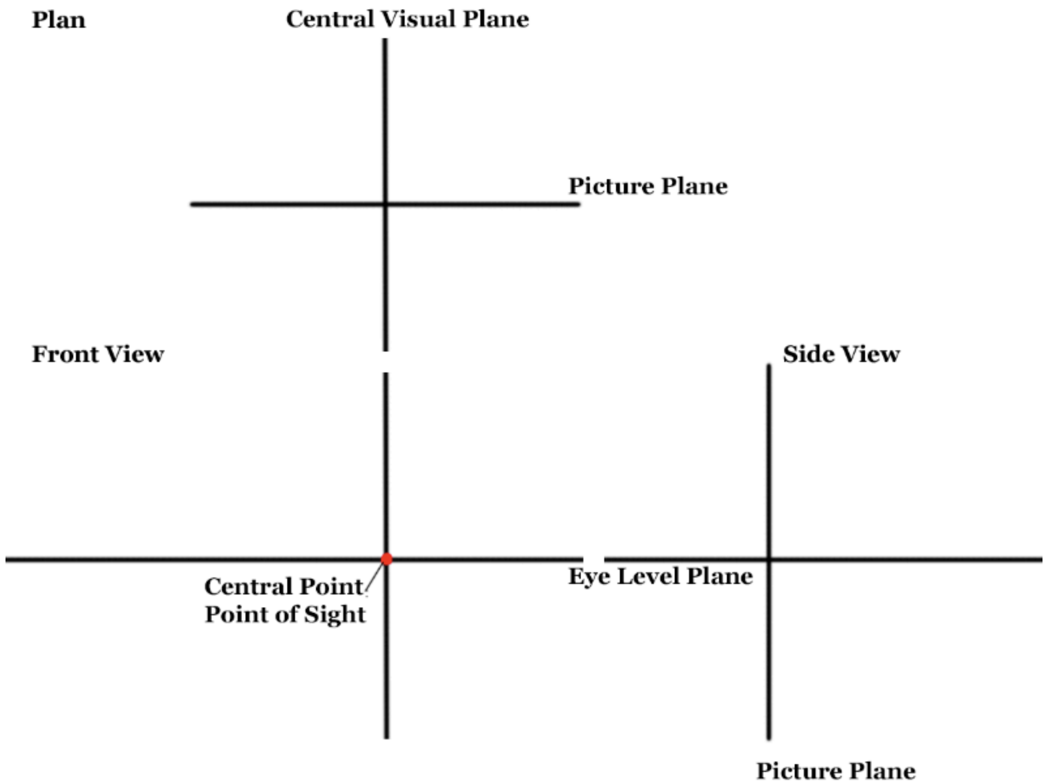
The following diagrams will show that the cube is behind the picture plane with one face coincident with it. Its front face will be found to be perpendicular to the central visual ray. It is shown to be above the eye level and to the right of center.

To generate the view in Figure 38 below, the artist will first draw the reference planes (Fig 39). In Figure 40, the object is placed both against the picture plane and above the eye level in the side elevation, and to the right of the central visual plane in the plan in Fig 40.

Fig. 38



The reference planes are drawn in their accustomed relationship - Fig. 39



In Fig. 40 the artist measures the width and height of the cube in the front elevation by using the plan and side elevation measurements. Measurements of the cubes facing plane on the front elevation will be retained in the perspective drawing (Rule 3).

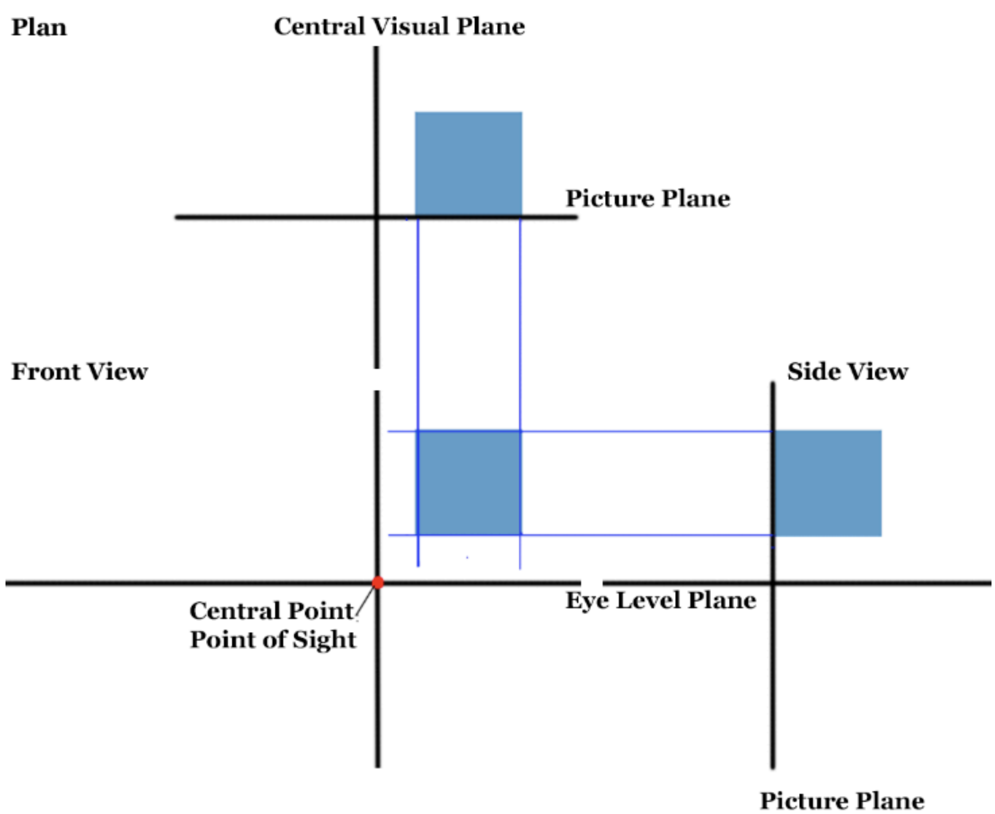


Fig.40

The next step is to find the *direction of the lines created by the receding edges* of the intersecting planes. These lines are perpendicular to the picture plane. They are shown in perspective in Figure 38 and diagramed in Figure 40. These lines will recede towards a common *Vanishing Point.* They are all parallel. They are all perpendicular to the picture plane. Rules 5, 6, and 7 are applied.

To find the vanishing points of the edges of the receding sides in Fig. 38:

Rule 5. *A line perpendicular to the picture plane will vanish at the central point.*

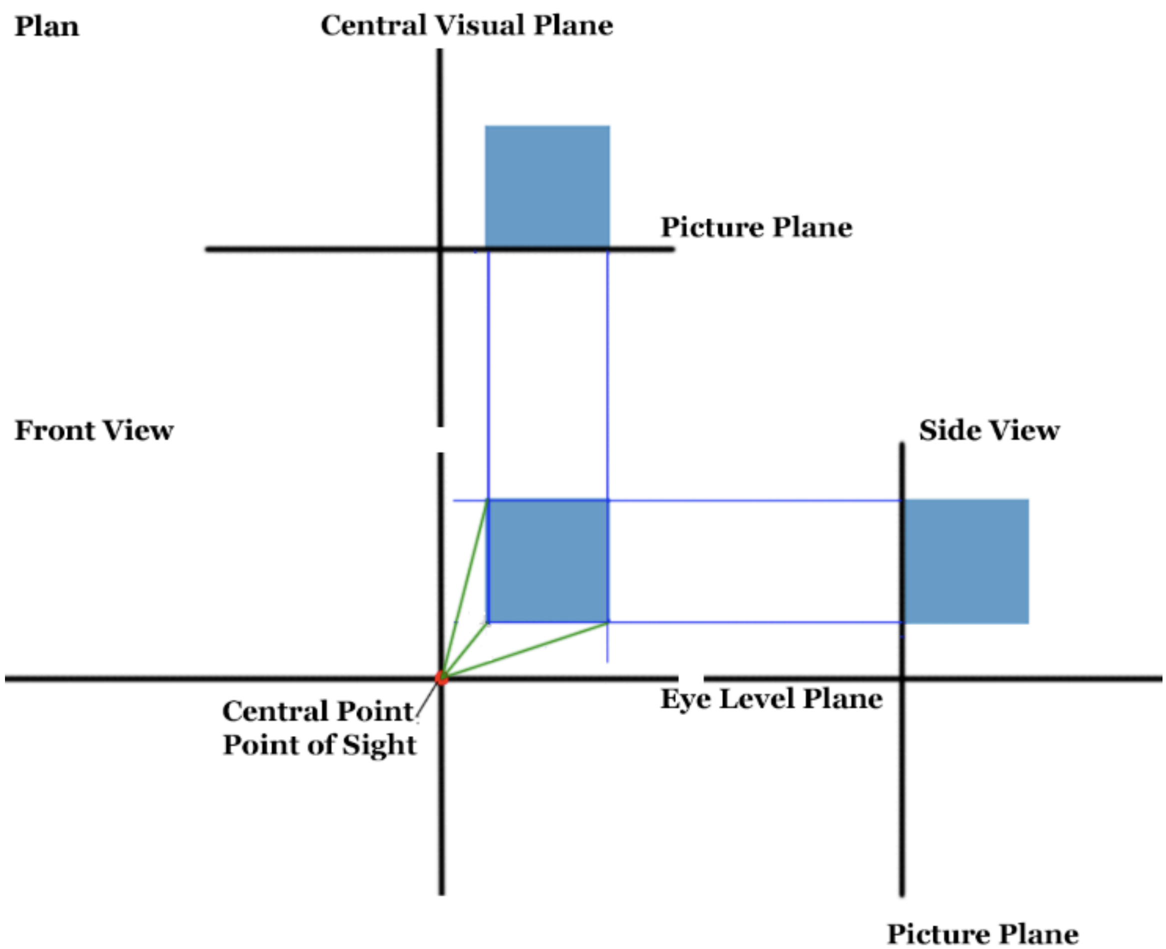
Rule 6. Parallel lines all vanish at the same point.

Rule 7. A line parallel to the eye level plane will vanish on the eye level plane.

These are all just special cases of ***Rule 1****. To find the vanishing point of any line, imagine a visual ray from the point of sight, parallel to that line, and ascertain where it pierces the picture plane.*

The receding edges of the cube are all parallel to one another and will all "vanish" at the central point.

Fig. 41



Locating the back points of the cube in One-point Perspective.

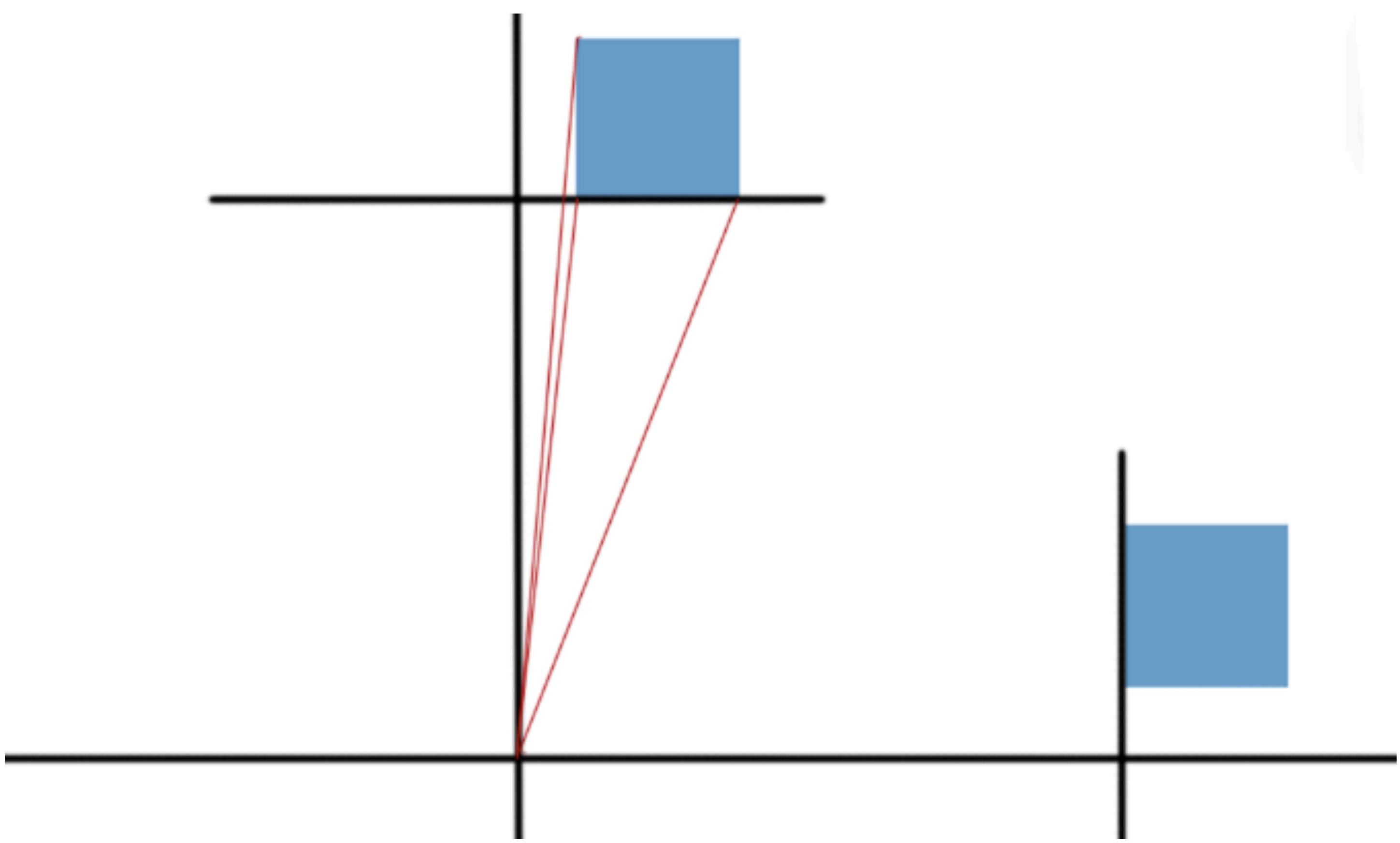
Figures 42 – 46 show how to limit the lines formed by the receding corner edges.

Their end points are defined by our general Rule 2.

Rule 2. To locate *any point* on an object found in the perspective drawing, imagine a visual ray from the point of sight to the point on the object itself, and ascertain where it pierces the picture plane.

Draw the visual rays from the point of sight to points on the cube, both on the plan (Fig. 42-43) and on the side elevation (Fig. 44-45), and ascertain where they cross the picture plane.

Fig. 42



Plan

The points at which the visual rays below cross the picture plane give the locations of the corners of the cube in the perspective drawing.

The face of the cube is on the picture plane, so in the perspective drawing, its edges and corners are drawn as they are shown in the front elevation.

To locate the more distant points on the cube, find where the visual rays from the point of sight to the point on the cube cross the picture plane.

The cube is to the right of center on the width line. Its corner points are found by ascertaining where the visual rays (the red lines) from the point of sight pierce the picture plane on the plan.

Those points are then transferred with descending vertical lines (blue lines) to ascertain the loction of these points in the front view perspective drawing.

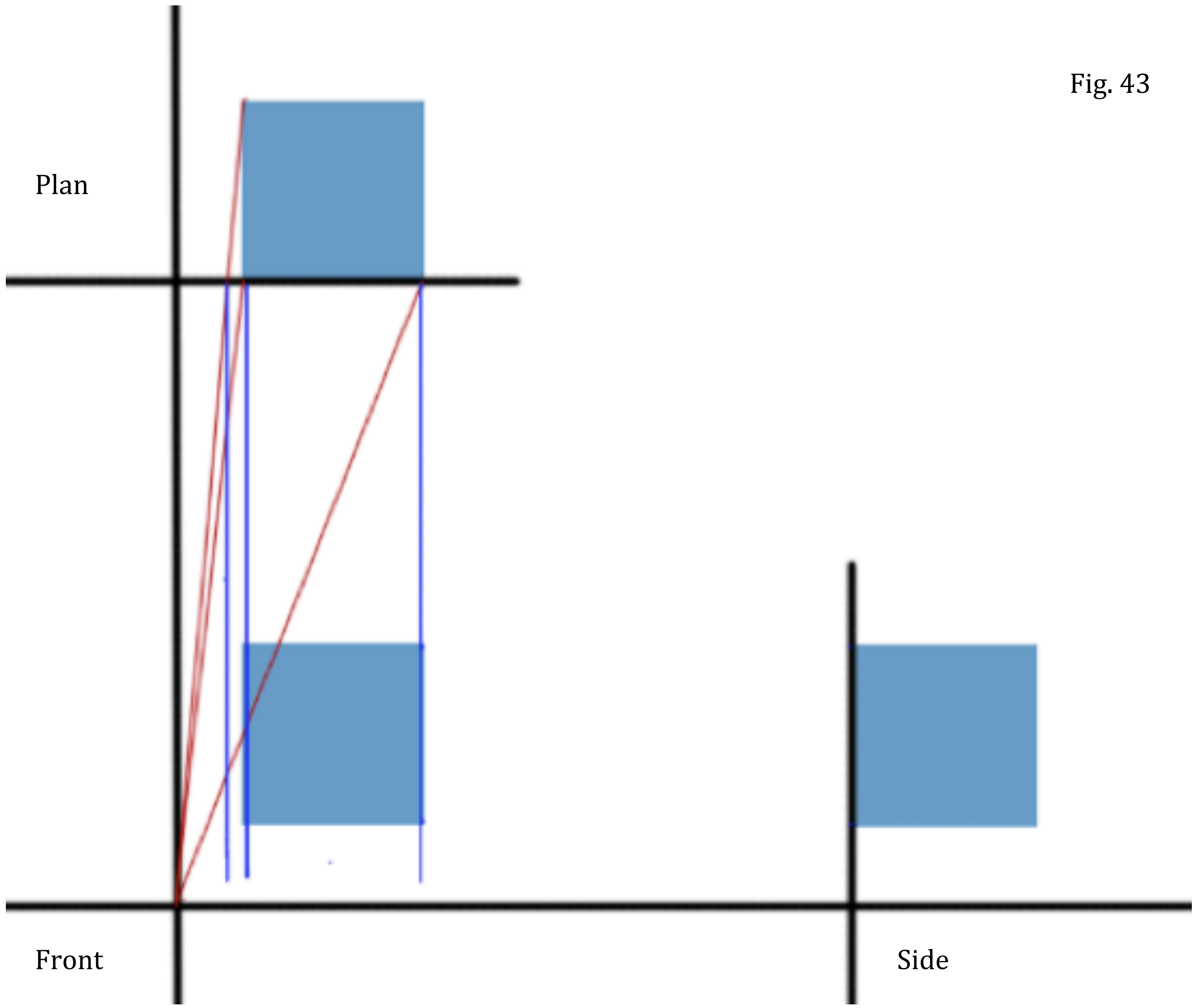


Fig. 43

Side Elevation

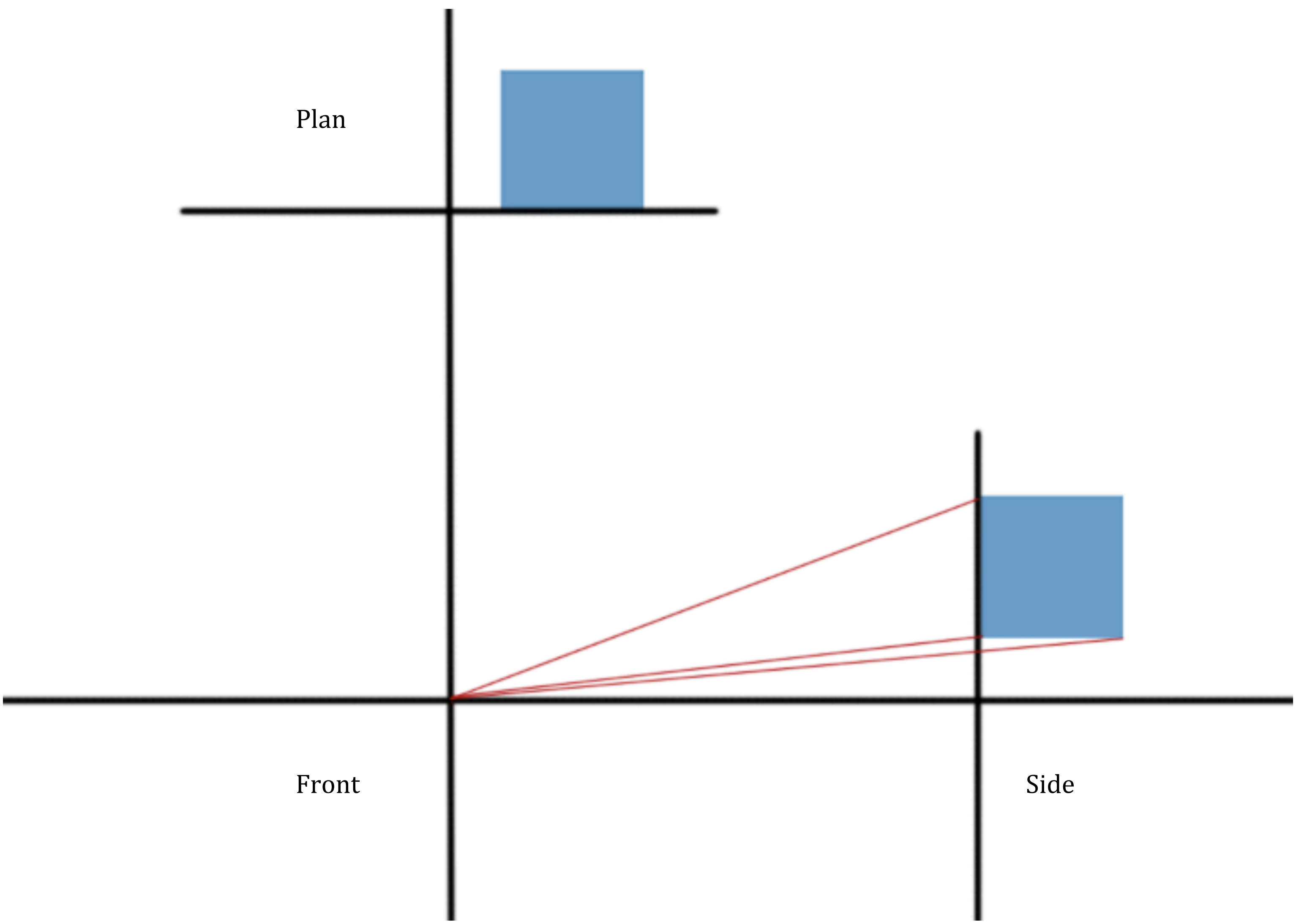
For the height or vertical measurement, the same process is applied to the side elevation.

The face of the cube is against the picture plane; the perspective drawing of that front face retains its actual height measurement.

The height of the corners of the cube on the front view are found by noting where the visual rays (red lines) pierce the picture plane in Figure 44, this time on the side elevation.

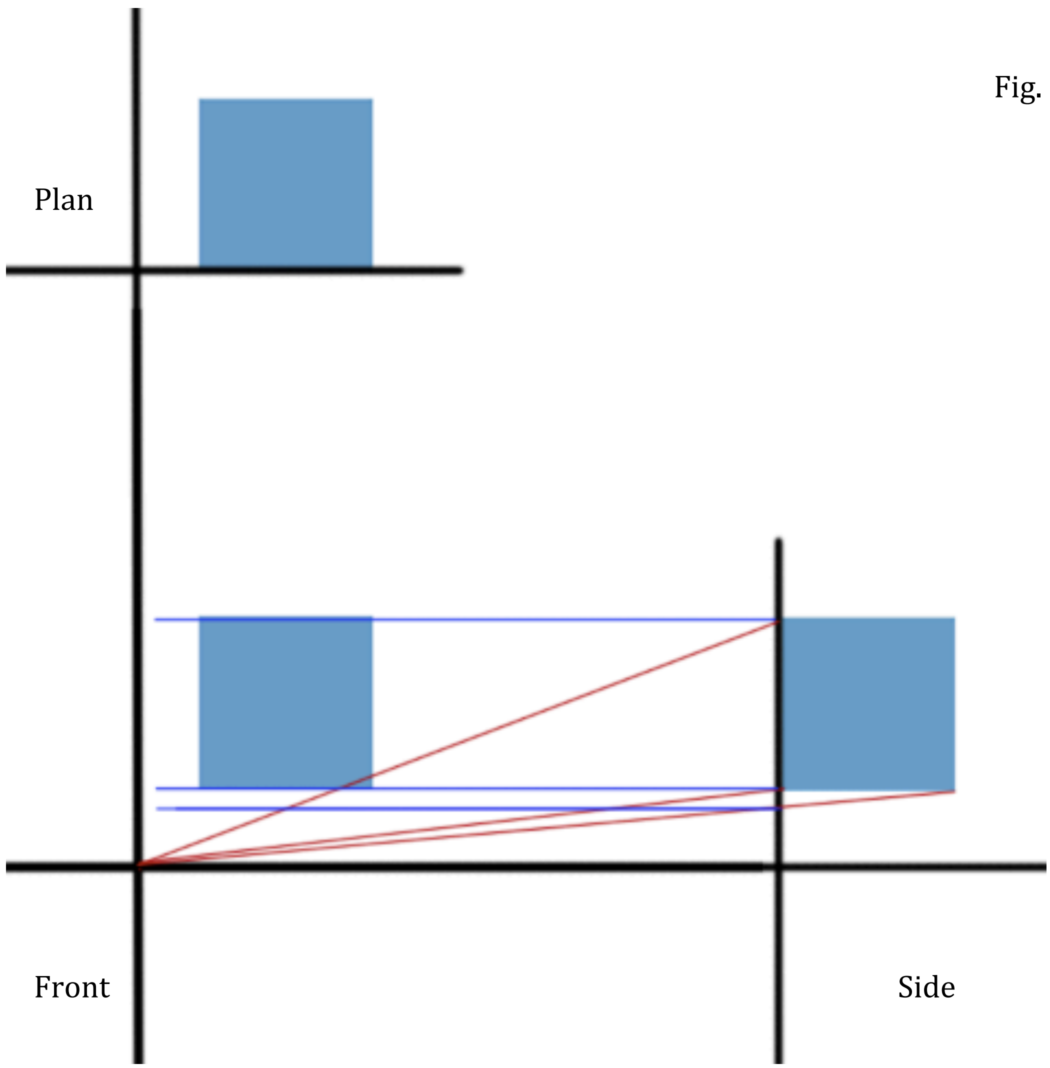
From the side elevation, locate the corner points where the visual rays cross the picture plane to the front elevation to show their *height* above eye level (Fig. 53).

Fig. 44



Transfer the height measurement where the visual rays cross the picture plane in the side elevation to the front view.

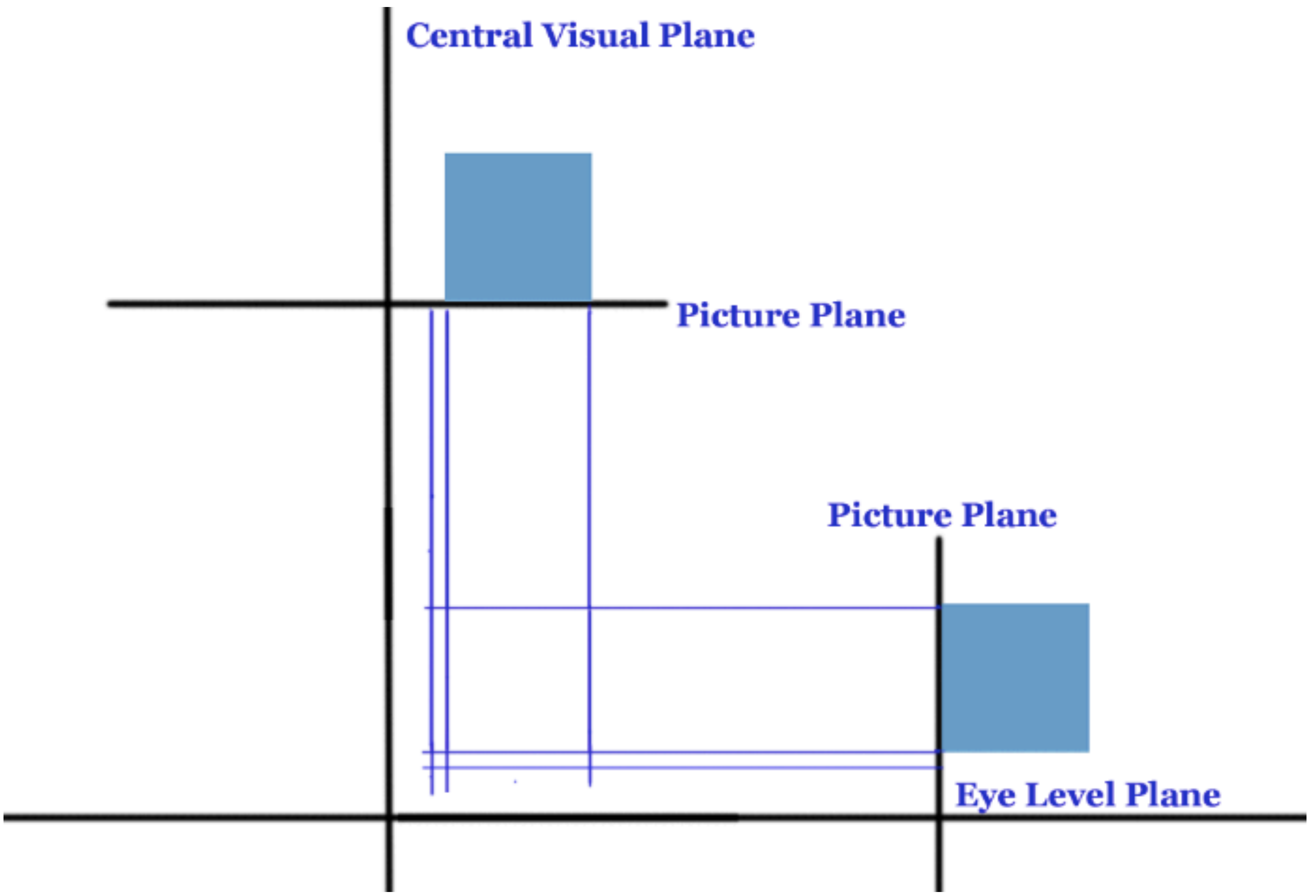
Fig. 45



Where height and width intersect, we find the corner points of the box in perspective.

These intersections are shown below with visual rays removed.

Fig. 46



The receding edges are all perpendicular to the picture plane and will vanish at the central point accordingh to Rule 5. Figure 47 shows the construction lines for the perspective. The corners are marked, and the receding edges, perpendicular to the picture plane are drawn to where they vanish at the central point (Rule 3).

Fig. 47

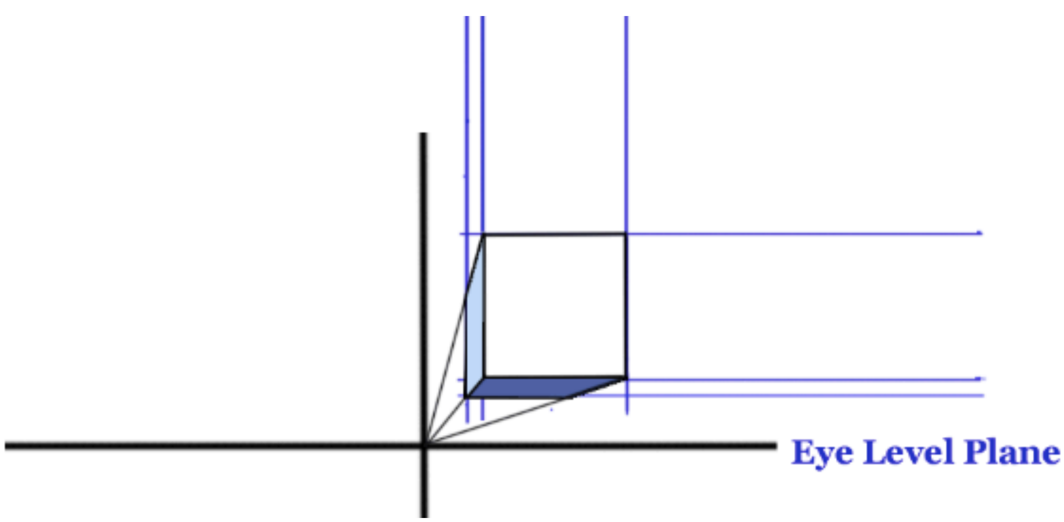
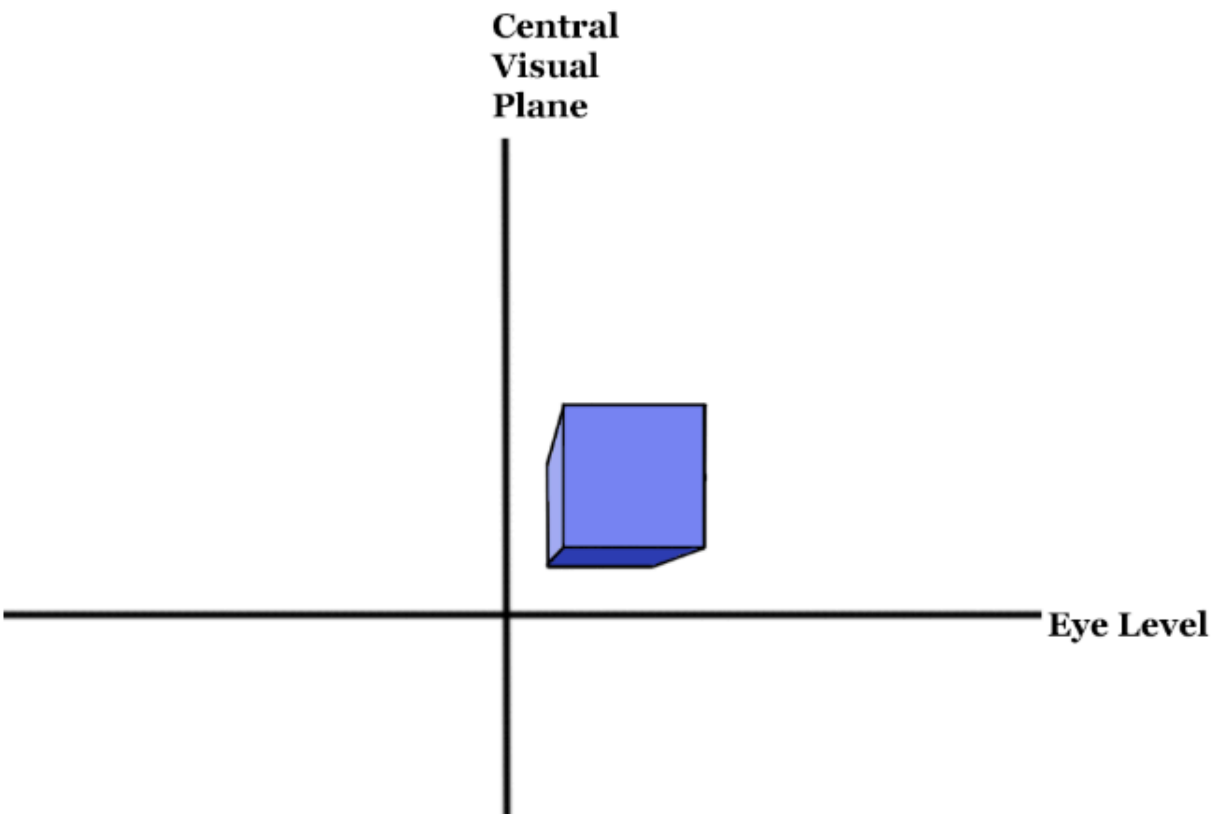


Figure 48, like Figure 38, is a one-point perspective drawing of a cube against the picture plane with its sides perpendicular to the picture plane, above the eye level and to right of the observer.

Fig.



Practice and familiarity with these measured drawings enables the artist to estimate line direction and the placement of points while working freehand.

In the next study, also of one-point perspective, the facing plane of the cube is still is parallel to the picture plane, but has been placed one cube-width behind it. The shape of its face is unchanged. The size in the perspective drawing is reduced compared to the front elevation.

One-point Perspective – Objects Distant from the Picture Plane.

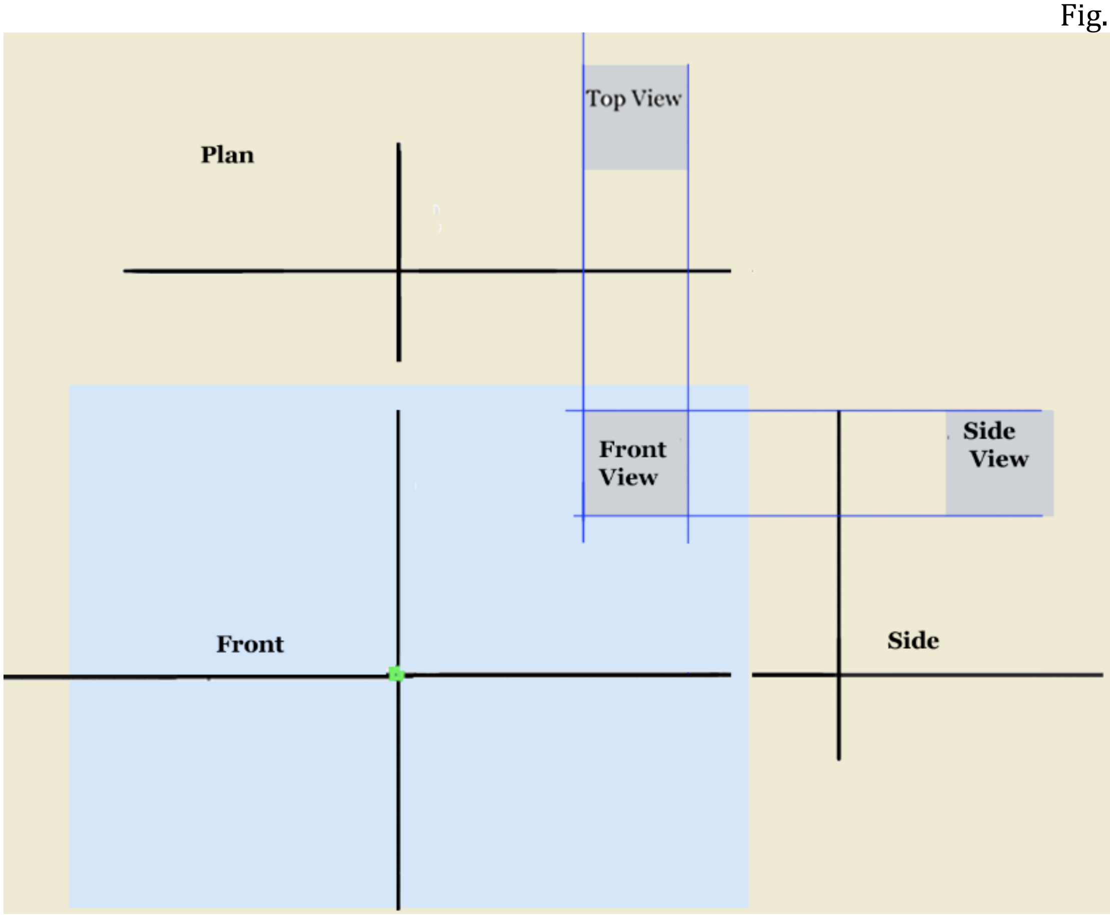
This exercise illustrates **Rule 2**. To locate *any point* on an object found in the perspective drawing, imagine a visual ray from the point of sight to the point on the object itself, and ascertain where it pierces the picture plane.

It will illustrate its corralary **Rule 4.** All lines *parallel* to the picture plane retain their directions, angles and their relative lengths as found in the front elevation.

But note: The cube has been moved back away from the picture plane in Fig. 49. Therefore, when our contstruction is complete - although its face will *retain its the relative lengths and the directions* of its edges - *the lengths will be reduced* in the final perspective image.

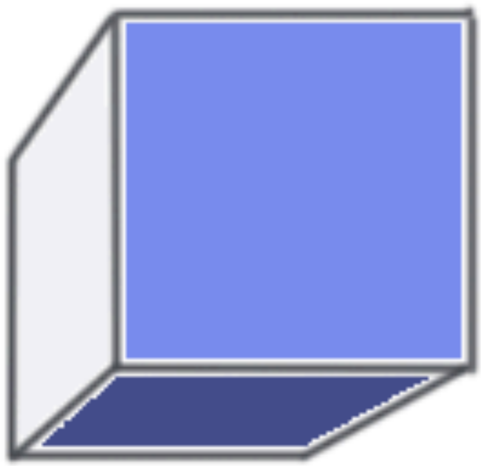
Here are the three reference planes, showing the location of the front of the box on the front elevation before the addition of visual rays or a point of sight.

Fig. 49



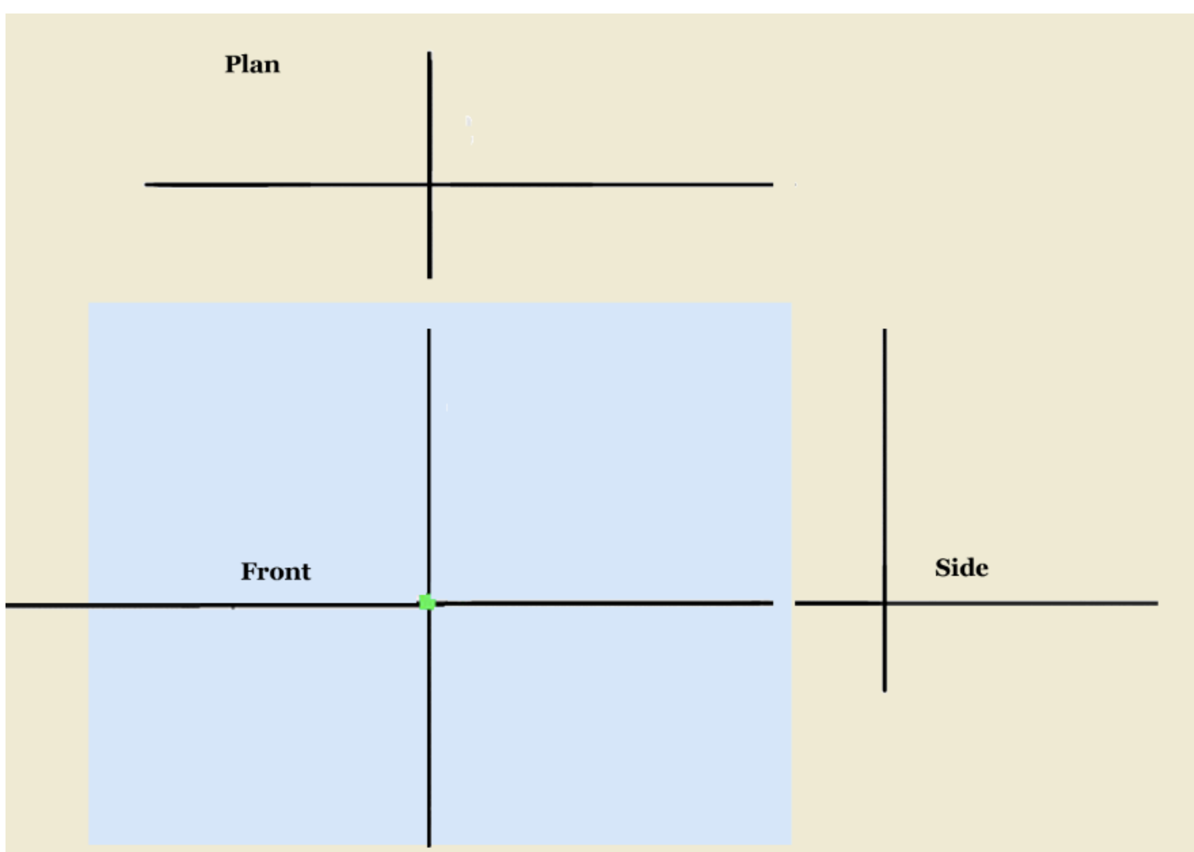
We will derive the cube in Fig. 50. It is imagined to be parallel to the picture plane, located behind it, to the right of the observer and above eye level.

Fig. 50



Below is the layout of for a plan, the front elevation and side elevation. It shows the reference planes: central visual plane and eye level plane as lines. The blue area will be the final perspective drawing.

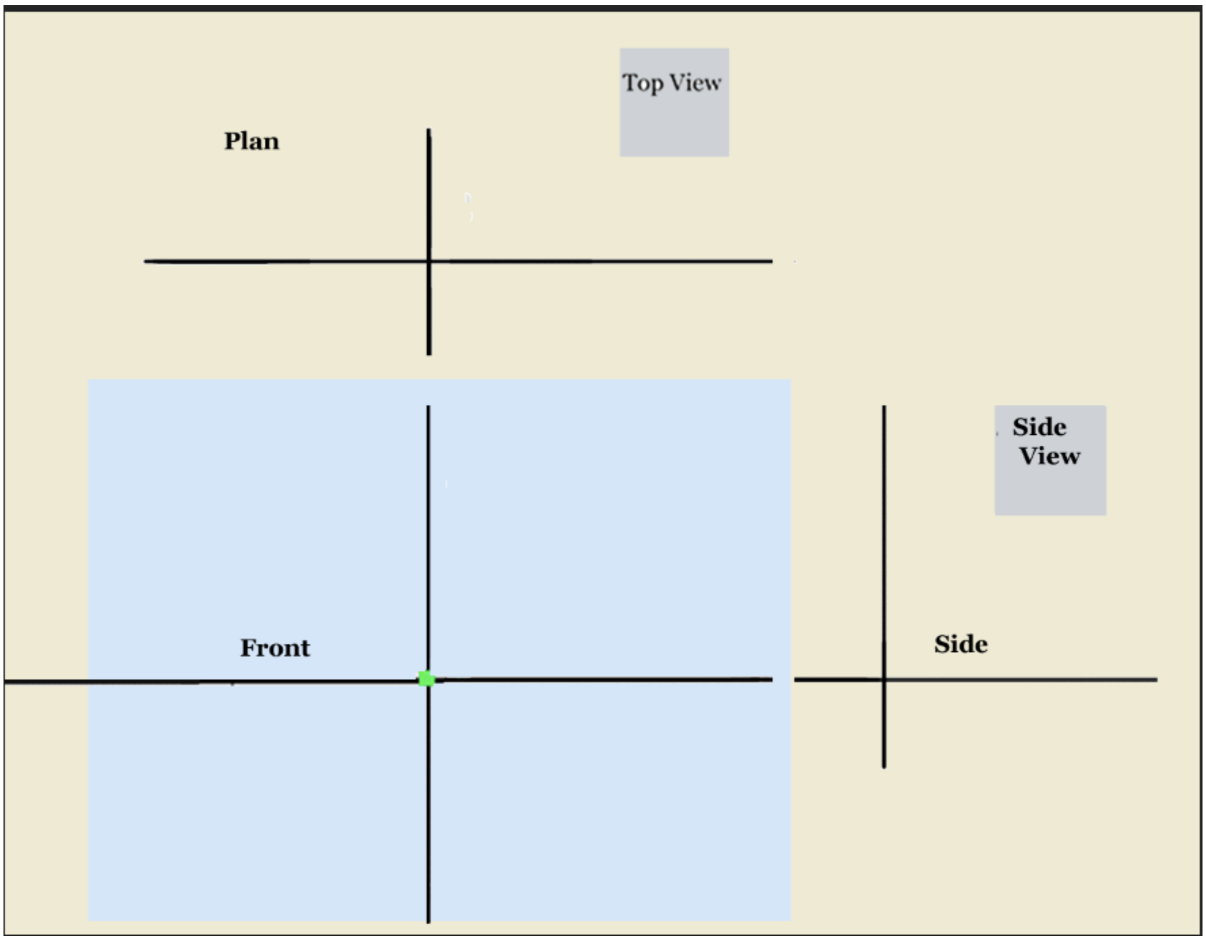
Fig. 51



Front Elevation and Side Elevation for Measurement Against the Picture Plane

In Figure 52, the cube shown in the elevations is grey and measures *one unit square.*
It is two units to the right of the central visual plane.
It is one unit behind the picture plane.
It is two units above the eye level plane.

Fig. 52



In Figures 53 and 54, on the plan, a point of sight is added and the distance from the picture plane measured in relation to the size of the cube. The red lines from the point of sight represent the visual rays to all visible points on the cube. The point where they cross the picture plane gives the distance from center that they will appear in the final front view perspective drawing. The blue lines show the construction lines drawn from the plan to mark points in the front view.

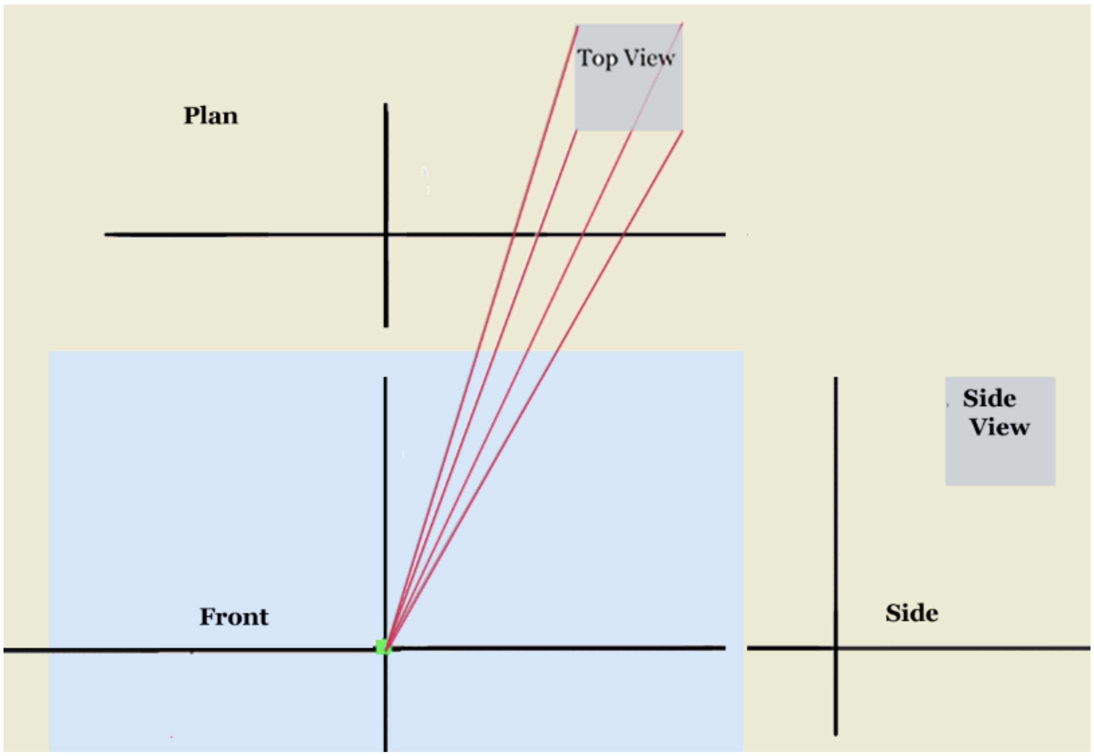


Fig. 53

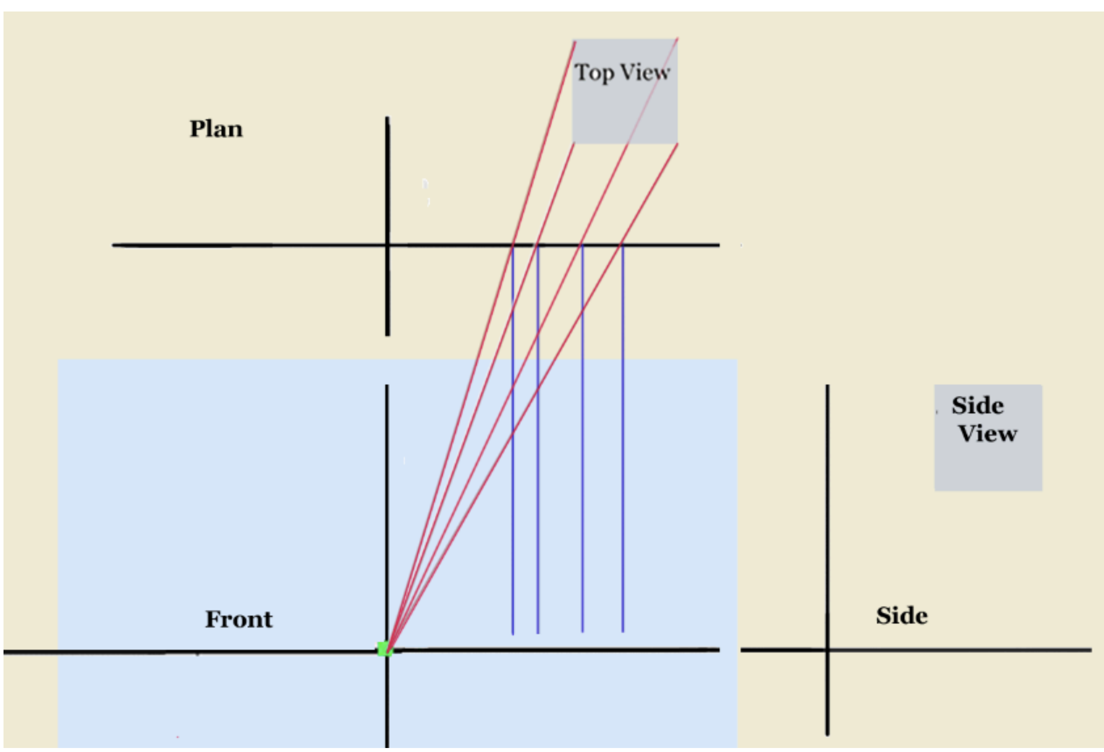


Fig. 54

The same is true of the side elevation in Figures 55 and 56. It is used to determine the height of each point on the cube in the perspective front view.

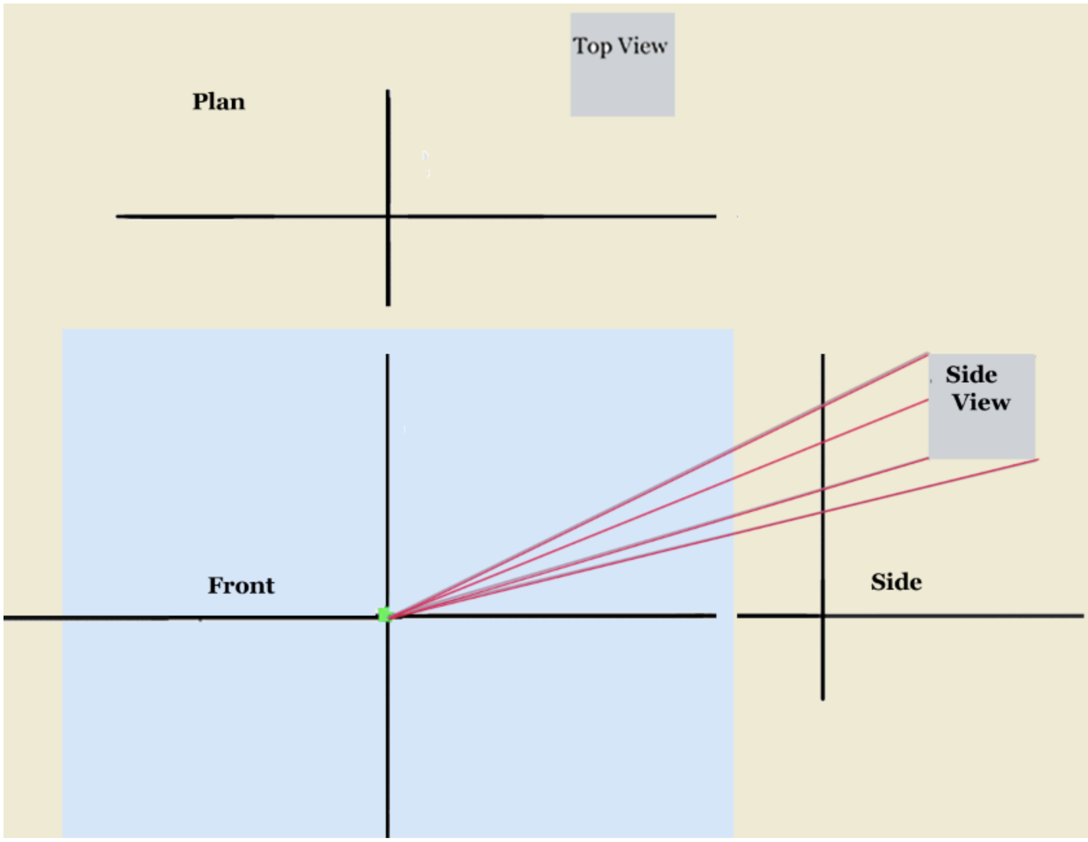


Fig. 55

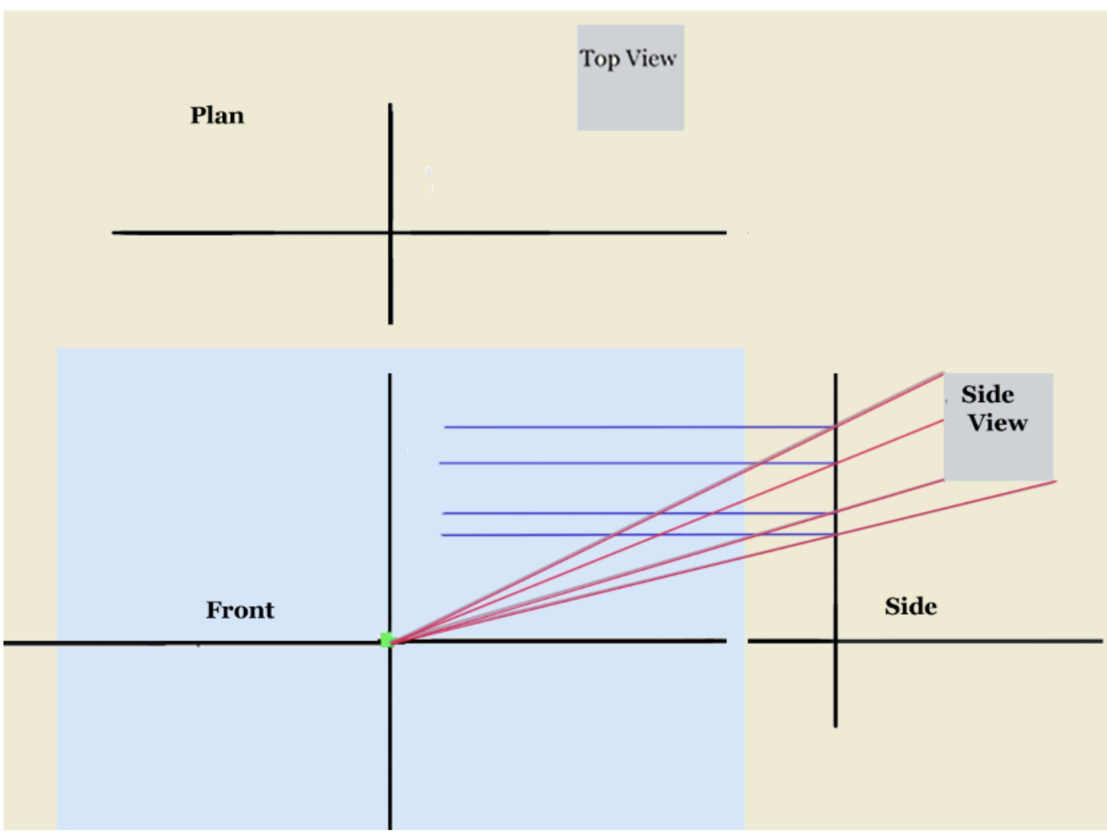


Fig. 56

Combining these construction lines in Figure 57 yields the points on the picture plane for each visible point on the cube. They are marked below.

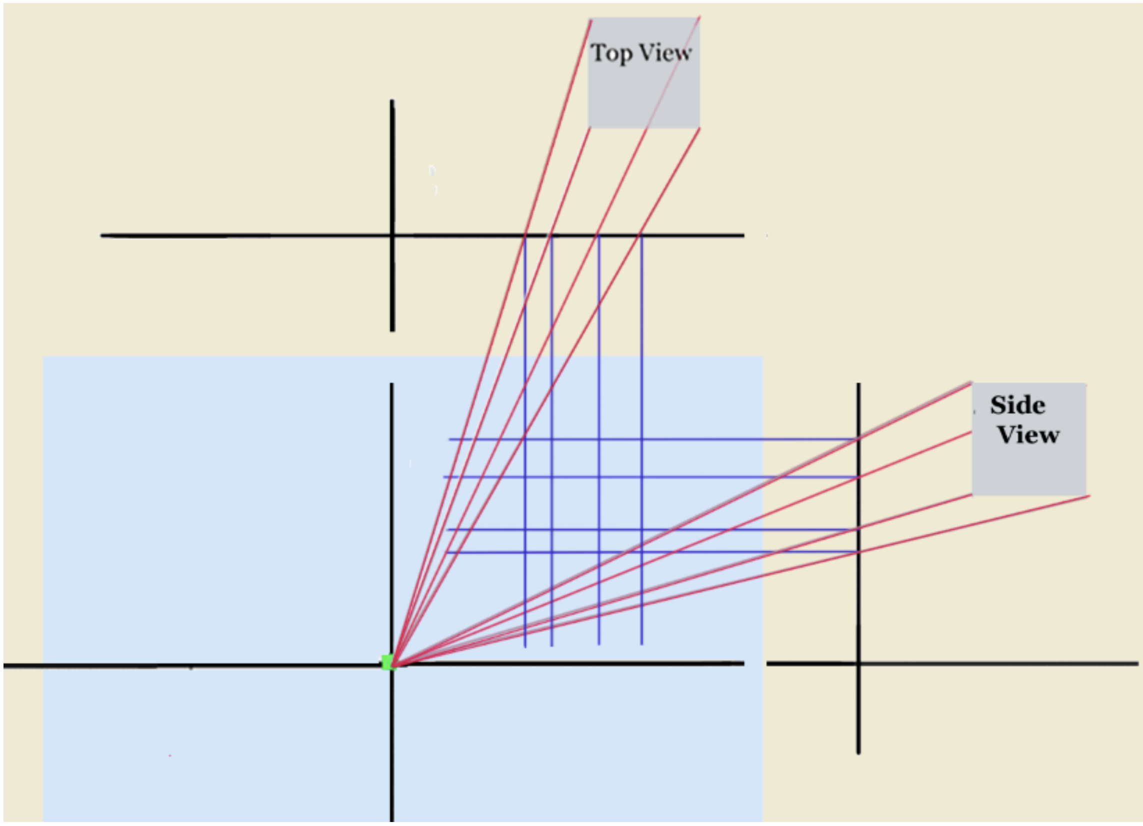


Fig. 57

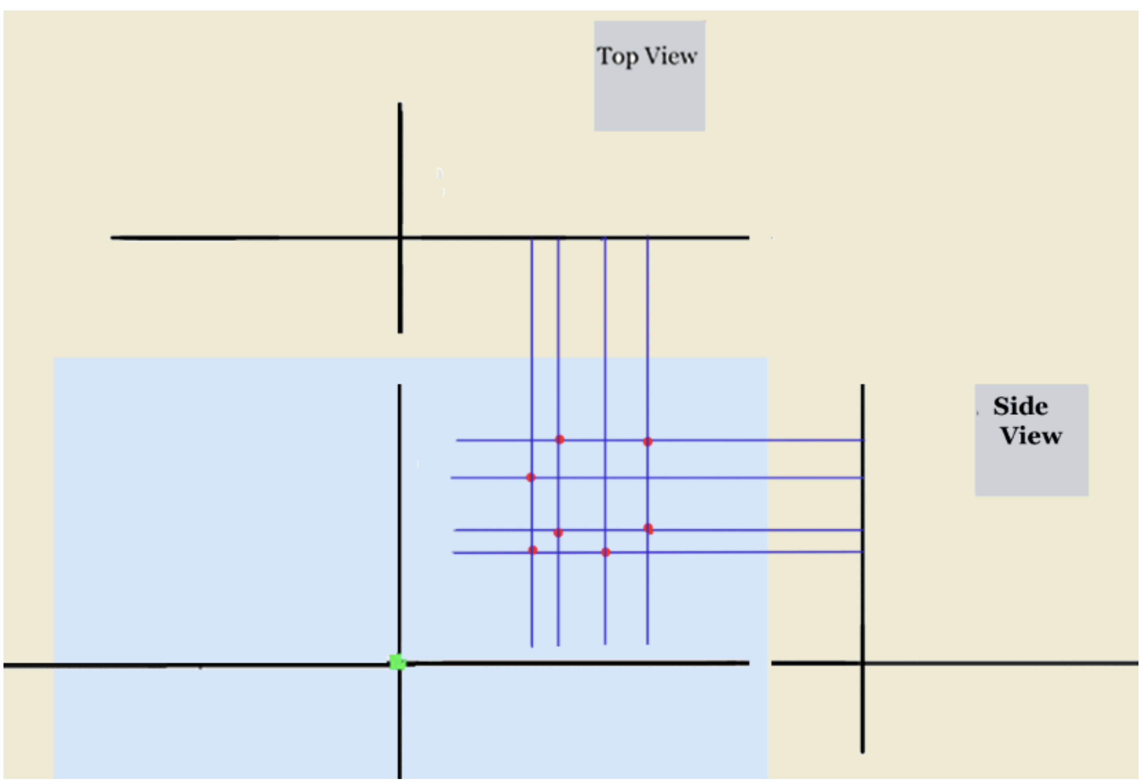


Fig. 58

This cube is behind, not touching but parallel to, the picture plane. The receding edges are each perpendicular to the picture plane, and so vanish at the central point (Figures 59 - 60) as indicated by **Rule 1 and Rule 3.** The corners found with visual rays by Rule 2, and their vanishing points determined by Rule 1 confirm one another in the images below.

Fig. 59

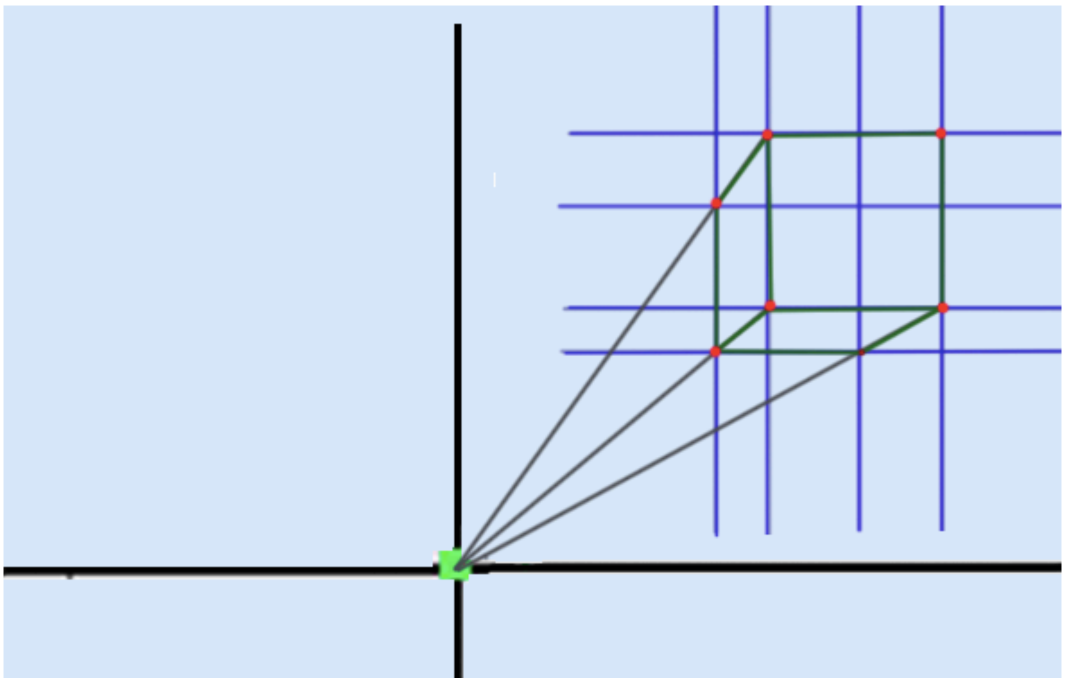


Fig. 60

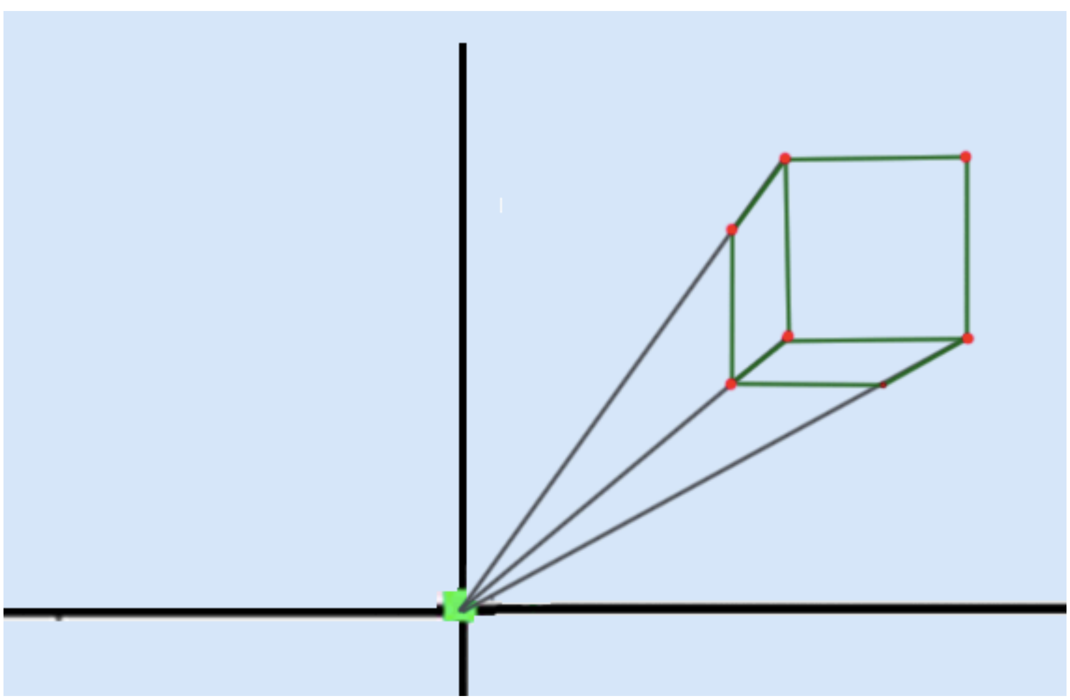
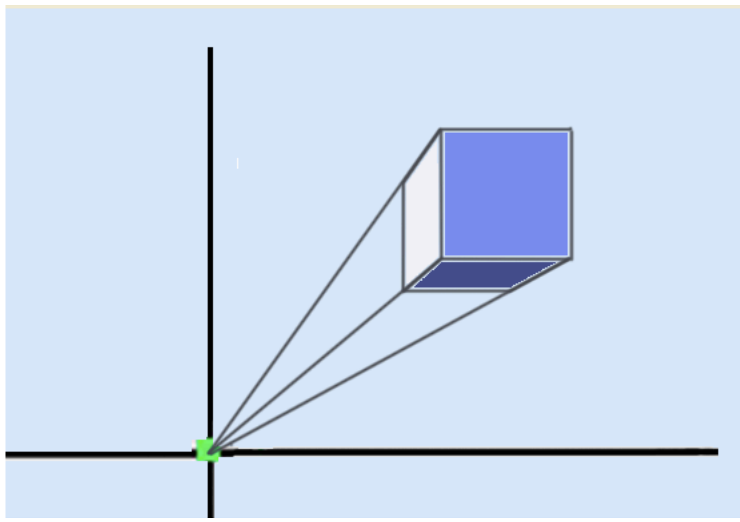


Figure 61 is a one-point perspective drawing of a cube with its face parallel to the picture plane, and its receding edges vanishing at the central point. It is above and right of center.

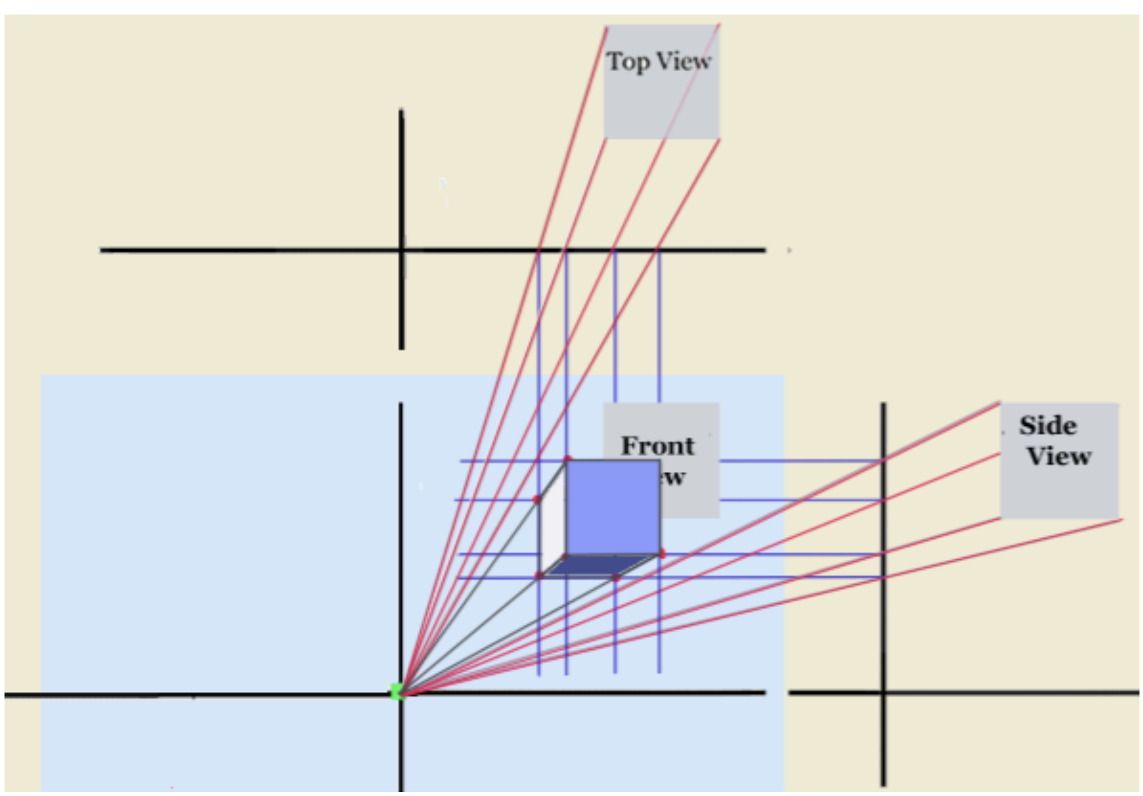
Fig. 61



Below, Figure 62 shows the front elevation with the cube in grey.

The visual rays and construction lines show how the blue perspective front face of the cube is reduced in size compared to its measured grey orthographic front elevation. The reduction occurs because of the cube's being moved back behind the picture plane. The corners of the front of the cube are drawn where the visual rays from the point of sight to each of those corners crosses the picture plane.

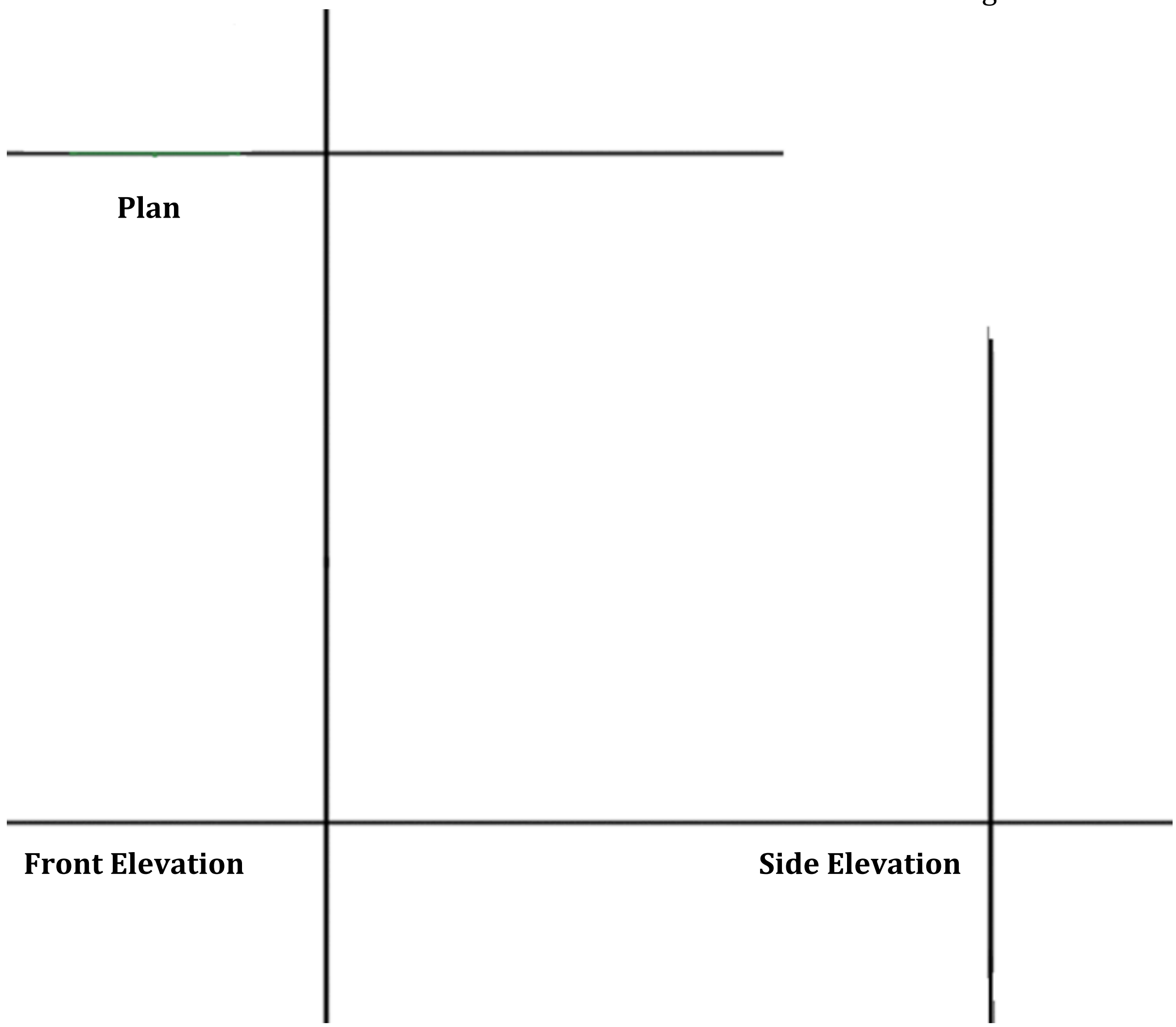
Fig. 62



One-point Perspective - A House Below the Observer and Against a Picture Plane -

The reference planes for this drawing are shown below and arranged in this fashion:

Fig. 63



In the plan, the house is seen from above with its front against the imaginary picture plane.

In the plan, its distance to the left of the central visual plane is measured.

In the side elevation, the observer height above the ground plane, and the height of the cube in relation to both the ground and the eye level are shown.

In both the plan and side elevation, the observer's distance from the picture plane is measured.

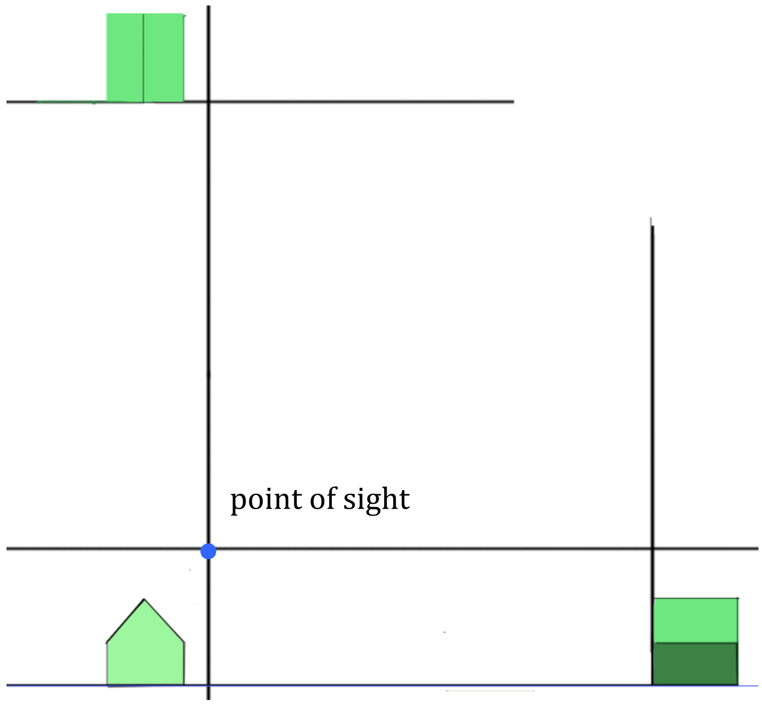


Fig. 64

In Figure 65, the points on the object's face that lie against the picture plan may be transferred directly to the one-point perspective front View.

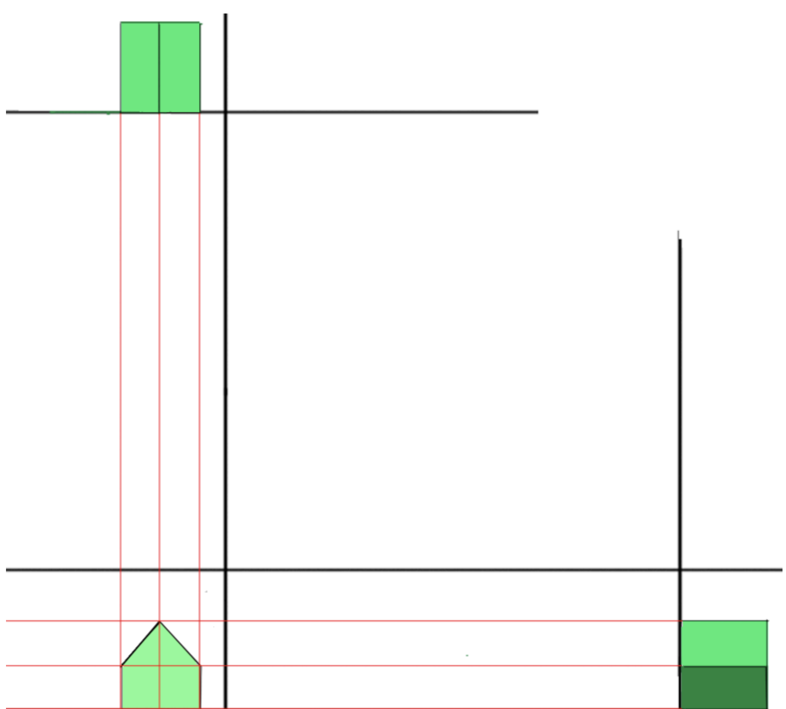


Fig. 65

Visual rays from the point of sight to the back points on the house are drawn on the plan.

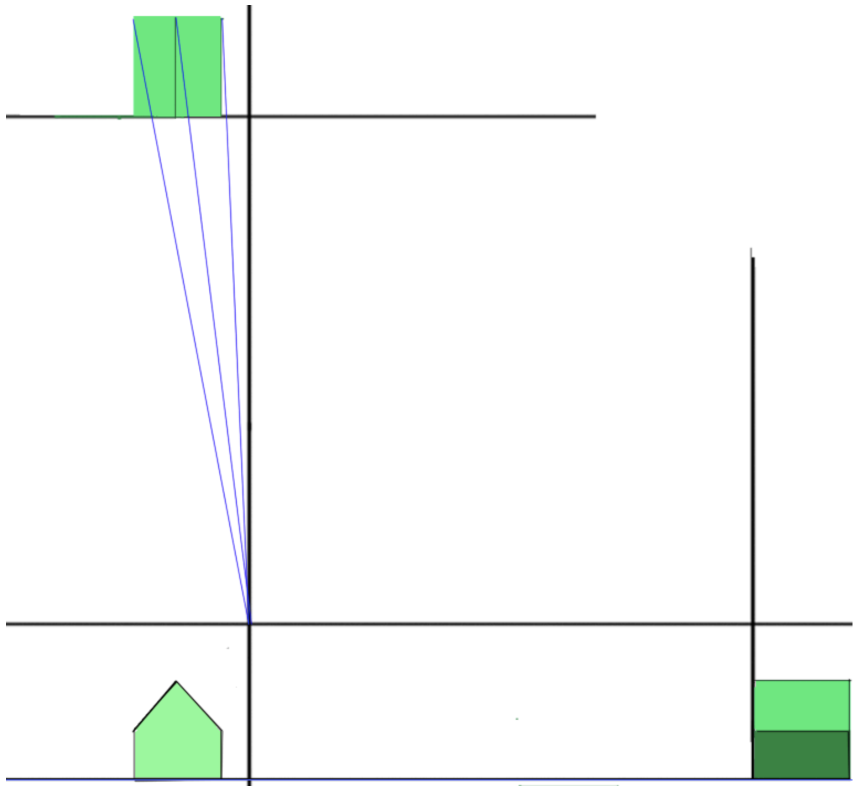
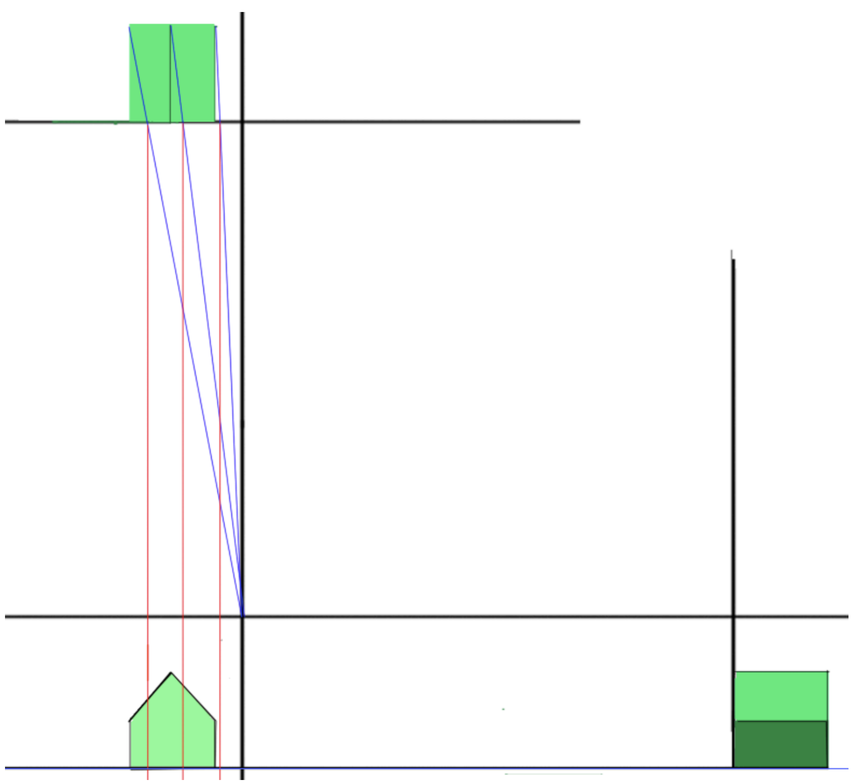


Fig. 66

In Figure 67, where the visual rays cross the picture plane of the plan, construction lines are drawn down to the front view to locate the distance to the left of center that the points occupy when seen on the front view.

Fig. 67



The same is done with the side view in Figure 68 to locate the height of each point on the house as it will appear on the picture plane.

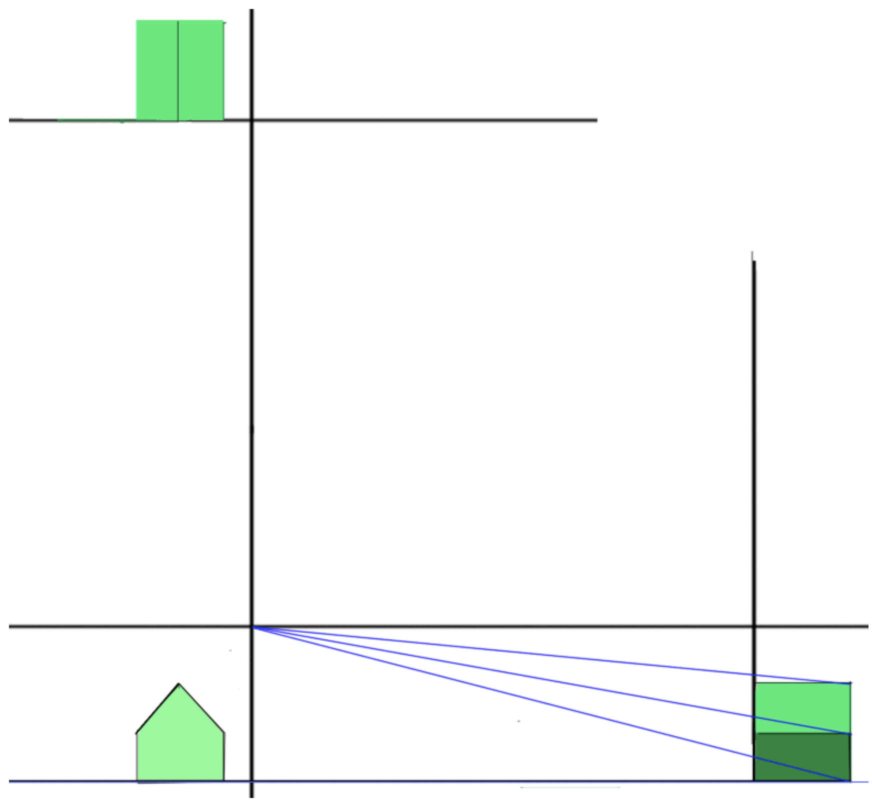


Fig. 68

In Figure 69, the vertical measurements of each point crossing the picture plane on the side elevation is transferred with construction lines to the front view.

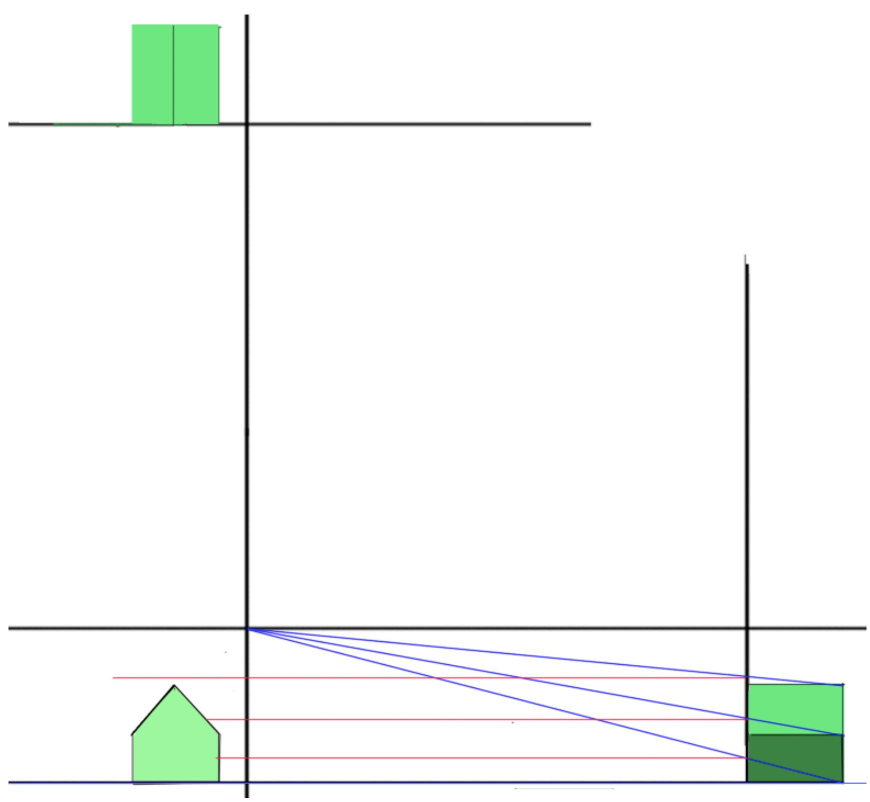
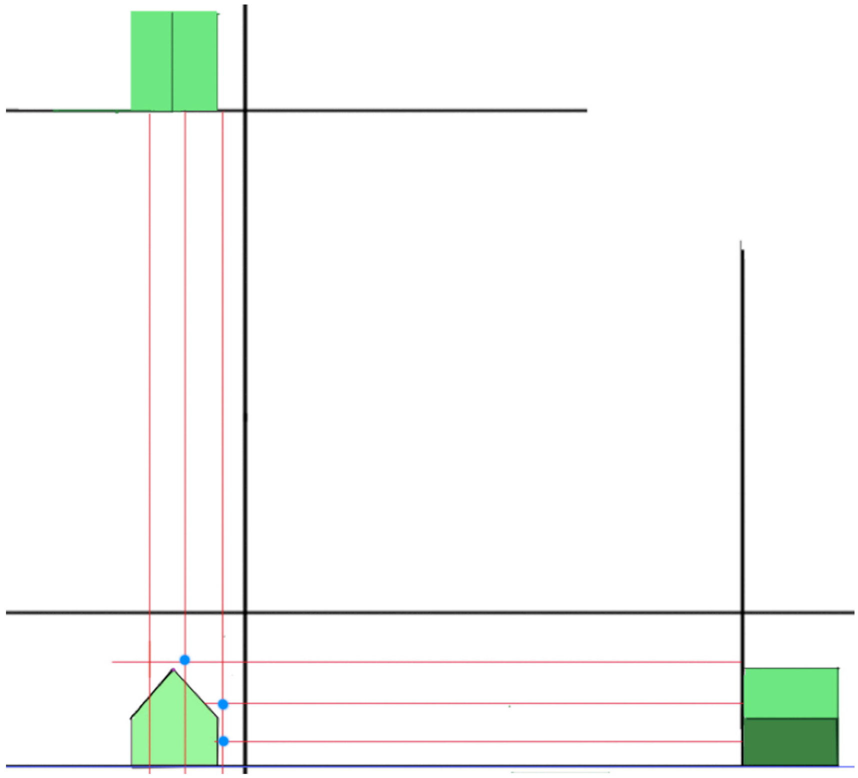


Fig. 69

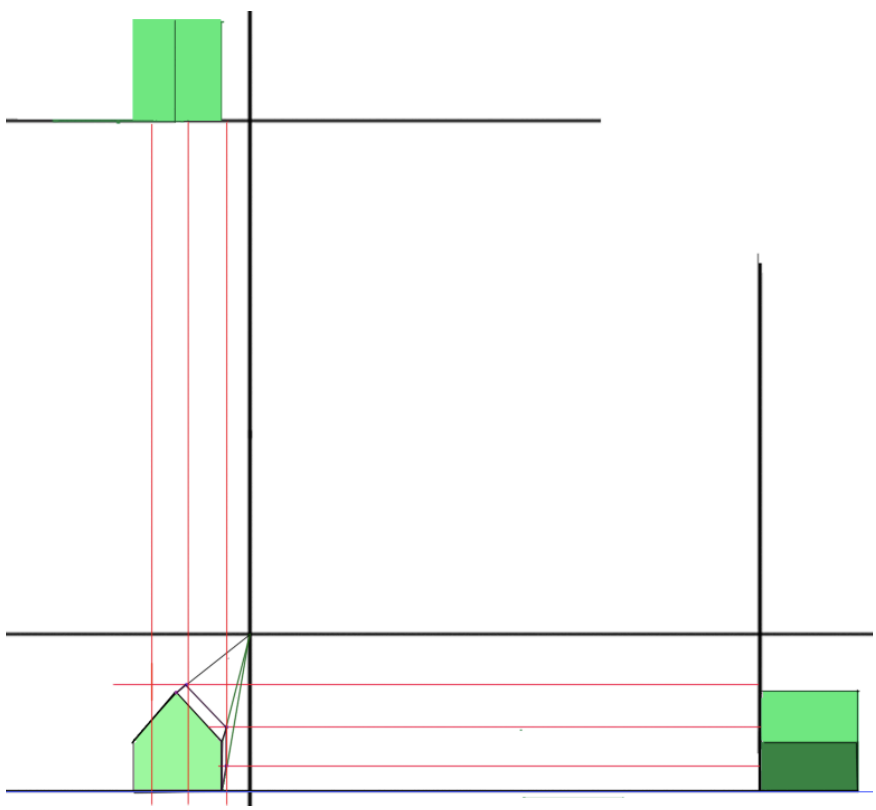
Deleting the visual rays in Figure 70 and combining the construction lines show the points where the corners of the back of the house will appear in perspective.

Fig. 70



All lines perpendicular to the picture plane vanish at the central Point.

Fig. 71



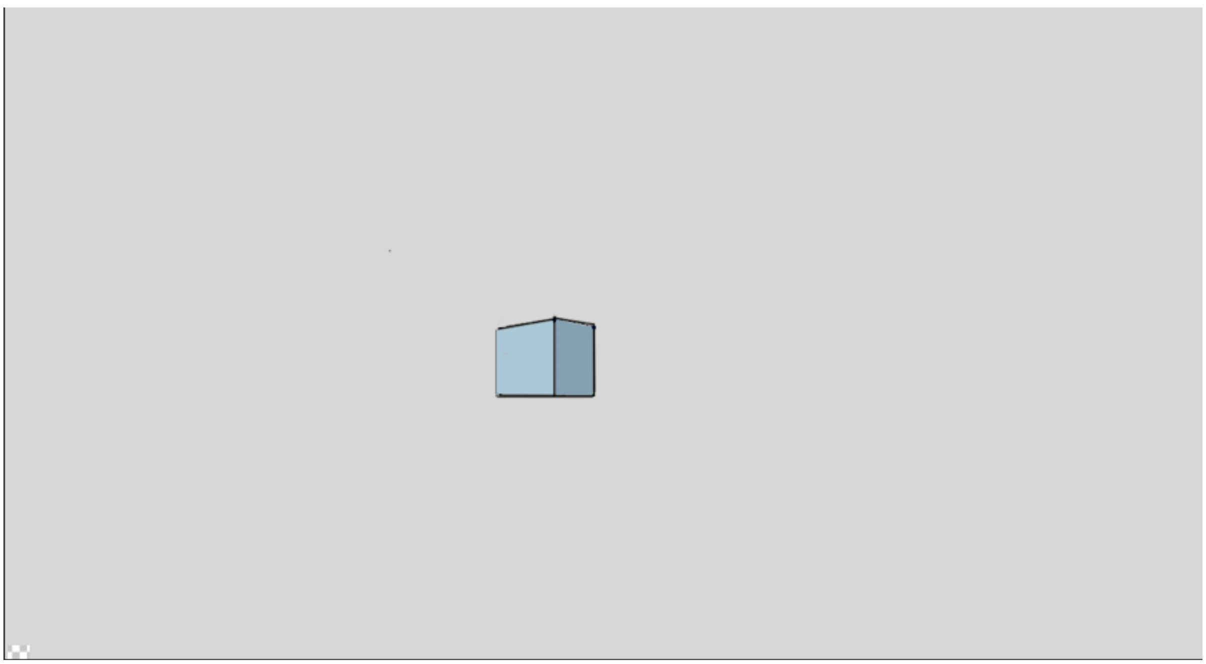
6. Two-point Perspective – The Diagonal Vanishing Point

A Rotated Cube with Base at Eye Level

In Figure 73, a cube is imagined turned 45 degrees to the picture plane and seen from a particular point of sight. It is to the right of the central visual plane. Therefore, the artist sees more of the left side of the cube than of the right. Its base rests on eye level.

A two-point perspective of a cube has one of its three dimensions (in this case the height line) parallel to the picture plane, and two of its line systems at an angle to the picture plane.

Fig 73.



The vanishing points of the receding lines are found with **Rule 1.** *To find the vanishing point of any line, imagine a visual ray from the point of sight, parallel to that line, and ascertain where it pierces the picture plane.*

Diagonal Vanishing Points: In the special case of drawing an object at 45 degrees to the picture plane, it is easy to estimate vanishing points. *The vanishing point of a line 45 degrees to the picture plane is the same distance relative distance from central point as the observer is from the picture plane.* Diagonal vanishing points can be a useful starting place for identifying vanishing points as an object rotates. If one knows the size relations between the object size and observer distance, one can plot diagonal vanishing points using the object size as a basis for measurement.

Diagonal Vanishing Points are found by Rule 8: The diagonal vanishing point is as far from the central point as the observer is imagined to be from the picture plane.

On a cube rotated 45 degrees to the picture plane, the vanishing points of edges of the receding planes will vanish equidistant from the center point (Rule 8).

And because the receding edges are parallel to the eye level plane (the cube is upright relative to the observer), they will vanish at the eye level (Rule 7).

The cube in this example rests behind an imaginary glass wall at the back of a room. Its base is at eye level. Its facing edge is against the picture plane. **Rule 8.** The diagonal vanishing points will be the same distance from the central point as the point of sight is from the picture plane.

Fig. 74

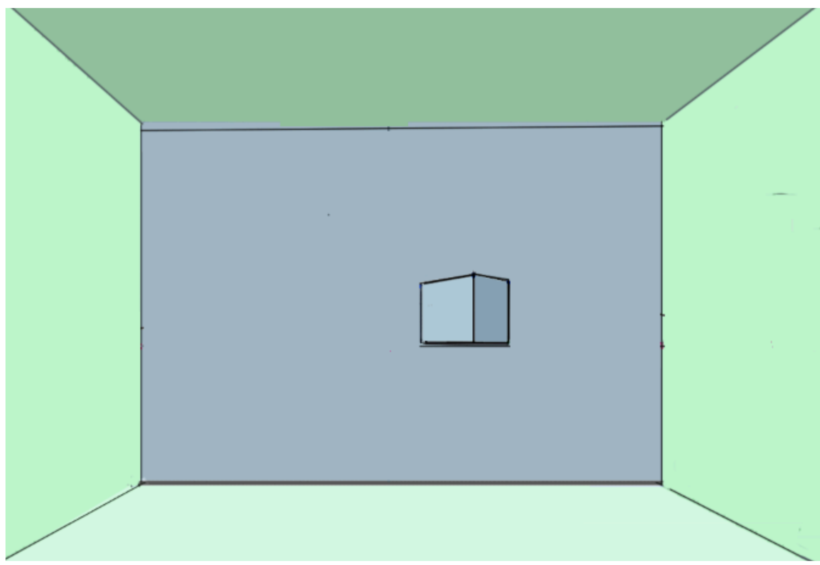
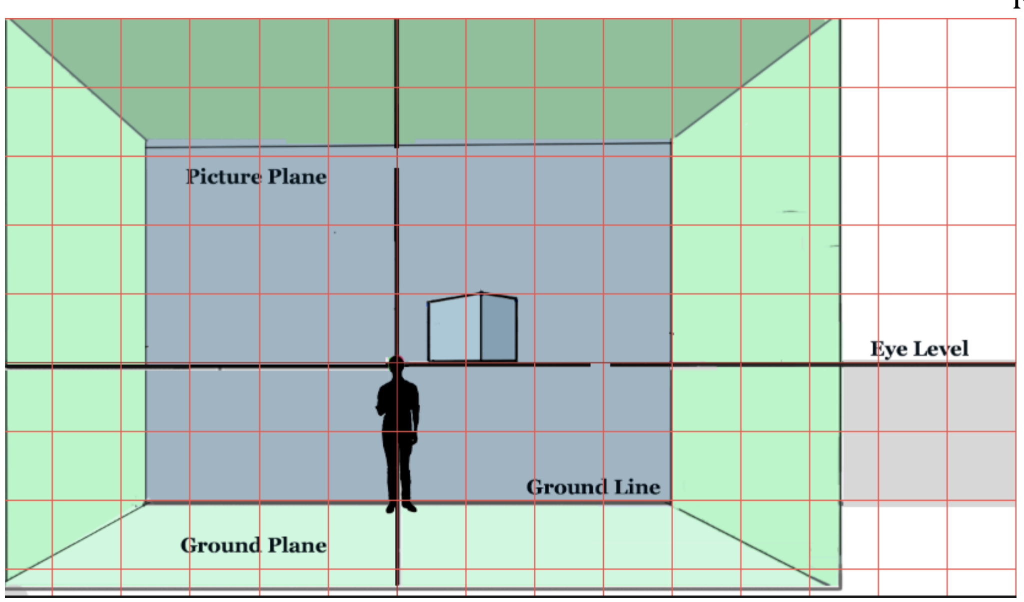


Figure 75 shows the relative measurements. A 3-foot square cube is rotated 45 degrees in relation to the picture plane and up against it. Its base is two cubes or 6 feet from ground line. Its facing edge is one cube or 3 feet to the right of the central visual plane. Below, an observer with a 6-foot eye level poses with his back to the picture plane. The central visual and eye level planes on end are drawn as lines on the picture plane.

Fig. 75



Diagonal Vanishing Points - A Cube in Two-point Perspective

Below is the plan. The vanishing points of the receding edges of the cube are found at the point where a line from the point of sight, parallel to that edge, pierces the picture plane.

When the visual rays are drawn, parallel to the sides of the cube that are receding at a 45 degree angle from the picture plane, they pierce the picture plane:

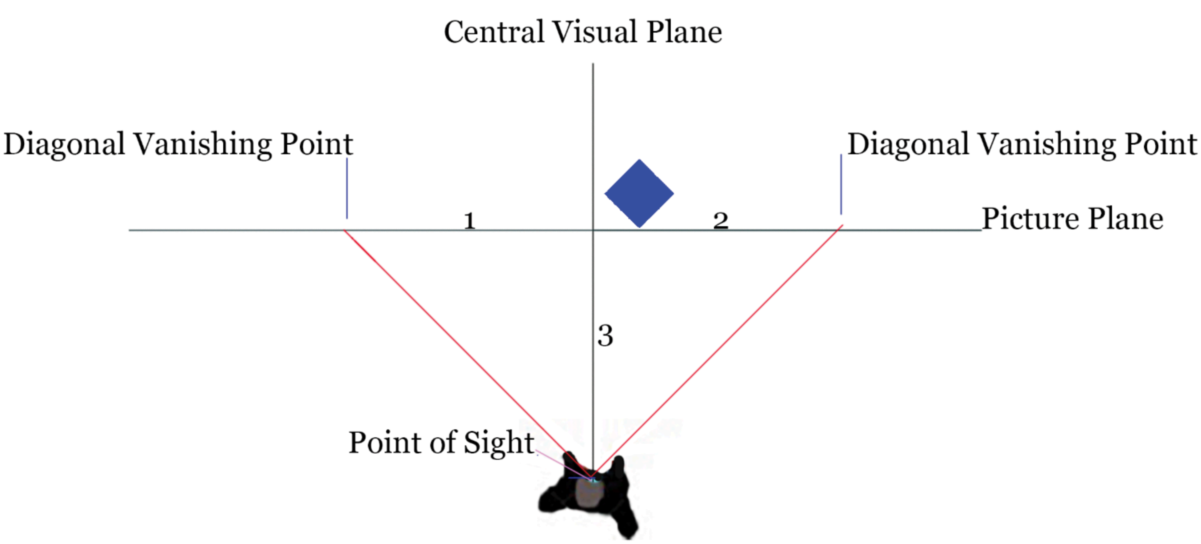
1. Equidistant from the center point, and

2. As far from the center point as the observer is to the picture plane.

If an artist imagines the size of the cube and figures the distance from the point of sight to the picture plane on the same scale, those measurements can be transferred proportionally to the perspective drawing. In that scale, the two diagonal vanishing points will be equal distances from center, and as far from the center as the imagined observer's proportional distance to the picture plane.

When one can *imagine* this picture plane and consider the length of the cube's dimensions in relation to the distance of the artist from the picture plane, it is easy to place the vanishing point.

Fig. 76



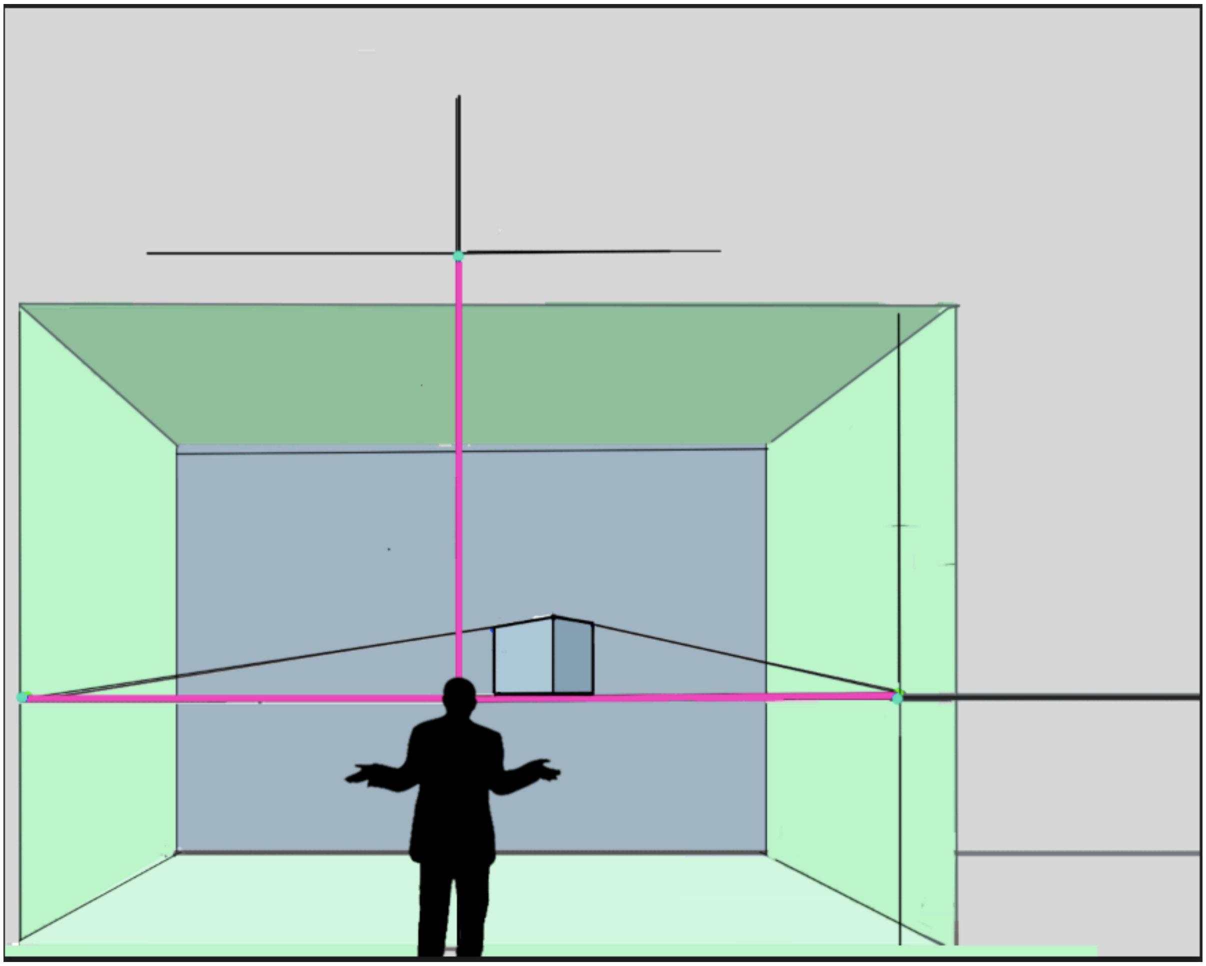
Line segments 1, 2 and 3 are of equal length.

Figure 77 shows the cube rotated 45 degrees to the picture plane and resting on eye level to the right of center.

The observer is at a distance equal to the length of the vertical red line

.

Fig. 77



The Diagonal Vanishing Points are equal distances from the center.

In relation to the cube, each is the same distance from Center Point as the point of sight is imagined to be from the picture plane *with the edge of the cube on the picture plane providing a unit of measurement.*

This is a special case of **Rule 1.** To find the vanishing point of any line, imagine a visual ray from the point of sight parallel to that line, and ascertain where it pierces the picture plane.

Two-Point Perspective - A Cube Above the Observer and to the Left.

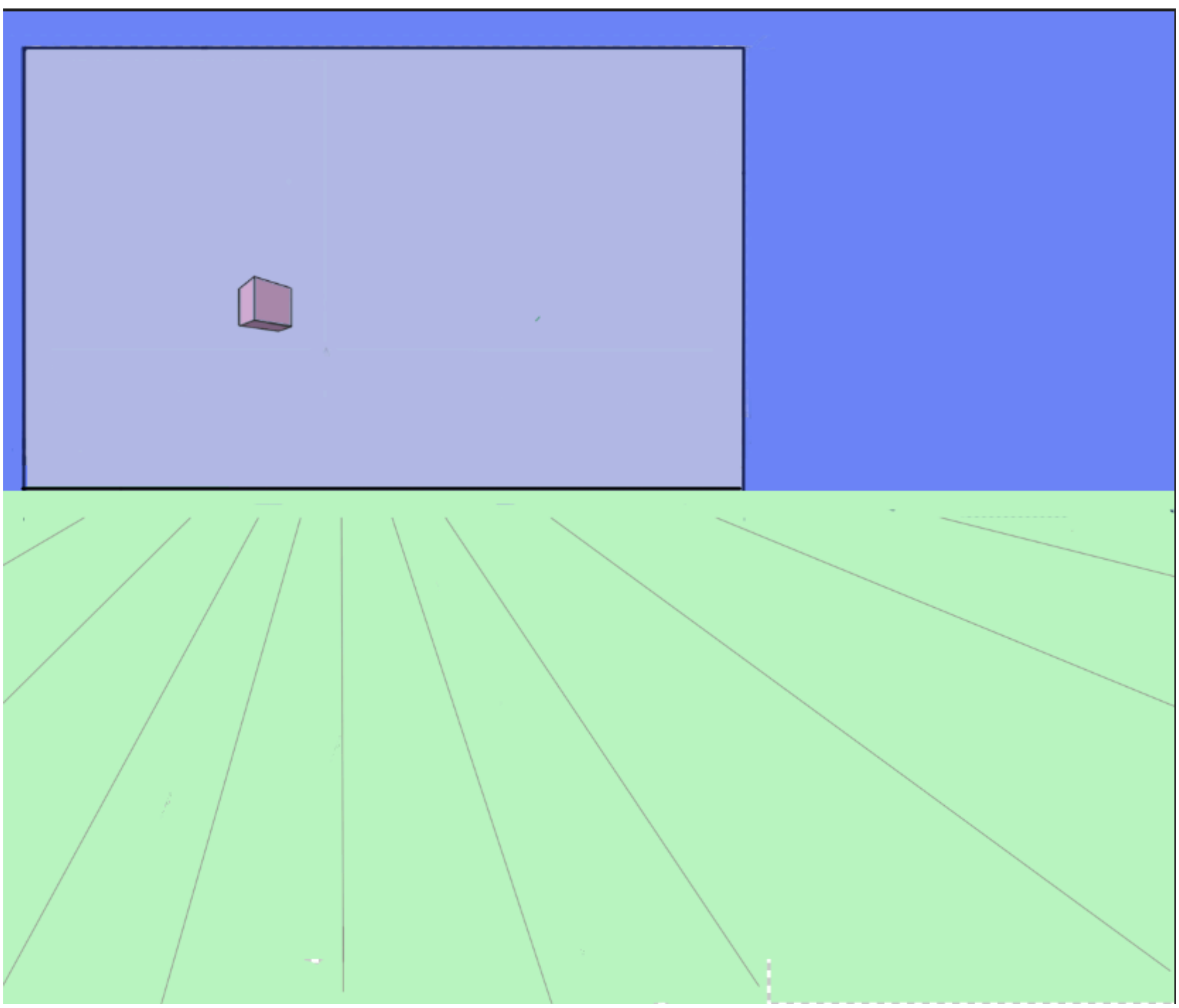
This set of images beginning with Fig. 87 suggests is a way of thinking about a freehand perspective drawing. In this example, the cube is turned 45 degrees for convenience, but Rule 1 still gives the vanishing points.

This exercise assumes some experience making perspective drawings based on of plans and elevations. With practice, the artist imagines the top and side views as well as the front view to inform his drawing.

Here is a cube against a picture. The cube's facing edge is vertical in this two-point perspective example. Because the cube is above the artist and turned, the artist knows that only the sides and the bottom of the cube will be visible.

The relative measurements are: the cube is two feet square, against a picture plane nine feet from observer. It is two feet above eye level and its facing edge is two feet left of the centerline. All these distances may be estimated visually, diagrammed or imagined based on the artist's creative intent and habitual experience.

Fig. 78



The artist stands before an imaginary picture plane and locates his eye level and his central visual plane on the imaginary picture plane in Figure 79. With the diagrams in Fig 81 through 83 understood, the final image can be imagined. The artist can run imaginary lines from his point of sight to points on the cube - or for vanishing points, from the point of sight parallel to the receding corners of the cube estimating in each case where the ray would cross the picture plane.

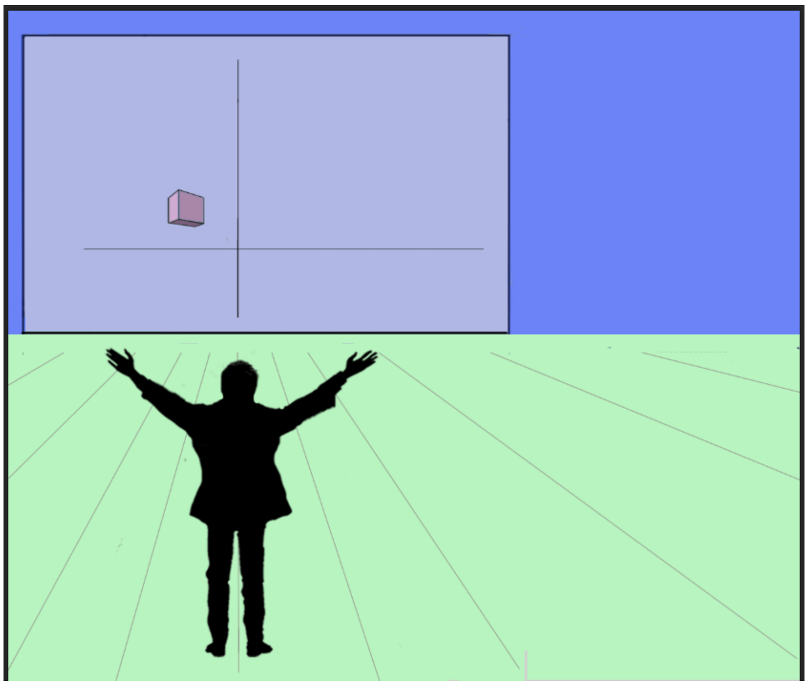


Fig. 79

Once conceptualized, the artist looks at the easel, imagines his diagonal vanishing points and imagines transferring the view seen on the imaginary picture plane to the canvas.

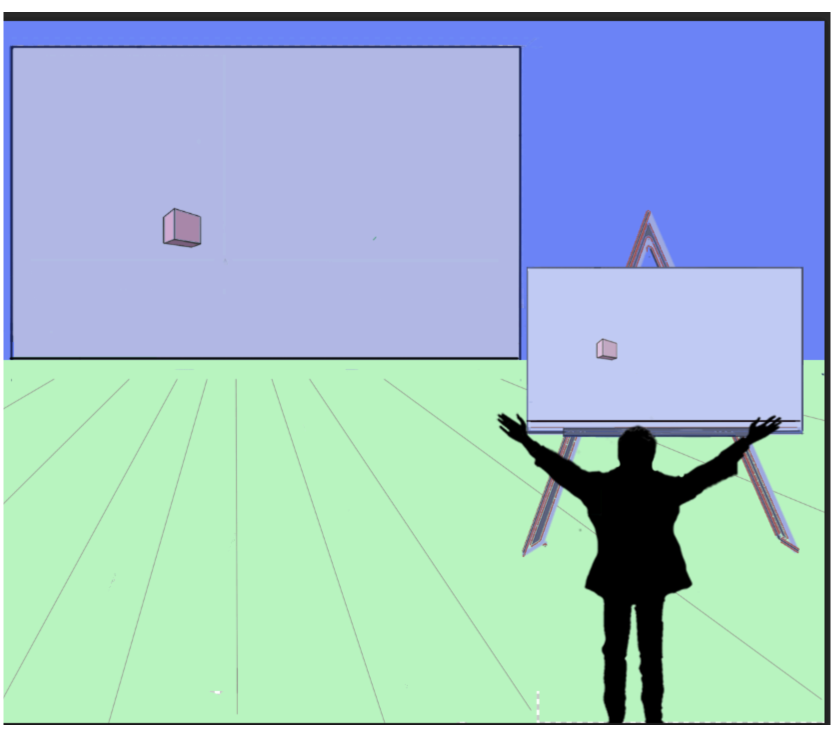
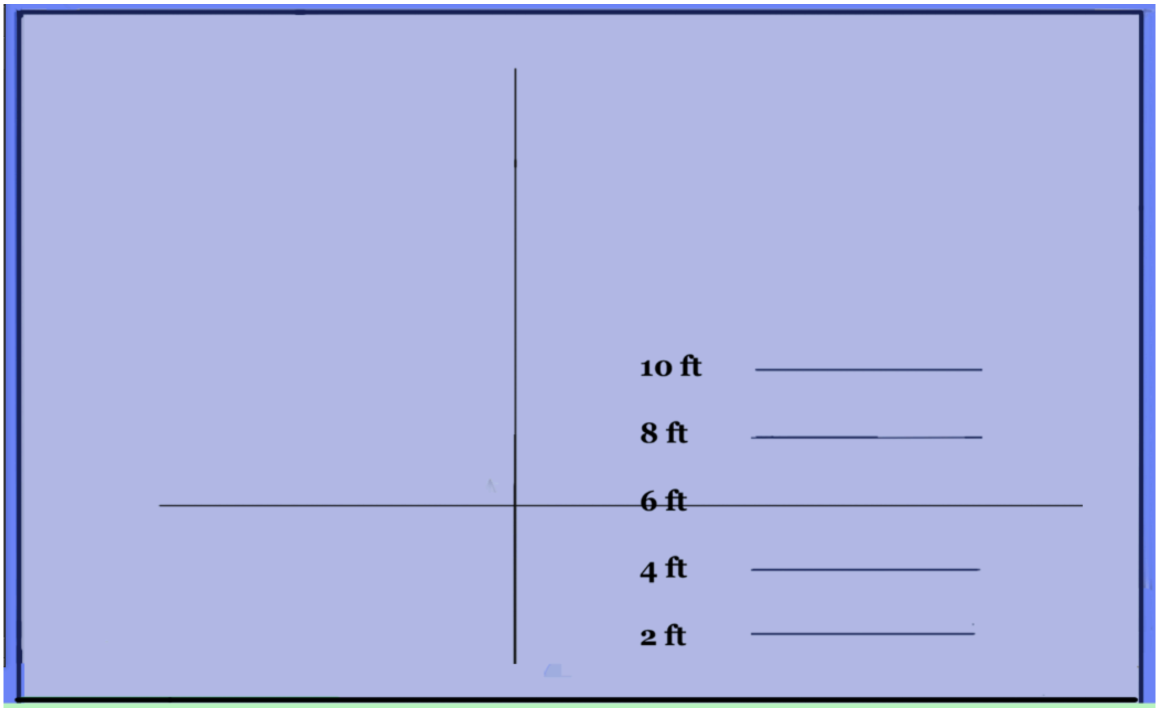


Fig. 80

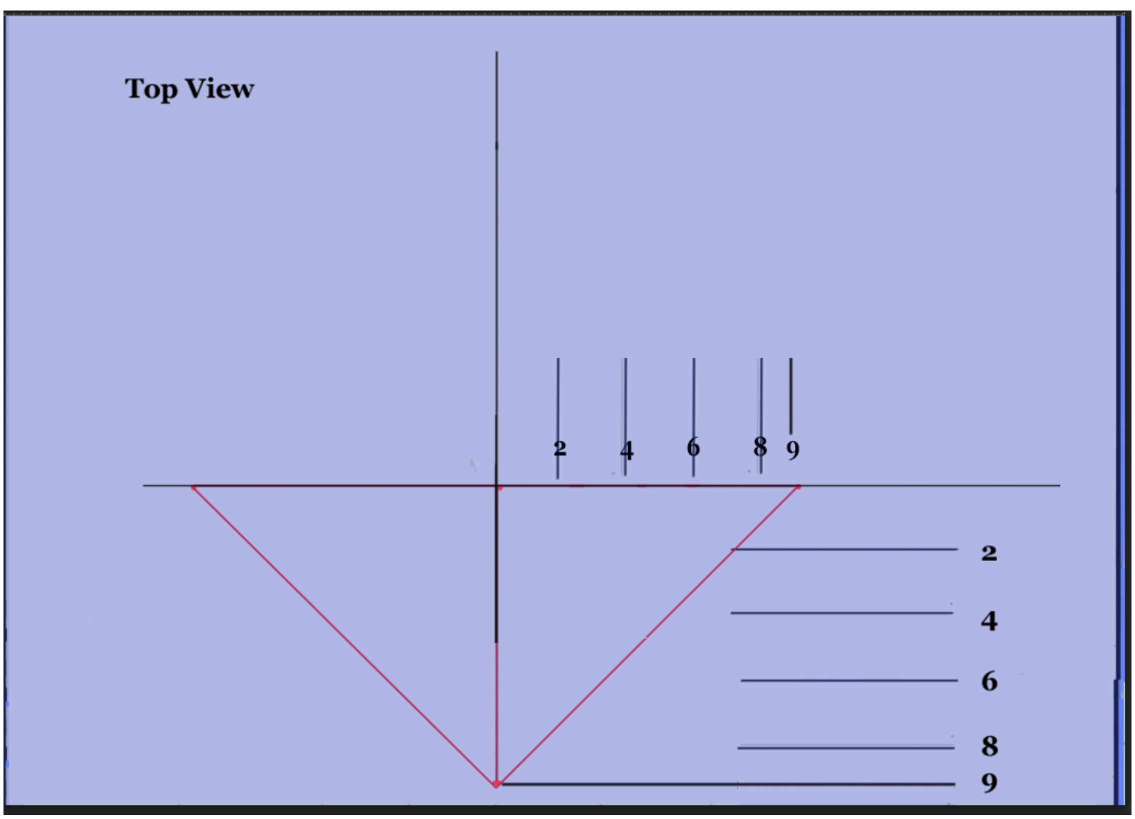
Here are the relative measurements on the picture plane. The *ground line* at the bottom of the image (where picture plane and ground plane meet) is six feet below eye level.

Fig. 81



Imagining a plan from above, the artist determines the point of sight 9 feet from the picture plane, and so identifies the Diagonal Vanishing Points.

Fig. 82

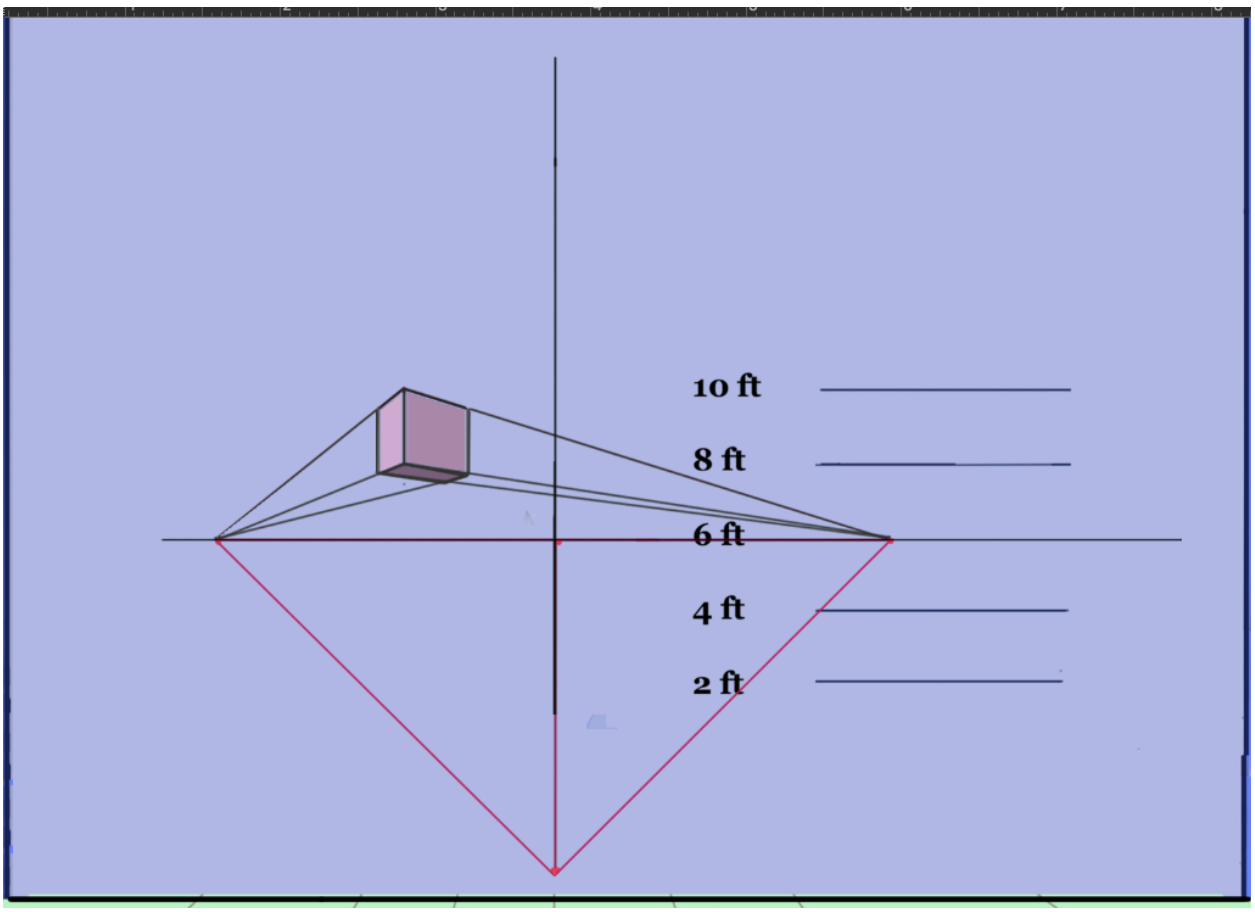


This is the picture plane, with the cube imagined behind and against it. The size relationships between the edge of the box on the picture plane and the location of the diagonal vanishing points remain constant. Each is measured on the picture plane.

The cube is two feet above eye level. The diagonal vanishing points are 9 feet from center (the observer's distance) and will vanish on the eye level because these receding edges are parallel to the eye level plane.

After practice, all this is possible in the imagination. The relative measurements are transferred to the drawing in proportion.

Fig. 83



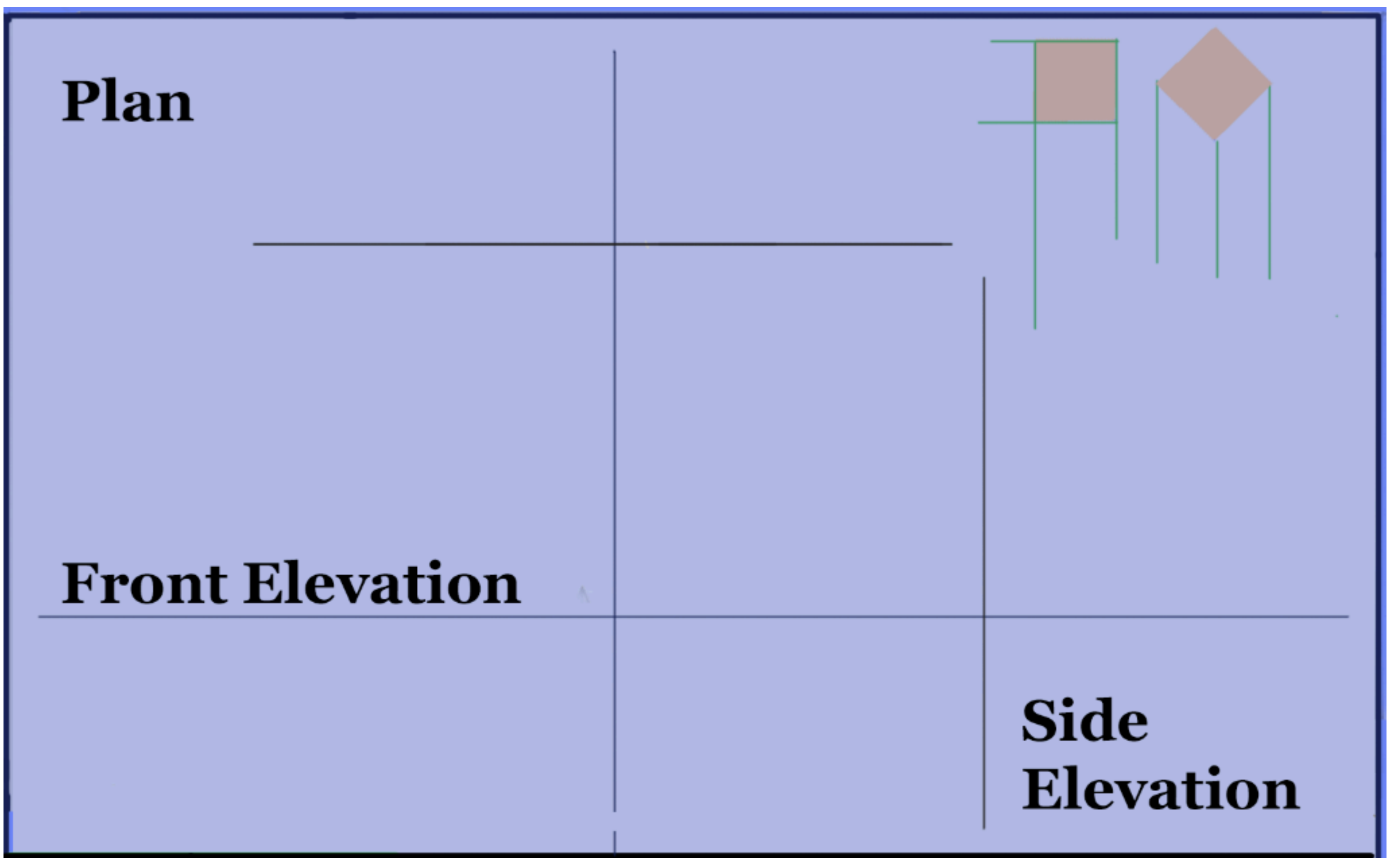
To explain this view or to mechanically create it, the elevations are drawn separately on the following pages.

Figures 84 displays these elevations together for measurement.

The true measurements of the cube are illustrated by the brown boxes at the upper right of Figure 84.

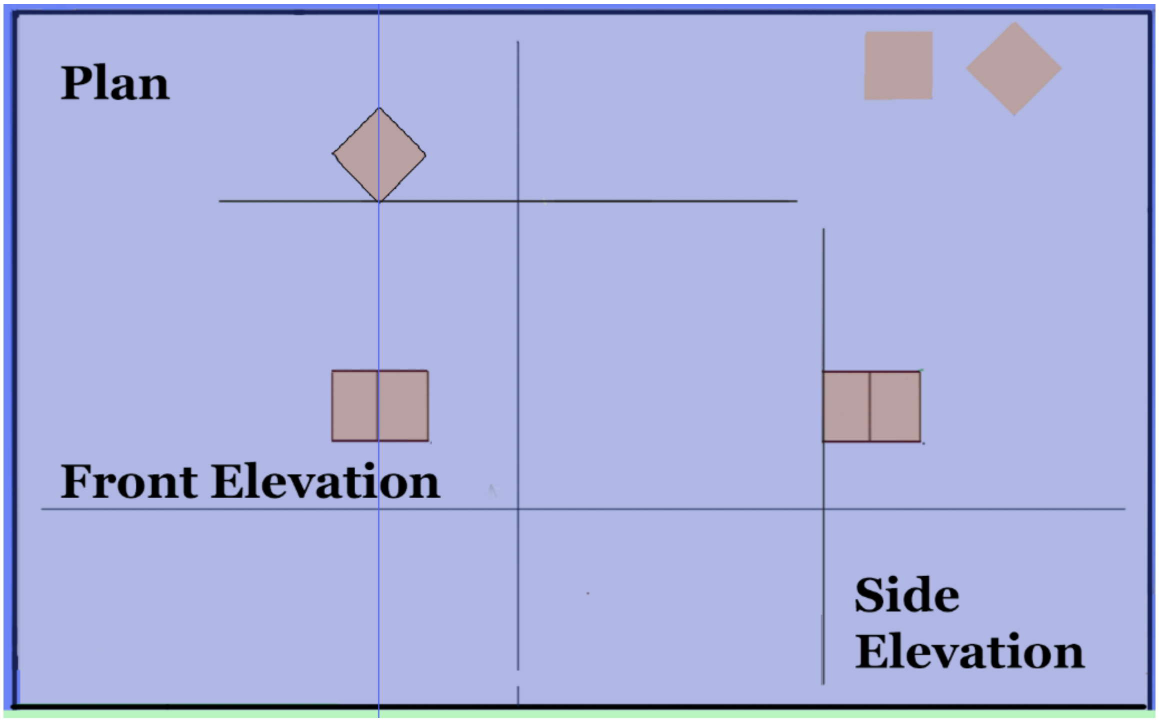
Measurements will be taken from the plan and side elevations, and used to construct a perspective front view shown above. This is two-point perspective with one line system parallel to the picture plane, and it is a special case, where the cube happens to be rotated exactly 45 degrees.

Fig. 84



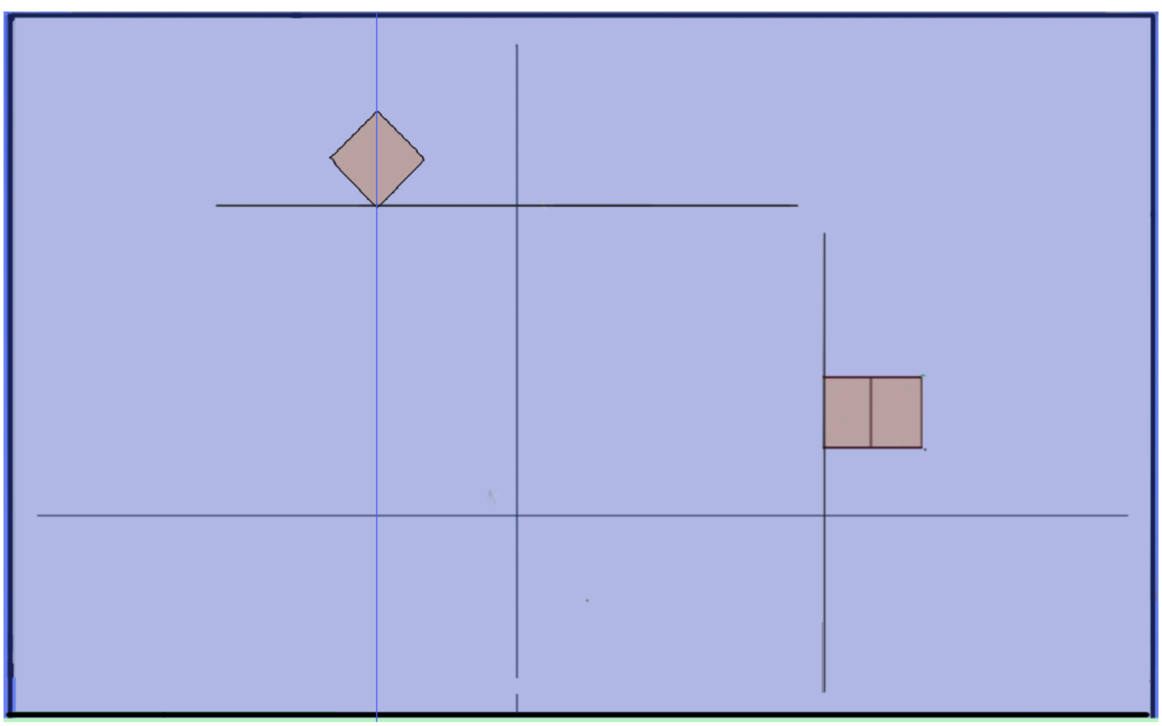
Below are reference planes and a cube drawn in three elevations. On the front elevation the vertical facing corner edge is against the picture plane and retains its true measurement. All remaining measurements were transferred from the plan and side elevation.

Fig. 85



In Figure 86, the front elevation has been deleted to permit construction of the perspective front view. Only the side elevation and plan of the cube are shown.

Fig. 86



From the point of sight, on the side elevation, draw visual rays to points on the cube.

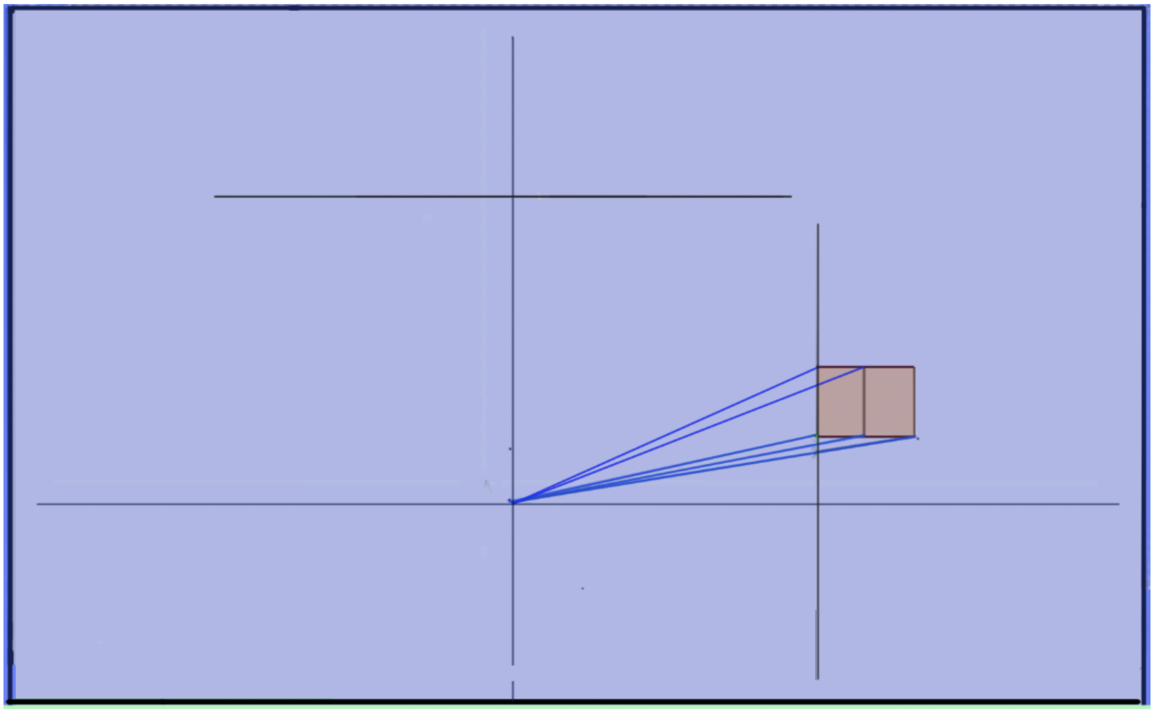
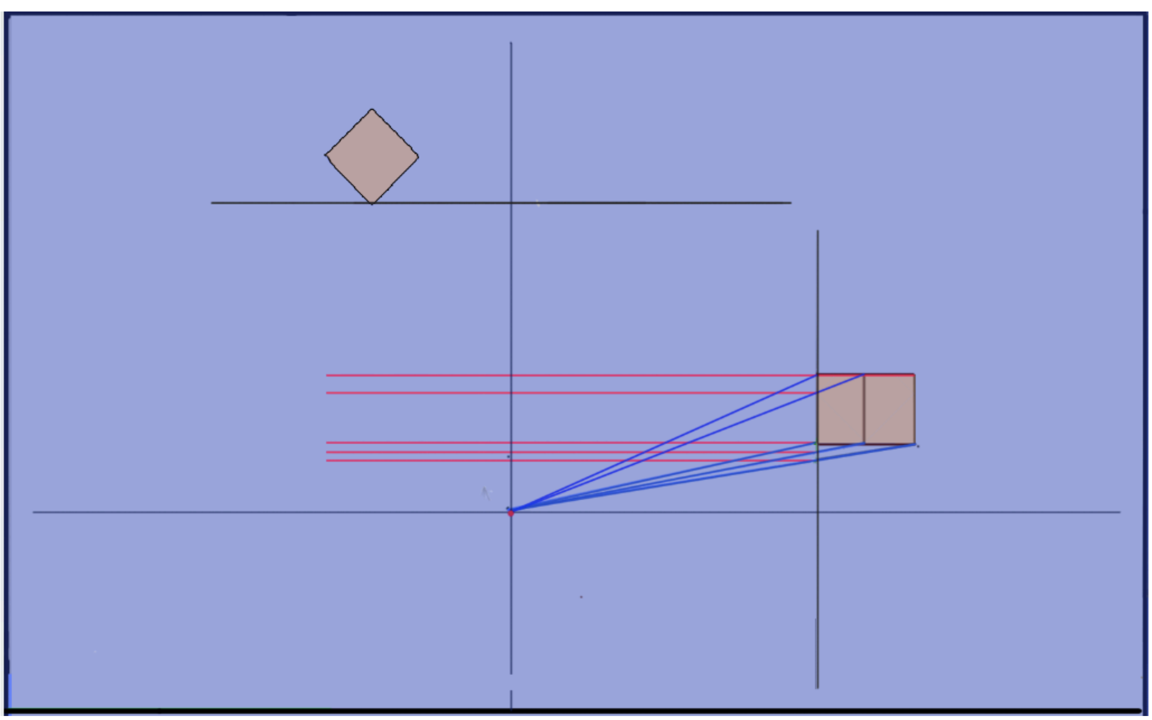


Fig. 87

Rule 2. To locate *any point* on an object in the perspective drawing, imagine a visual ray from the point of sight to the point on the object itself, and ascertain where it pierces the picture plane.

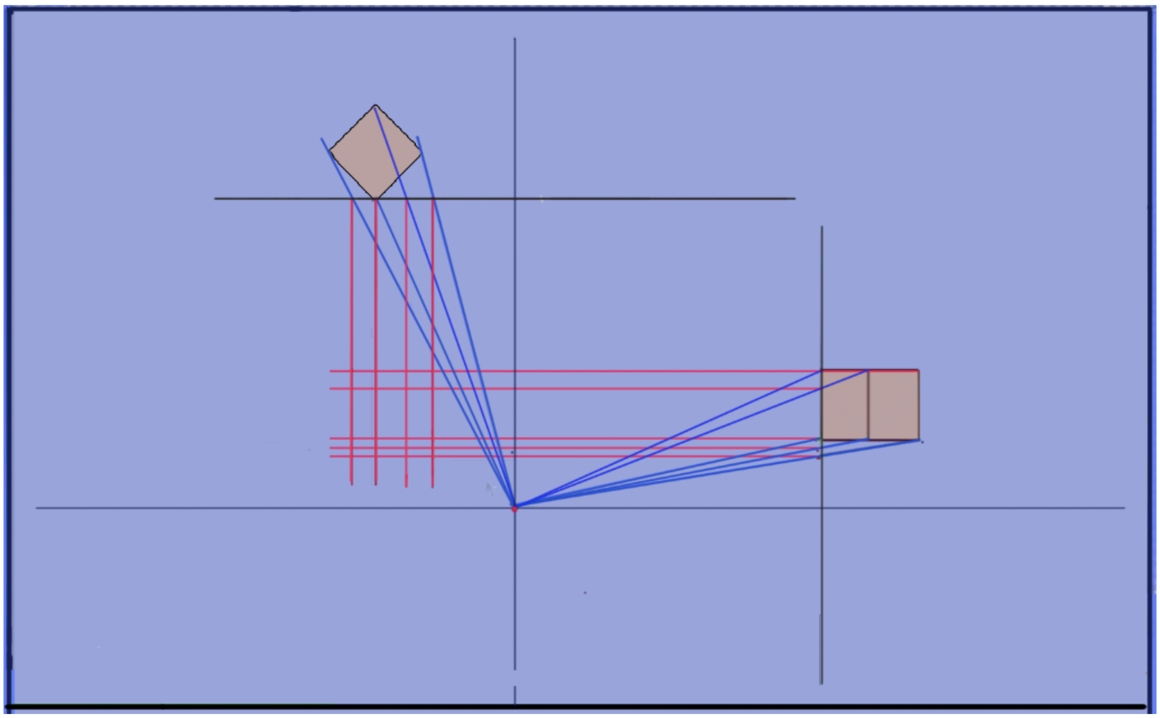
On the side elevation, find the points where visual rays to points on the cube pierce the picture plane, and transfer these vertical locations to the front view.

Fig. 88



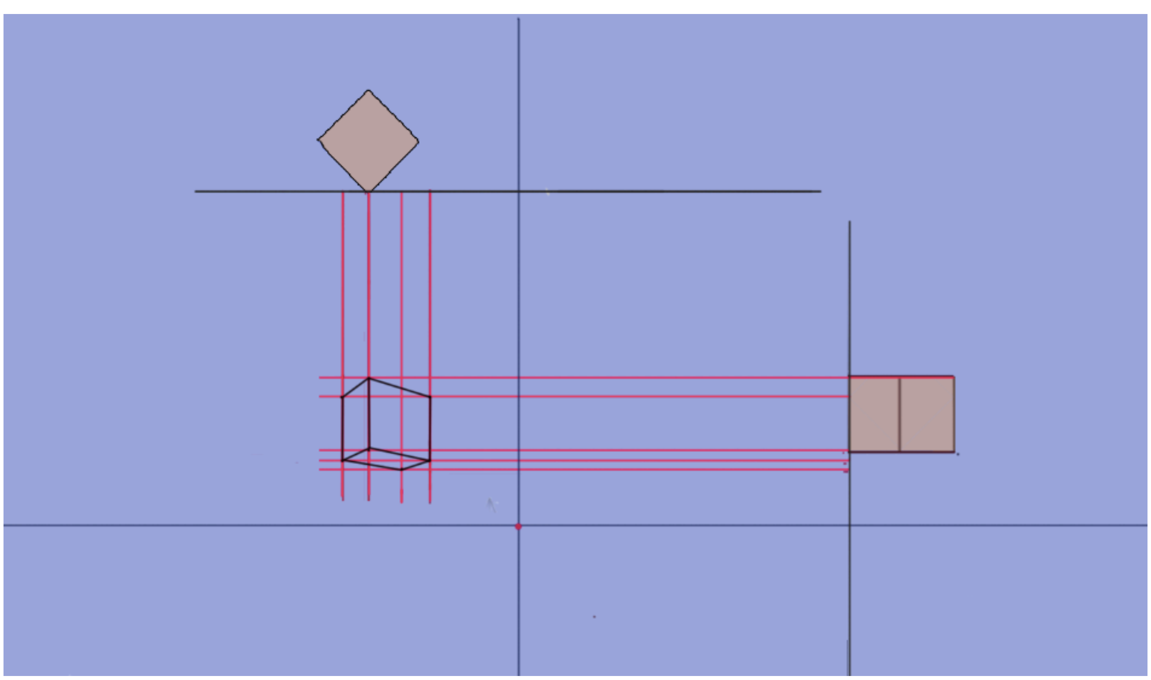
Construction lines are drawn on the plan to mark the horizontal locations of each point.

Fig. 89



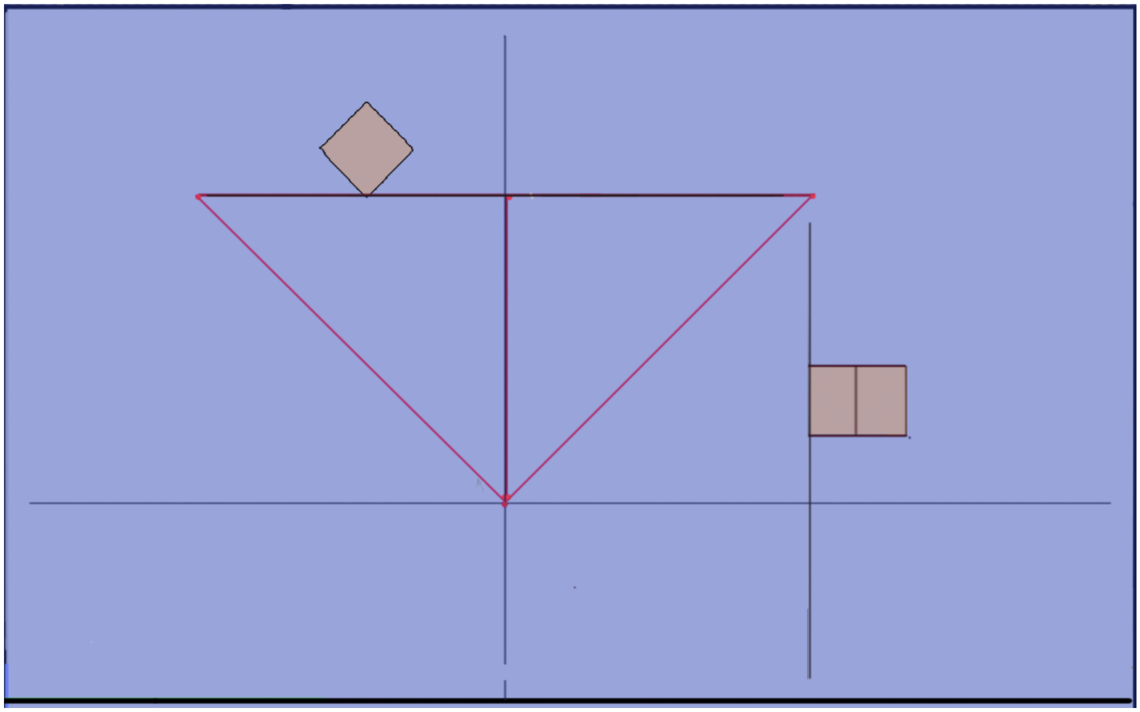
The corners of the cube in perspective are found at the intersections of these lines. The outlines and the meeting of planes on the cube can be marked by connecting the intersecting points. The observer will see portions of its bottom plane and two of its receding side planes. The receding edges will travel towards the diagonal vanishing points.

Fig. 90



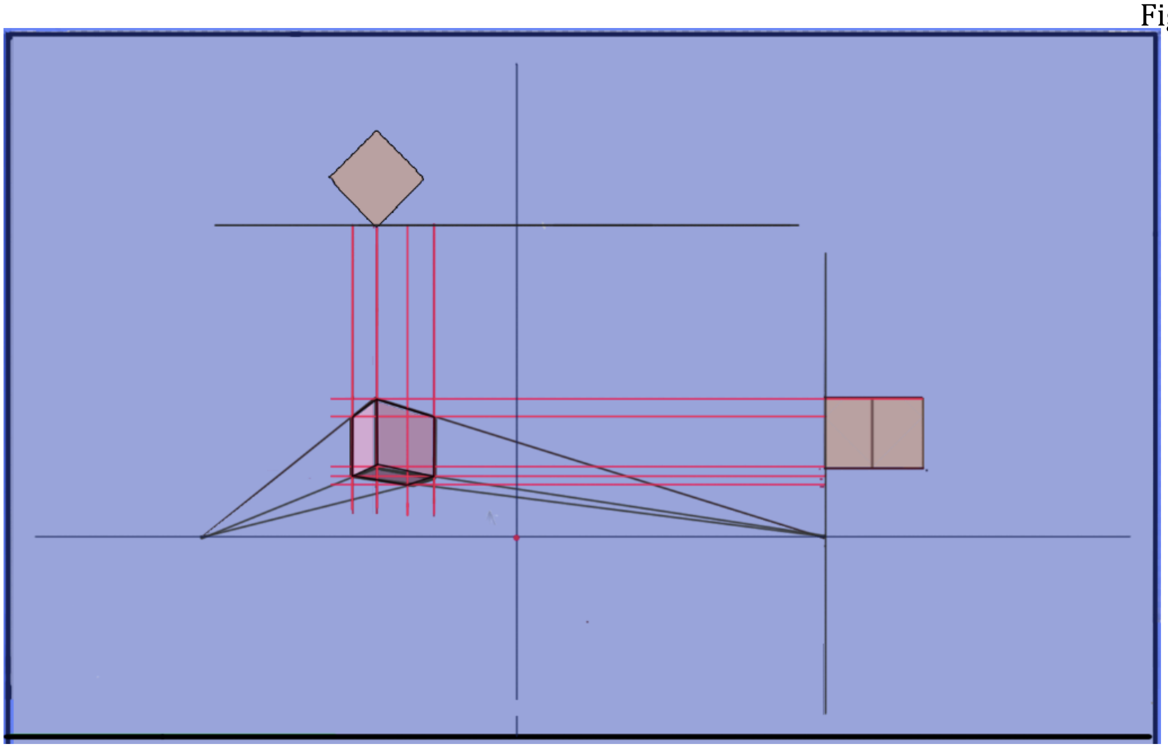
The diagonal vanishing point is developed in the plan. Each diagonal vanishing point is the same distance from the centerline as the observer is from the picture plane (Figure 91). They will be transferred down to the picture plane as shown in Figure 92, below.

Fig. 91



The diagonal receding edges of the are parallel with eye level and will meet their vanishing points at eye level.

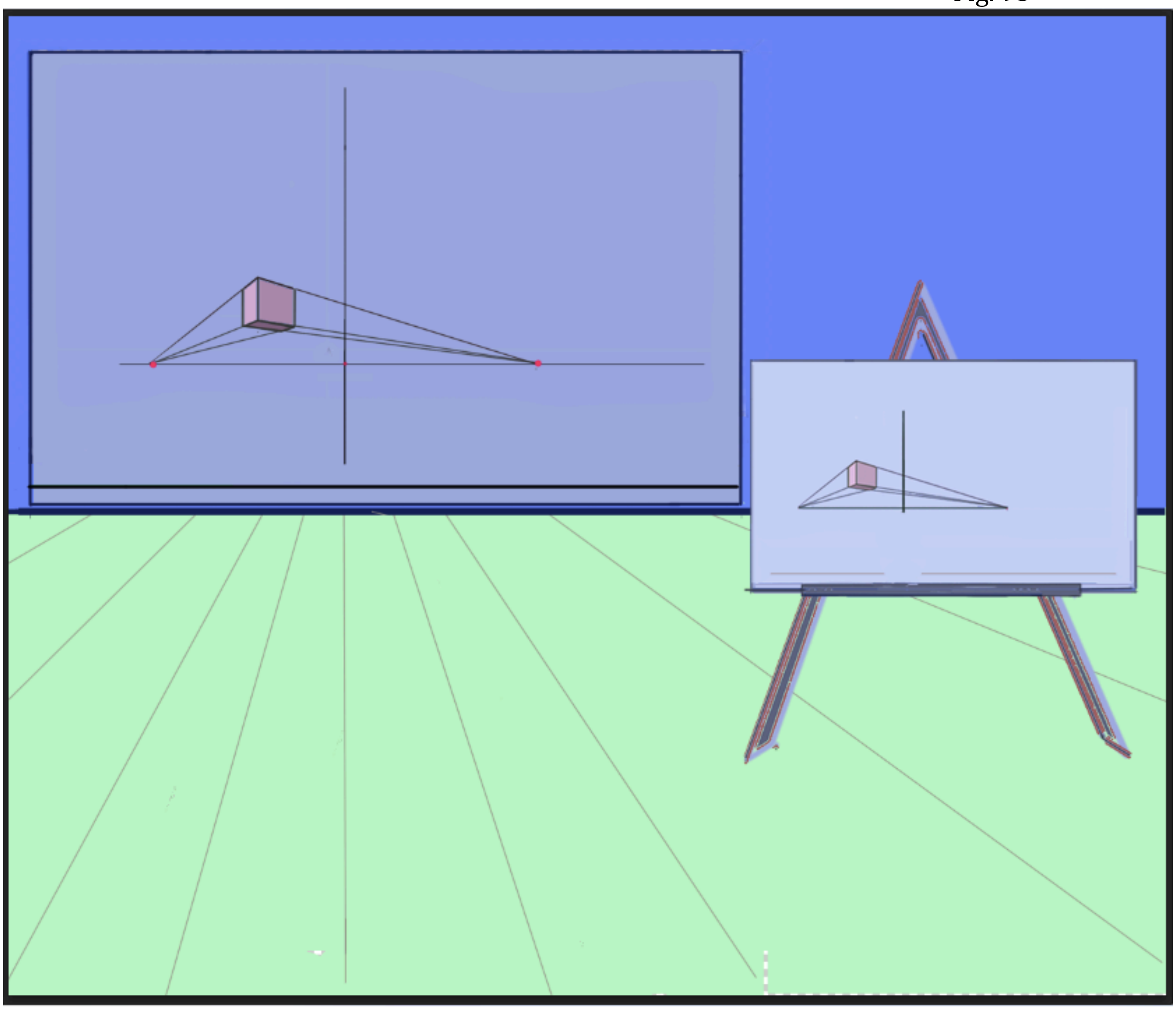
Fig.92



With the vanishing points and corners of the cube established, the concept can be transferred to the canvas.

The mechanical exercises inform the visual experience and facilitate freehand expression.

Fig. 93



7. Three Point Perspective.

The purpose of this essay has been to introduce the vocabulary and concepts related to representing a solid object seen from a fixed point of sight on a flat working surface.

The cube is used to enclose complex shapes in order to rationalize the behavior of lines and light on the enclosed shape. Enclosing complex shapes in simple cubes enables their accurate drawing in perspective.

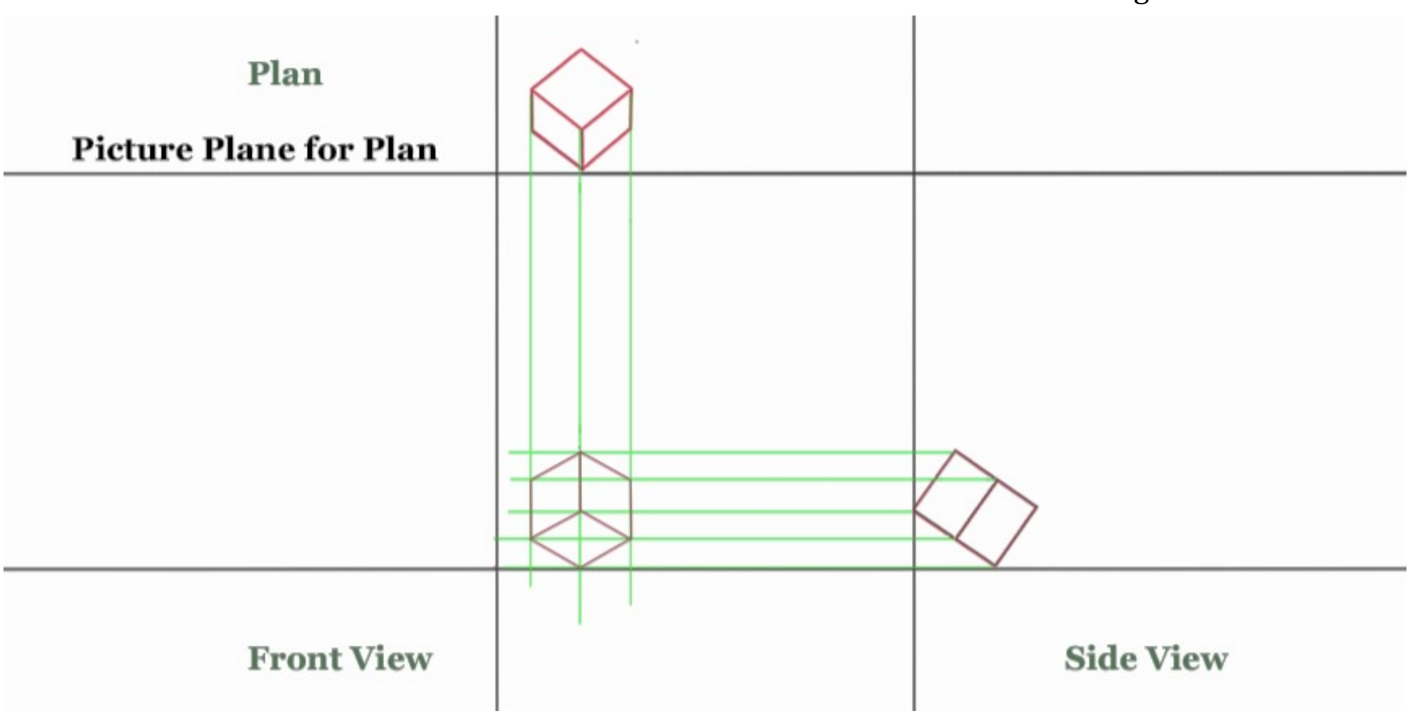
In the examples of one-point and two-point perspective, at least one line system of the enclosing cube has been parallel to the picture plane.

First, the cube was first presented with a face parallel to the picture plane (one-point perspective), then rotated (for two-point perspective). One edge remained parallel to the picture plane.

However, when the top of the cube is tilted away from or towards the observer, no line system – neither the height, width, nor depth lines of the cube – are parallel to the picture plane.

Figure 94 shows a typical setup for three-point perspective. The tilted and rotated cube is shown in the plan and side elevations and a front elevation is provided for measurement.

Fig. 94



Picture Plane in Side View

Finding the Vanishing Points.

To establish the height and width dimensions on the picture plane of the vanishing point of a line, the artist uses the side view and plan.

On the side view, establish the height of the vanishing point, with a visual ray parallel to the line in question run from the point of sight to where it crosses the picture plane. To locate the height on the picture plane of the vanishing point of that line, project a visual ray from the point of sight, parallel to the line and ascertain where it crosses the picture plane. The combined hight and width give the point's location on the picture plane.

Fig. 95

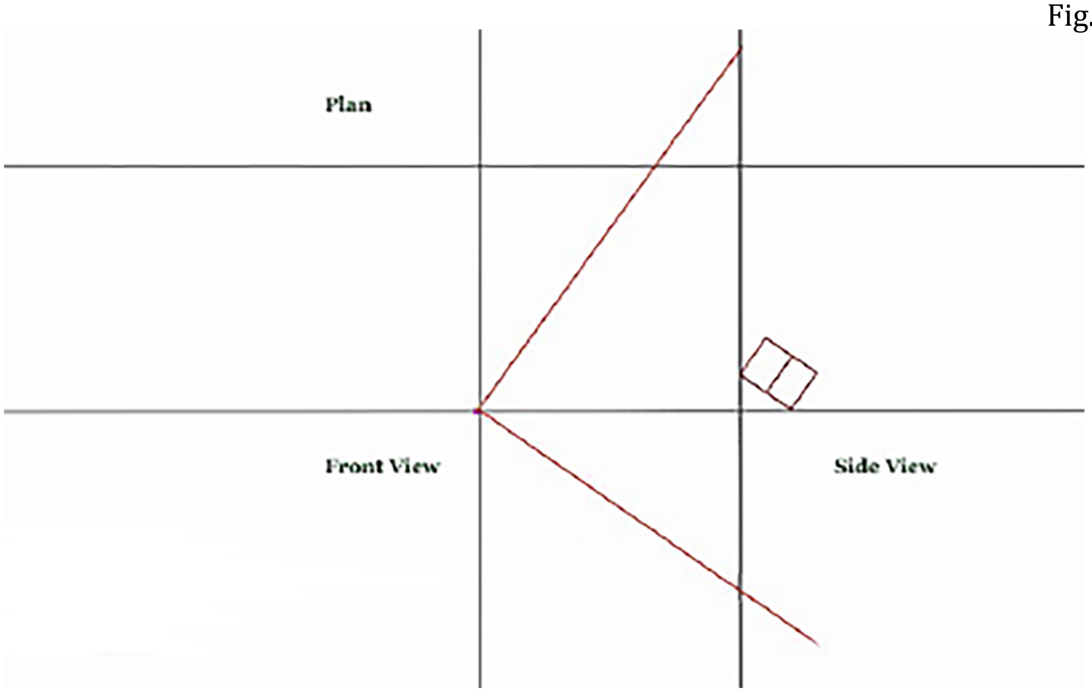
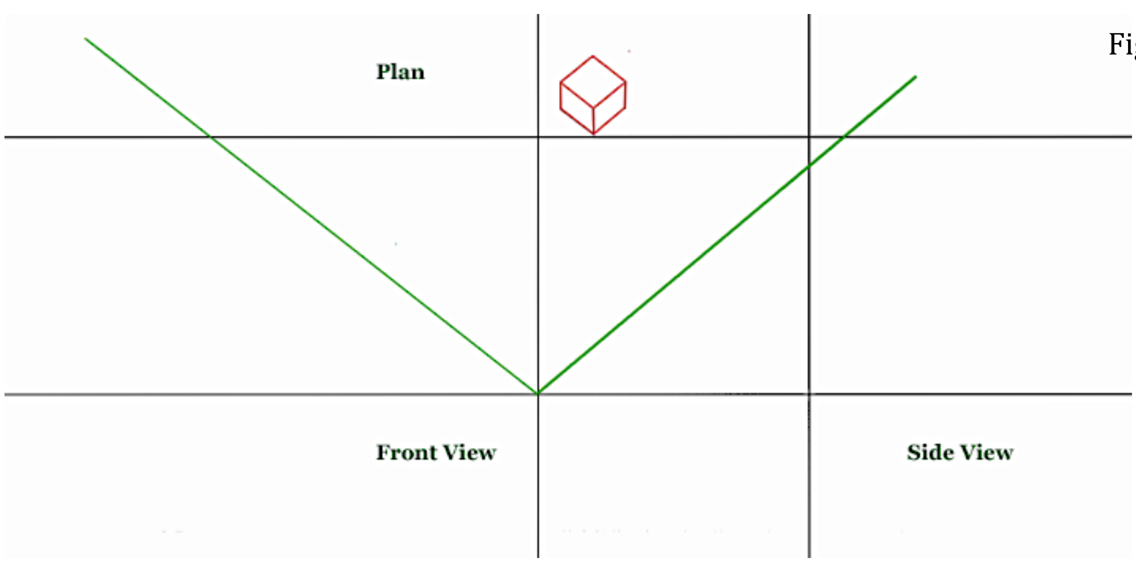


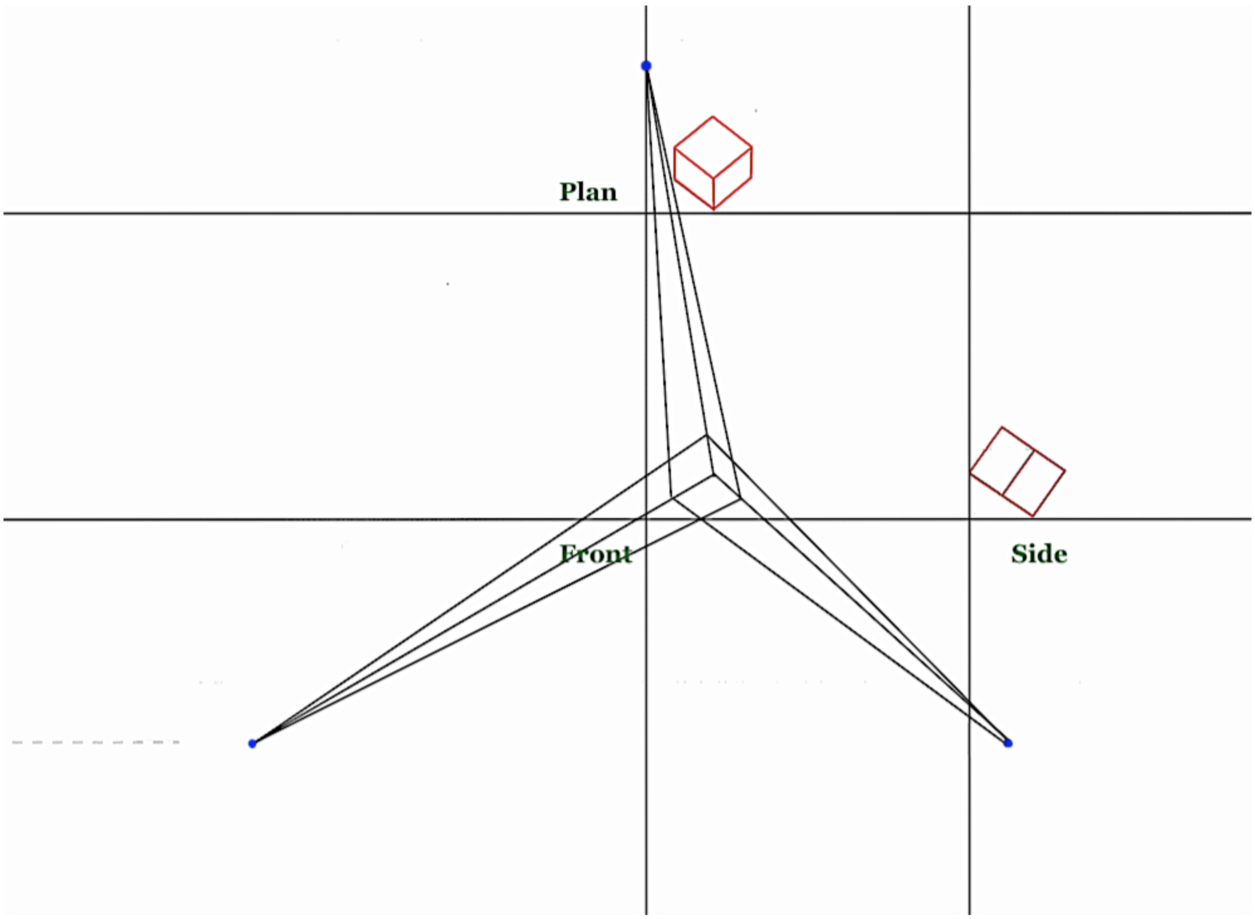
Figure 95 shows the height of the points using the side eleation for measurement. Figure 96, below, shows the widths of the vanishing points in the perspective drawing using the plan for measurement.

Fig. 96



When each line on the cube is studied in plan and side elevation, the three parallel line systems will each have their vanishing points.

Fig. 97



While it is not practical for most artists to use measured perspective while drawing, the benefit of pursuing this exercise is similar to the benefits to a ship's pilot of learning to navigate with compass and maps. It resolves the initial variance experienced between actual and apparent conditions. A line must begin somewhere and end somewhere. Drawing systems allow the artist to draw a line from beginning to end without hesitating about direction along the way.

8. Picture Planes in Daily Visual Experience vs. One Picture Plane for Drawing

A conventional perspective drawing on a flat surface is based on a single point of sight, with a central visual ray perpendicular to the picture plane and located a fixed distance from it.

The artist looks straight ahead at the subject, and the observer looks straight ahead at the canvas. The artist imagines the picture plane. The canvas is the picture plan for the observer.

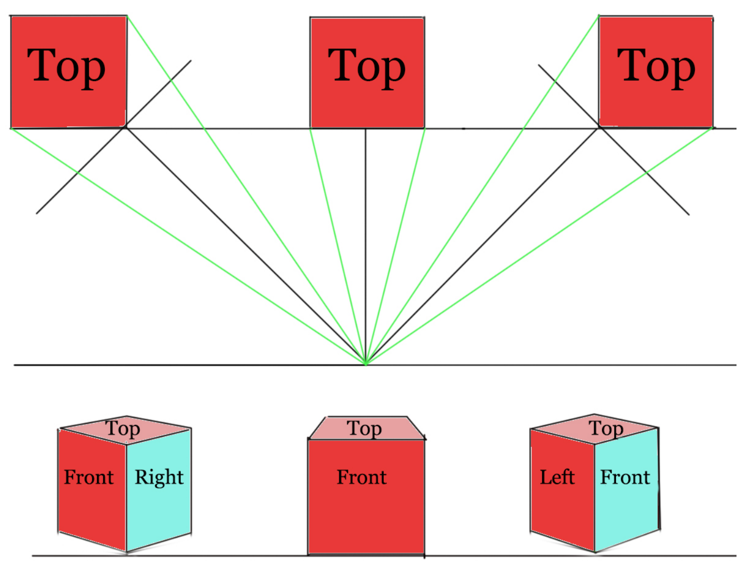
In daily life, however, we do not look at objects in this way at all. Our head and eyes constantly move to evaluate what we observe. We do not see a single image, but a series of images, often many images in the space of a second. Three glances may tell us about the boxes (Figure 98).

But we take in many more. We have two eyes, each a point of sight. We move the eyes and head up and down, as well as left and right to assess position and understand shape. When look people "up and down." Our brains assemble the various images. We imagine that we know what we see. But in fact, we see in our minds what we know from our hands.

Below is a top view of three blocks lined up on a single plane. They will appear parallel and we can touch them to prove it, but our eyes have seen something else.

When we look at three big cubes lined up in a row on a single plane, somewhat near to us, we move our gaze to left and right to see each cube directly. Shifting the direction of our central visual ray changes the orientation of the picture plane. The picture plane is perpendicular to the central visual ray. The three cube fronts are against a single plane, but look different to the eye as we see each one separately, shifting our perspective slightly as we move a single eye from one to another.

Fig. 98



The top view in the upper portion of Figure 98, shows the visible faces of the cube, enclosed by the green visual rays piercing the three picture planes.

Drawing what we see in each of the three views, the three cubes would look somewhat like the lower drawing.

On the left, we see some front and right side. In the center, only the front; with the right cube, we see some of the left and front. Copying what we see will not make the front faces appear to be parallel.

Fig. 12

However, our brains do create summary or tolerate multiple images that violate the experience of touch. Although the three aligned boxes may look different as we move our eyes around, the brain makes the corrections required to keep what we see consistent with what we touch, in this case making facing planes appear parallel, and giving them more of the look and feel of the perspective rendering below, with its single central visual ray.

This summary view satisfies the viewer gazing directly at the picture, and the image feels consistent with what is felt to be true. A hundred years of flat plate photography – which creates perspective images – has further accustomed us to interpreting perspectives from a single point of sight to be representations of reality.

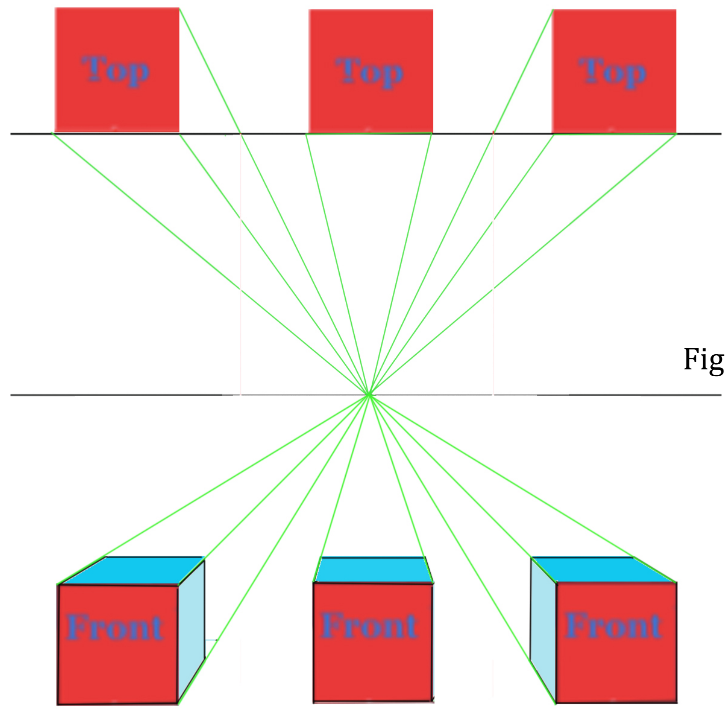


Fig 99

These rules are very powerful tools for illusionary drawing. The language of diminishing sizes and apparent converging of parallel lines as they recede are matters of optics not culture.

However, effective use of perspective without the appearance of exaggeration has strict limits. It is most effective within an arc of about 30 – 40 degrees. Outside of a 60 degree cone of vision, significant distortion develops.

In Figure 99, the sides and top of the perspective drawing were <u>*not*</u> *cropped at their far ends at the points where the visual rays crossed the picture plane as required by Rule 2. The back points were drawn where they seemed to look good.*

In fact, in a measured perspective with a point of sight this close as in Figures 99 and 100, the sides and tops of the cubes would be very distorted.

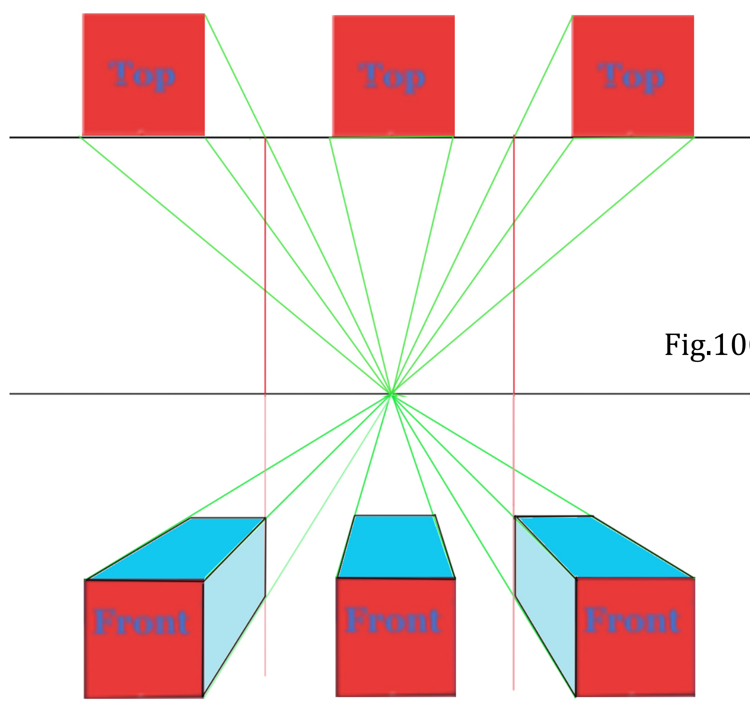


Fig.100

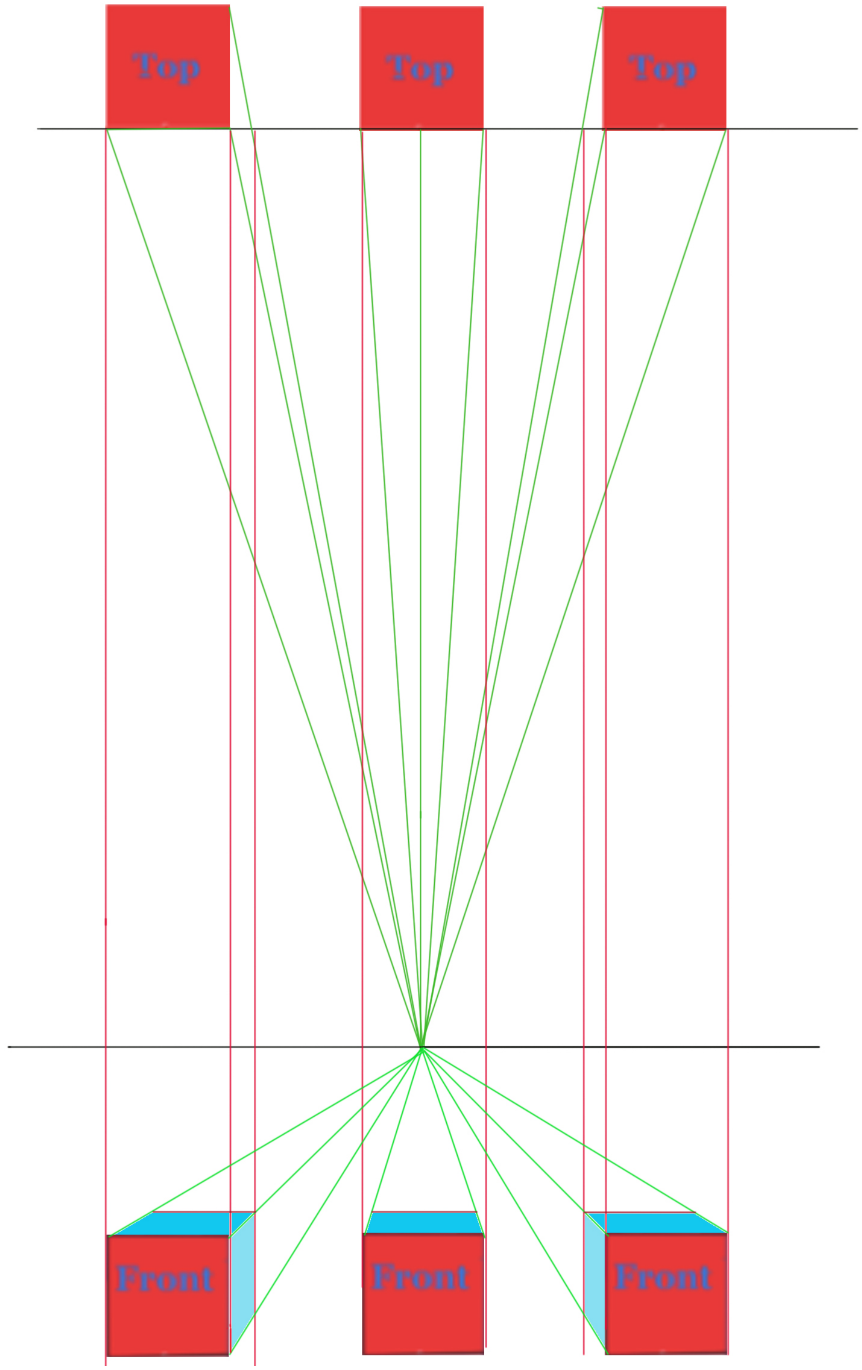
Figure 100 is the actual perspective drawing, where the cone of vision is a bit over 90 degrees and the back points plotted according to Rule 2..

When painting a close scene, an artist may back up to reduce the cone of vision, taking the point of sight back from the picture plane to retain convincing proportions on receding planes.

By moving the imaginary picture plane back this far from the point of sight, the distortion in Figure 100 is resolved.

Each point in the front view is found using Rule 2, locating in the plan where the visual rays from the point of sight cross the picture plane, and applying that measurement to the front view.

With practice, this can all be done in the mind as part of one's drawing vocabulary.



Related Works

The following books are recommended for further study. The first three informed this essay.

Dubery and Willats, 1972. *Drawing Systems*, Van Nostrand Reinhold Co., New York

Alberti, Leon Battista. 1967. *On Painting*, (Spencer, J. trans.), Yale University Press, New Haven.

Walters and Bromham, 1970. *Principles of Perspective,* Whitney Library of Design, Watson Guptill, New York

Blunt, Anthony, 1940. *Artistic Theory in Italy 1450 – 1600*, Oxford University Press, London

Hale, Robert Beverly, 1964. *Drawing Lessons from the Great Masters*. Watson-Guptill, New York

Goll, Peter, 1980. *On Perspective*, Dan Humphrey Publishers, Haines, Alaska