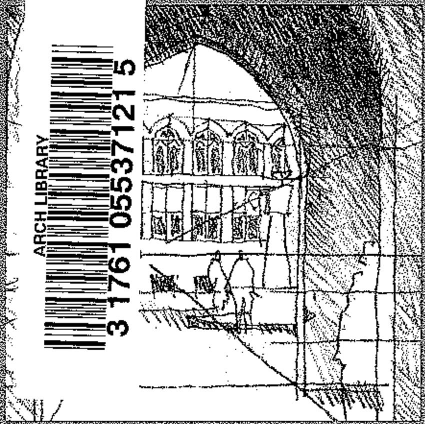
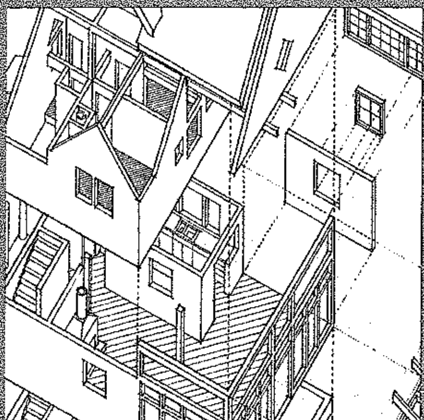
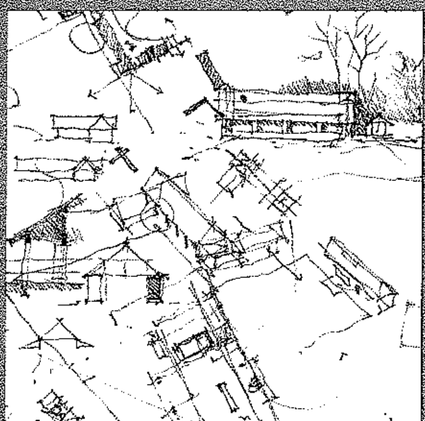




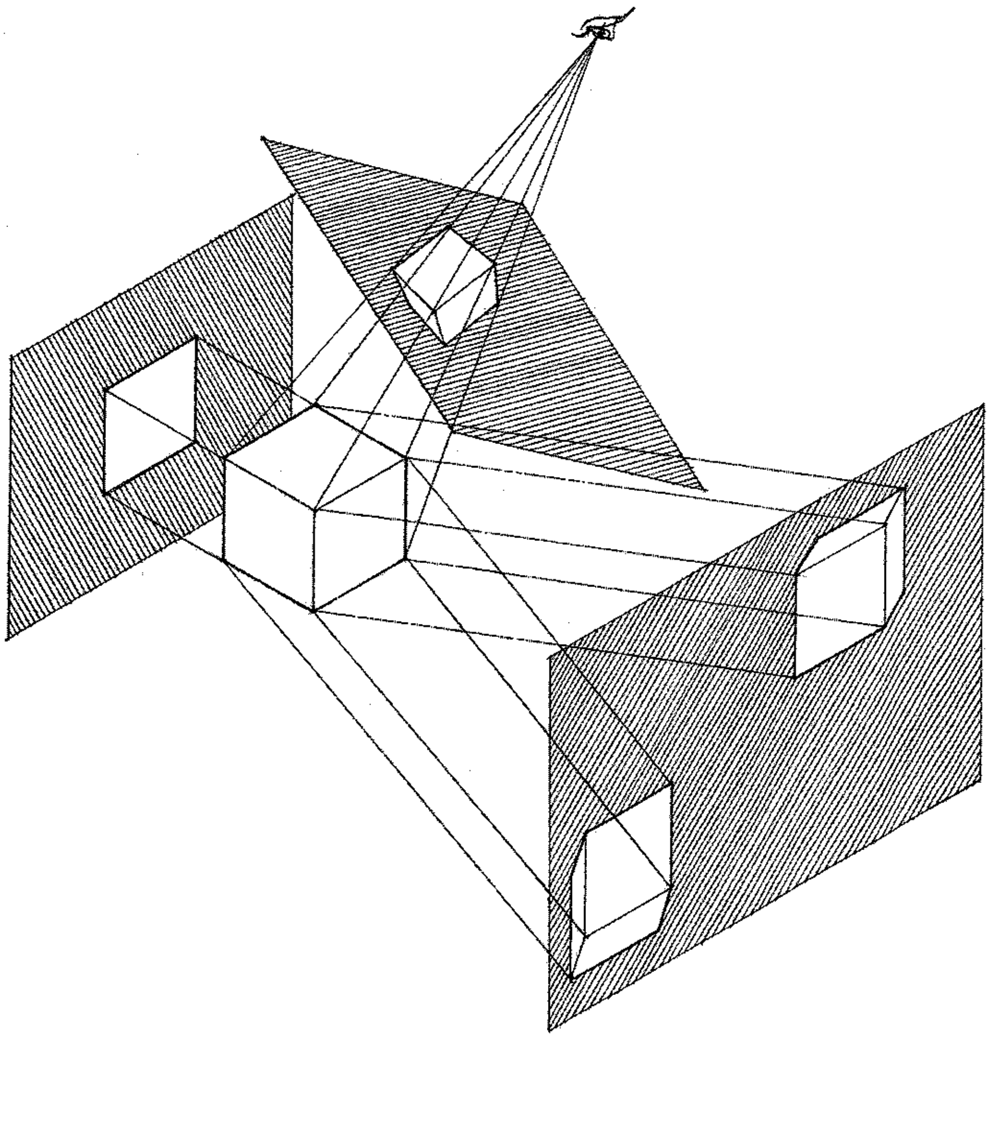


Design Drawing

Francis D.K. Ching
with **Steven P. Juroszek**

CD-ROM

In design, drawing systems provide alternative ways of thinking about and representing what we see before us or envision in the mind's eye. Each drawing system involves a built-in set of mental operations that directs our exploration of a design problem In selecting one drawing system over another to convey visual information we make conscious as well as unconscious choices as to which aspects of our perception or imagination can or should be expressed The choice of a drawing system is as much a question of what to conceal as it is a decision about what to reveal



5

Pictorial Systems

We classify drawing systems according to method of projection as well as by resulting pictorial effect Projection refers to the process or technique of representing a three-dimensional object by extending all its points by straight lines, called projectors, to a picture plane, an imaginary transparent plane assumed to be coextensive with the drawing surface We also call the picture plane the plane of projection

There are three major types of projection systems—orthographic projection, oblique projection, and perspective projection The relationship of the projectors to each other as well as the angle at which they strike the picture plane differentiate each projection system from the other two We should recognize the particular nature of each projection system and understand the principles that guide the construction of each drawing type within the system These principles define a common language that allows us to read and understand one another s drawings

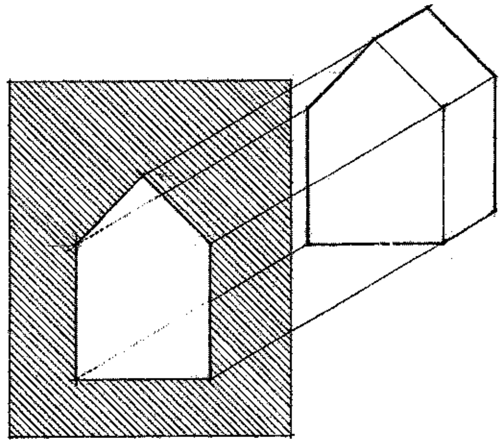
In addition to its utility as a means of communication, projection drawing both requires and facilitates learning how to think spatially in three dimensions In working through the process of constructing a projection, we navigate through a three-dimensional field of space in order to locate points, determine the length and direction of lines, and describe the shape and extent of planes Projection drawing thus embraces the system of Cartesian coordinates and the principles of descriptive geometry

When we lay out the major types of projection systems, it becomes apparent that the images they present of an object vary in appearance It is easiest to discern both the pictorial similarities and differences by studying how each projection system represents the same cubic form as having mutually perpendicular sets of lines and planes

Based on similarities of appearance, there are three major categories of pictorial systems—multiview drawings, paraline drawings, and perspective drawings Multiview drawings represent a three-dimensional subject through a series of distinct but related two-dimensional views Both paraline and perspective drawings, on the other hand, depict two or more facets of a three-dimensional structure in a single image The major pictorial difference between the two is that parallel lines remain parallel in paraline drawings while they appear to converge in perspective drawings

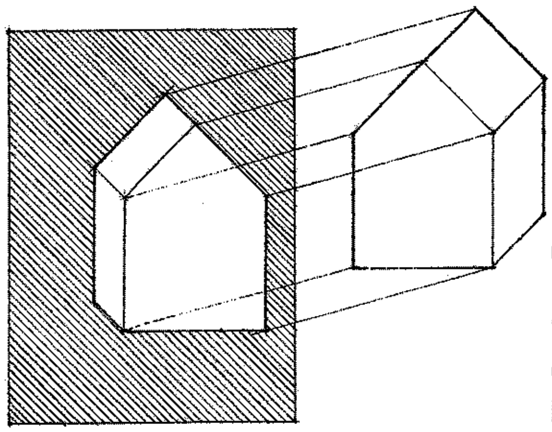
Multiview, paraline, and perspective drawings represent a range of choices for the designer. We should not only know how to construct each drawing type but also understand the particular pictorial effects that each projection system produces. No one drawing system is superior to the others; each has inherent pictorial characteristics that influence how we think about what we are illustrating and what others read into it. Each defines a unique relationship between subject and viewer, and describes different aspects of a subject. For every aspect revealed by a particular drawing system, other aspects are concealed In the end, the selection of a drawing system should be appropriate to the nature of the subject and the requirements of communication

Projection System



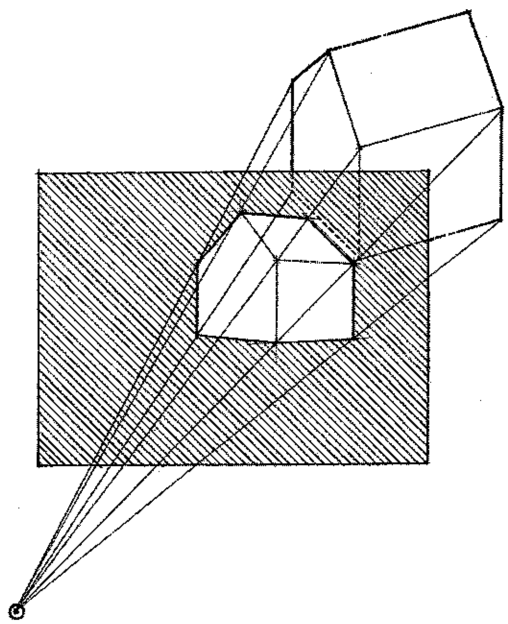
Orthographic Projection

Projectors are parallel to each other and perpendicular to picture plane; see Chapter 6



Oblique Projection

Projectors are parallel to each other and oblique to picture plane; see Chapter 7



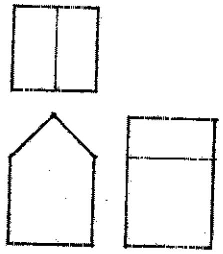
Perspective Projection

Projectors converge to a point that represents the eye of the observer; see Chapter 8

Projection System — **Pictorial System**

Orthographic Projection → Multiview Drawings

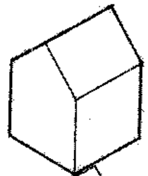
Plan, section, elevation
Principal face of rectangular form in each view is parallel to the picture plane



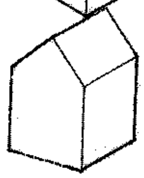
Axonometric Projection → Paraline Drawings

See Chapter 7

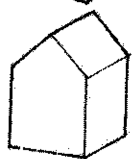
Isometric
Three major axes make equal angles with the picture plane.



Dimetric
Two of the three major axes make equal angles with the picture plane

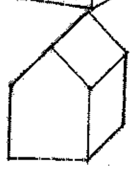


Trimetric
Three major axes make different angles with the picture plane

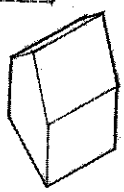


Oblique Projection → Paraline Drawings

Elevation Oblique
Principal vertical face of rectangular form is parallel with the picture plane

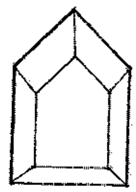


Plan Oblique
Principal horizontal face of rectangular form is parallel with the picture plane

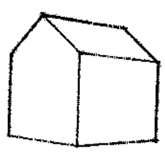


Perspective Projection → Perspective Drawings

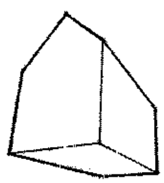
1-point Perspective
One horizontal axis is perpendicular to the picture plane; the other horizontal axis and the vertical axis are parallel with the picture plane



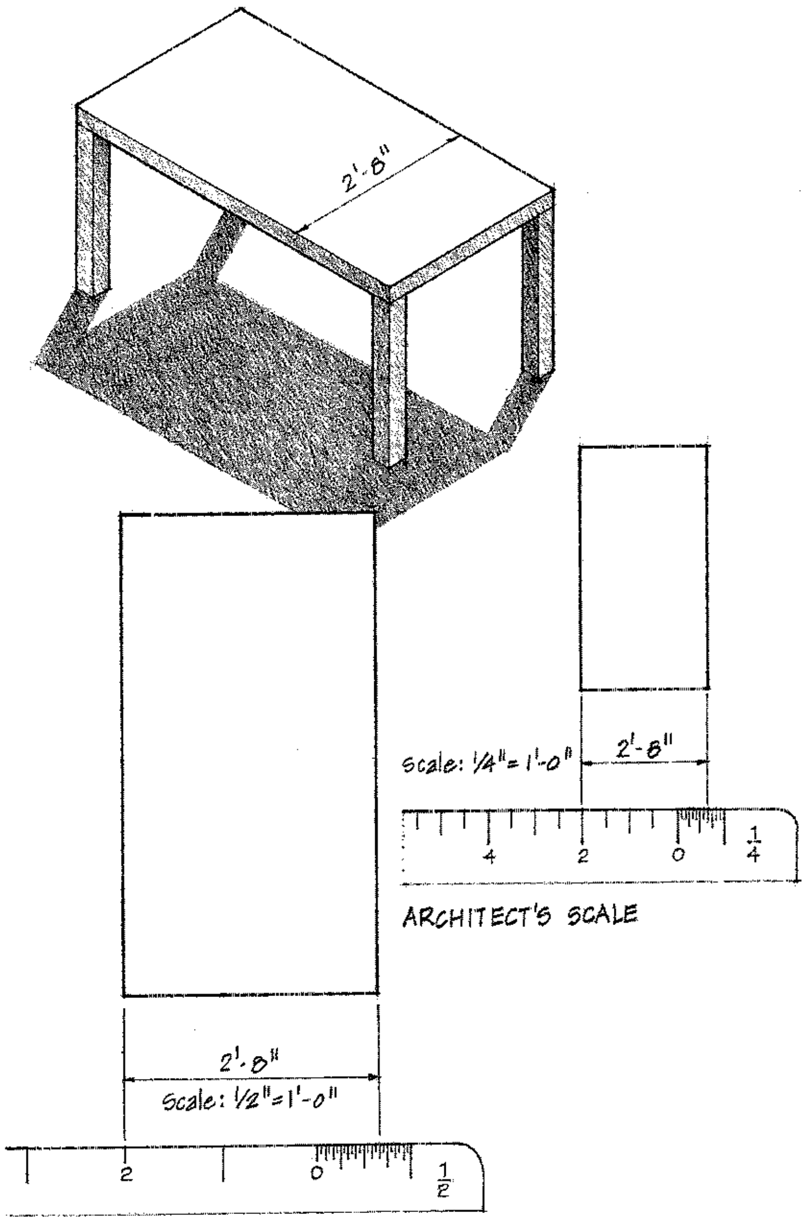
2-point Perspective
Both horizontal axes are oblique to the picture plane; vertical axis remains parallel with the picture plane



3-point Perspective
Three major axes of rectangular form are oblique to the picture plane



DRAWING SCALE

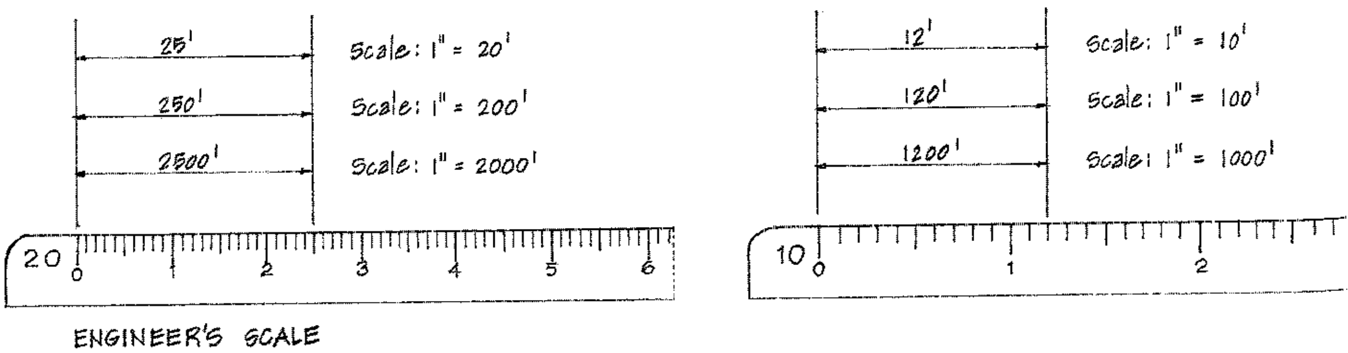


Mechanical scale is the calculation of the physical dimensions of an object according to a standard system of measurement. For example, we can say that a table, according to the U.S. Customary System, measures 5' long, 32" wide, and 29" high. If we are familiar with this system and to objects of similar size, we can visualize how big the table is. Using the International Metric System, however, the same table would measure 1524 mm long, 813 mm wide, and 737 mm high.

The drawings we use to represent this table or any other design must fall within the confines of the drawing surface. Since a design object or construction is usually much larger than the drawing surface, we must reduce the size of the drawing to fit. We refer to the proportional reduction in drawing size as the scale of the drawing.

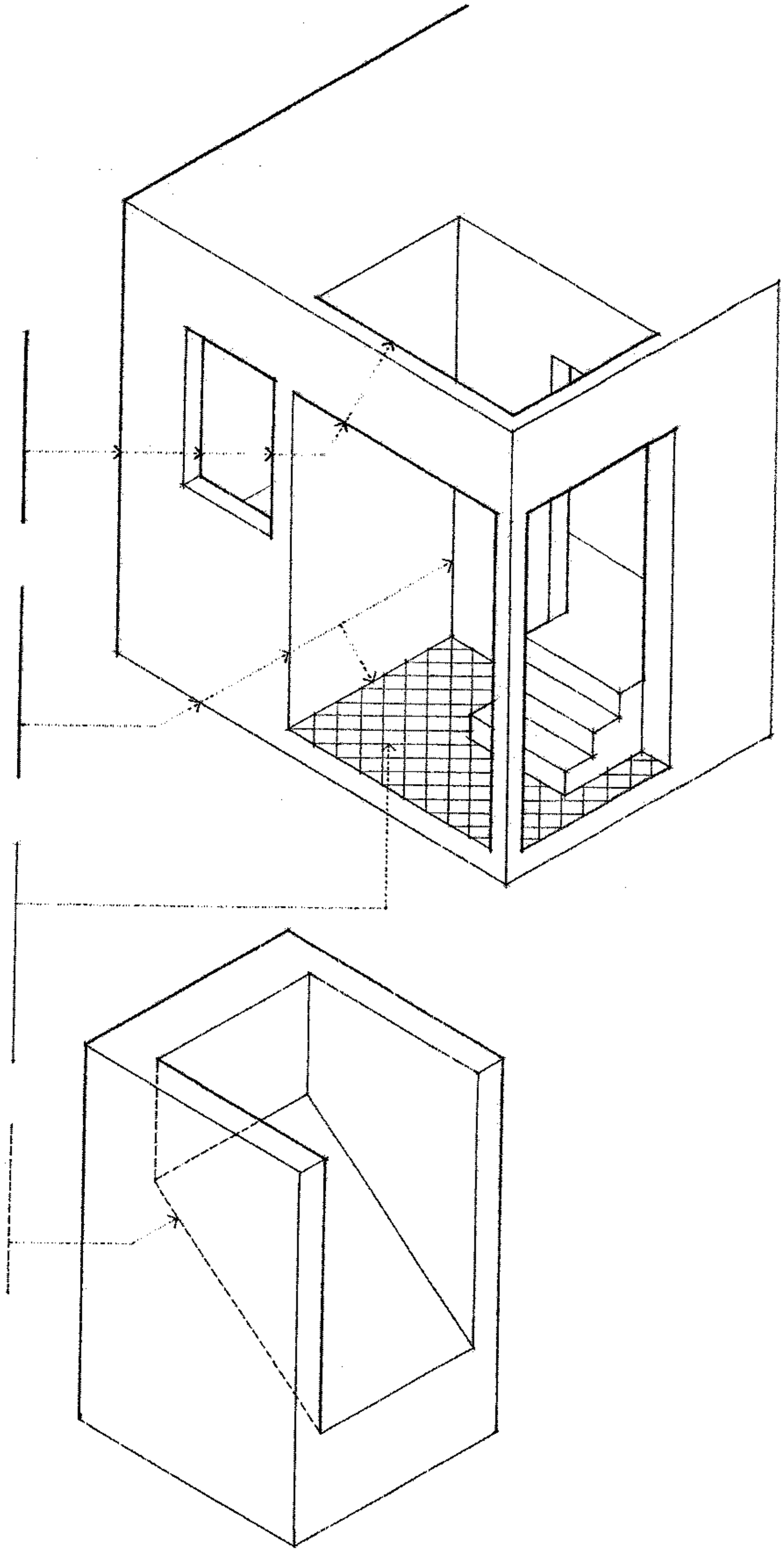
To construct an accurate representation of a design, we use a proportional measuring system. When we say a drawing is made to scale, we mean that all of its dimensions are related to the full-size object or construction by a chosen ratio. For example, when we draw at a scale of ¼" = 1'-0", each ¼" in the drawing represents a foot in the full-size object or construction. In a large-scale drawing, the size reduction is relatively small, while in a small-scale drawing, the size reduction is considerable.

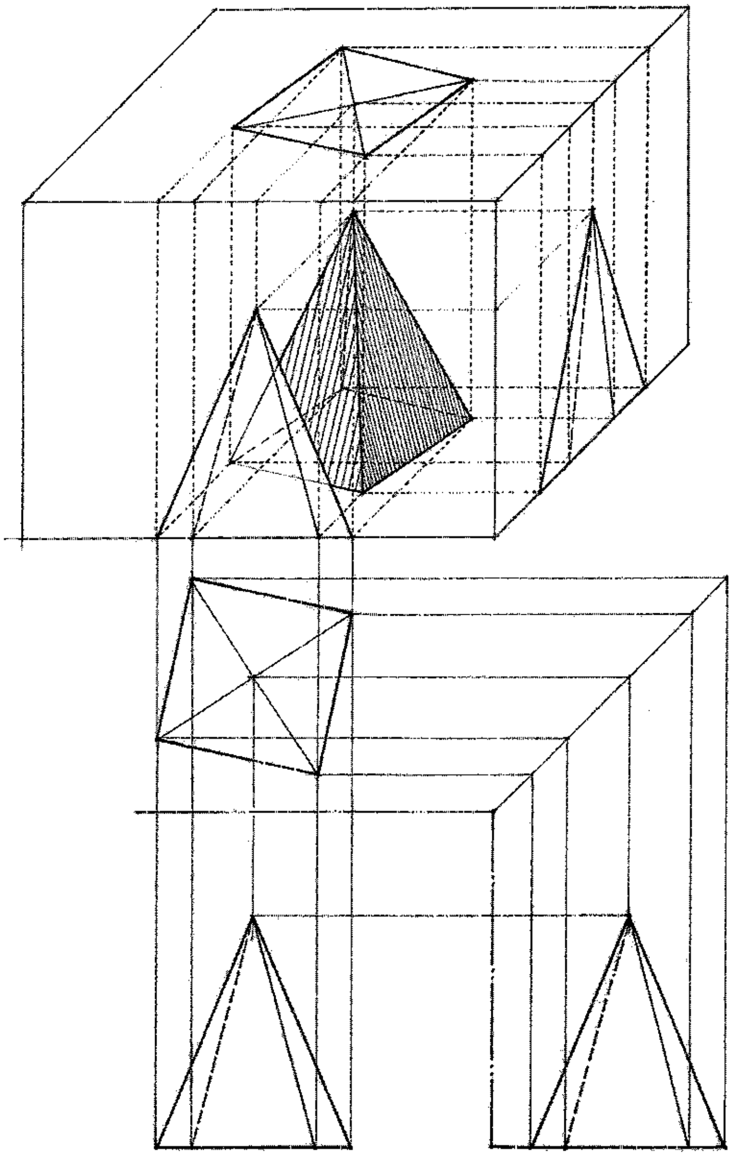
The term scale also refers to the device we use to accurately make measurements. Architect's scales have one or more sets of graduated and numbered spaces, each set establishing a proportion of a fractional part of an inch to one foot. Engineer's scales have one or more sets of graduated and numbered spaces, each set divided into multiples of ten parts per inch.



In all drawing systems, object lines define the shape and form of the physical entity or construction we are designing. We draw all object lines visible to the eye as solid, continuous lines. Depending on our point of view, however, the contour that an object line represents may appear to be a spatial edge, an intersection of two visible planes, or simply a change in material or color. To represent and communicate these distinctions, we use a hierarchy of line weights.

- Spatial Edges
  The most important object lines are those which depict the edges where solid matter meets spatial void. These contours define the shape and profile of objects and distinguish one object from another where they overlap in space. We typically use the heaviest line weight to delineate these edges of space.
- Planar Corners
  The second most important object lines are those which describe contours appearing within the outer silhouette of a three-dimensional volume. These interior contours articulate the surface structure of a three-dimensional volume. To distinguish these inner edges from the outer profile of a form, we use an intermediate range of line weights.
- Surface Lines
  The third type of object line simply indicates discernible changes in color, tonal value, or texture on the surface of a plane or volume. To indicate these lines of tonal or textural contrast, we use the lightest range of line weights. When the slimmest possible solid line is not light enough in value, a dashed or dotted line may be used to preserve the hierarchy of line weights.
- Hidden Lines
  Hidden lines reveal edges which would be concealed otherwise by another part of the object in a particular view. Hidden lines consist of a series of closely spaced dashes or dots.





6

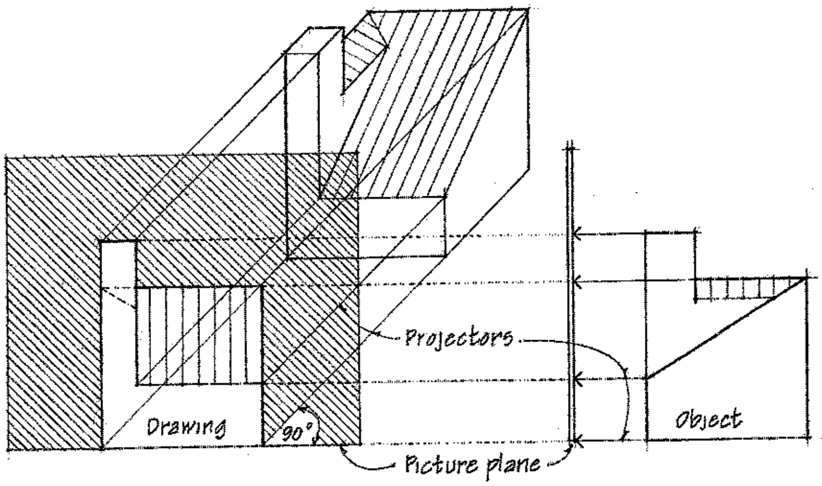
Multiview Drawings

Multiview drawings comprise the drawing types we know as plans, elevations, and sections Each is an orthographic projection of a particular aspect of an object or construction These orthographic views are abstract in the sense that they do not match optical reality They are a conceptual form of representation based on what we know about something rather than on the way it is seen from a point in space. There is no reference to an observer, or if there is, the spectator's eye is an infinite distance away

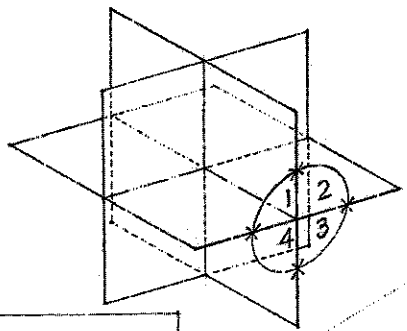
In orthographic projection, parallel projectors meet the picture plane at right angles Therefore, the orthographic projection of any feature or element which is parallel to the picture plane remains true in size shape, and configuration This gives rise to the principal advantage of multiview drawings—the ability to precisely locate points, gauge the length and slope of lines and describe the shape and extent of planes

During the design process, multiview drawings establish two-dimensional planar fields on which we can study formal patterns and scale relationships in a composition, as well as impose an intellectual order on a design The ability to regulate size placement and configuration also makes multiview drawings useful in communicating the graphic information necessary for the description, fabrication and construction of a design

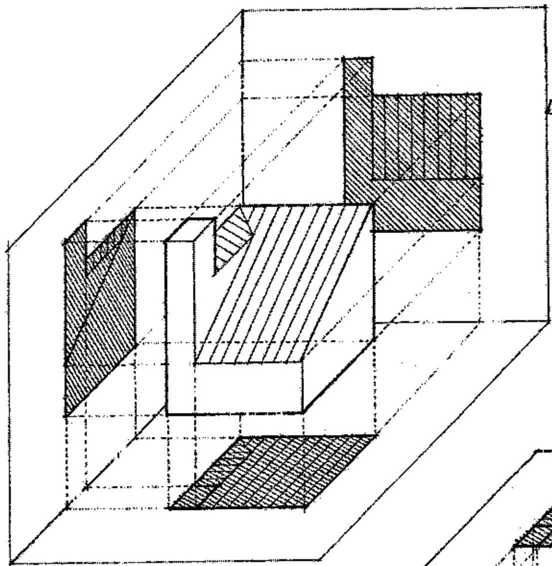
On the other hand, a single multiview drawing can only reveal partial information about an object or construction There is an inherent ambiguity of depth as the third dimension is flattened onto the picture plane Whatever depth we read in a solitary plan, section, or elevation must be implied by such graphic depth cues as hierarchical line weights and contrasting tonal values While a sense of depth can be inferred, it can be known with certainty only by looking at additional views We therefore require a series of distinct but related views to fully describe the three-dimensional nature of a form or composition—hence the term multiview



Orthographic projection is a system of projection which represents an object by projecting lines perpendicular to the picture plane To construct an orthographic projection we draw parallel projectors from the various points in the object to intersect the picture plane at right angles We then connect the projected points in their proper order to obtain the view of the object on the picture plane We refer to the resulting image on the picture plane as an orthographic view

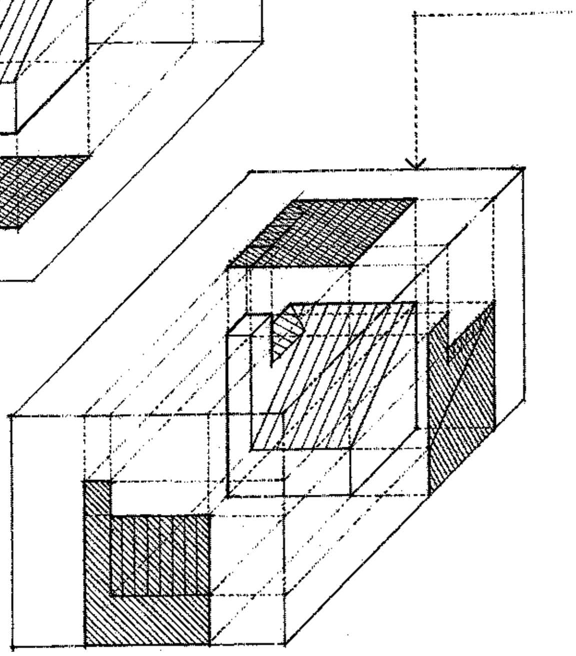


A single orthographic view is insufficient to fully describe a three-dimensional object We need a set of related orthographic views. There are two conventions for regulating the relationship between orthographic views: first-angle projection and third-angle projection To understand the distinction between the two, imagine three mutually perpendicular picture planes—one horizontal and two vertical The frontal picture plane and the horizontal picture plane intersect to form four dihedral angles, numbered one through four in a clockwise direction starting with the upper front quadrant



First-angle Projection

Gaspard Monge, a French physicist and military engineer responsible for the design of fortifications, devised first-angle projection in the eighteenth century In first-angle projection, we locate the object in the first quadrant and project the images of the object back like shadows to the inner faces of the picture planes. What is projected back through the object are those aspects of the object nearest to the viewer.



Third-angle Projection

If we place the object in the third quadrant, the result is third-angle projection Since the picture planes lie between the object and viewer, we project the images of the object forward to the picture planes We therefore draw and view the images on the outer faces of the transparent picture planes.

If we enclose an object within a transparent picture-plane box we can name the principal picture planes and the images projected orthographically onto these planes Each orthographic view represents a different orientation and a particular vantage point from which to view the object Each plays a specific role in the development and communication of a design

Principal Planes

A principal plane is any of a set of mutually perpendicular picture planes on which the image of an object is projected orthographically

Horizontal Plane
The principal level picture plane on which a plan or top view is projected orthographically

Frontal Plane
The principal vertical picture plane on which an elevation or front view is projected orthographically

Profile Plane
The principal vertical picture plane on which a side or end view is projected orthographically

Fold Line
The trace representing the intersection of two perpendicular picture planes

Trace
A line representing the intersection of two planes

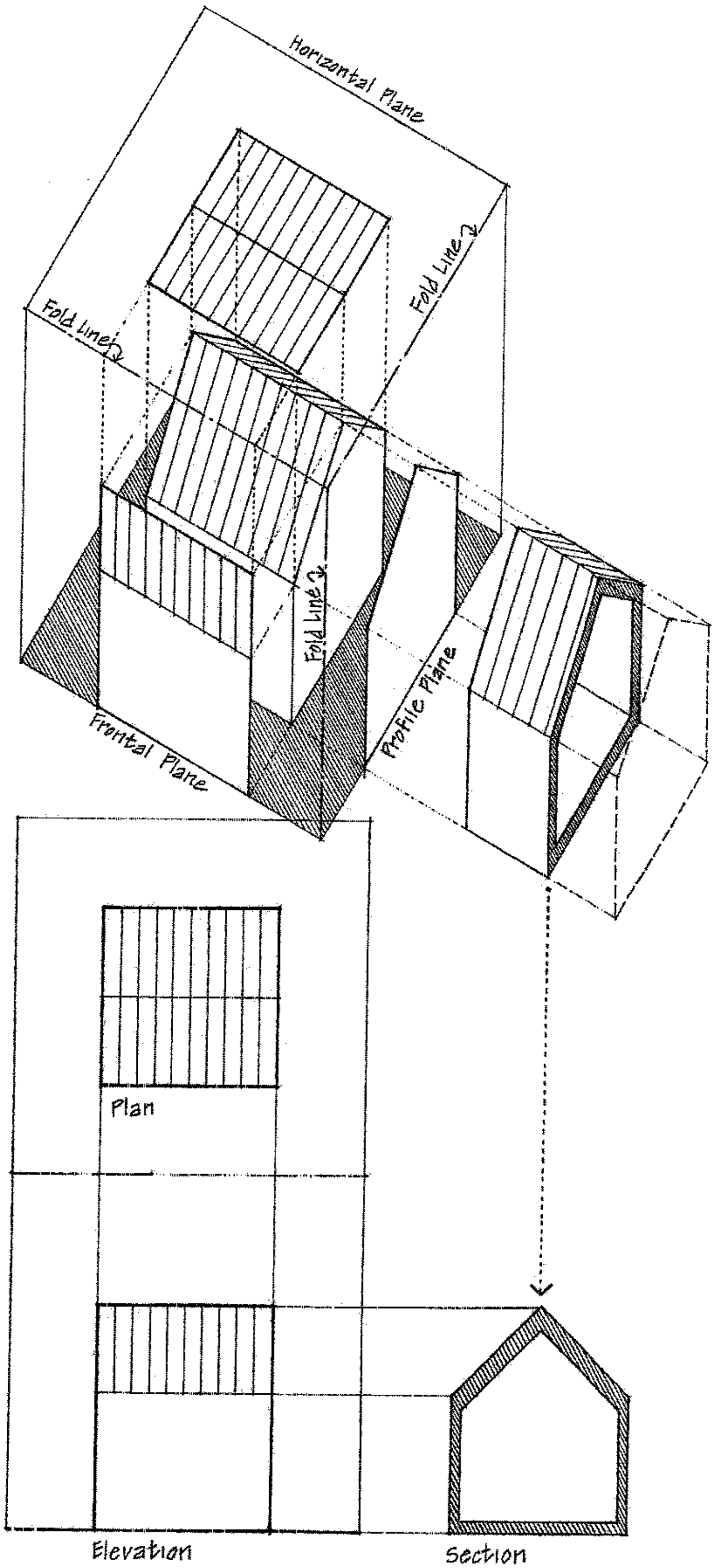
Principal Views

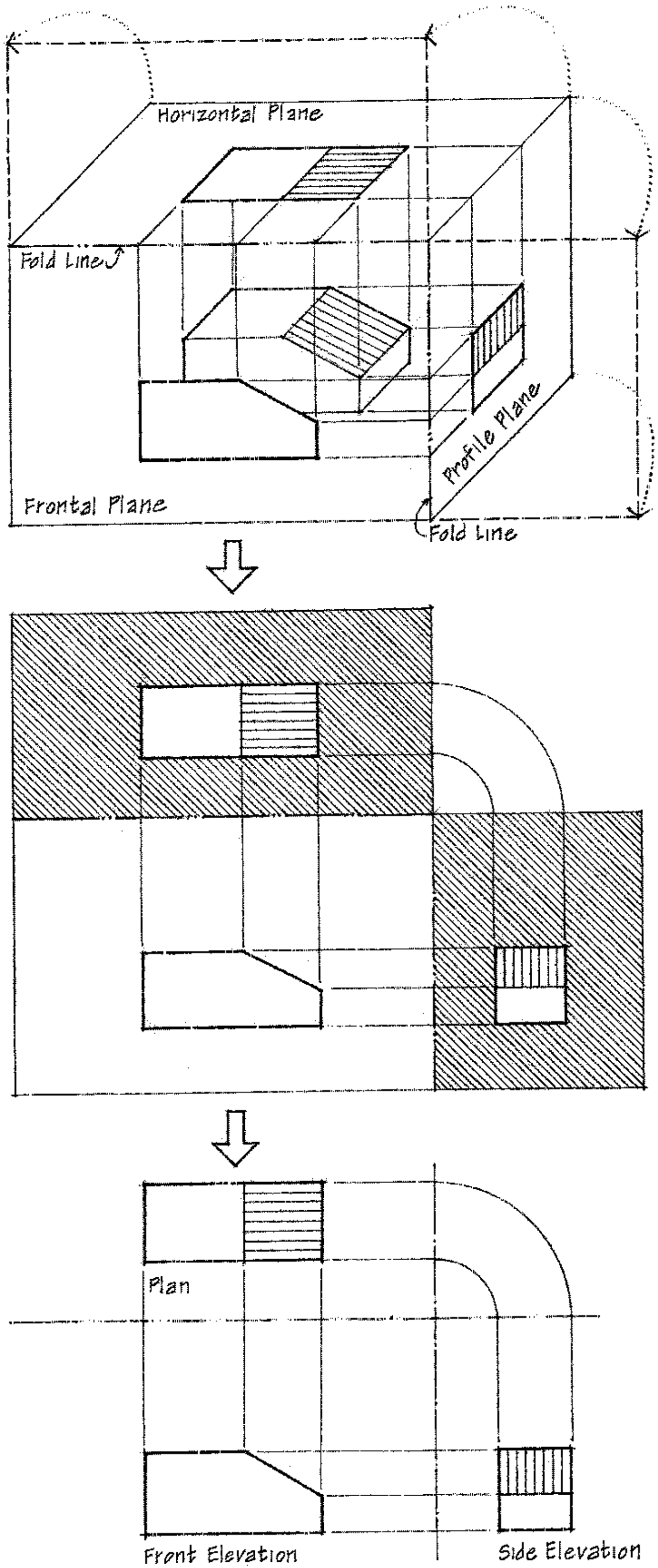
The principal orthographic views are the plan, the elevation, and the section

Plan
A principal view of an object projected orthographically on a horizontal picture plane; also called top view In architectural drawing, there are distinct types of plan views for representing various horizontal projections of a building or site

Elevation
A principal view of an object projected orthographically on a vertical picture plane An elevation view may be a front side, or rear view depending on how we orient ourselves to the object or assess the relative significance of its faces In architectural graphics we label elevation views in relation to the compass directions or to a specific feature of a site

Section
An orthographic projection of an object as it would appear if cut through by an intersecting plane

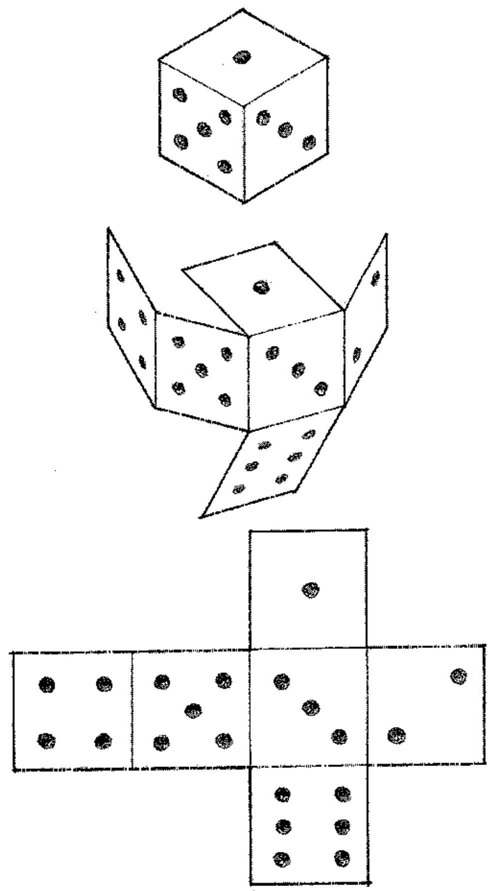




Arranging Views

To make it easier to read and interpret how a series of orthographic views describes a three-dimensional whole, we arrange the views in an orderly and logical fashion The most common arrangement of plan and elevations results from unfolding the transparent picture-plane box in third-angle projection

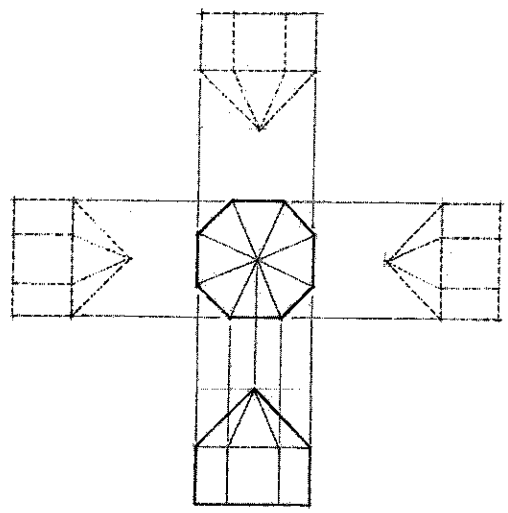
After each view is projected, we rotate the views about the fold lines into a single plane represented by the drawing surface The top or plan view revolves upward to a position directly above and vertically aligned with the front or elevation view while the side or profile view revolves to align horizontally with the front view The result is a coherent set of related orthographic views separated by fold lines



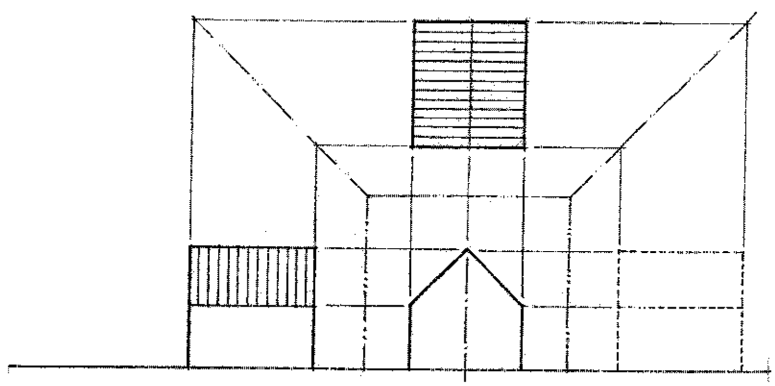
Number of Views

The number of orthographic views necessary to completely describe the three-dimensional form of an object varies with its geometry and complexity

Symmetrical conditions often eliminate the need for one or more views For example, a form or composition characterized by axial or bilateral symmetry has two sides which are mirror images of each other. Therefore, one side view would be redundant and could be omitted Similarly, multiple elevation views of a radially symmetrical form or composition would be unnecessary if a single elevation replicated the same information The omission of a view, however, can lead to ambiguity if a symmetrical condition does not in fact exist

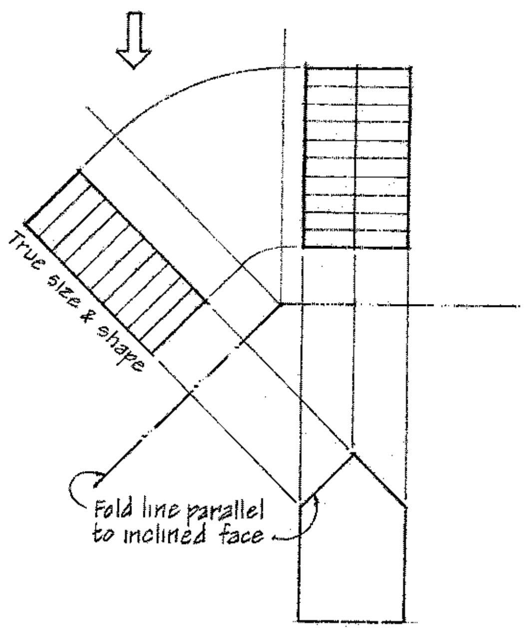


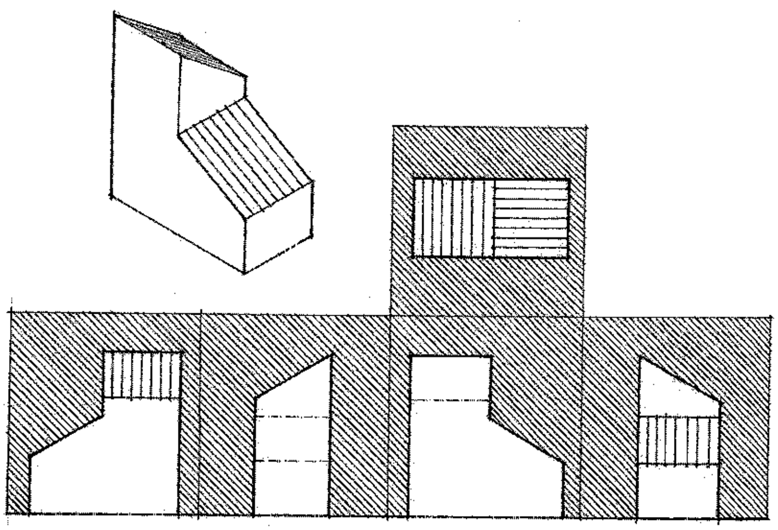
Most objects require a minimum of three related views to describe their form Complex forms and compositions may require four or more related views, especially if they have a number of oblique faces

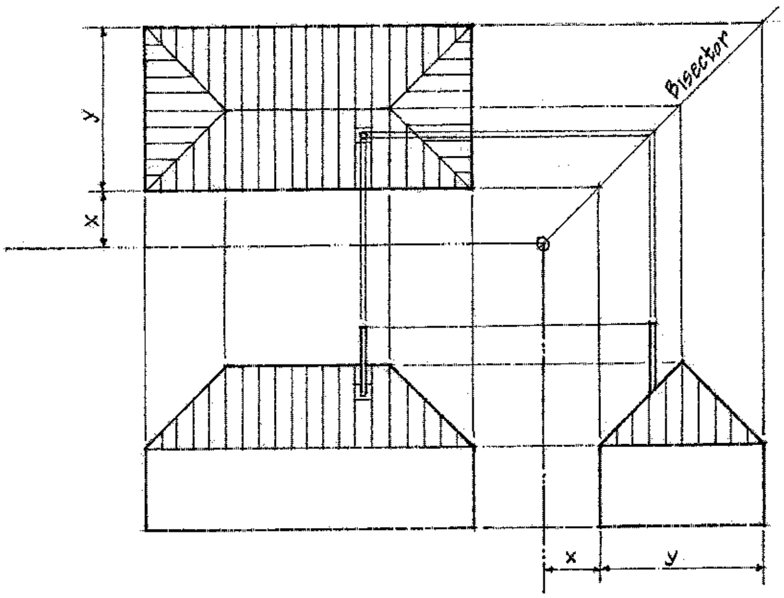


Auxiliary Views

For each oblique face of an object or construction, an auxiliary view is necessary to describe its true size and shape We establish an auxiliary view by inserting a fold line which represents the edge view of an auxiliary picture plane parallel to the inclined or oblique face



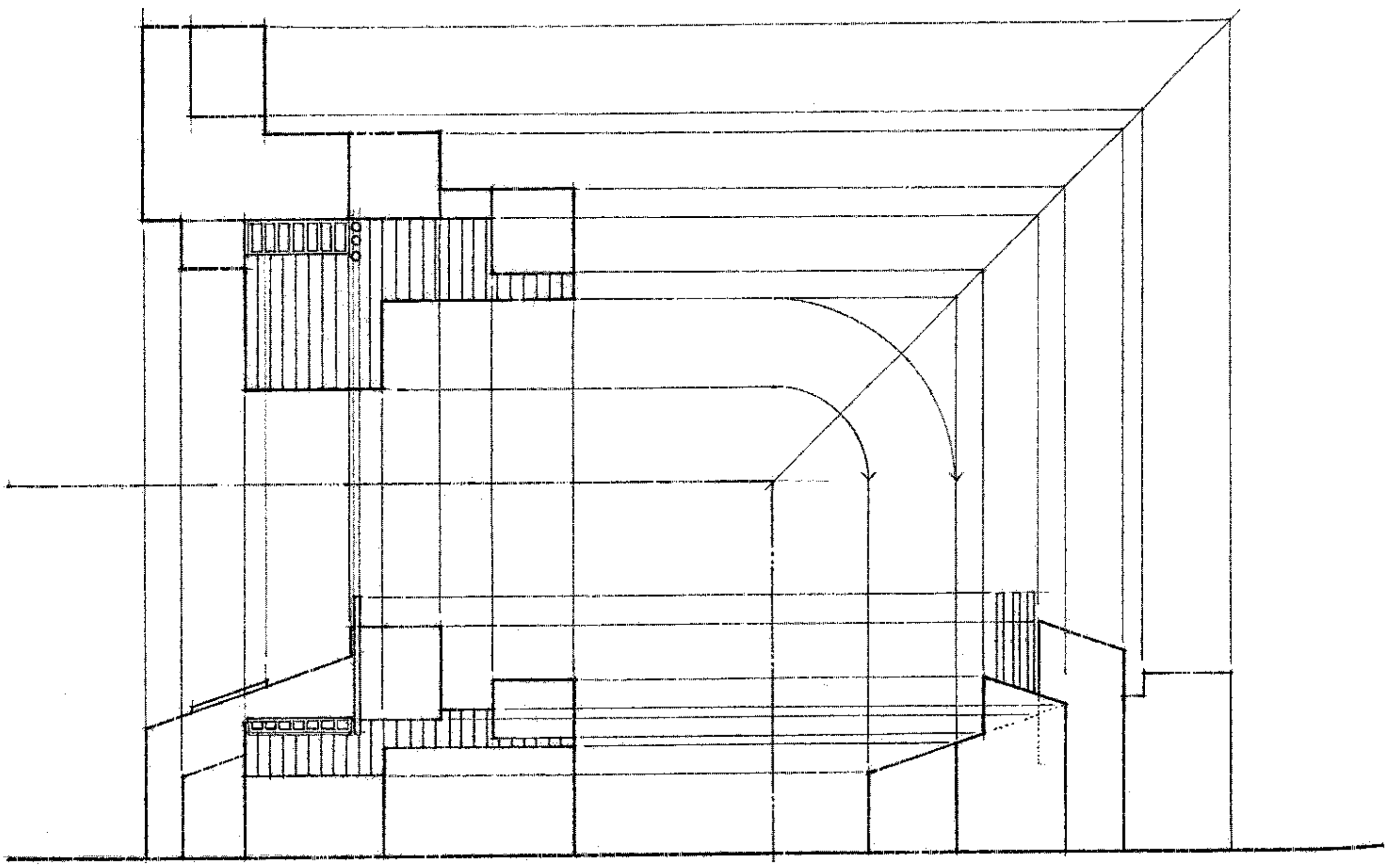


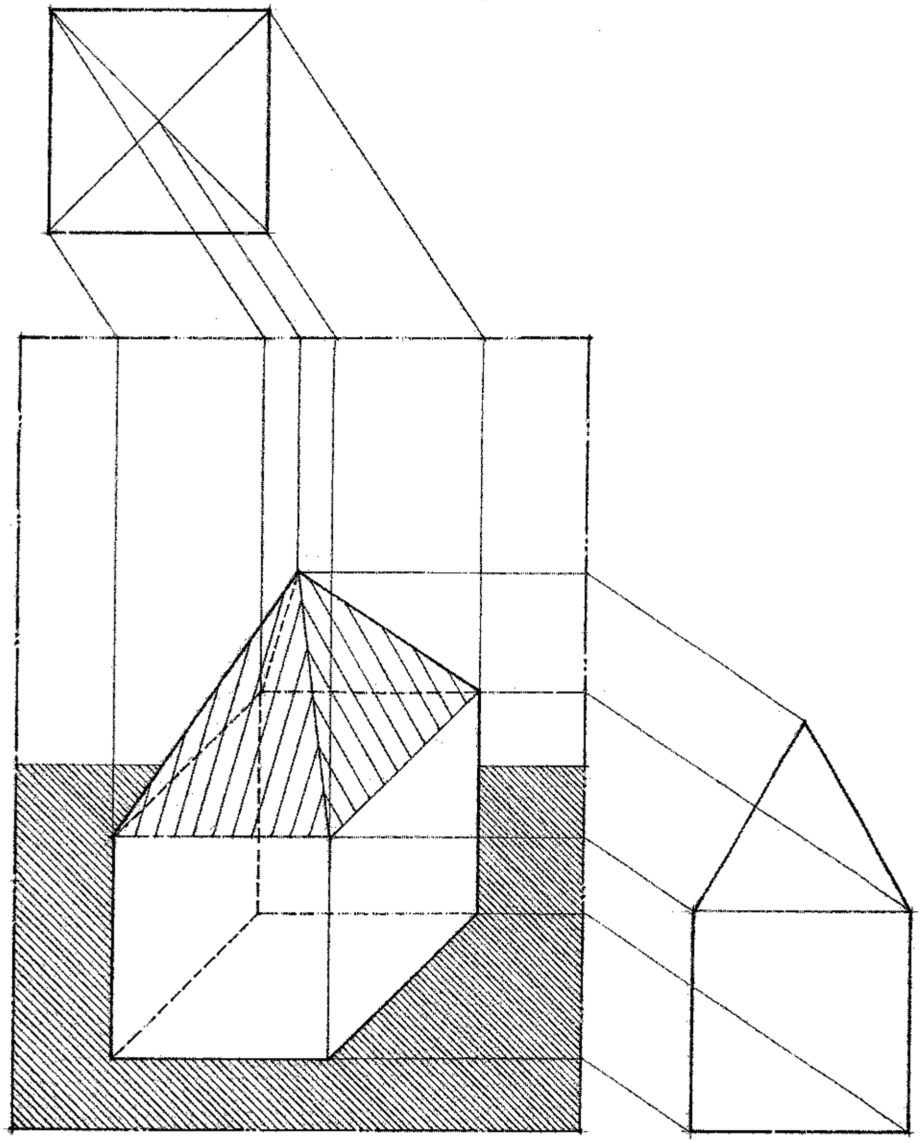


Constructing Views

Whenever possible, align related orthographic views so that points and dimensions can be transferred easily from one view to the next This relationship will not only facilitate the construction but also makes the drawings more understandable as a coordinated set of information For example, once a plan is drawn, we can efficiently transfer the horizontal dimensions of length vertically on the drawing surface to the elevation below In a similar manner, we can project the vertical dimensions of height horizontally on the drawing surface from one elevation to one or more adjacent elevations

Always project points to an adjacent view with projectors drawn perpendicular to the common fold line Since any point is the same distance away from the fold line in all views related to a common view, we can transfer a distance from the horizontal plane to the profile plane by constructing a diagonal bisector at the intersection of the fold lines An alternative is to use the intersection of the fold lines as the center for a series of quarter-circular arcs





7

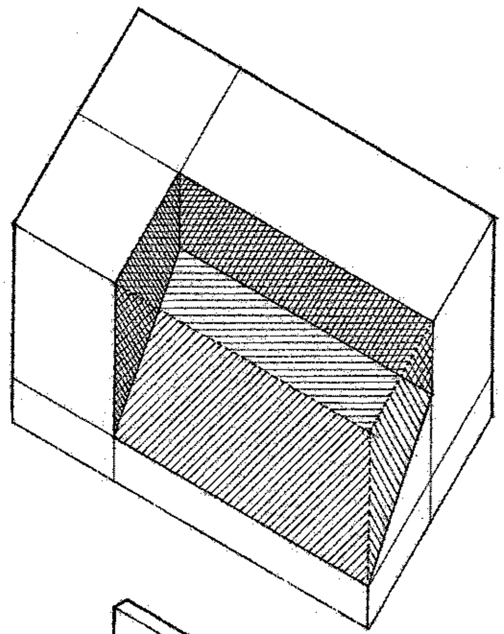
Paraline Drawings

Paraline drawings include a subset of orthographic projections known as axonometric projections—the isometric, dimetric, and trimetric—as well as the entire class of oblique projections Each type offers a slightly different viewpoint and emphasizes different aspects of the subject. As a family however, they combine the measured precision and scalability of orthographic multiview drawings and the pictorial nature of linear perspective

Paraline drawings communicate the three-dimensional nature of an object or spatial relationship in a single image Hence, they are also called single-view drawings to distinguish them from the multiple and related views of plans sections and elevations They can be distinguished from the other type of single-view drawing linear perspective, by the following pictorial effects Parallel lines, regardless of their orientation in the subject, remain parallel in the drawn view; they do not converge to vanishing points as in linear perspective—hence the term paraline. In addition any linear measurement parallel to the three major axes can be made and drawn to a consistent scale

Because of their pictorial nature and ease of construction, paraline drawings are appropriate for visualizing an emerging idea in three dimensions early in the design process They are capable of fusing plan, elevation, and section and illustrating three-dimensional patterns and compositions of space They can be cut or made transparent to see inside and through things, or expanded to illustrate the spatial relationships between the parts of a whole They can even serve as a reasonable substitute for a bird's-eye perspective

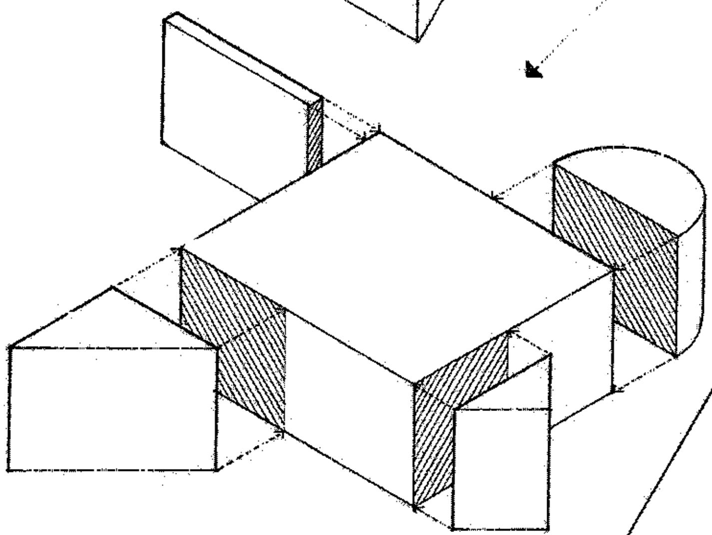
Paraline views, however, lack the eye-level view and picturesque quality of linear perspectives They present instead either an aerial view looking down on an object or scene or a worm's-eye view looking upward In either case, the drawing system can be extended to include a boundless and unlocalized field of vision, unlike perspective drawings which are strictly limited in scope by the size of the visual angle It reveals the view from an infinite set of positions rather than from a specific point in space The viewer can move in on a portion of the drawing or move back to take in a broader vista

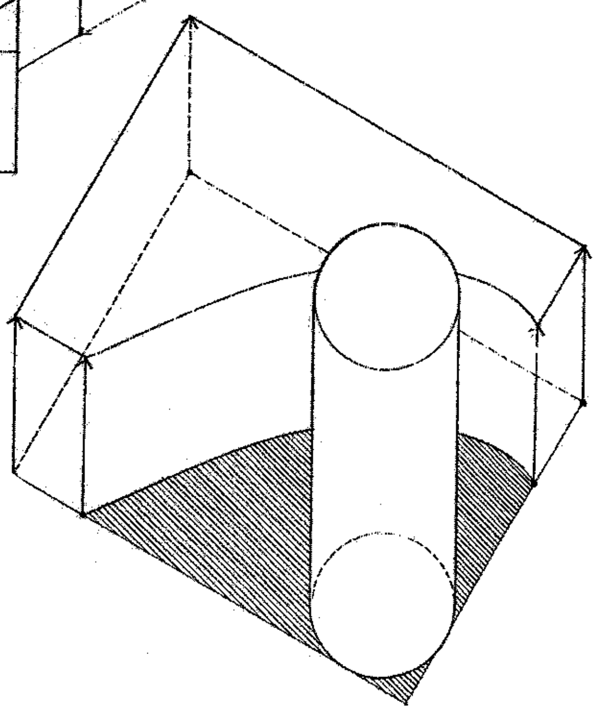


Constructing Paraline Drawings

Guiding the construction of all paraline drawings is the fundamental principle that lines which are parallel in space remain parallel in the drawn view There are therefore three basic approaches to constructing the entire class of paraline drawings When constructing and presenting a paraline drawing, keep in mind that paraline views are easiest to understand if vertical lines in space are also oriented vertically on the drawing surface

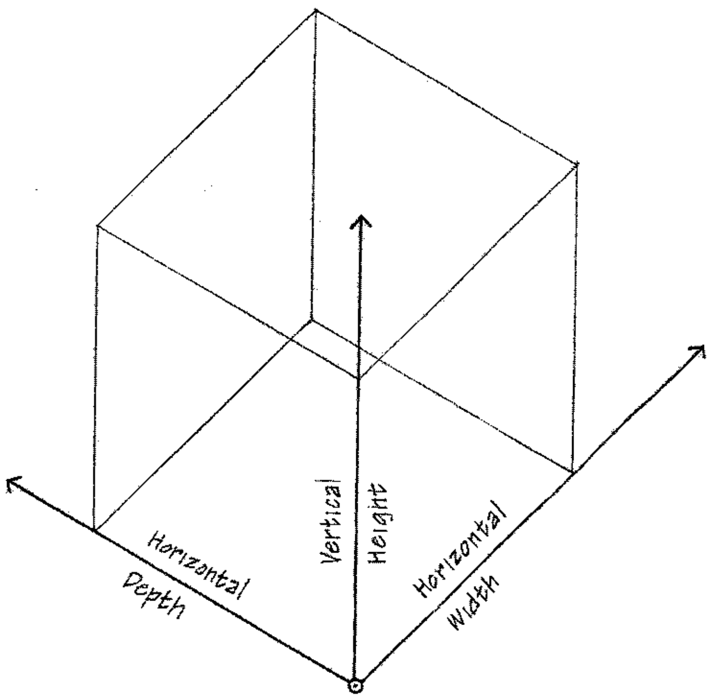
- The first is a subtractive approach appropriate for relatively simple forms. It involves constructing a paraline view of a rectangular box that encompasses the entire volume of the subject and then working in a subtractive manner to remove material and reveal the form
- A second approach appropriate for a composition of discrete forms reverses the procedure of the subtractive approach It requires drawing a paraline view of the parent form first and then adding the subordinate forms
- The third approach is appropriate for irregularly shaped forms It begins with a paraline view of a horizontal plane of the subject or the profile of a vertical section cut We can extrude the shape vertically or extend it back into the depth of the drawing





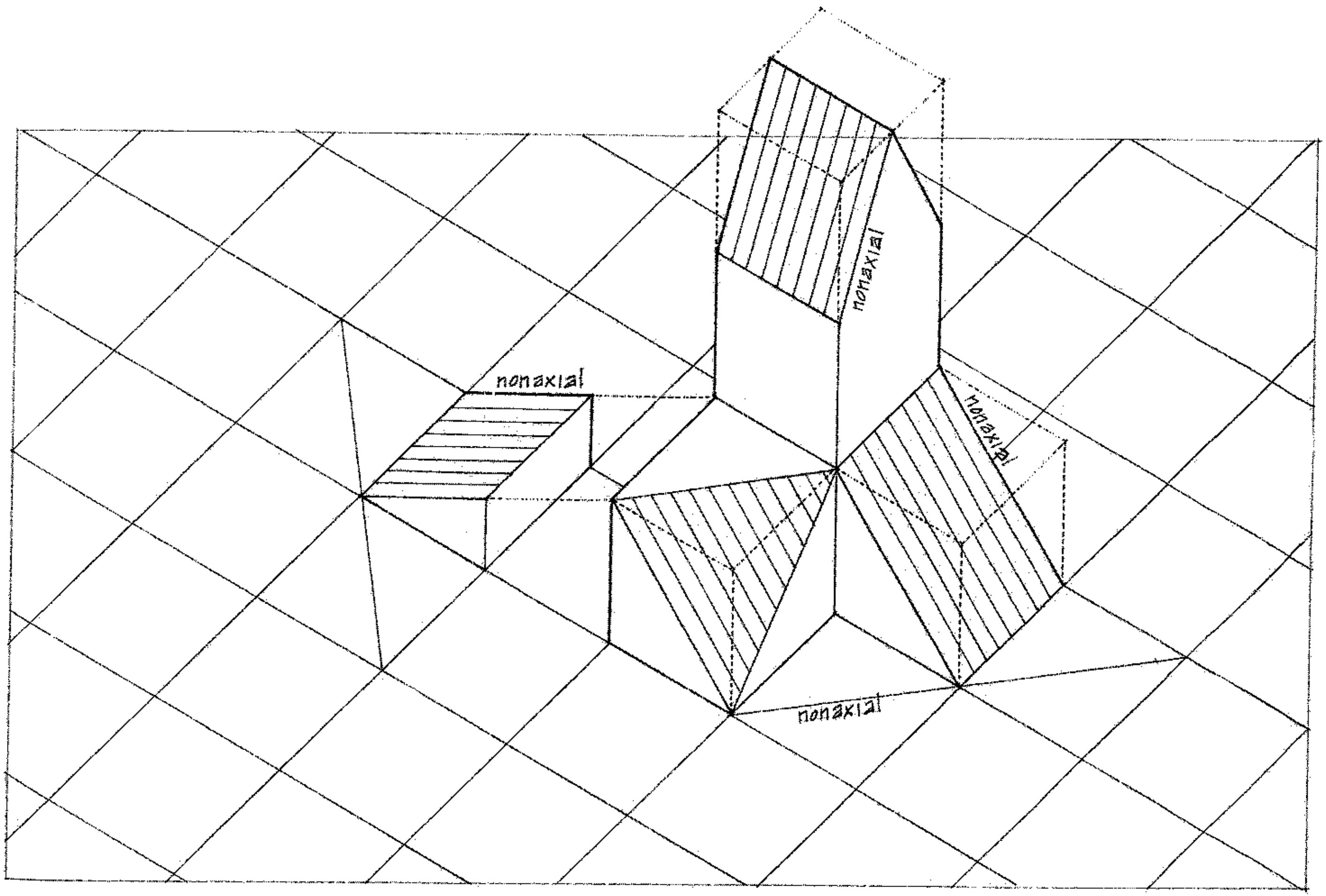
Axial Lines

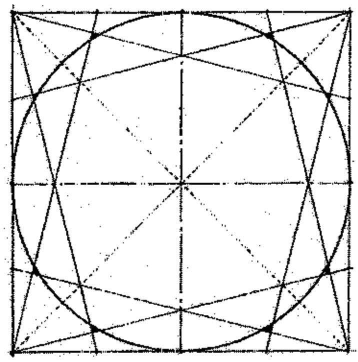
Axial lines refer to those lines which are parallel to any of the three principal axes Regardless of the approach we take in constructing a paraline drawing we can measure dimensions and draw to scale only along axial lines Axial lines naturally form a rectangular grid of coordinates which we can use to find any point in three-dimensional space

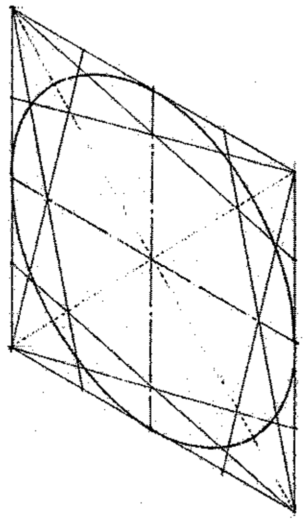


Non-axial Lines

Non-axial lines refer to those lines which are not parallel to any of the three principal axes We cannot measure dimensions along these non-axial lines, nor can we draw them to scale To draw non-axial lines we must first locate their end points using axial measurements and then connect these points Once we establish one non-axial line, however, we can draw any line parallel to that line since parallel lines in the subject remain parallel in the drawing



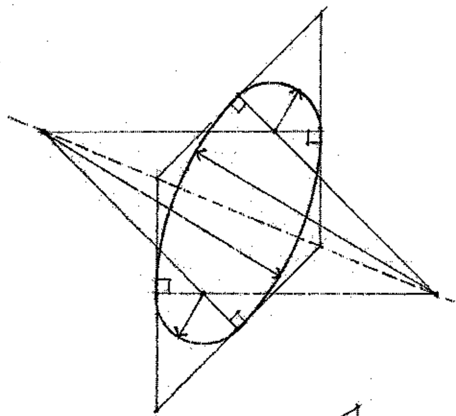


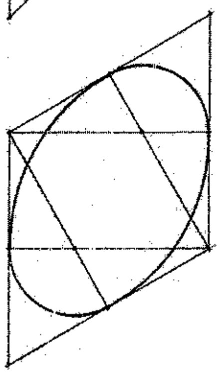


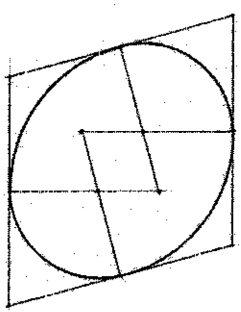
Circles

Any circle oblique to the picture plane appears as an ellipse In order to draw such a circle in a paraline drawing we must first draw a square that circumscribes the circle Then we can use either of following two approaches to drawing the circle within the square

- If we can divide the square into quadrants and draw the diagonals we can establish eight points along the circumference of the circle.
- The four-center method uses two sets of radii and a compass or circle template First draw the paraline view of the square that circumscribes the circle From the midpoints of the sides of the rhombus, extend perpendiculars until they intersect With the four points of intersection as centers and with radii r^1 and r^2 describe two sets of arcs in equal pairs between the origin points of the perpendiculars

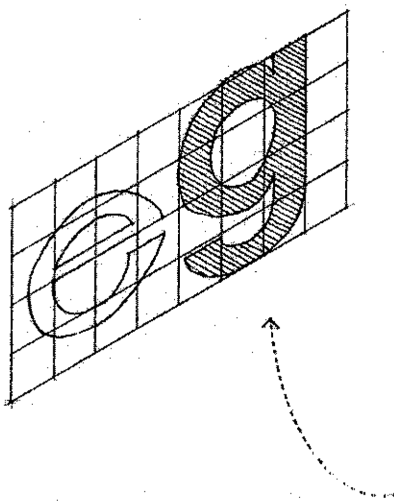






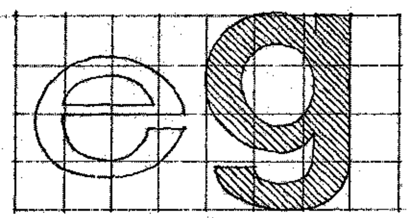
Curves

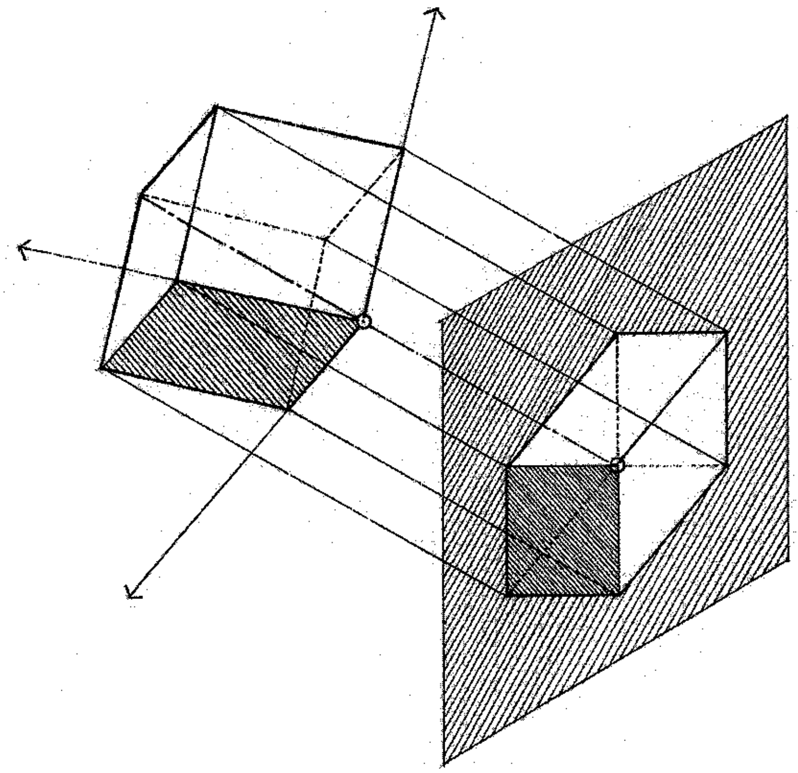
We can draw a paraline view of any curved line or surface by using offset measurements to locate the positions of significant points along the line or surface



Freeform Shapes

In order to draw a freeform shape in a paraline drawing, first construct a grid over a plan or elevation view of the shape This grid may either be uniform or correspond to critical points in the shape The more complex the shape the finer the grid divisions should be Construct the same grid in the paraline view Next, locate the points of intersection between the grid and the freeform shape and plot these coordinates in the paraline view Finally, we connect the transferred points in the paraline view



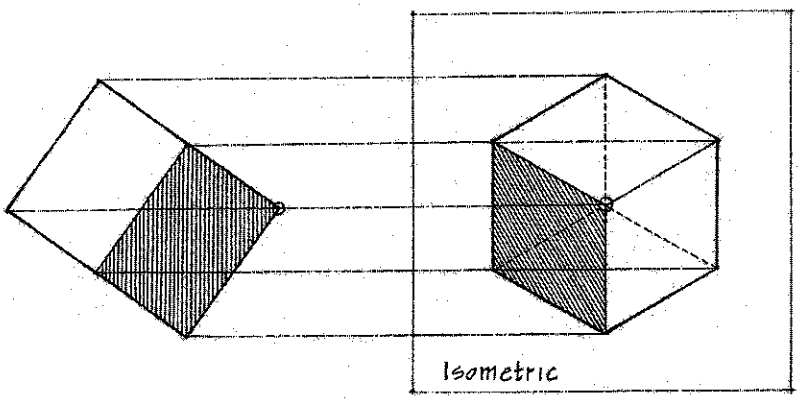


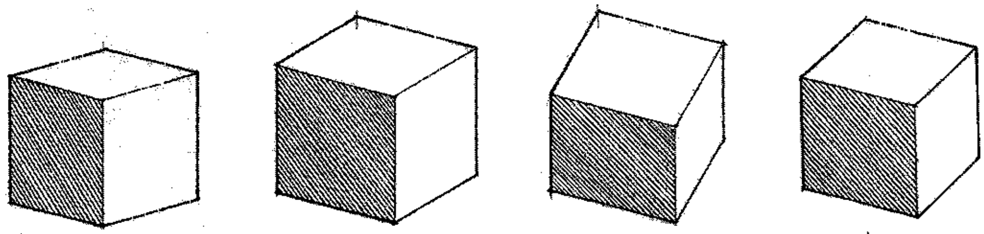
Axonometric = axono + metric or axis-measurement The term axonometric is often used to describe paraline drawings of oblique projections or the entire class of paraline drawings Strictly speaking, however, axonometric projection is a form of orthographic projection in which the projectors are parallel to each other and perpendicular to the picture plane The difference between orthographic multiview drawings and an axonometric single view drawing is simply the orientation of the object to the picture plane

Axonometric Projection

Axonometric projection is an orthographic projection of a three-dimensional object inclined to the picture plane in such a way that its three principal axes are foreshortened The family of axonometric projection includes isometric, dimetric, and trimetric projections They differ according to the orientation of the three principal axes of a subject to the picture plane

There is a significant difference between an axonometric projection and a drawing of that projection In a true axonometric projection the three principal axes are foreshortened to varying degrees, depending on their orientation to the picture plane However, in an axonometric drawing, we draw the true length of one or more of these axes to exact scale Axonometric drawings are therefore slightly larger than their corresponding axonometric projections





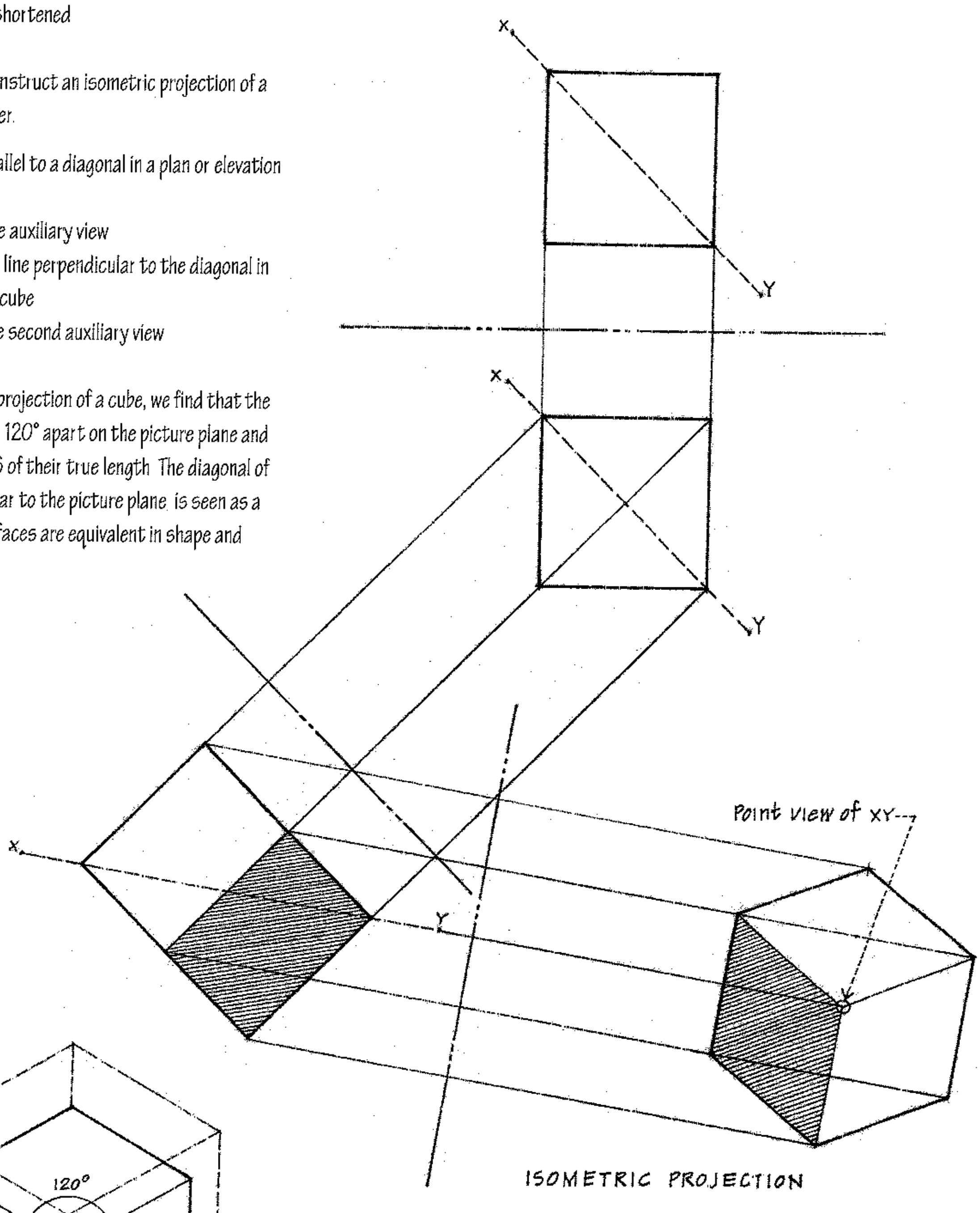
Dimetric Dimetric Dimetric Trimetric

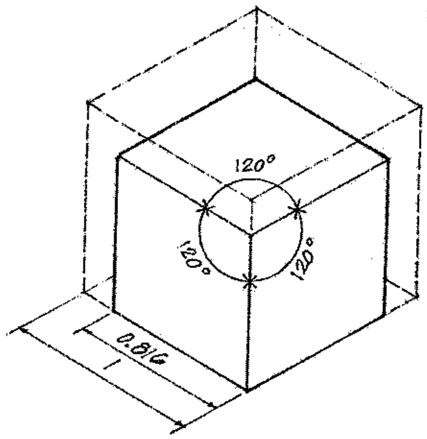
An isometric projection is an axonometric projection of a three-dimensional object inclined to the picture plane in such a way that the three principal axes make equal angles with the picture plane and are equally foreshortened.

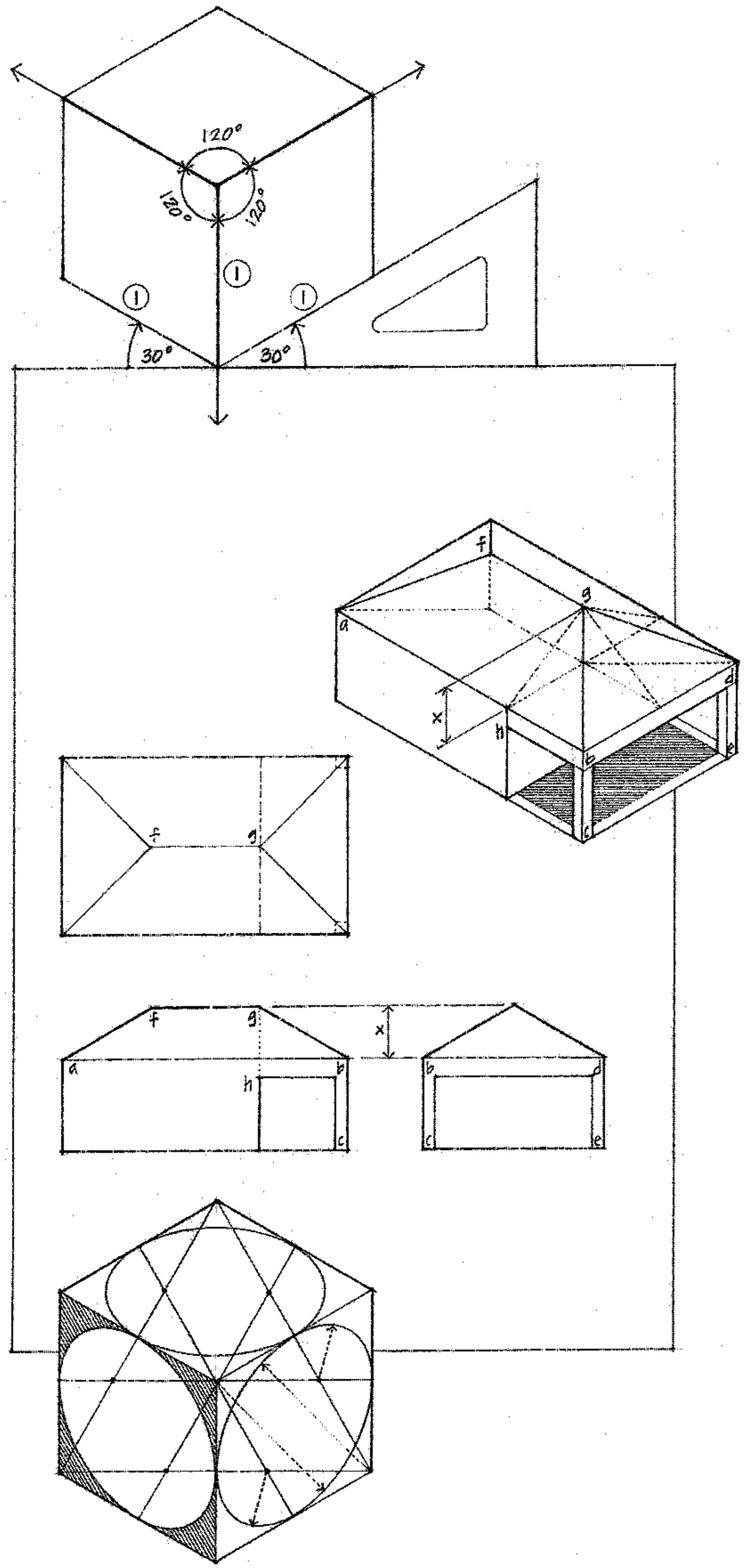
To better visualize this, construct an isometric projection of a cube in the following manner.

- Establish a fold line parallel to a diagonal in a plan or elevation view of the cube
- Project the cube into the auxiliary view
- Construct a second fold line perpendicular to the diagonal in the auxiliary view of the cube
- Project the cube into the second auxiliary view

In developing an isometric projection of a cube, we find that the three principal axes appear 120° apart on the picture plane and are foreshortened to 0.816 of their true length. The diagonal of the cube, being perpendicular to the picture plane, is seen as a point and the three visible faces are equivalent in shape and proportion.



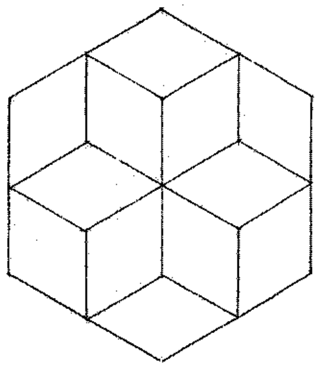


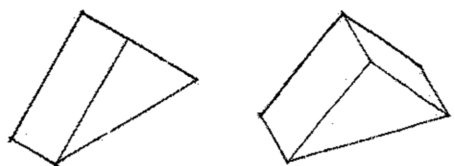


Instead of developing an isometric projection from a set of plan, elevation and auxiliary views, it is common practice to construct an isometric drawing in a more direct manner. First, we establish the direction of the three principal axes Since they are 120° apart on the picture plane, if we draw one axis vertically, the other two axes make a 30° angle with a horizontal on the drawing surface

To save time, we disregard the normal foreshortening of the principal axes. Instead, we lay out the true lengths of all lines parallel to the three principal axes and draw them to the same scale Thus, an isometric drawing is always slightly larger than an isometric projection of the same subject

An isometric drawing establishes a lower angle of view than a plan oblique and gives equal emphasis to the three major sets of planes It preserves the relative proportions of the subject and is not subject to the distortion inherent in oblique views Isometric drawings of forms based on the square however, can create an optical illusion and be subject to multiple interpretations This ambiguity results from the alignment of lines in the foreground with those in the background In such cases, a dimetric or oblique might be a better choice





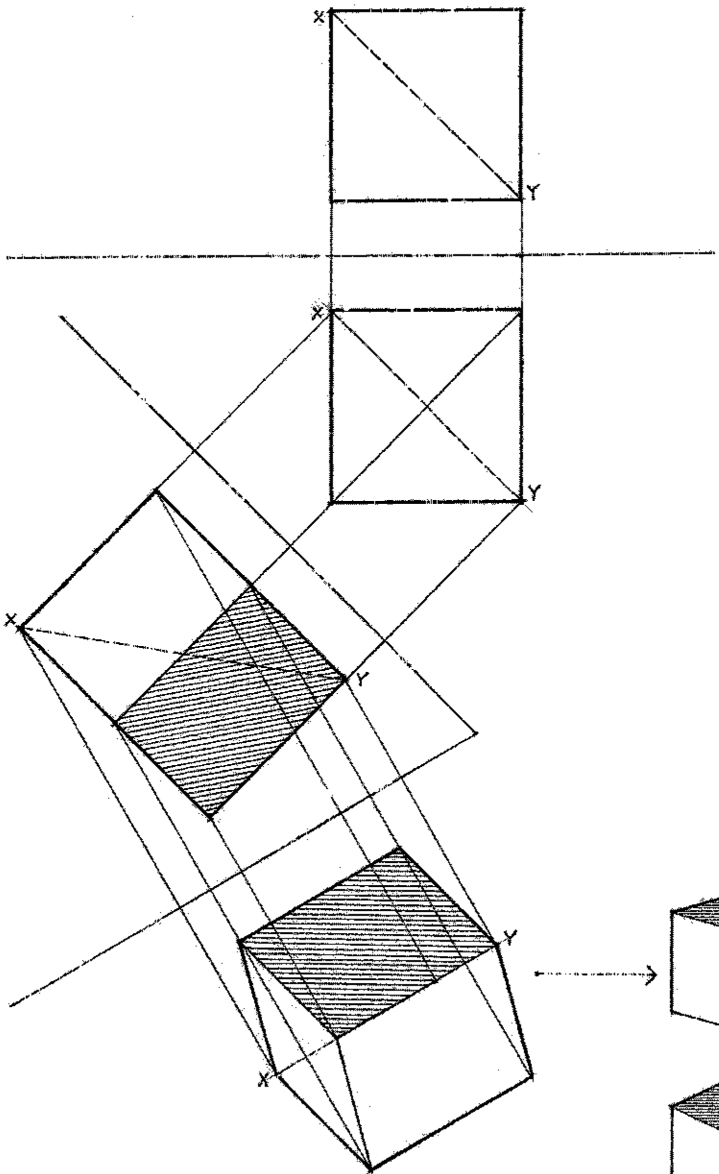
Isometric   Dimetric

A dimetric projection is an axonometric projection of a three-dimensional object inclined to the picture plane in such a way that two of its principal axes are equally foreshortened and the third appears longer or shorter than the other two

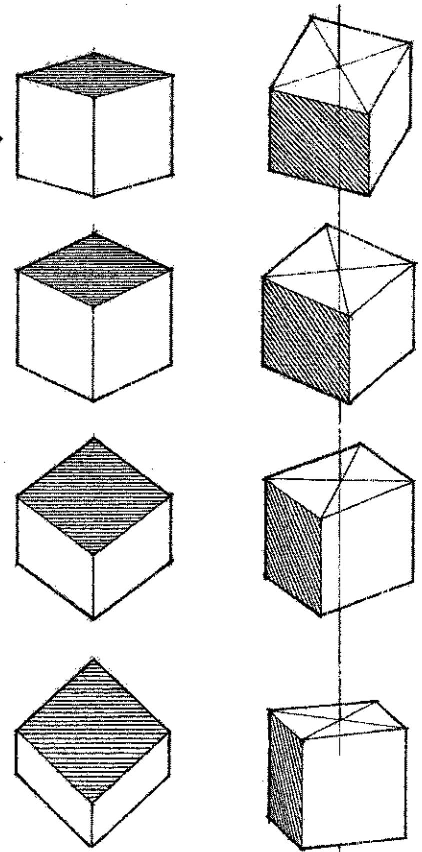
To better visualize this, construct a dimetric projection of a cube in the following manner

- Establish a fold line parallel to a diagonal in a plan or elevation view of the cube
- Project the cube into the auxiliary view
- Construct a second fold line that is not perpendicular to a diagonal in the auxiliary view of the cube
- Project the cube into the second auxiliary view

In developing a dimetric projection of a cube we find that an infinite number of views and pictorial effects are possible A series of symmetrical views develops as the cube rotates about a horizontal axis Another series of asymmetrical views emerges as the cube rotates about a vertical axis Depending on the orientation of the cube to the picture plane a dimetric view can either emphasize one major set of planes while subordinating the other two, or emphasize two major sets of planes equally while subordinating the third



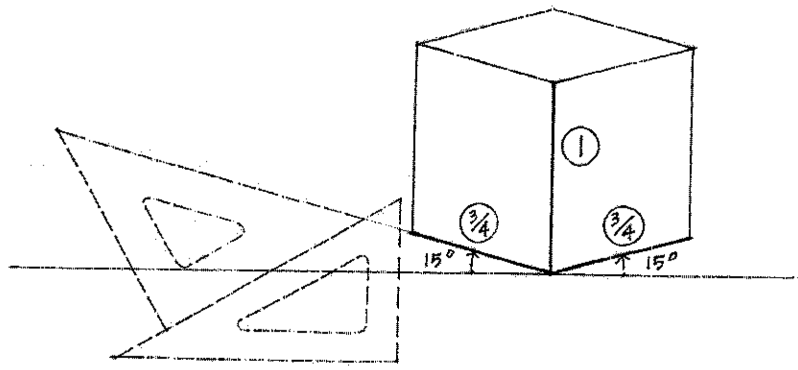
DIMETRIC PROJECTION



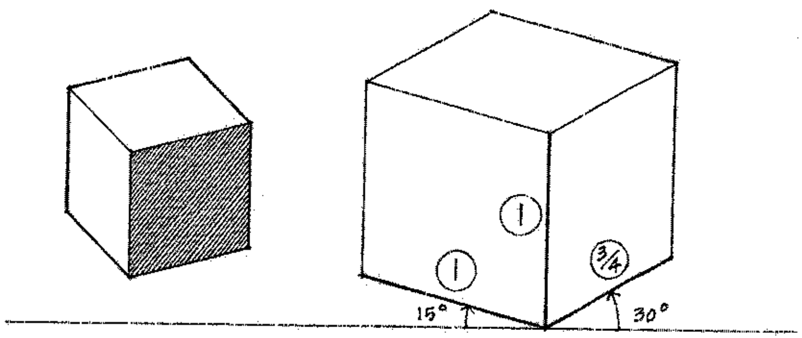
Symmetrical Asymmetrical

A dimetric is a paraline drawing of a dimetric projection, having all lines parallel to two of the principal axes drawn to true length at the same scale, and lines parallel to the third either elongated or foreshortened

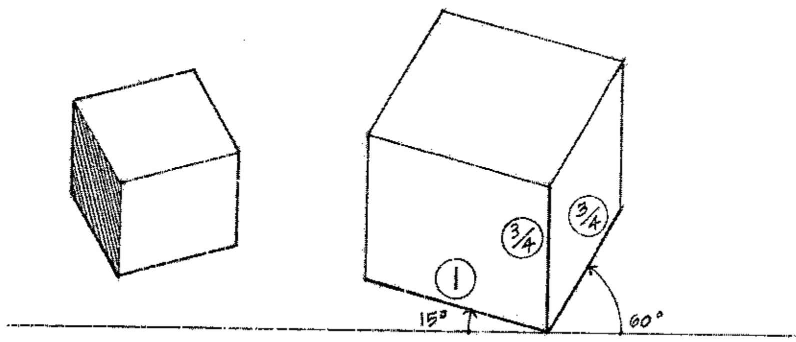
As with isometric drawings we usually construct dimetric drawings in a direct manner. We first establish the direction of the three principal axes Assuming one principal axis remains vertical, we can lay out the angles of the two horizontal axes in several ways. While these angles do not correspond exactly with the angles that result from dimetric projection, they are convenient to use when drafting with 30°/60° and 45°/45° triangles

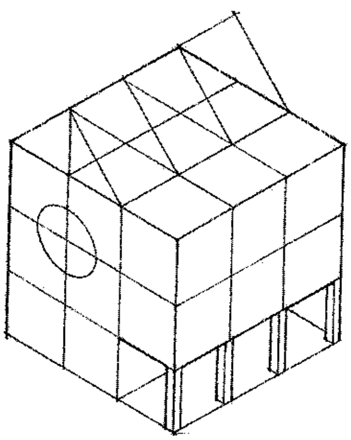


We can now lay out the lengths of all lines parallel to the three principal axes. Two of the three principal axes make the same angle with the picture plane We draw lines parallel to these two axes at the same scale, and lines parallel to the third at a proportionately greater or smaller scale The circled numbers indicate the whole and fractional scales at which we draw the three principal axes in each dimetric view

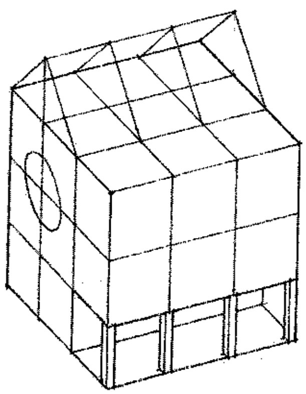


The use of two scales and odd angles make dimetric drawings slightly more difficult to construct than isometric drawings On the other hand, they offer a flexibility of viewpoint that can overcome some of the pictorial defects of isometric drawings. A dimetric view can emphasize one or two of the major sets of planes as well as provide a clearer depiction of 45° lines and surfaces

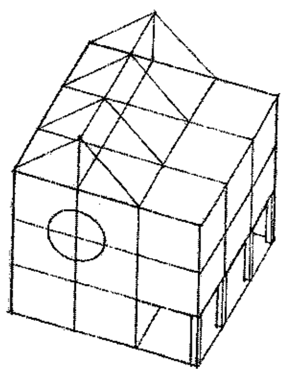




Isometric



Dimetric

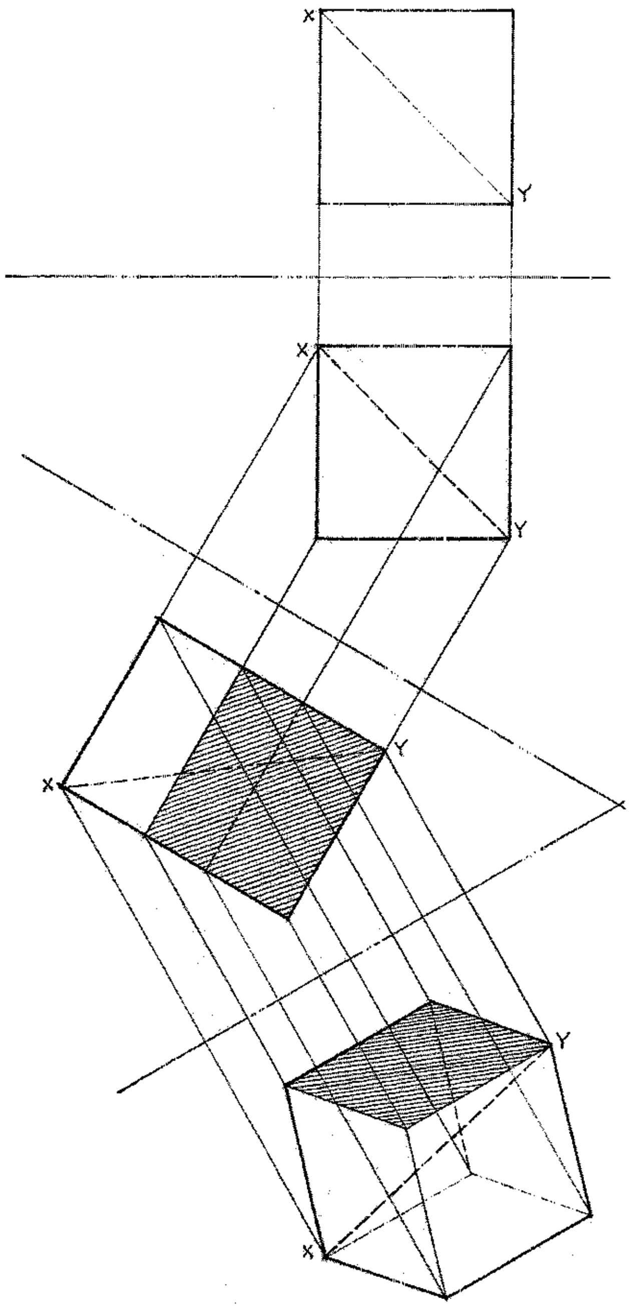


Dimetric

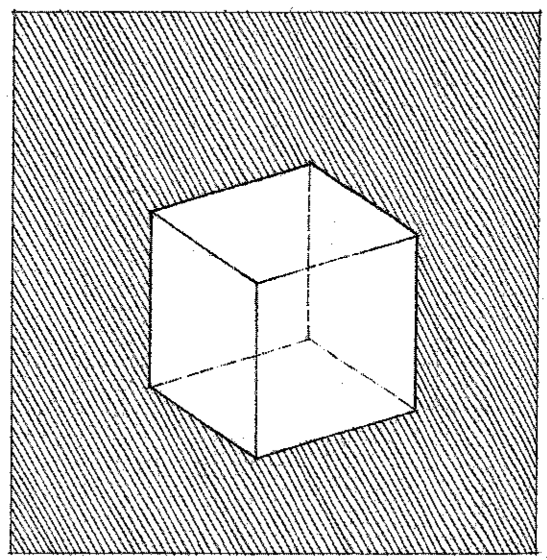
A trimetric projection is an axonometric projection of a three-dimensional object inclined to the picture plane in such a way that all three principal axes are foreshortened at a different rate

Trimetric Drawings

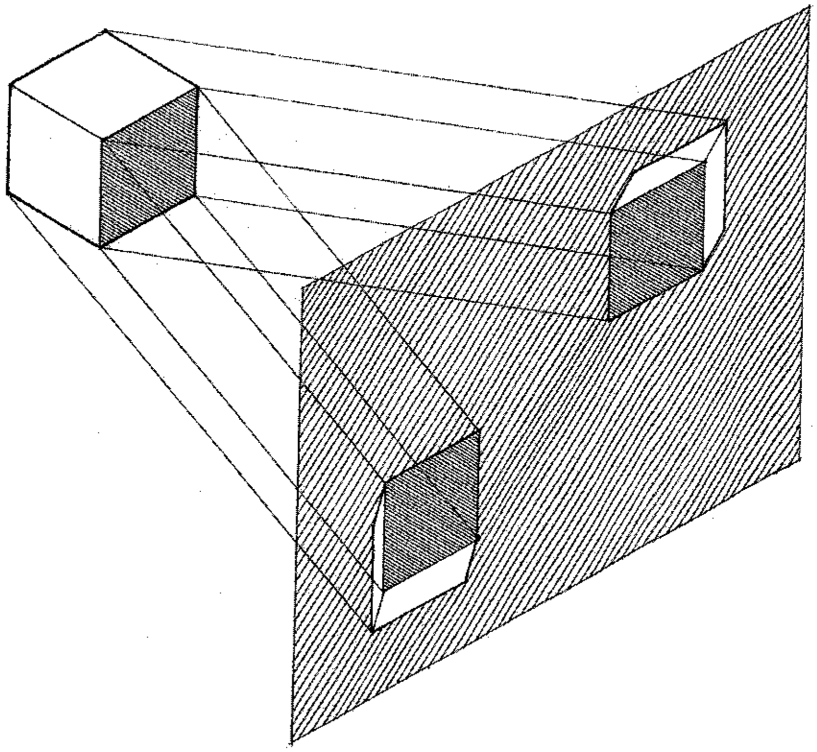
A trimetric is a paraline drawing of a trimetric projection, showing all three principal axes foreshortened at a different rate and therefore drawn at different scales Trimetrics naturally emphasize one major set of planes over the other two We rarely use trimetrics because what they reveal does not justify their complex construction Isometric and dimetric views are simpler to construct and just as satisfactory for most purposes



TRIMETRIC PROJECTION



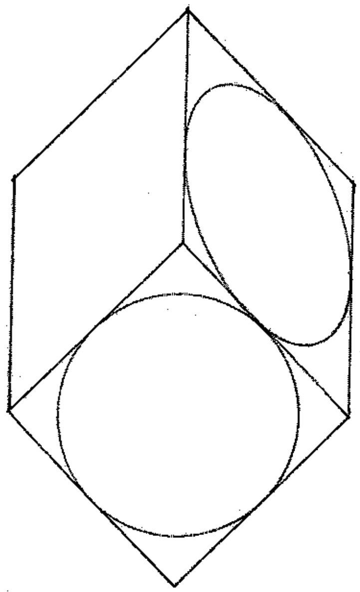
Oblique projection is one of three major types of projection drawing The images that emerge from oblique projections belong to the pictorial family of paraline drawings but are distinct from the isometric and dimetric views that develop from orthographic projection In oblique projection, a principal face or set of planes in the object is oriented parallel to the picture plane as in orthographic multiview drawing but the image is transmitted by means of parallel projectors oriented at any angle other than 90° to the picture plane

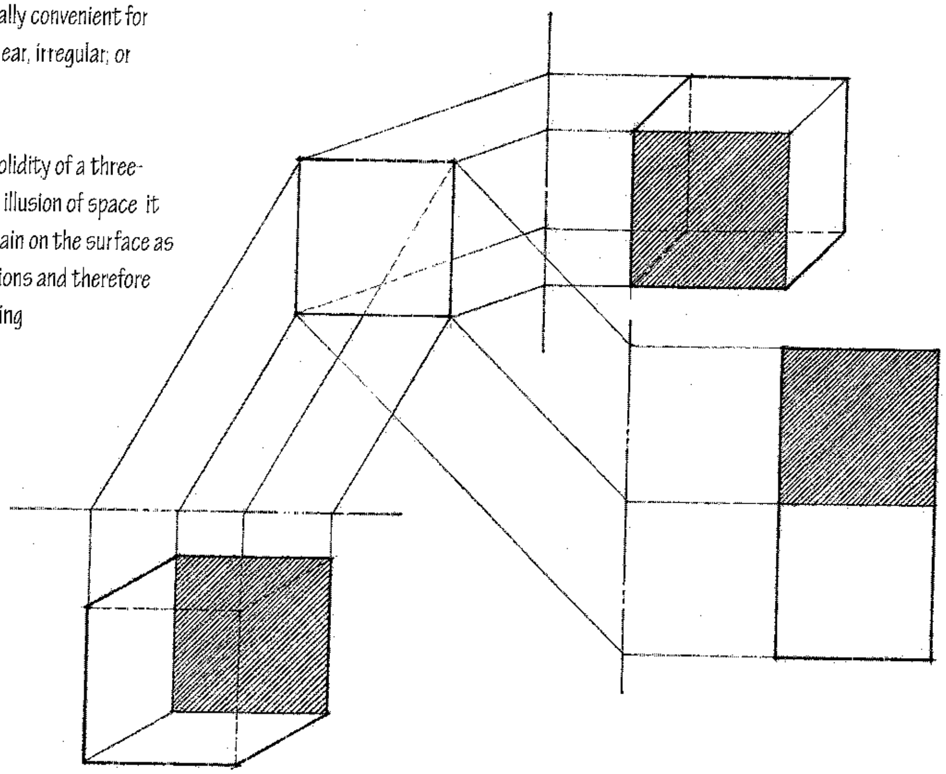


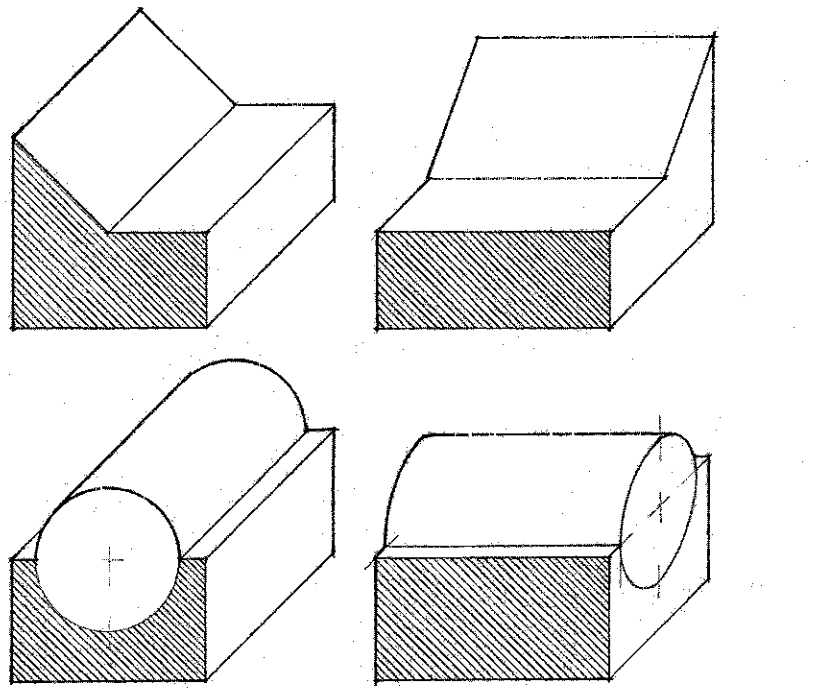
Oblique drawings show the true shape of planes parallel to the picture plane Onto this frontal view, top and side views are attached and projected back into the depth of the drawing This yields a three-dimensional image that represents what we know rather than how we see It depicts an objective reality that corresponds more closely to the picture in the mind's eye than the retinal image of linear perspective It represents a mental map of the world that combines plan and elevational views into a single expression

The ease with which we can construct an oblique drawing has a powerful appeal If we orient a principal face of an object parallel to the picture plane its shape remains true and we can draw it more easily Thus, oblique views are especially convenient for representing an object which has a curvilinear, irregular, or complicated face

While oblique projection can suggest the solidity of a three-dimensional object and produce a powerful illusion of space it also allows the composition of lines to remain on the surface as a flat pattern This can lead to optical illusions and therefore ambiguity in the reading of an oblique drawing







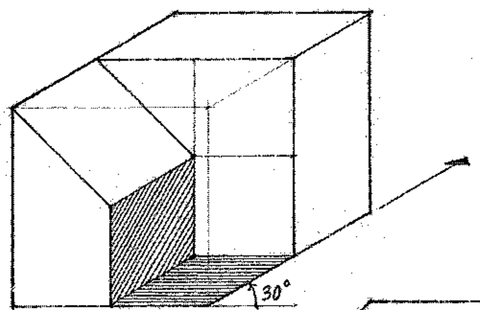
Oblique projection represents a three-dimensional object by extending parallel projectors at some angle other than 90° to the picture plane We usually orient a principal face of the object parallel to the picture plane so that we can draw it to exact scale and represent its shape and proportion accurately We can therefore construct an oblique drawing directly from an orthographic projection of that face

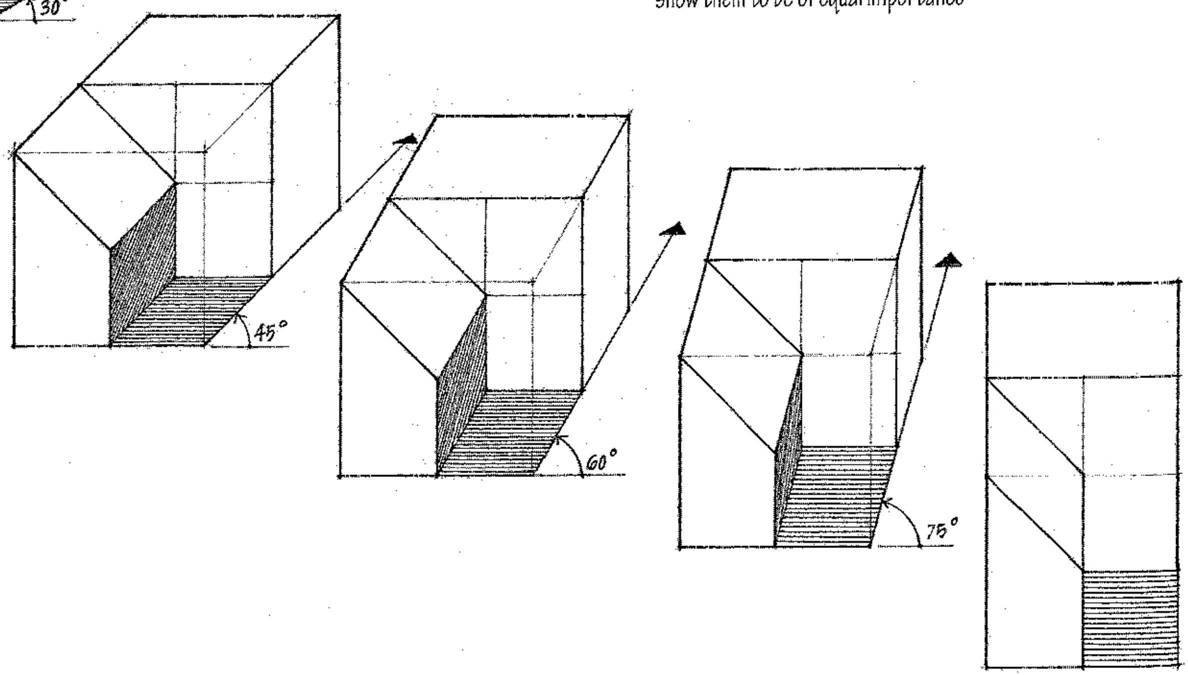
There are two rules that minimize distortion and make an oblique drawing easier to construct.

- Orient the length of the object parallel to the picture plane in order to offset the appearance of distortion in the depth of the drawing
- Orient the most complex or characteristic face of the object to the picture plane in order to show the true shape of the face and simplify construction Once we draw the true shape of this face, we can extend or extrude it into the third dimension by simply drawing a series of lines parallel to the receding axis

Direction of Receding Lines

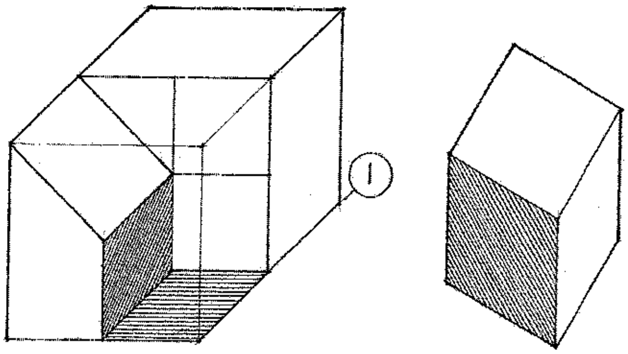
While an oblique drawing naturally emphasizes the planes parallel to the picture plane, planes perpendicular to the picture plane usually appear foreshortened in the drawing The apparent size and shape of receding planes depend on the angle at which the principal axes perpendicular to the picture plane recede into the depth of the drawing By varying this angle, we can emphasize one of the sets of receding planes over the other or show them to be of equal importance





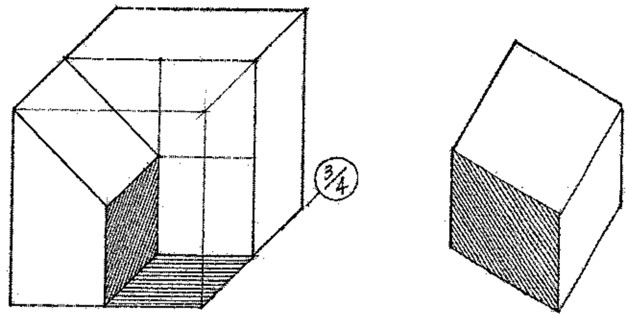
Length of Receding Lines

The angle that the oblique projectors make with the picture plane determines the lengths of the receding axial lines in an oblique drawing. If the projectors are at a 45° angle to the picture plane, the receding lines will be projected in their true length. At other angles, the projectors will cause the receding lines to appear either longer or shorter than their true length. In practice, we can lay out and draw the receding lines of an oblique drawing to their true lengths or at a reduced scale to offset the appearance of distortion.



Cavalier Projection

The term cavalier derives from the past use of this projection system in drawing fortifications. In cavalier projection, the projectors form a 45° angle with the picture plane. We can therefore draw the receding axial lines at the same scale as the lines parallel to the picture plane.



While the use of a single scale for all three principal axes greatly simplifies the construction of an oblique drawing, the lengths of receding lines can sometimes appear too long. To offset the appearance of distortion, we can foreshorten the receding lines by drawing their lengths at the same reduced scale, usually 2/3 to 3/4 of their true length.

Cabinet Projection

The term cabinet comes from its use in the furniture industry. In cabinet projection, a three-dimensional object is represented by an oblique drawing having all lines parallel to the picture plane drawn to exact scale and receding lines reduced to half-scale. Cabinet drawings suffer from a major pictorial defect—the length of receding lines can sometimes appear too short.