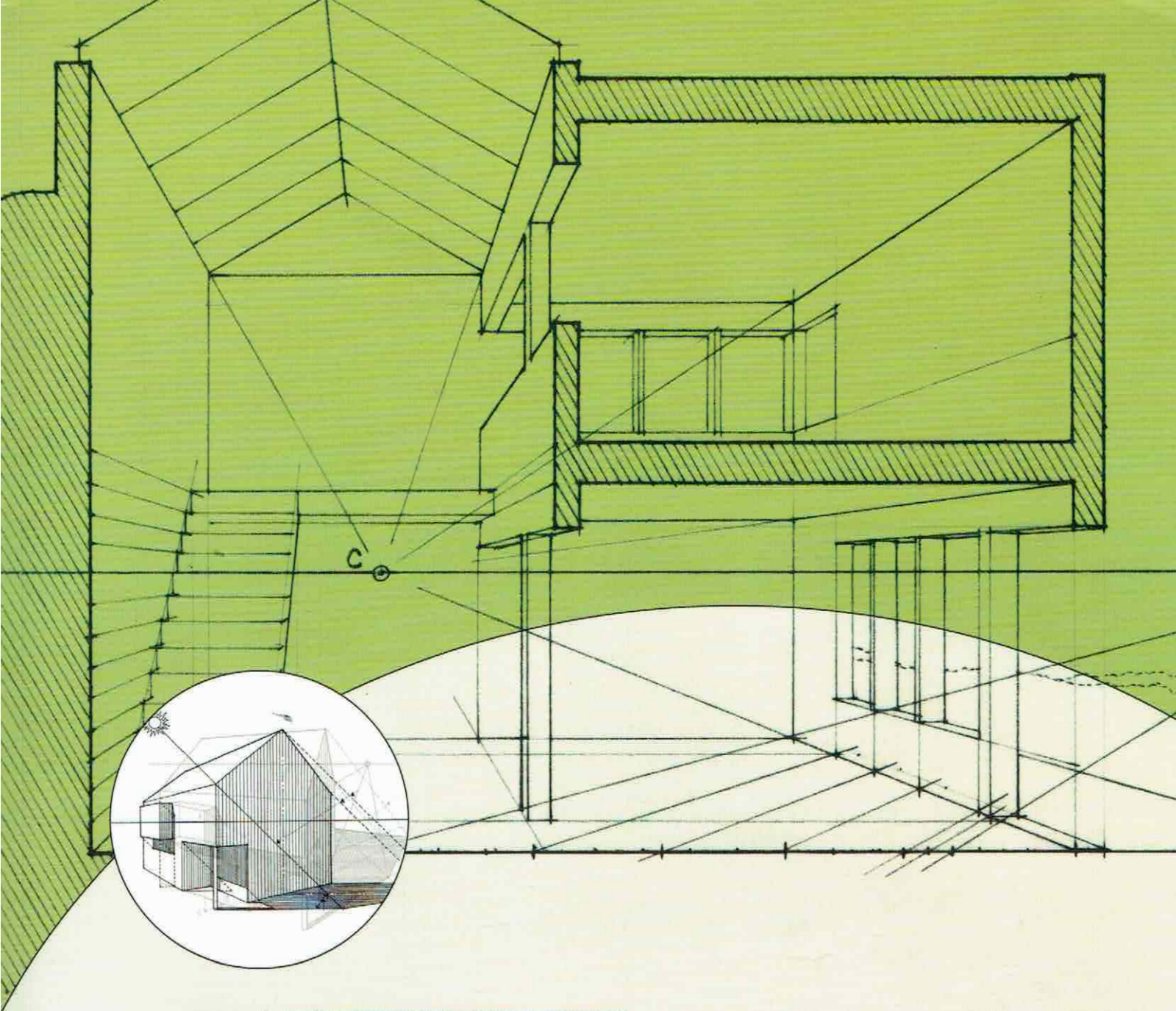




FOURTH EDITION

ARCHITECTURAL GRAPHICS

FRANCIS D.K. CHING

3

Architectural Drawing Systems

The central task of architectural drawing is representing three-dimensional forms, constructions, and spatial environments on a two-dimensional surface. Three distinct types of drawing systems have evolved over time to accomplish this mission: multiview, paraline, and perspective drawings. This chapter describes these three major drawing systems, the principles behind their construction, and their resulting pictorial characteristics. The discussion does not include media that involve motion and animation, made possible by computer technology. Nevertheless, these visual systems of representation constitute a formal graphic language that is governed by a consistent set of principles. Understanding these principles and related conventions is the key to creating and reading architectural drawings.

All three major drawing systems result from the way a three-dimensional subject is projected onto a two-dimensional plane of projection, or more simply, onto the picture plane.

- Projectors transfer points on the subject to the picture plane. These projectors are also called sightlines in perspective projection.
- The drawing surface or sheet of paper is the virtual equivalent of the picture plane.

Three distinct projection systems result from the relationship of the projectors to each other as well as to the picture plane.

Orthographic Projection

- Projectors are parallel to each other and perpendicular to the picture plane.
- Axonometric projection is a special case of orthographic projection.

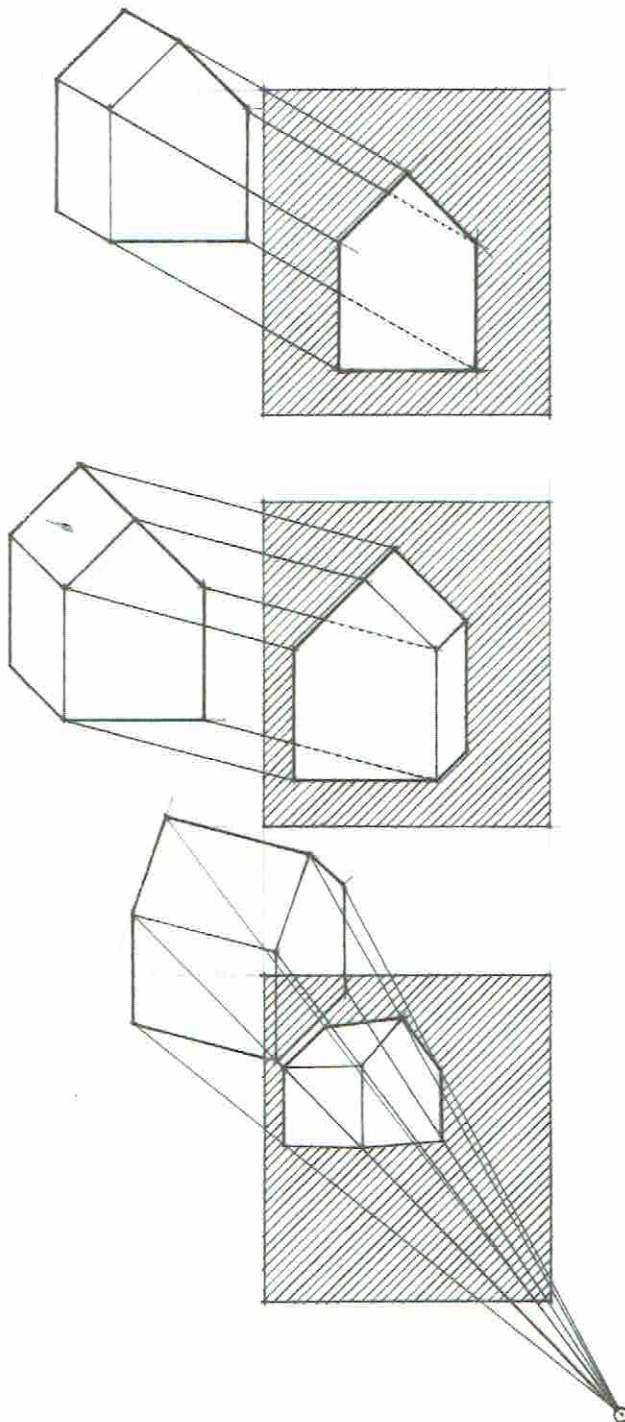
Oblique Projection

- Projectors are parallel to each other and oblique to the picture plane.

Perspective Projection

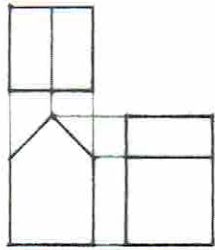
- Projectors or sightlines radiate from a central point that represents a single eye of the observer.

Once the information for a three-dimensional construction or environment has been entered into a computer, 3D CAD and modeling software can theoretically present the information in any of these projection systems.



Projection Systems

Orthographic Projection



Pictorial Systems

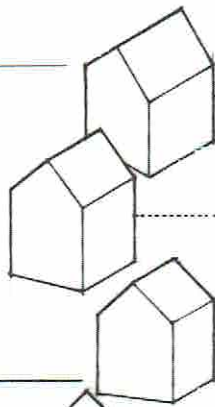
Multiview Drawings

- Plans, sections, and elevations.
- The principal face in each view is oriented parallel to the picture plane.

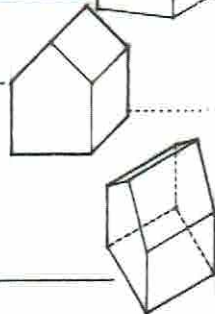
Paraline Drawings

- Isometrics: The three major axes make equal angles with the picture plane.
- Dimetrics: Two of the three major axes make equal angles with the picture plane.
- Trimetrics: The three major axes make different angles with the picture plane.

Axometric Projection

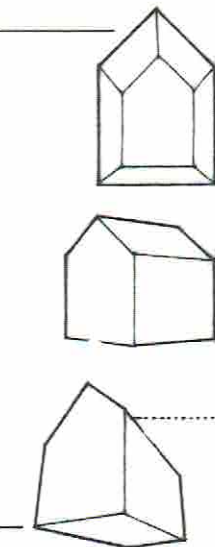


Oblique Projection



- Elevation obliques: A principal vertical face is oriented parallel to the picture plane.
- Plan obliques: A principal horizontal face is oriented parallel to the picture plane.

Perspective Projection



Perspective Drawings

- 1-point perspectives: 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 perspectives: Both horizontal axes are oblique to the picture plane, and the vertical axis remains parallel with the picture plane.
- 3-point perspectives: Both horizontal axes as well as the vertical axis are oblique to the picture plane.

These pictorial views are available in most 3D CAD and modeling programs. The terminology, however, may differ from what is presented here.

Orthographic Projection

Orthographic projection represents a three-dimensional form or construction by projecting lines perpendicular to the picture plane.

Projectors are both parallel to each other and perpendicular to the picture plane.

Major faces or facets of the subject are typically oriented parallel with the picture plane. Parallel projectors therefore represent these major faces in their true size, shape, and proportions. This is the greatest advantage of using orthographic projections—to be able to describe facets of a form parallel to the picture plane without foreshortening.

Ambiguity of depth is inherent in any orthographic projection, as the third dimension is flattened onto the picture plane.

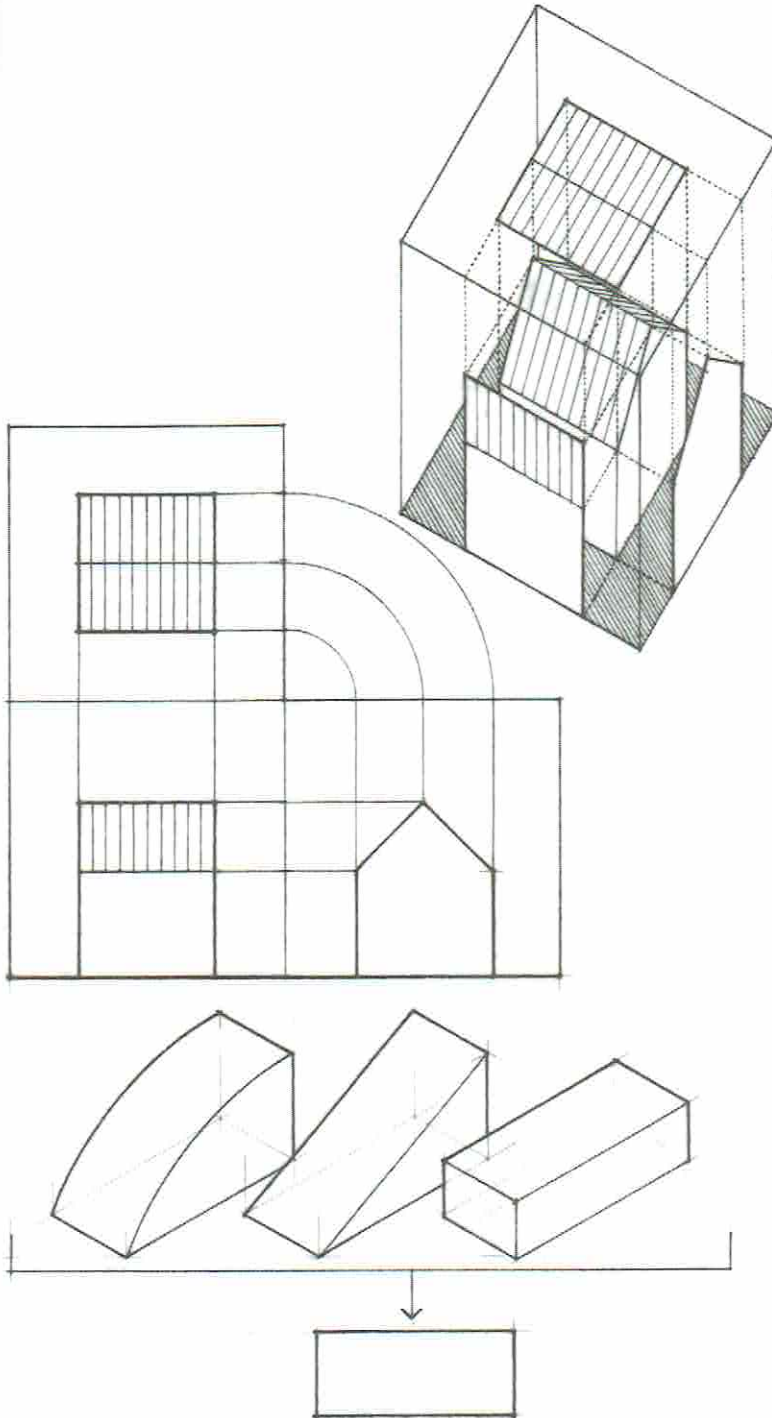
Lines that are perpendicular to the picture plane are projected as points.

Planes that are perpendicular to the picture plane are projected as lines.

Curved surfaces and those that are not parallel to the picture plane are foreshortened.

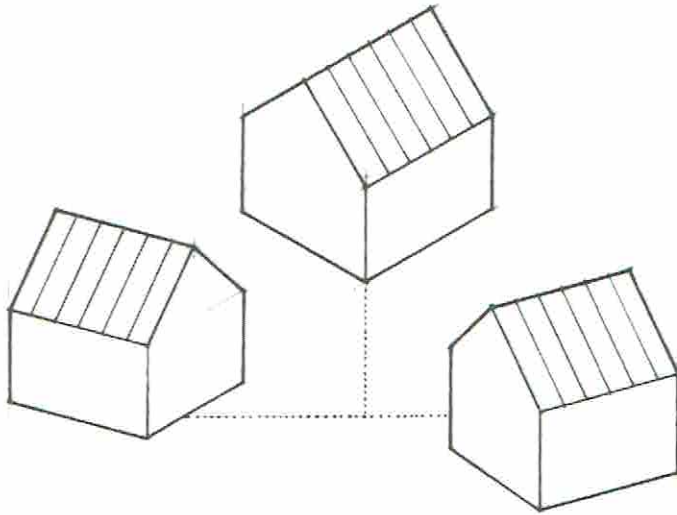
Note that the projected size of an element remains constant regardless of how far forward or back it is from the picture plane.

Any single orthographic projection cannot convey facets of a subject that are oblique or perpendicular to the picture plane. Only by looking at related orthographic projections can this information be discerned. For this reason, we use the term "multiview drawings" to describe the series of orthographic projections necessary to fully and accurately describe a three-dimensional subject.



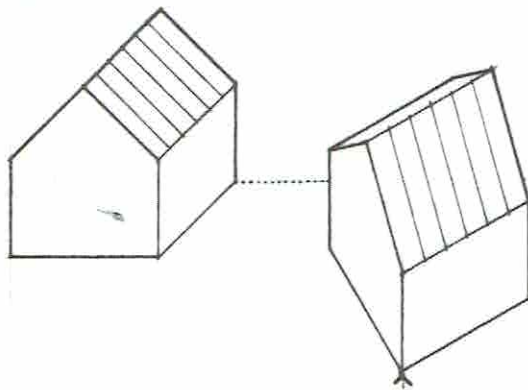
- If we enclose an object within a transparent picture-plane box, we can name the images projected orthographically onto the principal picture planes.
- Top views are orthographic projections cast onto the horizontal picture plane. In architectural drawing, top views are called plans.
- Front and side views are orthographic projections cast onto the vertical picture planes. In architectural drawing, front and side views are called elevations.
- See Chapter 4 for floor plans and sections, which are orthographic projections of cuts made through a building.
- To make it easier to read and interpret how a series of orthographic projections describes a three-dimensional whole, we arrange the views in an orderly and logical fashion.
- The most common layout results when we unfold the transparent picture-plane box 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 view revolves to align horizontally with the front view. The result is a coherent set of related orthographic views.
- Although these three objects have different forms, their top views appear to be identical. Only by looking at related orthographic projections are we able to understand the three-dimensional form of each object. We should therefore study and represent three-dimensional forms and constructions through a series of related orthographic projections.
- The mind must be able to read and assemble a set of multiview drawings to fully understand the nature of the three-dimensional subject.

While orthographic projections describe a three-dimensional subject through a series of distinct but related two-dimensional views, paraline drawings convey the three-dimensional nature of a form or construction in a single pictorial view. Properly speaking, any orthographic projection is a paraline drawing. However, we use the term "paraline drawing" to refer specifically to those single pictorial views described below.



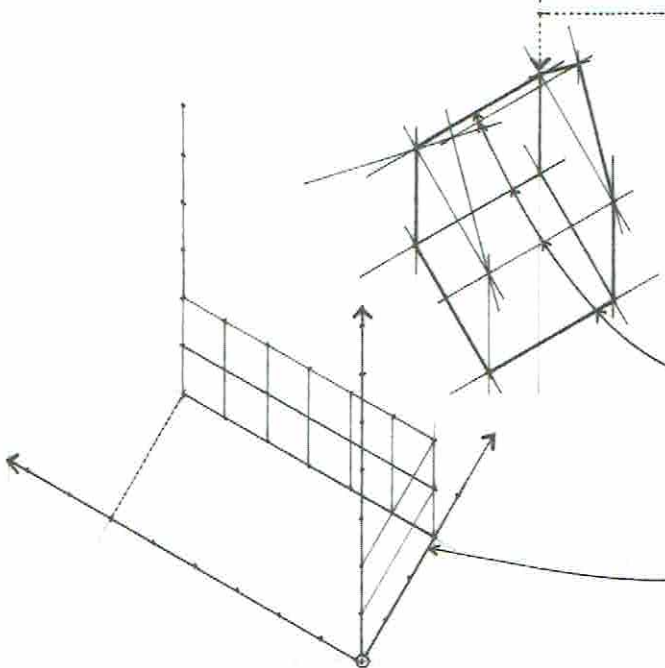
Types of Paralane Drawing

- Axonometric projections can produce isometric, dimetric, or trimetric views.



- Oblique projections can result in plan obliques or elevation obliques.
- Unfortunately, CAD and modeling programs do not use these terms for the different types of paralane drawings in a consistent manner.

Pictorial Characteristics of Paralane Drawings



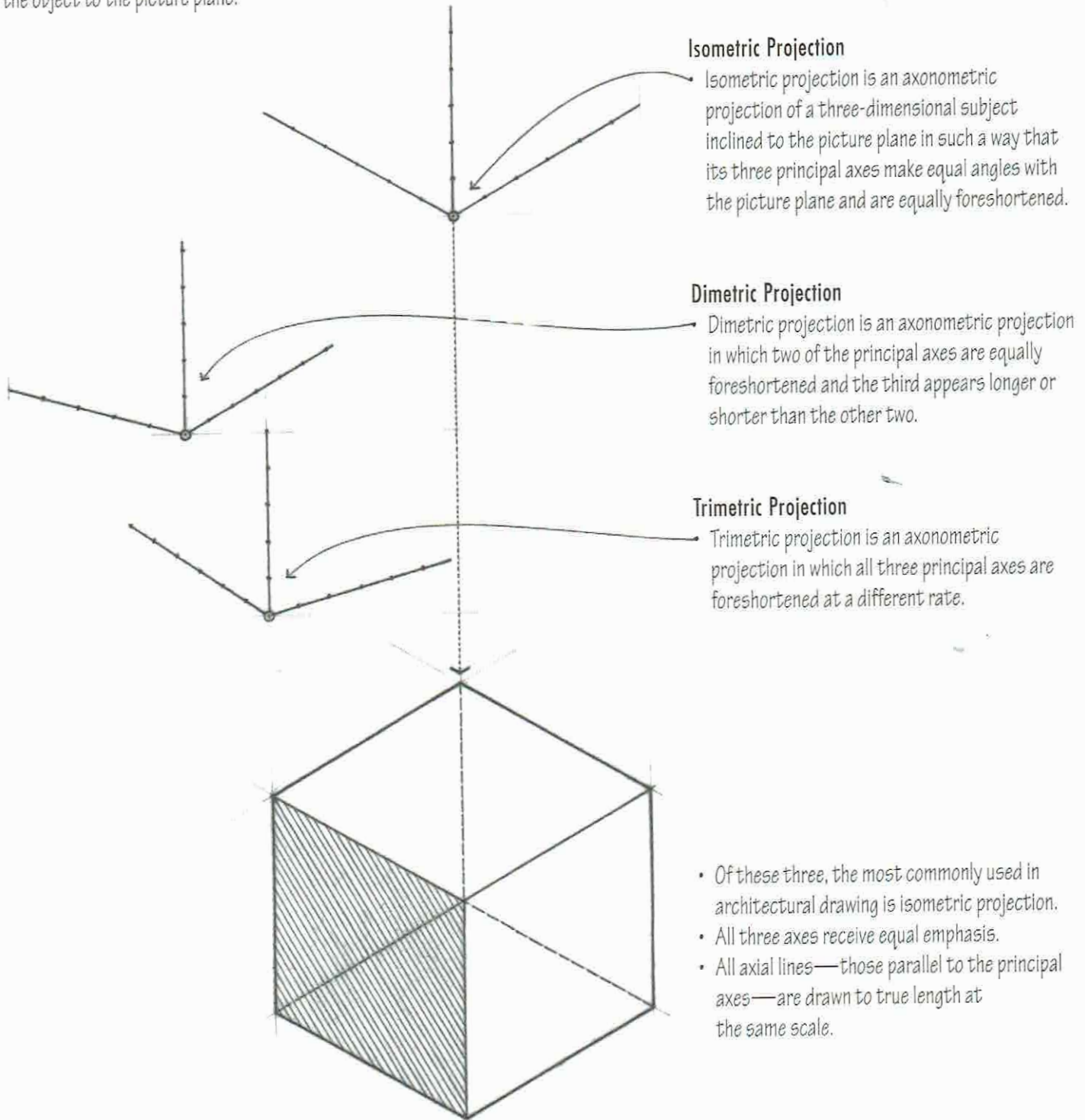
- Paralane drawings are always aerial or worm's-eye views.

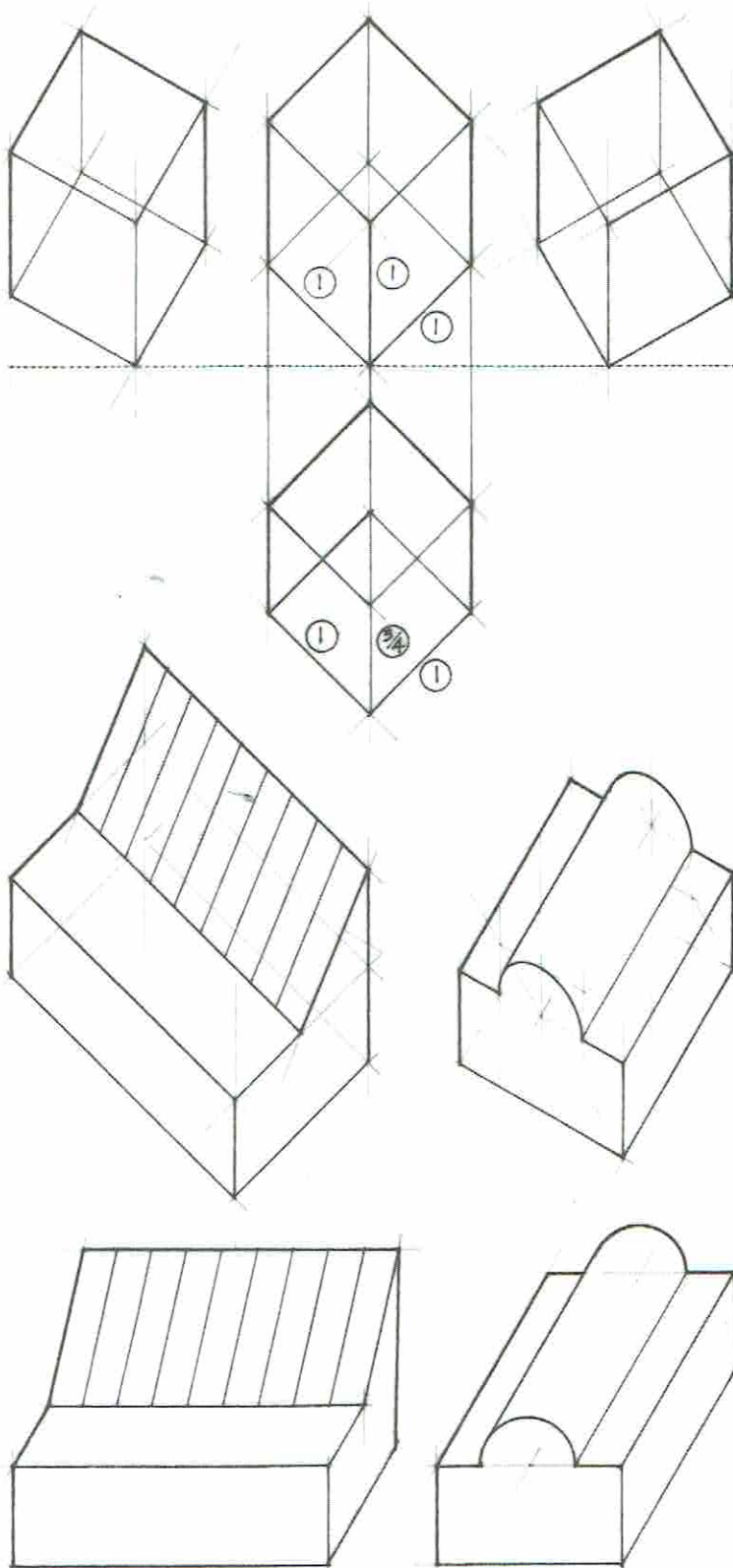
- Parallel lines in the subject remain parallel in the drawing.

- All axial lines—those lines parallel to the major X-, Y-, and Z-axes—are scalable. Conversely, nonaxial lines are never scalable.

Axonometric Projection

An axonometric projection is an orthographic projection of a three-dimensional form that is inclined to the picture plane in such a way that its three principal axes are foreshortened. The term "axonometric" is often misused to describe paraline drawings of oblique projections or the entire class of paraline drawings. Strictly speaking, 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.





Oblique Projection

Oblique projection represents a three-dimensional form or construction by projecting parallel lines at some convenient angle other than 90° to the picture plane. A principal face or set of planes of the subject is usually oriented parallel to the picture plane and is therefore represented in accurate size, shape, and proportion.

- For convenience, the receding lines perpendicular to the picture plane are typically drawn to the same scale as the lines parallel to the picture plane.
- The receding lines may be foreshortened to $\frac{3}{4}$ or $\frac{1}{2}$ their true scaled length to offset the appearance of distortion.

In architectural drawing, there are two principal types of oblique drawings: plan obliques and elevation obliques.

Plan Obliques

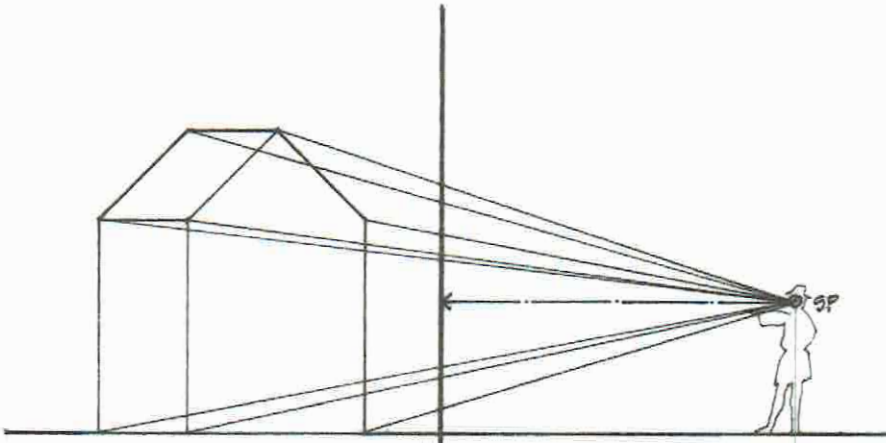
- Plan obliques orient the horizontal planes of the subject parallel to the picture plane. These horizontal planes are therefore shown in true size and shape, while the two principal sets of vertical planes are foreshortened.
- Plan obliques have a higher angle of view than isometric drawings.
- An advantage in constructing plan obliques is the ability to use floor plans as base drawings.

Elevation Obliques

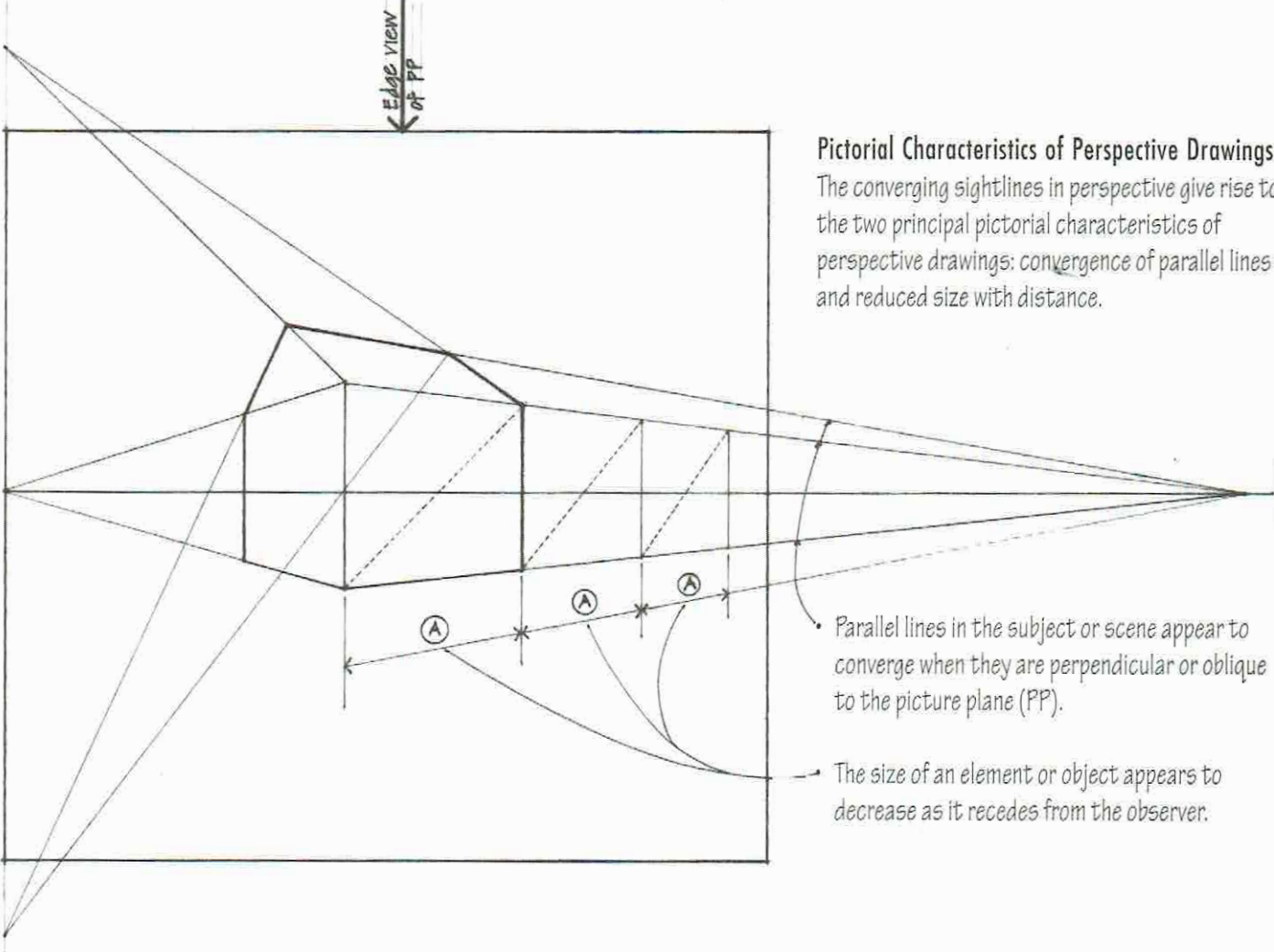
- Elevation obliques orient one principal set of vertical planes of the subject parallel to the picture plane. This set is therefore shown in true size and shape, while the other vertical set and the principal horizontal set of planes are both foreshortened.
- The face selected to be parallel to the picture plane should be the longest, the most complex, or the most significant face of the building or construction.

Perspective Projection

Perspective projection portrays a three-dimensional form or construction by projecting all of its points to a picture plane (PP) by straight lines that converge at a fixed point representing a single eye of the observer.



- While we normally see through both eyes in what we call binocular vision, perspective projection assumes we view a three-dimensional subject or scene through a single eye, which we call the station point (SP). Unlike the parallel projectors in orthographic and oblique projections, the projectors or sightlines in perspective projection converge at this station point.



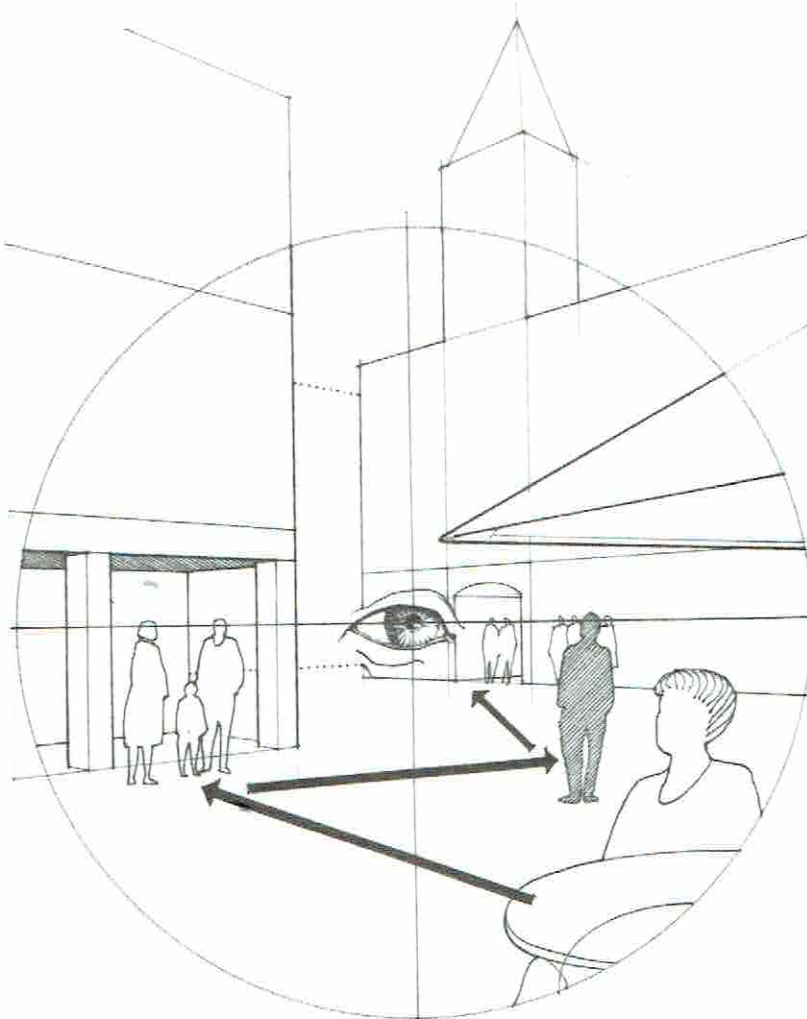
Pictorial Characteristics of Perspective Drawings

The converging sightlines in perspective give rise to the two principal pictorial characteristics of perspective drawings: convergence of parallel lines and reduced size with distance.

- Parallel lines in the subject or scene appear to converge when they are perpendicular or oblique to the picture plane (PP).
- The size of an element or object appears to decrease as it recedes from the observer.

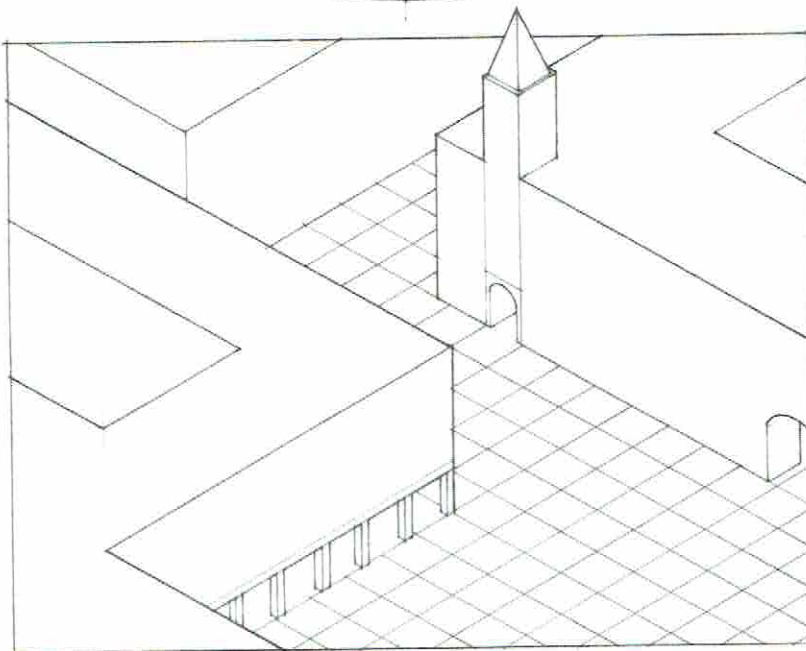
PERSPECTIVE DRAWINGS

A well-drawn perspective excels in conveying the experience of being in a three-dimensional spatial environment.



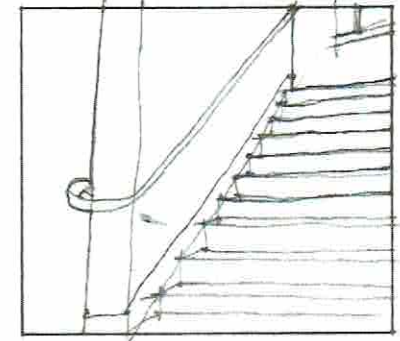
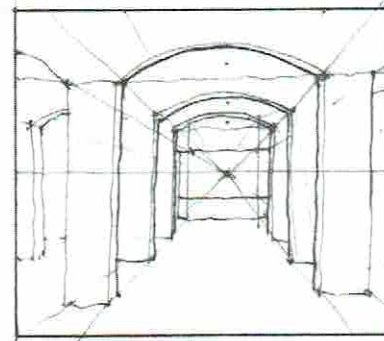
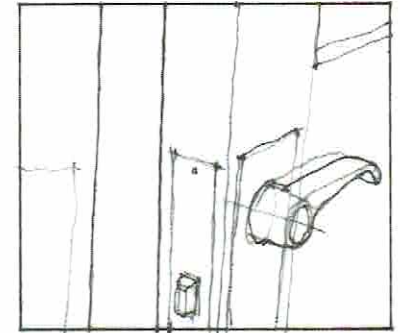
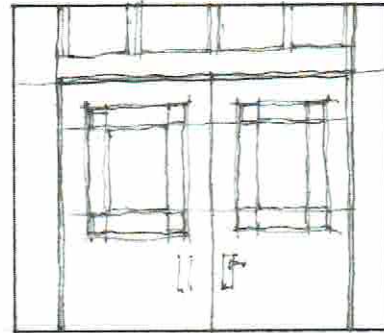
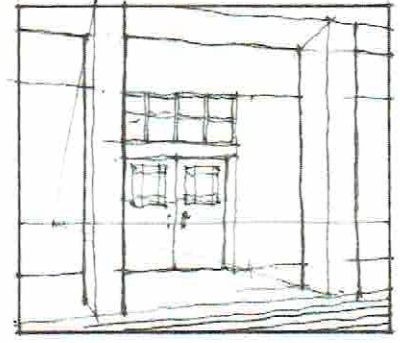
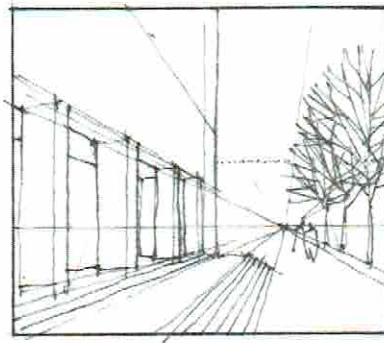
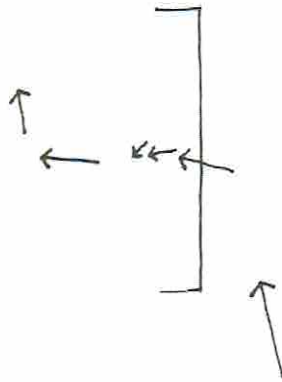
- The experiential nature of a perspective drawing relies on our ability to define at least three layers of depth within a scene: a foreground, a middleground, and a background.

- Perspective drawings assume there is an observer located at a specific point in space and looking in a specific direction.

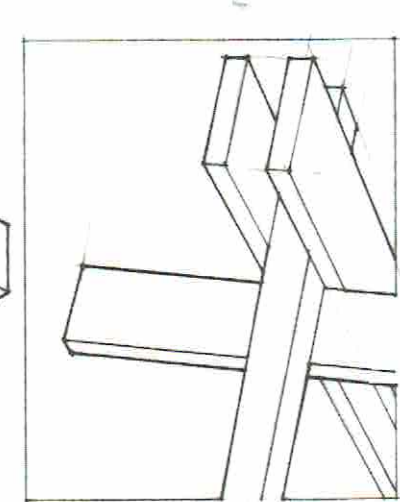
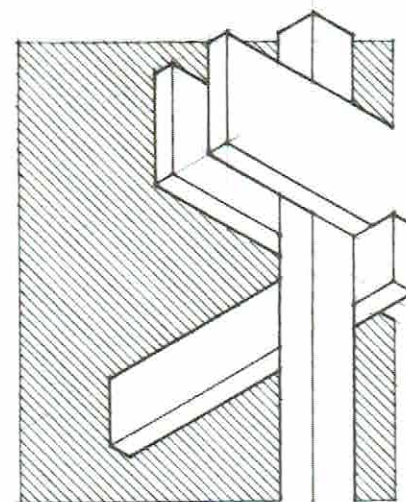


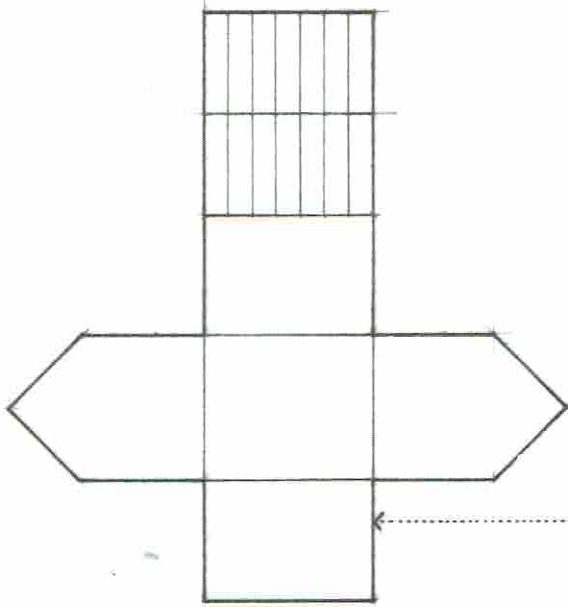
- Multiview and paraline drawings, on the other hand, do not make reference to the point of view of an observer. We can view the drawings from various angles and be comfortable in reading the objective information. Our eyes can roam over the expanse of a plan or paraline drawing and be able to correctly interpret the graphic information.

- We can use a series of perspectives—what we call serial vision—to convey the experience not only of being in a place but also of moving through a sequence of spaces.
- 3D-modeling programs often have the ability to create a sequential series of perspective views and animate a walk-through or fly-through of a building or spatial environment. There is an ongoing question regarding how to use these capabilities to simulate more effectively the way we experience space.



- There is little advantage in drawing a perspective of a small-scale object, such as a chair or structural detail, unless it exists in a spatial environment. At these scales, the degree of convergence of parallel lines is so slight that a paraline view is usually a better and more efficient choice.

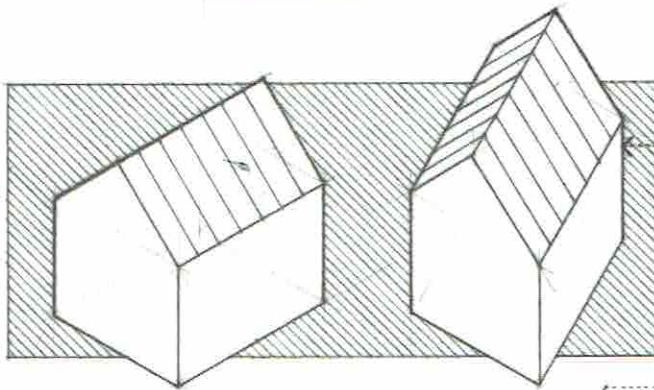




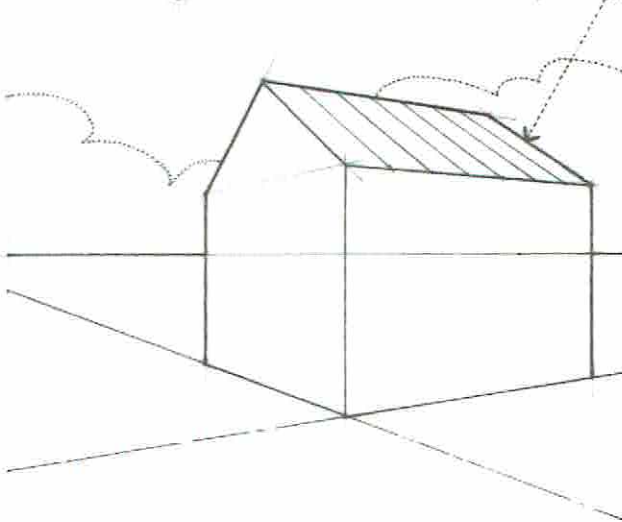
We use architectural drawings to initiate, explore, develop, and communicate design ideas. No one drawing can ever reveal everything about its subject. Each pictorial system of representation provides an alternative way of thinking about and representing what we see before us or envision in the mind's eye. The choice of a particular drawing system influences how we view the resulting graphic image, establishes which design issues are made visible for evaluation and scrutiny, and directs how we are inclined to think about the subject of the drawing. In selecting one drawing system over another, therefore, we make conscious as well as unconscious choices about what to reveal as well as what to conceal.

Point of View

- Multiview drawings represent a three-dimensional subject through a series of distinct, but related, two-dimensional views.
- These are abstract views that the viewer must assemble in the mind to construct an objective reality.



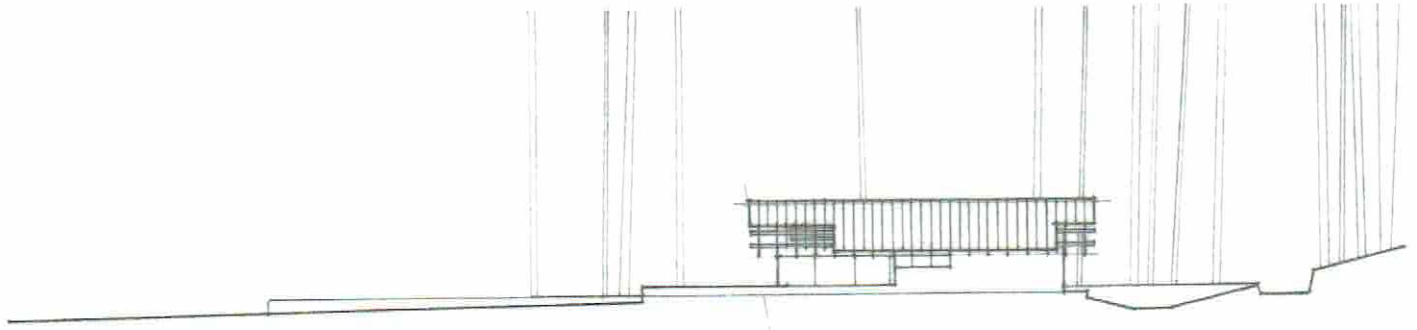
- Parallel drawings describe the three-dimensional nature of the same subject in a single view.
- These views combine the scalability of multiview drawings and the easy-to-understand, pictorial nature of perspectives.



- Perspectives are experiential views that convey a sense of being present in a spatial environment.
- Perspectives depict an optical reality rather than the objective reality of multiview and parallel drawings.
- It is a paradox that multiview drawings are relatively easy to develop but often difficult to interpret, while perspective drawings are challenging to construct but usually easy to understand.

Digital Views

A distinct advantage of digital drawing over traditional drawing is the ability to experiment with design modifications, study alternative points of view, or try out different drawing techniques. These advantages arise from the ability to undo an action or series of operations, or to save one version of a drawing while working on a copy and return to the saved version if necessary.

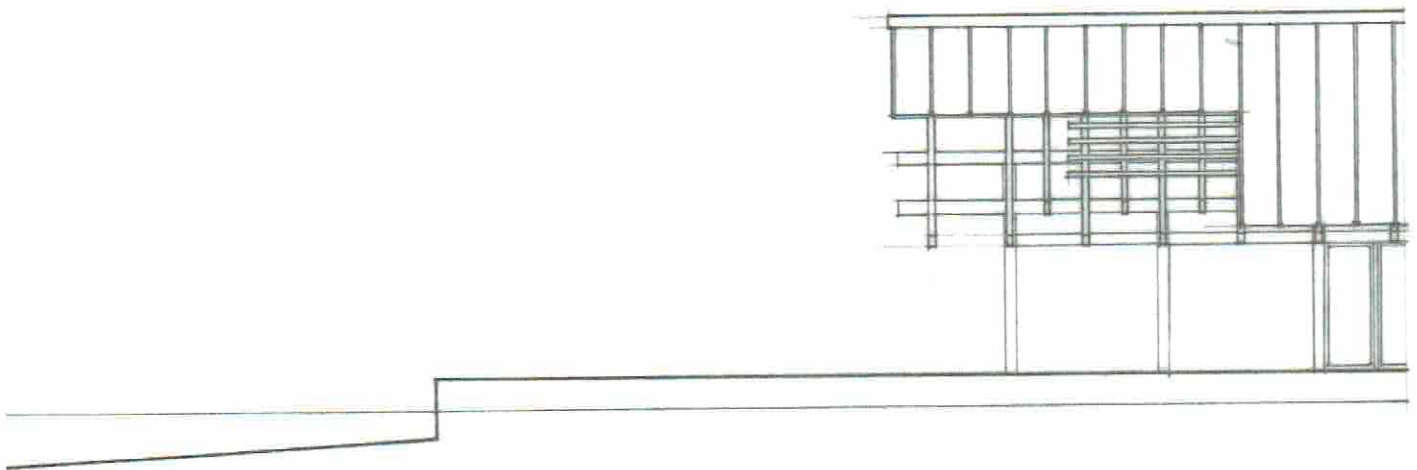
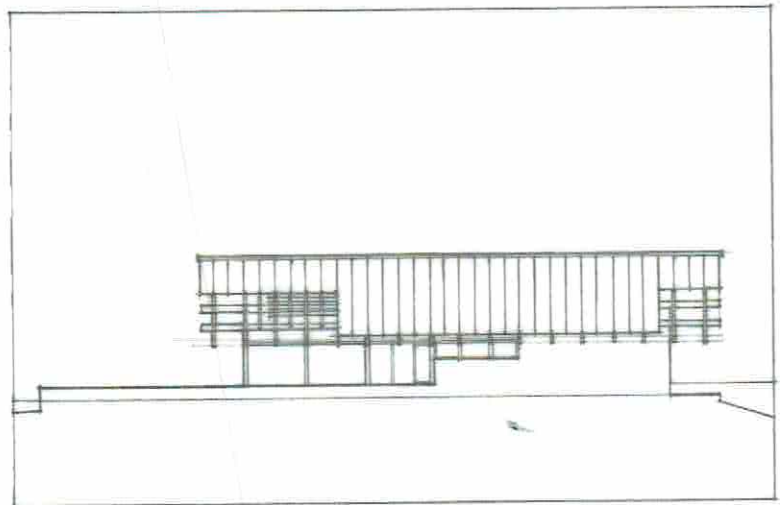


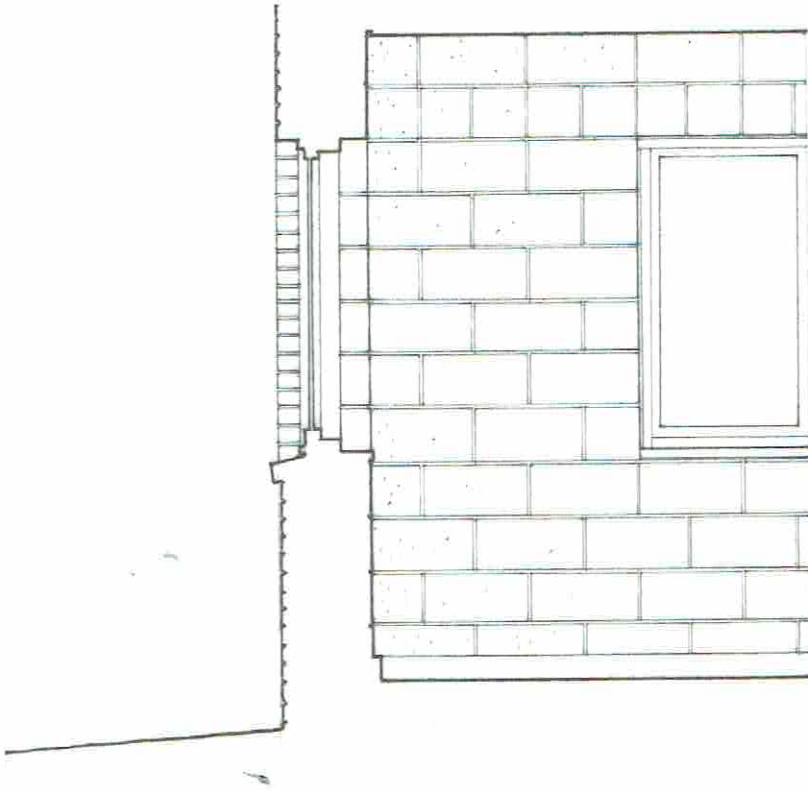
Scale & Detail

Architectural drawings are typically executed at a reduced scale to fit onto a certain size sheet of paper, vellum, or illustration board. Even digital printers and plotters have paper size limitations. The scale of a drawing determines how much detail can be included in the graphic image. Conversely, how much detail is desirable determines how large or small the scale of a drawing should be.

Digital Scale

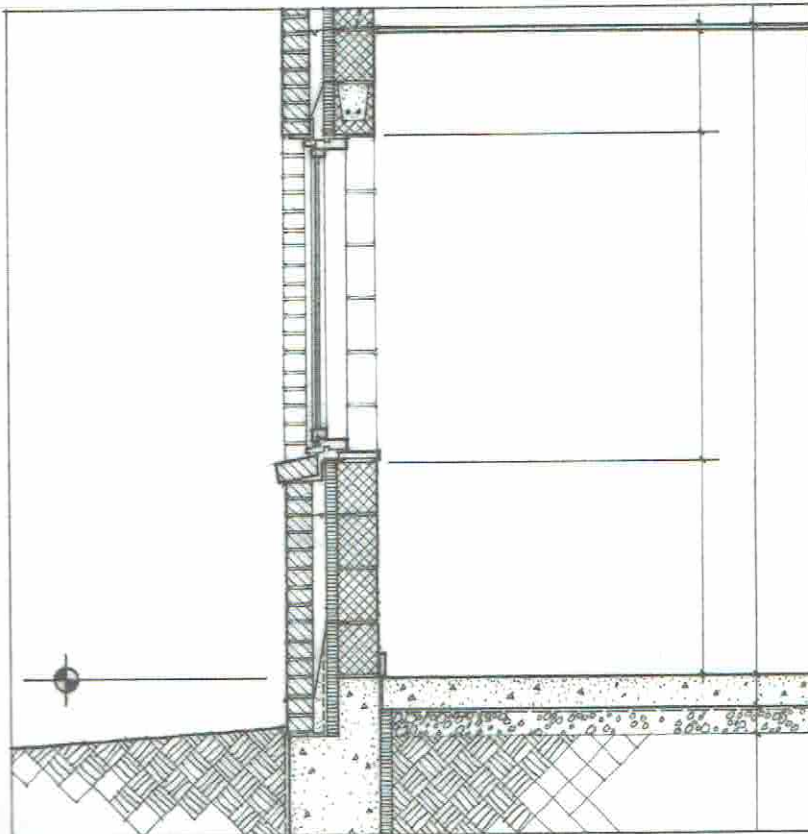
Resizing or rescaling a set of digital data is fairly easy to accomplish. Printing or plotting a small-scale drawing that contains too much data, however, can result in an image that is too dense to read.





Design & Construction Drawings

In architectural design, we use drawings to convey the experiential qualities of spatial compositions and environments. Design drawings, therefore, focus on illustrating and clarifying the essential solid-void nature of forms and spaces, scale and proportional relationships, and other sensible qualities of space. For these reasons, design drawings convey information primarily through graphic means.



Construction drawings, on the other hand, are intended to instruct the builder or fabricator about the implementation or construction of a design. These contract drawings, which constitute part of a legal document, often rely on abstract conventions and include dimensions, notes, and specifications.