ME 101 ENGINEERING GRAPHICS

CHAPTER 4

F_{p_1}

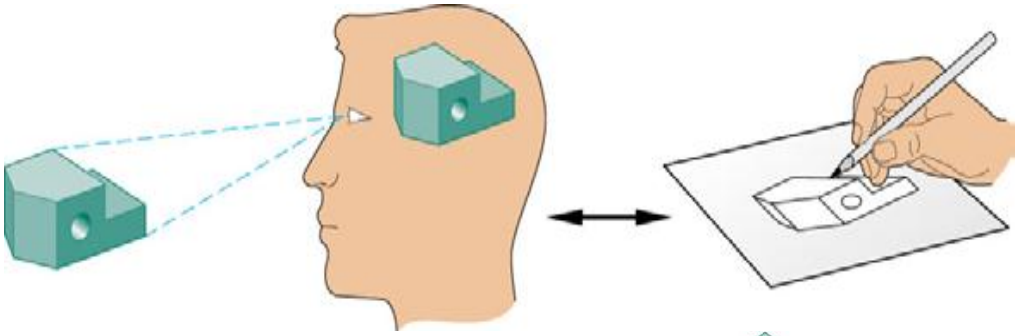
ORTHOGRAPHIC DRAWING

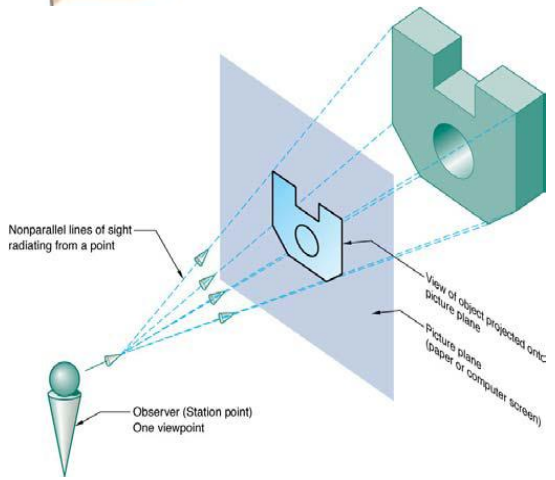
Introduction and Objectives

- Ortho_ Greek word meaning perpendicular.
- A system of drawing to represent 3D objects by using multiple-view drawings.
- In this system of projection, the 3D object is projected perpendicularly onto a projection plane with parallel projectors.

Objectives:

- To understand the basic principles of orthographic projection
- To be able to construct orthographic views of simple objects
- To visualize 3D objects from drawings showing their orthographic views





4.1 THEORY OF PROJECTION

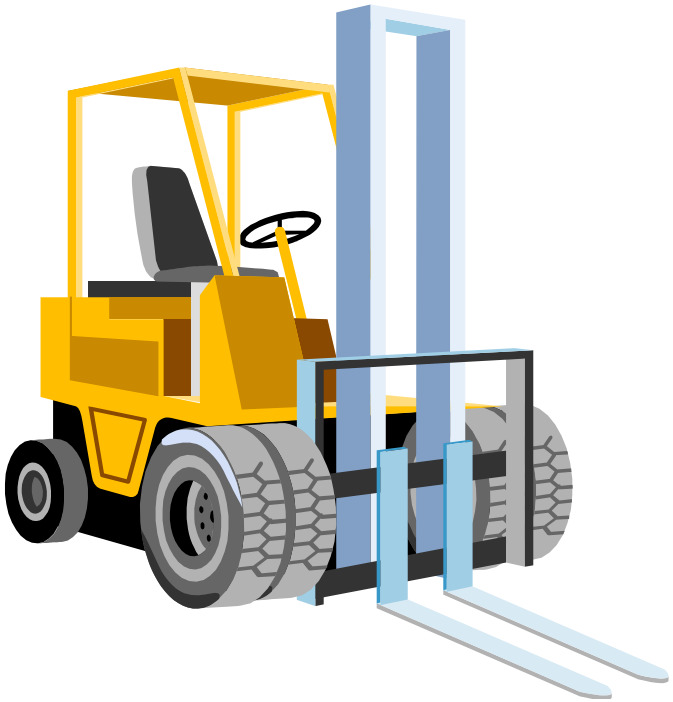
Technical drawing is a "Universal Graphic Language" by means of which the shape, size, finish; construction of an object can be described accurately and clearly. Only as a supplement, for notes and specifications is the word-language used. This language used by engineers and architects to develop and record their ideas and then communicate every detail of their design to the people who are to execute the design and to manufacturers.

The descriptions must be prepared that show every aspects of the shape and size of each part and of the complete machine and structure shape described by projection, that is, by the process of causing an image to be formed by rays of sight taken in a particular direction from an object to a picture plane.

Projection Theory

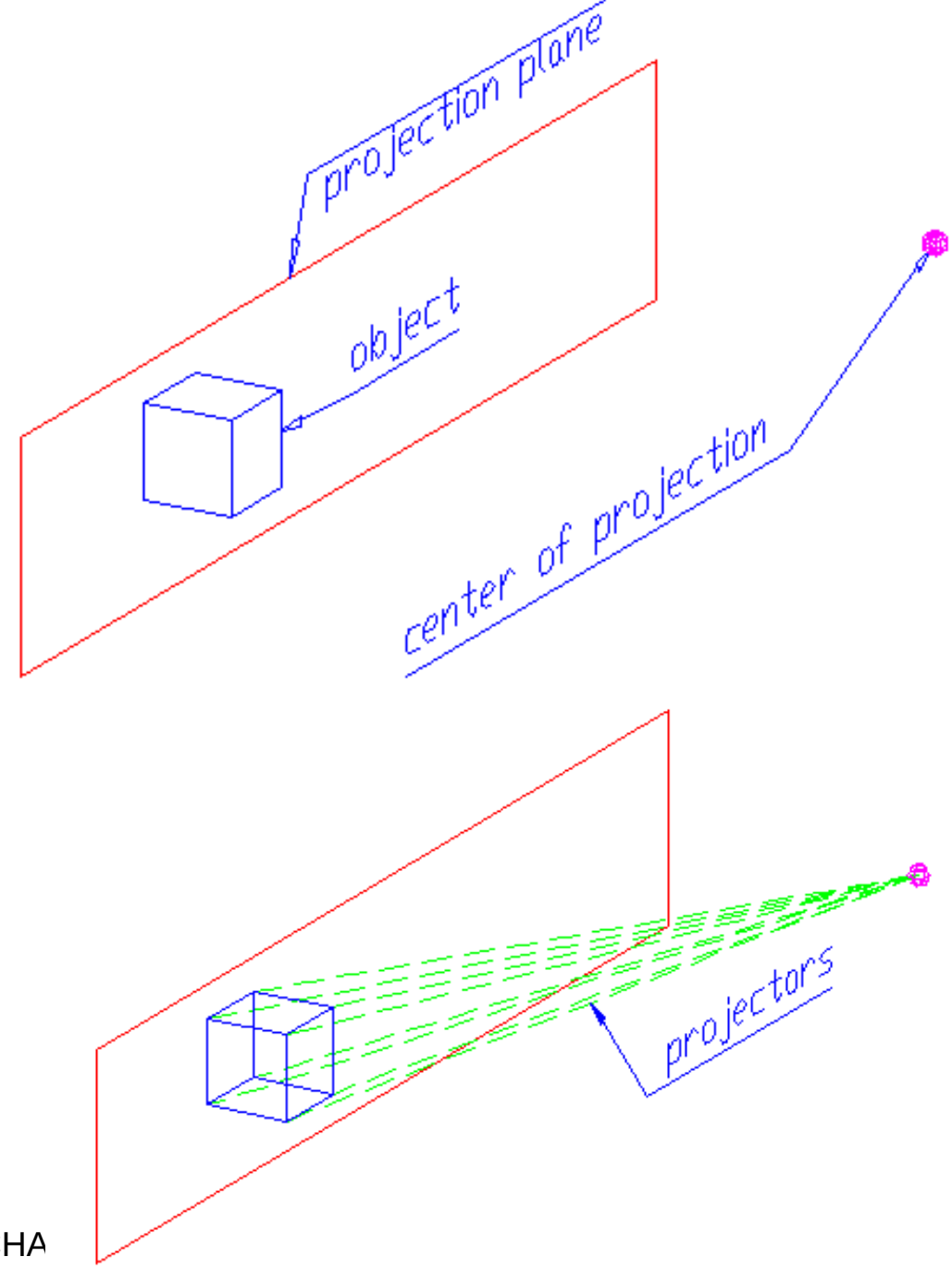
A *projection* is a mapping of a 3D space onto a 2D subspace

- 2D space is called the projection plane
- Projection also refers to image resulting from such a mapping



Common Elements of a Projection System

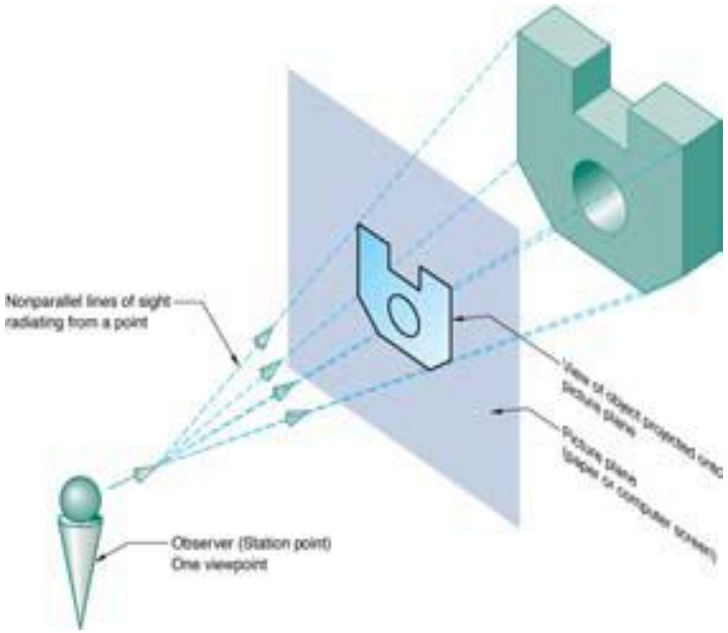
- Center of Projection (Perspective)/Direction of Projection (Parallel)
- Projection Plane
- Object(s) to be projected
- Projectors



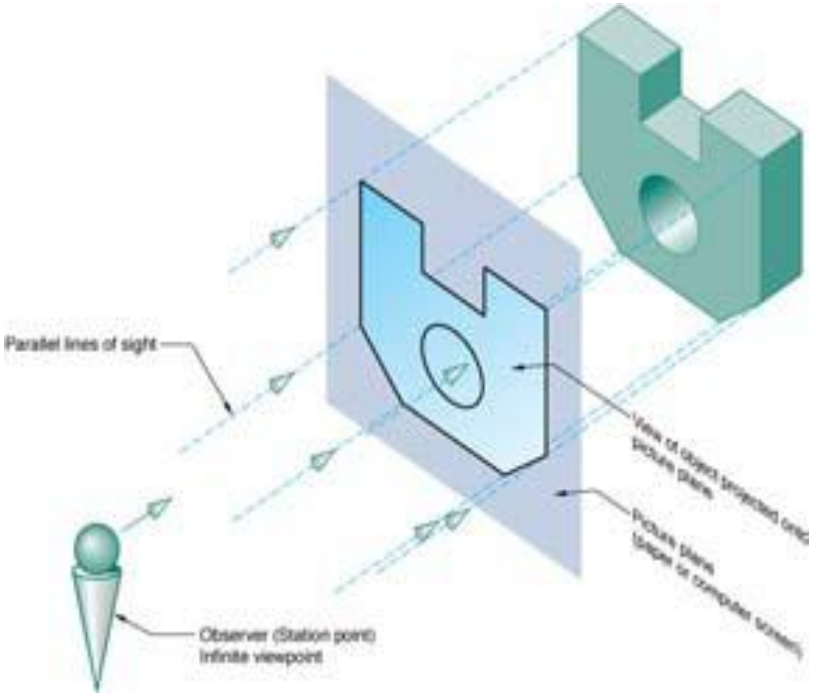
Some Terminology

- Center of Projection = Station Point = Viewpoint of observer
- Projection Plane = Viewplane = Picture Plane
- Projectors = Sightlines = Line of Sight

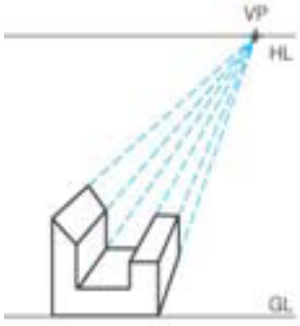
Projection Methods

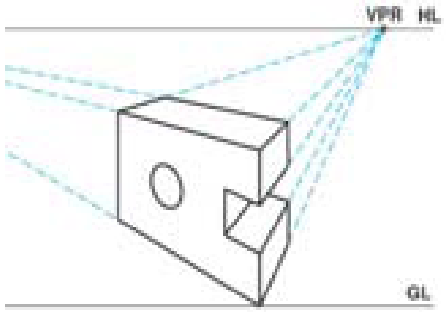


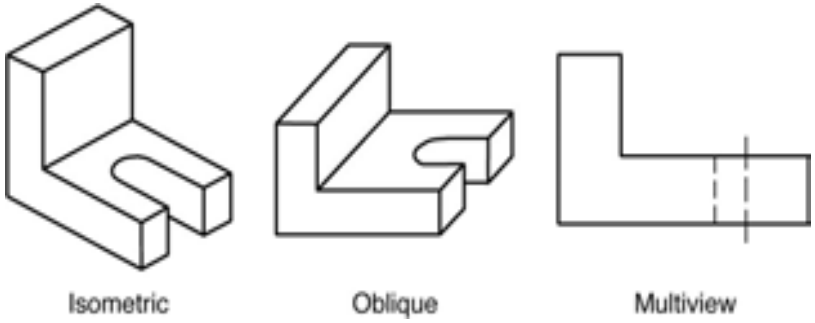
Perspective projection



Parallel projection







Isometric Oblique Multiview

Projection Methods: Perspective projection

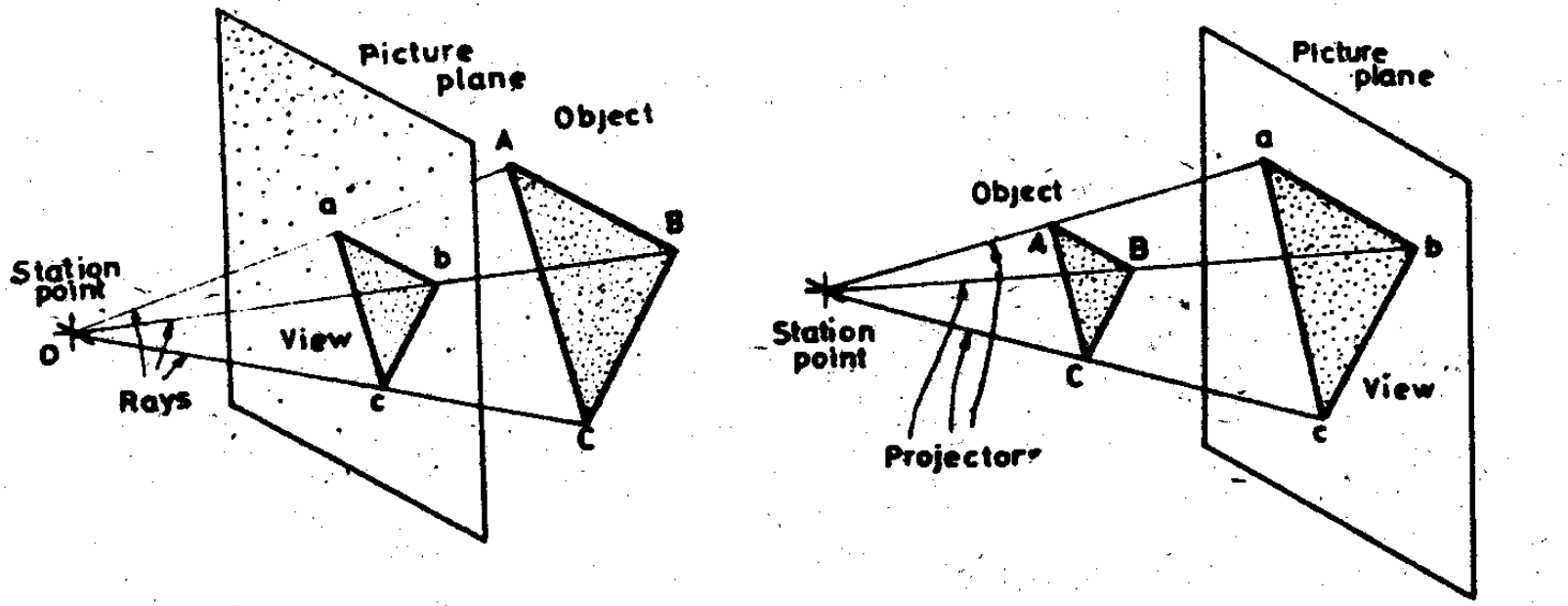


Fig.4.1. Perspective projection

Projection methods vary according to the direction in which the rays of sight are taken to the plane. If the rays are taken to a particular station point result is called "perspective projection" or "central projection" (Fig.4.1)

Projection Methods: Parallel projection

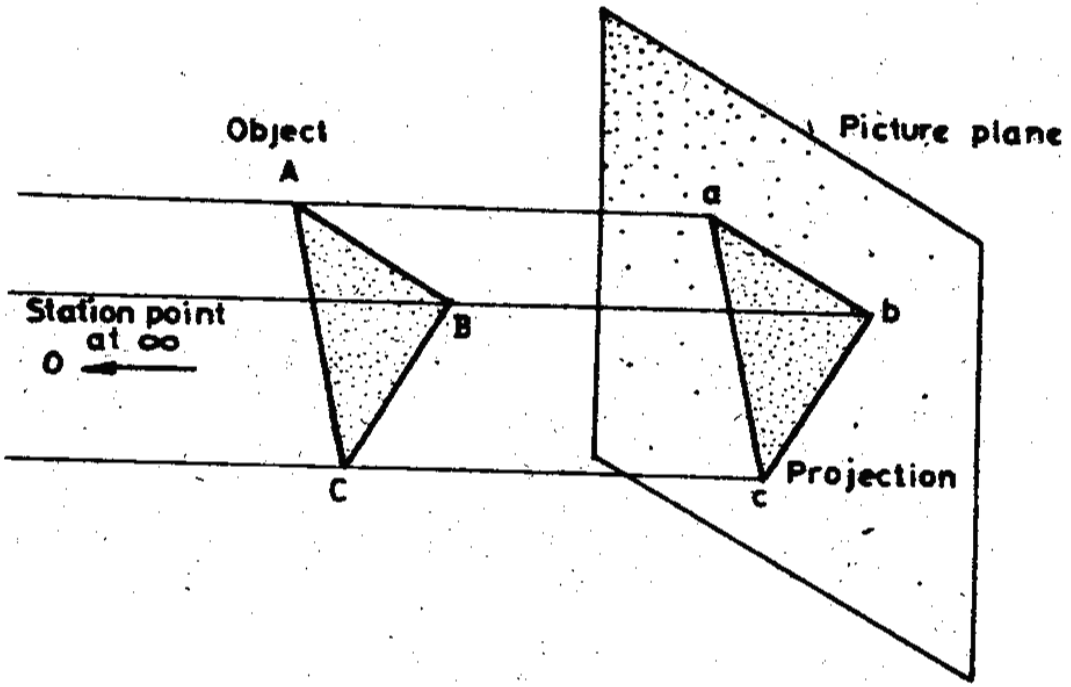
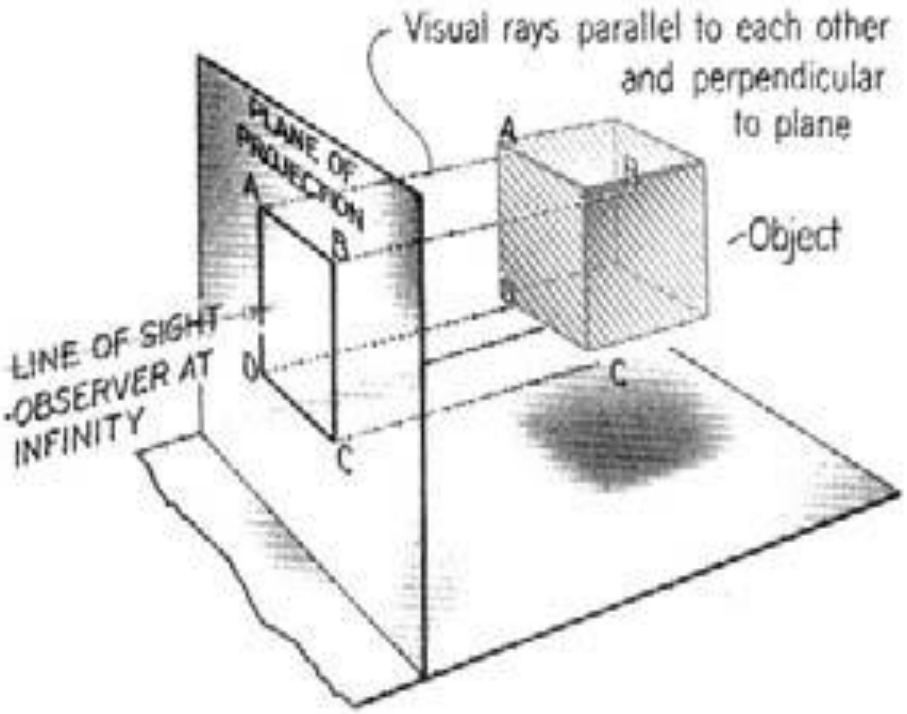


Fig.4.2. Parallel projection

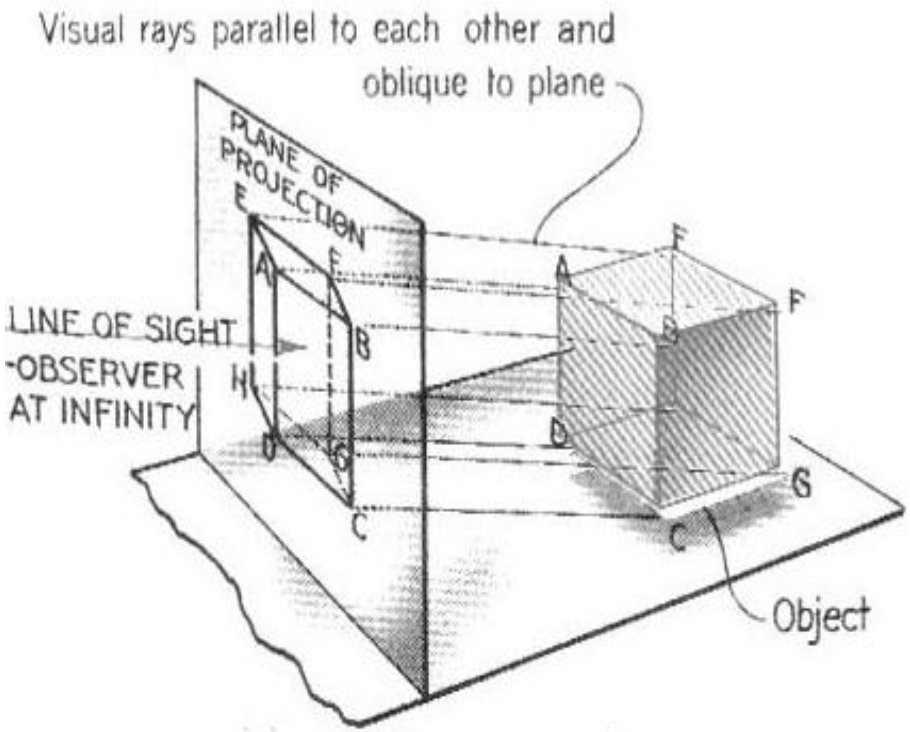
When the station point O is infinitely distant from the projection plane, the rays of projection will be parallel to each other as shown in (Fig.4.2). In this case the projection is called "parallel projection".

Projection Methods: Parallel projections



Orthographic

Line of sight is perpendicular to plane



Oblique

Line of sight is oblique to plane

If the rays of parallel projection are perpendicular to the plane of projection, the resulting projection is an "Orthographic projection", if the rays of parallel projection, oblique to the plane of projection the resulting projection is an "oblique projection" (Fig.4.3).

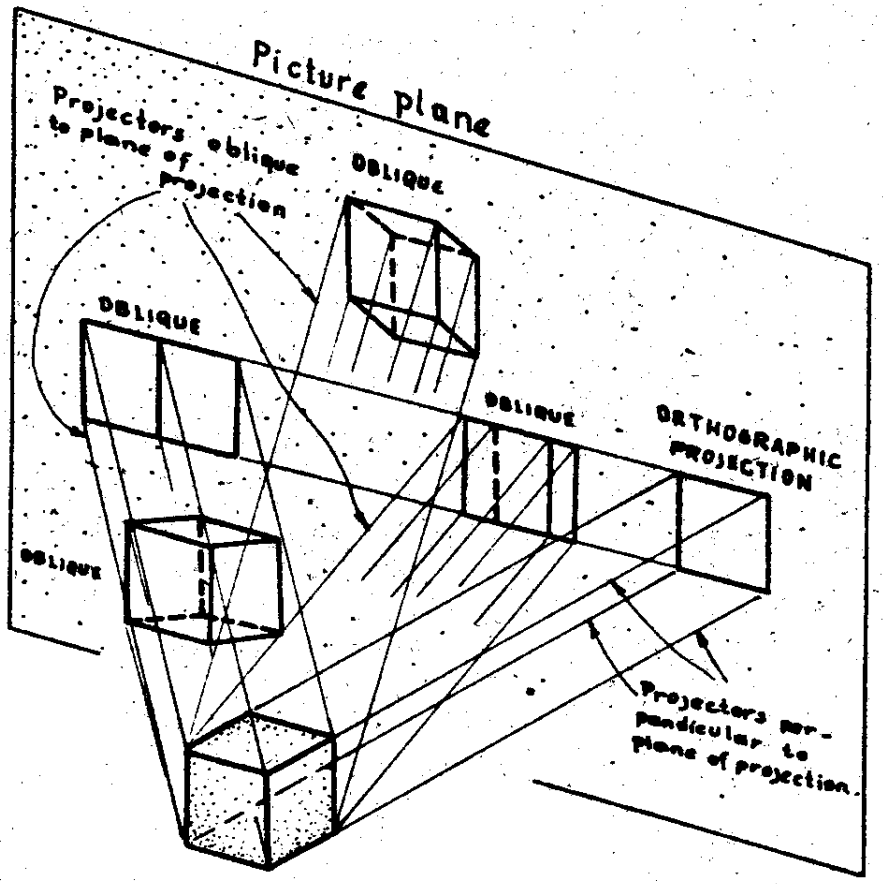


Fig.4.3. Orthographic and oblique projections

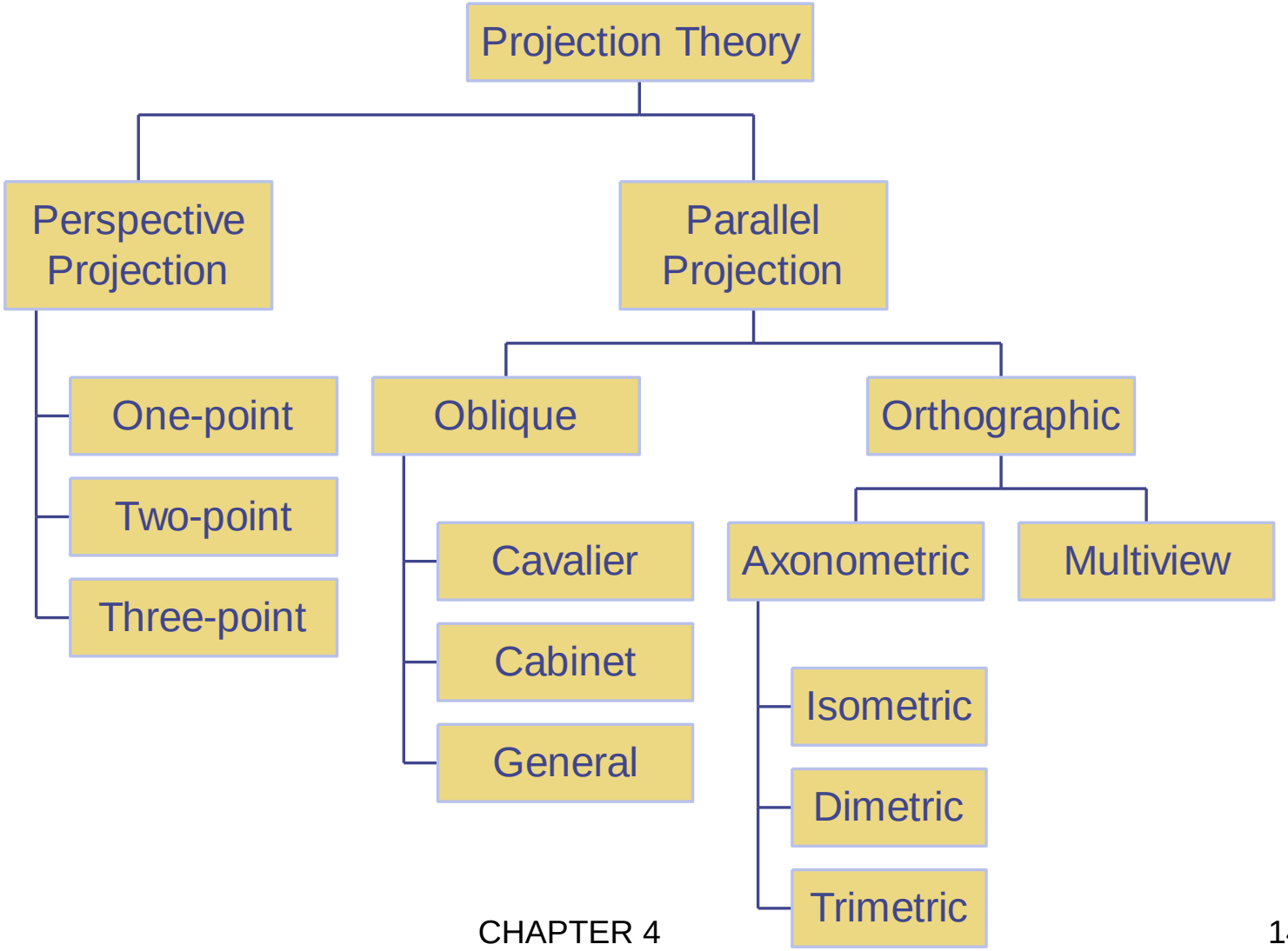
As shown in (Fig.4.3) the cube A can have only one orthographic projection; but it can have any number of oblique projections on the plane since any number of lines can be drawn through any point in the cube oblique to the plane.

Projective theory is the basis of background information necessary for shape representation. In engineering drawing, two fundamental methods of shape representation are used:

1-Orthographic projections,
2-Pictorial projections

In this section we will discuss only the orthographic projection

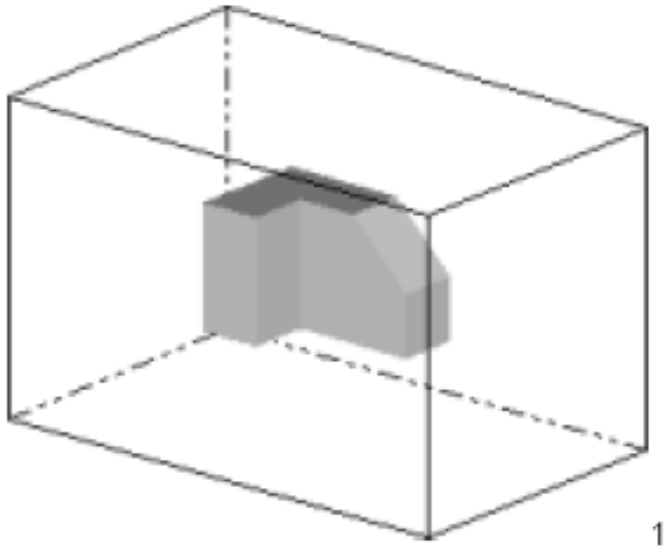
Classification of Projections



4.2. DEFINITION OF ORTHOGRAPHIC PROJECTION

Orthographic projection is the method of representing the exact shape of an object by dropping perpendiculars from two or more sides of the object to planes, generally at right angles to each other; collectively, the views on these planes describe the object completely.

Views may be thought of as being projected onto planes that form a transparent "box" around the object:



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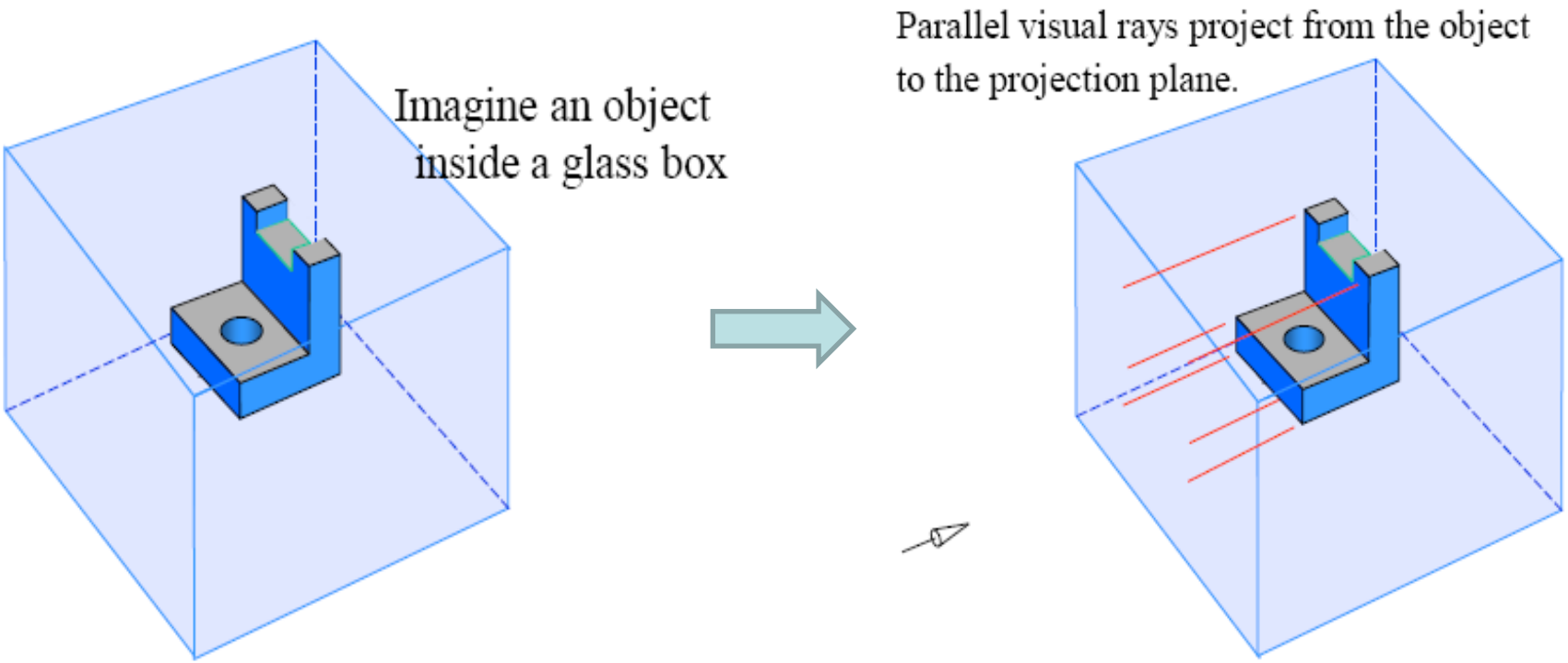
Glass-box approach

Place the object in a glass box

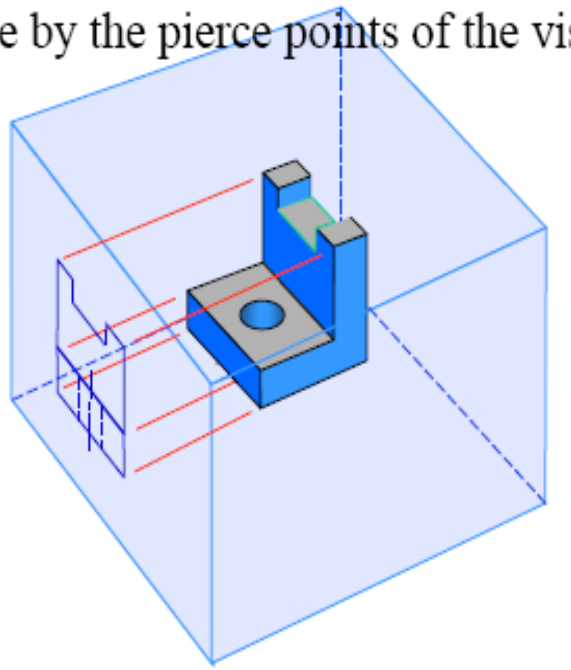
Glass-box approach is used for developing orthographic projection drawings



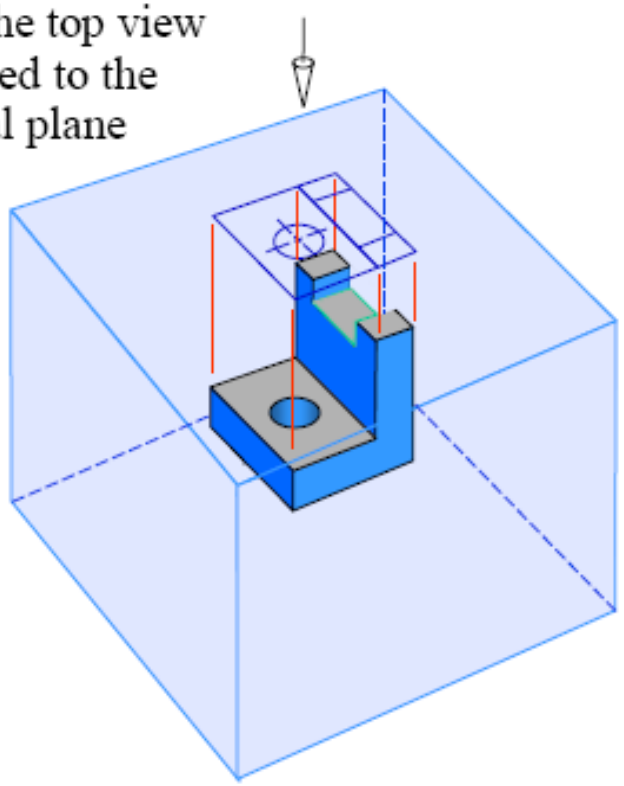
Project points on the front view of the glass-box

Glass-box approach

The object's image is formed on the projection plane by the pierce points of the visual rays.

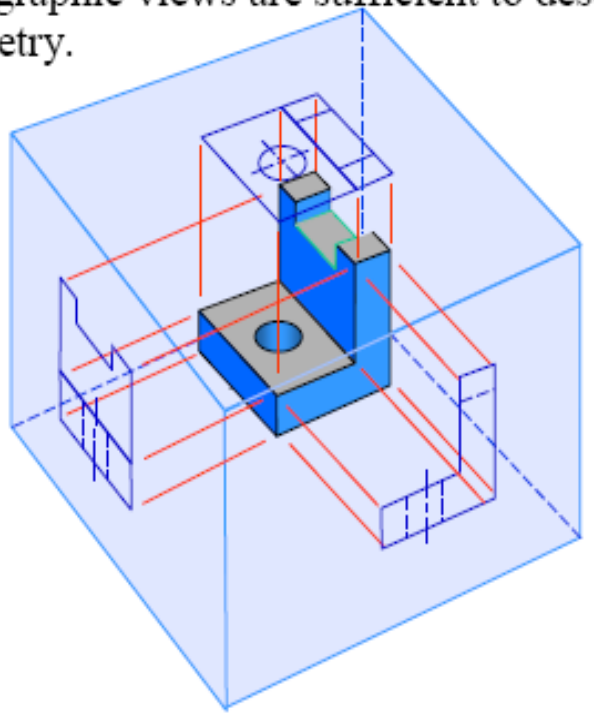


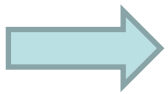
Similarly, the top view is projected to the horizontal plane

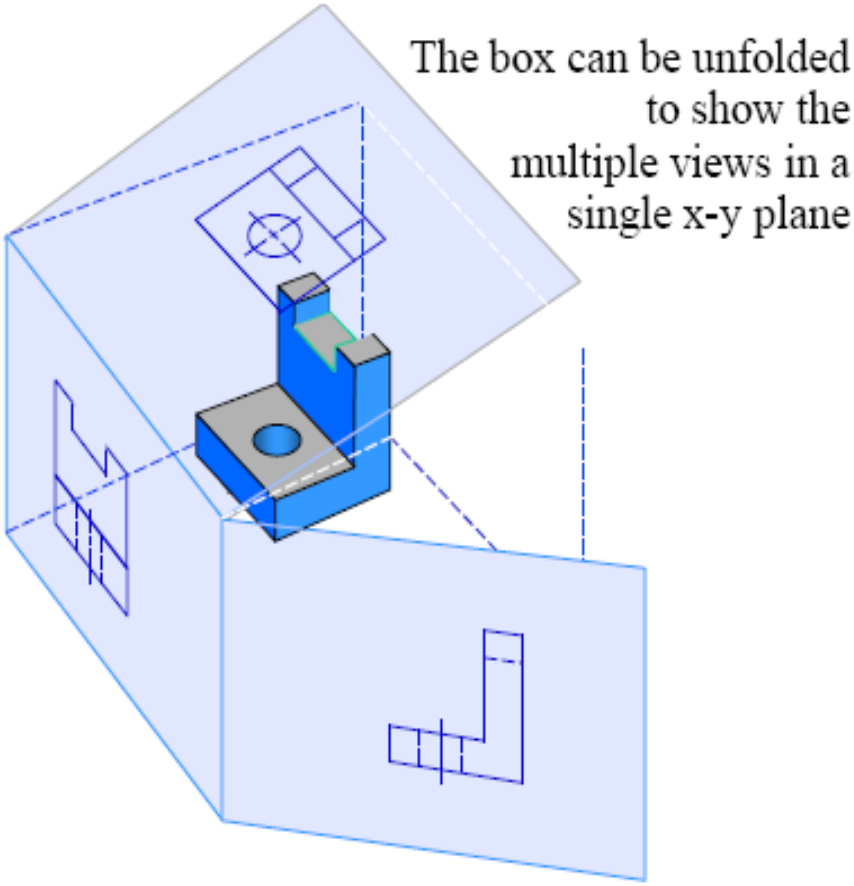


Glass-box approach

For many three-dimensional objects, two to three orthographic views are sufficient to describe their geometry.







The box can be unfolded to show the multiple views in a single x-y plane

4.3. MULTIVIEW PROJECTION

There are three principal planes of projection:

1. Horizontal,
2. Vertical and
3. Profile

as illustrated in Fig.4.4.

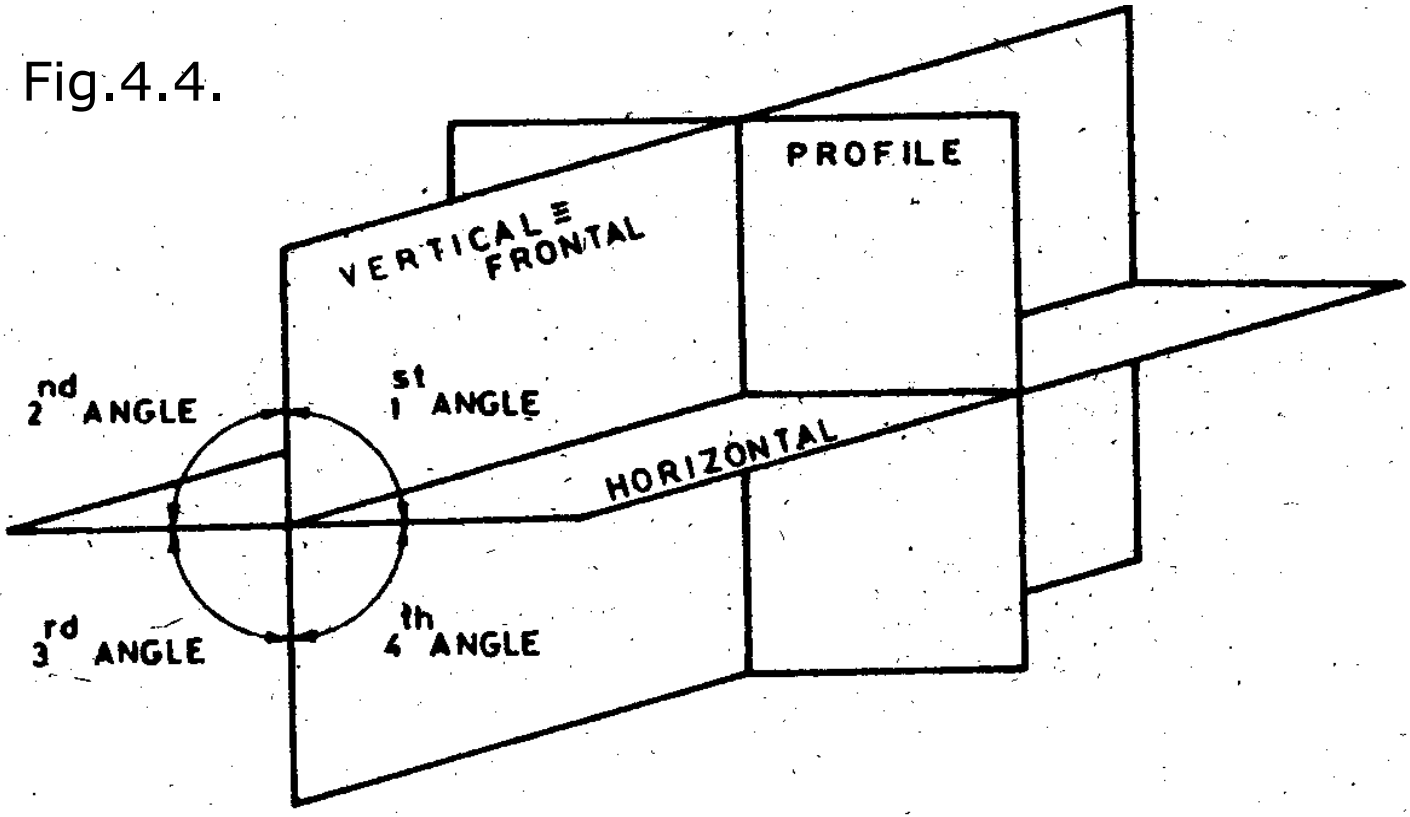


Fig.4.4. Three planes of projection

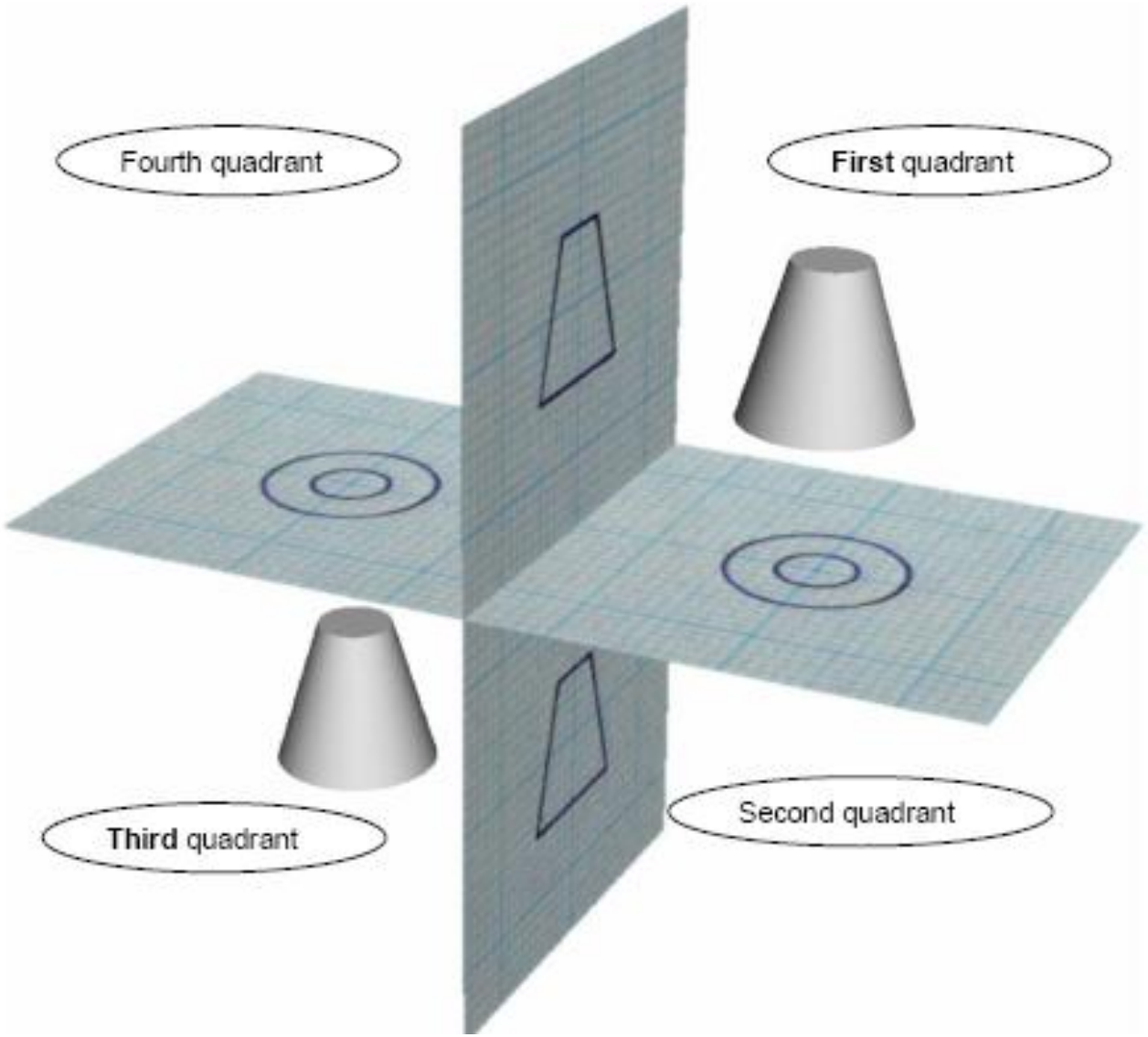
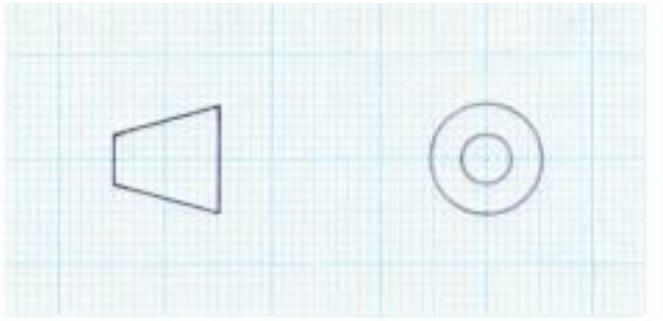


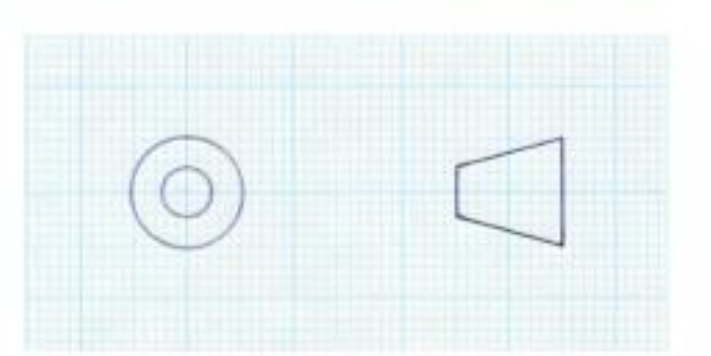
Fig.4.4. Three planes of projection

These planes intersect each other at right angles, forming the first, second, third and fourth angles or quadrants. Theoretically, an object can be projected in any one of the four angles. An object projected in any angle or quadrant so that. Its sides are parallel to the principal planes will show the object in its true size and shape. Remember that, the observer should view every object projected from a position in front of the vertical plane and above the horizontal plane as shown in Fig.4.5 and 4.6.

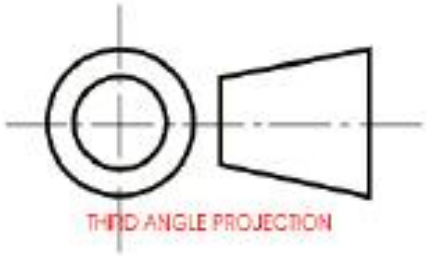
Technical people are concerned chiefly first angle and third angle projection. Third angle projection is used in America, England and some other countries First angle projection is used in Turkey and in the other countries those are using metric system.



First Angle projection.

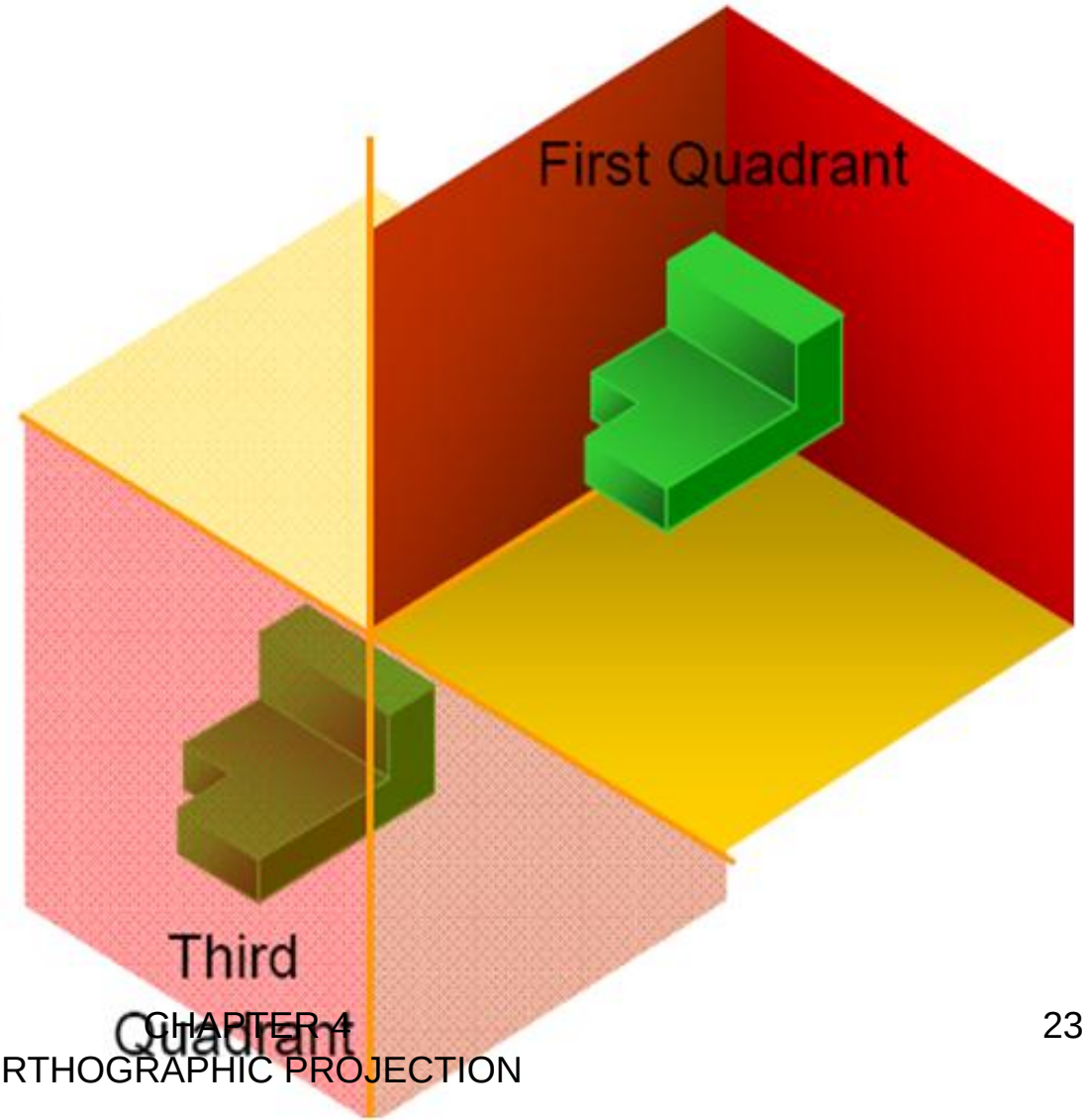


Third Angle projection.

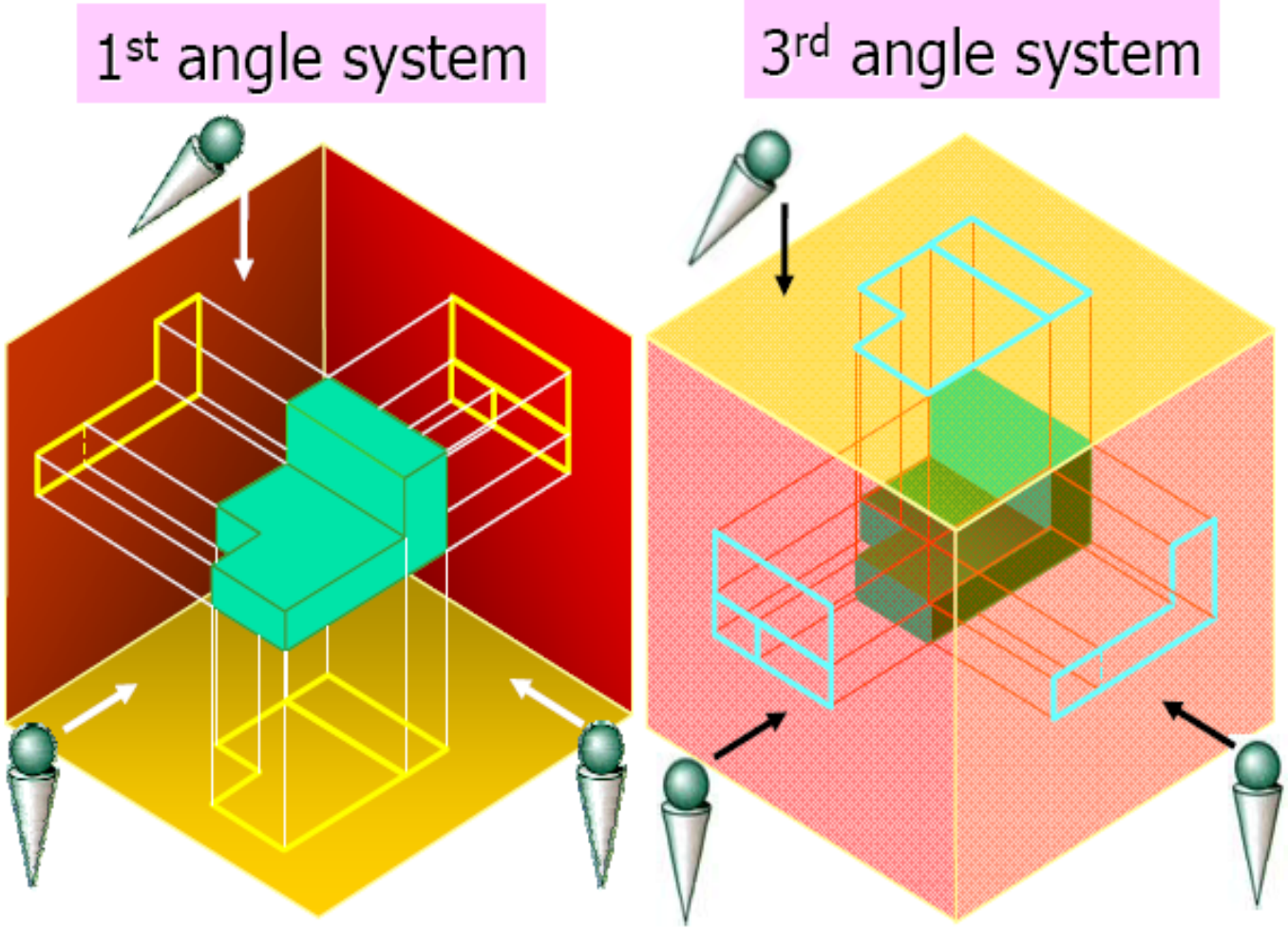


Projection Systems

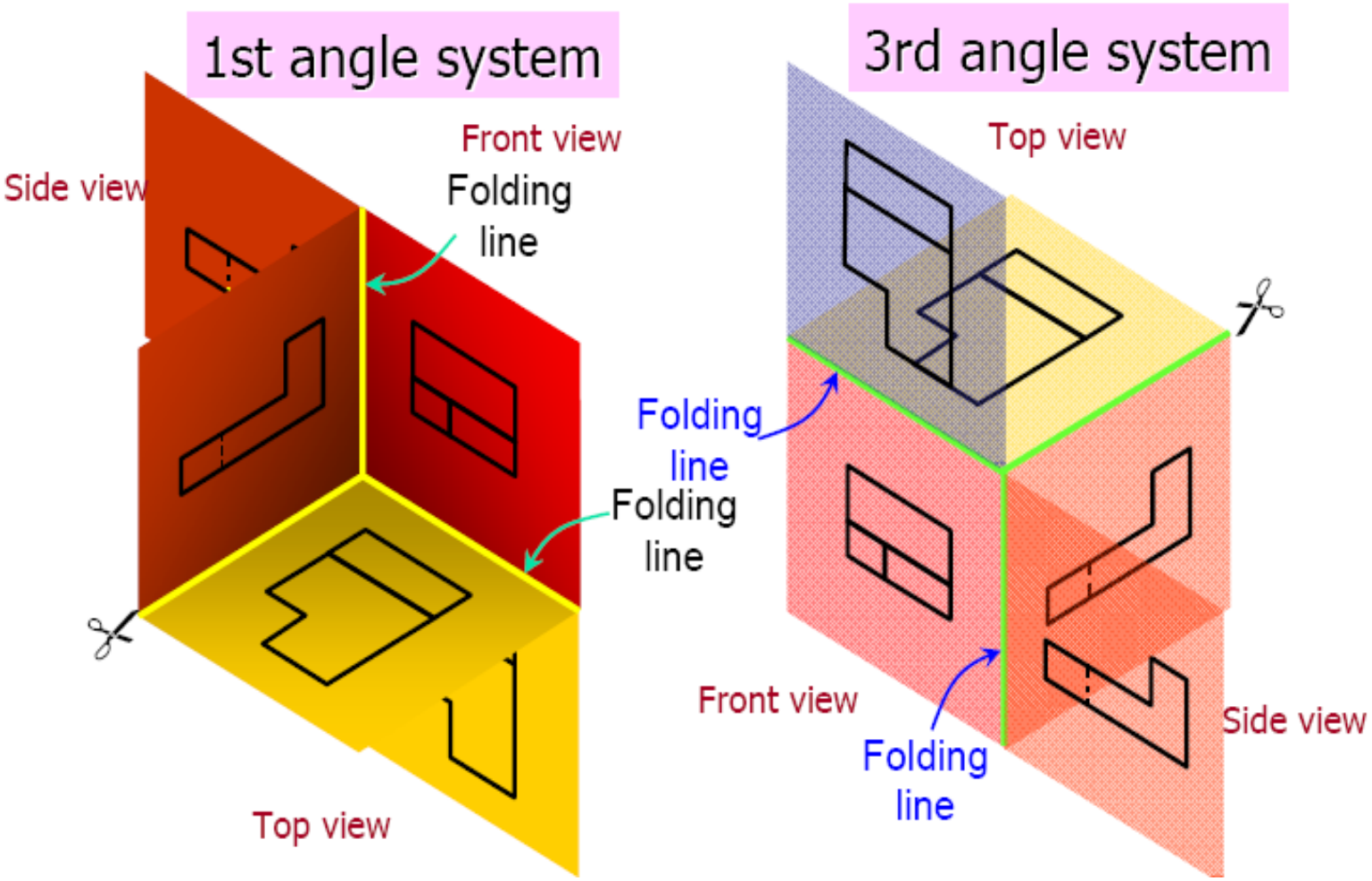
1. First angle system
   - European country
   - ISO standard
2. Third angle system
   - Canada, USA
   - Japan, Thailand



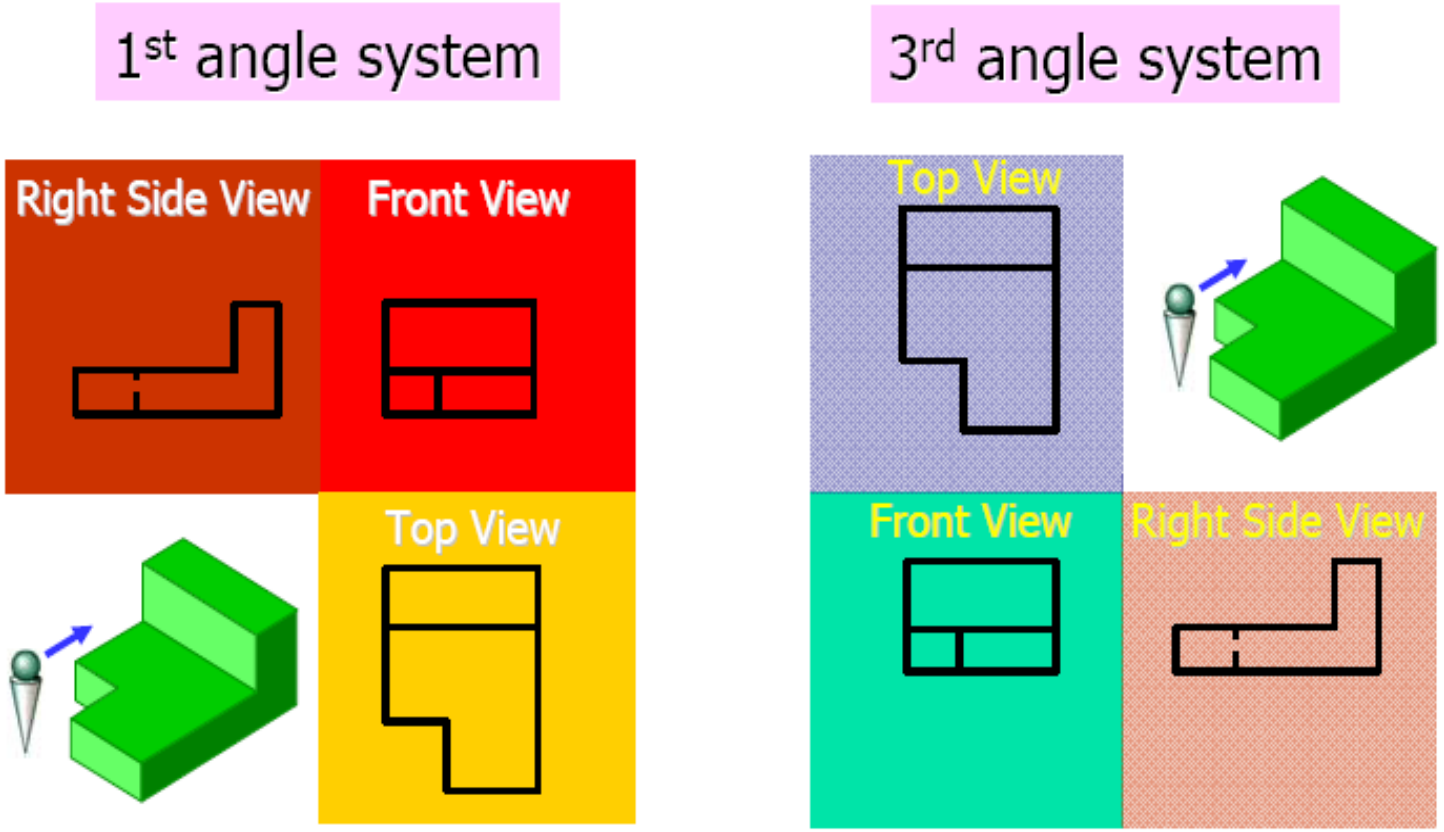
Projection Systems



Projection Systems

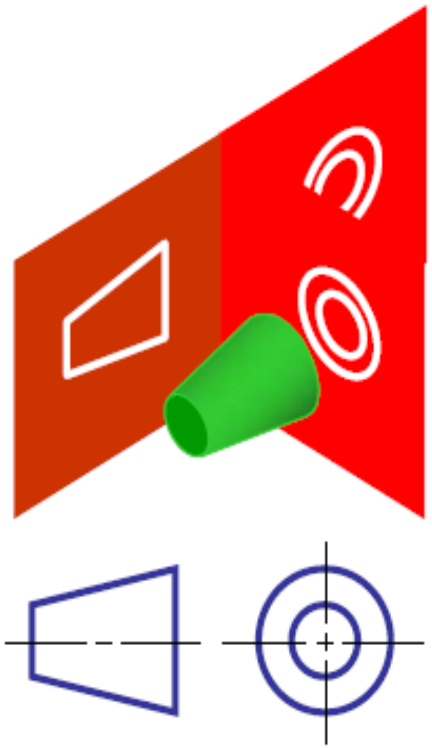


Projection Systems

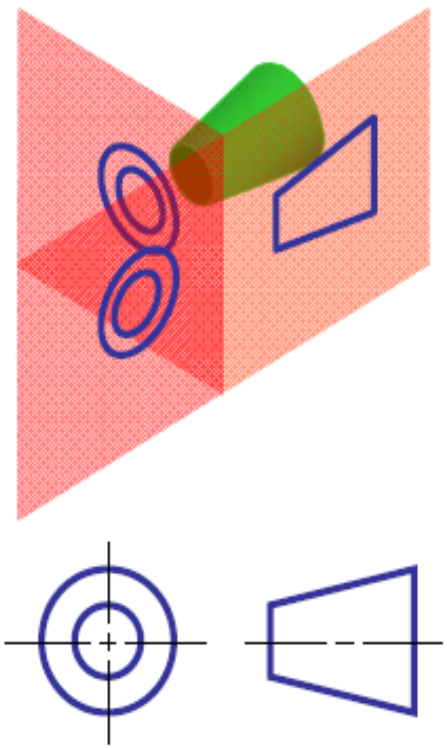


Projection System symbols

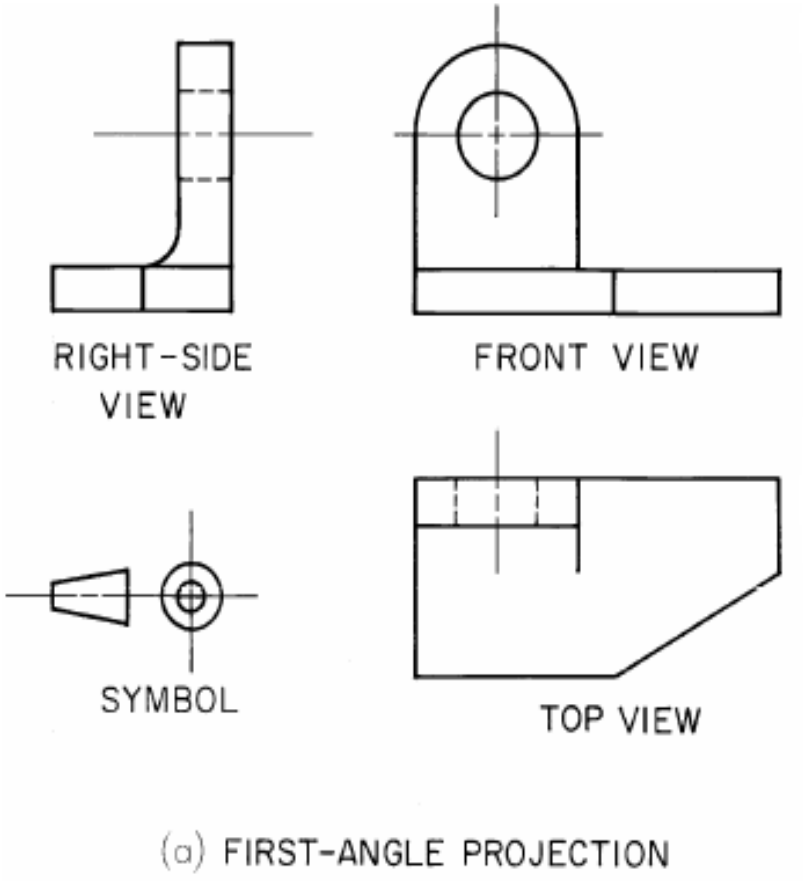
First angle system
ISO (1st-angle projection)

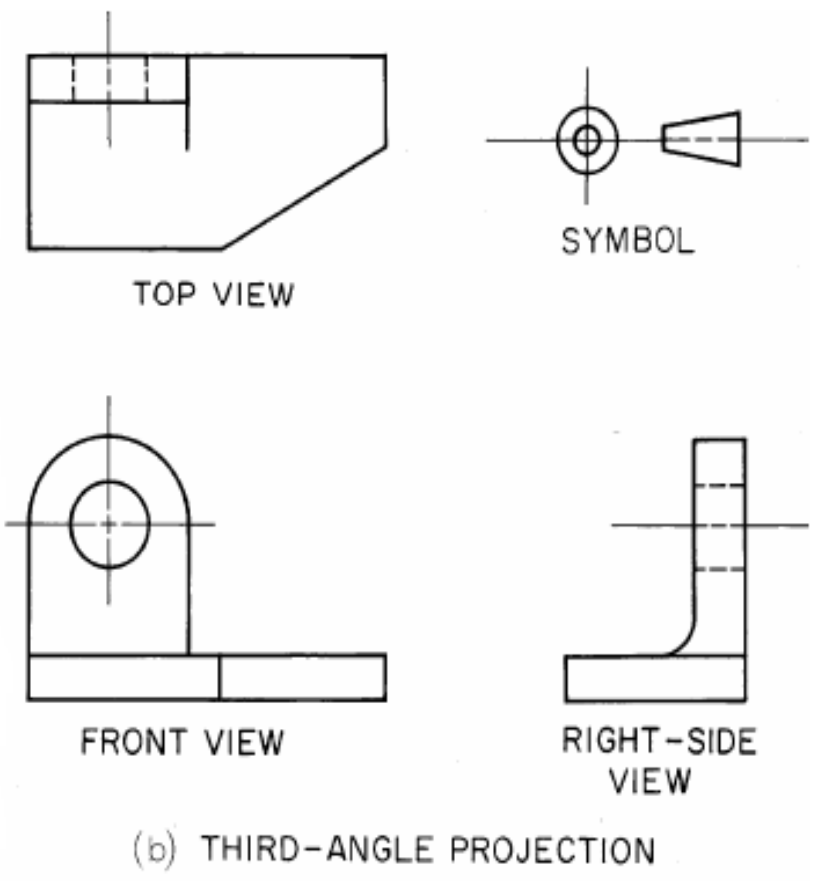


Third angle system
US (ANSI 3rd-angle projection)

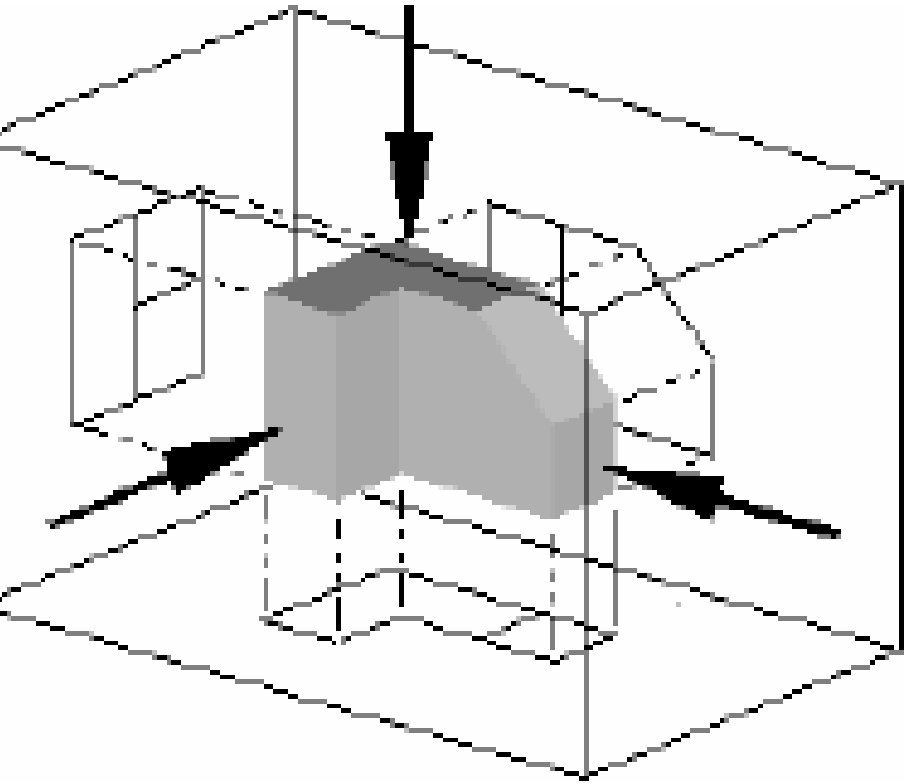


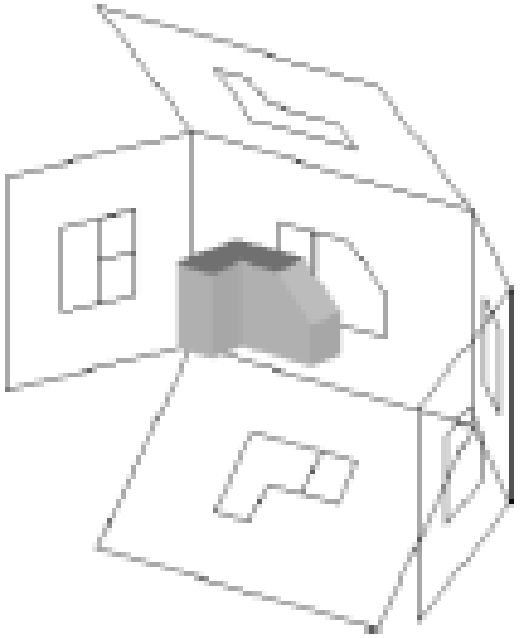
Projection Systems

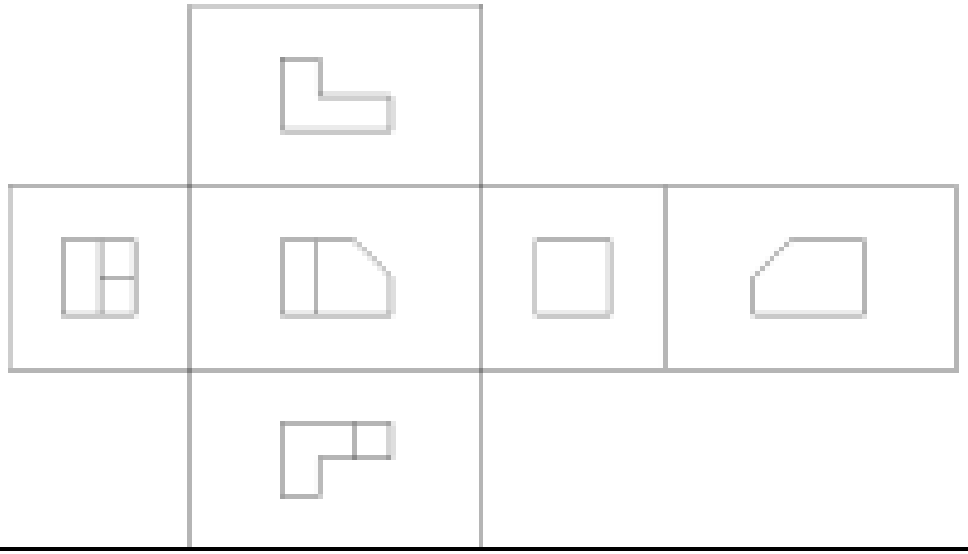


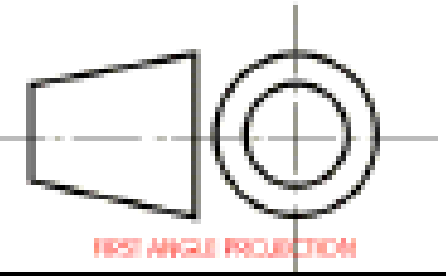


First angle projections









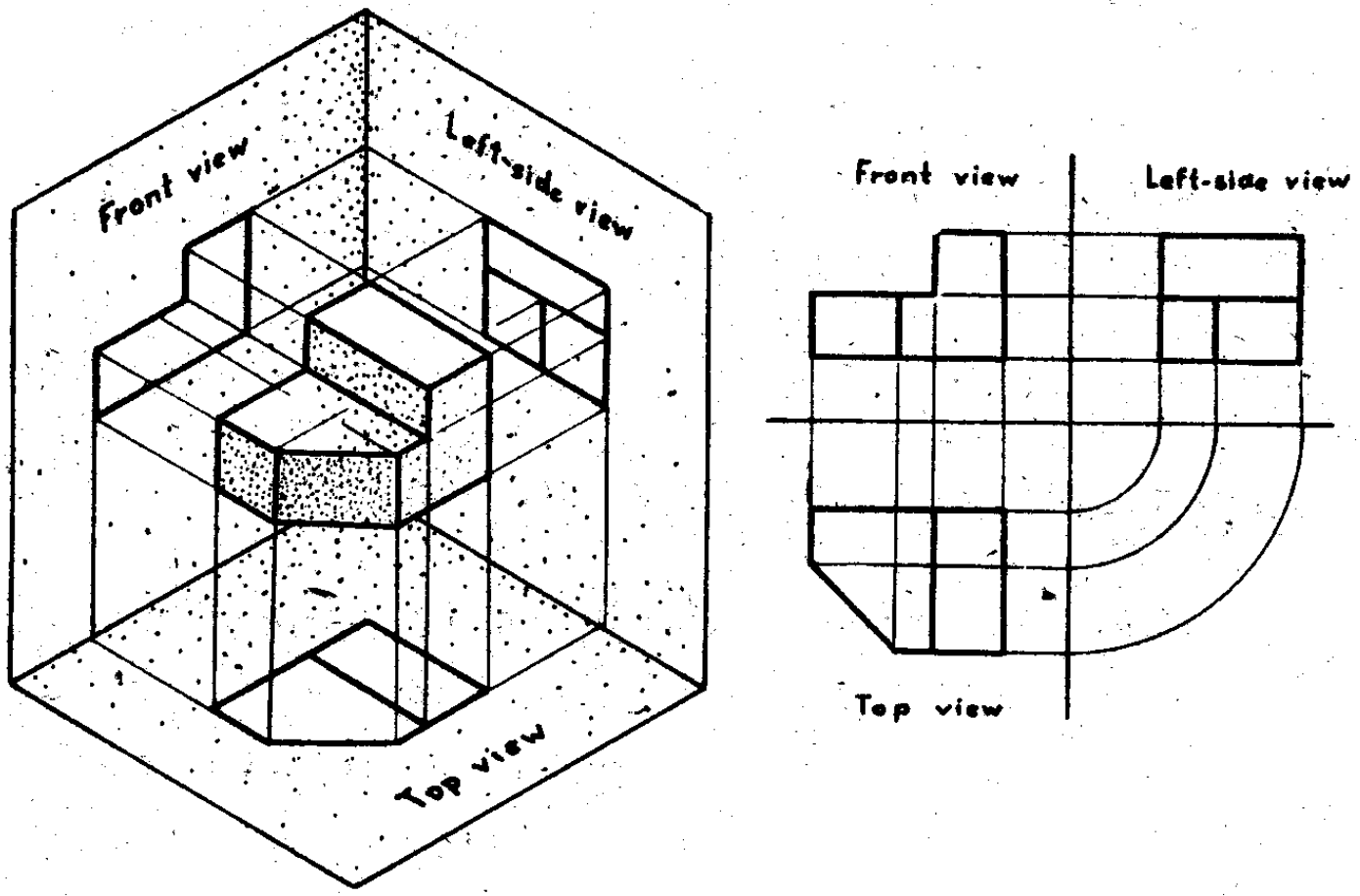
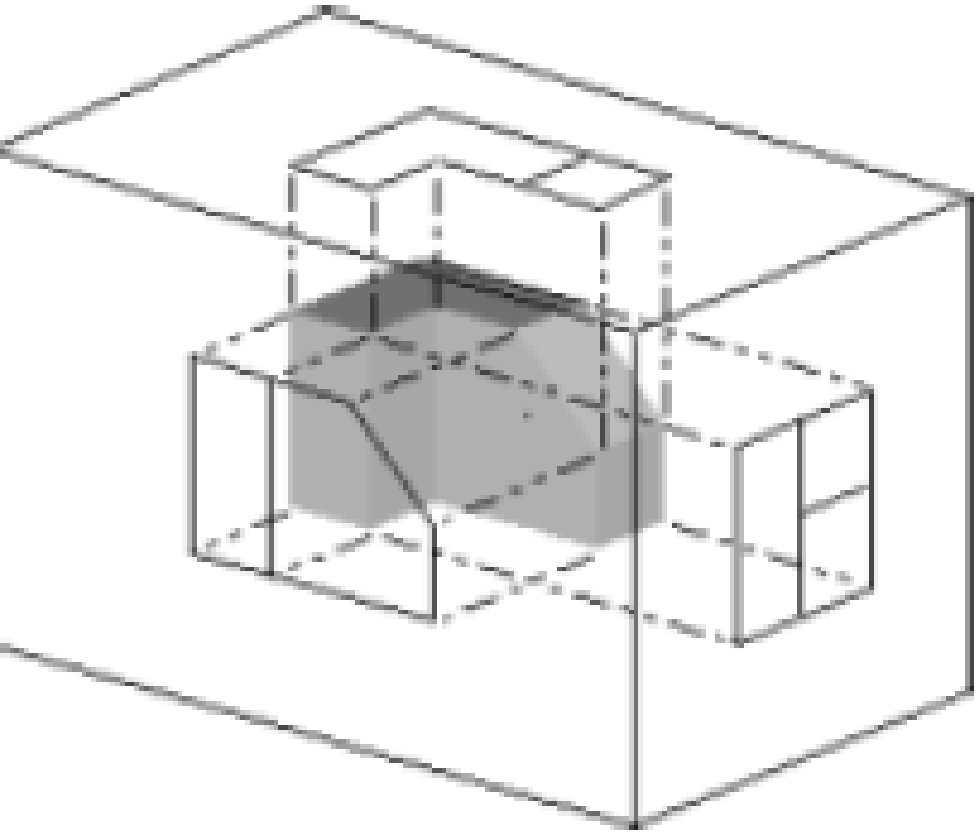
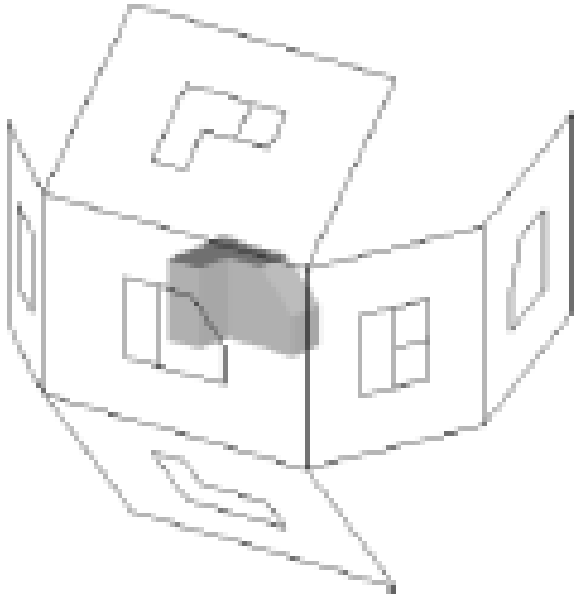
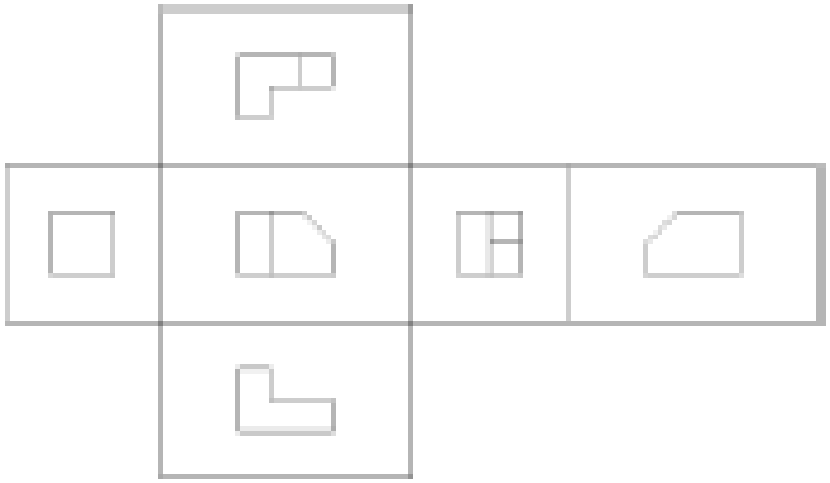


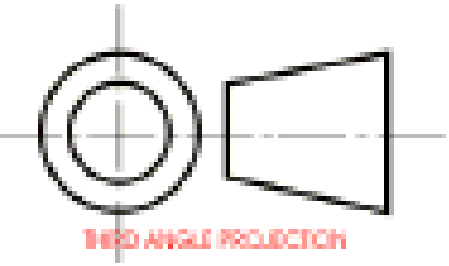
Fig.4.5. First-angle projection

Third angle projections

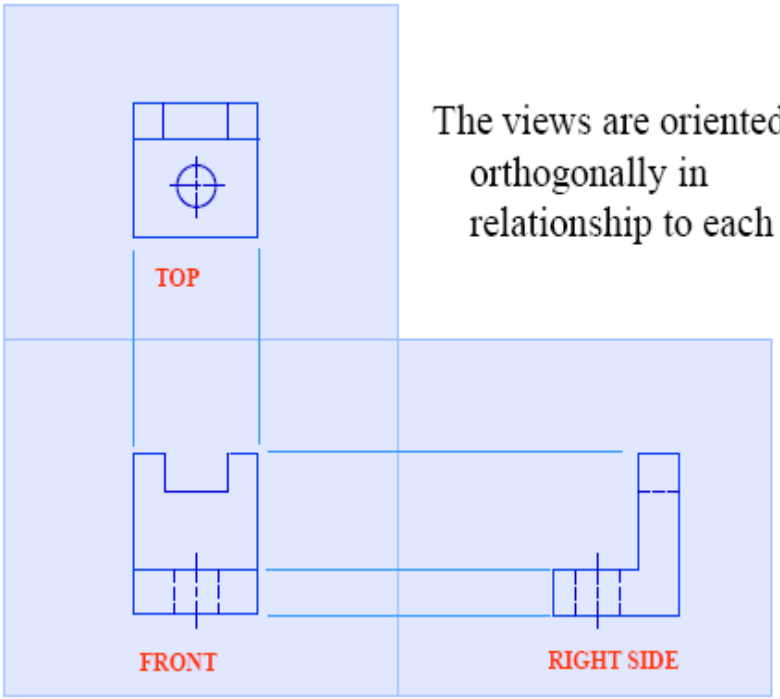




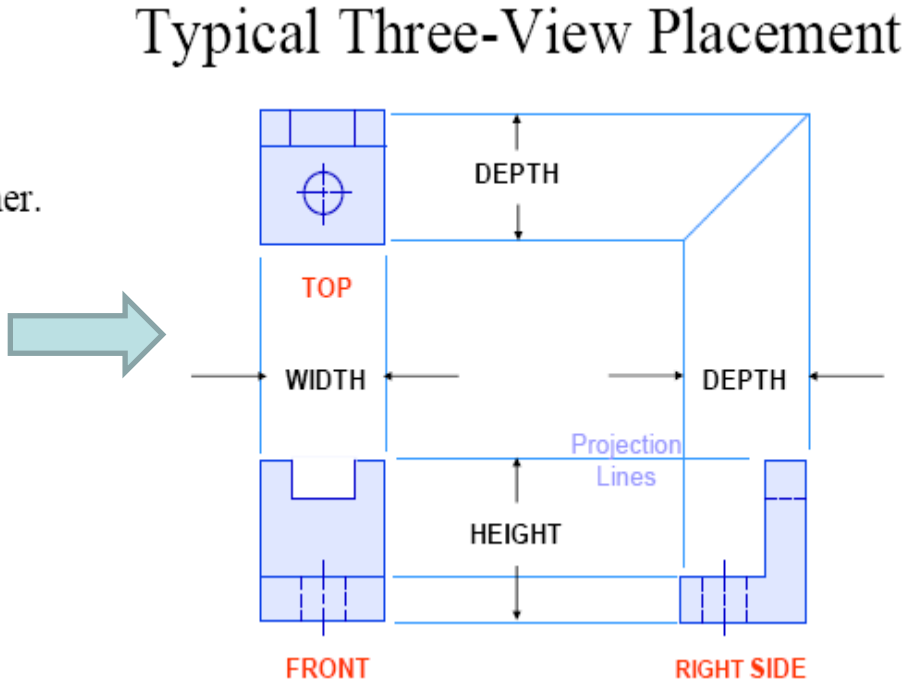




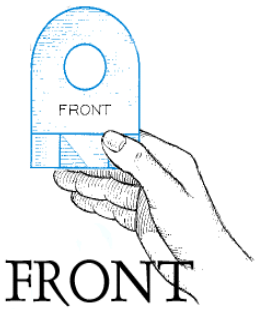
Glass-box approach

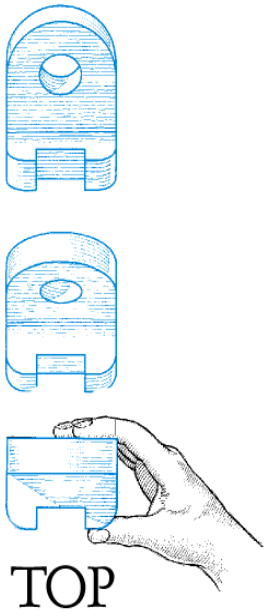


The views are oriented orthogonally in relationship to each other.

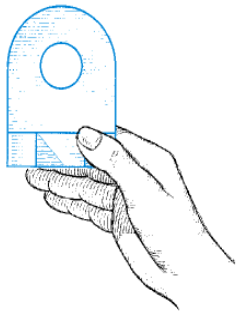


Multi-view

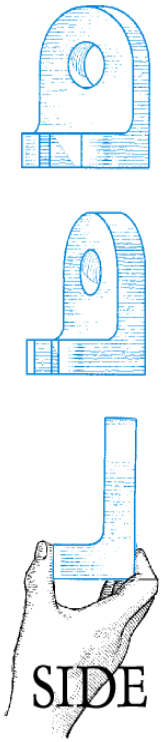




Rotate 90 degrees “up” to get top view



Rotate Back



Rotate 90 degrees clockwise to get right side

FRONT view is the most descriptive view of the object. The view that gives more information about the object.

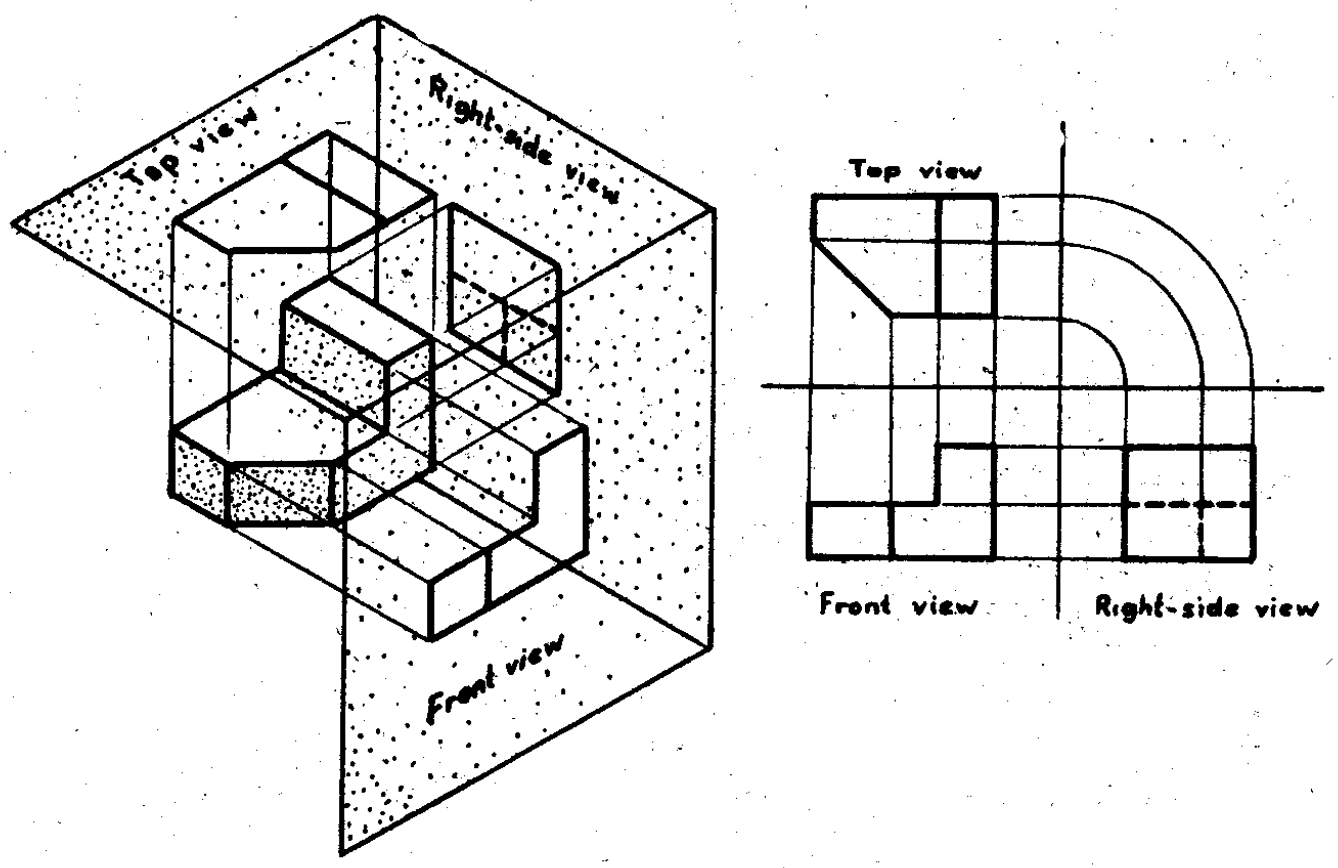


Fig.4.6. Third-angle projection

4.4. FIRST-ANGLE PROJECTION

If the object is situated so that its front and back faces are parallel to the vertical plane of projection, and its top and bottom faces parallel to the horizontal plane, the side face also be parallel to the profile plane, and the faces will be shown in their true forms and sizes in their respective projections. These projections are known respectively in technical drawing as front, top and side views of the object Fig.4.7.

Having determined the three views of the object on the respective planes situated at right angles to each other as shown in (Fig.4.7a), the next step in the representation of the object is to revolve two of the panes into the third plane, so that the three views of the object may be shown on one plane as is necessary when the views are to be drawn on a sheet of paper as shown in (Fig.4.7b). It should be noted that the top view is directly below the front view and, the left side view is to the right of the front view. This system allows three-dimensional objects to be represented by means of related, two-dimensional views in a manner, which is developed in this chapter.

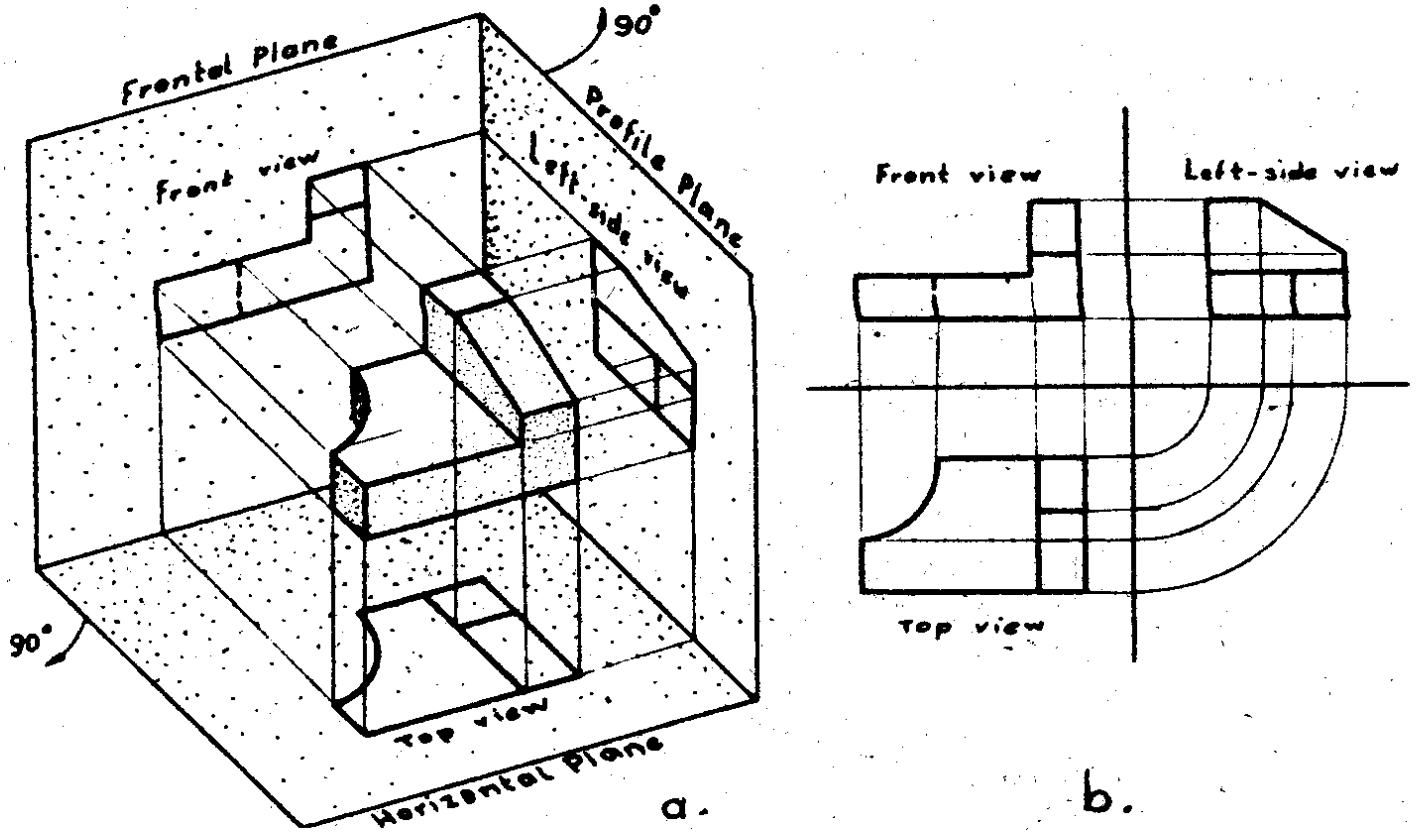


Fig.4.7. First-angle projection and-revolved position of planes

4.5. THIRD ANGLE PROJECTION

If the object in third angle (Fig.4.8) with is faces parallel, respectively, to the planes of projection, the front, top and side faces of the object will be shown in their true forms and sizes in the respective views. The horizontal and profile planes are in the conventional direction as shown by arrows till coincide with the vertical plane and the three views of the object will appear as shown in Fig.4.9.

It should be noted that the top view, in this case, is directly above the front view, and the right side view is directly to the right of the front view.

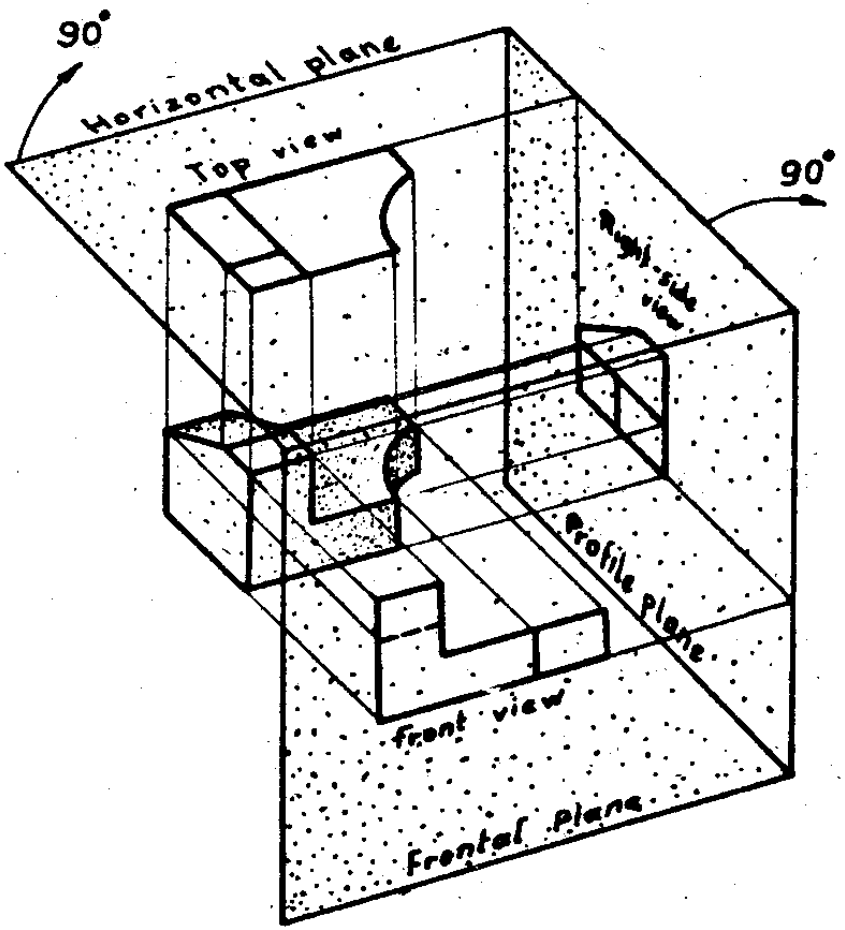


Fig.4.8.Third-angle projection

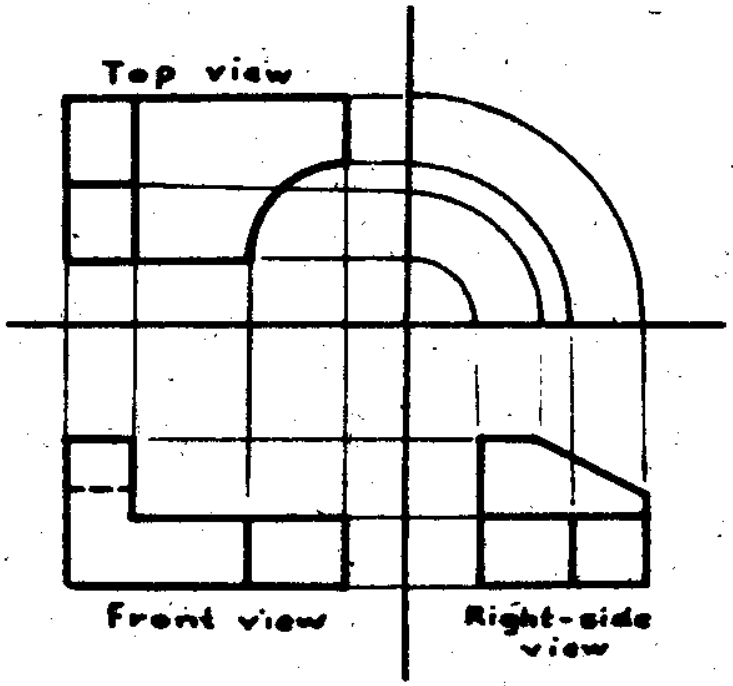


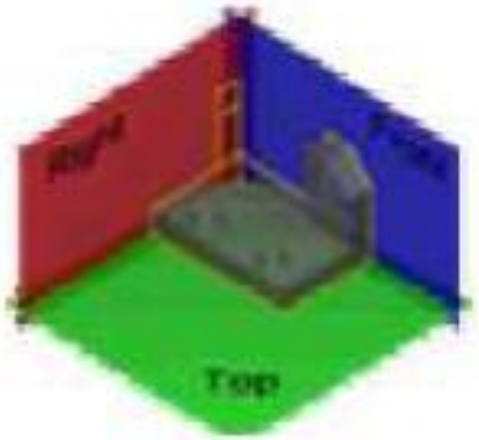
Fig.4.9. Revolved position-of planes in third-angle projection

Difference between First and Third angle projections

- They differ only in the position of the plan, front and side views
- First Angle – Eye>Object>Image
- Third Angle – Eye>Image>Object

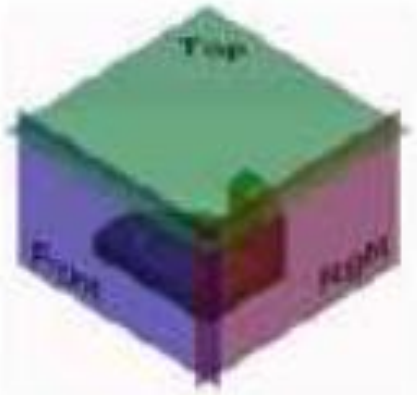
First Angle Projection

– **Object between Plane and Viewer**



Third Angle Projection

– **Viewing Plane between Object and Viewer**



4.6. THE SIX PRINCIPAL VIEWS

Some objects can not be fully represented through the three views mentioned before, but require separate views projected from each side. The system of orthographic projection permits six principal views of a given object to be drawn. (Fig.4.10) Suggests how an imaginary box formed by the six principal planes is opened to form one common plane- as shown in (Fig.4.11).

It should be observed that the top and bottom planes are both horizontal planes, the front and rear views are both frontal planes, the left and right side views are both profile planes. In actual work, there is rarely an occasion when all six principal views are needed on one drawing. But no matter how many are required to give full shape description of the object. Their positions relative to one another should be as in (Fig.4.11). All these six views are principal views. Each of the six views shows two of three dimensions of Height, Width, and Depth

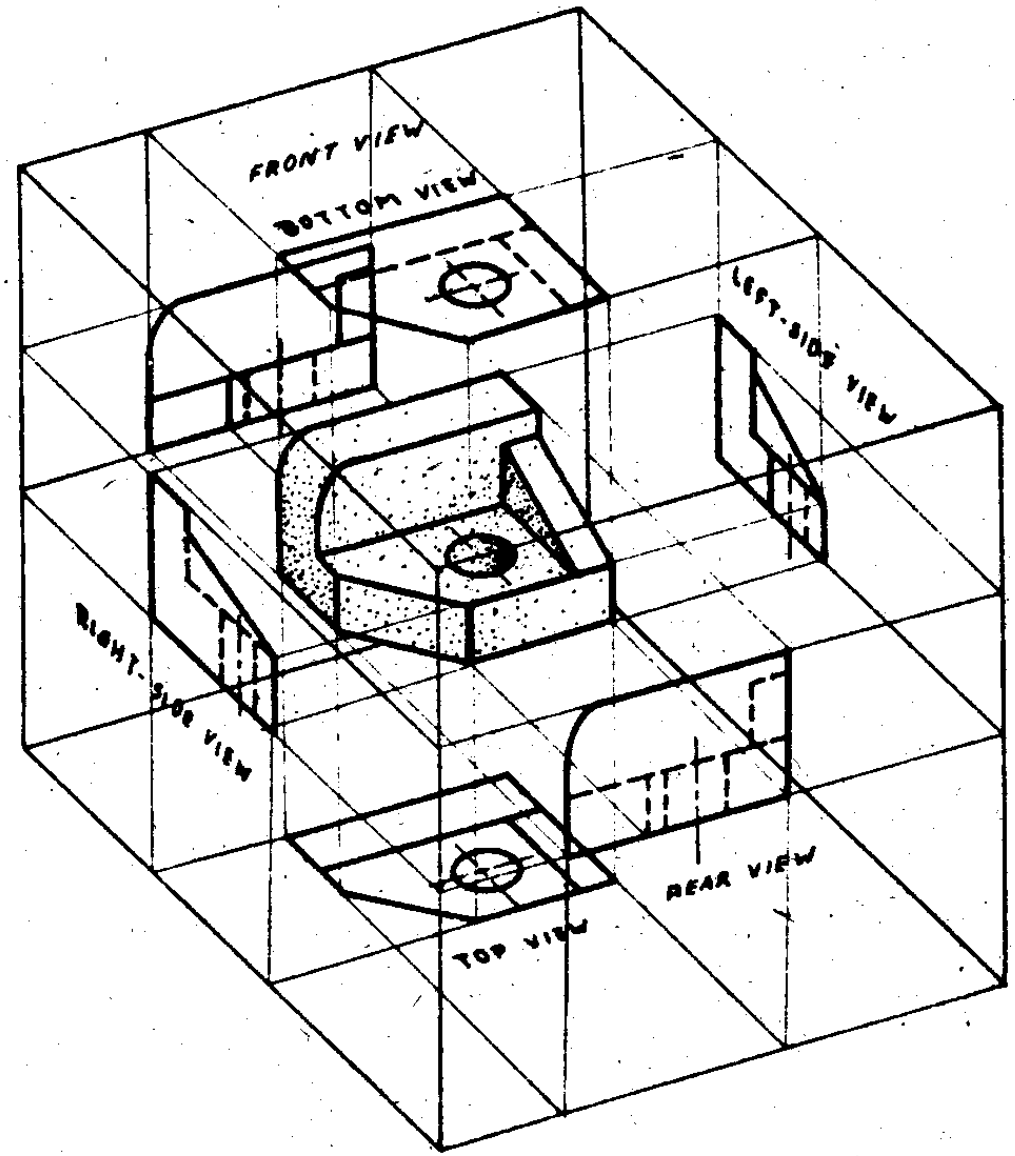


Fig.4.10.The six projection planes enclose the object. This box can be opened into a single plane to give six principal views of an object

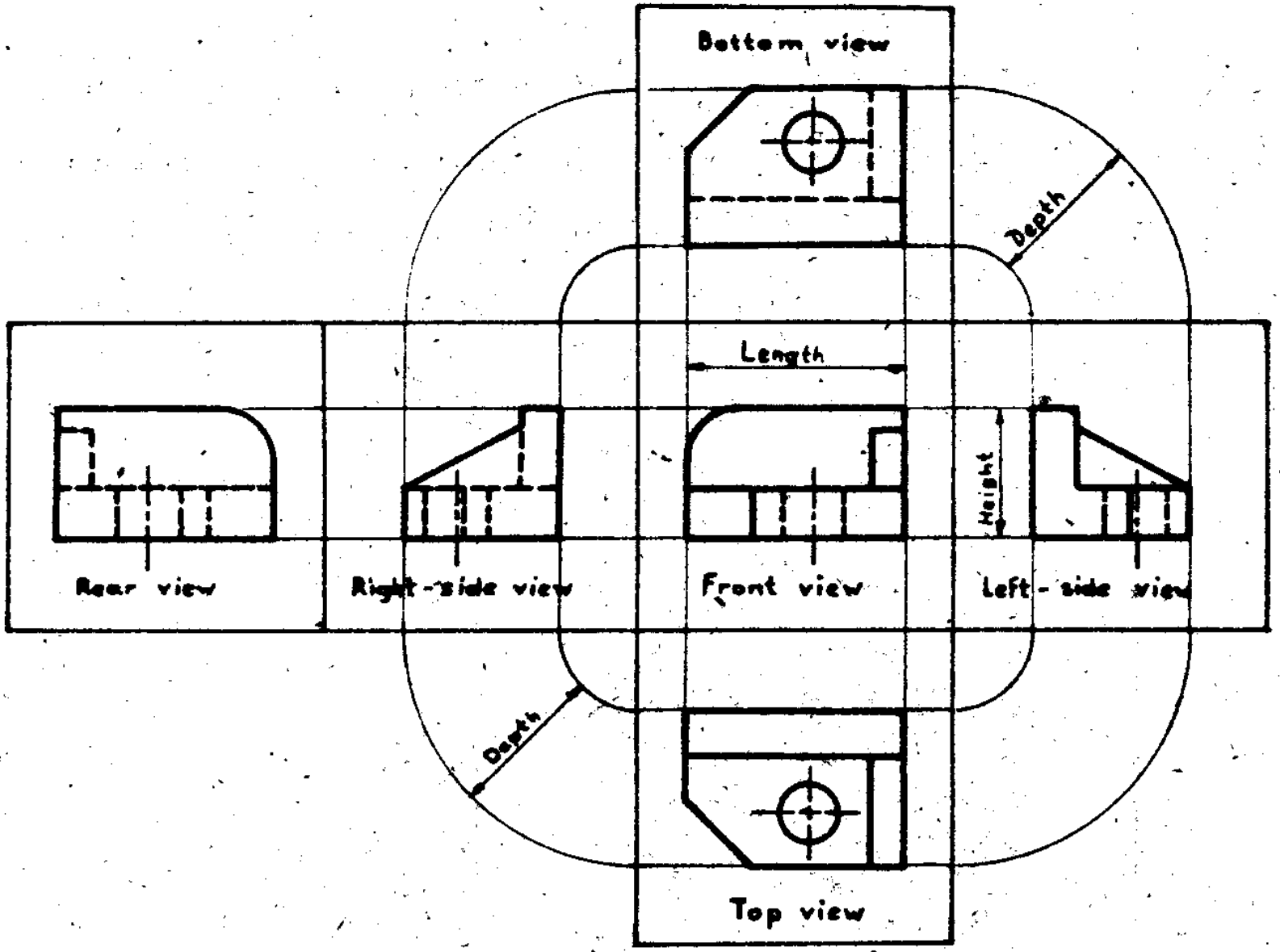
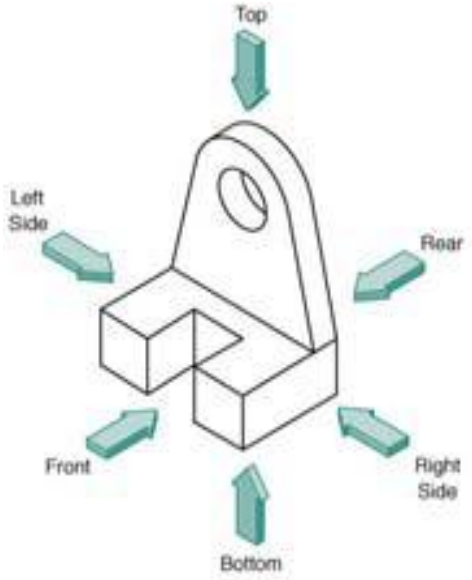


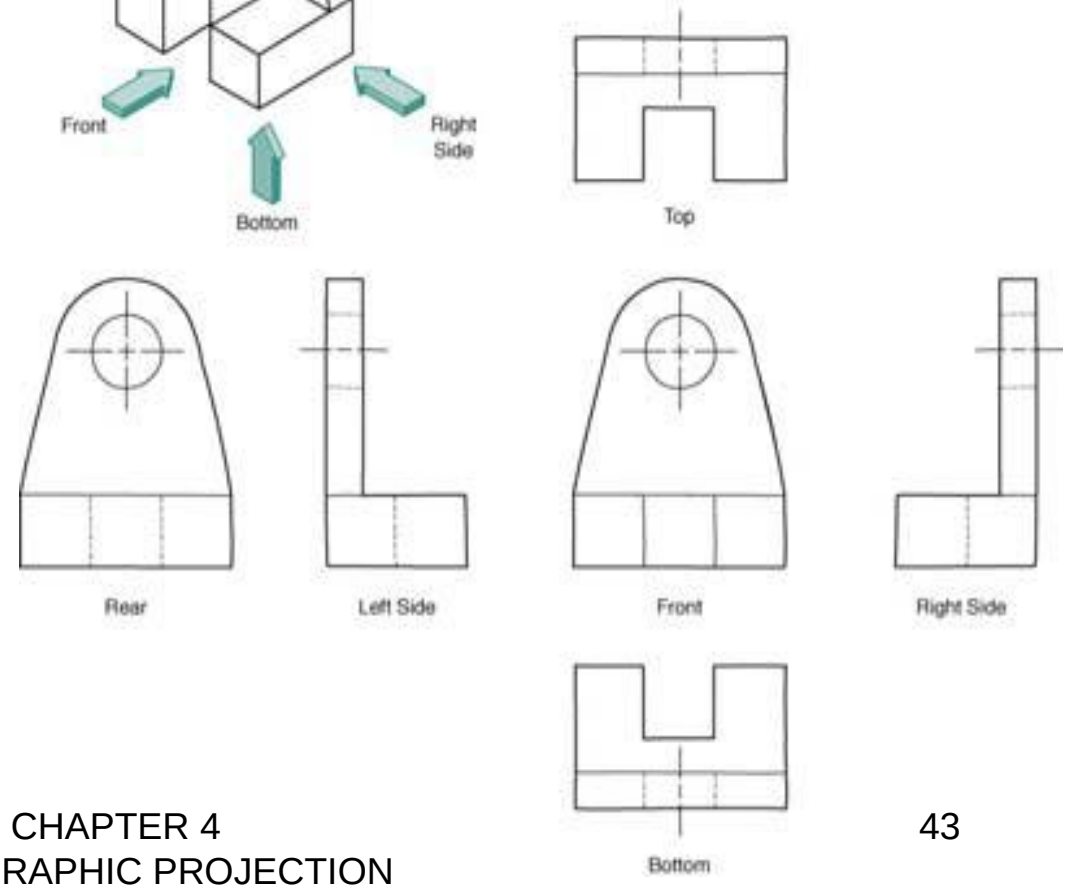
Fig.4.11. The relative positions of the six views. Study this figure carefully

Six principal views

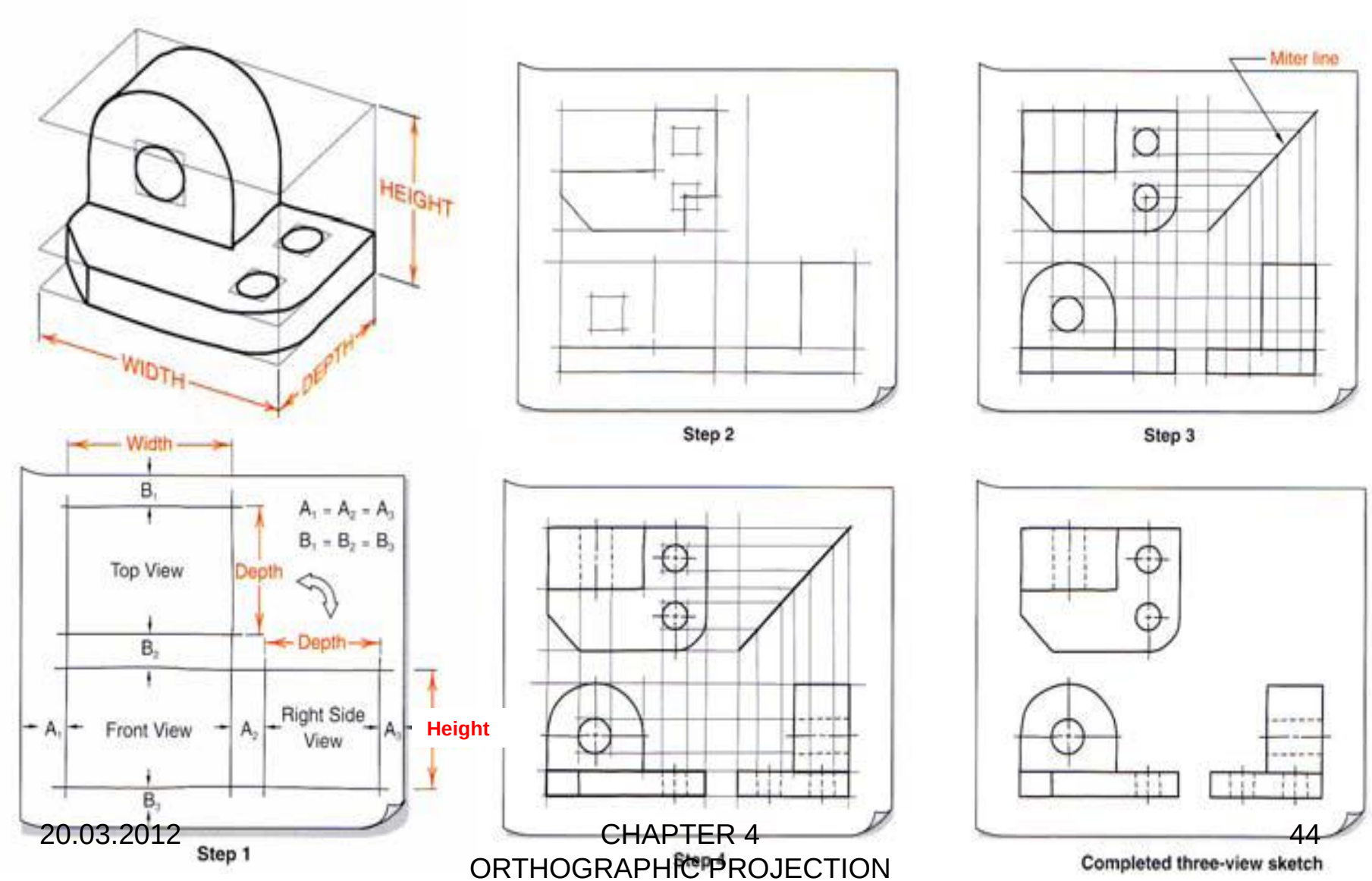
- Generally do not need all six to fully describe the object.

- A conventional Engineering Drawing will normally have 2 to 3 views unless it required more views to describe the geometry/ profile.



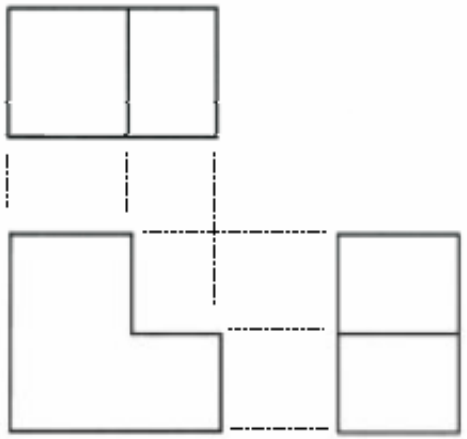


Conventional Orthographic Views

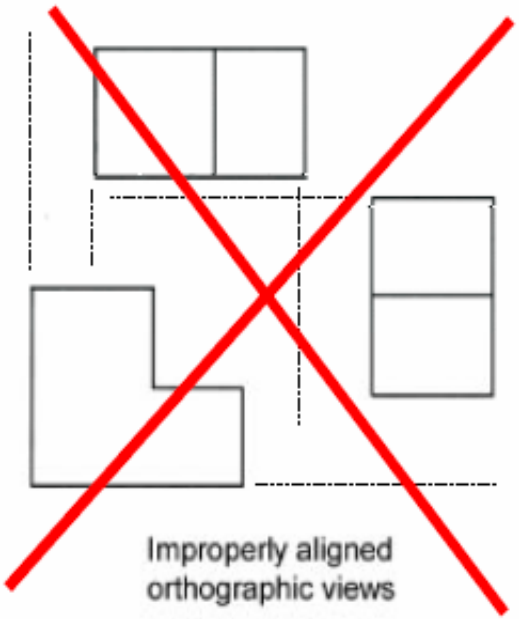


Conventional Orthographic Views

Align views with each other (features project from one view to the next)



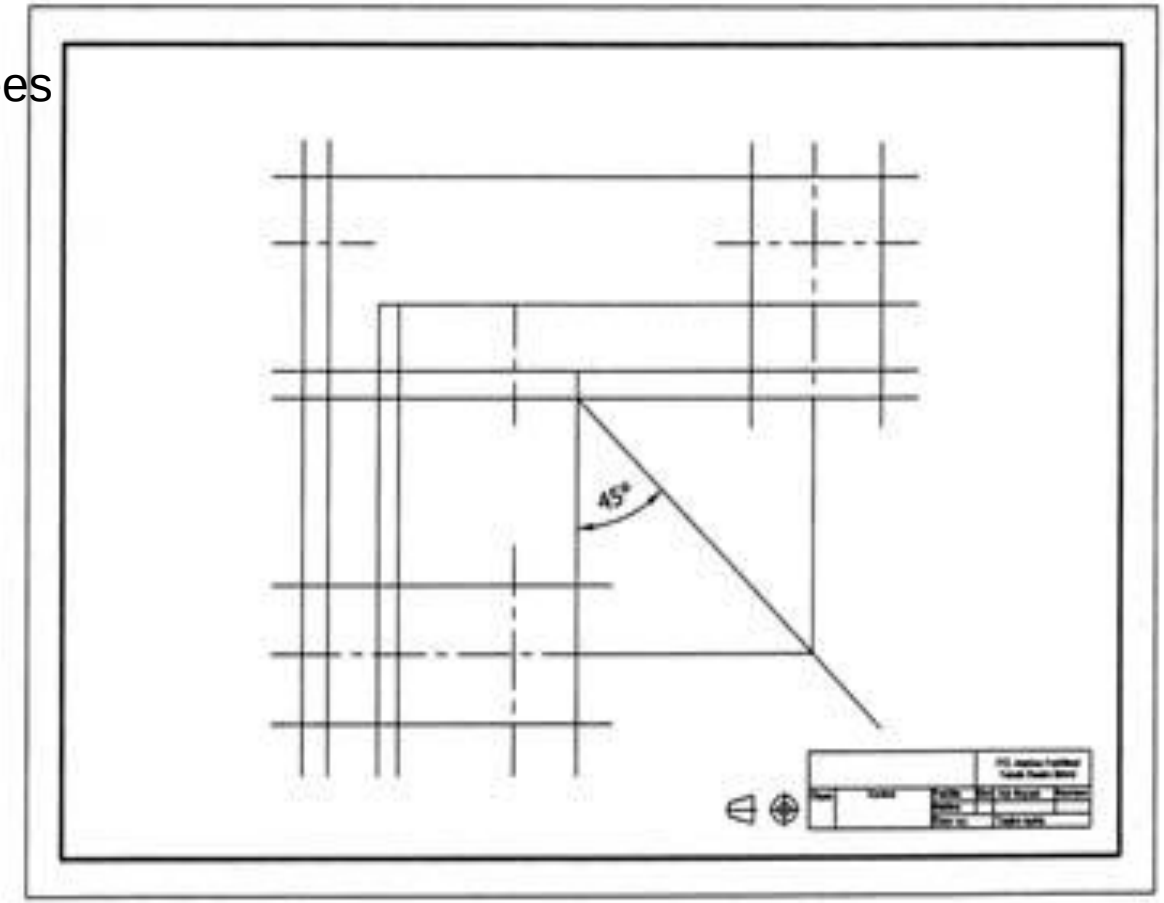
Properly aligned orthographic views



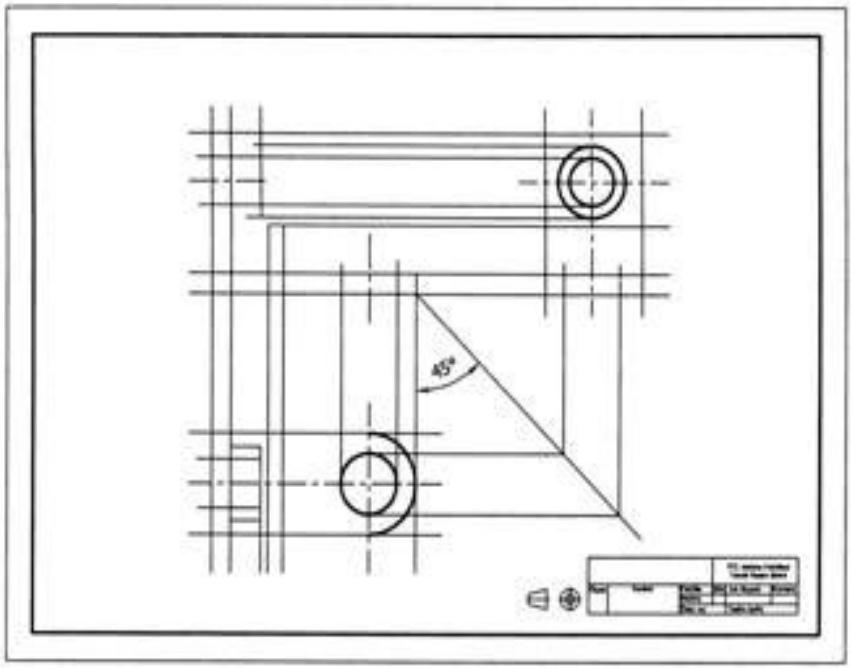
Improperly aligned orthographic views

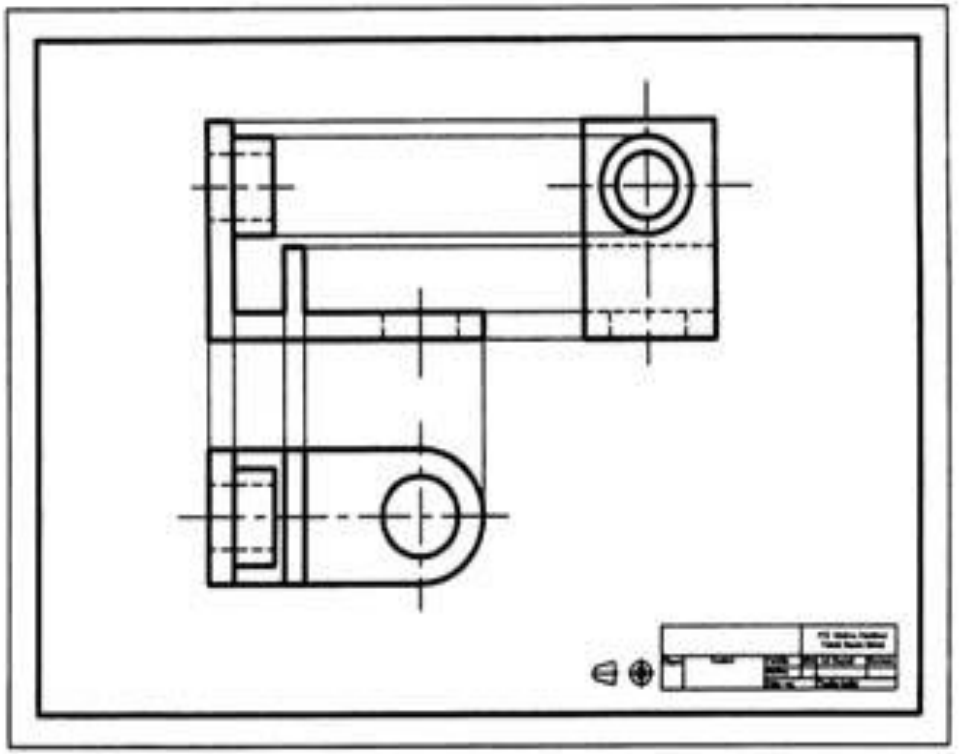
Transferring dimensions

Draw a miter line at 45 degrees at a convenient distance to produce the desired view.



Transferring dimensions





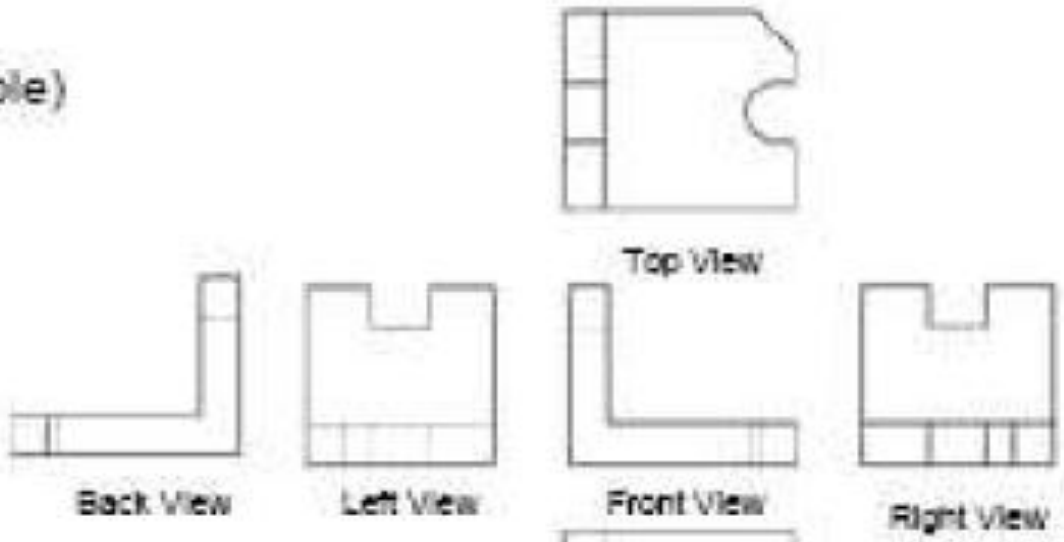
Sketch light lines projecting depth locations for points to miter line and then up into side view as shown.

4.7. COMBINATION OF VIEWS

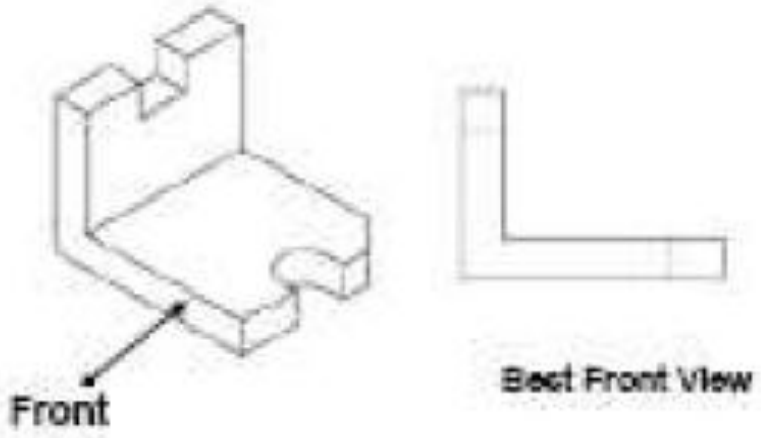
The most usual combination selected from the six possible views consists of the top, Front and left side views as shown in fig.4.12. In each case the best shape description of the object is necessary. For this reason sometimes we can select different combination of views. They can be only two views such as front and top or front and a side view, three views such as front, top and left-side views (Fig.4.13).

Which is the best front view

- Most natural position (most stable)
- Least hidden lines
- Best shape description
- Longest dimensions



Multi-view Orientation



FRONT view is the most descriptive view of the object.
The view that gives more information about the object.

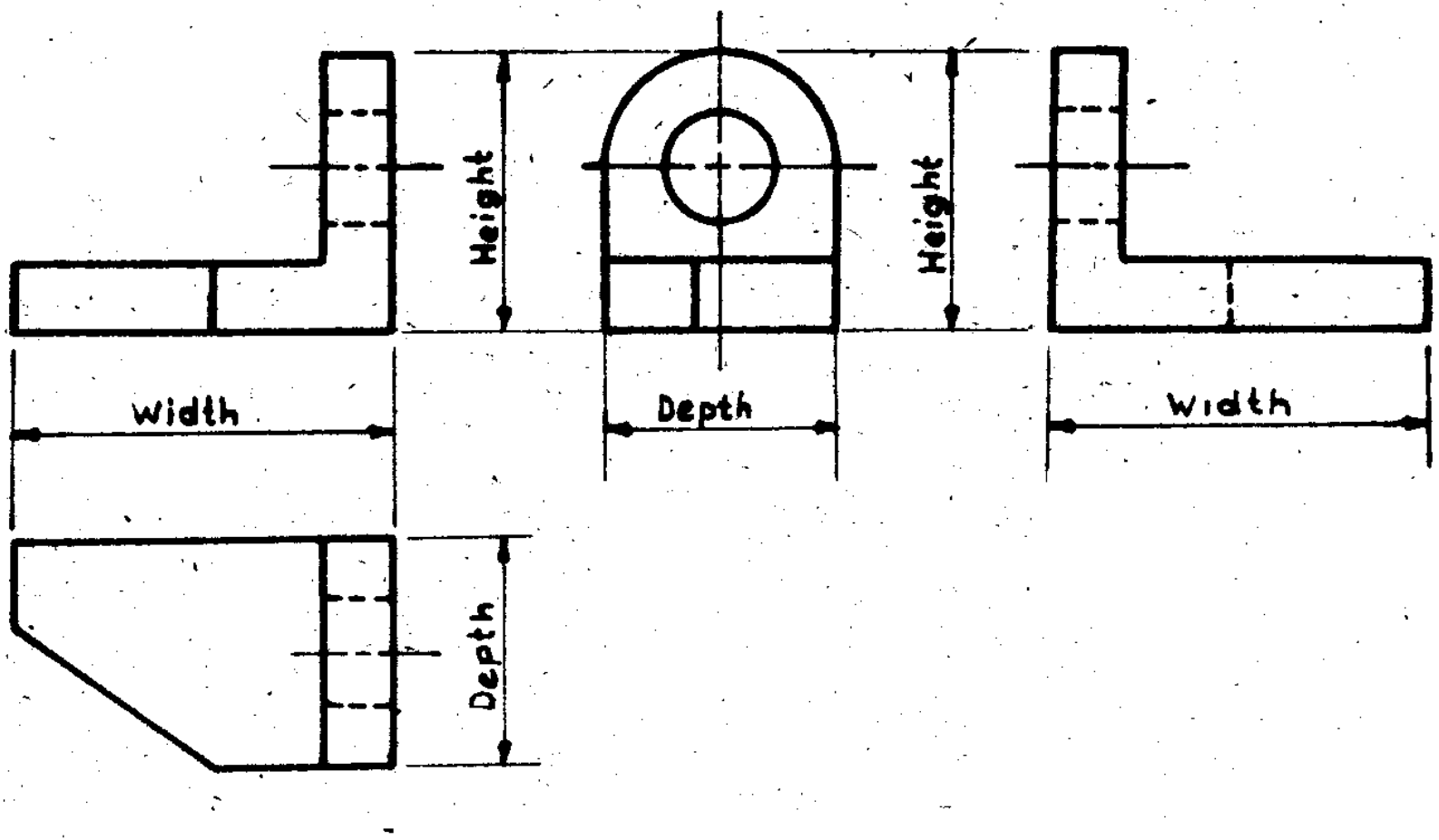


Fig. 4. 12. Top, front and left side views. This is the most common combination. Note that the top view is directly blow and in projection with the front view. The left-side view is to the right of and in the projection with the front view. Observe also that two (remember which to) space dimension are represented in each view

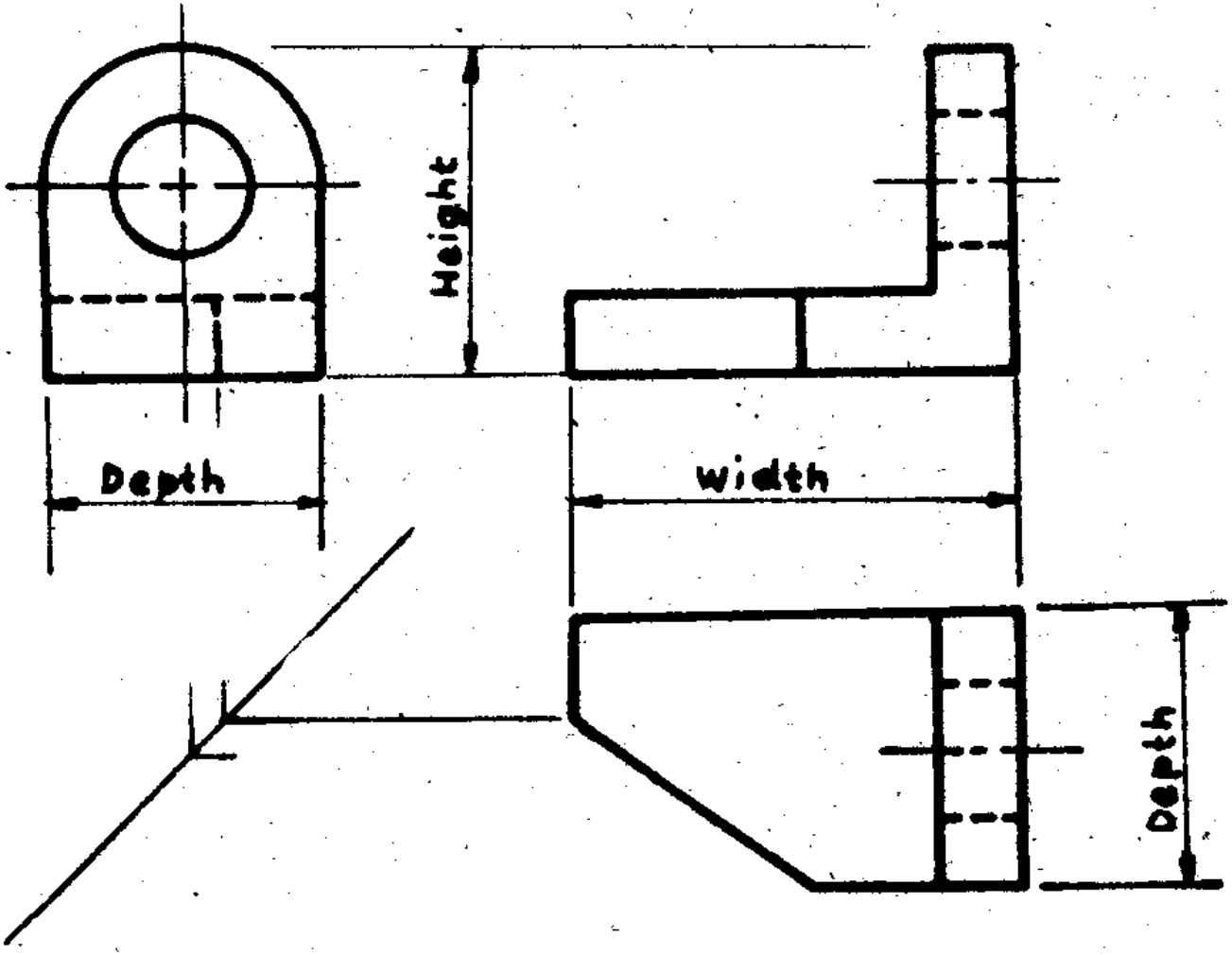


Fig. 4. 13 Front top and right-side views. The right side view is preferred only because of the shape of the object, representation is clearer with the right-side view than the left-side view.

If the object is a complicated one and for the one or more additional view or views could be required at that time we could add those necessary views to the principal views. Such as bottom, right side, rear or required one (Fig.4.14).

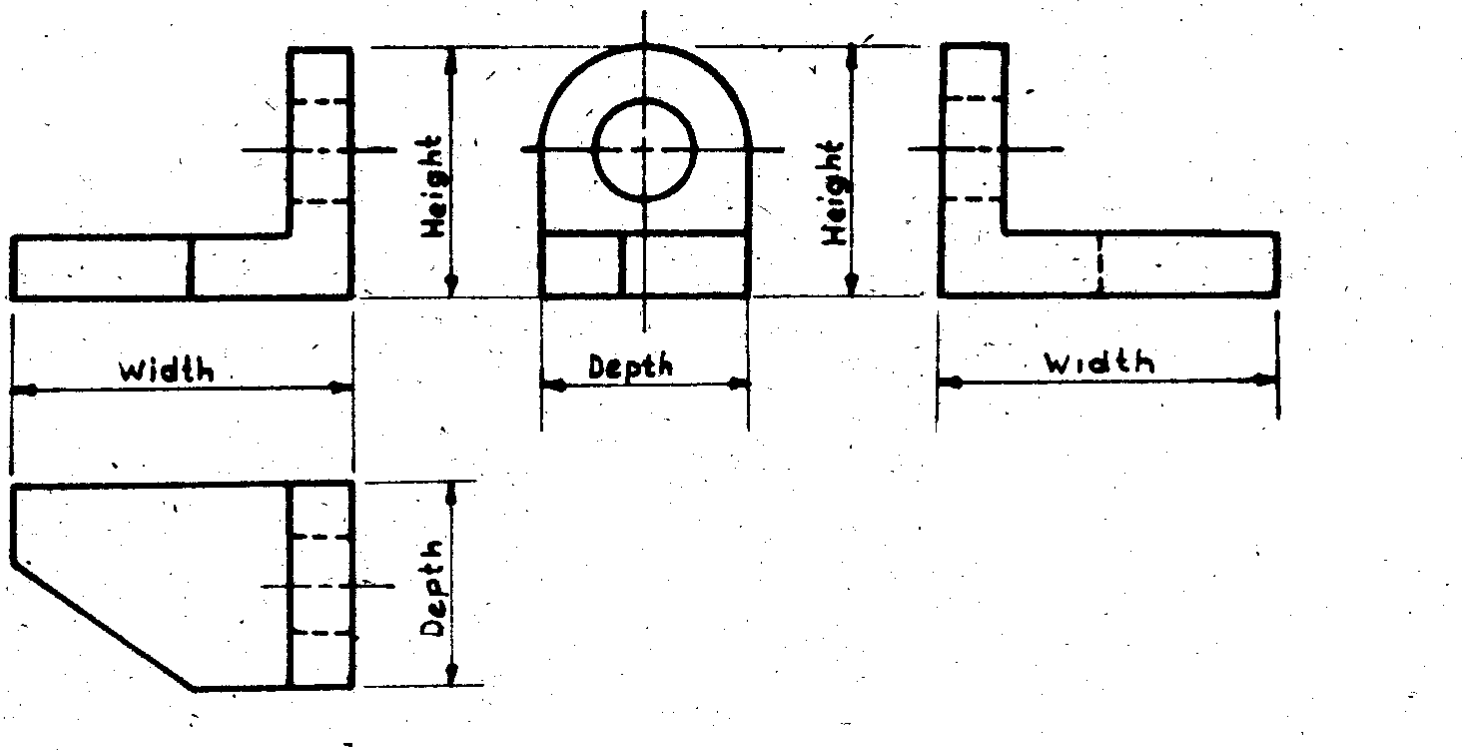


Fig. 4. 14. Top, front, left-side and rear views. The rear view is added only when same details on the rear of the object is important and the shape representation can be improved by its use.