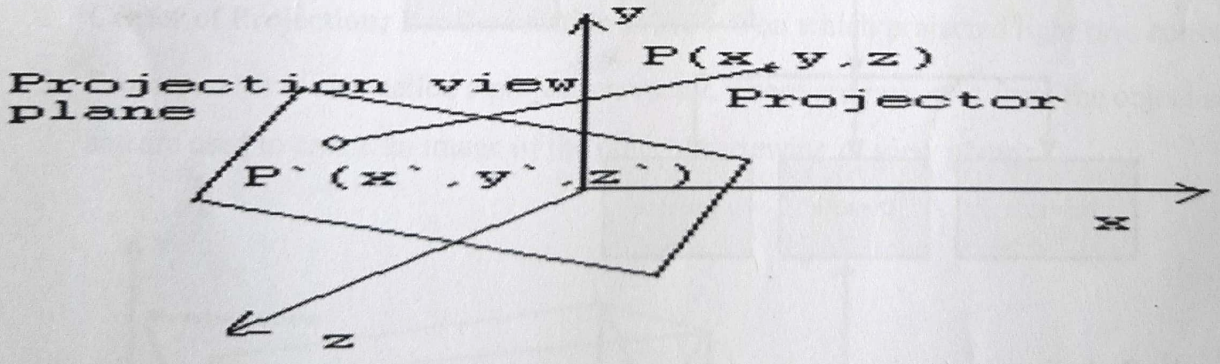
Projection

In the 2D system, we use only two coordinates X and Y but in 3D, an extra coordinate Z is added. 3D graphics techniques and their application are fundamental to the entertainment, games, and computer-aided design industries. It is a continuing area of research in scientific visualization.

Furthermore, 3D graphics components are now a part of almost every personal computer and, although traditionally intended for graphics-intensive software such as games, they are increasingly being used by other applications.

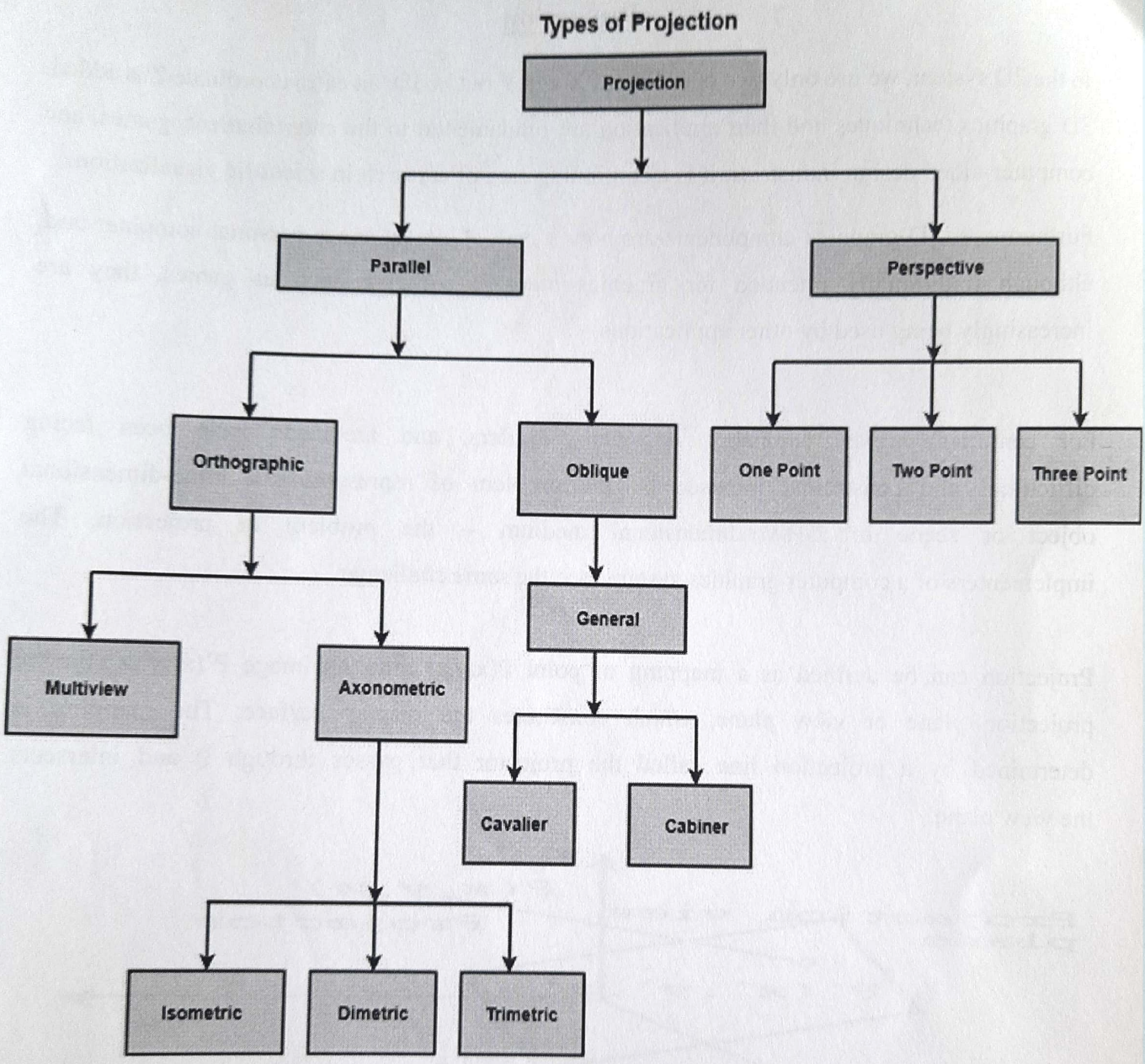
For centuries, artists, engineers, designers, drafters, and architects have been facing difficulties and constraints imposed by the problem of representing a three-dimensional object or scene in a two-dimensional medium -- the problem of projection. The implementers of a computer graphics system face the same challenge.

Projection can be defined as a mapping of point P(x,y,z) onto its image P`(x`,y`,z`) in the projection plane or view plane, which constitutes the display surface. The mapping is determined by a projection line called the projector that passes through P and intersects the view plane.



The Problem of Projection

Projection is the process of converting a 3D object into a 2D object. It is also defined as mapping or transformation of the object in projection plane or view plane. The view plane is displayed surface.



Perspective Projection

In perspective projection, the distance from the center of projection to project plane is finite and the size of the object varies inversely with distance which looks more realistic.

The distance and angles are not preserved and parallel lines do not remain parallel. Instead, they all converge at a single point called **center of projection** or **projection reference point**.

Vanishing Point

It is the point where all lines will appear to meet. There can be one point, two point, and three point perspectives.

One Point: There is only one vanishing point as shown in fig (a)

Two Points: There are two vanishing points. One is the x-direction and other in the y -direction as shown in fig (b)

Three Points: There are three vanishing points. One is x second in y and third in two directions.

In Perspective projection lines of projection do not remain parallel. The lines converge at a single point called a center of projection. The projected image on the screen is obtained by points of intersection of converging lines with the plane of the screen. The image on the screen is seen as of viewer's eye were located at the center of projection, lines of projection would correspond to path travel by light beam originating from object.

Important terms related to perspective

1. **View plane:** It is an area of world coordinate system which is projected into viewing plane.
2. **Center of Projection:** It is the location of the eye on which projected light rays converge.
3. **Projectors:** It is also called a projection vector. These are rays start from the object scene and are used to create an image of the object on viewing or view plane.

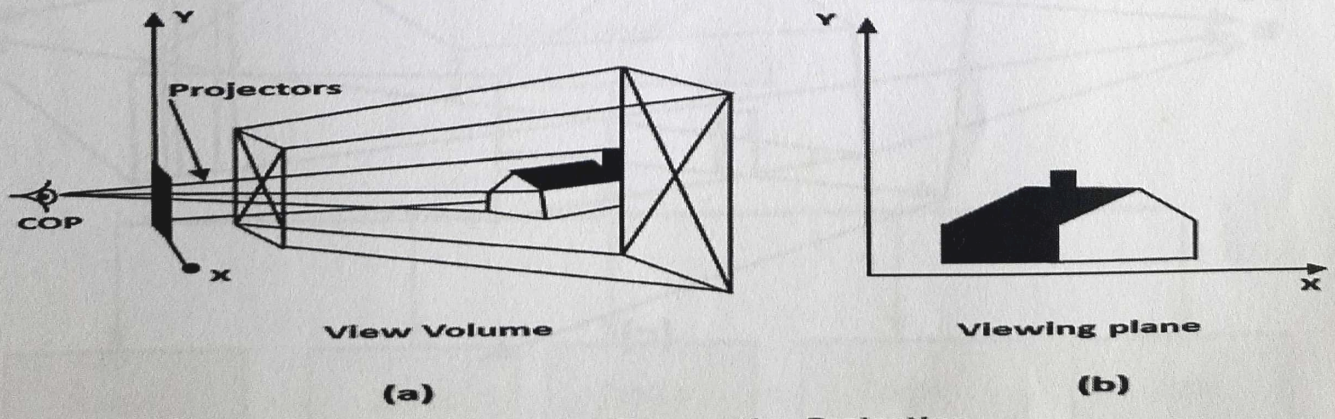
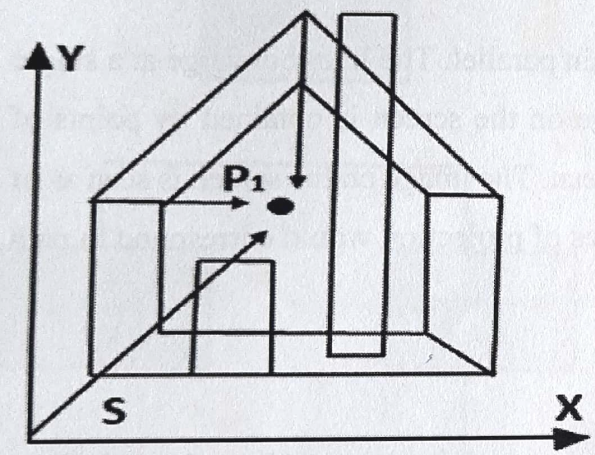


Fig: Prespective Projection

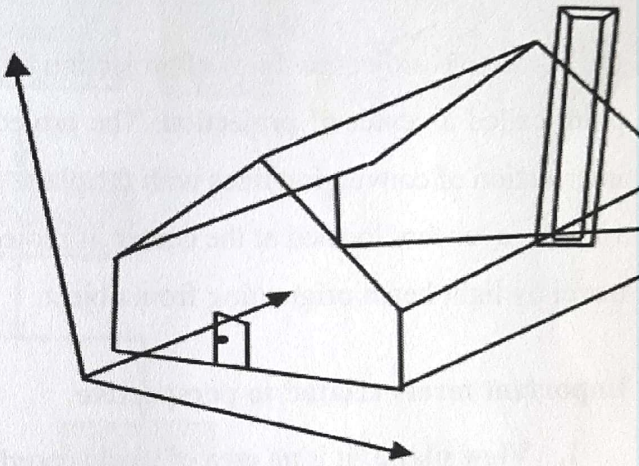
Anomalies in Perspective Projection

It introduces several anomalies due to these object shape and appearance gets affected.

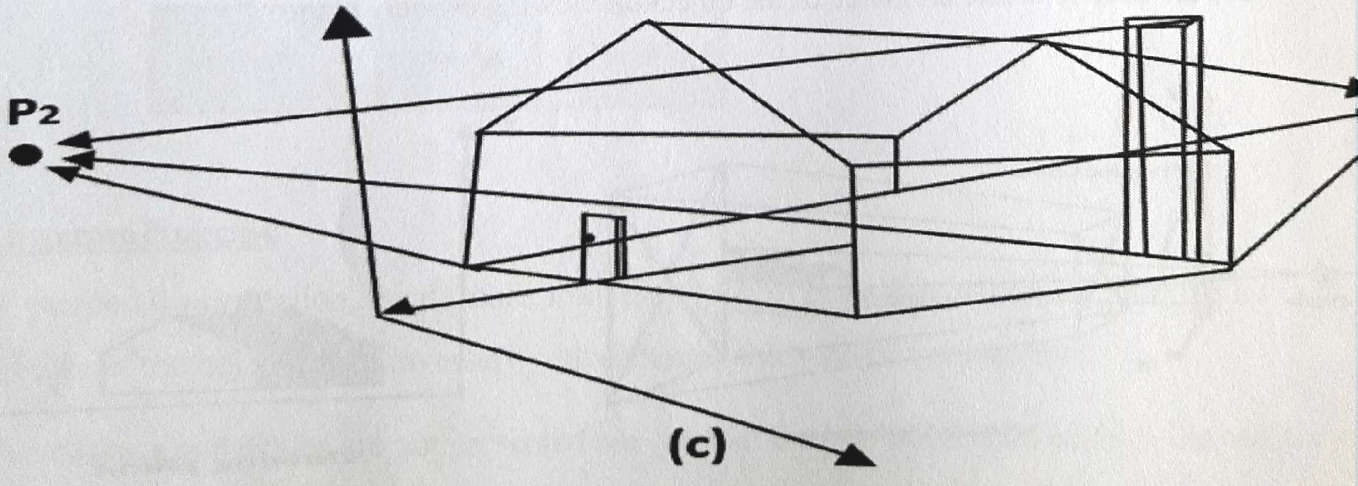
1. **Perspective foreshortening:** The size of the object will be small of its distance from the center of projection increases.
2. **Vanishing Point:** All lines appear to meet at some point in the view plane.
3. **Distortion of Lines:** A range lies in front of the viewer to back of viewer is appearing to six rollers.



(a)



(b)



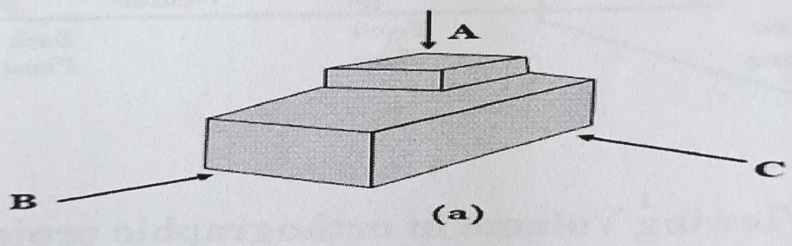
(c)

Foreshortening of the z-axis in fig (a) produces one vanishing point, P_1. Foreshortening the x and z-axis results in two vanishing points in fig (b). Adding a y-axis foreshortening in fig (c) adds vanishing point along the negative y-axis.

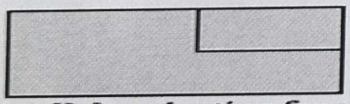
Parallel Projection

Parallel Projection use to display picture in its true shape and size. When projectors are perpendicular to view plane then is called **orthographic projection**. The parallel projection is formed by extending parallel lines from each vertex on the object until they intersect the plane of the screen. The point of intersection is the projection of vertex.

Parallel projections are used by architects and engineers for creating working drawing of the object, for complete representations require two or more views of an object using different planes.

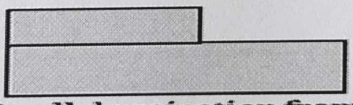


(a)



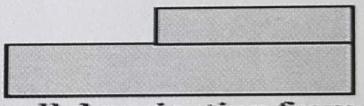
Parallel projection from top i.e. A direction

(b)



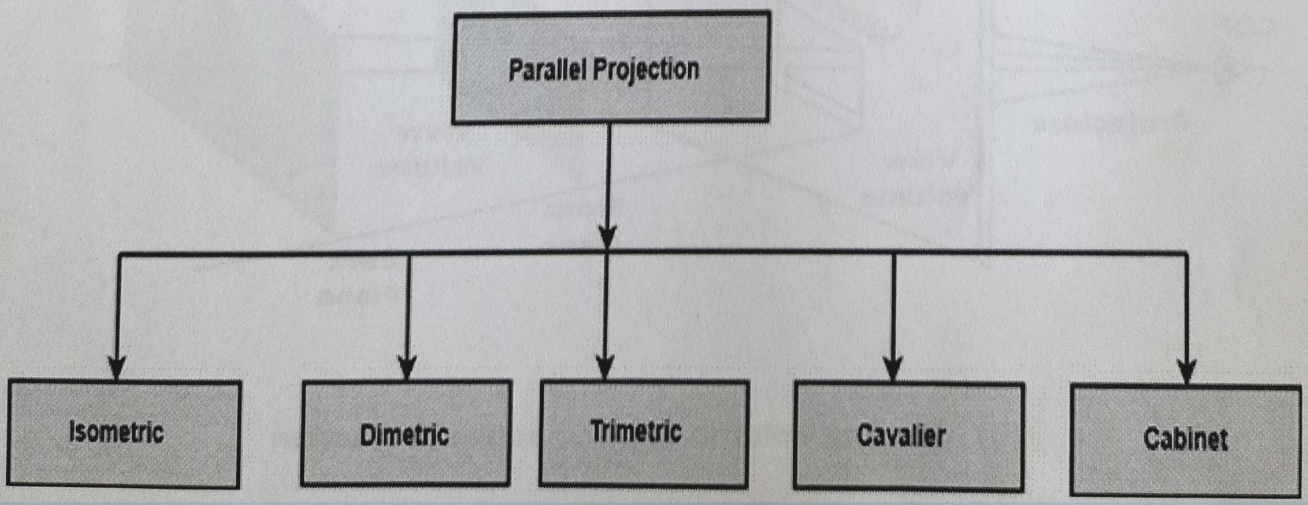
Parallel projection from top i.e. B direction

(c)

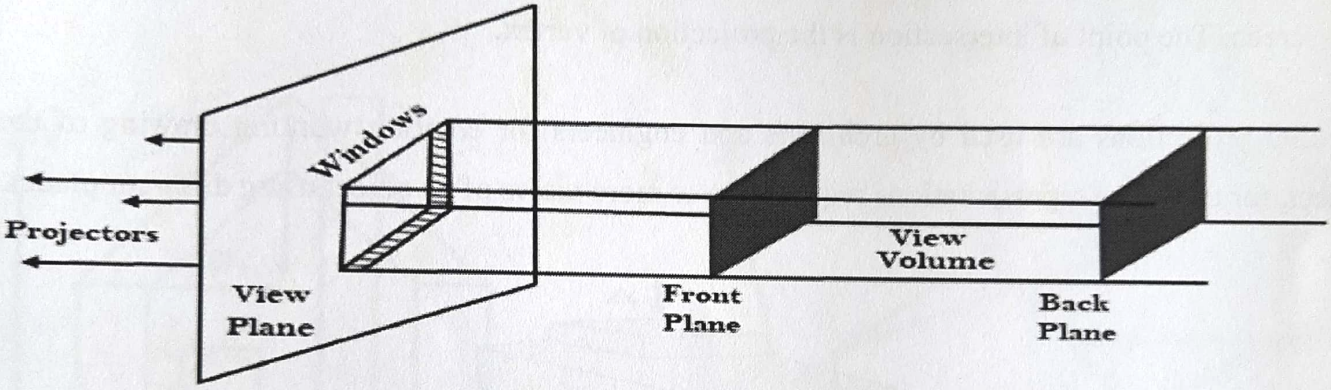


Parallel projection from top i.e. C direction

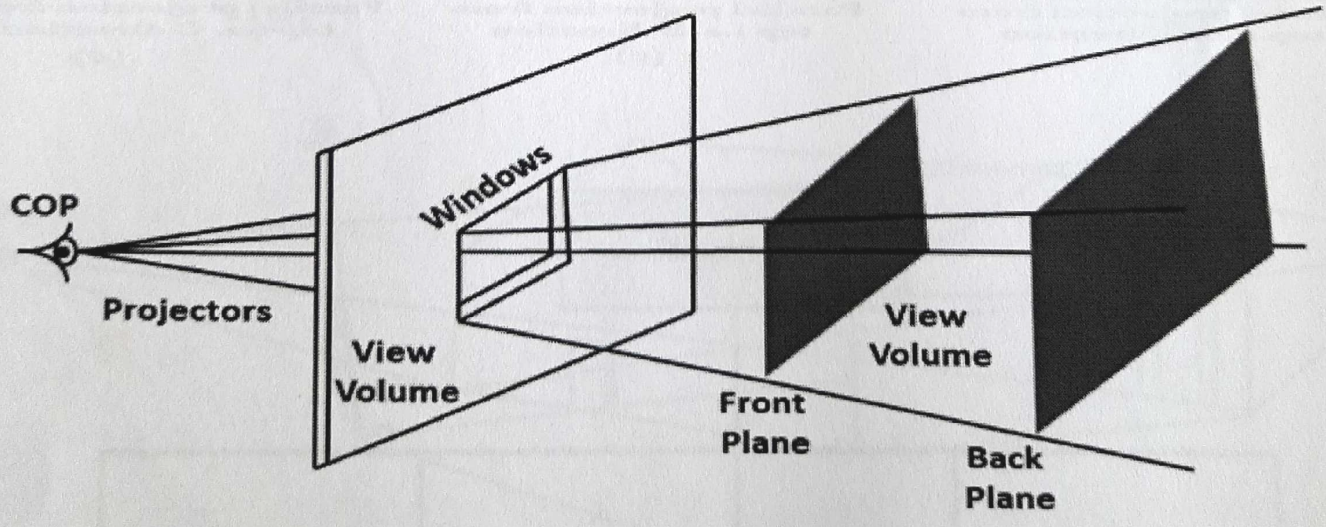
(d)



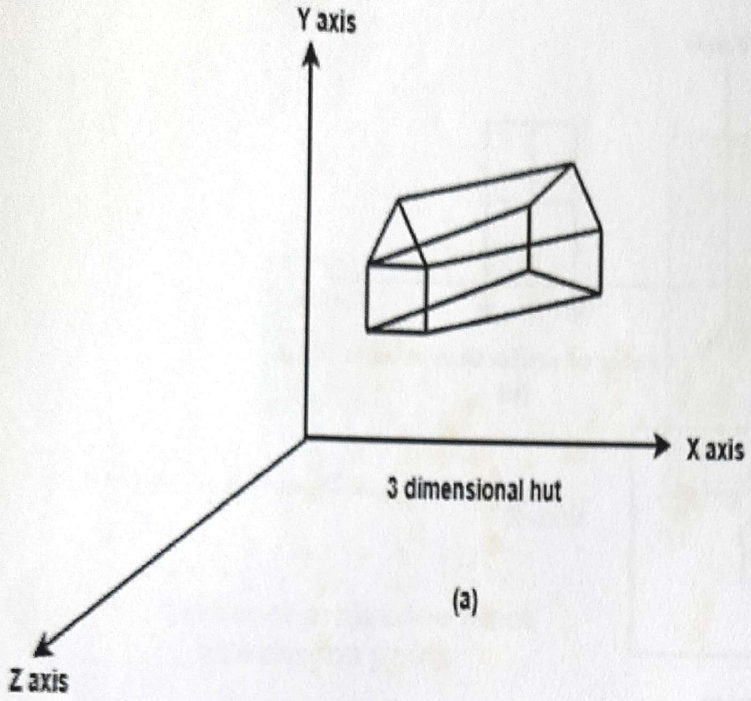
1. **Isometric Projection:** All projectors make equal angles generally angle is of 30°.
2. **Dimetric:** In these two projectors have equal angles. With respect to two principle axis.
3. **Trimetric:** The direction of projection makes unequal angle with their principle axis.
4. **Cavalier:** All lines perpendicular to the projection plane are projected with no change i length.
5. **Cabinet:** All lines perpendicular to the projection plane are projected to one half of the length. These give a realistic appearance of object.



(a) Viewing Volume in orthographic projection

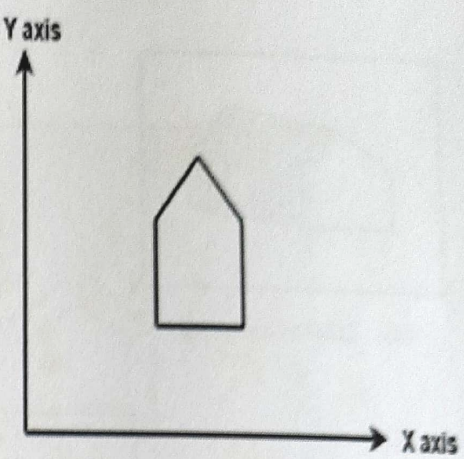


(b) Viewing volume in perspective projection



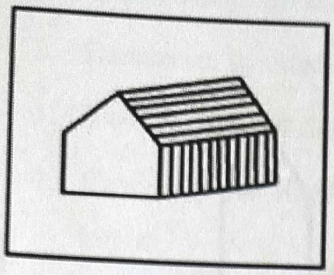
3 dimensional hut

(a)

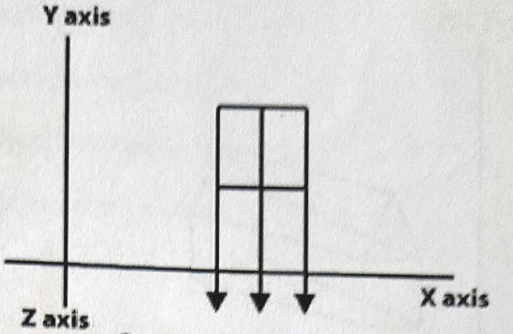


Parallel Projection of hut

(b)

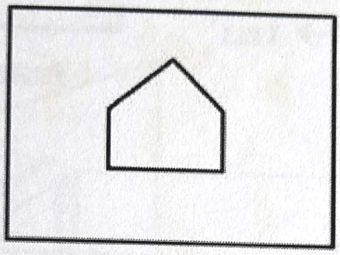


(a) Object original



Center of projection is from front

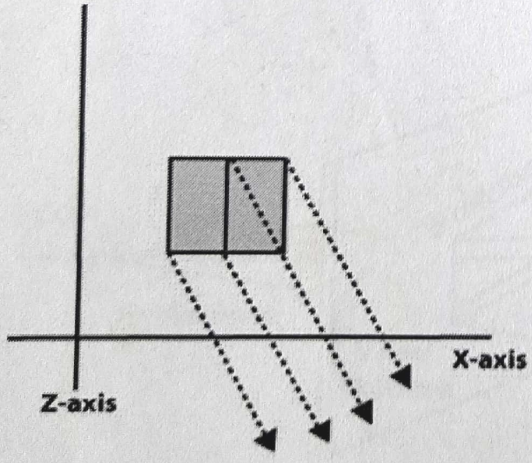
(b)



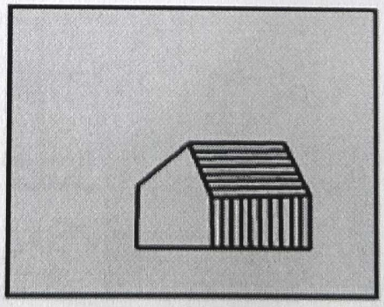
projected object

(c)

Fig (a) shows original object. Fig (b) shows object when projection is taken. Fig (c) gives projected object.



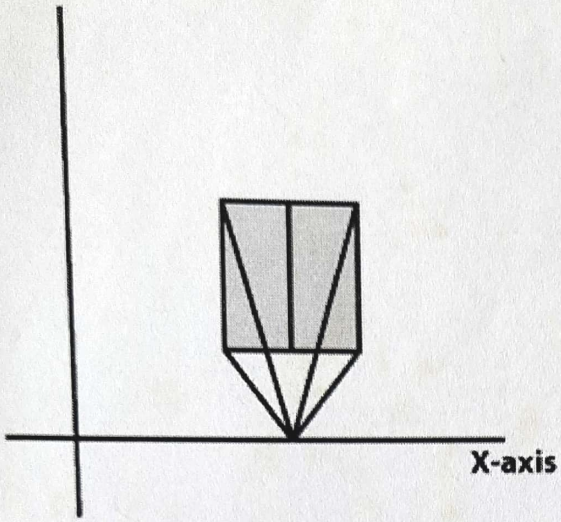
(d)



(e)

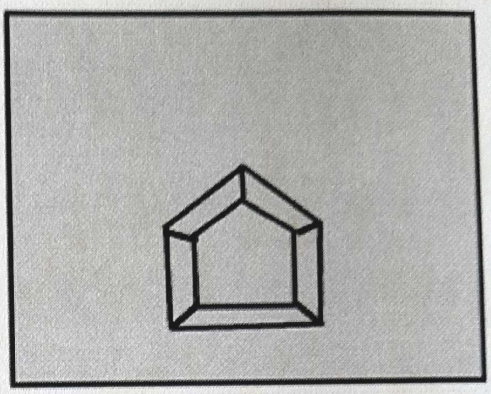
Fig (d) changes the direction of projection

Fig (e) shows object after changing direction of projection.



Center of projection meet at a chosen point

(a)



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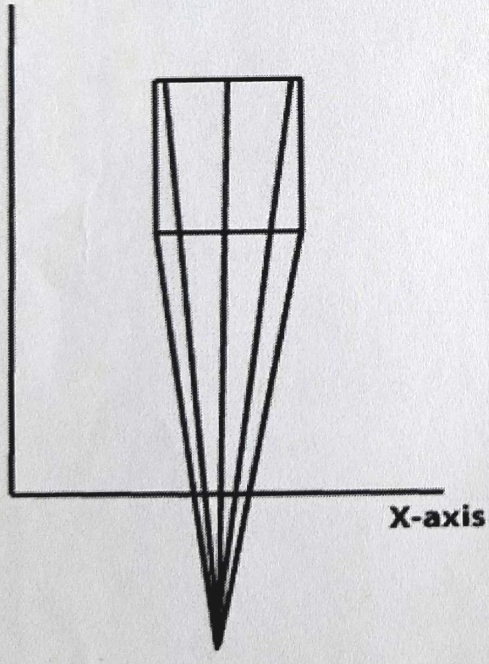
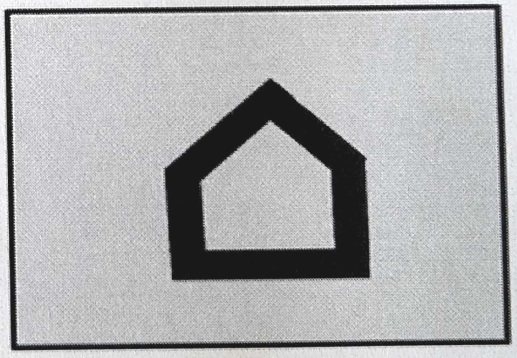


(a)



(b)