Introduction to Projection

The art of representing a three-dimensional object or scene in a 2D space is called *projection.*

Projection is carried out by passing **projectors** through each vertex and intersecting the projectors with the two-dimensional Viewplane.

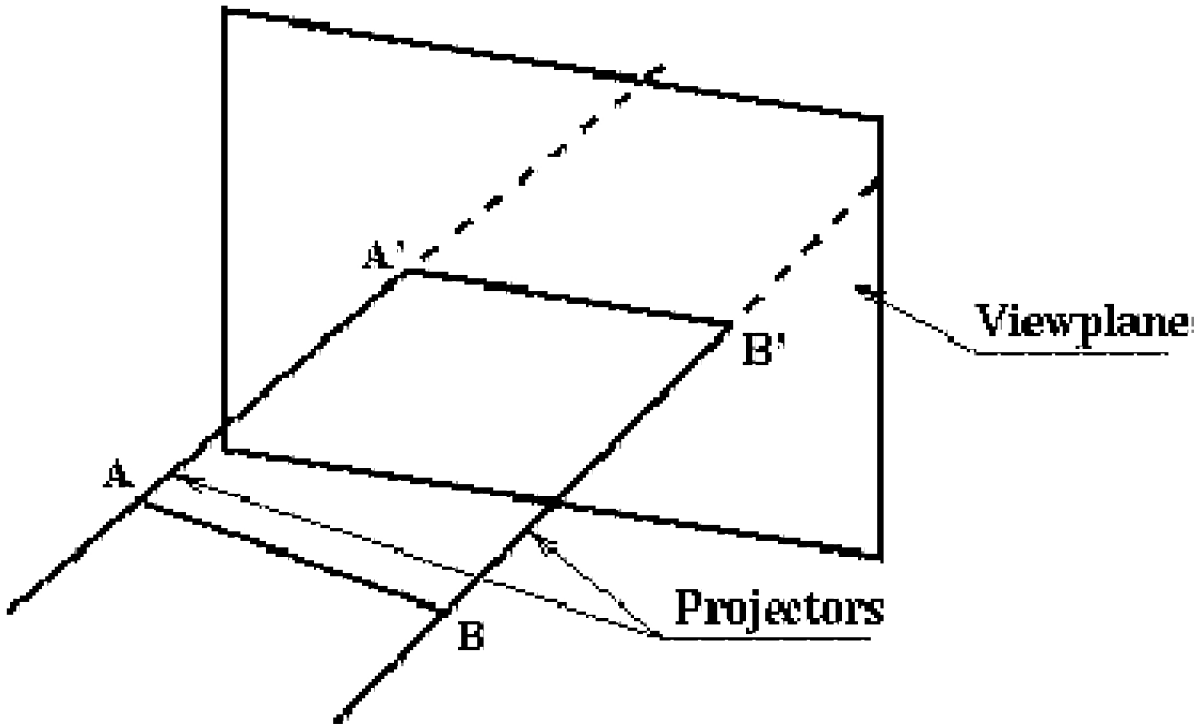
Projectors emanate from a *centre of projection*, pass through every point in the object and intersect a projection surface to form the 2D projection.

In graphics we only deal with planar projections – where the projection surface is a plane.

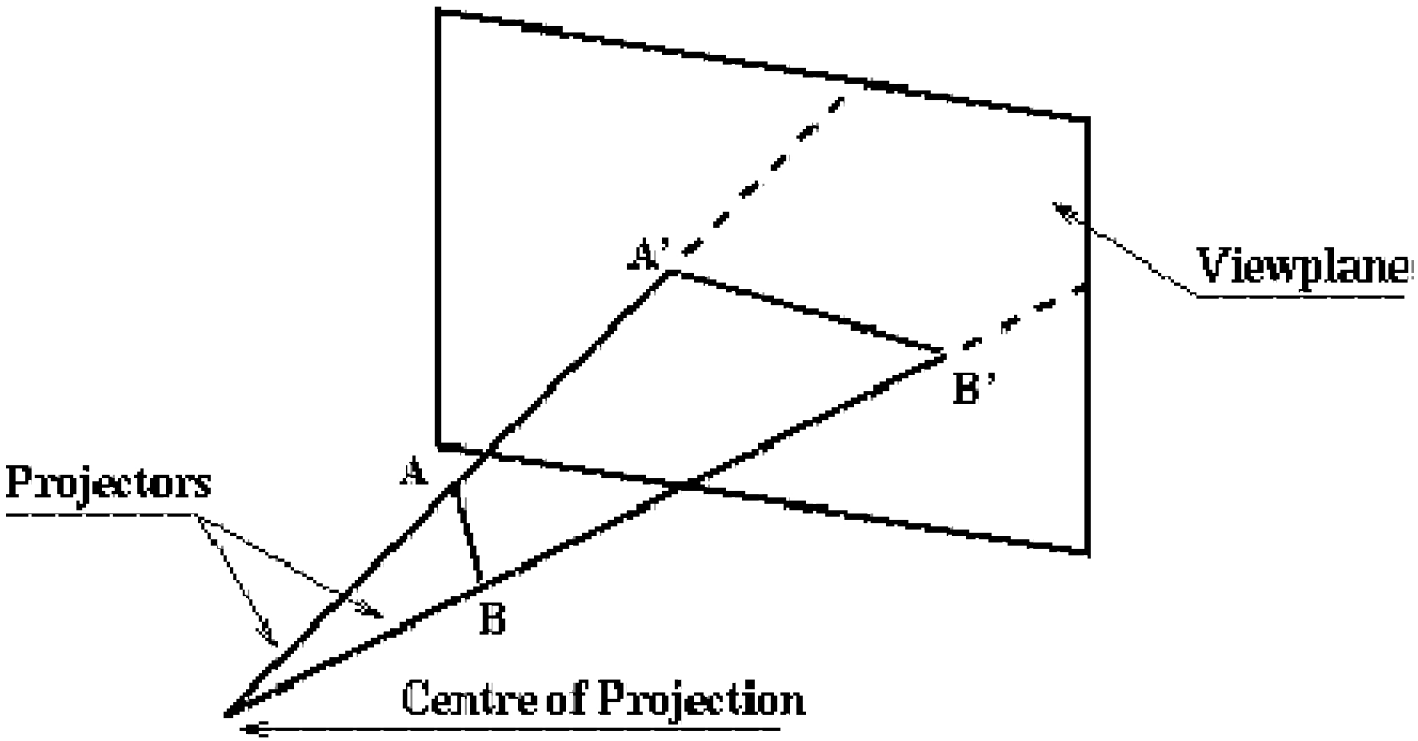
Only deal with geometric projections – Here All the projections considered are **planar** projections, i.e. the projectors are straight lines and project onto a planar viewplane

Two classes of projections :

- Parallel.
- Perspective.

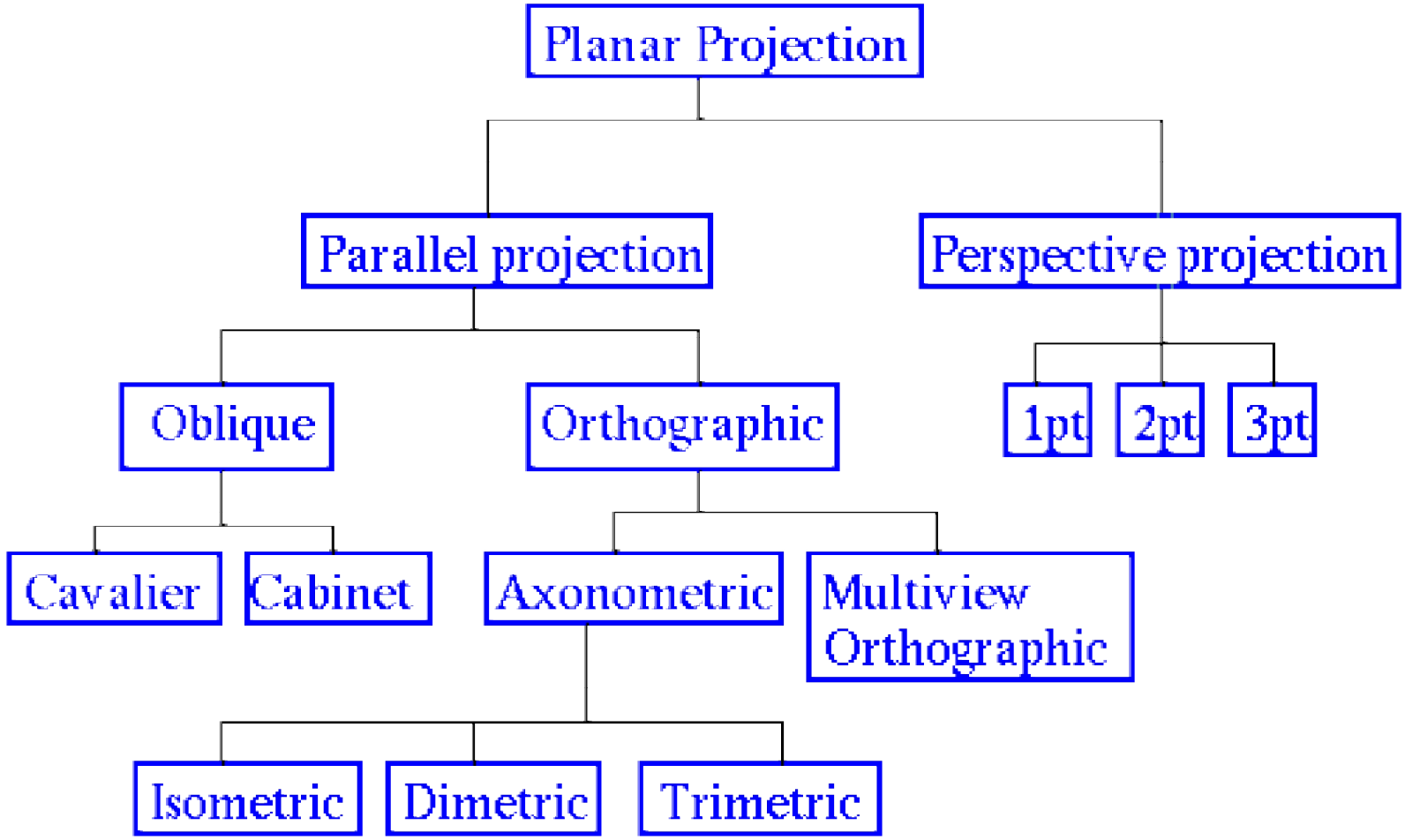


Parallel Projection: Distance to Center of Projection is infinite.



Perspective: Distance to Center of Projection is finite

A Taxonomy of projections.



Multiview Orthographic parallel projections

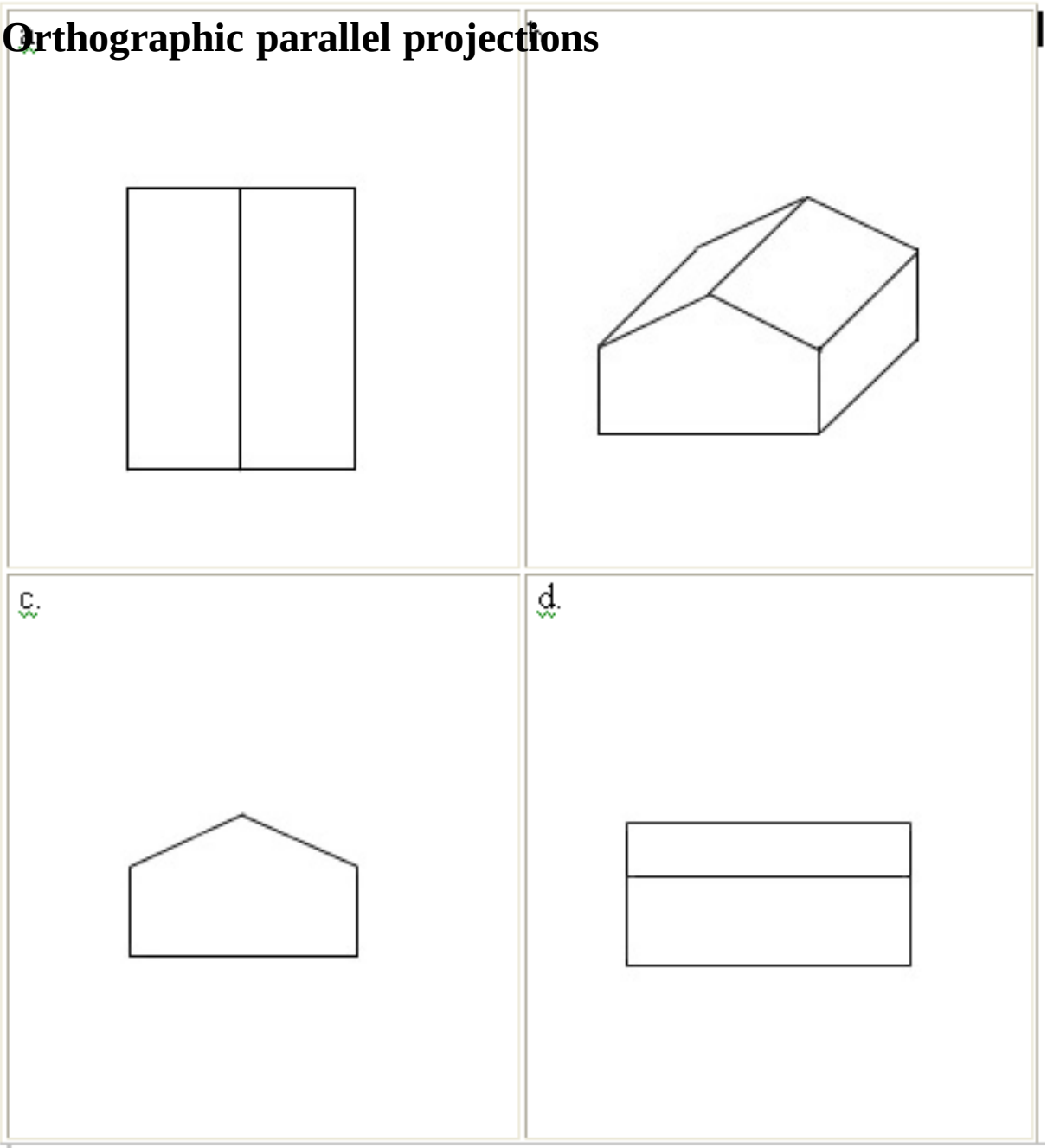
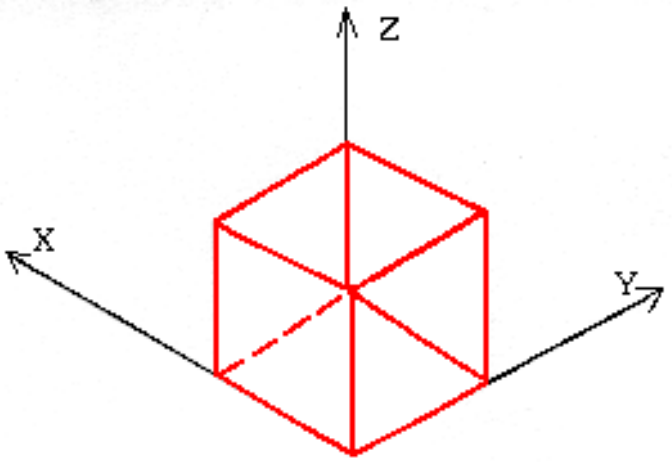
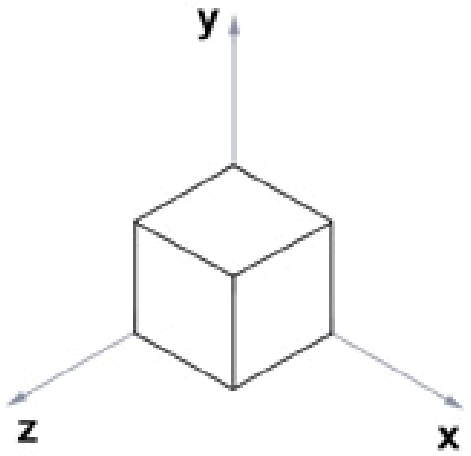


Figure Two and three dimensional projections; a) top or planar view; b) three-dimensional view for reference; c) front view; and d) side view.

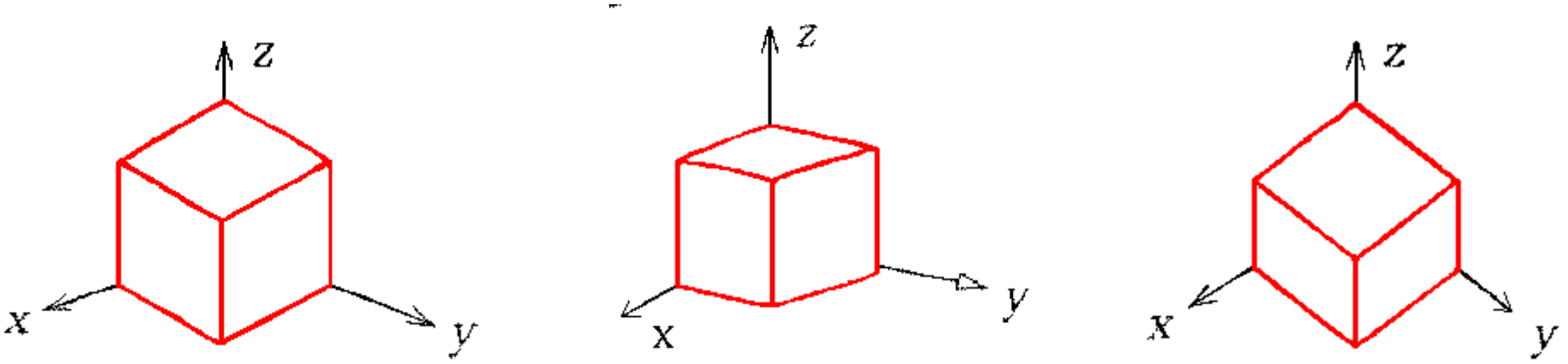
Axonometric projections: Used to represent 3D objects as they allow many sides of an object to be seen. The view plane normal is not parallel to any principal axis. An orthogonal projection in which the direction of projection is not aligned with the axes. Parallel lines remain parallel, and receding lines are equally foreshortened by some factor.

1.Isometric projections -- The projection plane normal (projector) makes equal angles with each principal axis (all three axes are equally foreshortened).

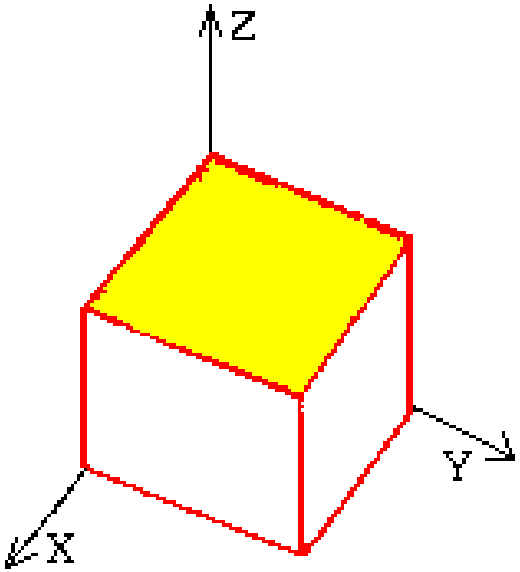


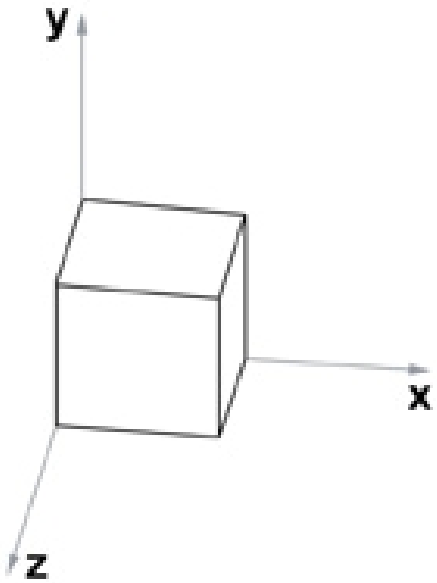


Dimetric projections -- The projection plane normal (projector) makes equal angles with two of three principal axes (two of three axes are equally foreshortened).

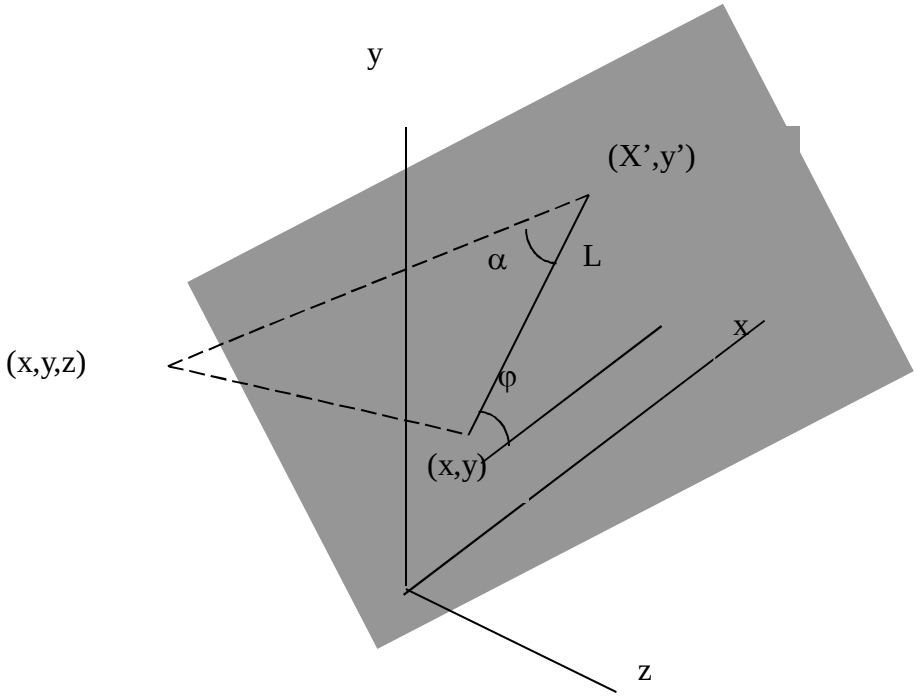


Trimetric projections -- The projection plane normal (projector) makes unequal angles with each principal axis (all three axes are unequally foreshortened).





Oblique parallel projections : Oblique projections have their projectors that are **NOT** perpendicular to the projection plane i.e. Oblique projection is obtained by projecting points along parallel lines that are not perpendicular to projection Plane.



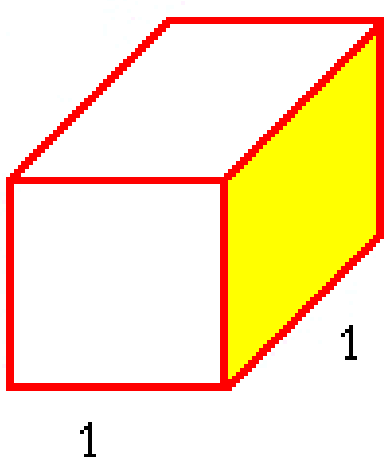
X'=x+Lcosφ
Y'=y+Lsinφ

Length L depends on the angle & z coordinates α of the point to be projected
Tanα =z/L
L=z/Tanα=zL1

L1 is inverse of Tanα.
X'=x+z(L1cosφ)
Y'=y+z(L1sinφ)

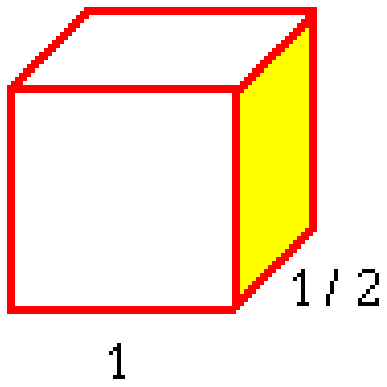
M= $\begin{bmatrix} 1 & 0 & L1Cos\phi & 0 \\ 0 & 1 & L1Sin\phi & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

•**Cavalier parallel projections** -- The lines perpendicular to projection plane are preserved in length, that is, **L1=1**



$$\begin{bmatrix} 1 & 0 & Cos\phi & 0 \\ 0 & 1 & Sin\phi & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

•**Cabinet parallel projections** -- Lines perpendicular to projection plane are 1/2 their true length, that is, **L1=1/2**



$$\begin{bmatrix} 1 & 0 & \cos\phi/2 & 0 \\ 0 & 1 & \sin\phi/2 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

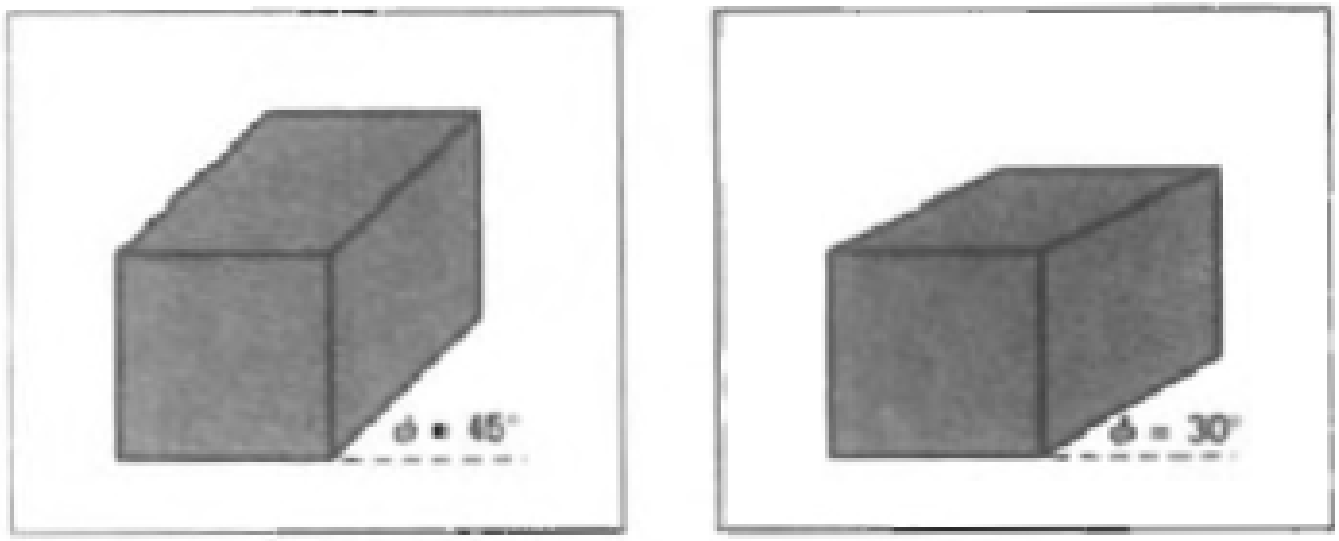


Figure 12-23
Cavalier projections of a cube onto a view plane for two values of angle ϕ.
Note: Depth of the cube is projected equal to the width and height.

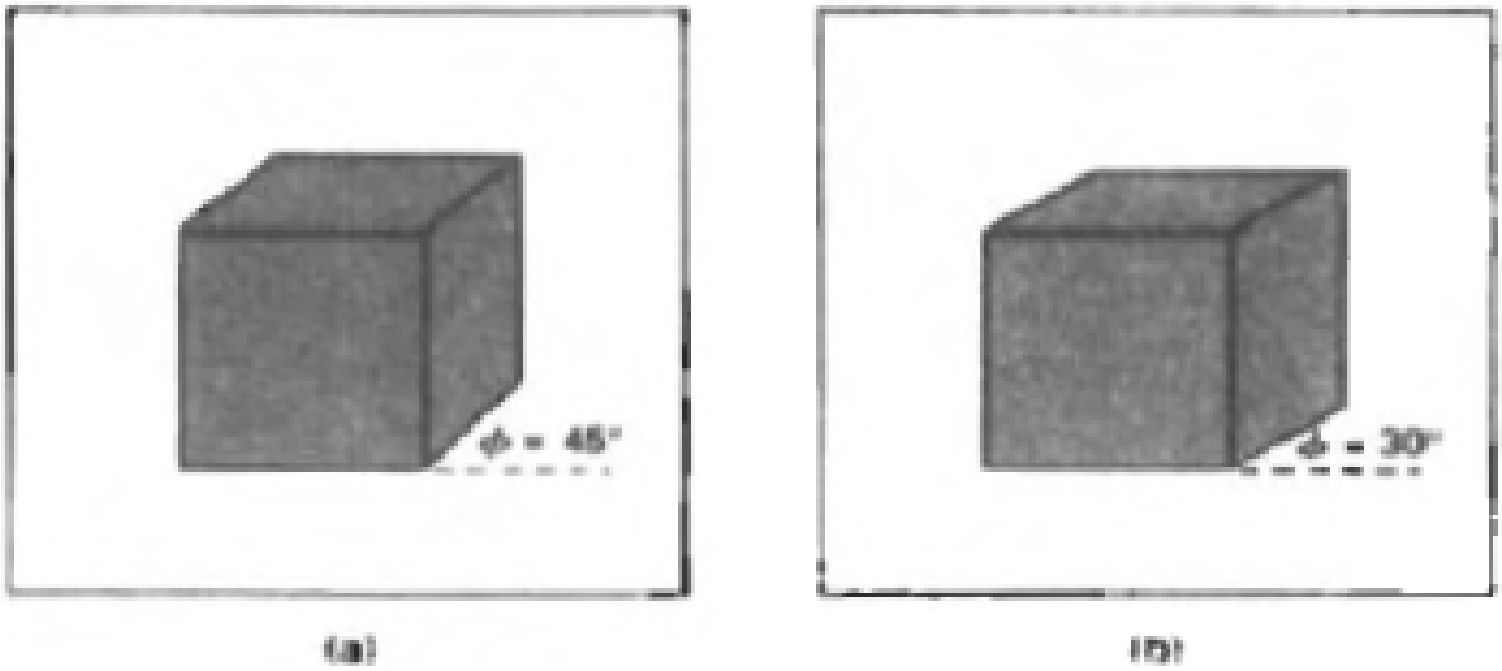
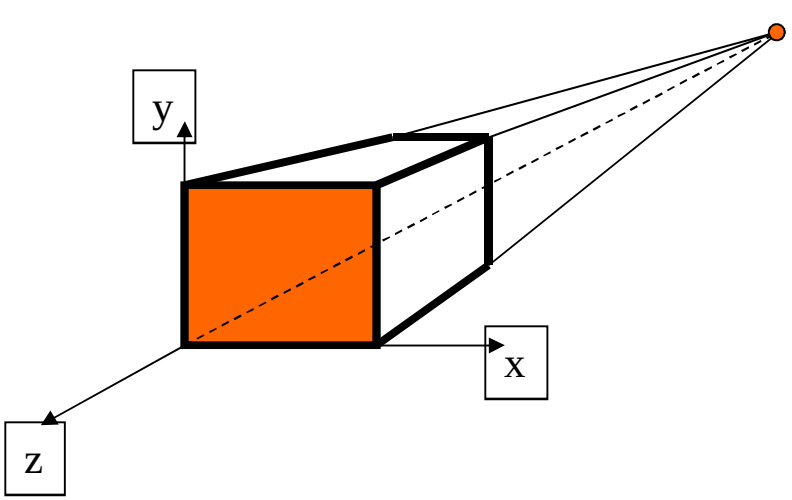
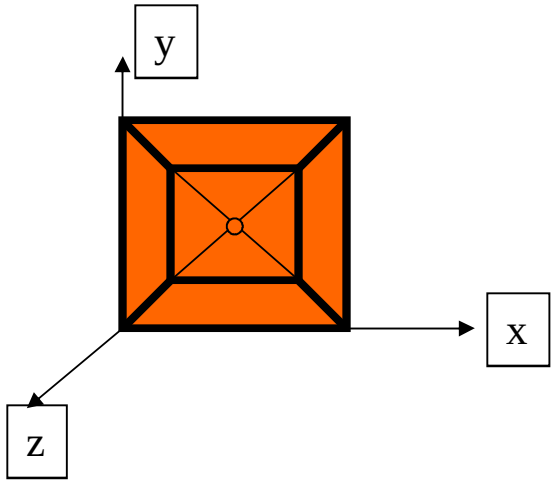


Figure 12-24
Cabinet projections of a cube onto a view plane for two values of angle ϕ. Depth is projected as one-half that of the width and height.

Perspective projections : Projectors radiate out from a **Centre of Projection** (COP).

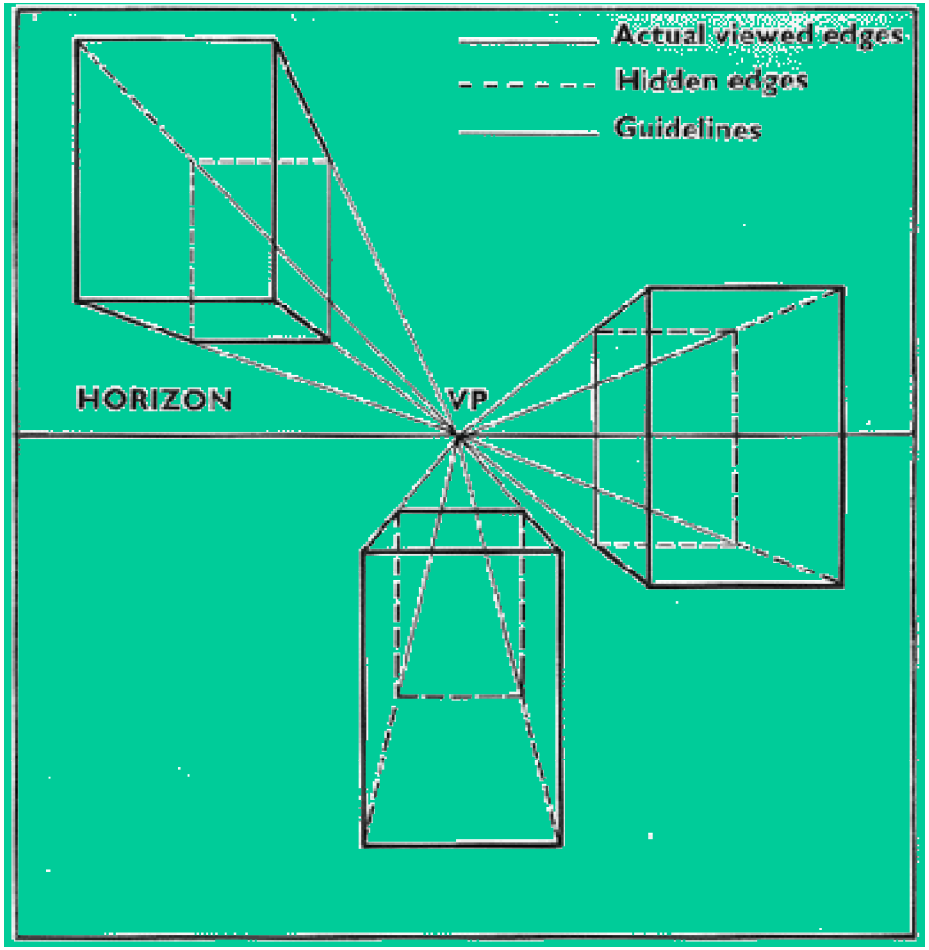
Any set of parallel lines which are not parallel to the viewplane will , after perspective projection, converge to a single point on the viewplane called the **Vanishing Point**. There are one, Two- and Three-point perspective projections.



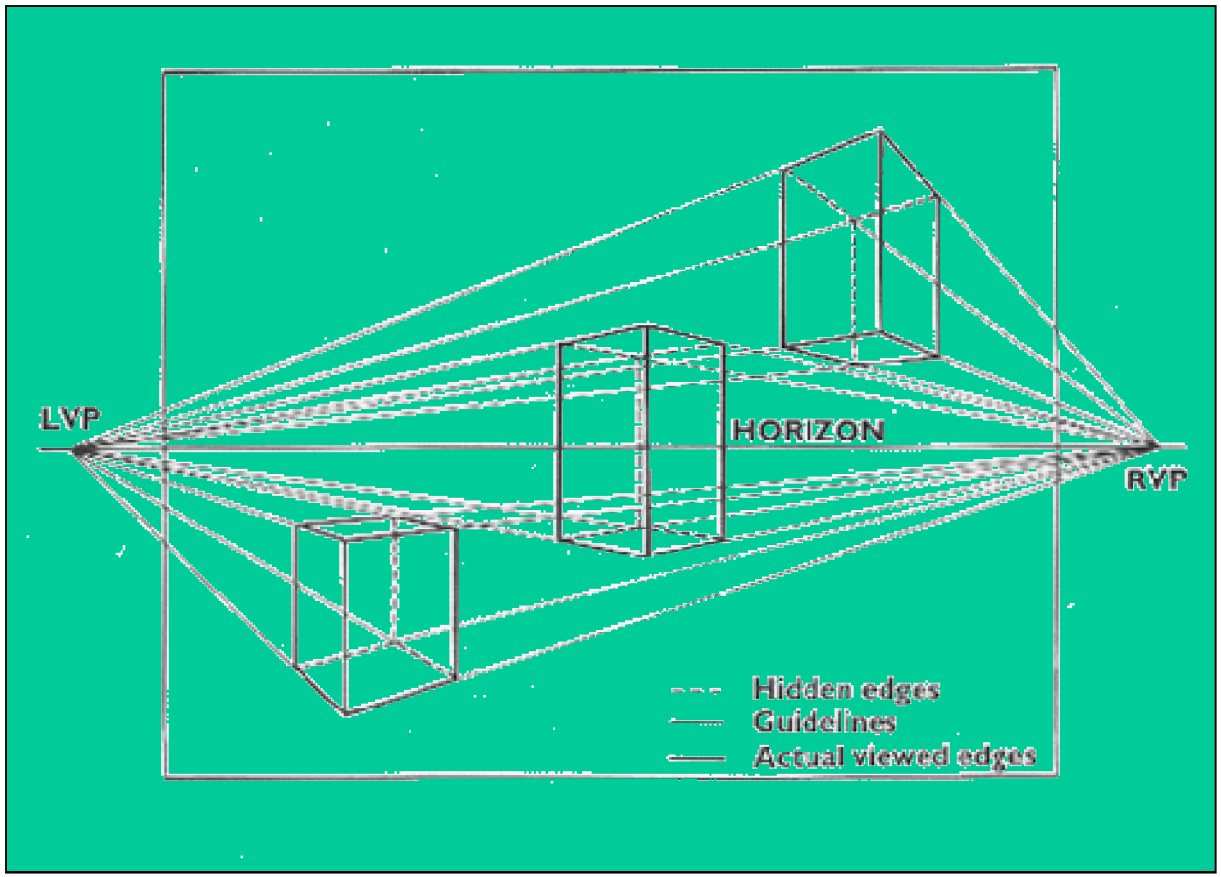


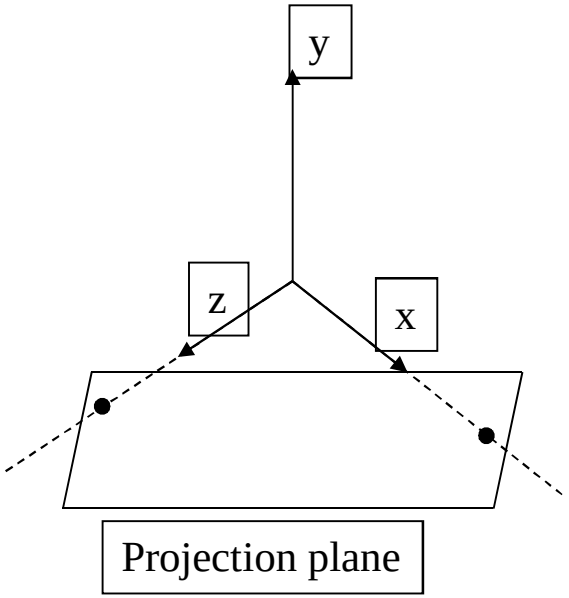
One point perspective : When the projection plane is parallel to two principal axes. Conversely, when the projection plane is perpendicular to one of the principal axis, one point perspective occurs. Receding lines along one of the principal axis converge to a vanishing point.

Projection plane cuts 1 axis only.

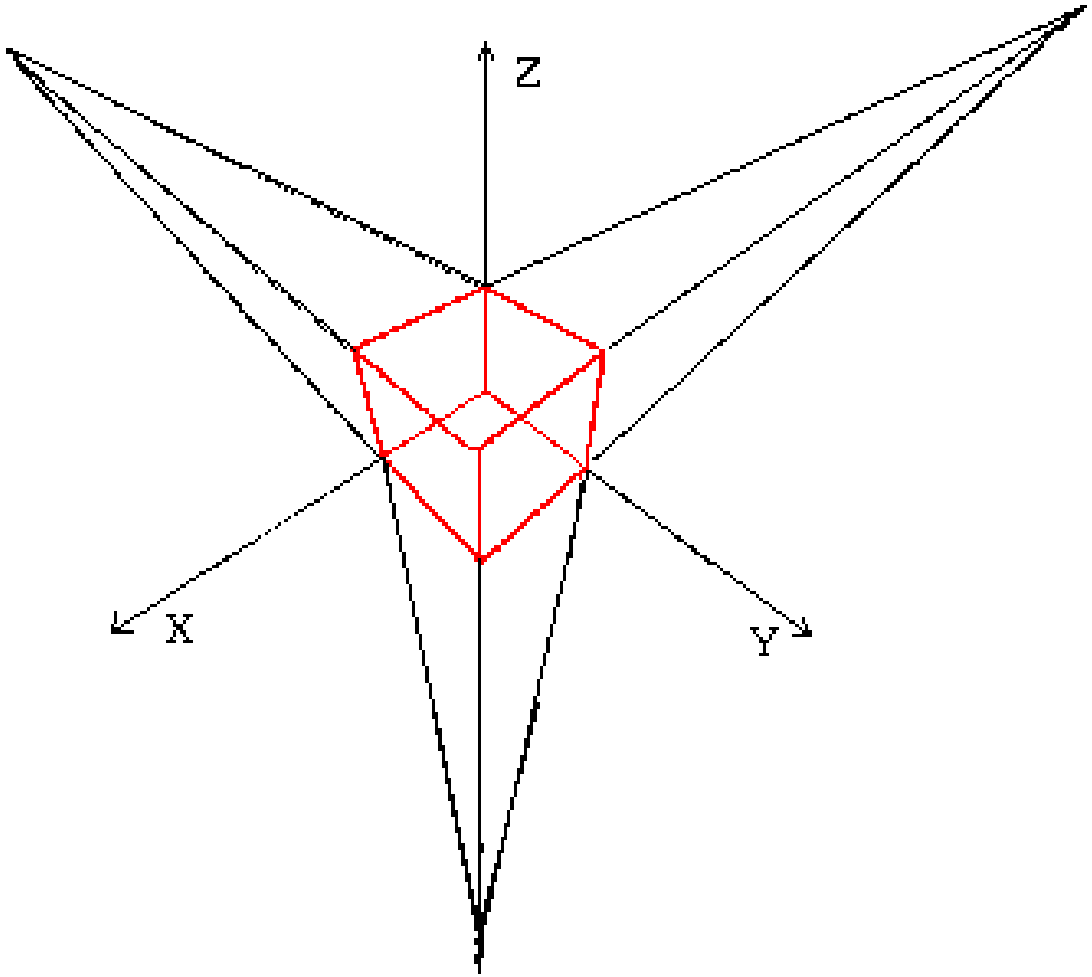


Two point perspective : If the projection plane is parallel to one of the principal axes or if the projection plane intersects exactly two principal axes, a two-point perspective projection occurs.





Three point perspective : If the projection plane is not parallel to any principal axis, a three-point projection occurs



Application

A **projection screen** is an installation consisting of a surface and a support structure used for displaying a projected image for the view of an audience. Projection screens may be permanently installed, as in a movie theater; painted on the wall, or semi-permanent or mobile, as in a conference room or other non-dedicated viewing space such as an outdoor movie screening (open air cinema).

Scope of Research

Projection pursuit is a type of statistical technique which involves finding the most "interesting" possible projections in multidimensional data. Often, projections which deviate more from a Normal distribution are considered to be more interesting. As each projection is found, the data are reduced by removing the component along that projection, and the process is repeated to find new projections; this is the "pursuit" aspect that motivated the technique known as matching pursuit.