ECOR 1010
Lecture 5

Engineering Graphics - 1

How Do Engineers Communicate?

- Engineers convey information in three principal ways
  - Written Documents
  - Oral Presentations
  - Graphically
- Sometimes a combination is needed

Importance of Engineering Graphics

- The majority of engineering information is transmitted by graphical means
- But unambiguous written and verbal communication is also central to successful engineering communication

Example – Describing an Object

- Written Communication
  - Made of metal, this tool has a handle and a heavy irregular shaped head
  - The handle has a rubber grip
  - The length of the head runs perpendicular to the handle
  - The head has a rounded blunt end for impact, along with two flattened stems formed by a tapered grove at the opposite end
  - The length of the tool is approximately 30 cm and it weighs about 1 kg

A Picture is Worth ...

- Graphical Communication

Figure 12.1 This picture is worth at least 75 words.

The Point

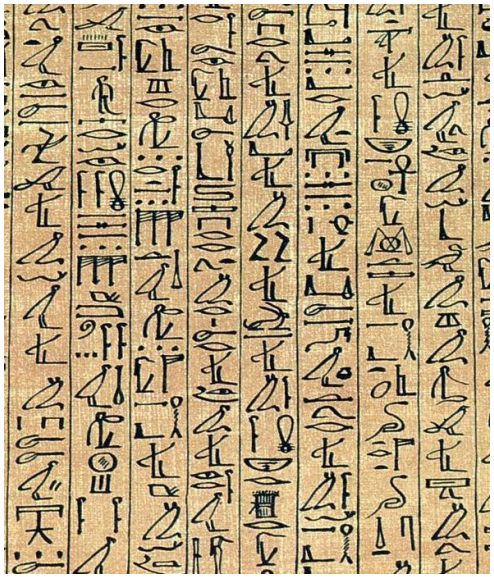
- Obviously, graphics can convey some information in an easier to understand way
- Imagine how difficult some things would be without graphical communication:
  - Advertising
  - Instructions
  - Education
  - Engineering!

Advantages of Graphical Communication

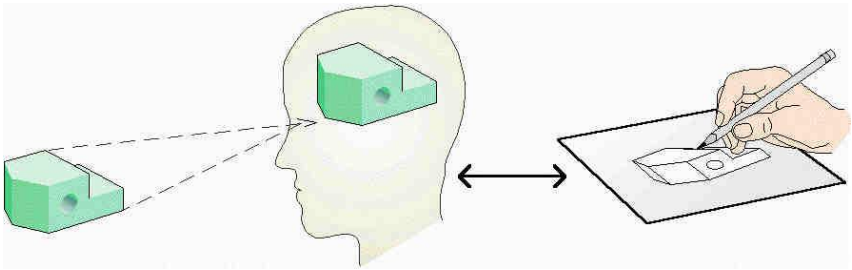
- Clear
- Concise
- Efficient
- Reduced Ambiguity

Engineering Graphics

- Graphics is a universal language
- The earliest forms of written communication were pictorial
  - Egyptian Hieroglyphics
- Engineering graphics are directed towards graphical problem solving
- A good drawing is “worth a thousand words”
- Moreover, good engineering graphics are self explanatory!



Graphical Representation



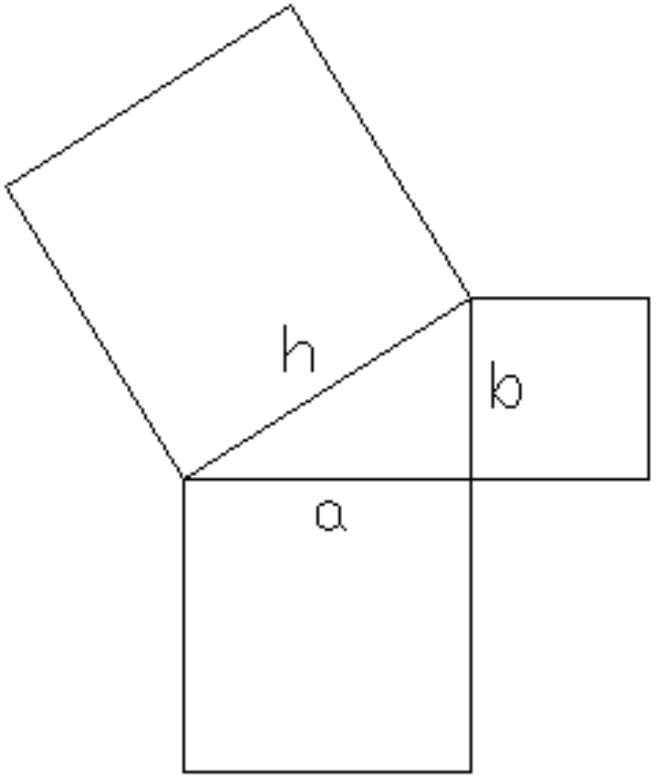
- Practical engineering problems stem from problems associated with the graphical representation of ideas that have to be turned into physical reality: parts
- A visual image is formed in the mind, reviewed, modified, and ultimately communicated to someone else in the form of graphics

Graphical Representation

- It is crucial that the graphical representation be clear and unambiguous
- The image must be precise and exact

Engineering Graphics & Geometry

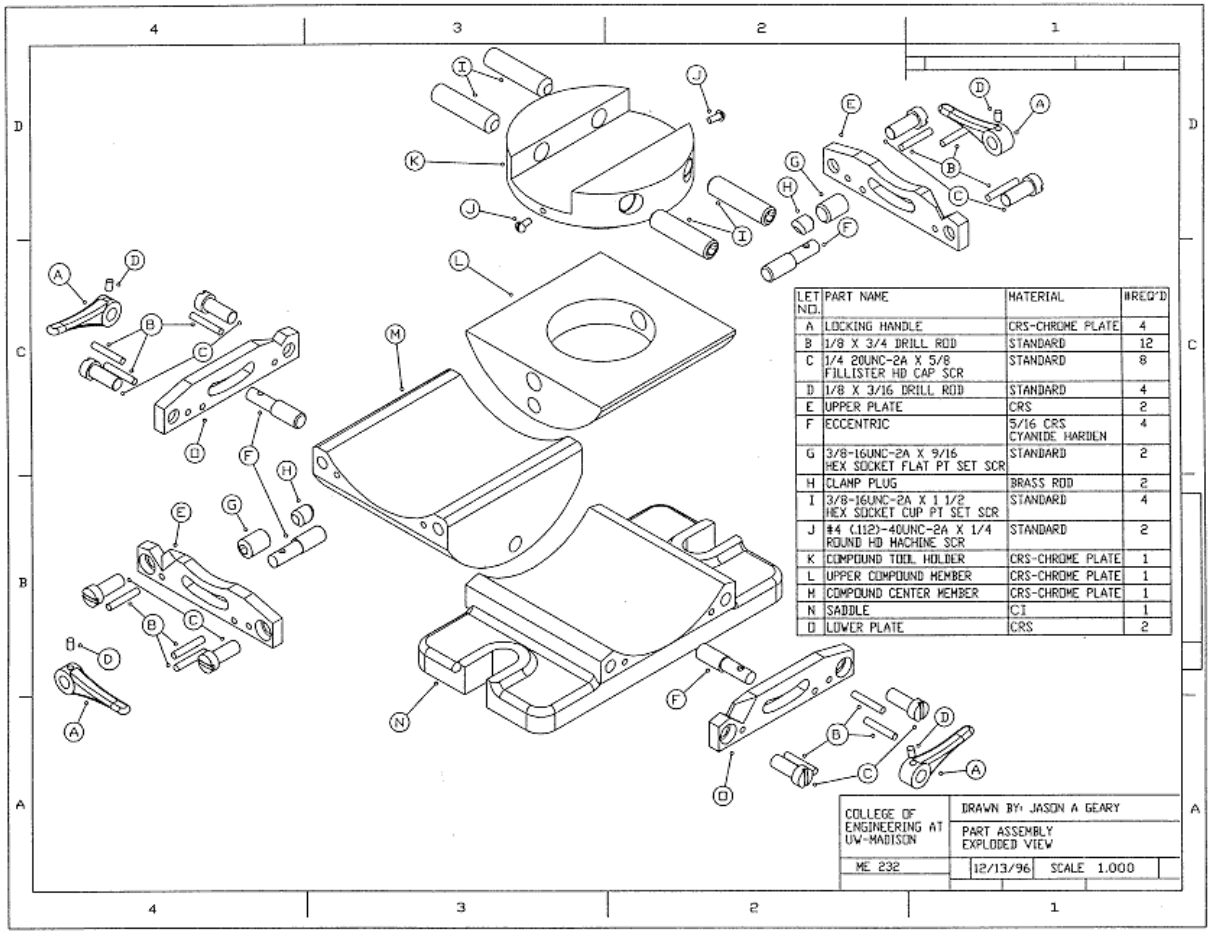
- The word geometry means “earth measure”
- Geometry as a science may have begun in Egypt, to measure the areas of fields to assess taxes
- Calculus and algebra are abstractions of geometry
  - e.g., Pythagorean theorem
- Ancient Indian, Chinese, Egyptian, Greek and Roman builders, among others, used graphics to solve complex design problems associated with large structures



Technical Illustration

- Also called pictorial drawings, technical illustrations are used to describe products in catalogues, user, and maintenance manuals
- Pictorial sketching is an important engineering communication tool
- Useful to describe difficult to visualize components or assemblies
- How to put components together – NOT how to make them
- Three common types
  - Perspective
  - Oblique
  - Isometric (Axonometric)

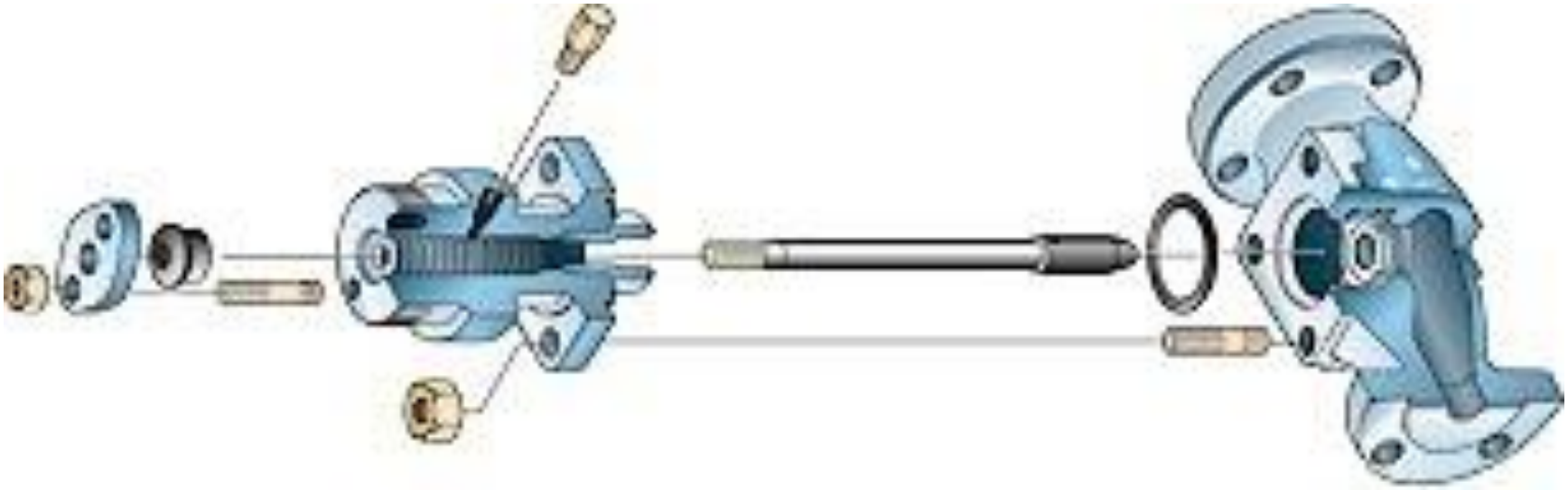
Production Assembly Drawings



LET NO.	PART NAME	MATERIAL	#REQ'D
A	LOCKING HANDLE	CRS-CHROME PLATE	4
B	1/8 X 3/4 DRILL ROD	STANDARD	12
C	1/4 20UNC-2A X 5/8 FILLISTER HD CAP SCR	STANDARD	8
D	1/8 X 3/16 DRILL ROD	STANDARD	4
E	UPPER PLATE	CRS	2
F	ECCENTRIC	5/16 CRS CYANIDE HARDEN	4
G	3/8-16UNC-2A X 9/16 HEX SOCKET FLAT PT SET SCR	STANDARD	2
H	CLAMP PLUG	BRASS ROD	2
I	3/8-16UNC-2A X 1 1/2 HEX SOCKET CUP PT SET SCR	STANDARD	4
J	#4 (.112)-40UNC-2A X 1/4 ROUND HD MACHINE SCR	STANDARD	2
K	COMPOUND TOOL HOLDER	CRS-CHROME PLATE	1
L	UPPER COMPOUND MEMBER	CRS-CHROME PLATE	1
M	COMPOUND CENTER MEMBER	CRS-CHROME PLATE	1
N	SADDLE	CI	1
O	LOWER PLATE	CRS	2

COLLEGE OF ENGINEERING AT UW-MADISON	DRAWN BY: JASON A GEARY
	PART ASSEMBLY EXPLODED VIEW
ME 232	12/13/96 SCALE 1.000

Pictorial Assembly Drawings



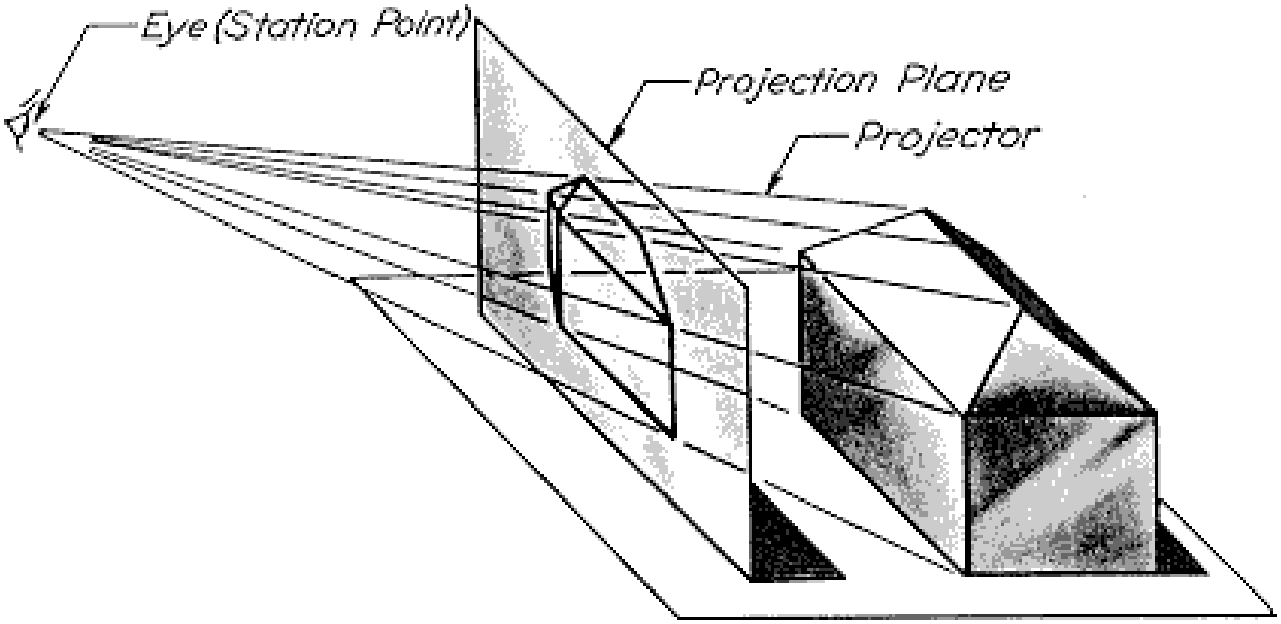
Pictorial assembly (exploded) drawing
Used to illustrate catalogues, user manuals, etc.

Perspective Projection

- In perspective projection the projectors intersect at finite points, called vanishing points (VP)
- The representation on the projection plane may be considered the view that would be seen by a single eye at a known point in space (station point)
- The picture is formed on the projection plane by the intersections of the projecting lines from the object to the focal point of the eye

Perspective Projection

- Perspective projection is used primarily by architects and commercial artists to describe the external appearance of an object



Perspective Projection

- One-Point Perspective
  - The projection plane is parallel to two principal axes. Receding lines along one of the principal axis converge to a vanishing point
  - A one-point perspective is used almost exclusively for interior-room views. It gives the observer the illusion of looking into the room

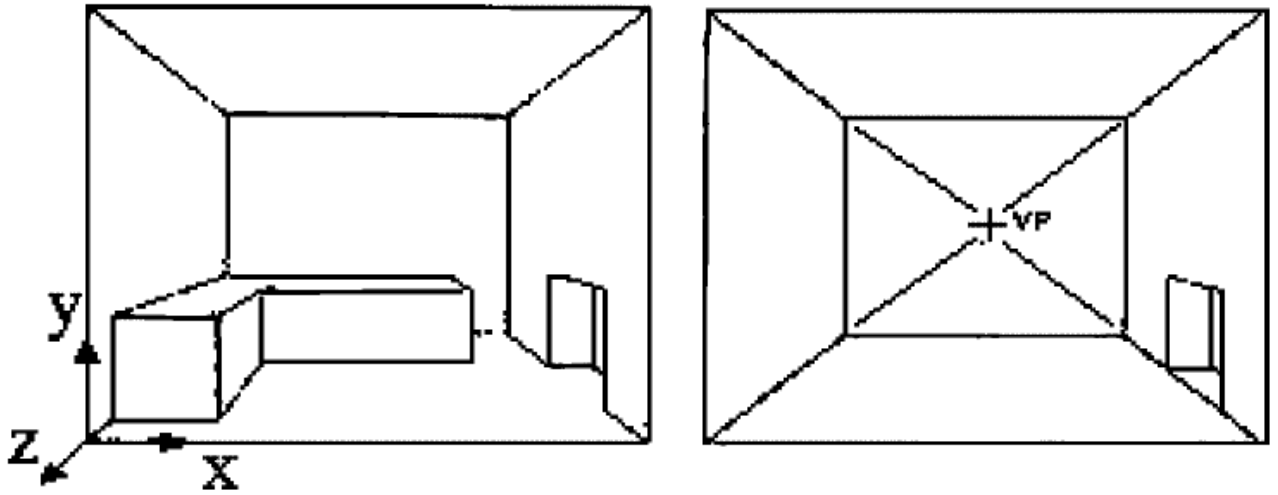
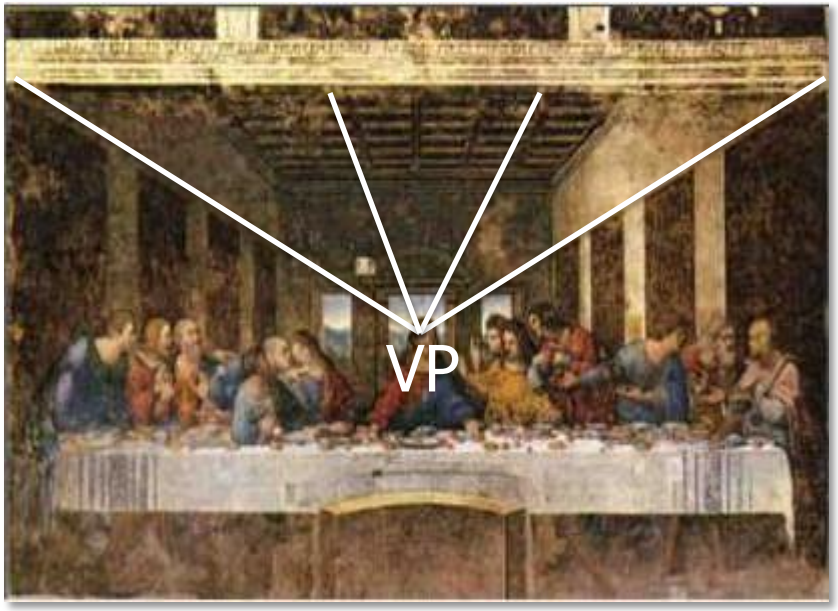


Figure 12.12 One-point perspective.

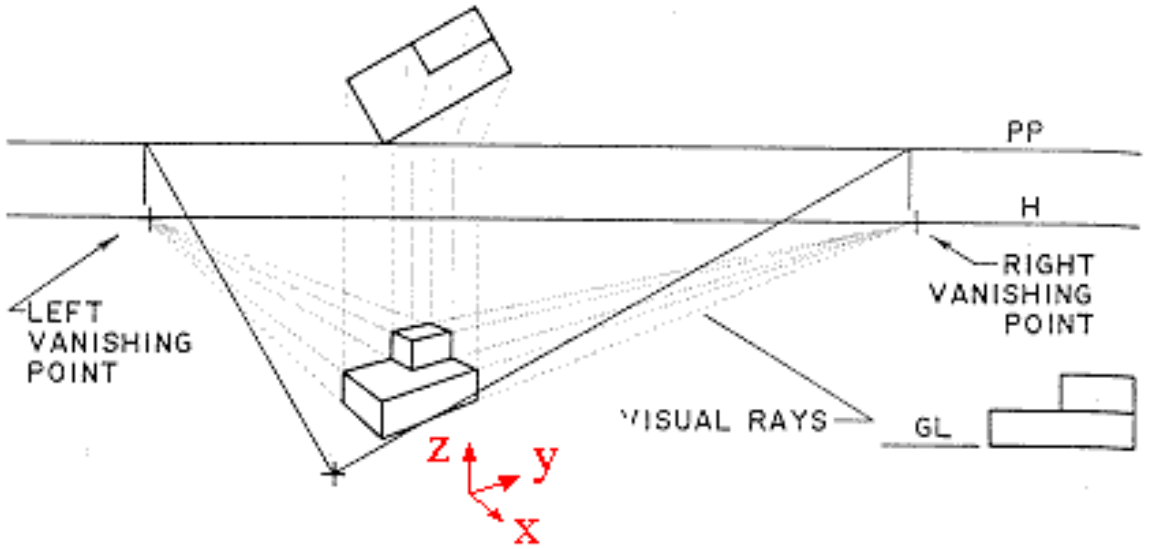
Perspective Projection

- LenardoDa Vinci: The Last Supper employed one-point perspective to focus the attention of the viewer to the vanishing point (VP)



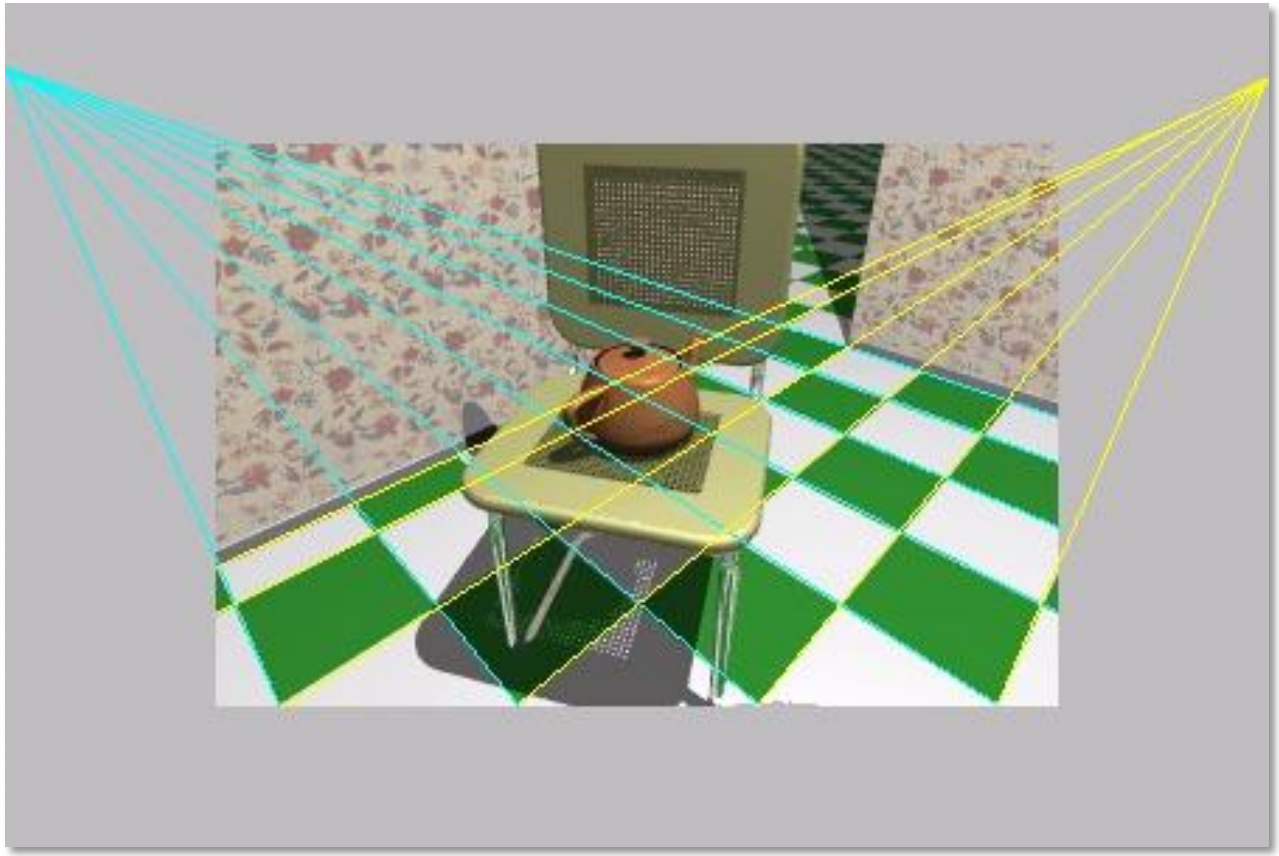
Two-Point Perspective

- Often used in architectural renderings
- If the projection plane intersects exactly two principal axes, a two-point perspective projection occurs
- In this perspective the visual rays converge at two vanishing points



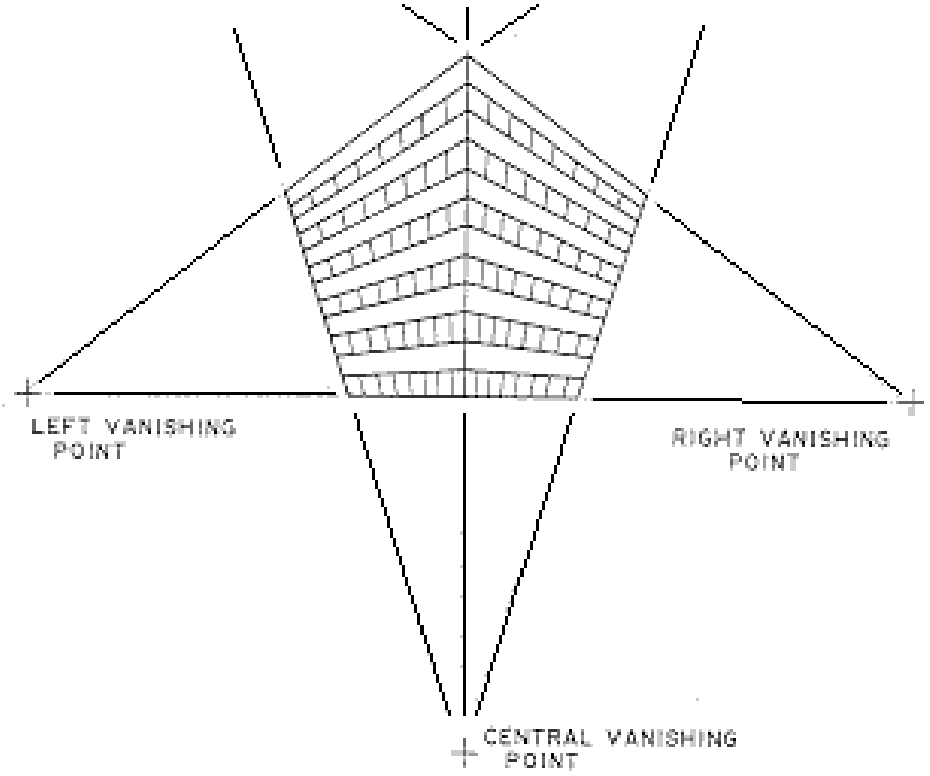
Perspective Projection

- Computer graphics two-point example



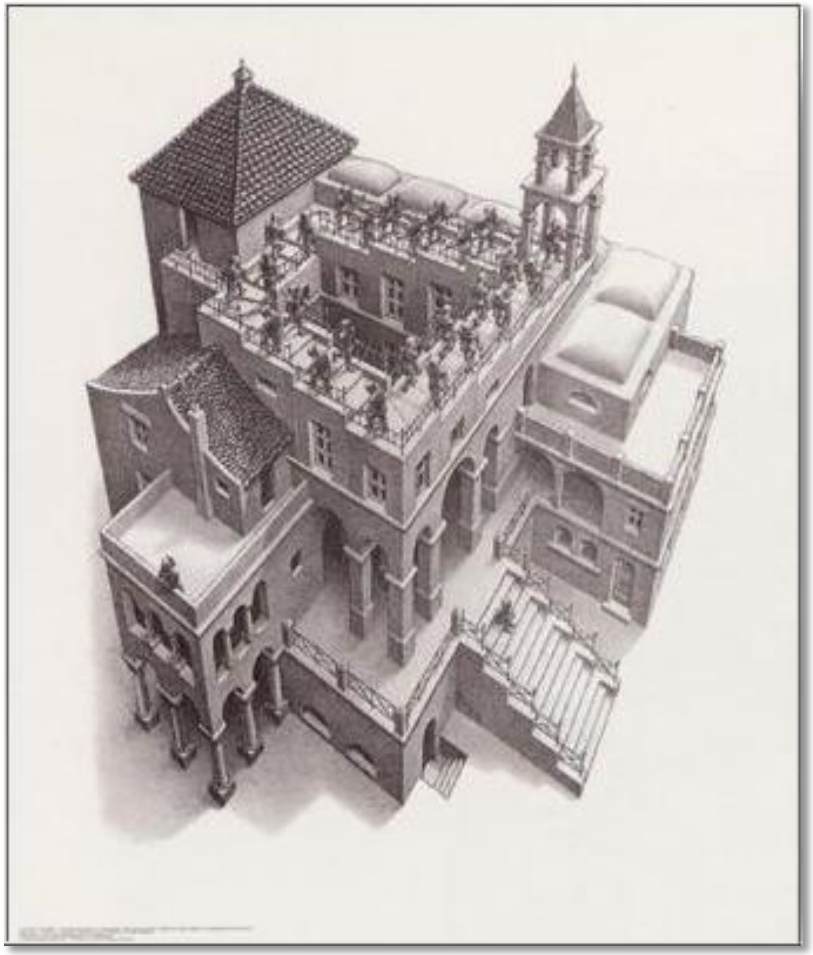
Perspective Projection

- If the projection plane is not parallel to any principal axis, a three-point projection occurs with the visual rays converging to three vanishing points

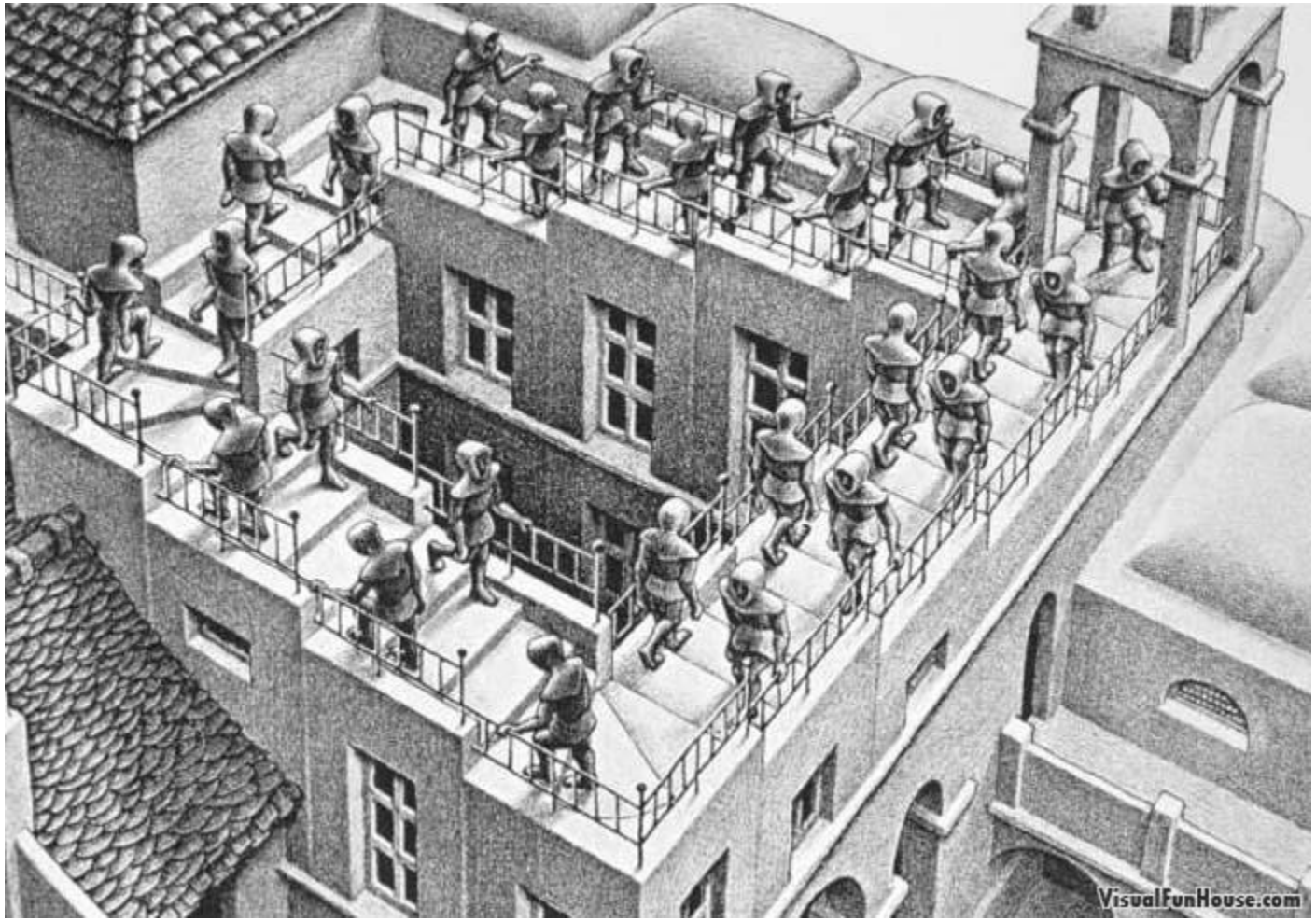


Perspective Projection

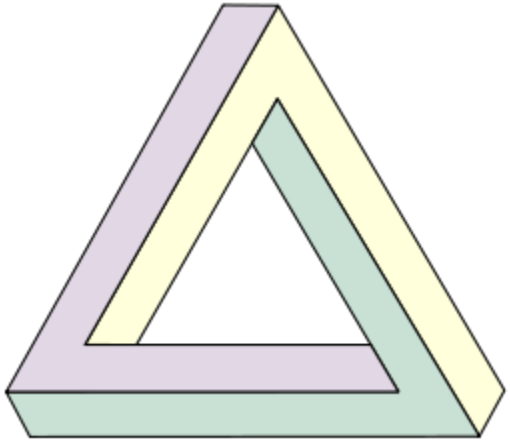
- M.C. Escher created optical illusions using three-point perspective in “Ascending and Descending”



Perspective Projection



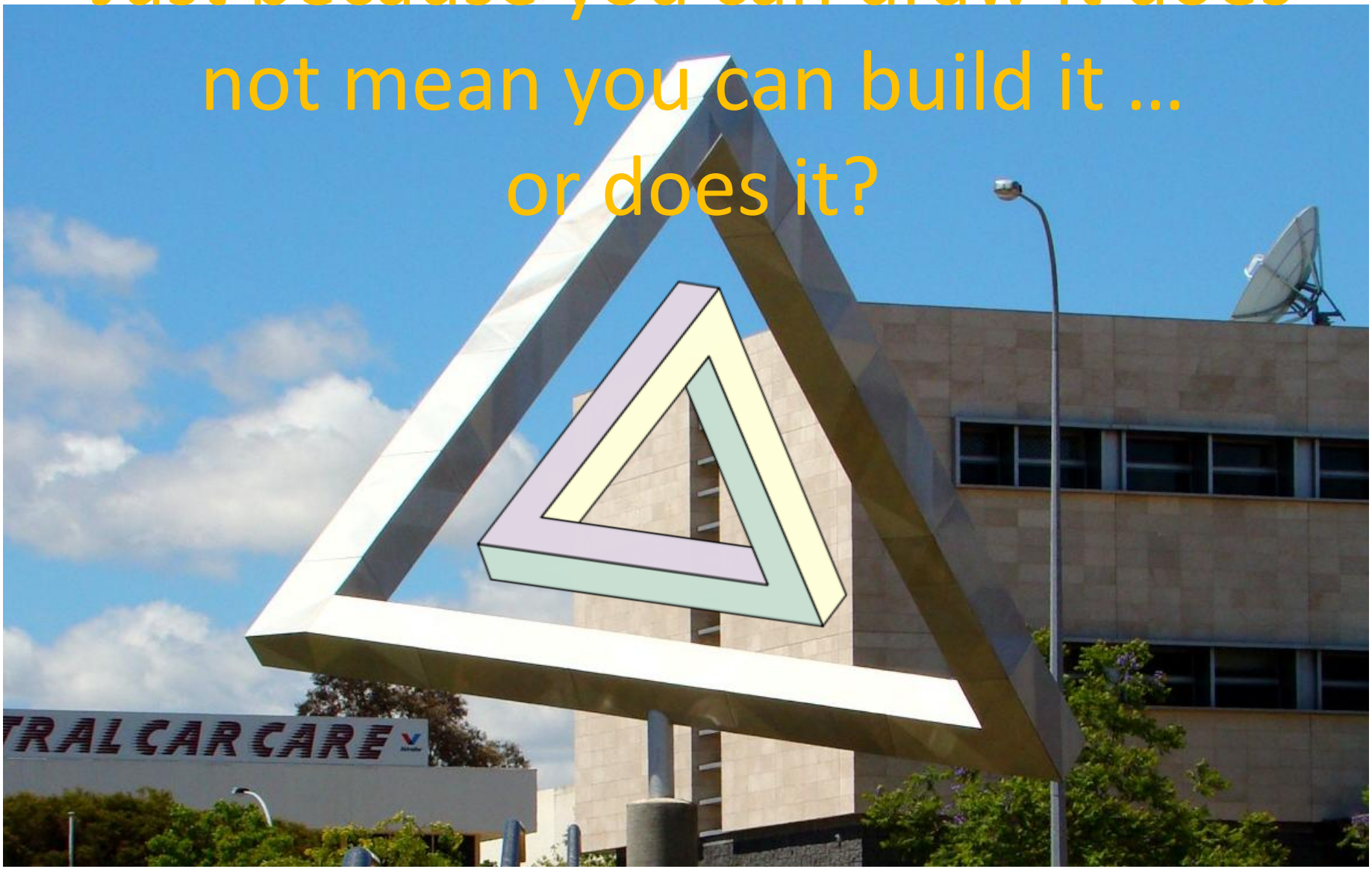
Just because you can draw it does not mean you can build it …



Penrose Triangle

Escher`s Waterfall

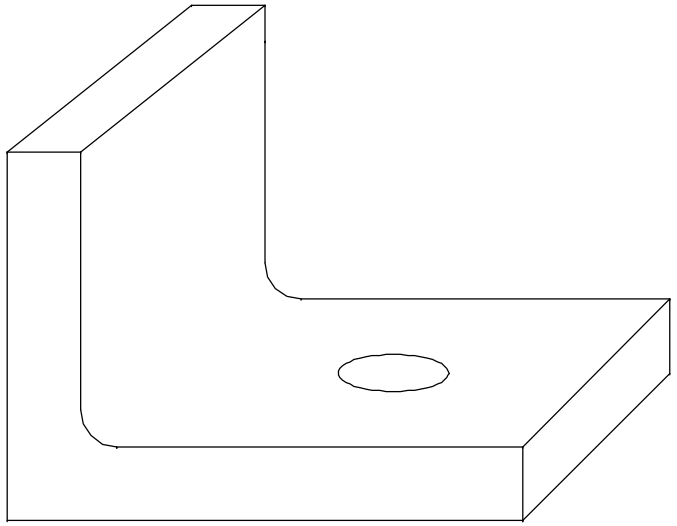
Just because you can draw it does not mean you can build it … or does it?



Brian McKay and Ahmad Abas in Perth Austrialia

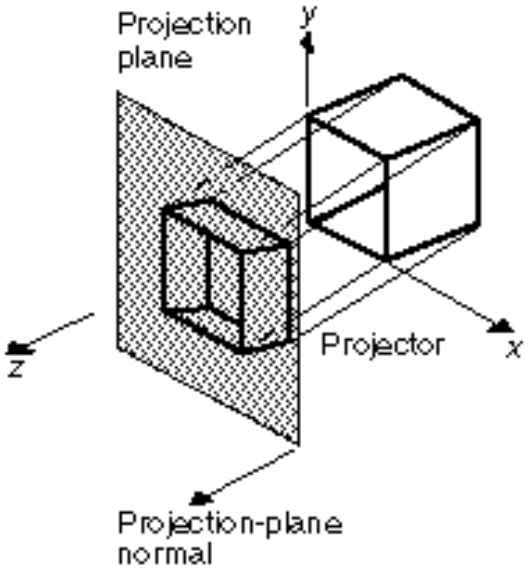
Oblique Projection

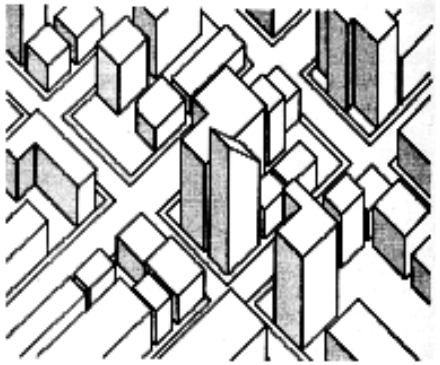
- Front face of object is parallel to the viewer, therefore that face is true size
- Projection lines do not converge to a vanishing point



Oblique Projection

- Parallel projectors are at an oblique angle (*i.e.,* not 90^{o}) to the paper plane
- Used to give an indication of depth
- Presents the exact shape of one face
- Lack of perspective foreshortening makes it easier to compare sizes

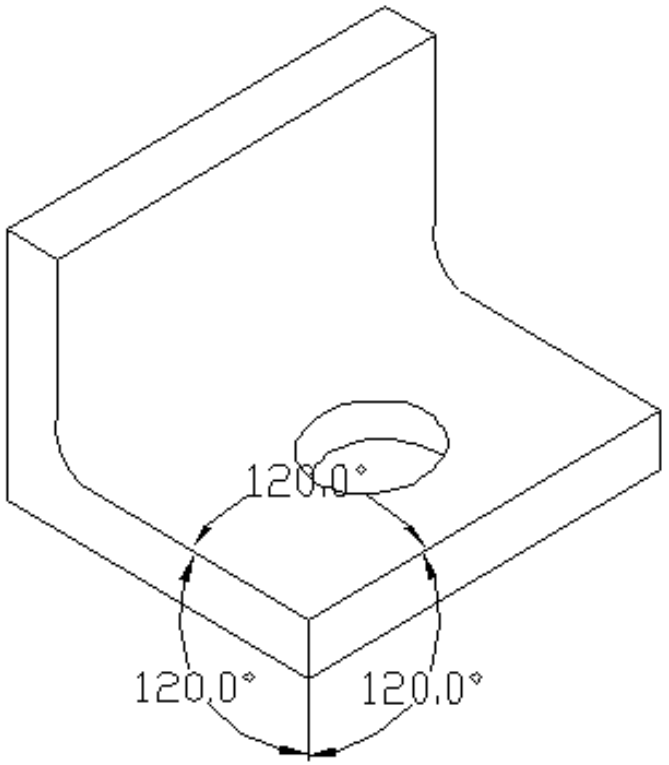




Foreshortening is a technique used in perspective to create the illusion of an object receding strongly into the distance or background.

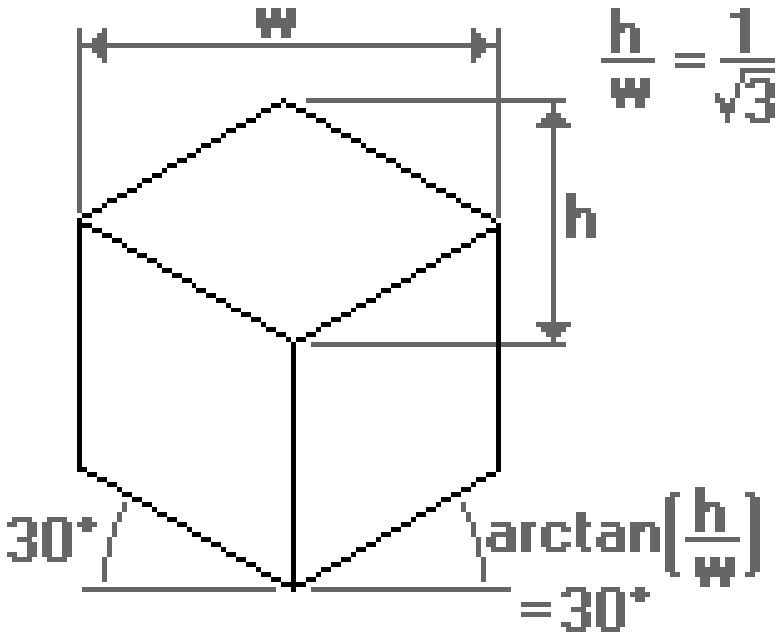
Isometric Projection

- Parallel lines remain parallel instead of converging to a vanishing point
- Axis are each 120 degrees apart
- Special case of *Axonometric* projection
  - Viewed so as to reveal more than one side



Isometric Projection

- Isometric projection uses parallel projectors (orthogonal projection), but it shows more than one face of the object (axonometric)
- The x-, y- and z-axes have the same metric: a unit (say, a cm) along the x-axis is equally long along the y- and z-axes
- In a cube, all edges in the 2D picture have the same length
- The projected cube is also symmetric; all sides are rhombuses (a rhombus is a parallelogram with sides that are equal in length)



Isometric *Sketching*

- Isometric projection uses parallel projectors (orthogonal projection), but it shows more than one face of the object (axonometric)
- The x-, y- and z-axes have the same metric: a unit (say, a cm) along the x-axis is equally long along the y- and z-axes
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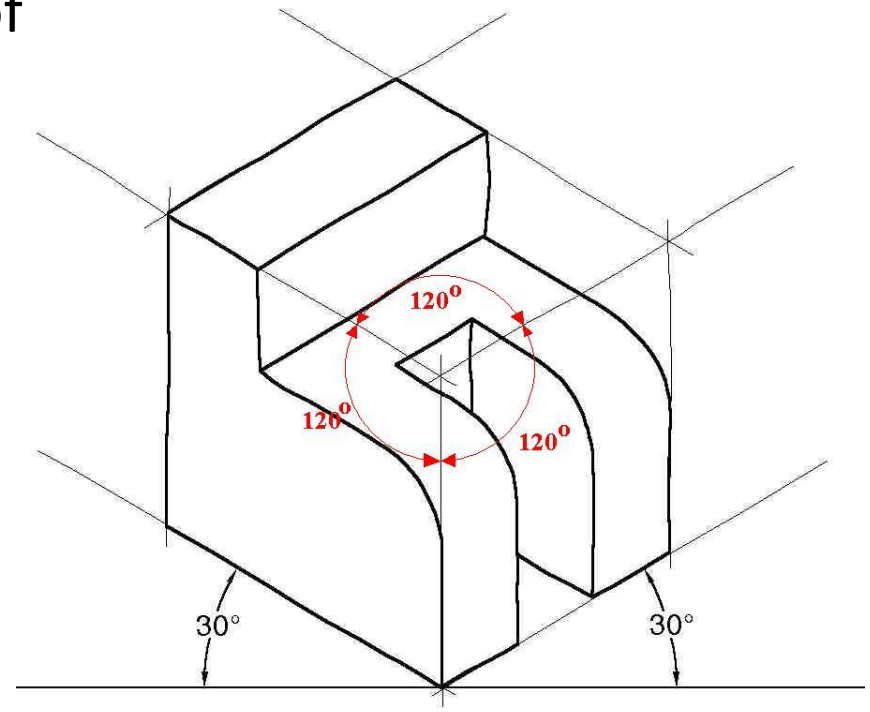
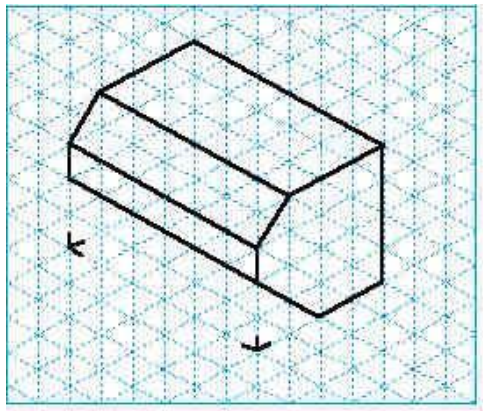
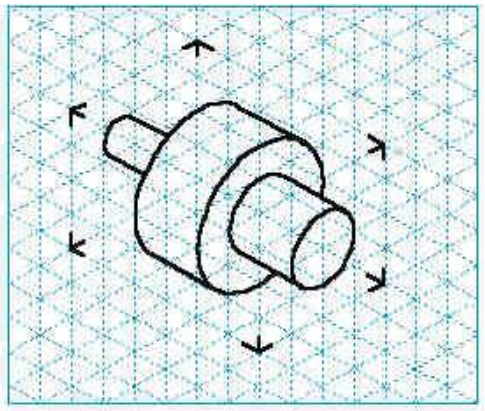
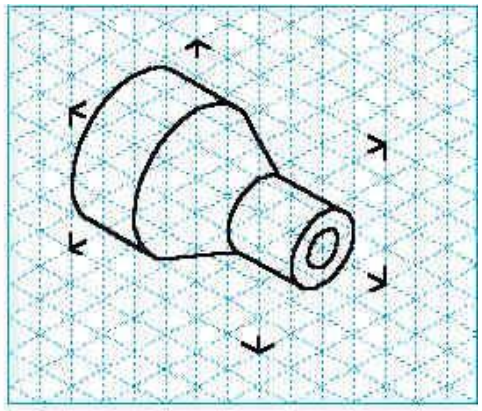
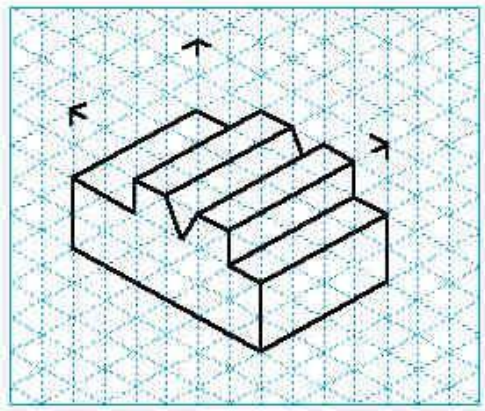


Isometric Sketch Paper









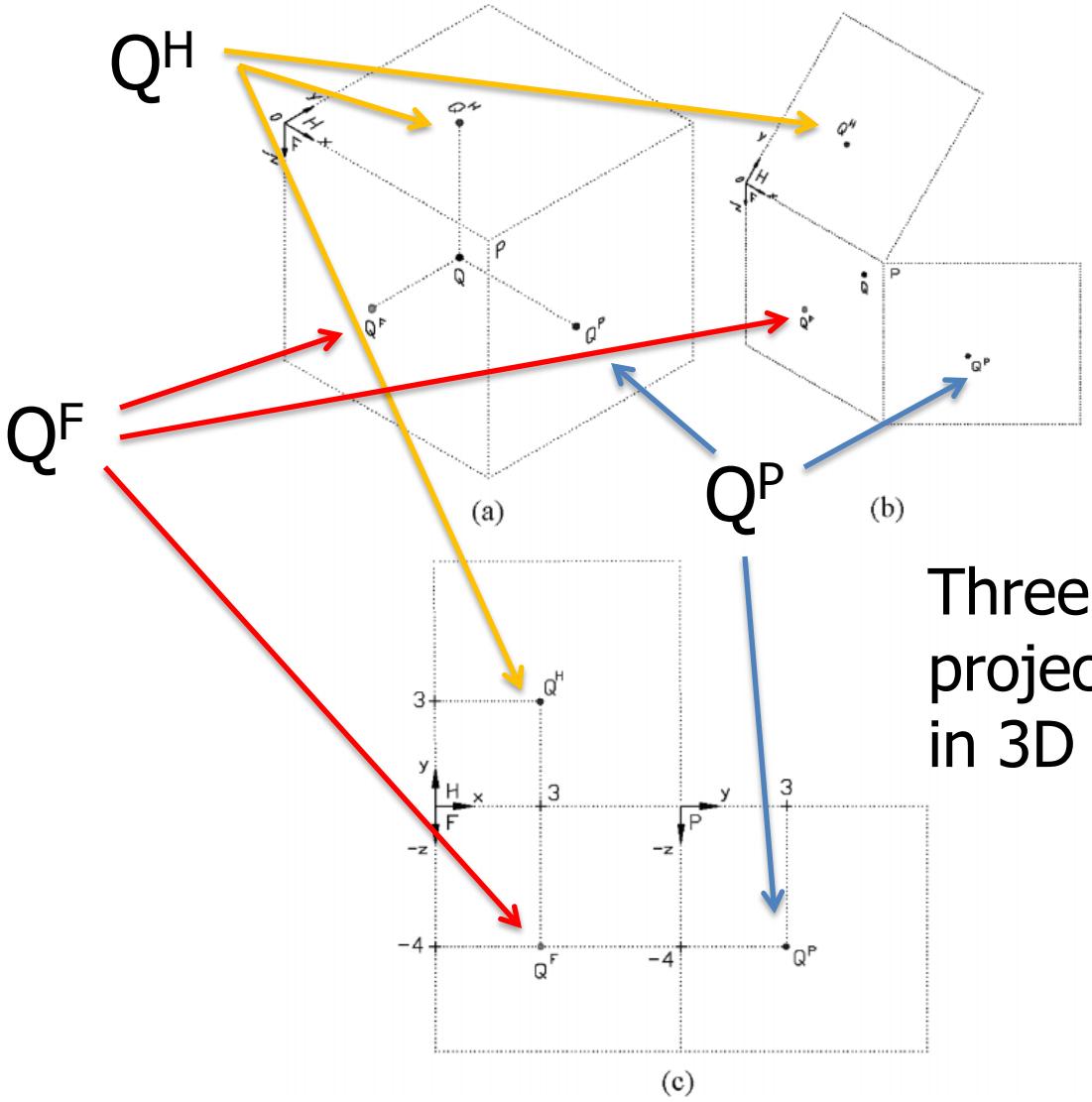
Orthographic Projection

- The most important method of the four outlined here
- 2D representations of a 3D object
- Extensively used in Engineering
- Useful when technical information is needed
- They enable parts to be made
- Often an isometric view is included with the standard views

Orthographic Projection

- Orthographic projection is the geometric backbone of a technical drawing
- In order for the technical drawing to be useful, many conventions must be followed
  - The information in the drawing has to be clear and concise
  - Conventions apply to things like object placement, line types, and dimensioning

Orthographic Projection



Three orthographic projections of a point in 3D space

Figure 12.7 Three orthographic projections of a point in 3D space.

Orthographic Projection

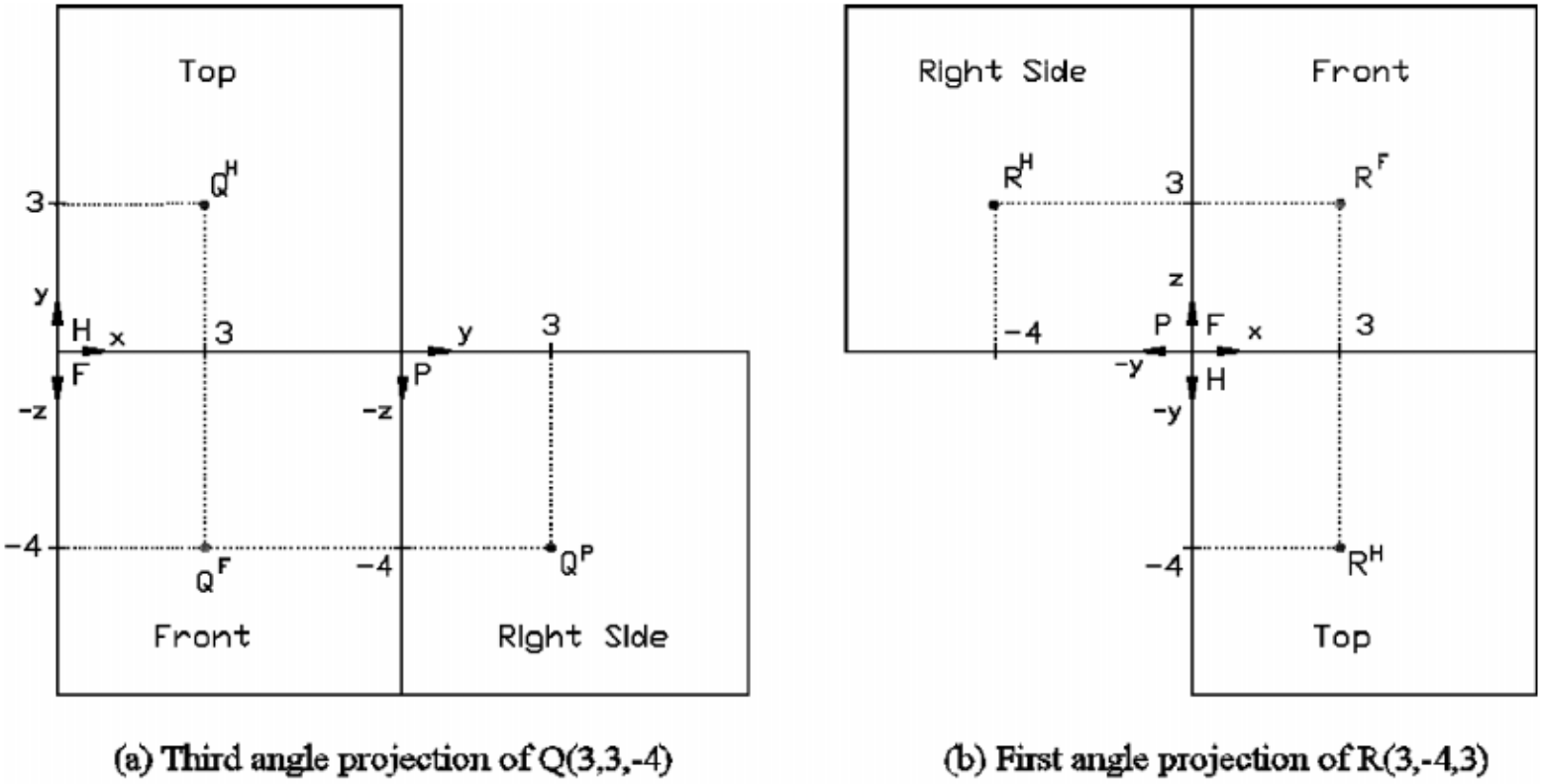
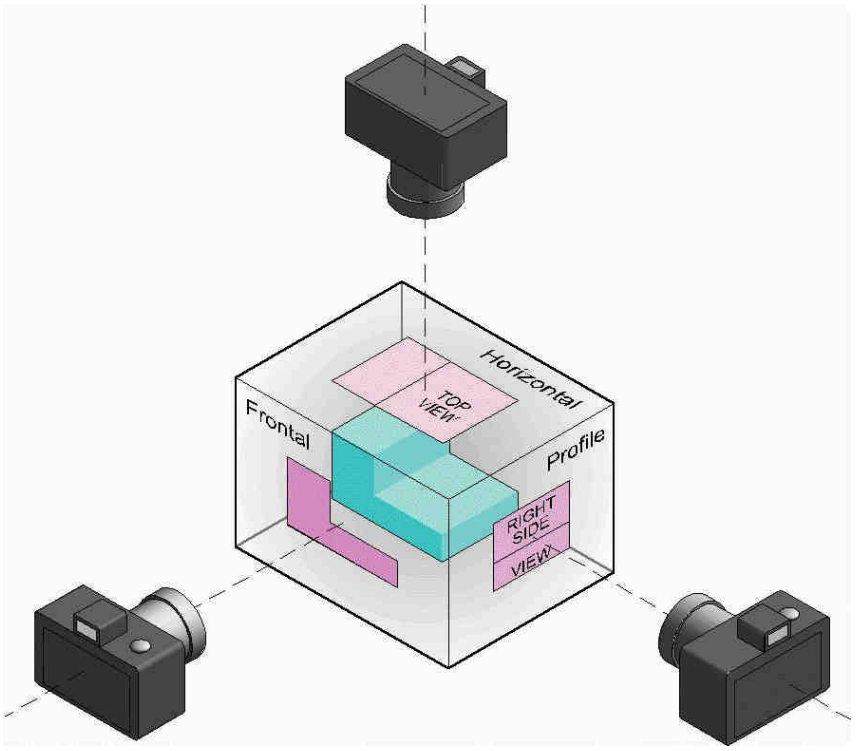


Figure 12.8 Three relative positions of the principal planes in third and first angle projection.

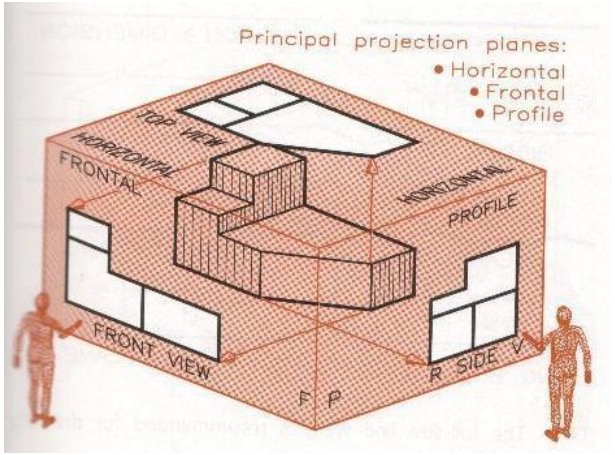
Orthographic Projection

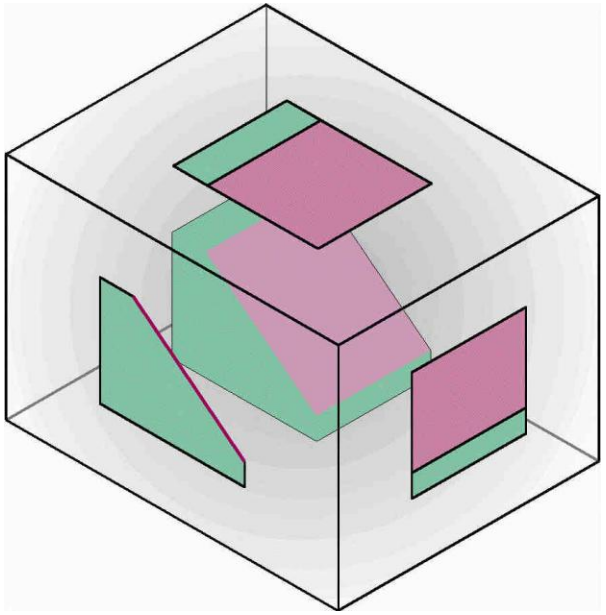
- The bracket in the figure is a simple part, but describing it with words is difficult
- Is it hard to make a 3D drawing of it?
- Not if you know how to project it *orthographically*!
- Orthographic projection represents different views separated by 90^{o} as the viewer moves around it



Orthographic Projection

- Orthographic projection involves projecting views of an object onto the sides of an imaginary rectangular glass box
- The projectors in any one view are parallel to each other and perpendicular (orthographic, or orthogonal) to the projection planes (the sides of the rectangular glass box)

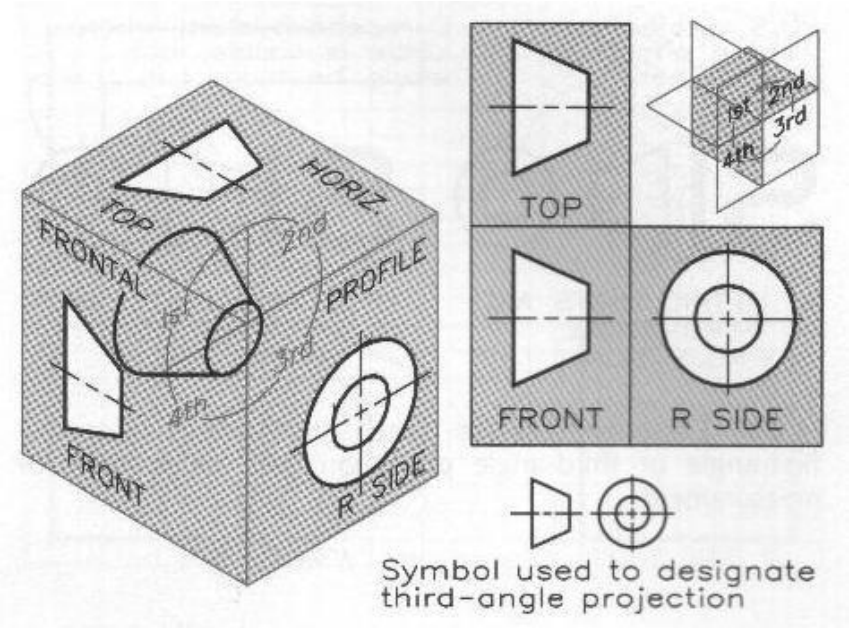




Third-Angle Orthographic Projection

Third-Angle Projection

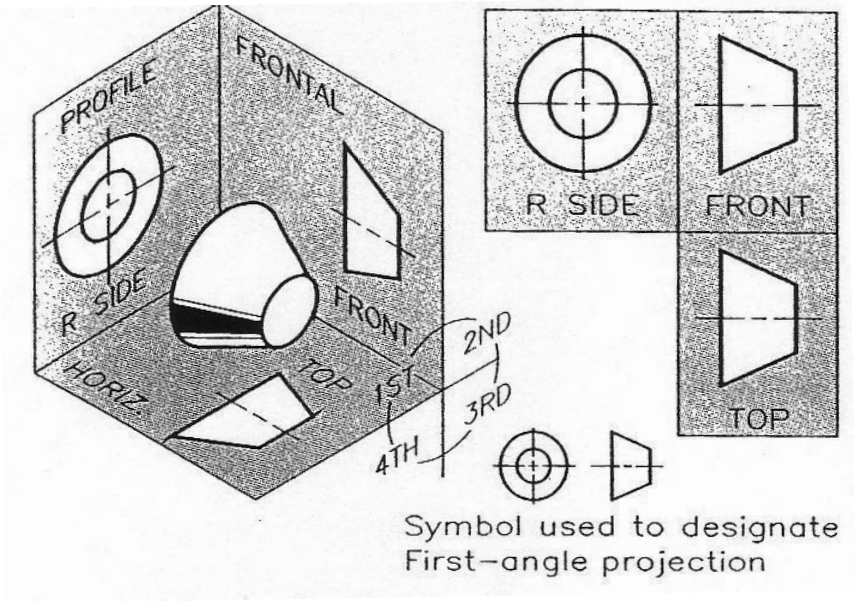
- The object is placed in the third quadrant and then viewed from the first quadrant
- Projection planes are between the observer and object
- Used in Canada, U.S., and Britain
- First-Angle Projection used in Europe
- The top view is placed over the front view; the right-side view is to the right of the front view



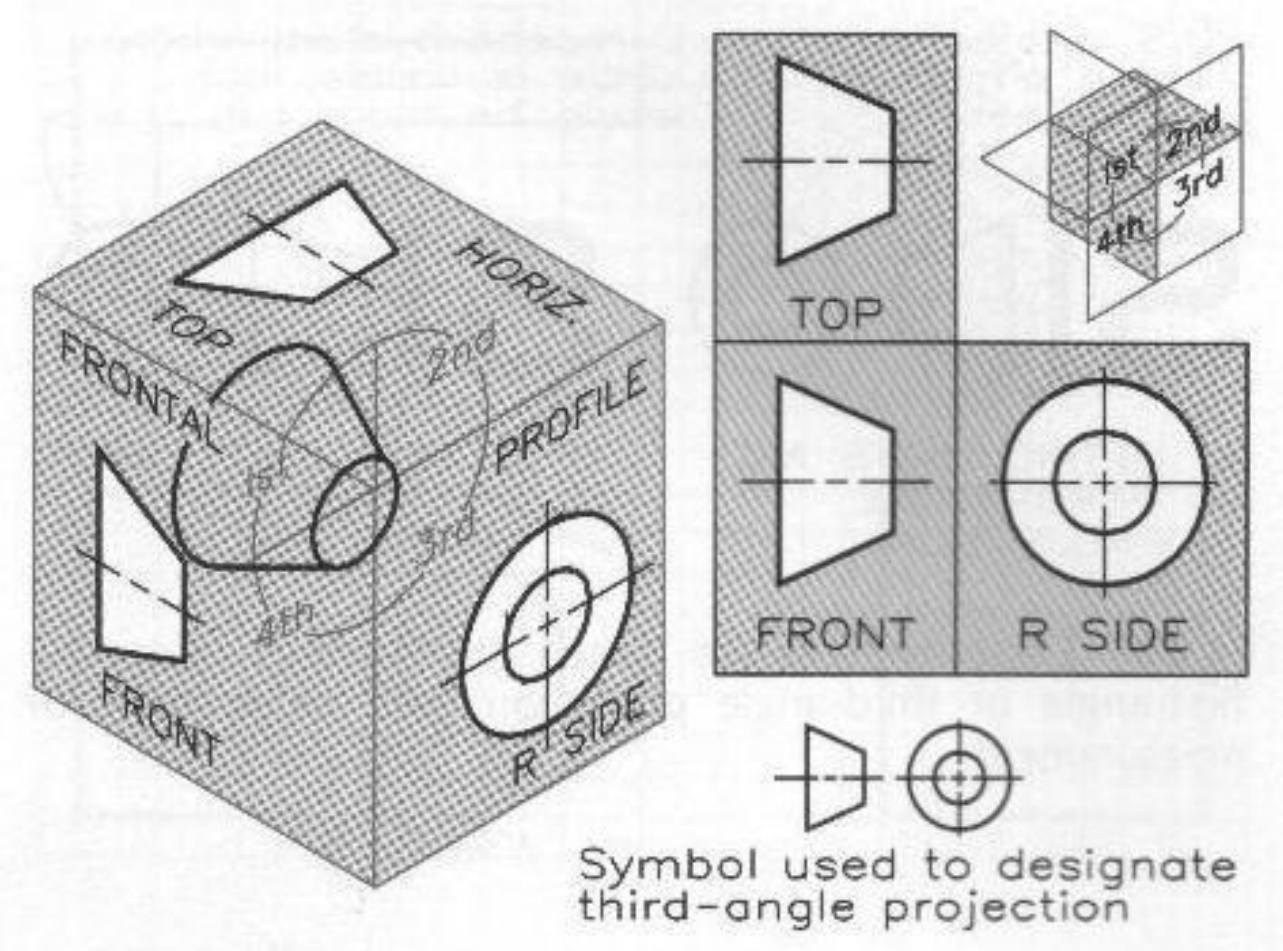
First-Angle Orthographic Projection

First-Angle Projection

- The object is placed in the first quadrant and viewed from the first quadrant
- The object is between the observer and projection planes
- Used in most of the world
- The top view is placed below the front view. The right-side view is to the left of the front view

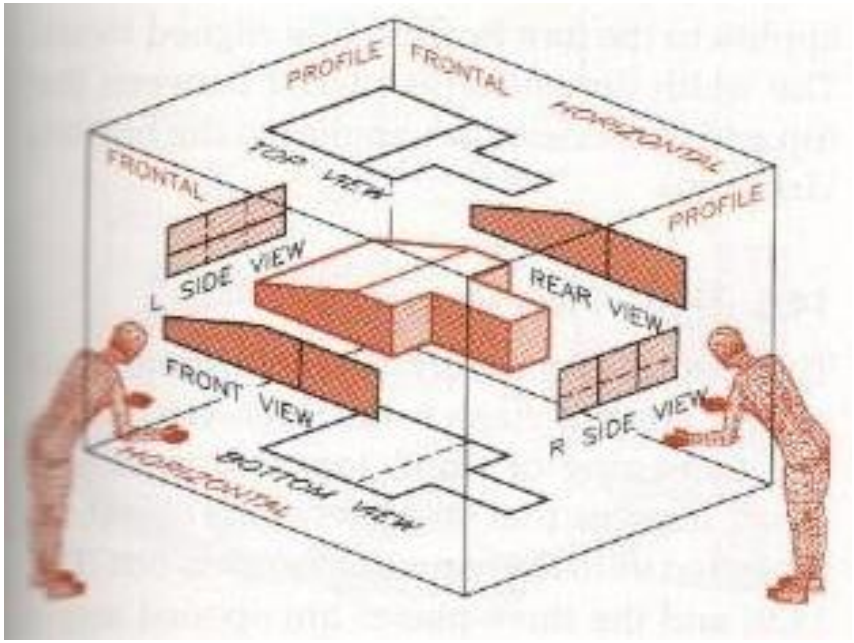


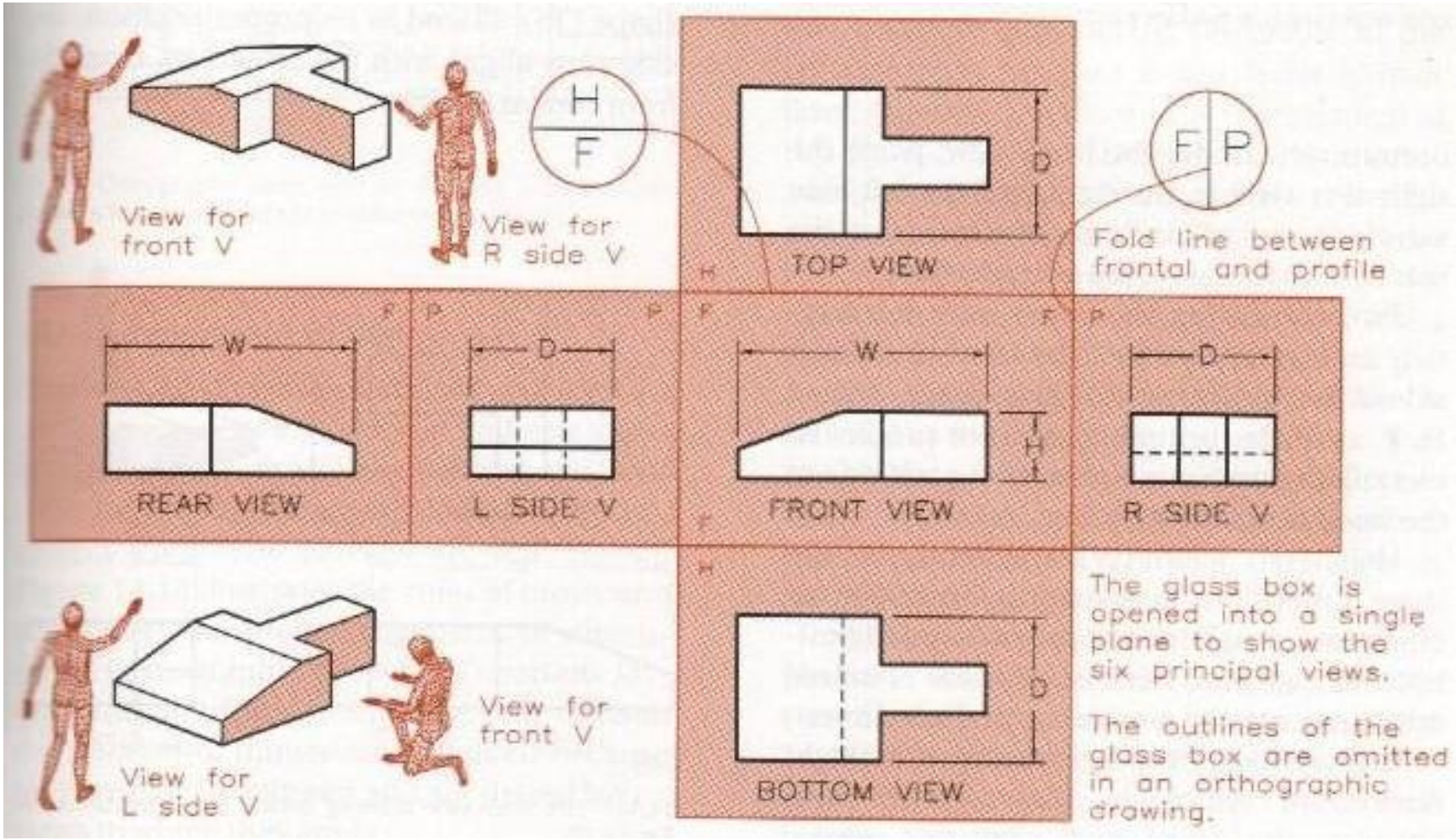
We use Third-Angle Projection



Orthographic Projection

- Six principal views can be drawn in orthographic projection
- Imagine a glass box with the views projected onto its six planes





Orthographic Projection

Opening the box into a single plane (the front plane) gives the six views

Orthographic Projection

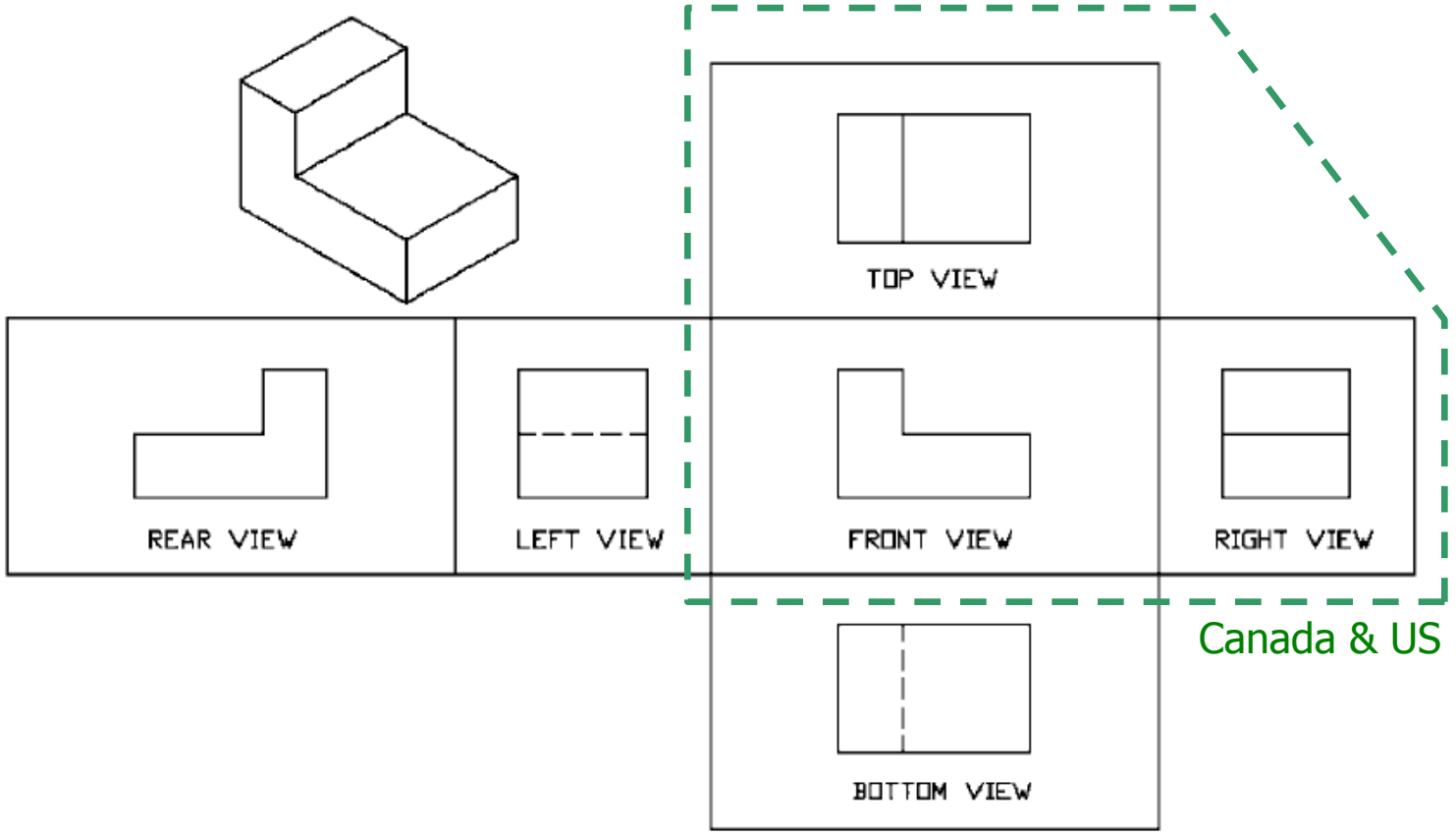
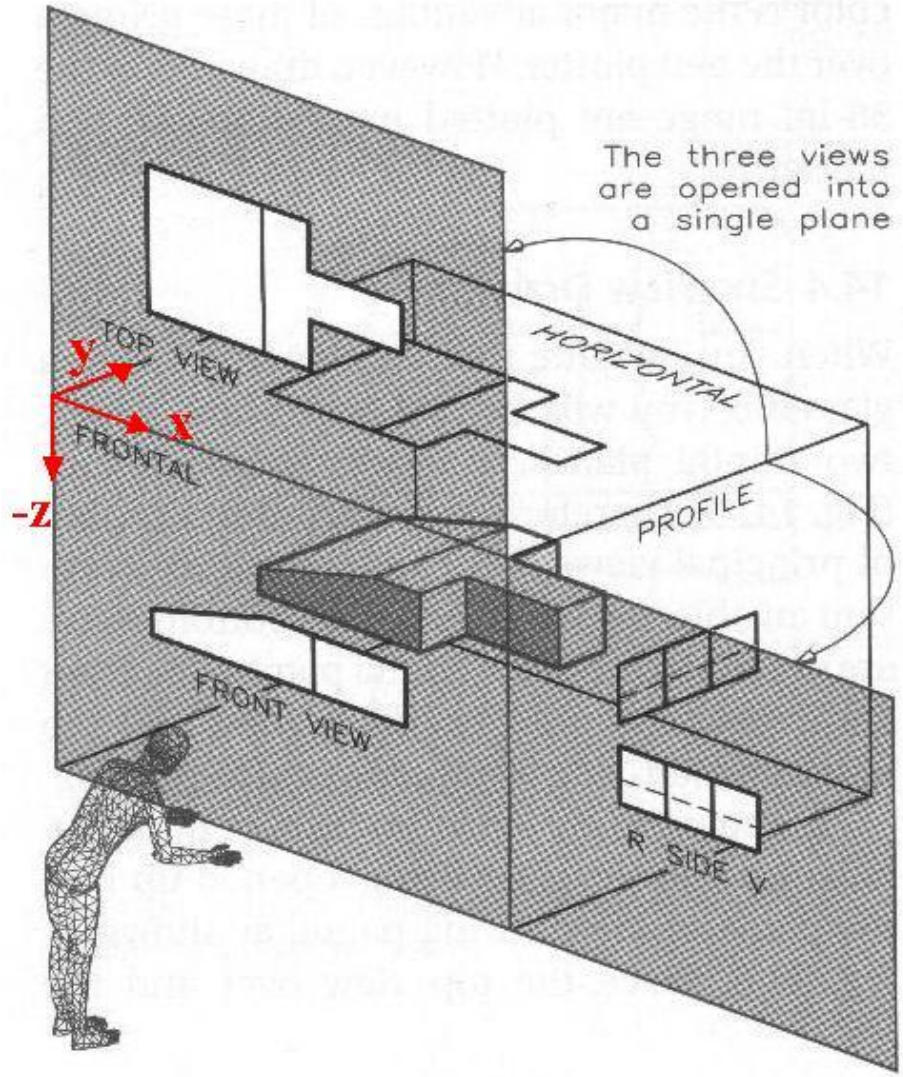
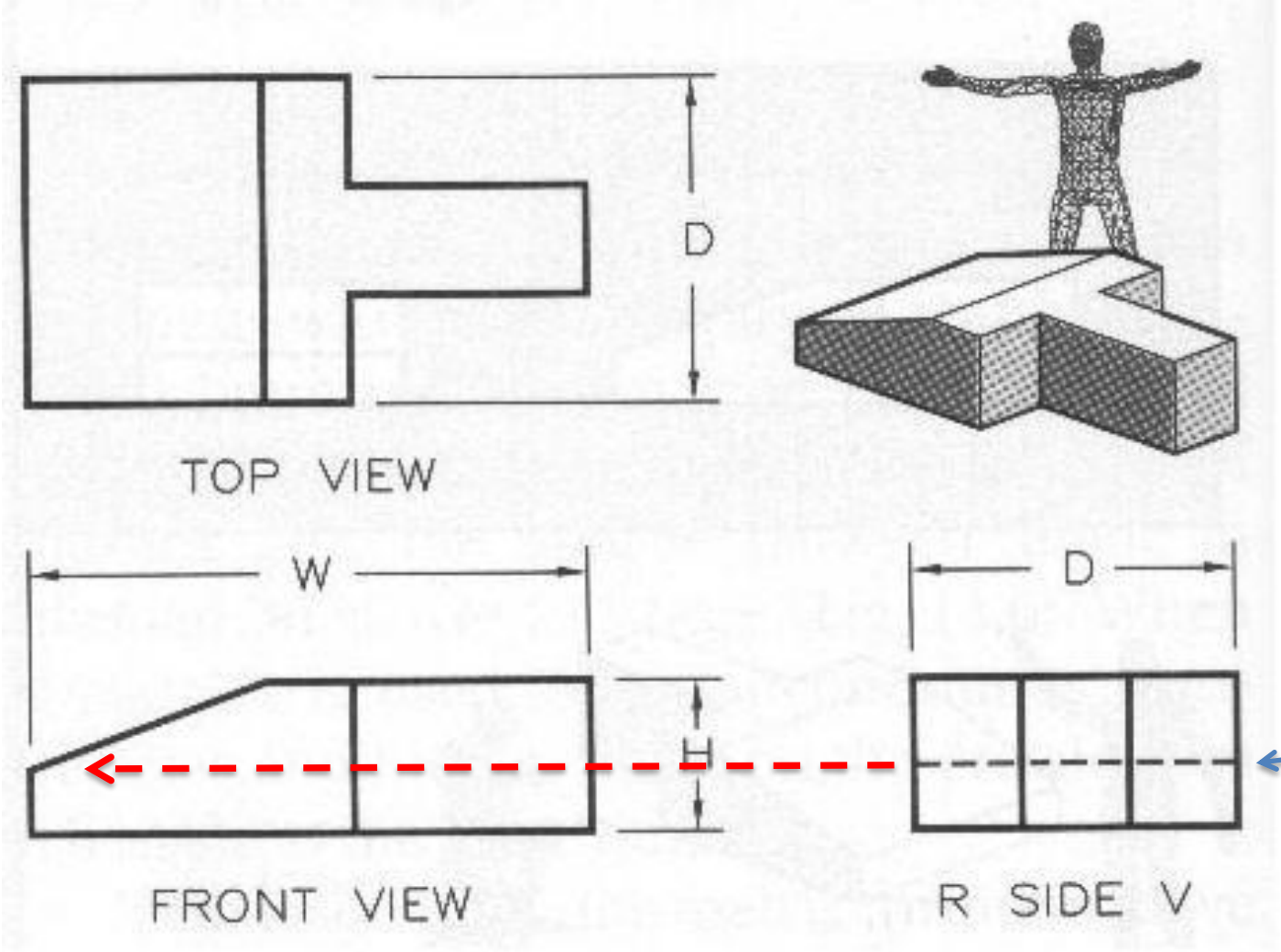


Figure 12.20 Six principal views.

Three-View Drawings

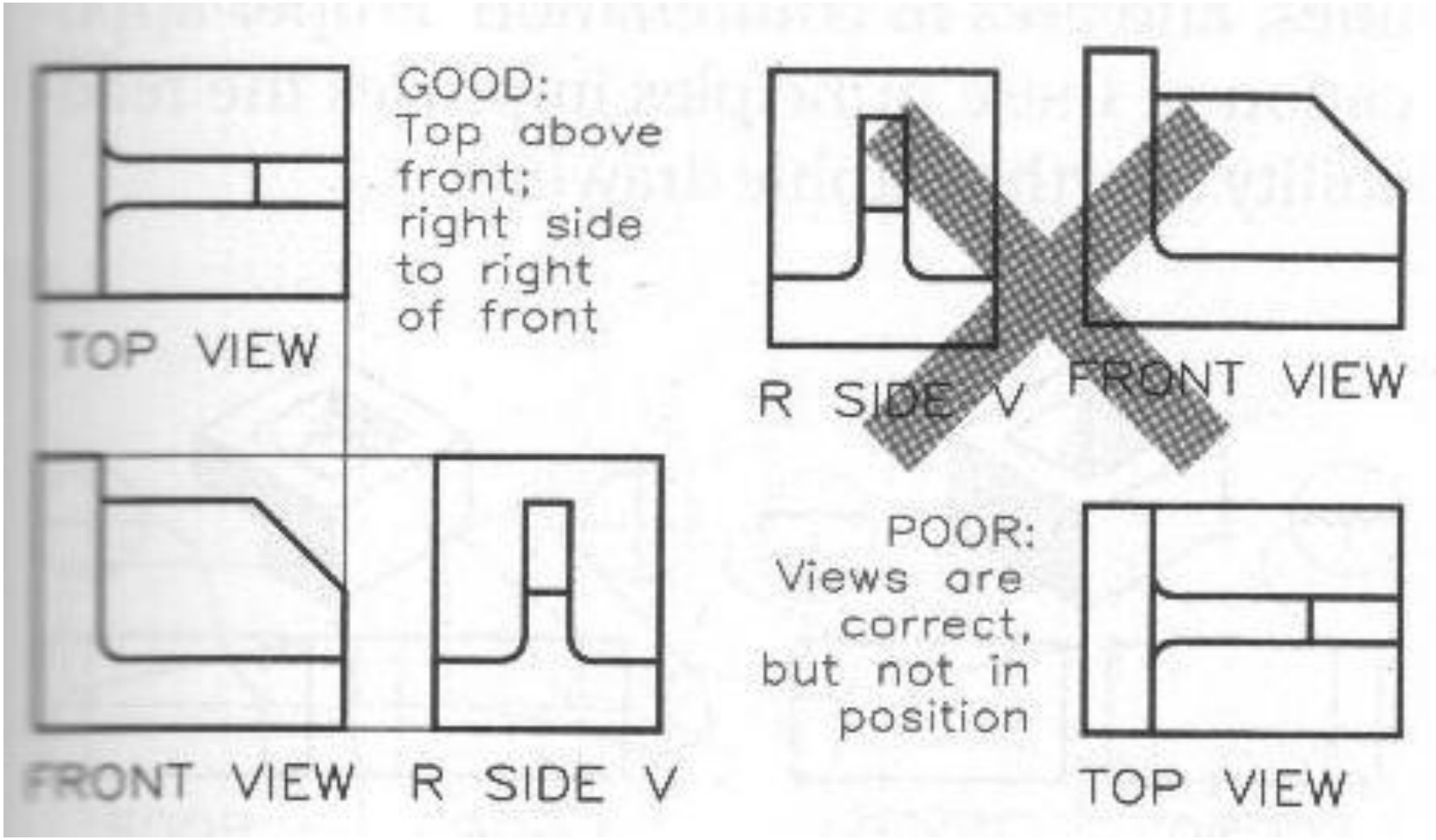
- We use third-angle projection
- Three-view drawings typically, though not always, consist of top, front, and right-side views
- Imagine the object is placed in the box and orthographically projected onto the three planes
- The box is then opened into the frontal plane





Three-View Drawings

Width, Height, and Depth dimensions can be represented, giving enough information to construct the object

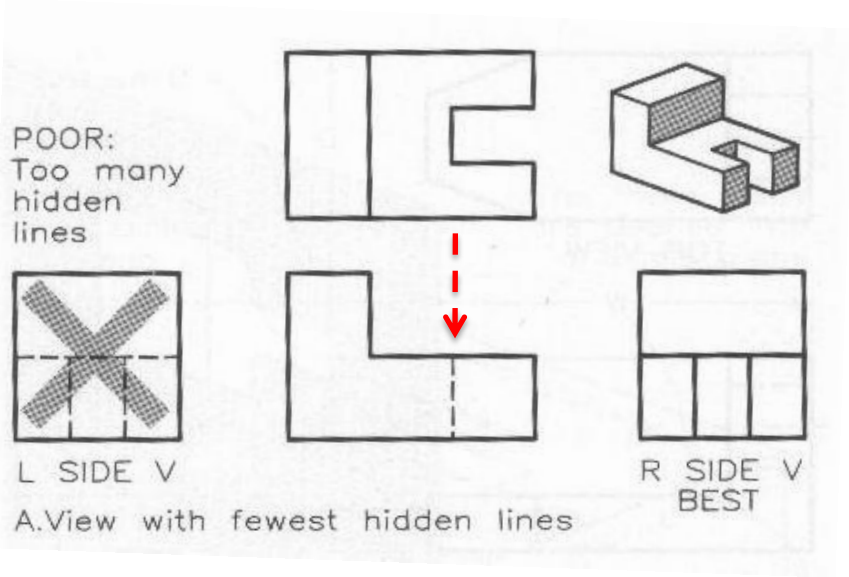


Arrangement of Views

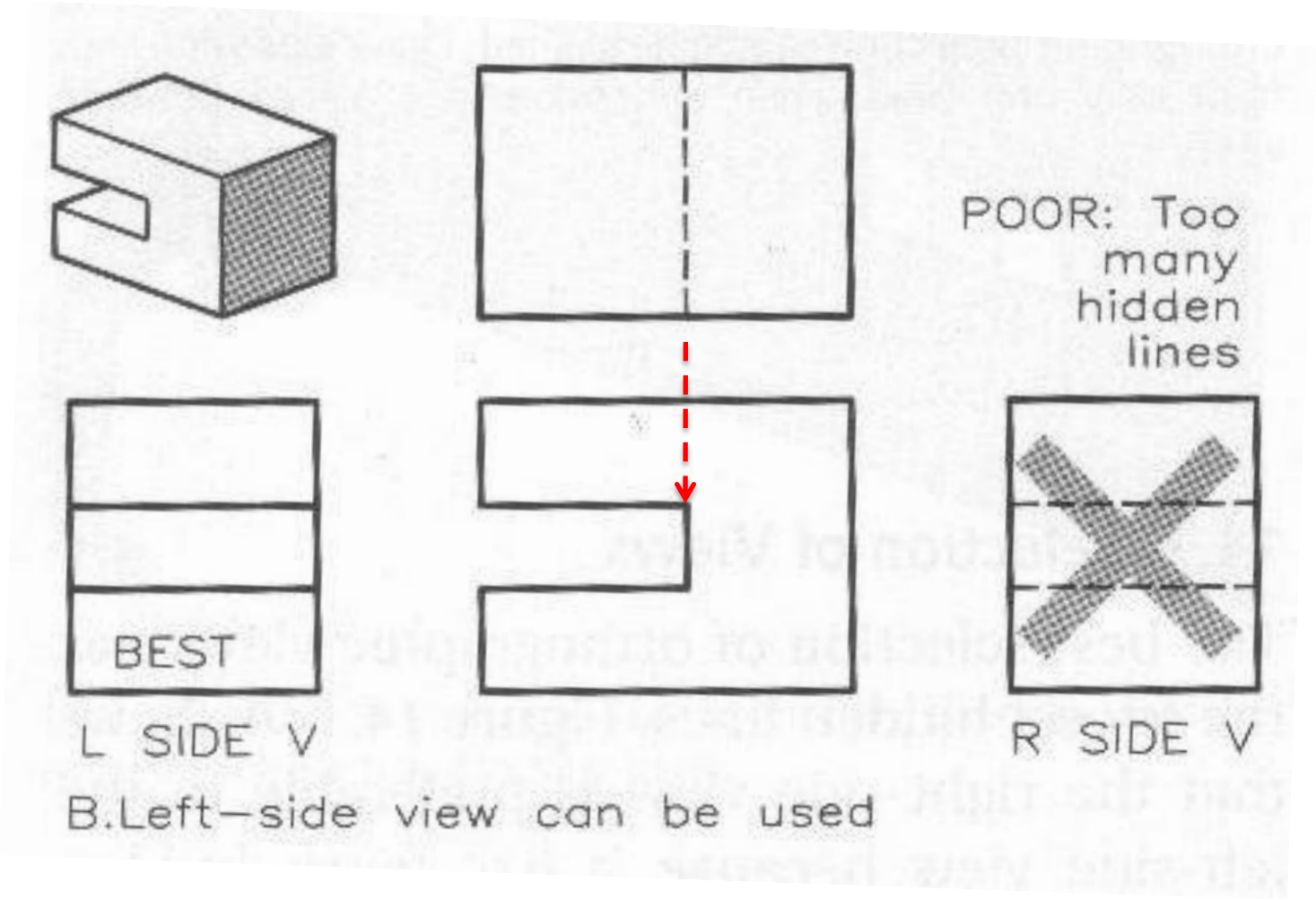
- The three views must be arranged according to the projection convention (first-angle or third-angle)
- Top and side views are projected from and aligned with the front view

Selection of Views

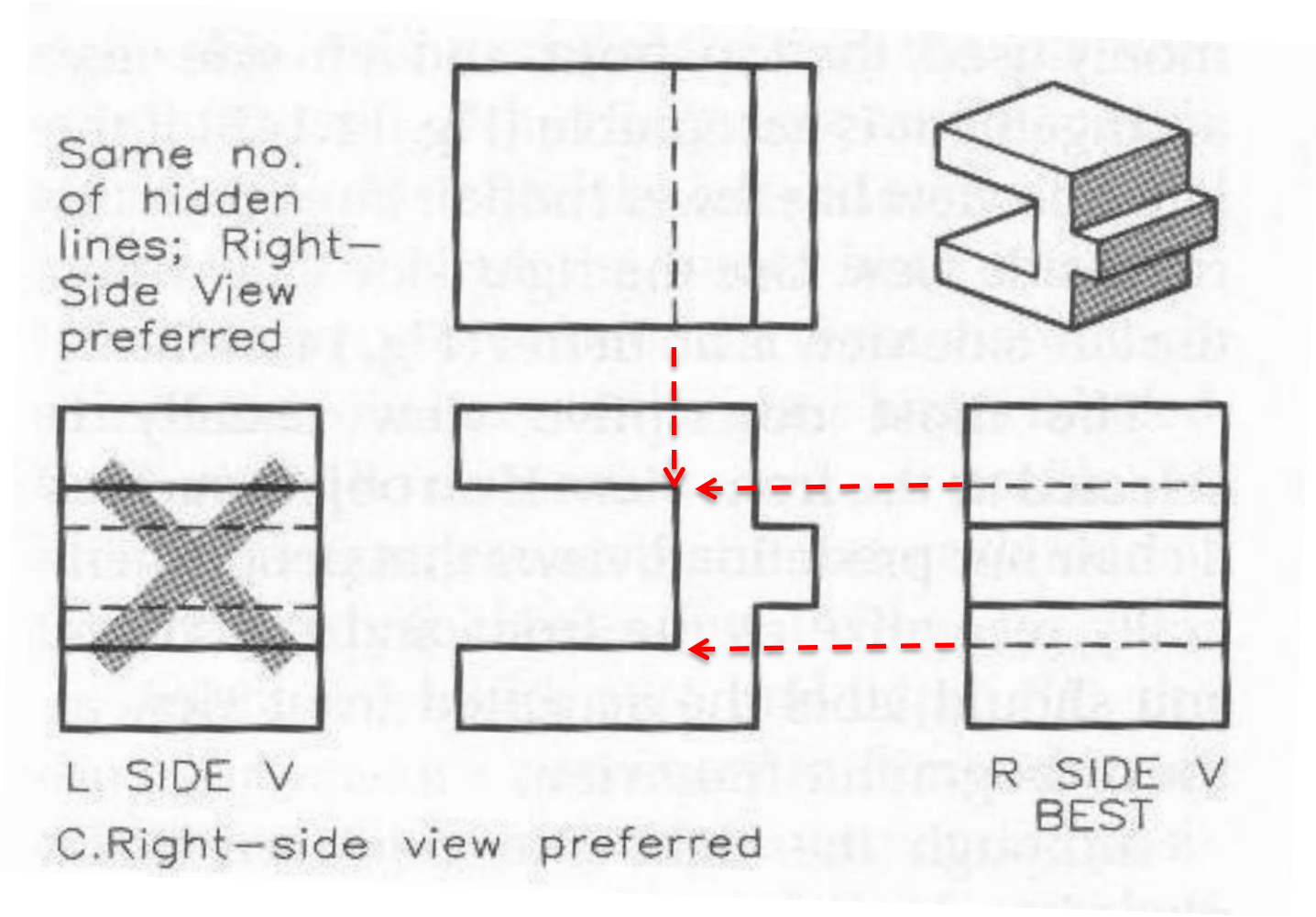
- The most descriptive view is usually selected to be the front view
- The remaining views are selected such that they contain the fewest hidden lines
- If a tie occurs (say between the left and right-side views) use the conventional view (top or right-side)



Selection of Views



Selection of Views



Assignment

- Read Chapters 12 & 14