

MECH 211 – Mechanical Engineering Drawing

François Tardy

Credits: 3.5

Lecture 1

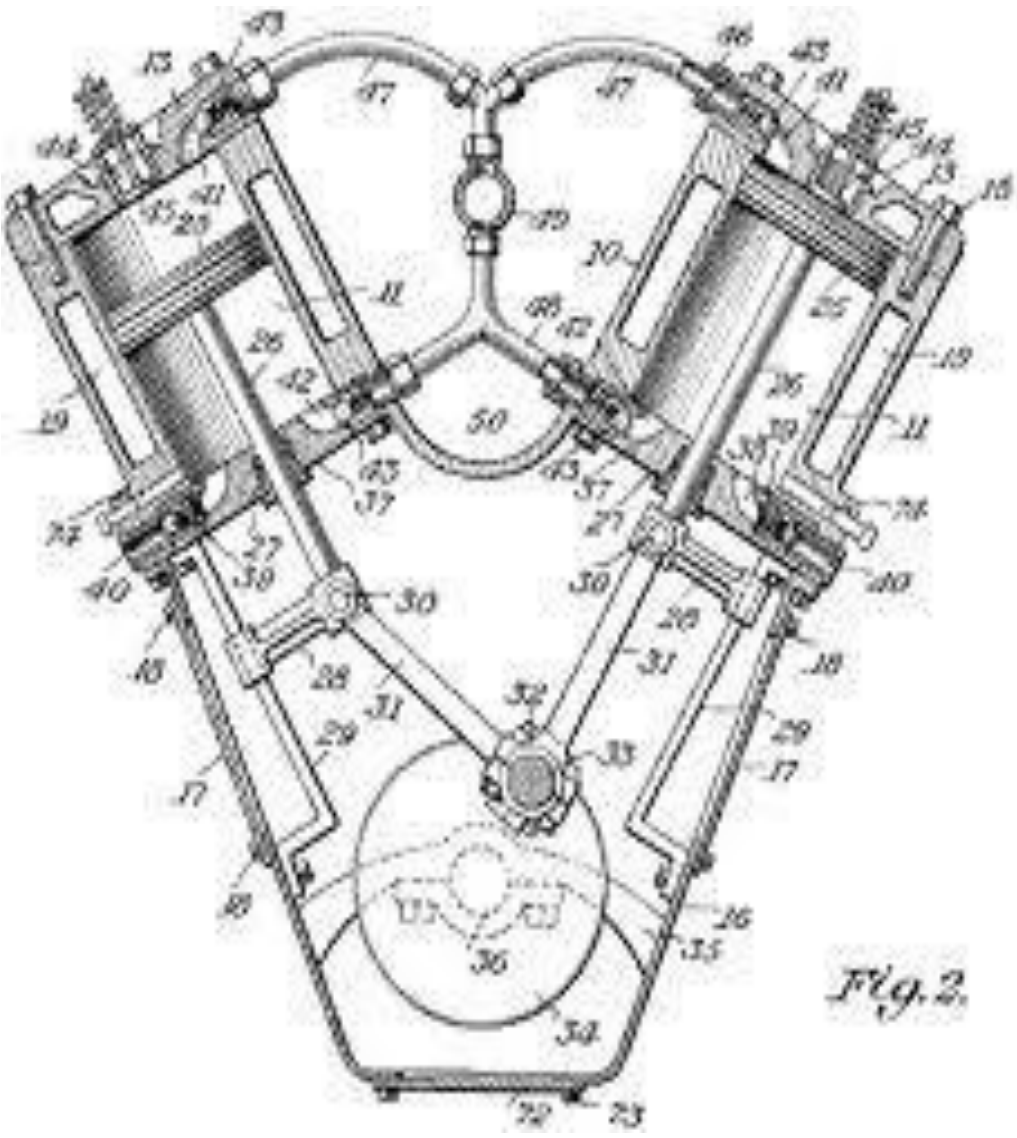
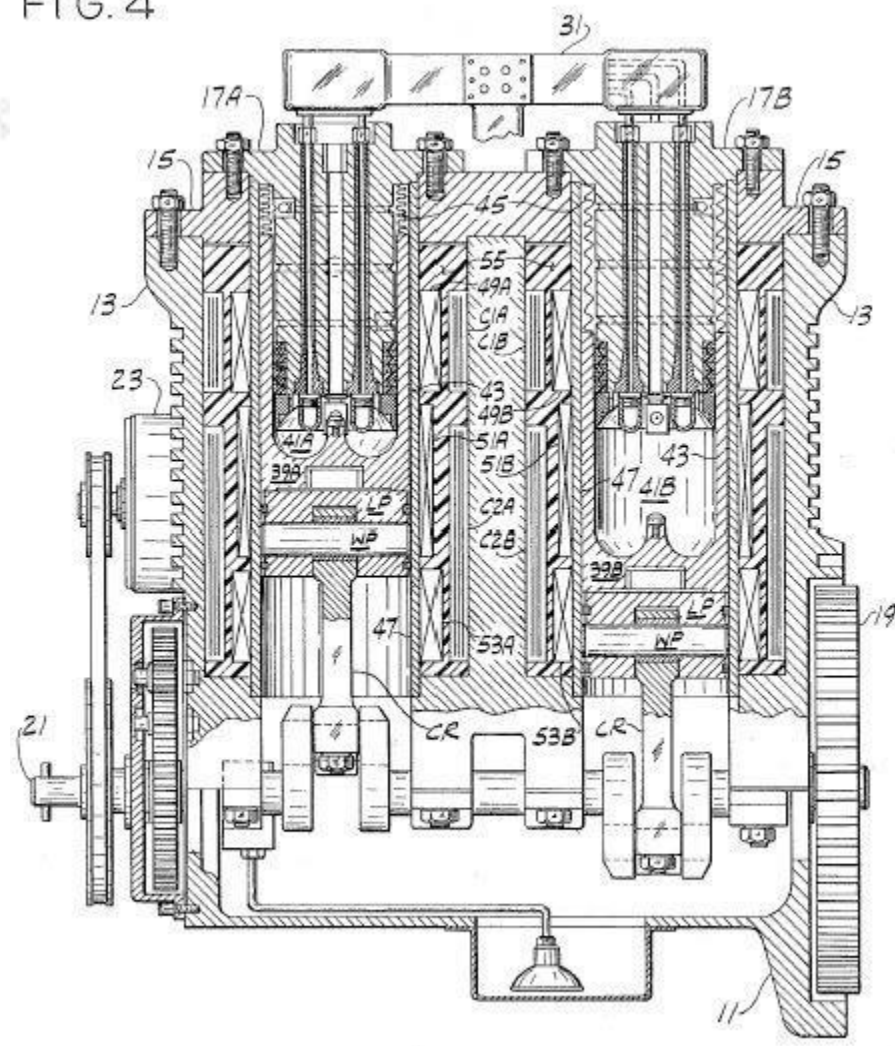
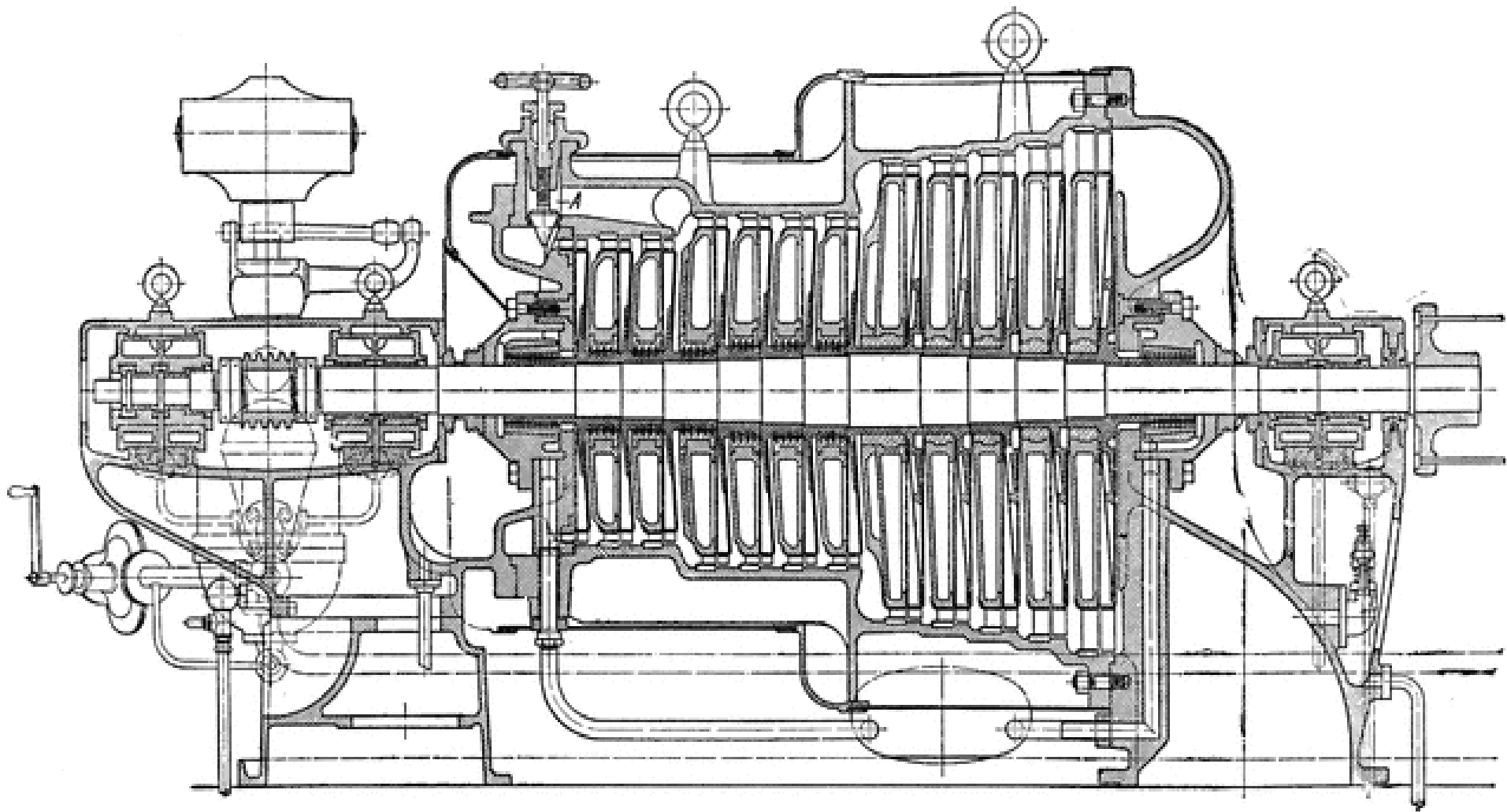


Fig. 2

FIG. 4





Course Objectives


This course enables the students to learn the techniques and standard practices of mechanical engineering drawings.

At the end of the lectures, you will be able* to :

- Read a working or assembly drawing (blueprint),
- Represent mechanical components in orthographic multiview representation,
- Create conceptual design sketches,
- Create assembly drawings (limited by the design knowledge),
- Capability to use AutoCAD for 2-D (3-D) representations.

* The quality of acquired skills will be proportional to the motivation, will and effort of the individuals.


Course Objectives

- To acquire essential skills that are part of the mechanical engineering practice.
 - To be able to communicate with other mechanical engineering professionals regardless of their language.
 - To be able to communicate with mechanical system manufacturers.
- 

Course Logistics

- 3 teaching hours/week: Mondays – Wednesdays 8:45 – 10:00.
- 12 lectures and one review class.
- Midterm (non-mandatory, given during tutorial period).
- 2 hour of tutorial following the CAD room class.
- Non-informal – CAD lab.
- The final will be same for all sections.
- 1 lab, once every four weeks (4 hours): “The Anatomy of Mechanical Engineering”.


Classes

- Theoretical material with examples will be presented during classes.
 - Lecture material will be available on the internet prior to the class so it can be read and become familiar before the lecture.
 - Questions during the class are entertained.
- 

Tutorials

- The tutorial classes will be held in the CAD rooms.
- Although the objective of the tutorial is not to teach AutoCAD, it is highly recommended to attempt to solve assignments with AutoCAD during tutorials while hand-drawn solutions should be completed at home.
- Questions about problems and AutoCAD are welcome during tutorials.

Laboratory

- Additional to the course (Anatomy of Mechanical Engineering).
 - A set of three sessions will be scheduled every four weeks, starting on week #2, the week of September 16th.
 - There are specific requirements that you have to follow in accordance with the course outline.
 - Attendance and a satisfactory completion of the requirements of the class are mandatory.
- 

Course outline

Grading:

- Assignments (10 in total): 16 %
- Midterm (November 1st, tentatively): 10 %
- Laboratories: 14 %
- Final Exam: 60 %

Important information such as: Graduate attributes, laboratory and tutorial information, etc. is on the course outline.

****PRINT/READ THE COURSE OUTLINE (On Moodle)****.

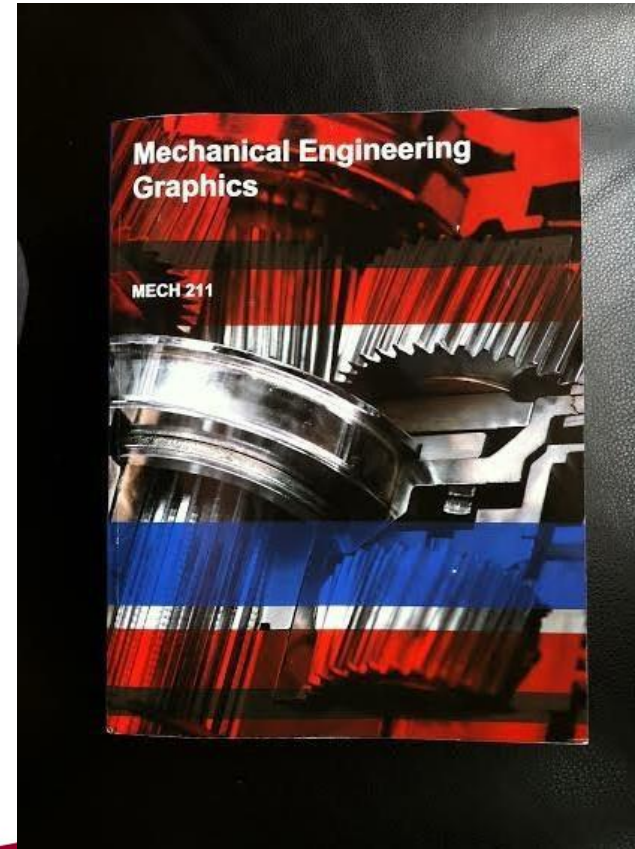
- Assignments are submitted in the tutorial (Assign 1 is due Sept.19th)... Late submission will be given 0 .
- Midterm is optional... given during the tutorial.
- All labs must be completed to pass the course.
- **Final Exam requires at least a 50% score to pass the course (regardless of total average).**

Class Materials

Web site: MyConcordia Moodle

Required textbook:

- Mechanical Engineering Graphics
MECH211 – custom textbook for
this course
- Lecture Material



Class Materials

- Individual study of AutoCAD material. Practice drawing sets are available on the web site.
- Tutorial materials: available before the tutorial or handed in.
- Assignments: 1 to 8 count as 2% weight each.
- Solutions to the assignments will be available after their submission.
- The assignments are to be submitted to the tutor during the tutorial class only.
- **RECOMMENDATION:** Attend the classes, tutorials and labs (labs are mandatory).

Class Instructors and Contacts

Available on the course outline handed in and on the web site

Available resources:

- Tutor – available during tutorial class (2 h/week).
- Lab instructor – available during the lab period (1 h/week).
- Programmer on duty – available 2 hours per week at a time other than teaching or tutorial period (3 h/week).
- Instructor – available during the classes (3 h) and office hours (3 h/week).

Please see the course outline.

Lecturer Background

François Tardy

- Department of Mechanical and Industrial Engineering
- Office: A-2112
- Phone: 3462
- francois.tardy@concordia.ca
- Moodle

B.Sc.A. Mechanical Engineering (U de Moncton)

M.Eng. Mechanical Engineering (ÉTS)

MBA Energy Management and Finance (HEC Montréal)

Engineering Experience:

- Phoenix Énergie
- PCO Innovation
- Volvo
- United Technologies (Carrier)
- Bombardier Aerospace
- EH2Solar
- Cadexair
- Trans-F-air
- Public Works Canada

Interests:

- Energy: production, management, transport, efficiency and economics
- Aerospace and transportation
- HVAC-R

Graduate Attributes

ATTRIBUTE	INDICATOR	LEVEL OF KNOWLEDGE
<p>Problem Analysis <i>An ability to use appropriate knowledge and skills to identify, analyze, and solve complex engineering problems in order to reach substantiated conclusions.</i></p>	Problem identification and formulation	Introductory
	Modelling	Introductory
	Problem solving	Introductory
	Analysis (uncertainty and incomplete knowledge)	Introductory
<p>Communication Skills <i>An ability to communicate complex engineering concepts within the profession and with society at large. Such abilities include reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.</i></p>	Research Methods	Introductory
	Documentation	Introductory

A few suggestions

- Attend the lectures, laboratories and tutorials – try to understand the objectives as well as the procedures.
- Use time at home to read and study the chapters in the book – use the material posted on the internet.
- Do your homework by yourself – consult only your colleagues, tutor, lab instructor or class instructor.
- Submit your assignments on time – late assignments receive no mark.
- Write the midterm test – it is a good way to measure your performance in the class.
- Write the final exam with confidence that you will do very well.
- Carry out your duties thoroughly.

MECH 211
LECTURE 1

MECHANICAL ENGINEERING DRAWING



First Lecture Content

- Why is design important?
- Graphics as means of communication
- History
- Multiview representation and orthographic projections
- Technical procedures
- Generating multi-view orthographic projection
- Representation rules
- Design process
- Role of drawings in the design process
- Drawing in product development

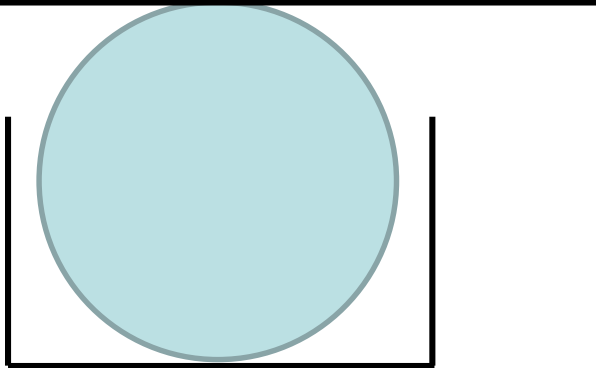
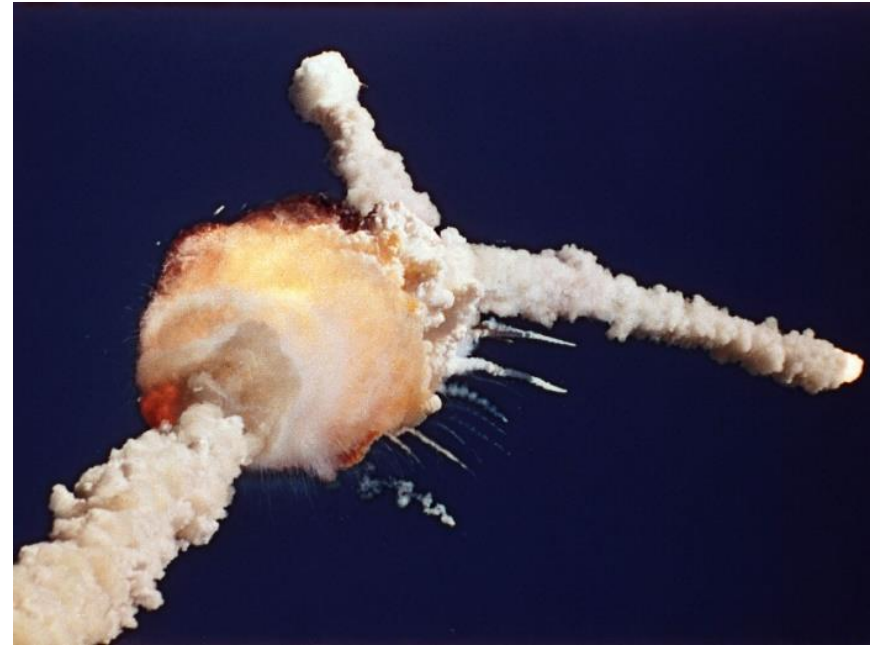
MECH211 – Mechanical Engineering Drawing

**KEY QUESTION:
WHY IS DESIGN IMPORTANT?**

The Importance of Design

Challenger Disaster (1986)

- O-rings were not designed for cold weather.
- 7 casualties
- How do O-rings work?



The Importance of Design

Turkish Airlines Flight 981

Design flaw in the cargo hatches made the rear of the plane break-off.

- 346 casualties

I-35W Mississippi River bridge

bridge's design specified steel gusset plates that were inadequate to support the intended load of the bridge.

- 13 casualties
- 145 injuries



The Importance of Design

A380

- Miscommunication between two design departments of the company.
- Wire harnesses too short!
- Billions of dollars lost.



The Importance of Design

MPM-10 (STM Azur)

According to a recent article:

- People less than 6 feet tall have problems reaching the bars.
- Delays in train commissioning.

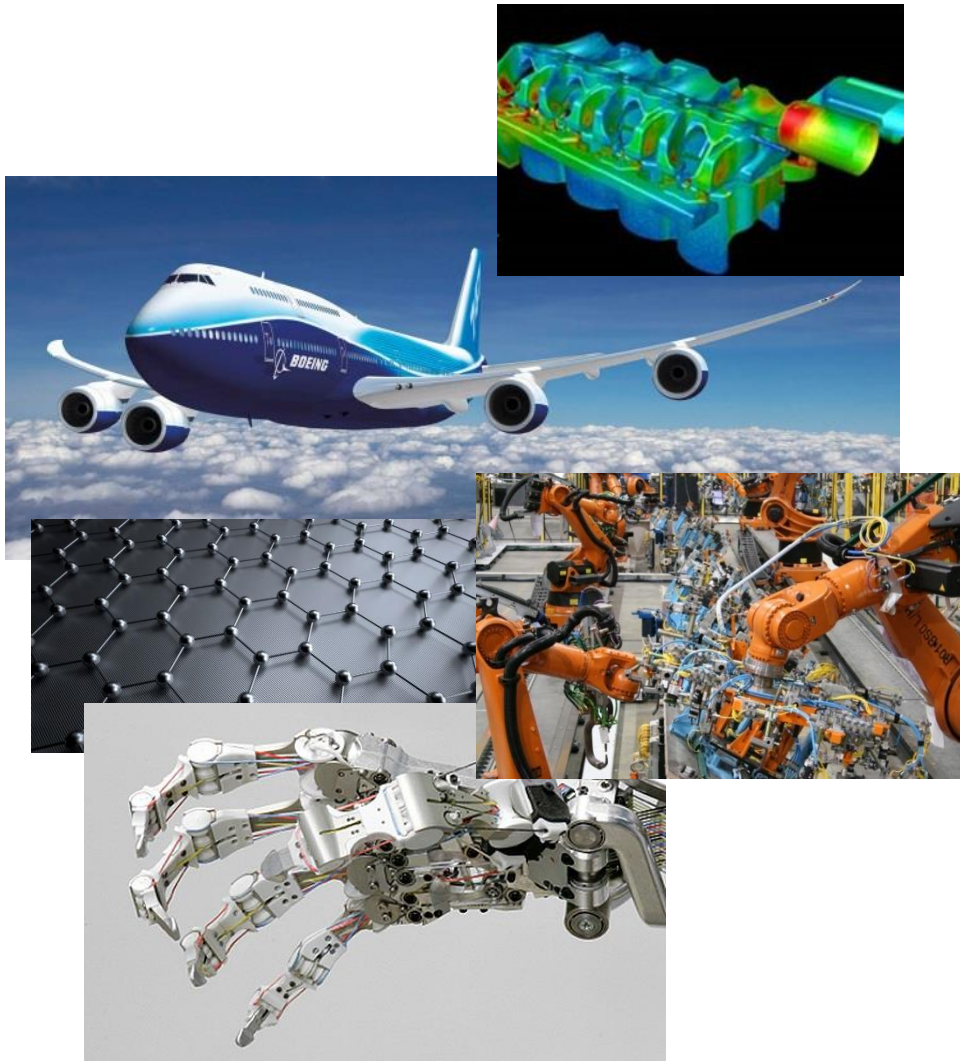


The Importance of Design

No matter what branch of Mechanical Engineering:

- Thermo-fluids / Combustion
- Aerospace
- Mechatronics / Robotics
- Materials
- Manufacturing, etc.

you will work with engineering drawings.

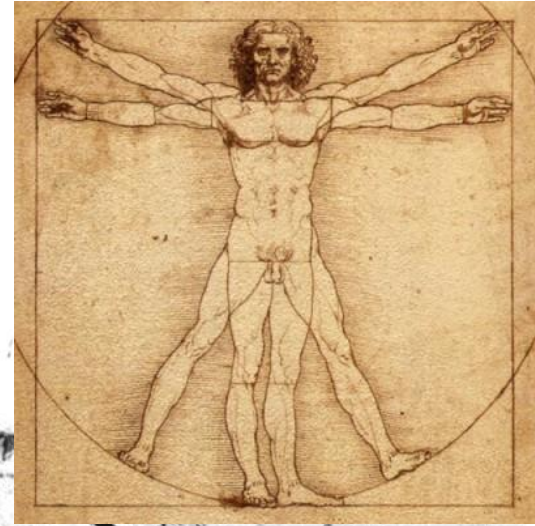
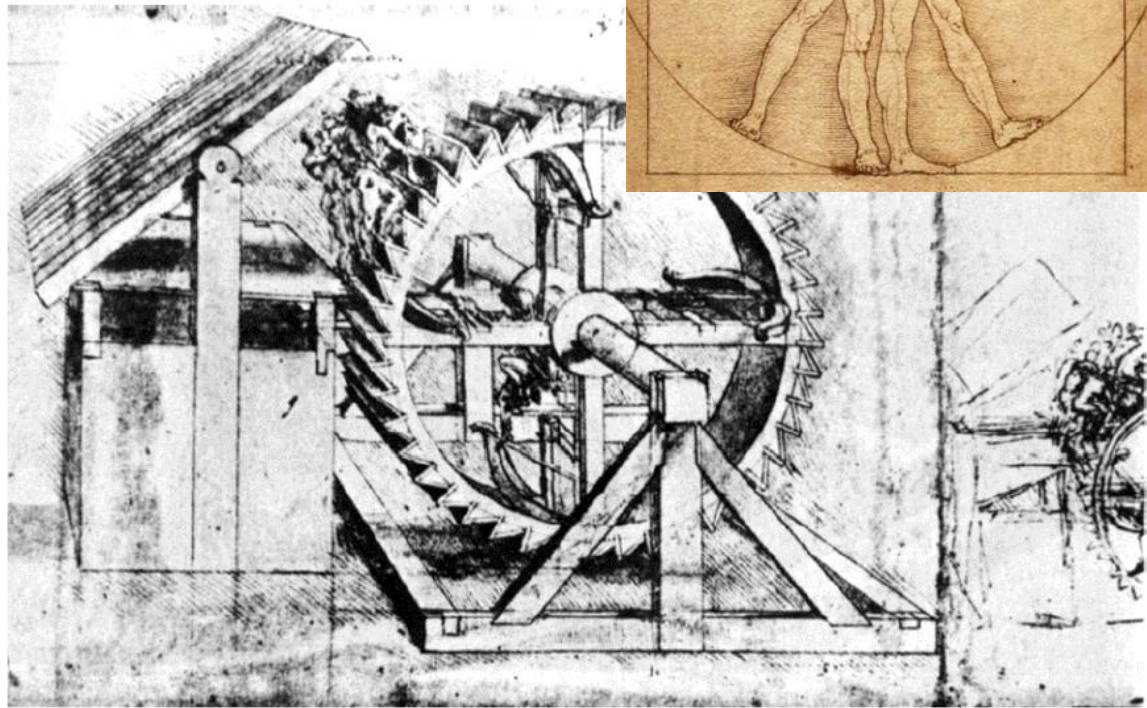


A Bit of History

The objective
need to
communicate



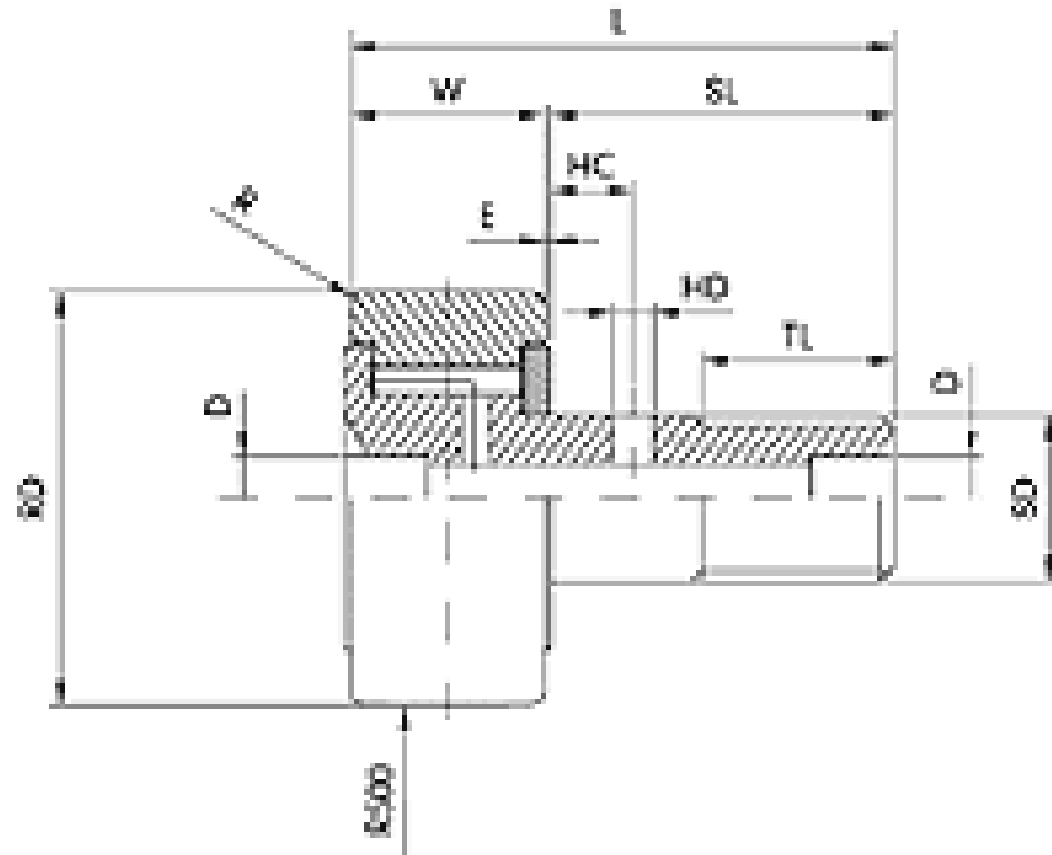
History in Pictures



The Fundamental Difference?

Artistic Drawing still have a purpose

Mechanical/Technical Drawings

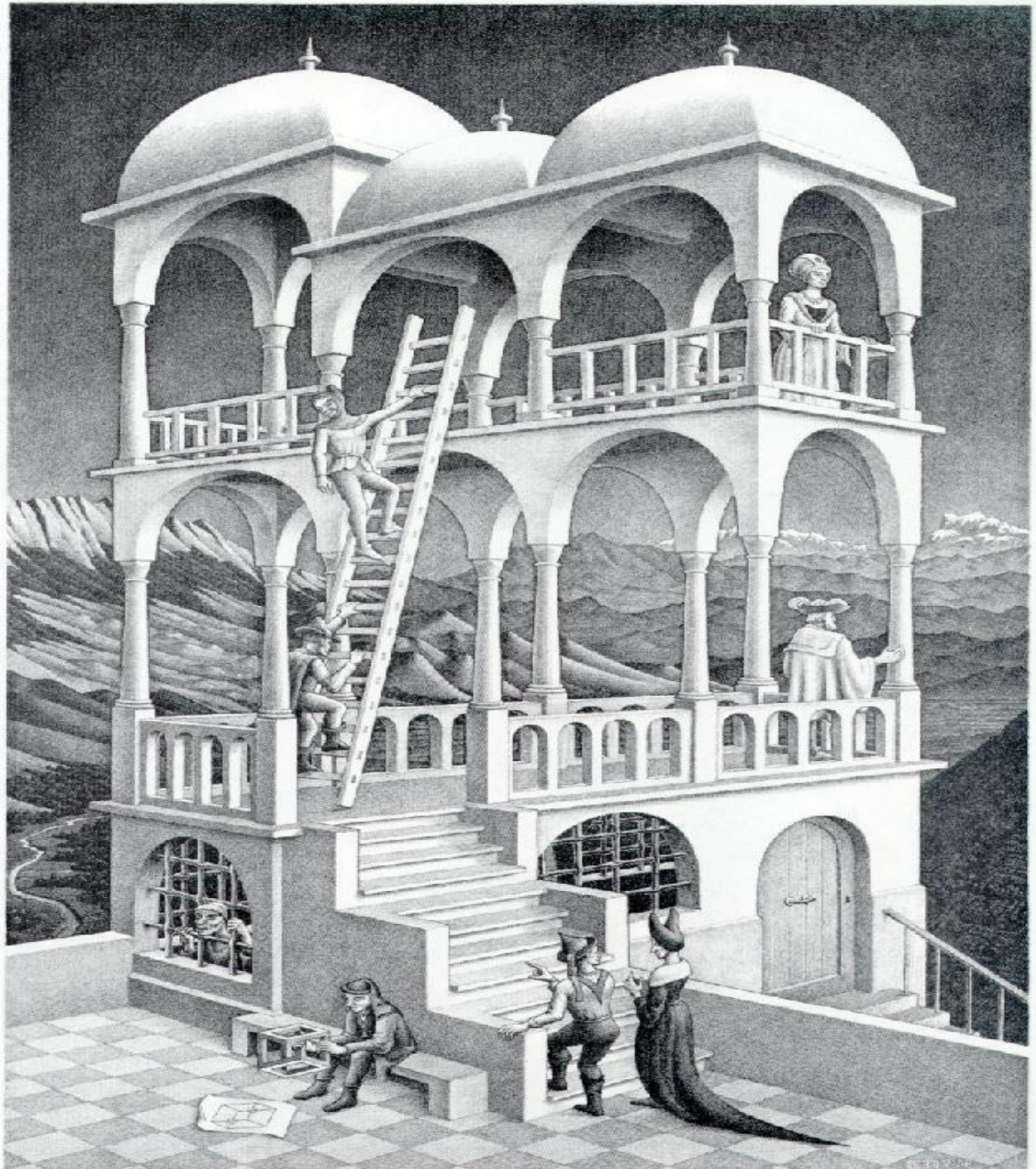


"On the Internet, nobody knows you're a dog."

“Paper can talk about anything”

Observe the way the columns are crossing.

Have you ever seen such a construction?



Mechanical Components

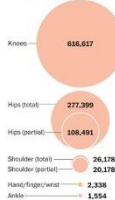
A JOINT SESSION

What's replaceable, and how long it lasts

Surgeons performed more than a million hip and knee replacements in the United States in 2008. Because they are becoming increasingly popular with people in their 40s and 50s, many patients will need to repair or replace their replacements 10 to 20 years later. The science of less common joint prosthetics is still evolving, so estimating the life span of a replacement elbow, wrist or ankle is difficult, and outcomes vary greatly.

How common are joint replacements?

U.S. basis in 2008



What are they made of?

Replacement joints are typically made of metal, titanium steel, stainless, chrome or cobalt alloys and ceramics or plastic.

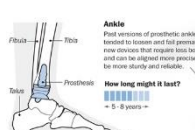


Why replace a joint?



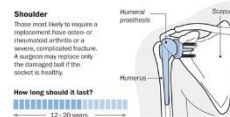
In healthy joints, smooth, articular cartilage covers the ends of bones, and it cushions and lubricates the joint with lubricating fluid, letting the bones glide easily against each other.

When the cartilage is damaged, usually by arthritis, bones rub against each other, grinding the ends and making the joint stiff and painful. When the joint and eventually, become intolerable, replacement is often the answer.



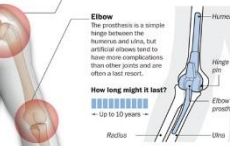
Ankle
First versions of prosthetic ankles have tended to loosen and fail prematurely, but new devices that require less bone removal and can be aligned more precisely seem to be more sturdy and reliable.

How long might it last?
= 5-8 years =



Shoulder
Those most likely to require a replacement have rotator cuff tears, severe osteoarthritis or a severe, complicated fracture. A surgeon may replace only the damaged ball of the socket as healthy.

How long should it last?
= 10-20 years =



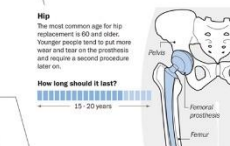
Elbow
The prosthesis is a simple hinge between the humerus and ulna, but artificial elbows tend to have more complications than other joints and are often a last resort.

How long might it last?
= Up to 10 years =



Wrist
Wrist replacements are rare. The joint is so complex that this surgery is considered only after all other options fail. The best candidates need pain relief but don't get heavy demands on their wrists. Finger joints are occasionally replaced as well.

How long might it last?
= 10-15 years =



Hip
The most common age for hip replacement is 60 and older. Younger people tend to put more wear and tear on the prosthesis and require a second procedure later on.

How long should it last?
= 15-20 years =



Knee
The most commonly replaced joint also has the highest success rate. Improved surgical techniques have shortened typical recovery time to weeks rather than months.

How long should it last?
= 10-15 years =



Graphic Language

- We think in terms of graphics/geometries.
- We conceptualize ideas in terms of geometries.
- We express those ideas through graphical representation by following specific rules.



Geometry is Fundamental

- In Nature
- Made by humans



Introduction to Graphic Language and Design

Why are graphics necessary?

- Communicate information that would not be possible to exchange in writing.

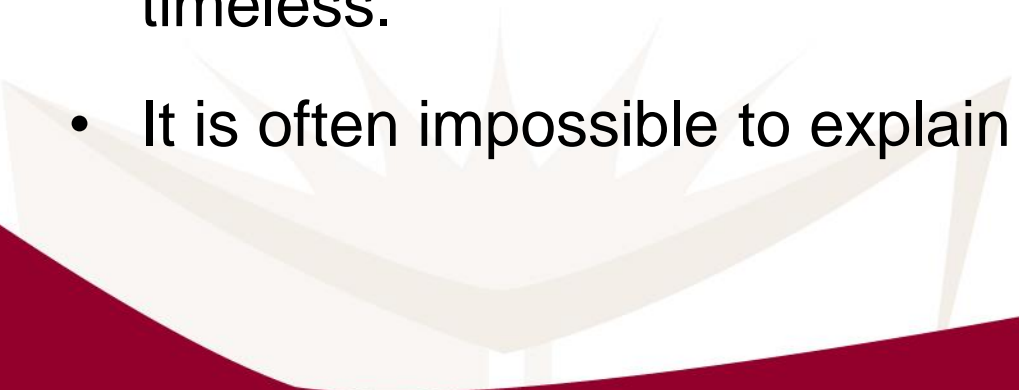
Why not use pictures to communicate visual information?

- Usually, a drawing represents something that exists just at conceptual level.

Why not use pictorial representation?

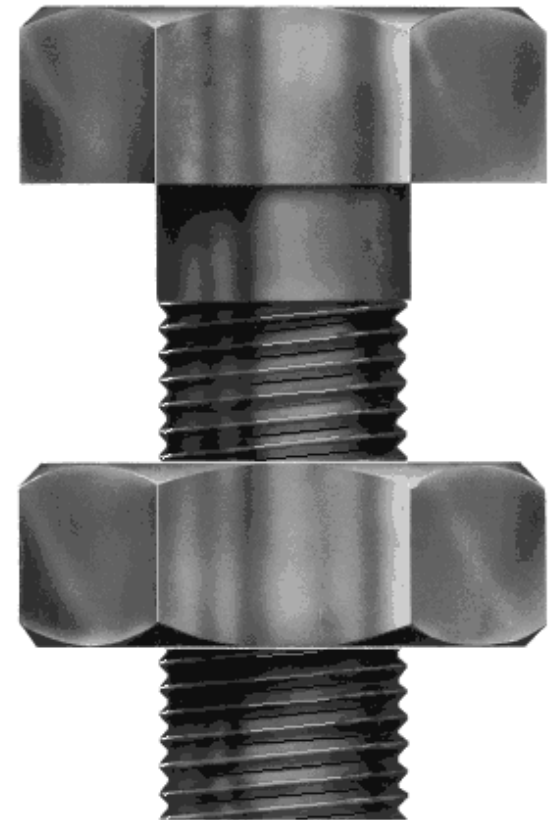
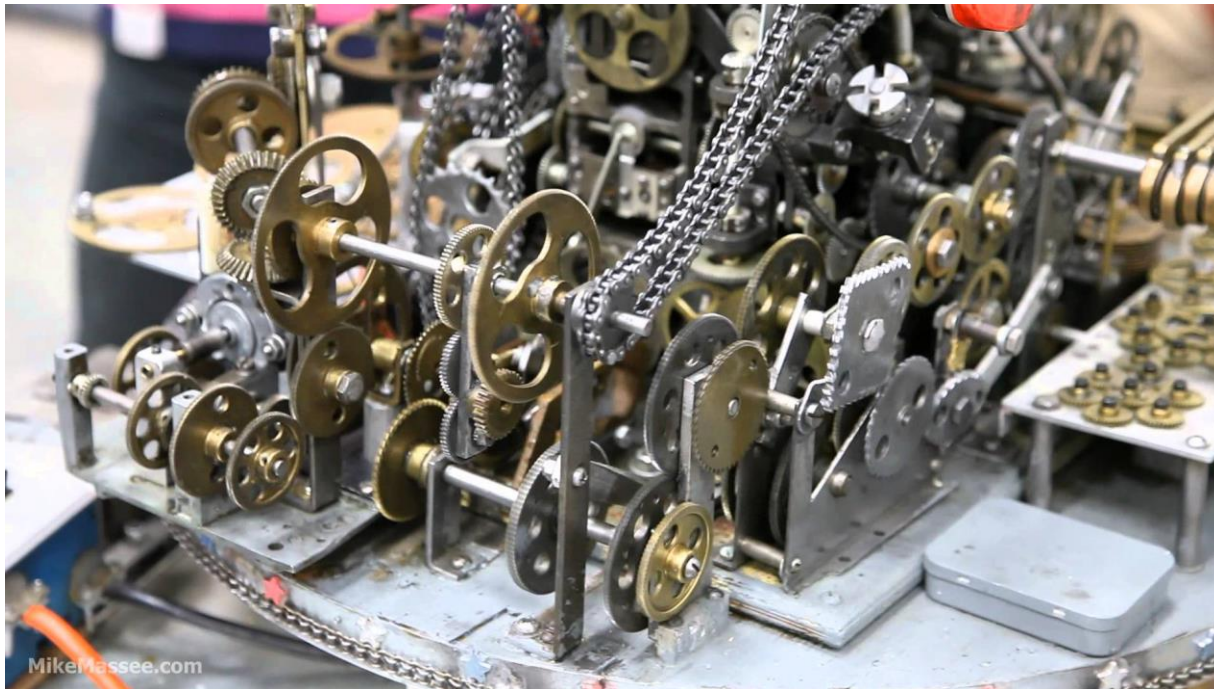
- The information contained in a drawing must be used to build an accurate component/system.

What is a Drawing?

- A drawing is a graphic representation of a real thing, an idea, or a proposed design.
 - Why do we need graphical representation?
 - Graphic method of representation is a basic natural form of communication of ideas that is universal and timeless.
 - It is often impossible to explain things with text alone.
- 

A Simple Component!

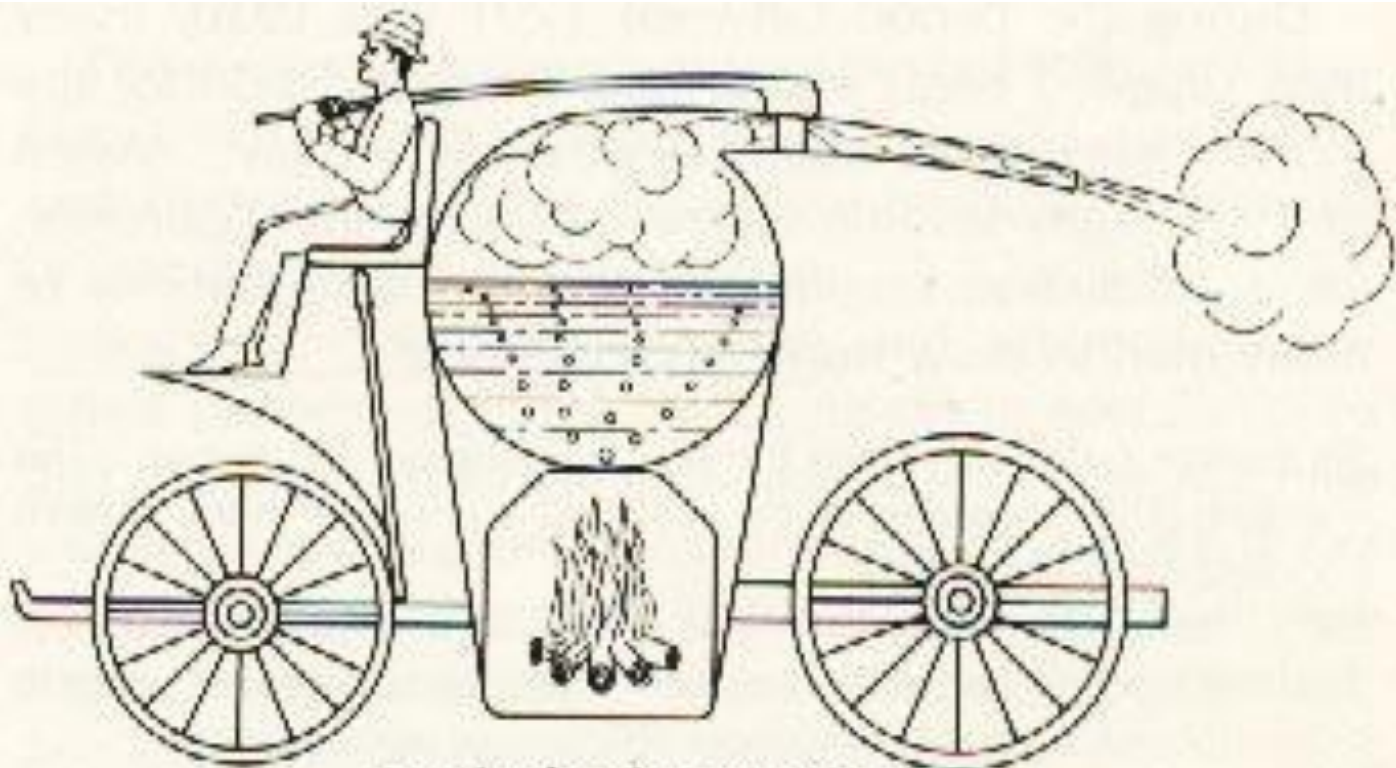
Try defining these objects with words only.



Graphic Language

Try to describe the following drawing in words:

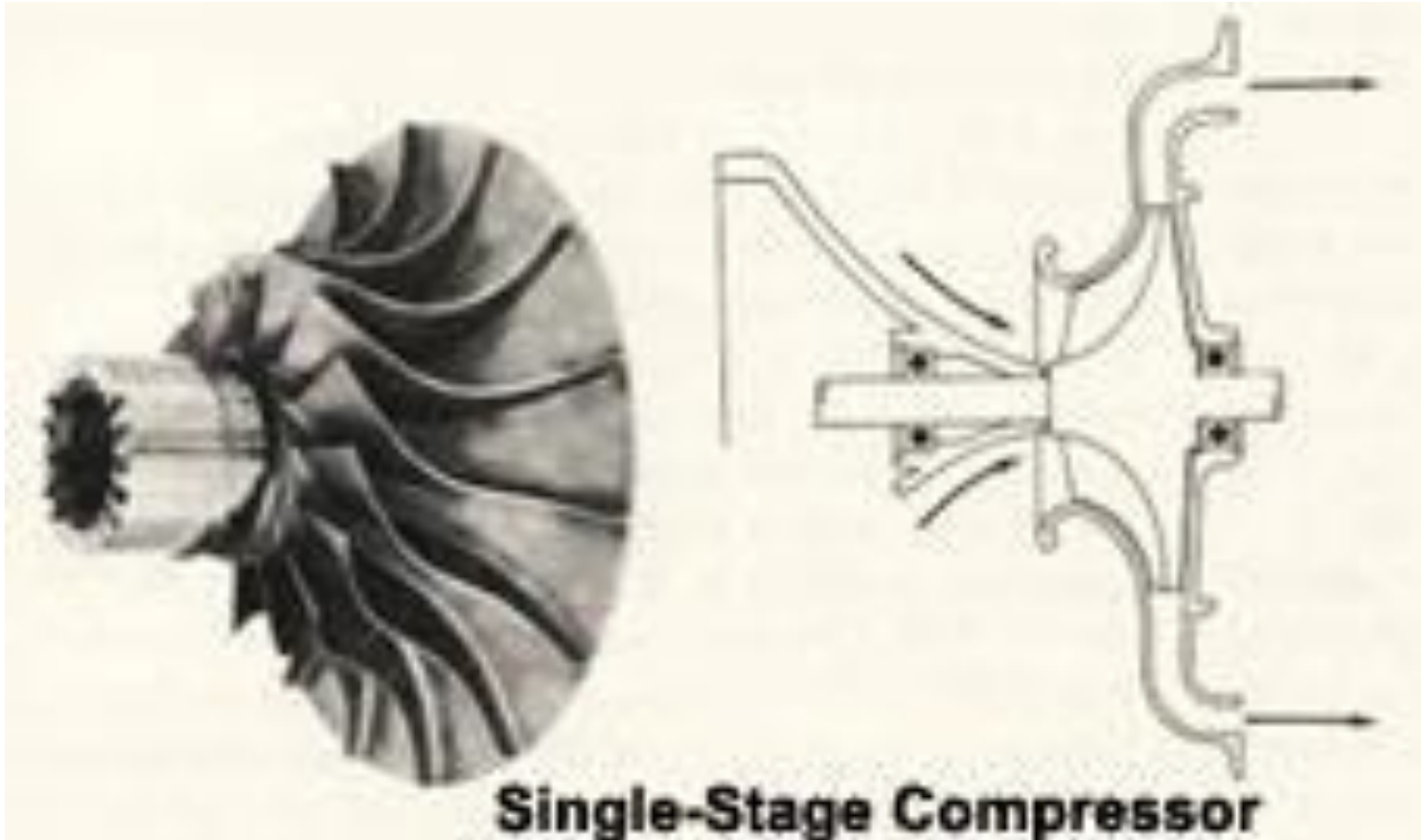
A MECHANISM OR A MACHINE



newton's steam wagon

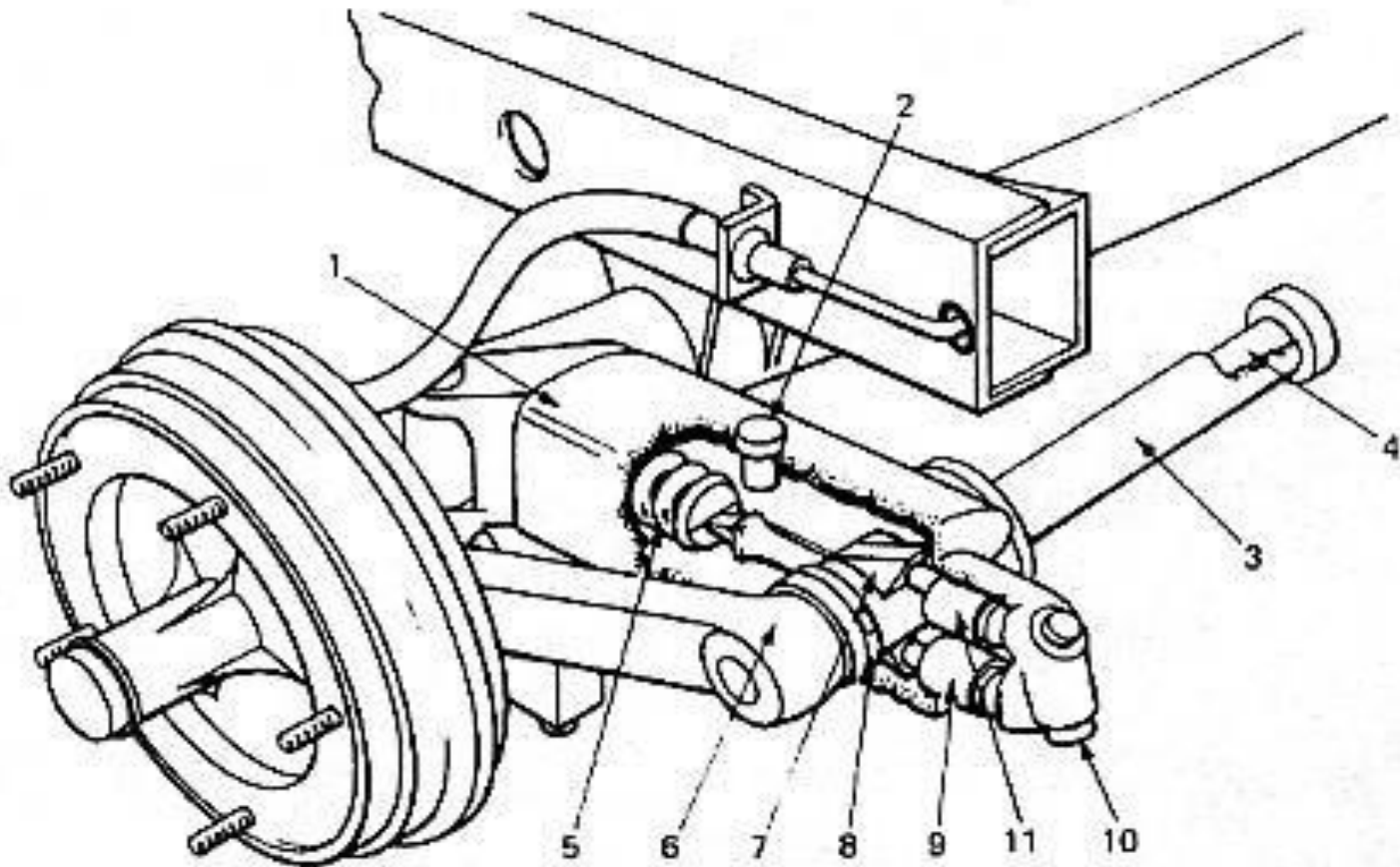
A Component !

Drawings are suggestive.



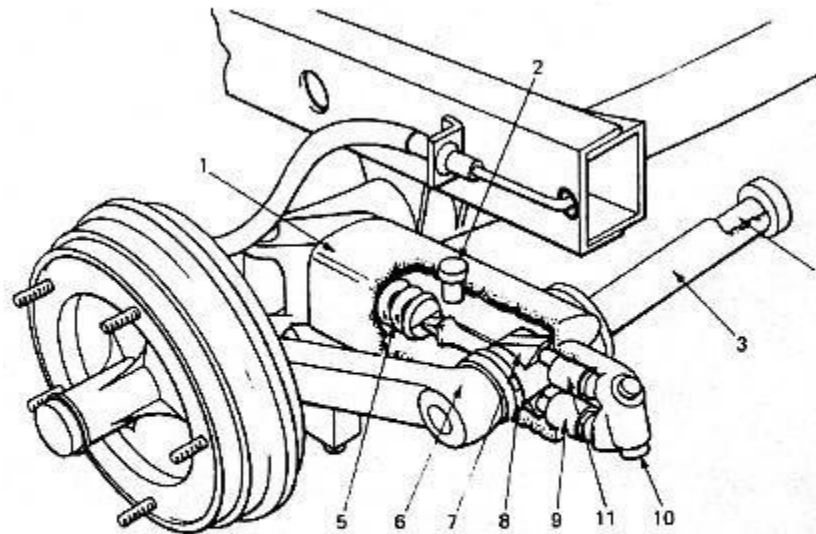
Graphic Language

Graphic language is universal.



Graphic Language

Information can be conveyed regardless of the spoken language.



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 DýBtāRc
 ©@μ¶œf/

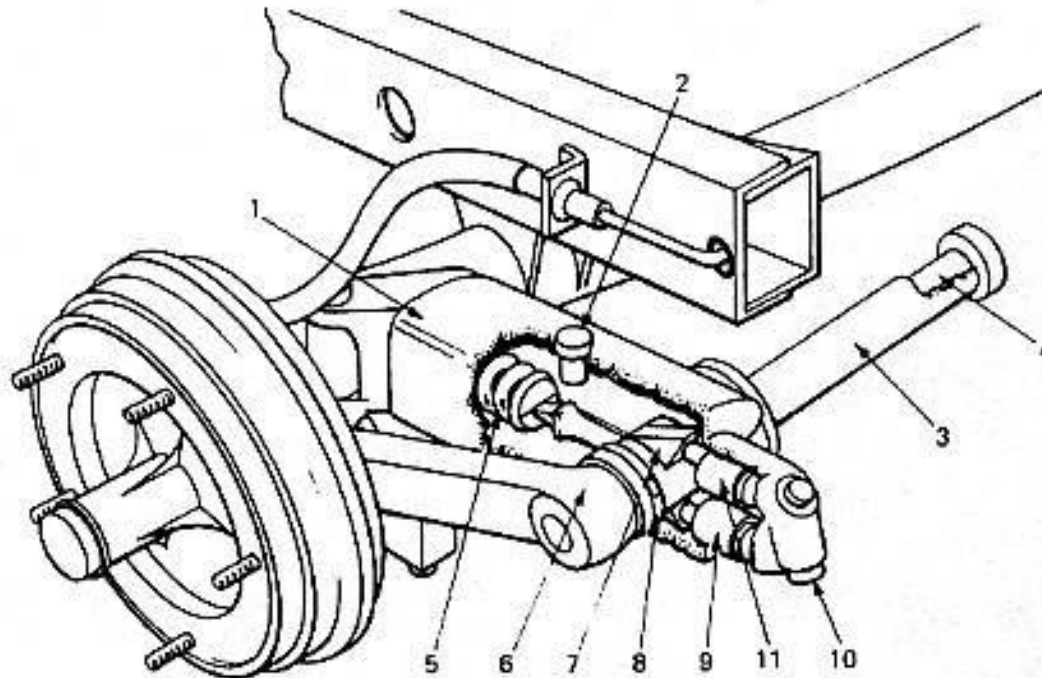
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Graphic Language

When the language is known, drawings become even more accurate.

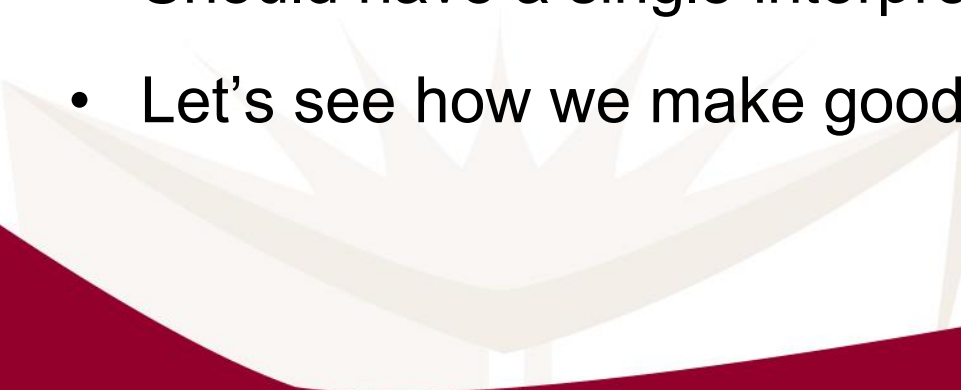


- 1 Suspension housing
- 2 Filler plug and bump-stop
- 3 Torsion tube
- 4 Torsion shaft

- 5 Compensating ring
- 6 Wheel carrier arm
- 7 Control lever
- 8 Oil seal assembly

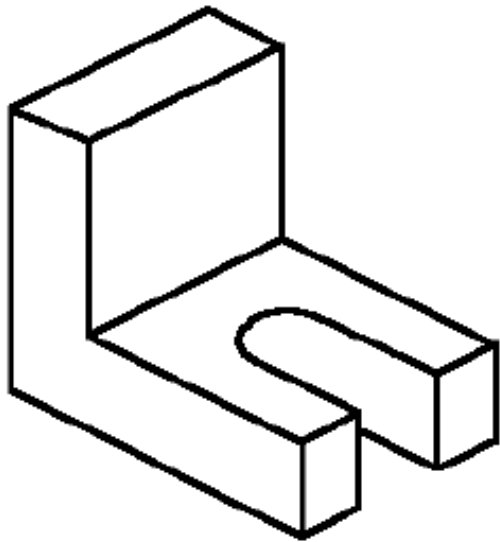
- 9 Shock damper piston
- 10 Shock damper relief valve plug
- 11 Shock damper return piston spring

Essentials of a Good Drawing

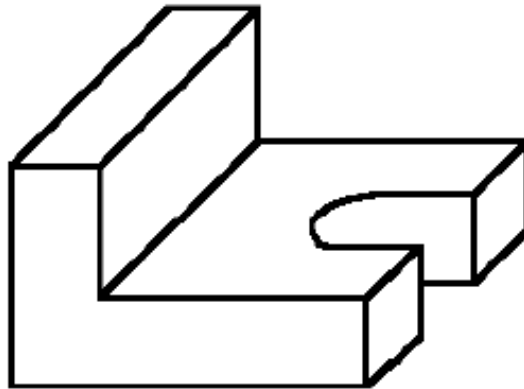
- Should represent the concept/idea/geometry clearly,
 - Should be able to communicate to others without doubt,
 - Should respect manufacturing feasibility,
 - Should comply with standardization,
 - Should have a single interpretation,
 - Let's see how we make good mechanical drawings!
- 

Views

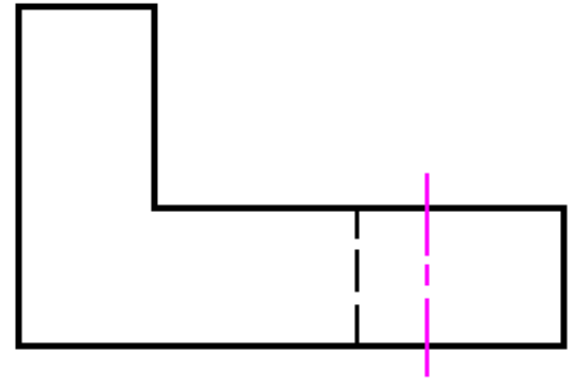
An object can be represented in several ways:



Isometric



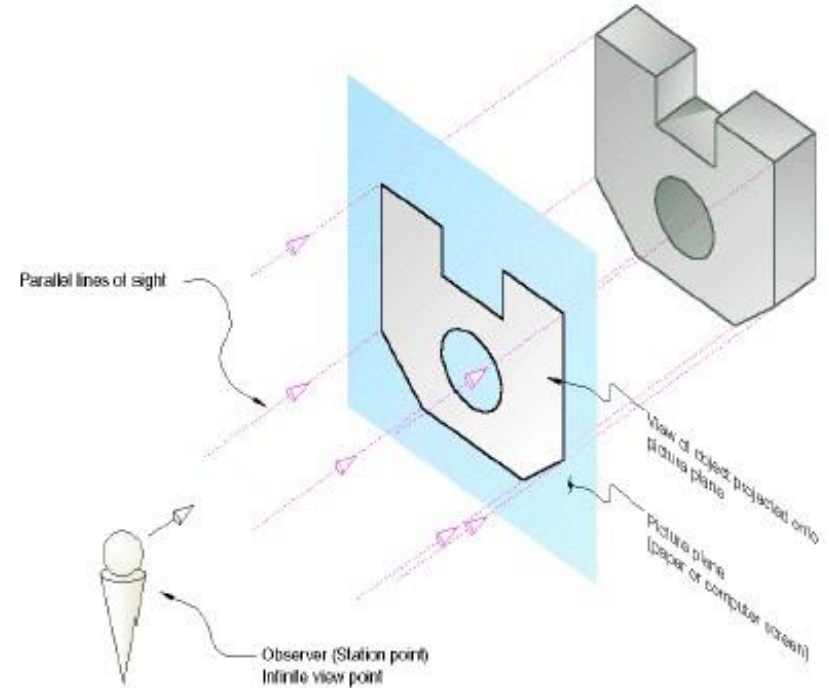
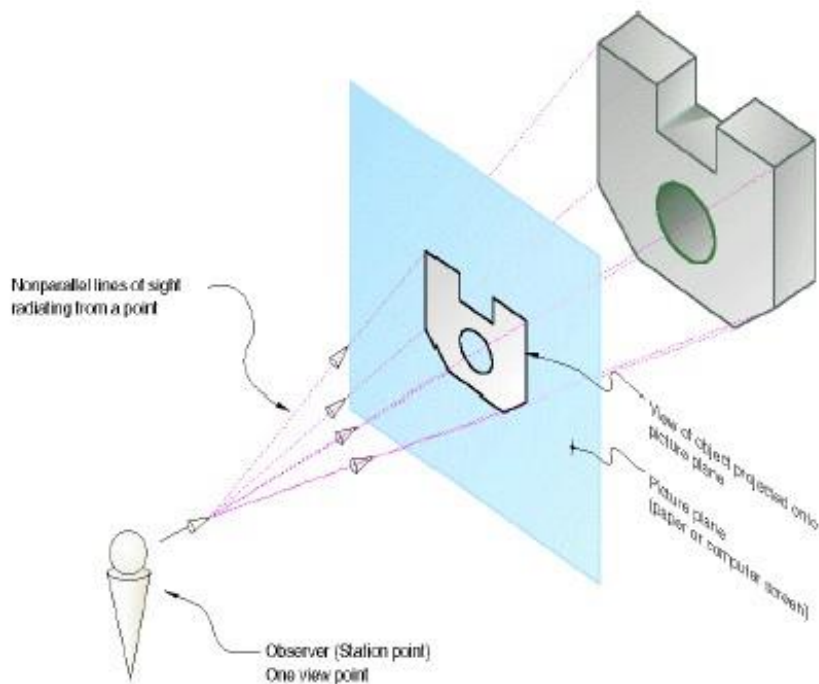
Oblique



Multiview

Projections/Drawing Basics

- Visualizing an object (Simple and sufficient)
- Two basic projection types – use parallel projection

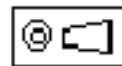
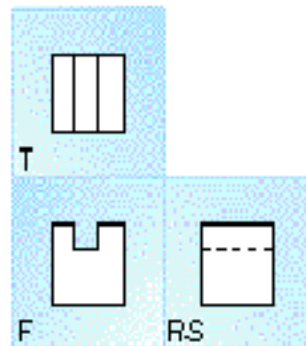
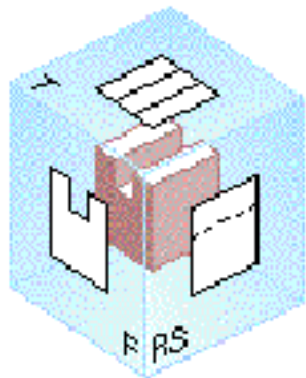


Perspective View

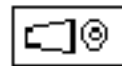
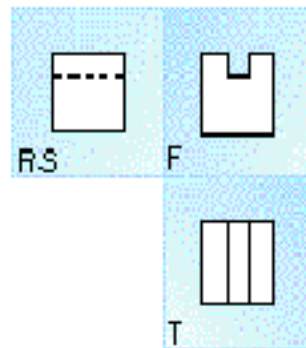
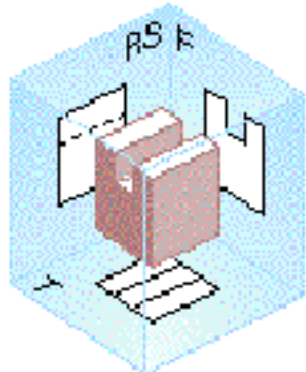


What should be drawn?

What is seen – follow certain rules.



Third-angle projection

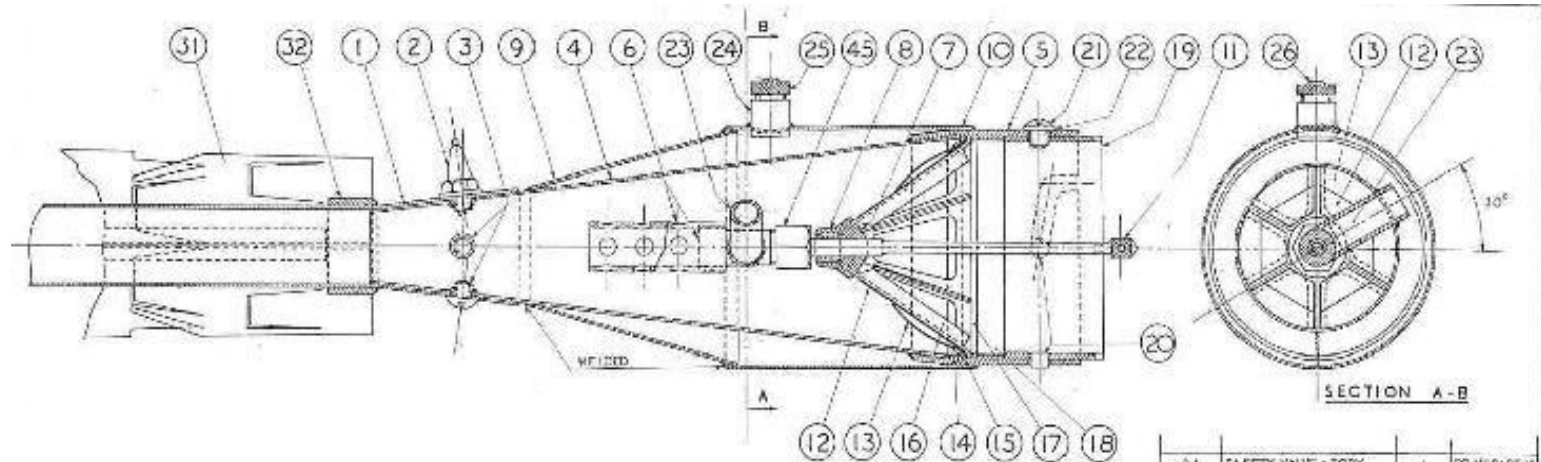


First-angle projection

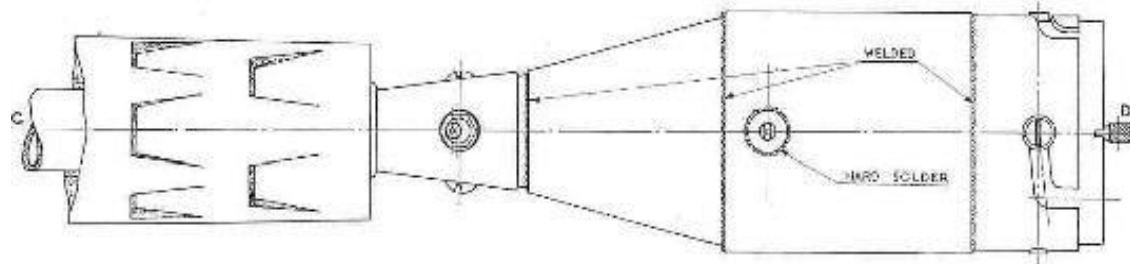
	.7 mm
VISIBLE LINE	
	.35 mm
HIDDEN (DASHED) LINE	
	.95 mm
CENTER LINE	
	.35 mm
DIMENSION & EXTENSION LINES	
	.7 mm
PHANTOM LINE	
	.7 mm
CUTTING PLANE LINE	
	.95 mm
CONSTRUCTION LINE	
	.35 mm
SECTION LINES	

Views

Multiview Representation



LONGITUDINAL SECTION C-D



GENERAL ASSEMBLY

45	LOCK NUT	1	DR.HQ-PARTS
32	RETAINING RING	2	
11	WELDS NOZZLE	2	
21	SAFETY VALVE SPRING RETAIN.	1	
25	SAFETY VALVE PLUG	1	
PART NAME	Q	REMARKS	

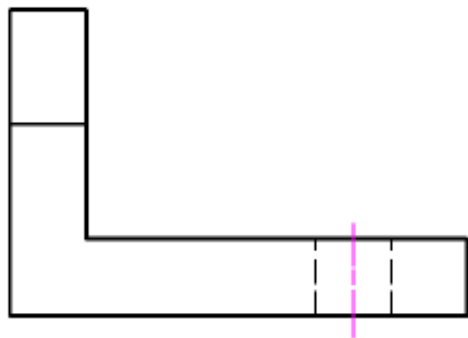
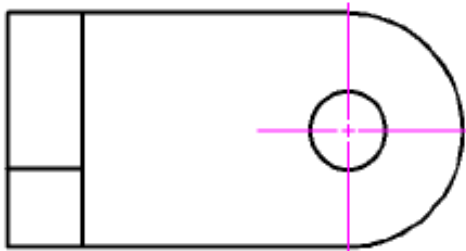
24	SAFETY VALVE BODY	1	DR.HQ-PARTS
23	INLET TUBE	1	
22	SPRING WASHER	1	STAND.
21	BAYONET LUG LOCKWASHER	1	B.A. N°2
20	BAYONET LUGS	3	
19	LOCKING RETAINER	1	
18	FRONT SPACER RING	1	
17	INTAKE VALVE FRAME RING	1	
16	INTAKE VALVE FRAME ELEM.	4	
15	VALVE LEAF RETAINER	1	
14	TEAR SPACER RING	1	
13	INTAKE VALVE LEAF STIFFEN.	6	
12	INTAKE VALVE LEAF	6	
11	NEEDLE	1	
10	FUEL JACKET CYLINDER	1	
9	FUEL JACKET CONE	1	
8	VALVE LOCK NUT	1	
7	VALVE BODY	1	
6	JECTOR	1	DR.HQ-PARTS
5	FRONT RING	1	
4	MOTOR BODY	1	
3	SCREEN-ROUND HEAD	3	3/16" DIA.
2	SPARK PLUG	1	STAND.MOD.
1	EXHAUST TUBE	1	
PART NAME	Q	REMARKS	
JET MOTOR MODEL Z.M.E.			
DR. BY	CHECKED BY	SCALE: FULL	DATE 3/29/45
			DR. N° 1.

Views

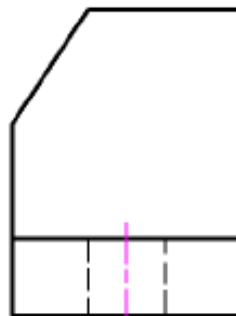
Multiview Representation

Project visible and hidden edges and corners.

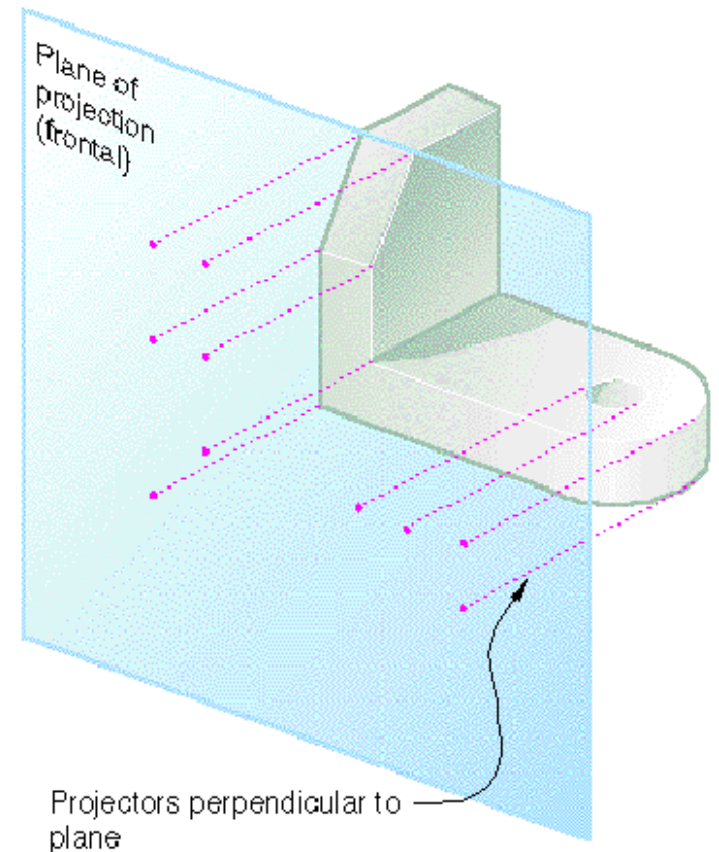
Top view



Front view



Right side view



Multiview

- A part is represented in multiple views. A single part is seen as more than one part.
- This representation allows the user to fully understand the shape of the part, perceive the relative proportions of the geometric features and position each features with respect to one another.
- The parallel projection principle and feature alignment are used in the representation.

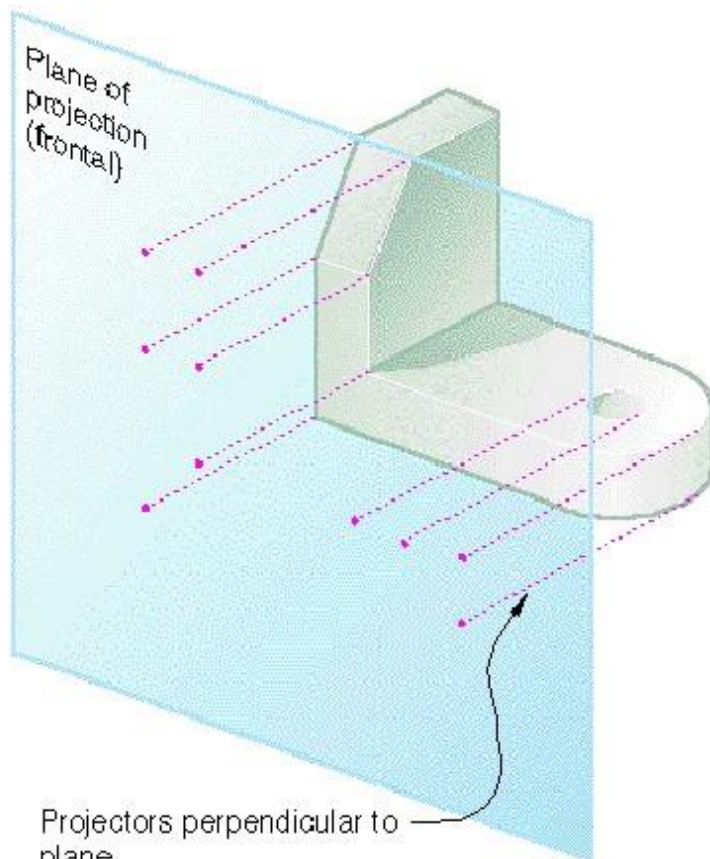
Projection Planes

The component is aligned with respect to the principal projection planes:

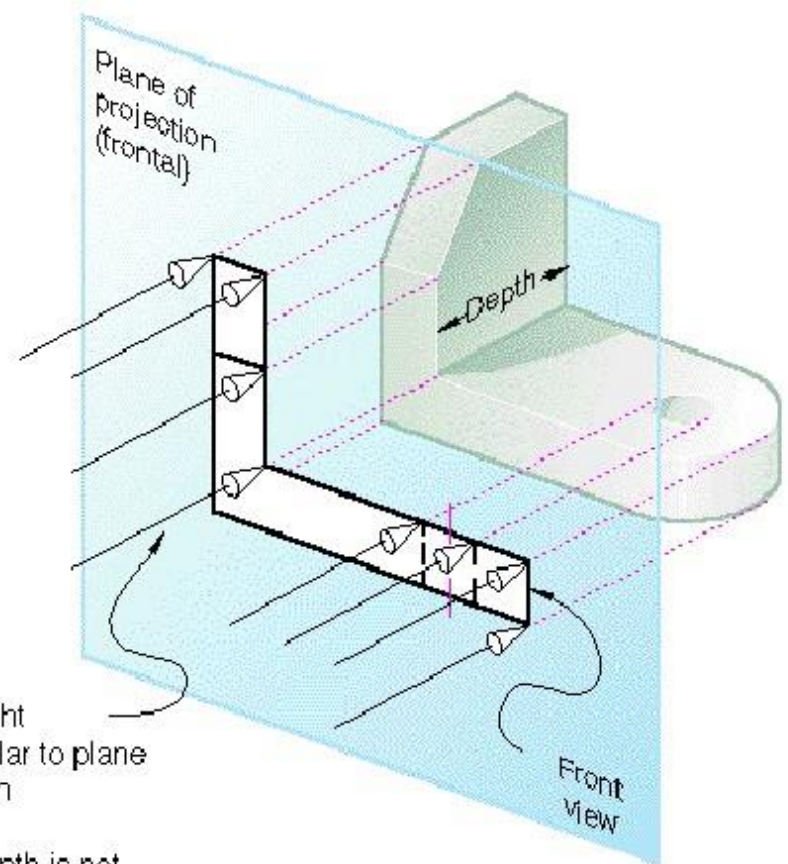
- Top (T) or Horizontal (H)
- Front (F) or Vertical (V)
- Side (S) or Profile (P)

The projection is drawn such that each feature parallel to the projection planes can be seen in their true length.

Projection Planes

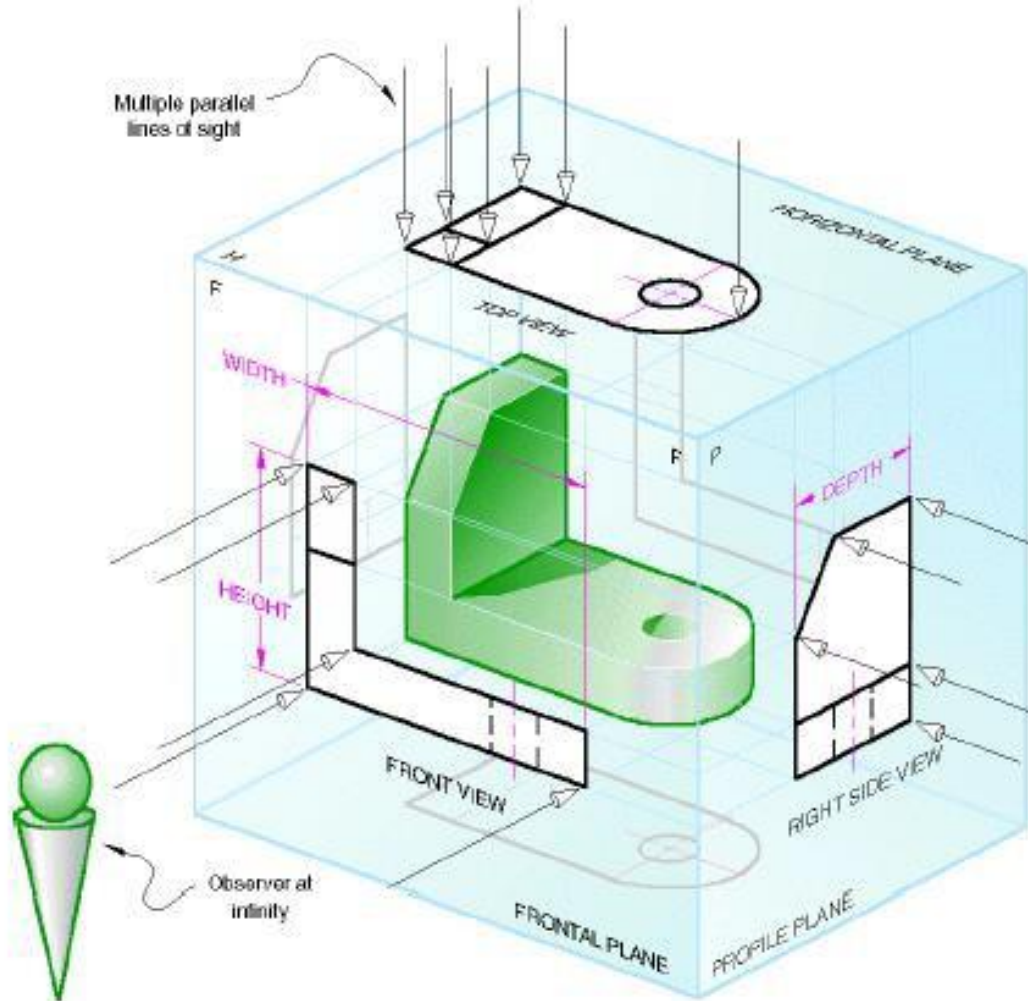


(A)

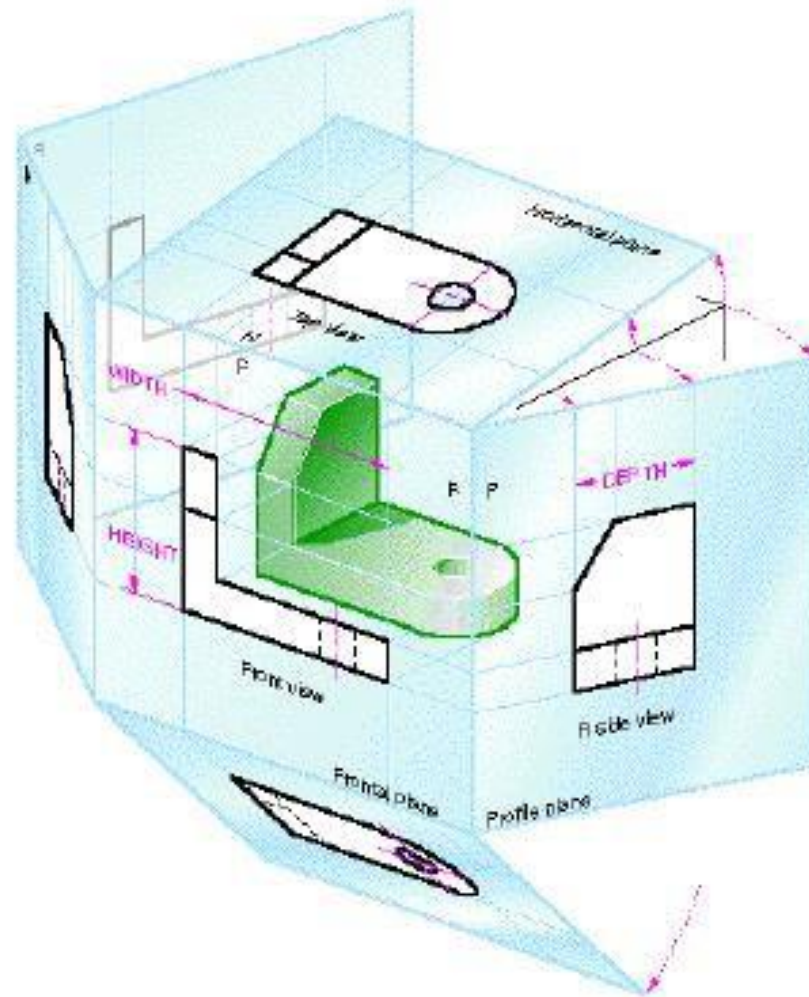


(B)

Projection Principles



Projection Principles



First and Third Angle View

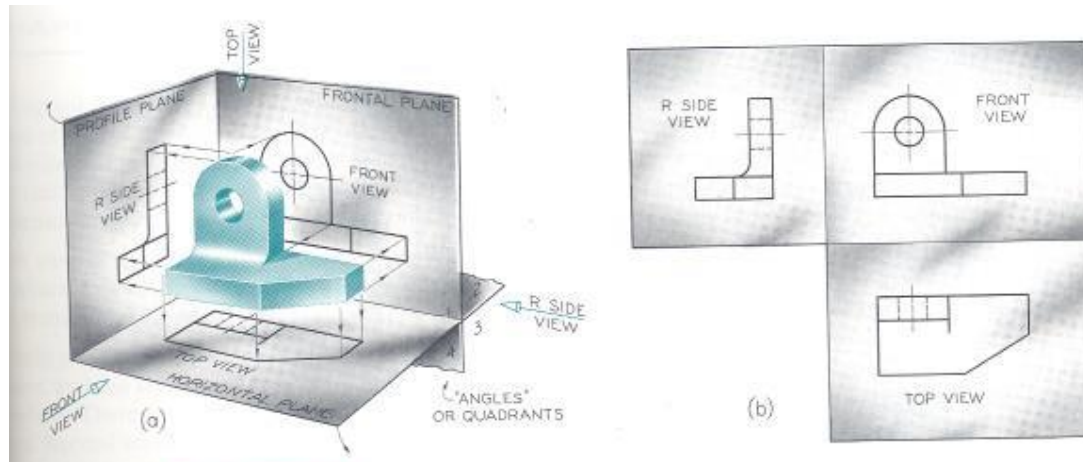
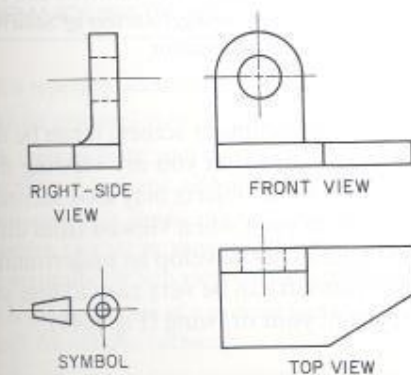
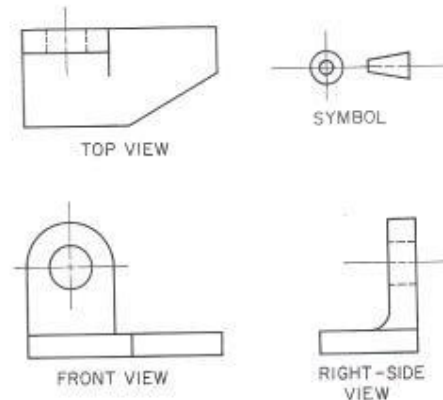


FIGURE 6.47 First-Angle Projection. An object that is above the horizontal plane and in front of the vertical plane is in the first angle. An observer looks through the object to the planes of projection.



(a) FIRST-ANGLE PROJECTION



(b) THIRD-ANGLE PROJECTION

Types of Representation

First Angle Projection

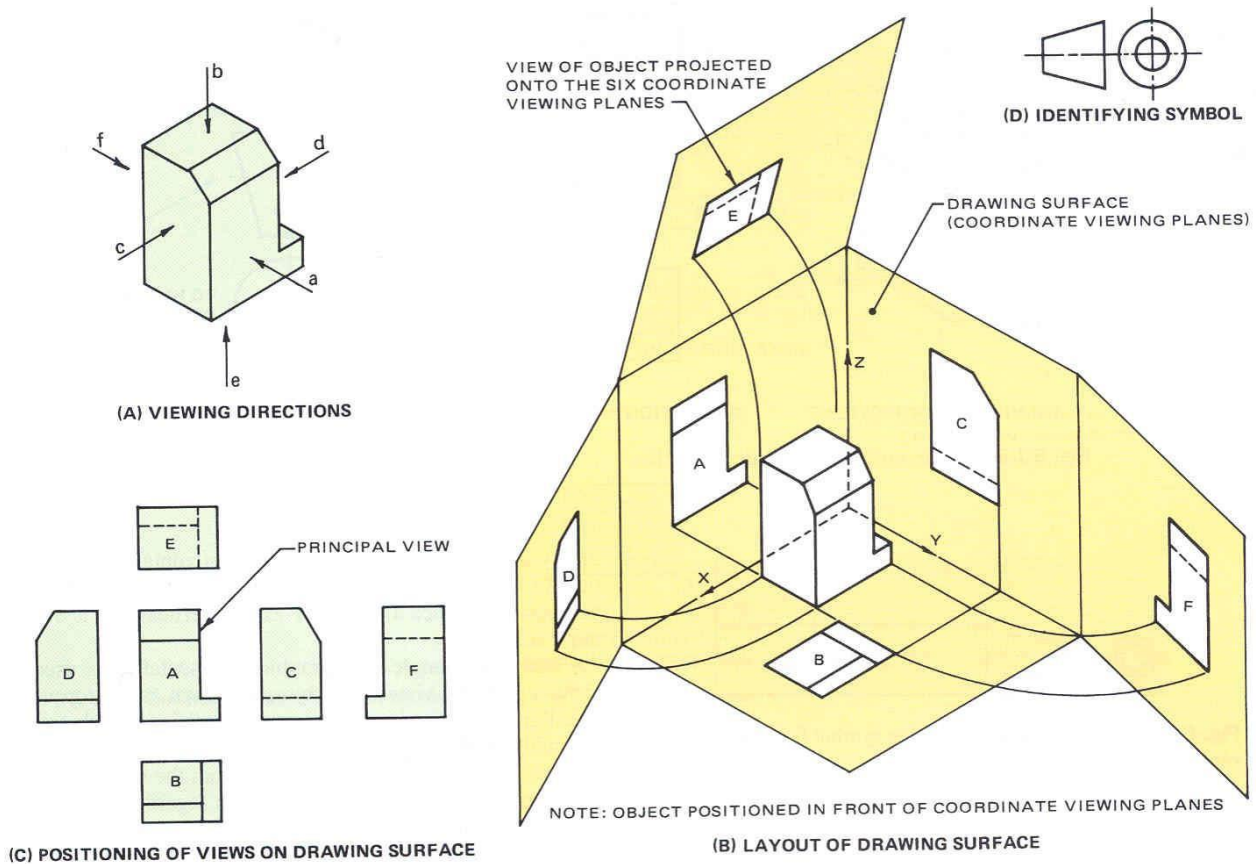


Fig. 6-1-4 First-angle projection.

Third Angle Projection

Third Angle Projection

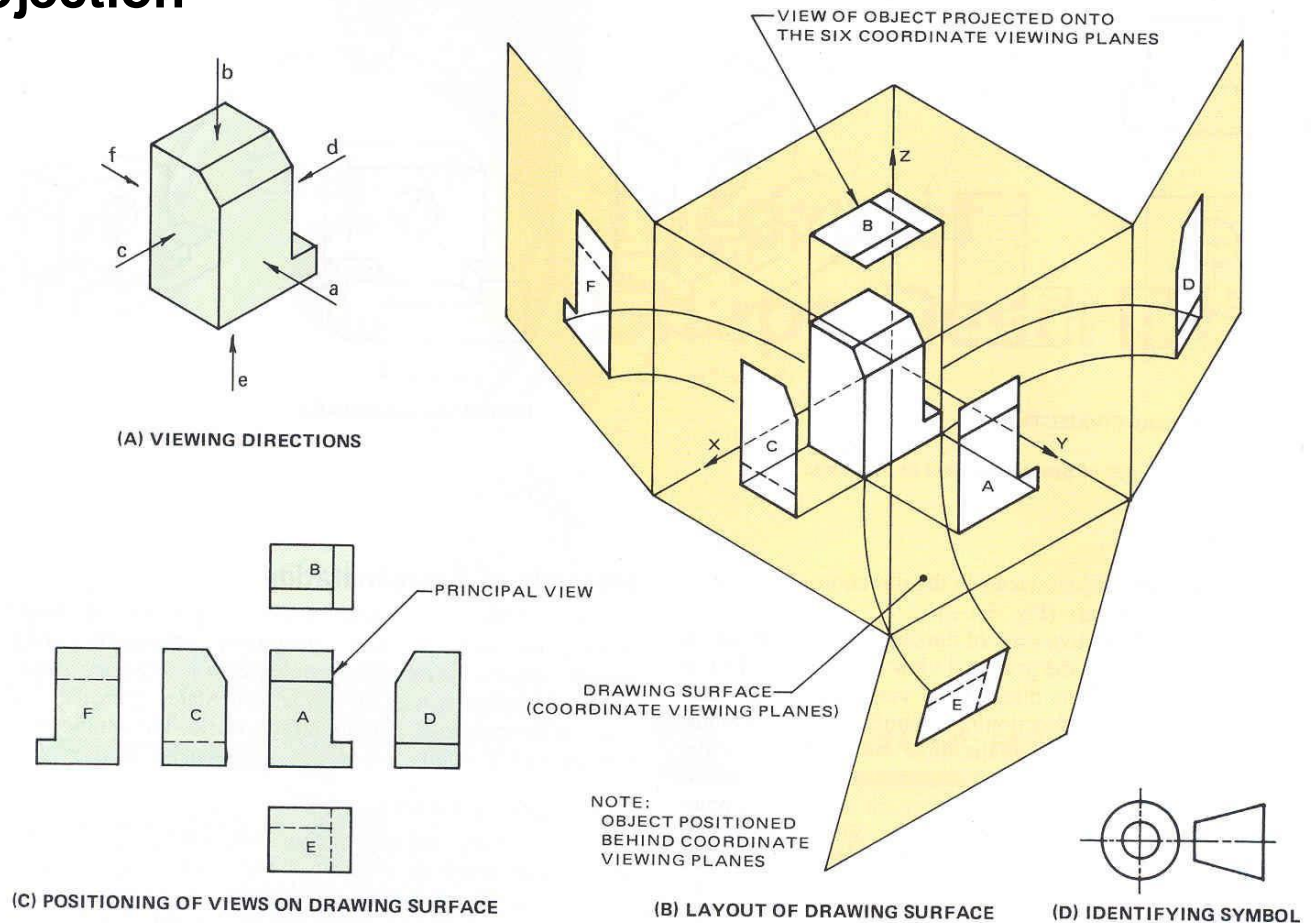
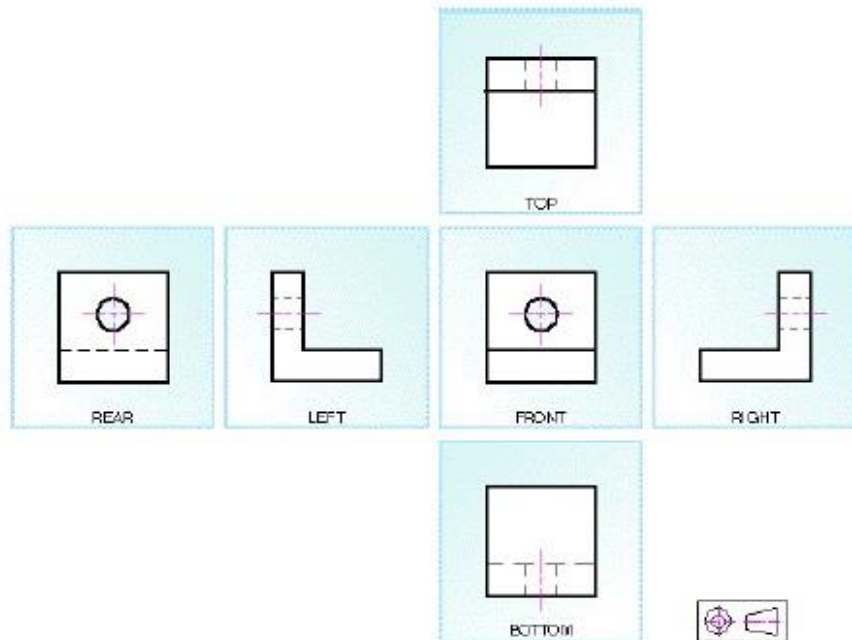


Fig. 6-1-3 Third-angle projection.

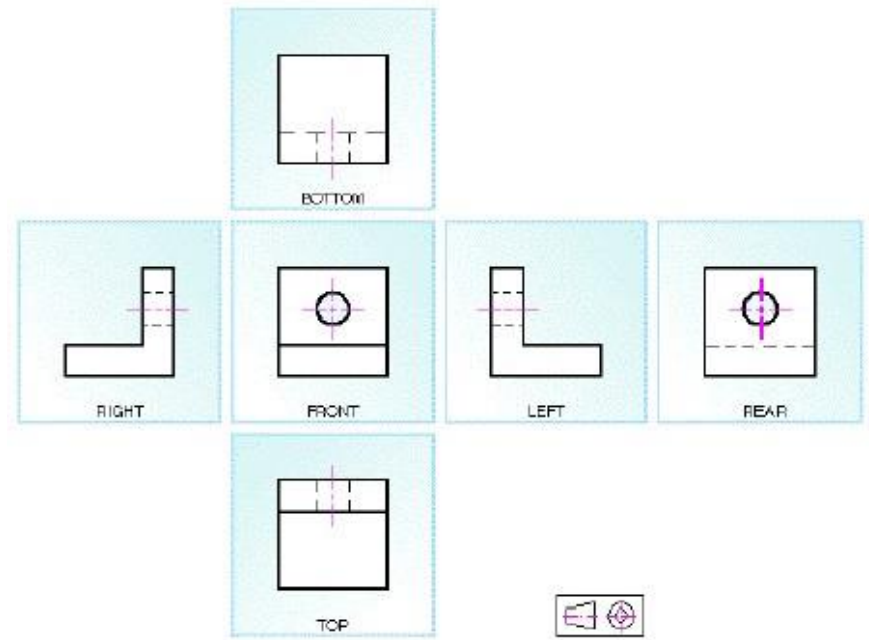
Same Types of Projection

First angle projection



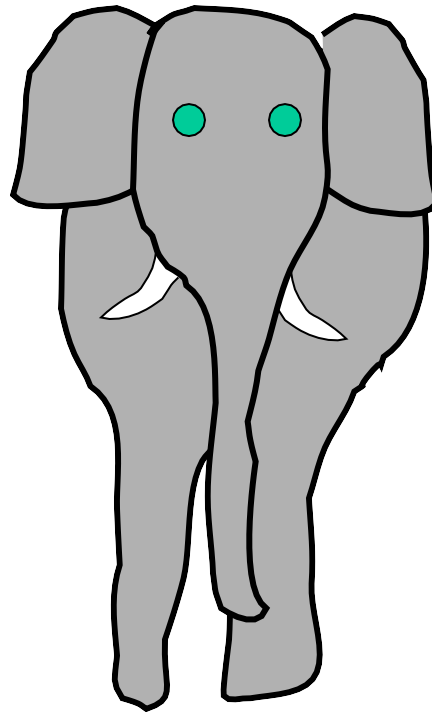
(A) U.S. Standard

Third angle projection

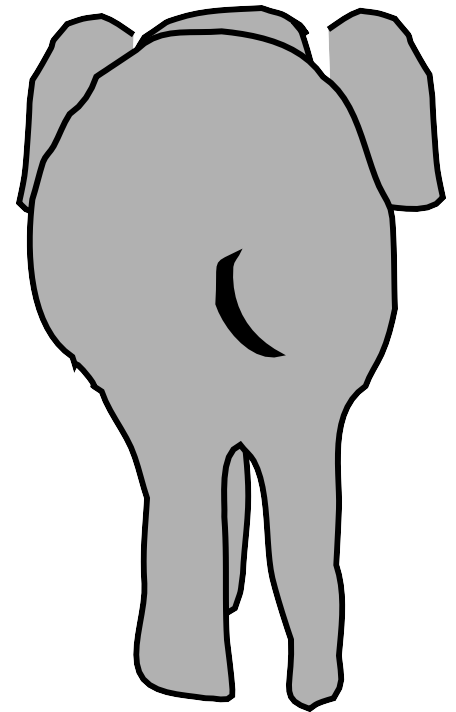


(B) European Standard

First Angle & Third Angle



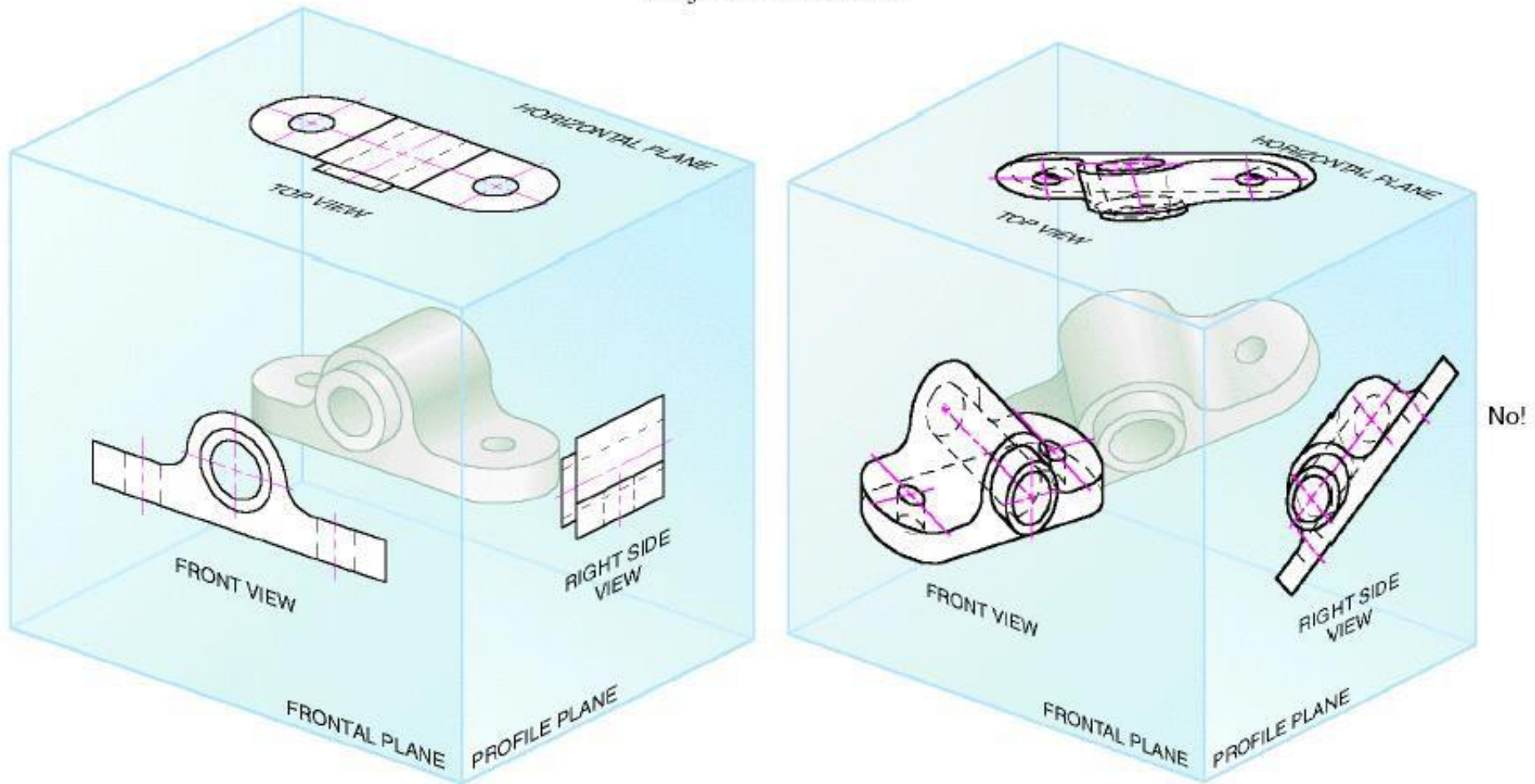
Third Angle
Projection



First Angle
Projection

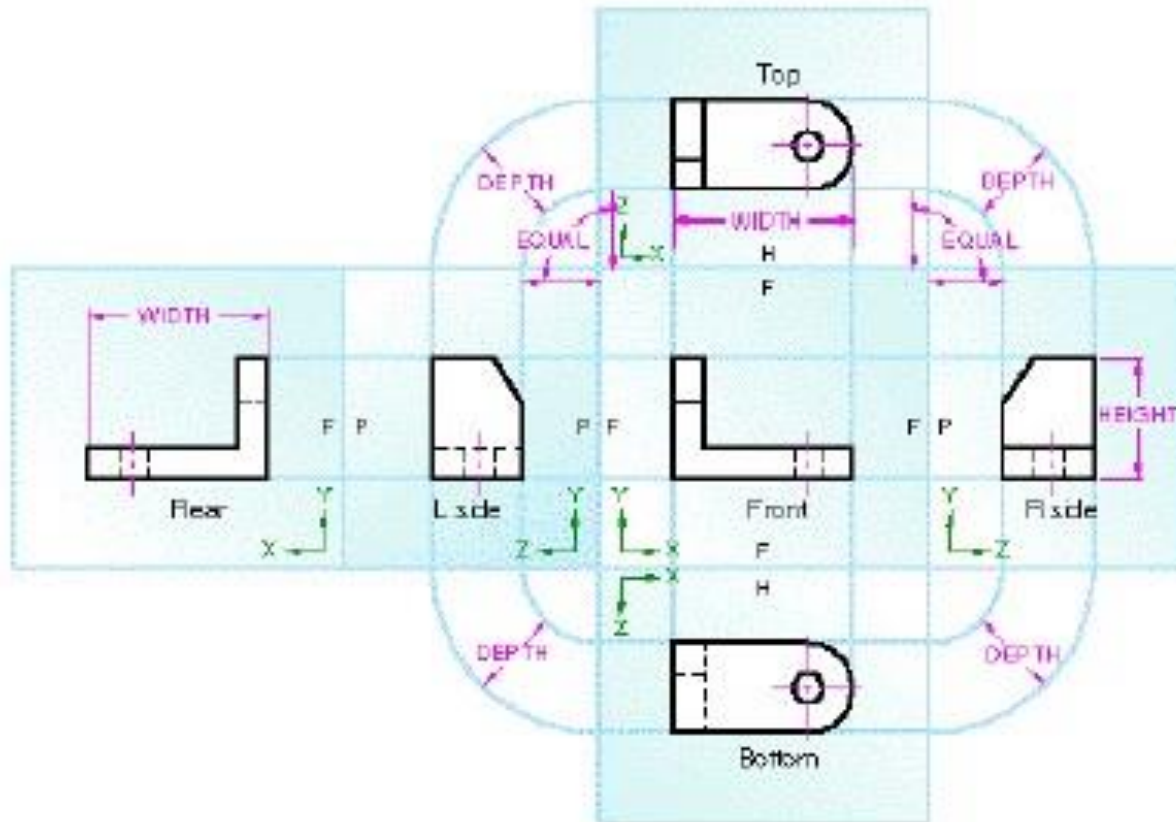
Object Orientation

Object orientation

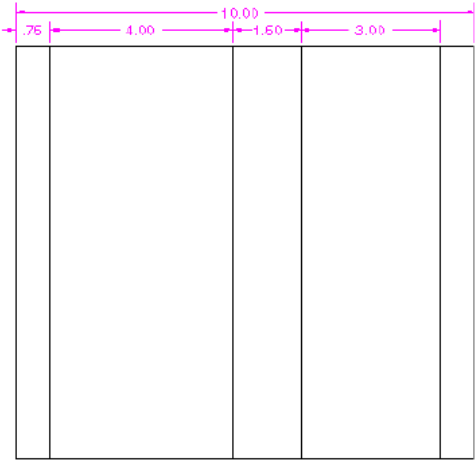


Relative Position of the Views

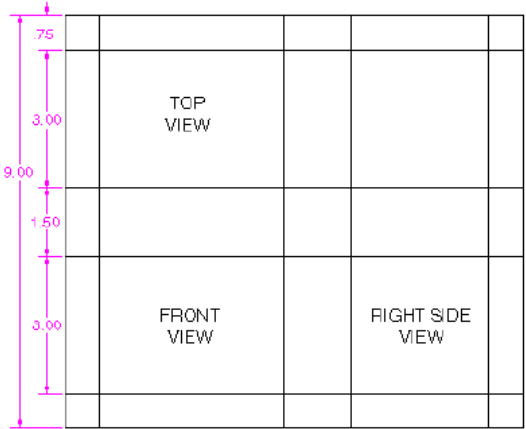
All views must be aligned with respect to each other, feature to feature.



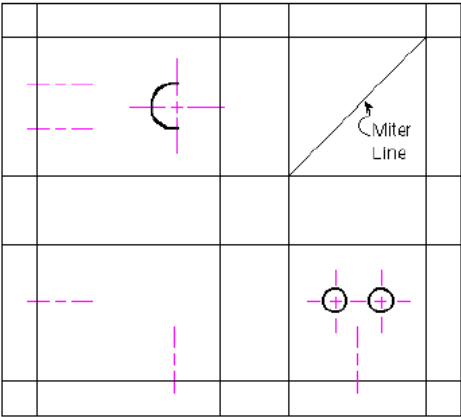
Drafting Strategies (3 Views)



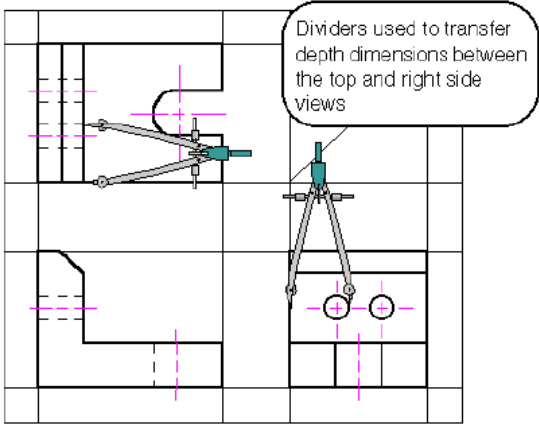
(A)



(B)



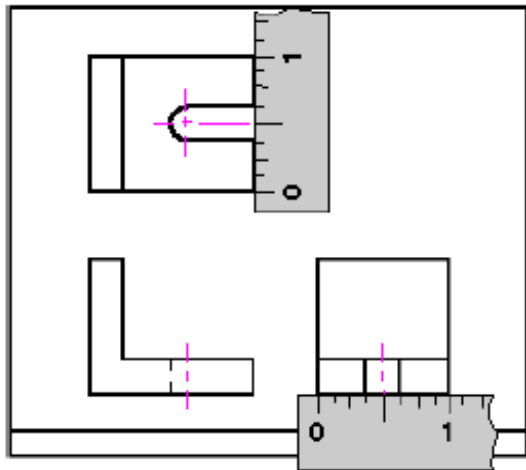
(C)



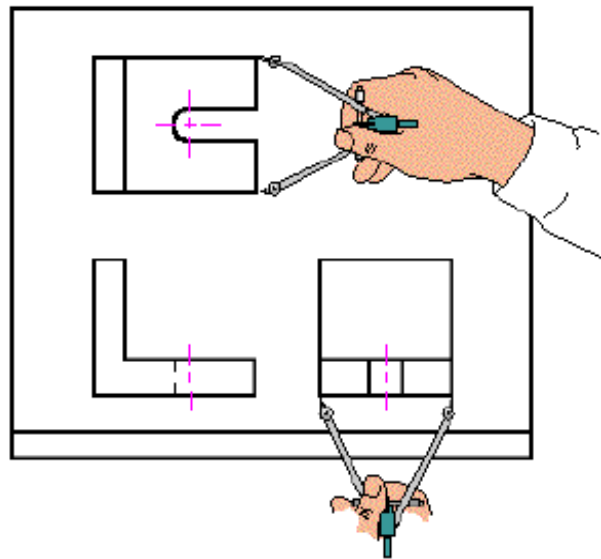
(D)

Technical Procedures

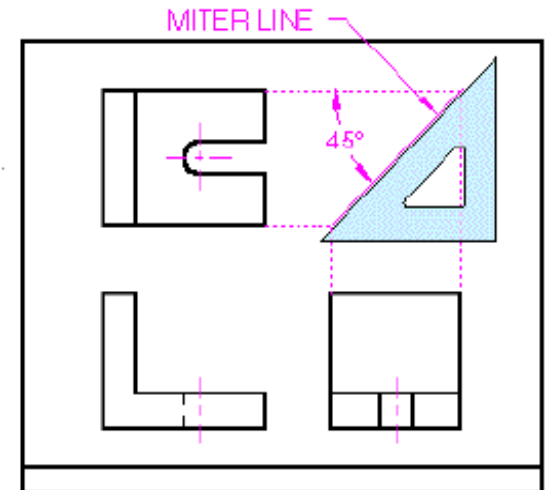
When representing the third view, a scale, divider or miter line is used to ensure the alignment of all three views.



(A) Scale



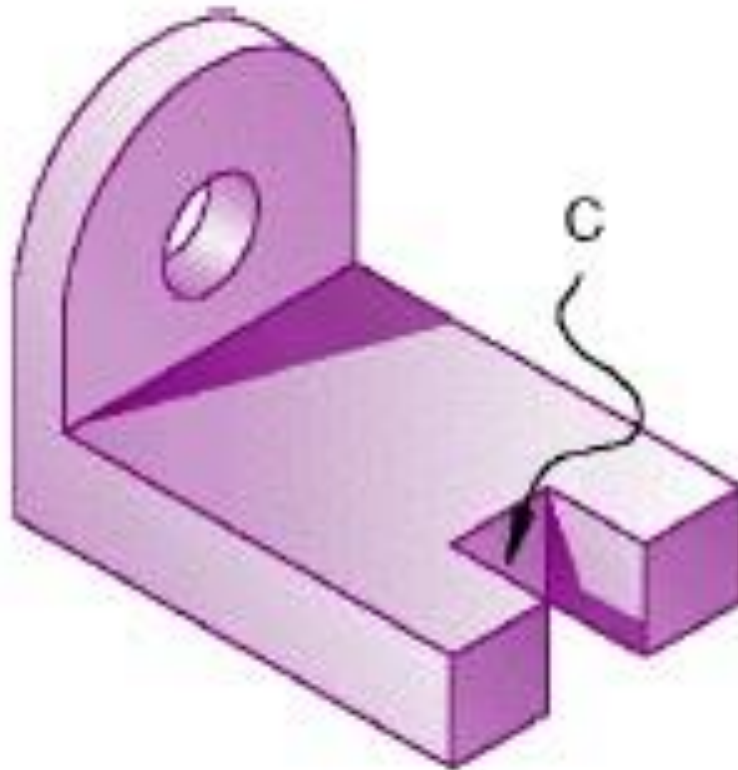
(B) Dividers



(C) Miter Line

Example

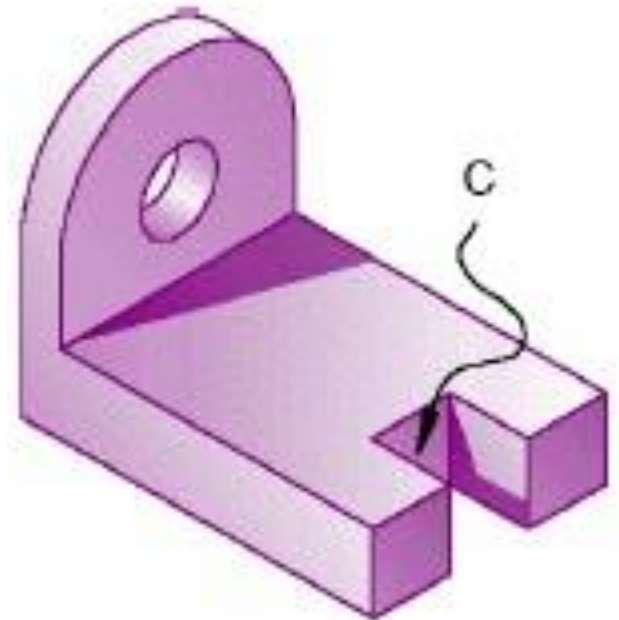
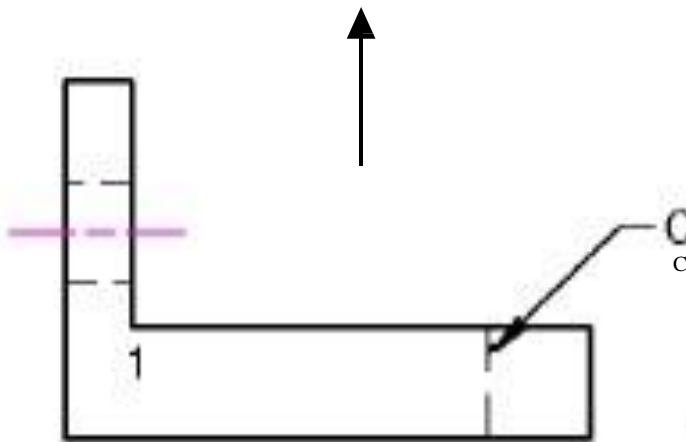
Represent the shown component using multiple view representation.



Example

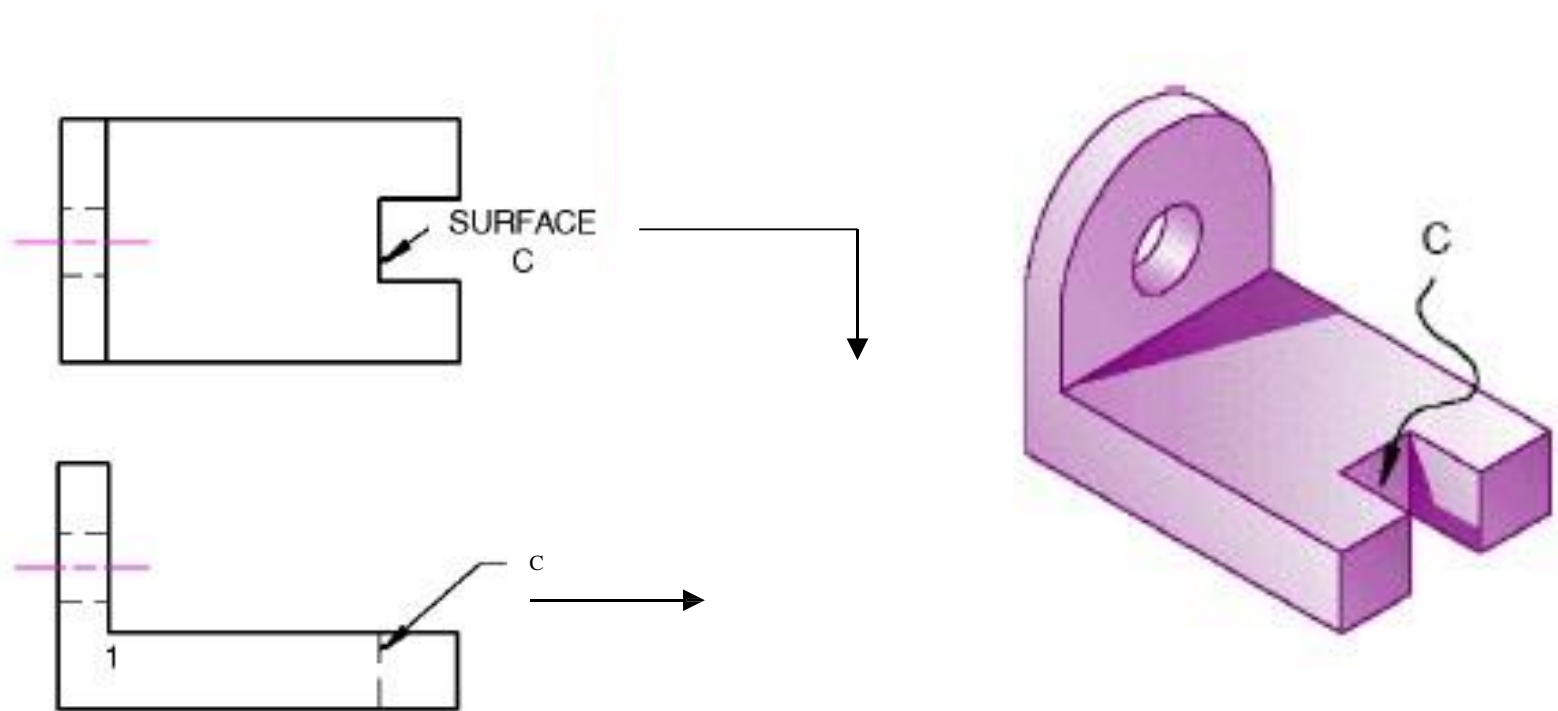
Start with the front view.

Edge “C” cannot be seen but is represented by a dashed line (hidden feature).



Example

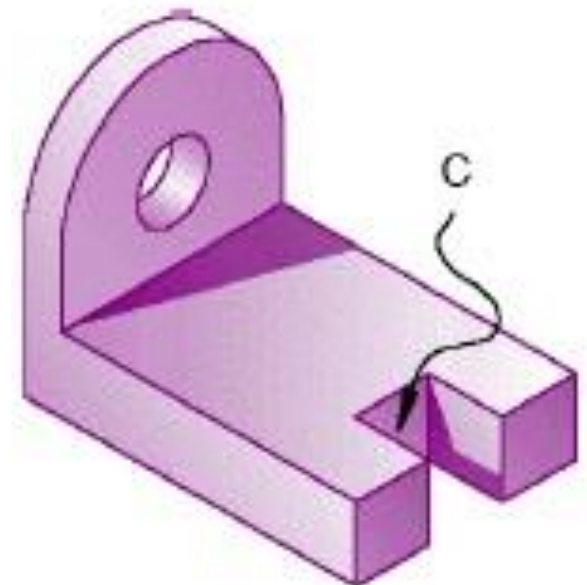
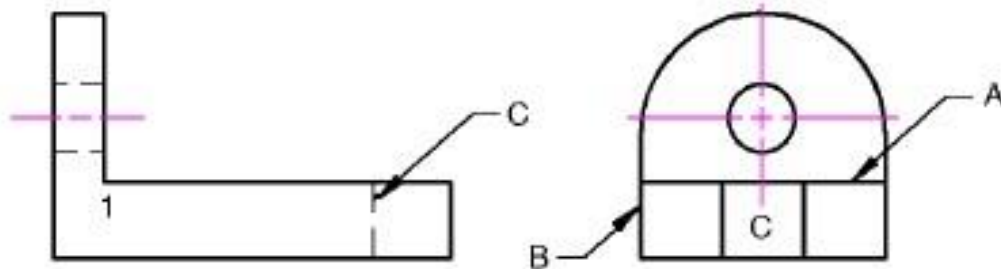
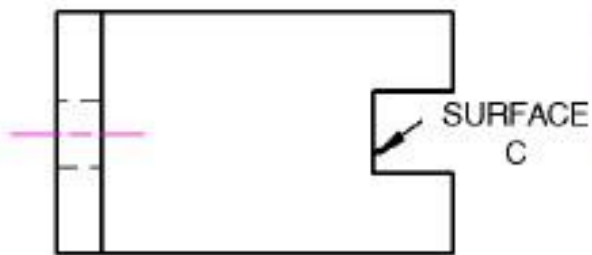
Align the top view with respect to the front view.



Example

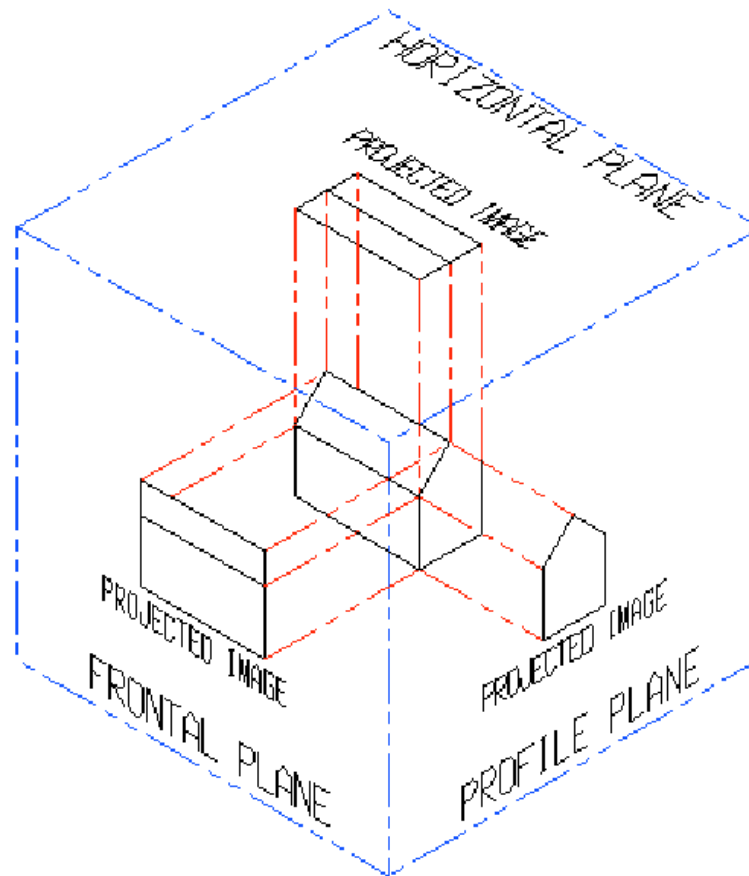
Complete the representation.

Dimensioning and comments will be added to the drawing afterwards.

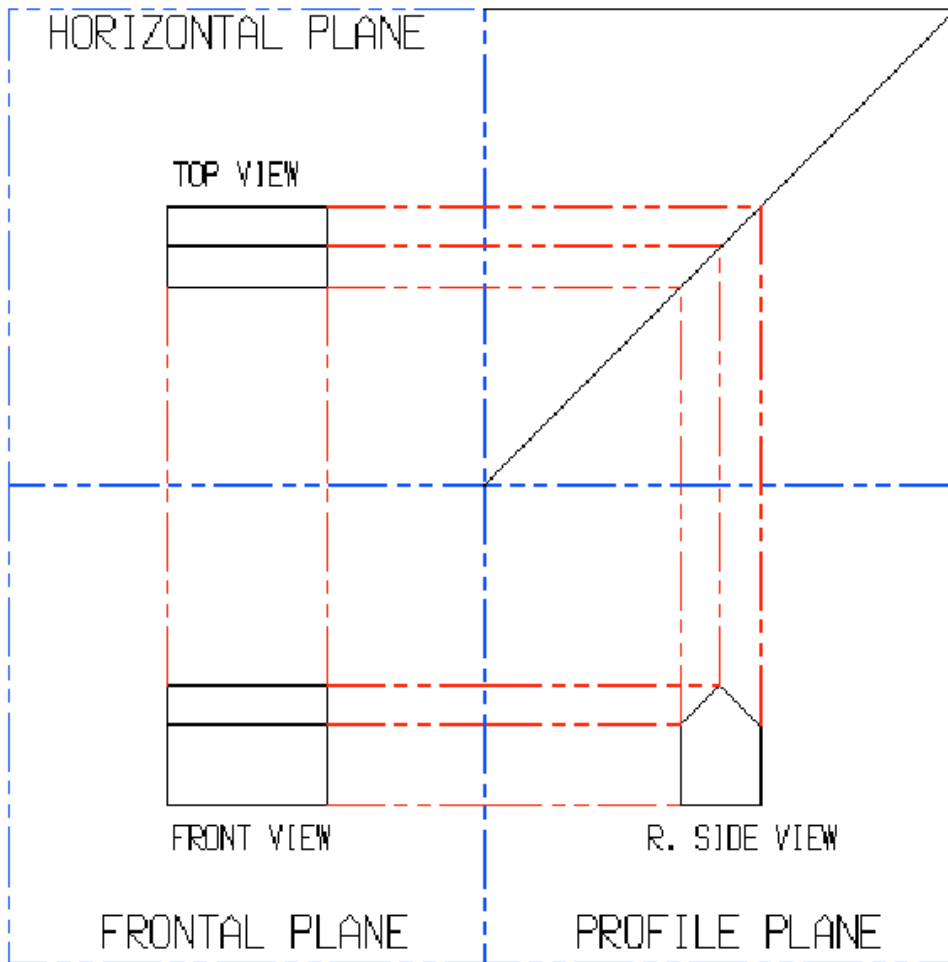


Principal Projection Planes

The object should be aligned with projection planes.



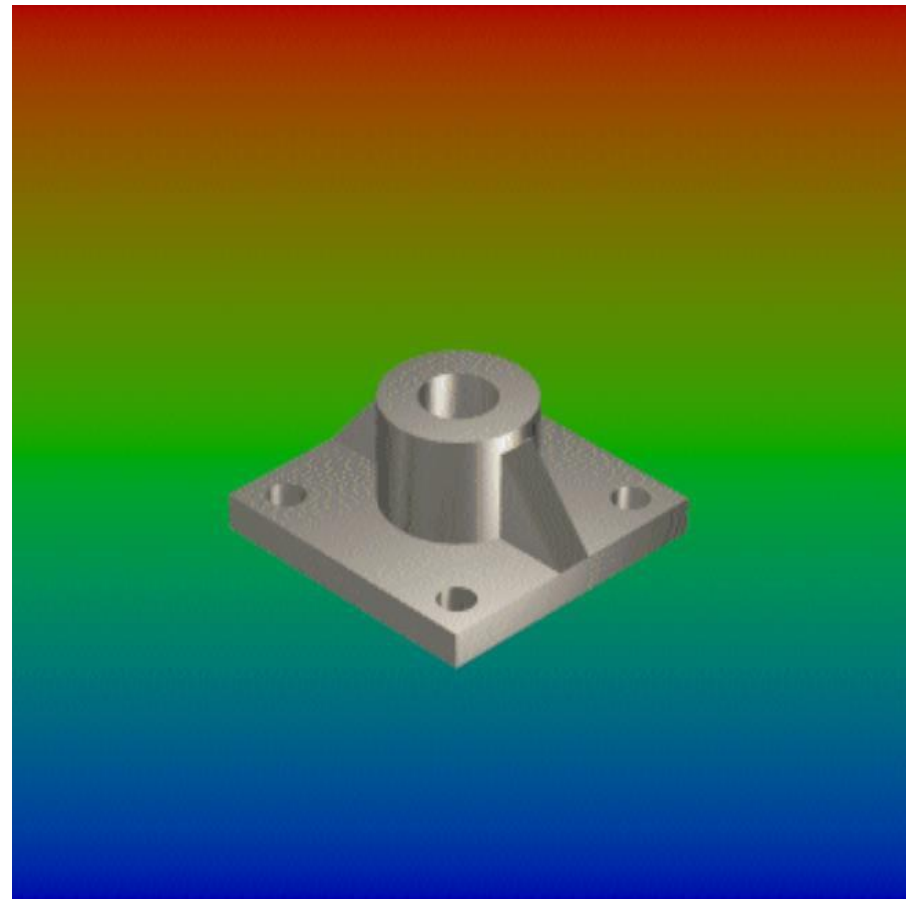
Principal Projection Planes, Unfolded



- Notice the relationship between the features.
- The depth & distance from the front to the object is measured in the Horizontal and Profile planes.

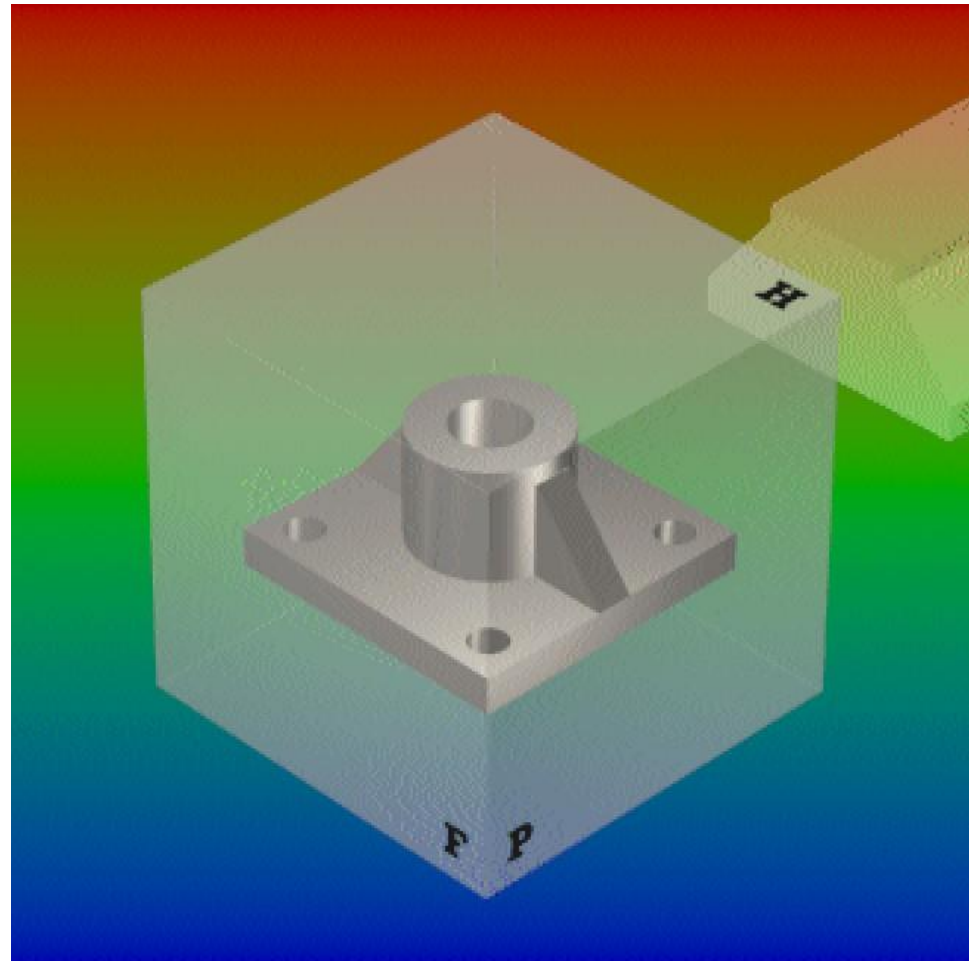
Generating a Multiview Projection Drawing

- Take the part shown here.
- Position the part in a convenient way, to simplify representation as much as possible.



Generating a Multiview Projection Drawing

- Select the position of the projection planes.
- Start with one of the projections, usually the front view.
- Each edge is represented based on the principle of the parallel projection.

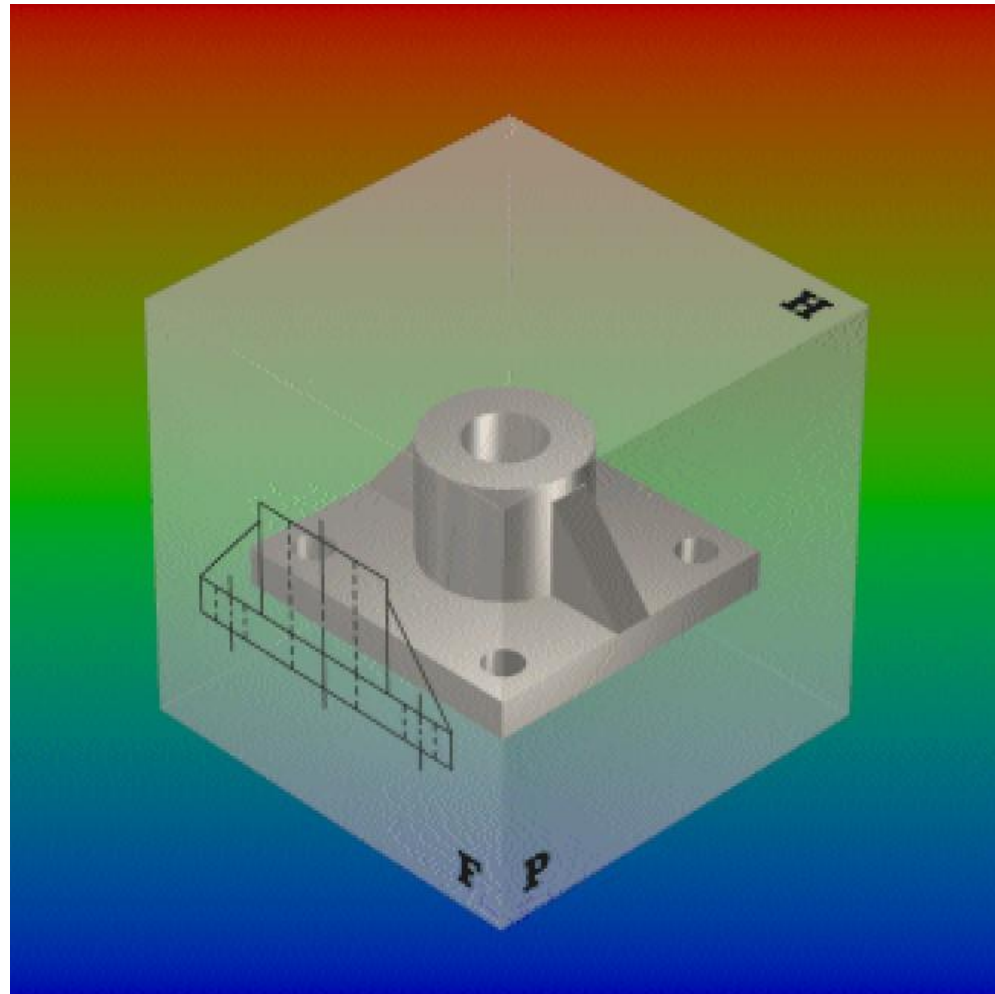


Generating a Multiview Projection Drawing

Complete the first view and use basic representation.

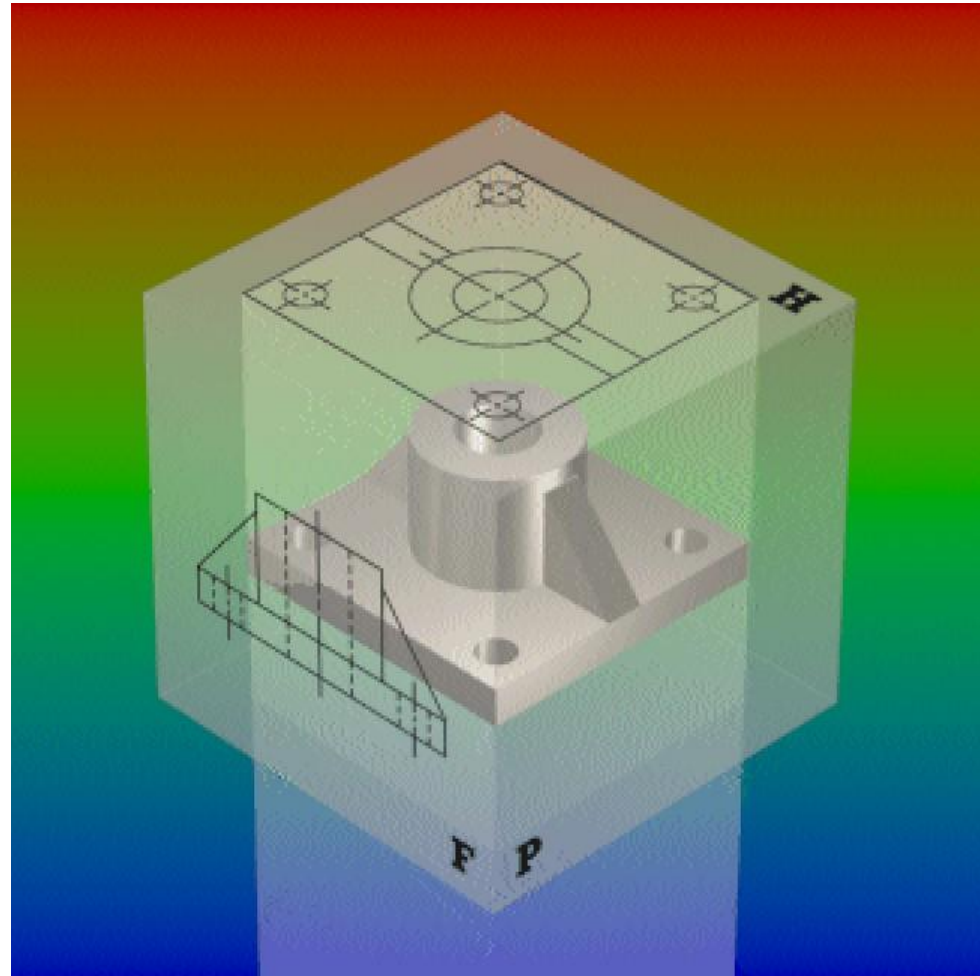
Principles:

- Visible edges are seen as full lines,
- Non-visible features are represented by a dash-line,
- Axes of symmetric features are represented by dash-dot lines.



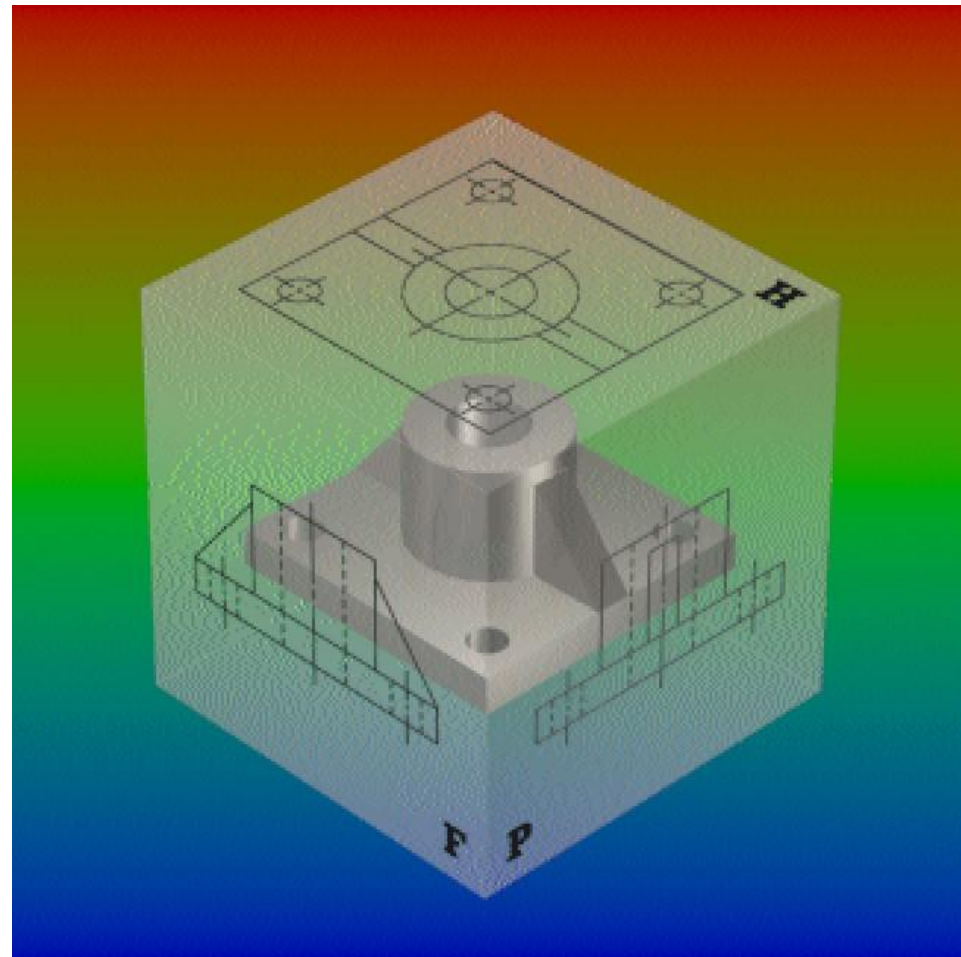
Generating a Multiview Projection Drawing

- Continue with the second view. Make sure that you have accurately aligned both views. Use the same rules for representation.
- Alignment lines must be perpendicular to the edge of the projection planes.
- (Lines of sight are always perpendicular to the fold line).



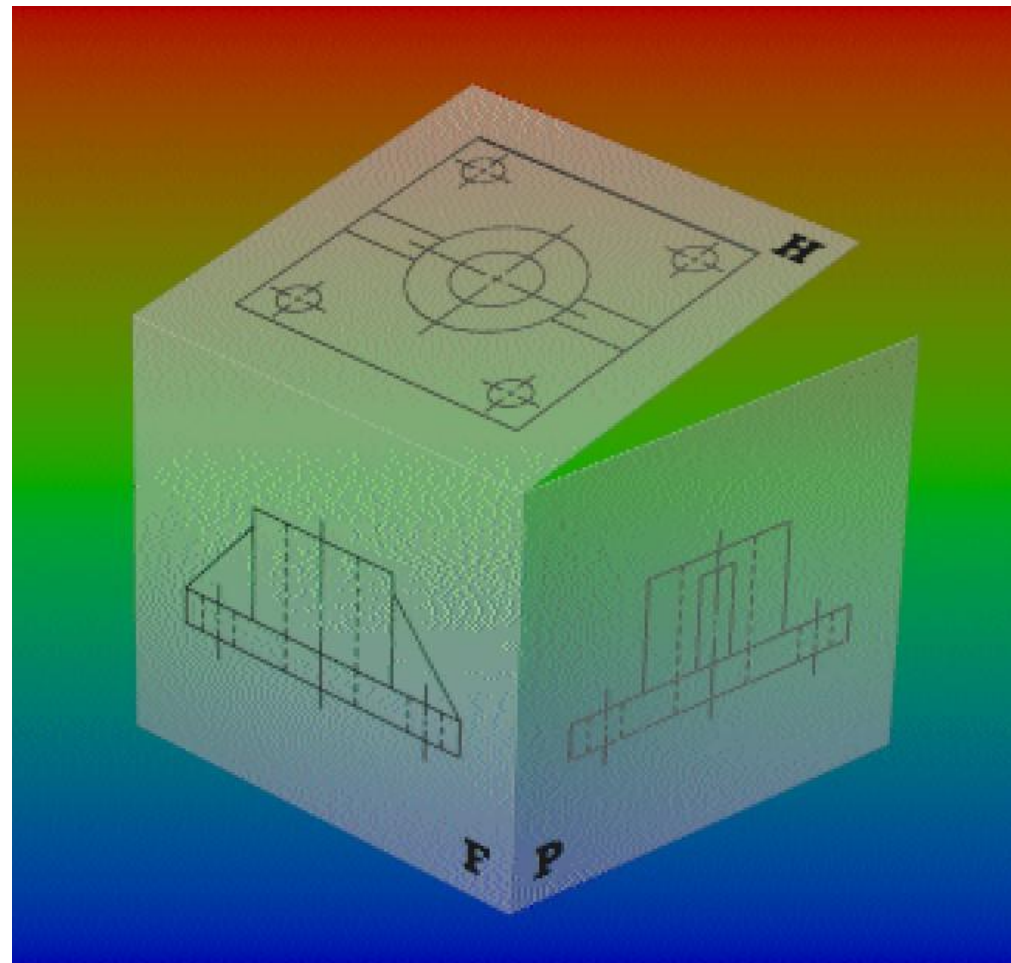
Generating a Multiview Projection Drawing

- Continue with the third view.
- Make sure that all views are accurately aligned.
- Use the same rules for representation.
- The alignment lines must be perpendicular to the edges of the projection planes.
- Lines of sight are always perpendicular to the corresponding fold lines.



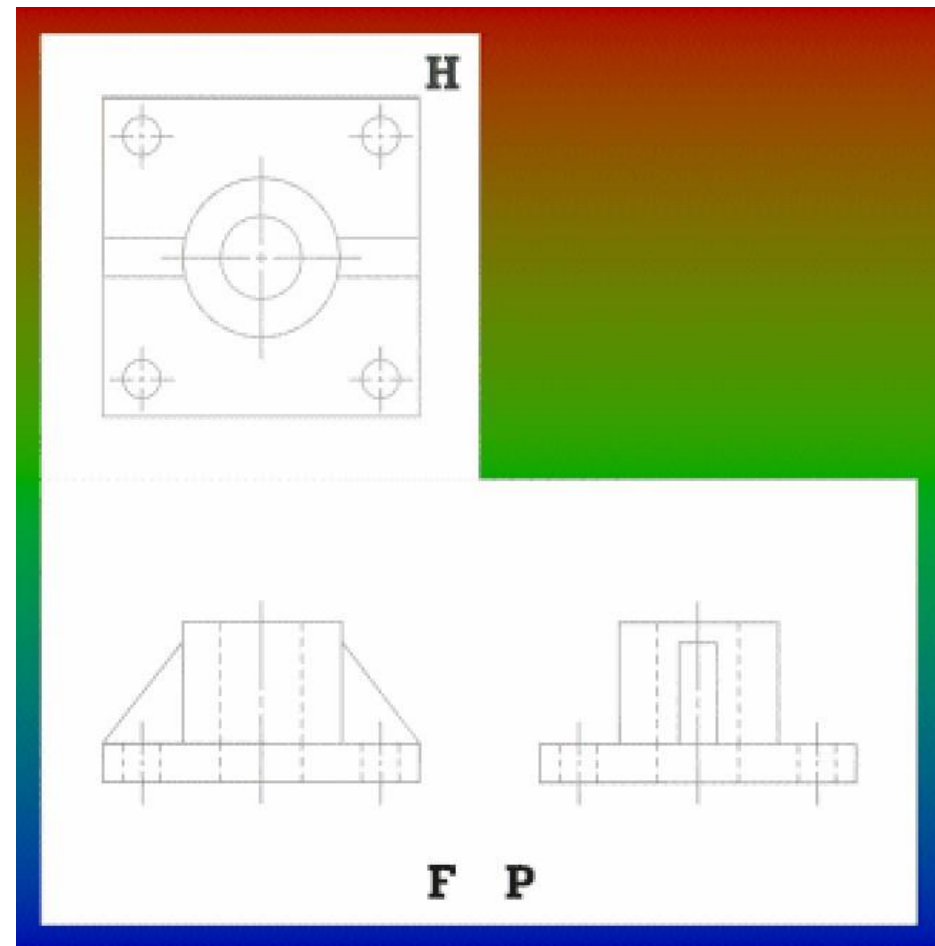
Generating a Multiview Projection Drawing

- Complete the representation.
- Separate the top view from the profile view along the edge (fold line).
- Unfold the three views to lay them on the same plane.



Generating a Multiview Projection Drawing

- This is the 3-view orthographic representation of the selected part (FLANGE).
- Do not erase any of the lines when writing a test.



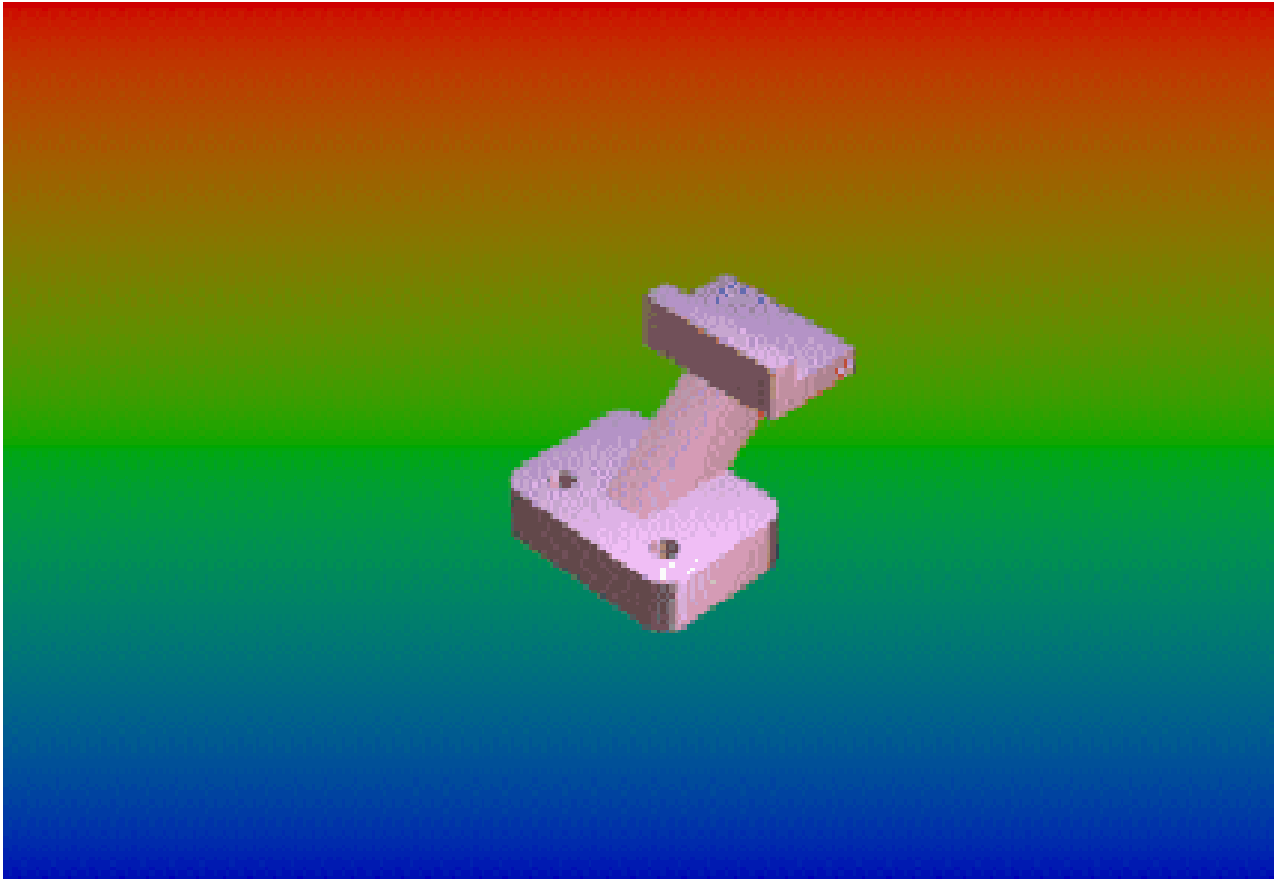
MECH211

SOME PRACTICE!

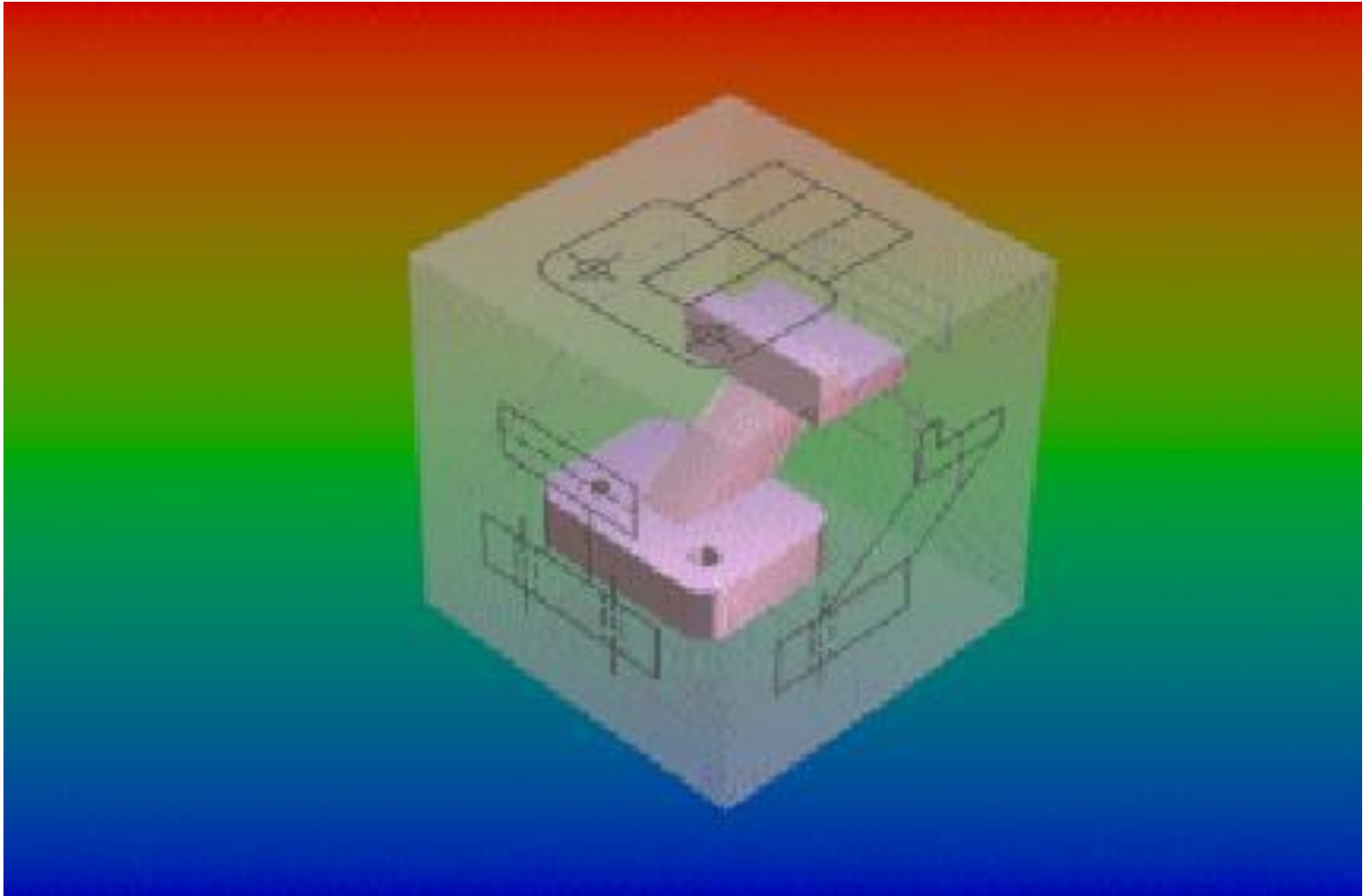


Orthographic multi-view

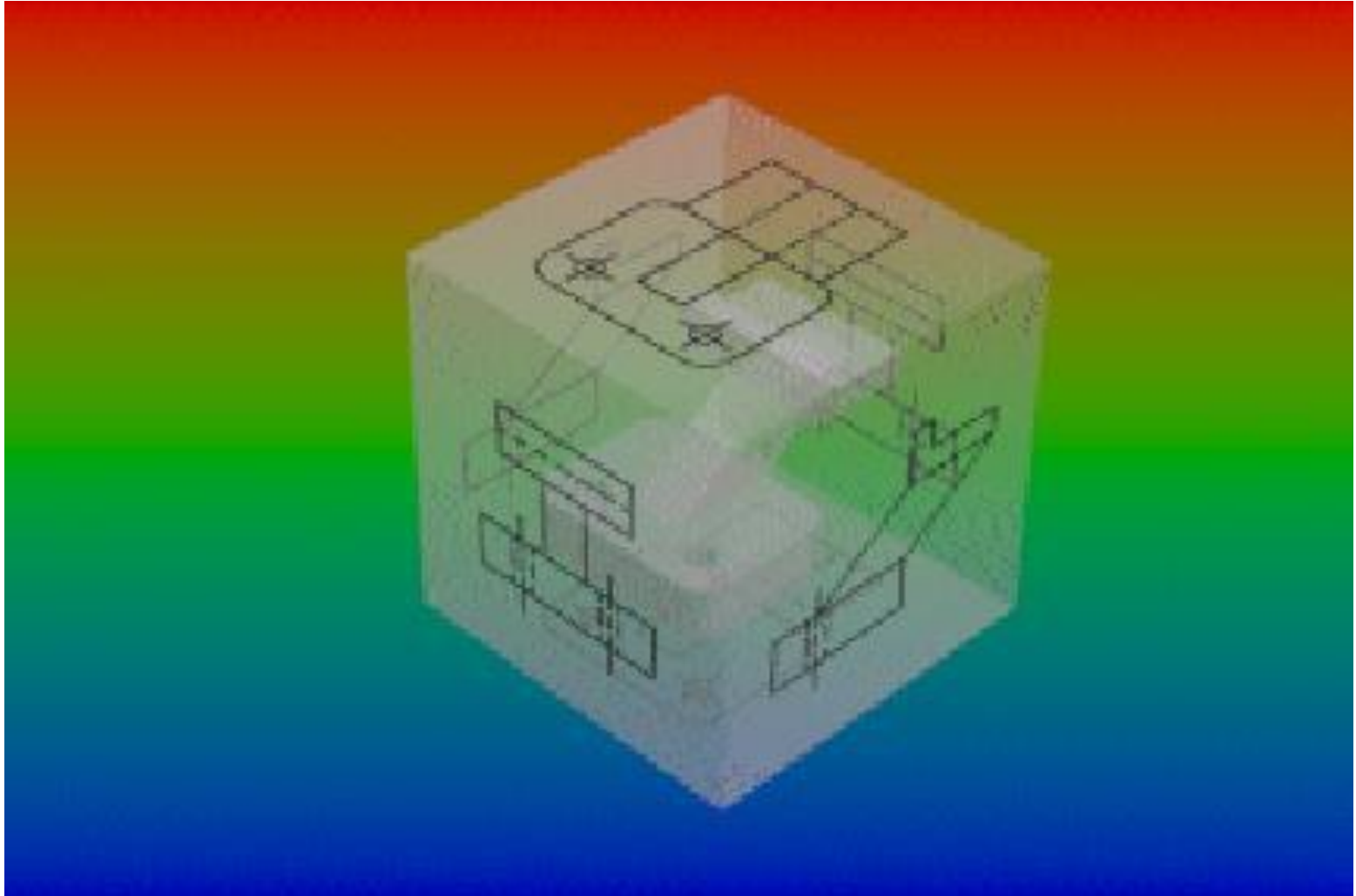
This part will be projected on all 6 projection planes.



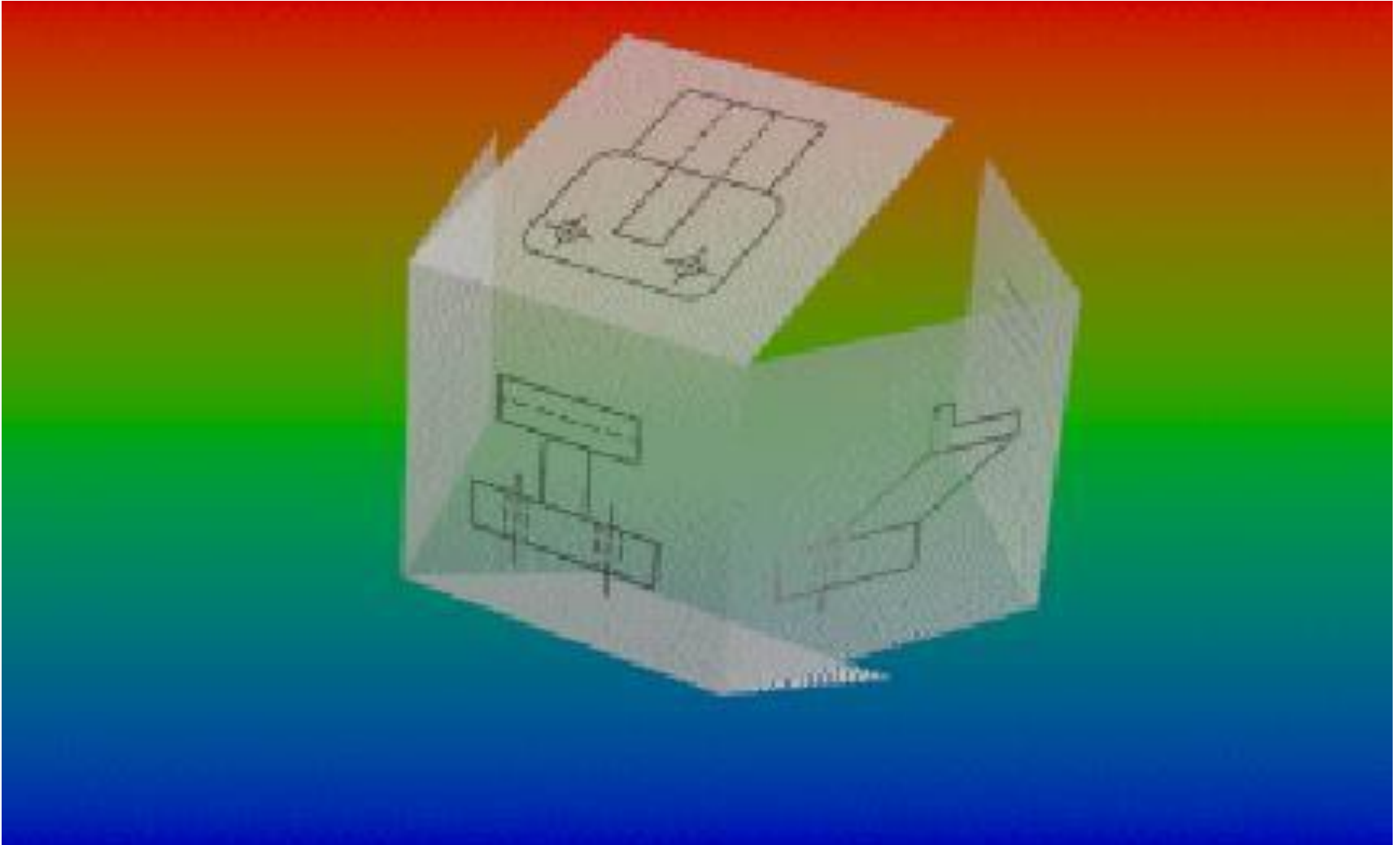
Orthographic multi-view



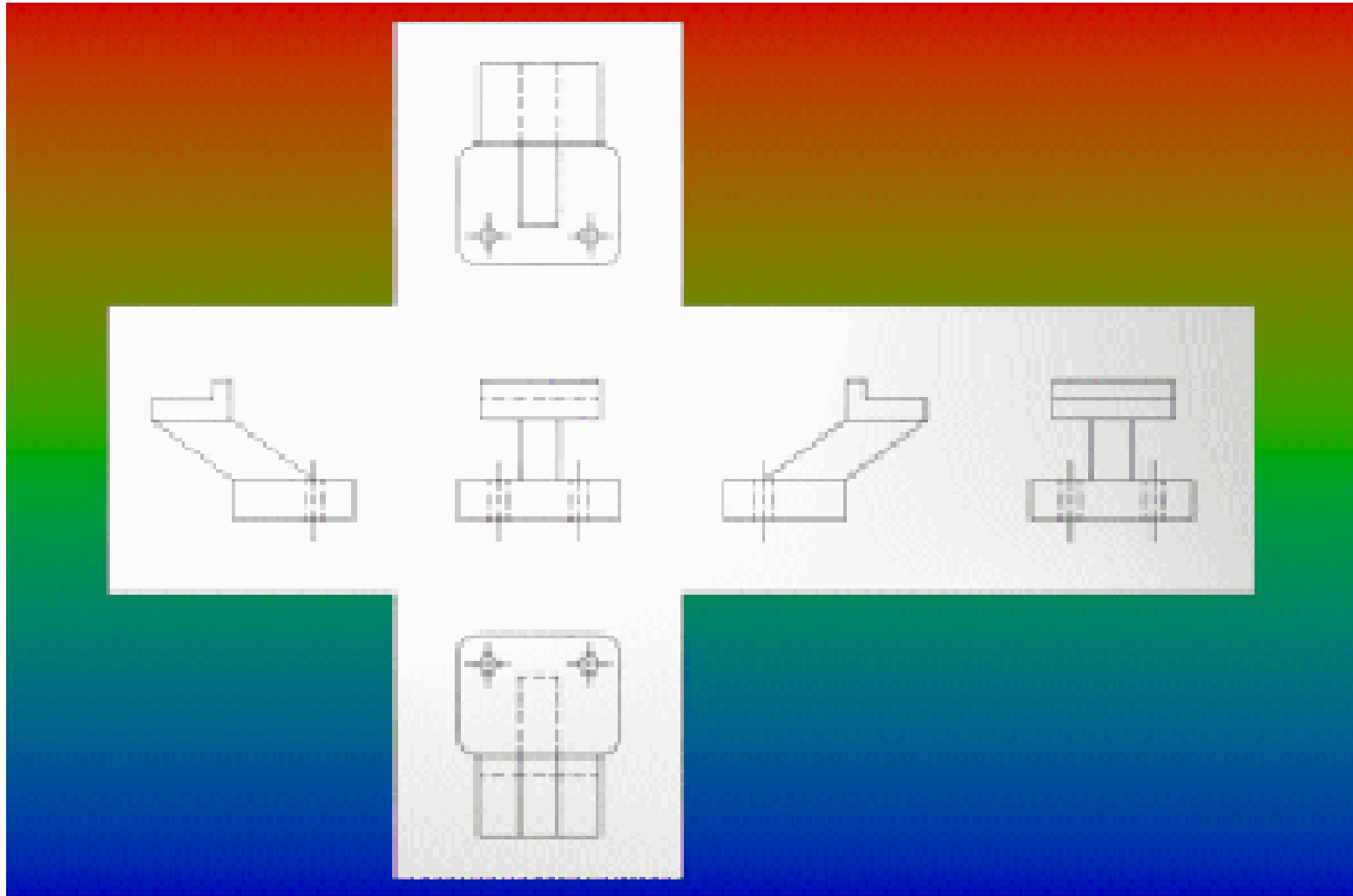
Orthographic multi-view



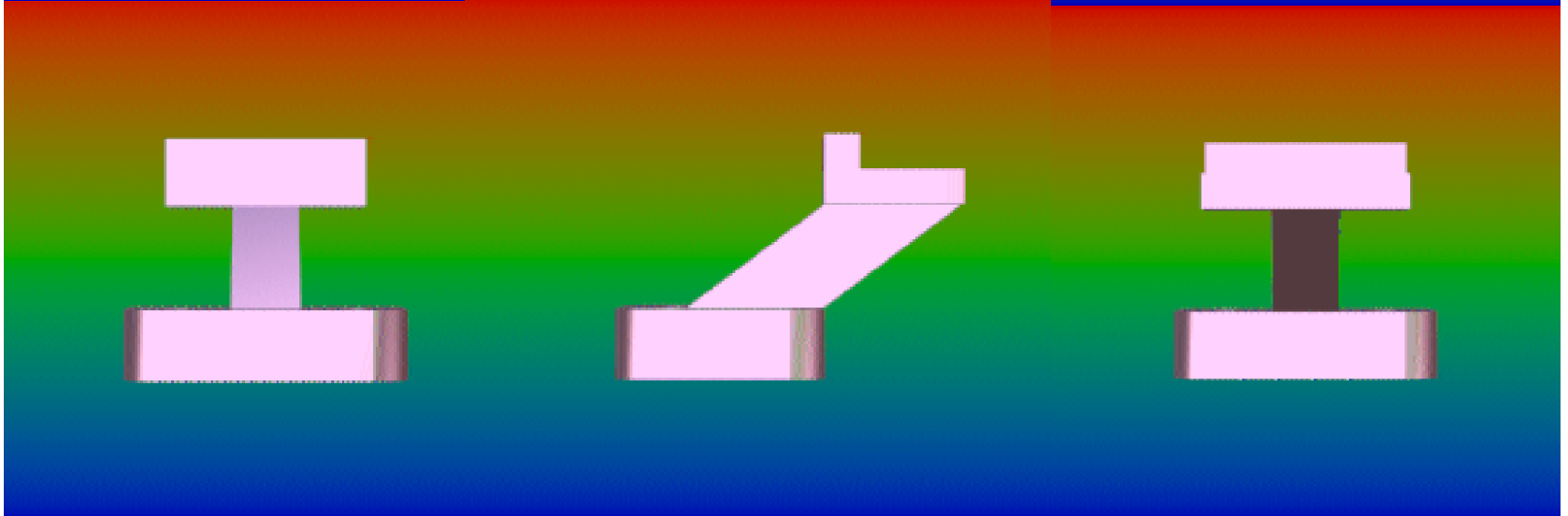
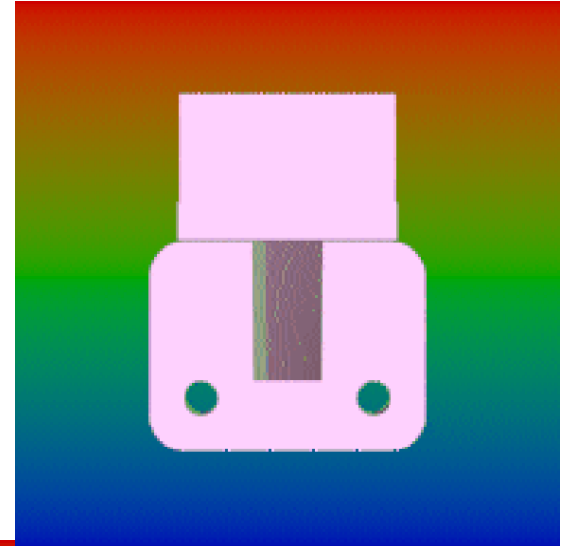
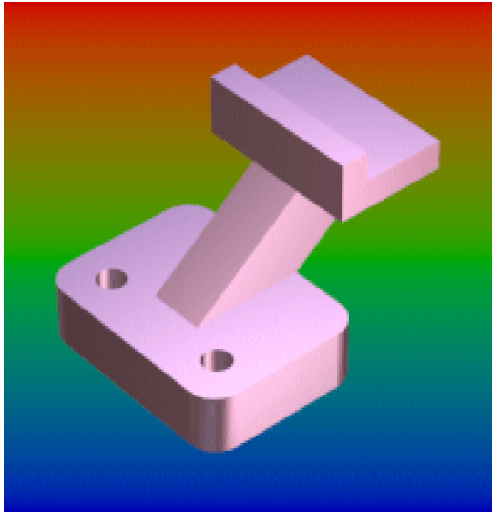
Orthographic multi-view



Orthographic multi-view

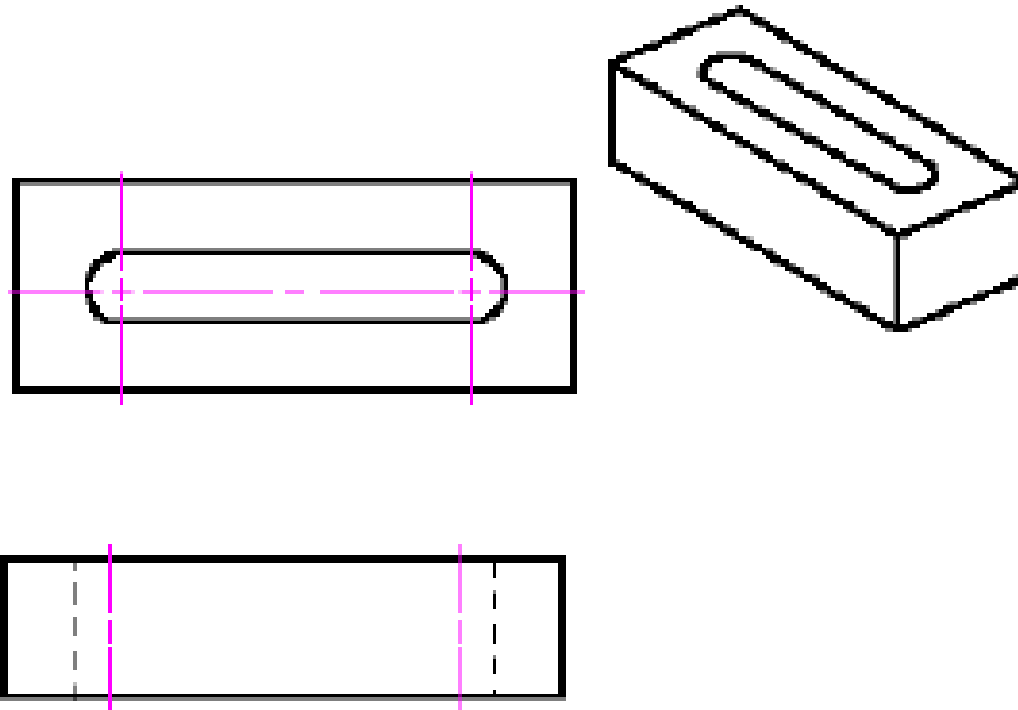


Solid models



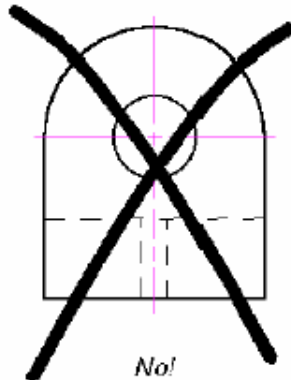
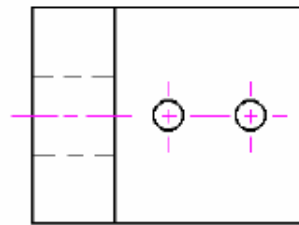
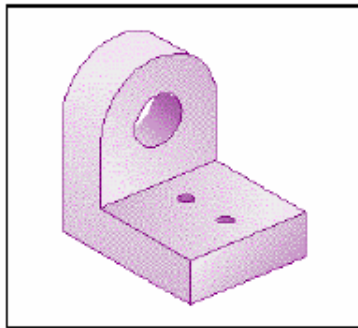
Minimum number of views

- Some shapes can be described with fewer views.
- Use the minimum number of views for representation.

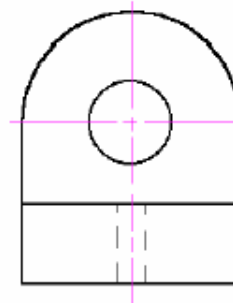
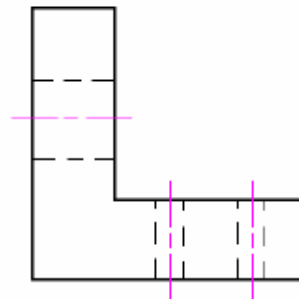


Minimum number of views

Do not produce more views than is necessary.

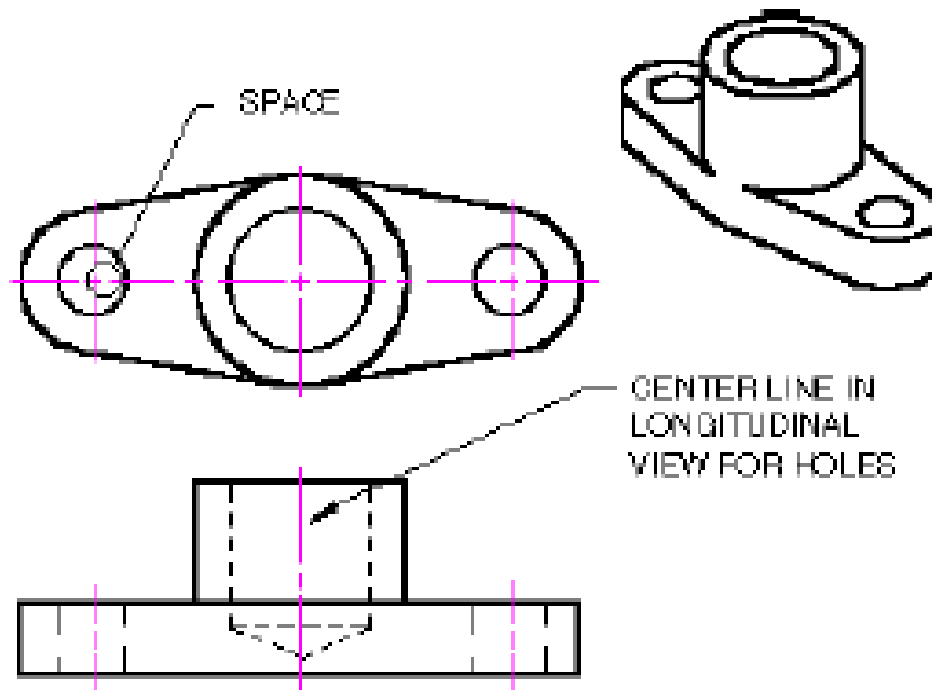


No!



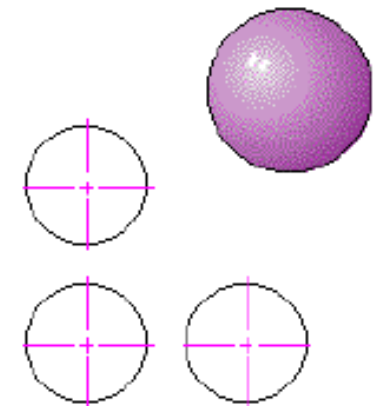
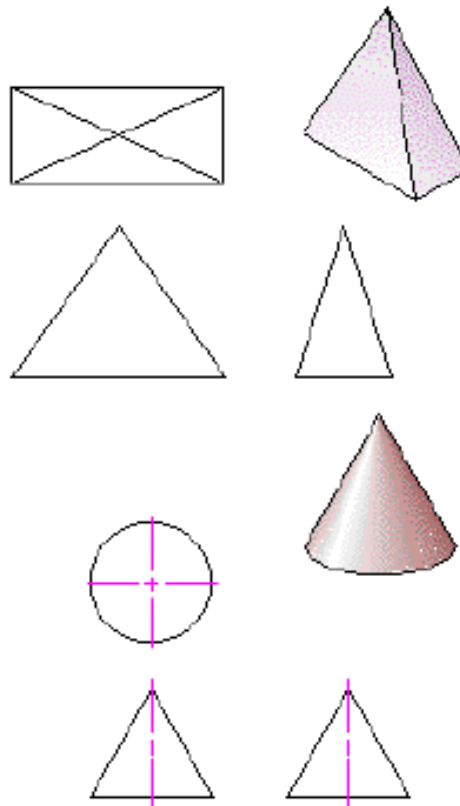
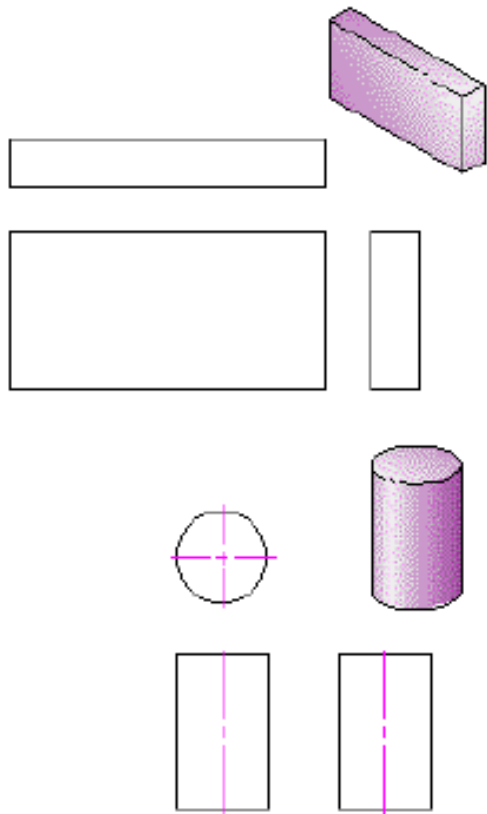
Centerline

Axisymmetric features are indicated with a dash-dot line CENTERLINE



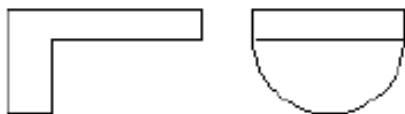
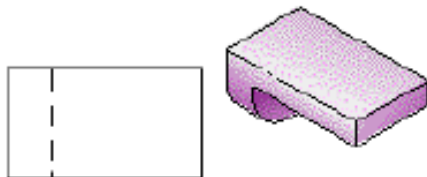
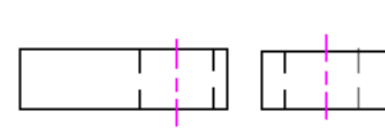
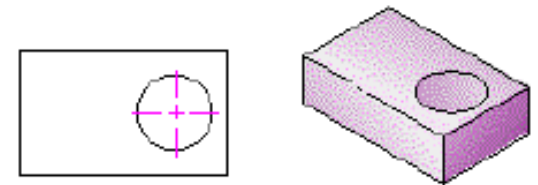
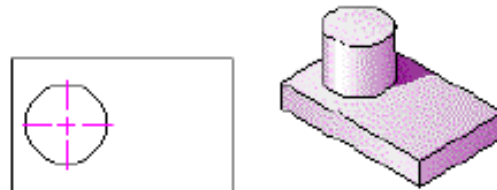
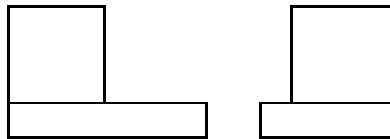
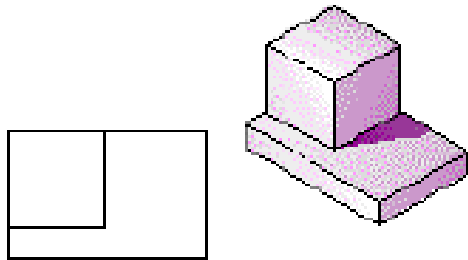
Hints on understanding shapes

Try to “see” how solids are created out of primitives.

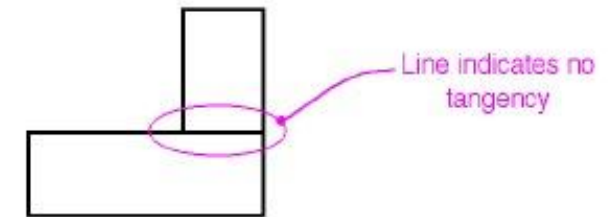
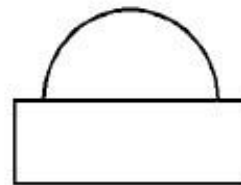
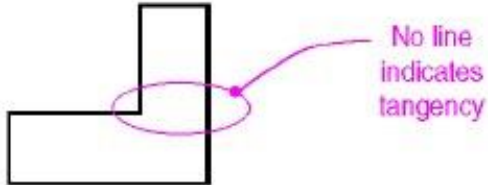
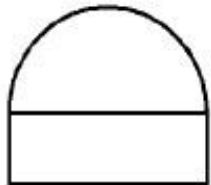
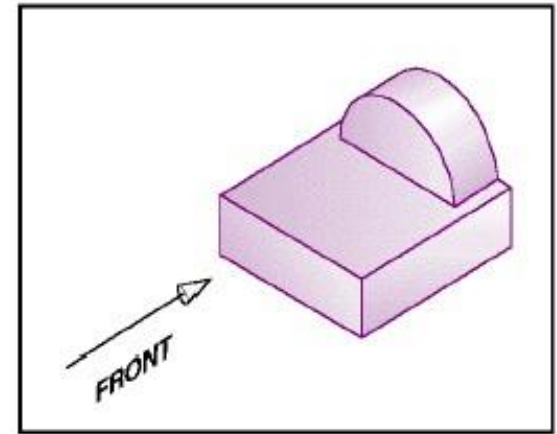
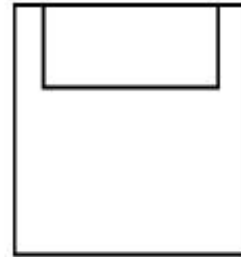
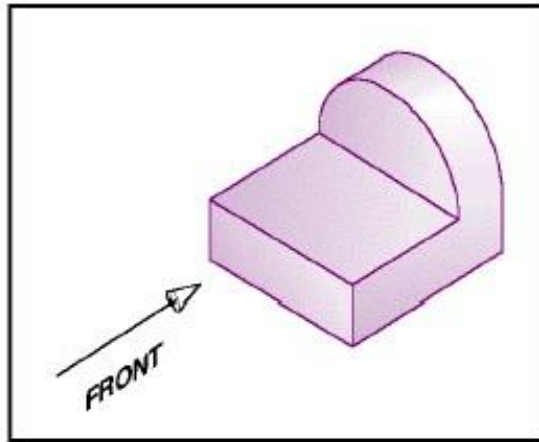
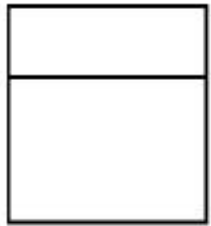


Hints on understanding shapes

Complex shapes can be generated with Boolean operations.



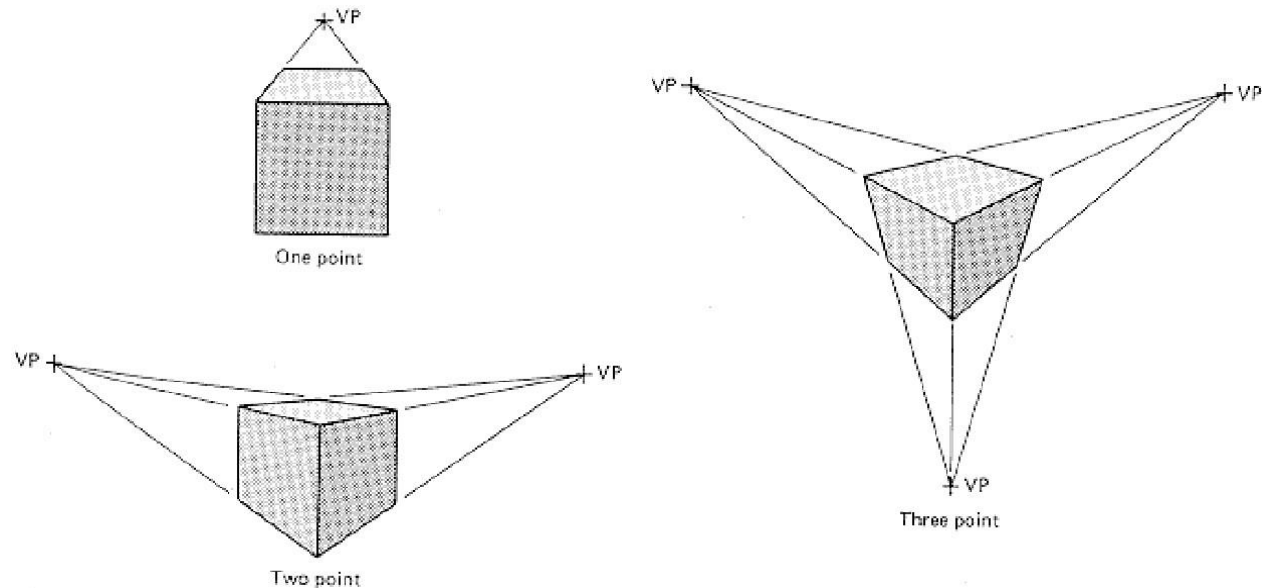
Pay attention to edges



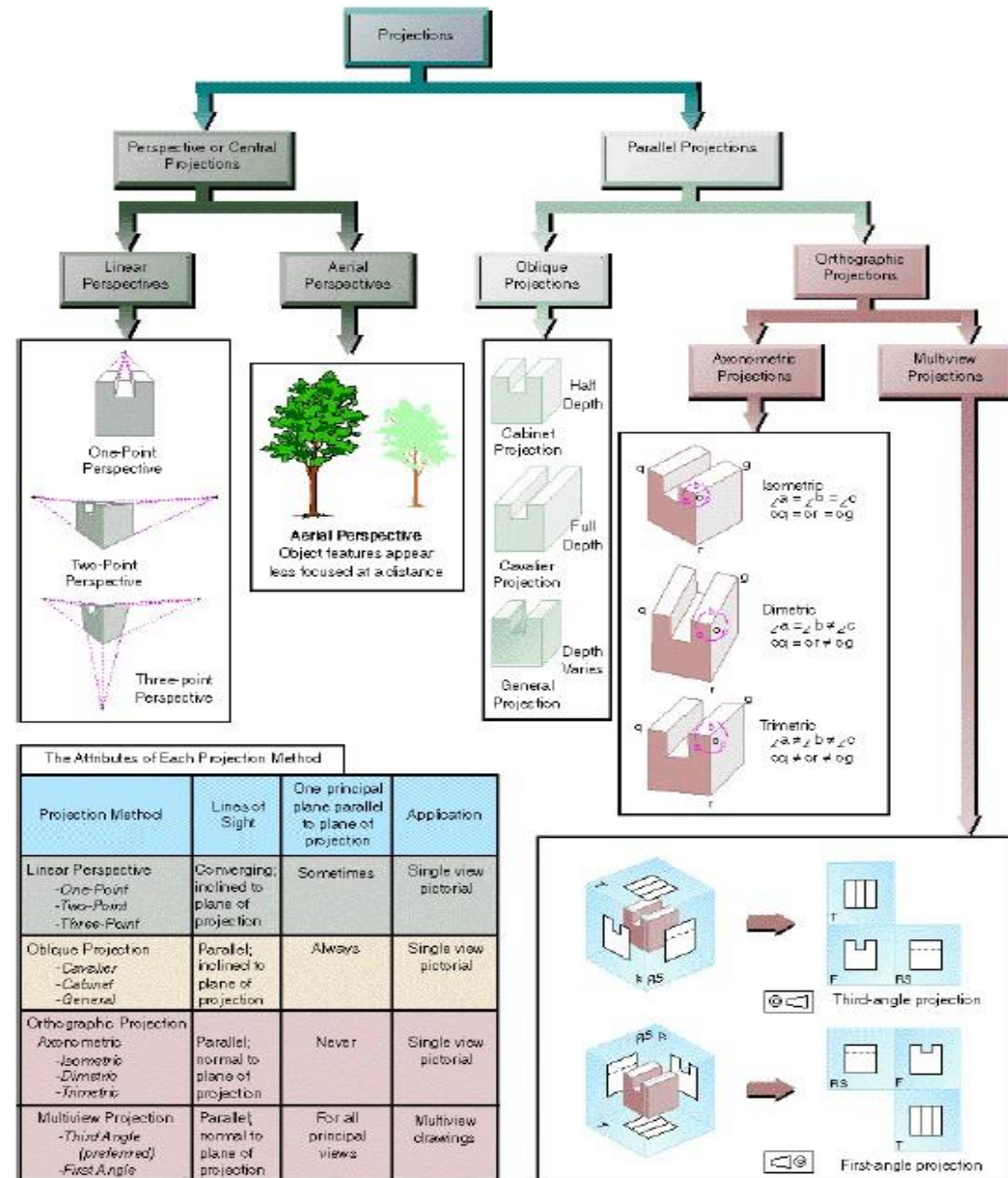
What is Perspective Representation?

Representation of objects based on a distance rule: 2 identical objects are seen as being different from different distances and shapes are deformed.

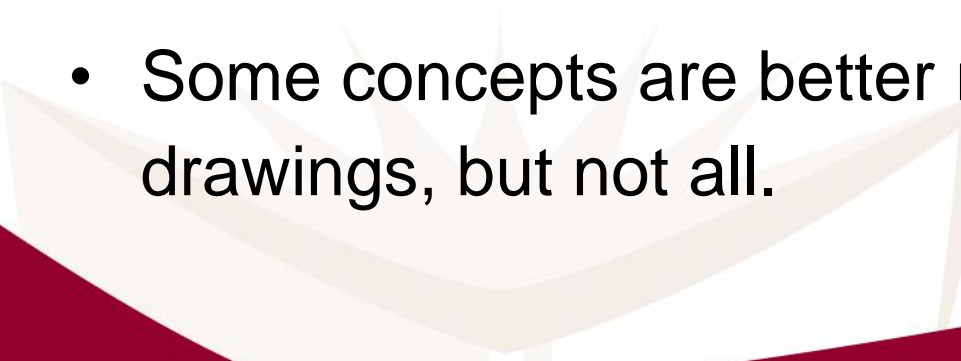
This type of representation is not used for technical purposes in the field of Mechanical Engineering.



Projections and views (brief)



Where are drawings used?

- It is important to know the rationale for drawings.
 - Drawings are an international communication language.
 - They are a quick way to convey certain types of information.
 - Some concepts are better represented with drawings, but not all.
- 

The Design Process

- Drawings are created to represent parts that do not yet exist.
- Designed parts are intended to be manufactured.
- Drawings must carry all the necessary information for the fabrication of the part.



The Design Process

Design involves constrained creation.

Constraints:

- Limits to technology,
- Human and environmental concerns,
- Durability and reliability,
- Cost,
- Market requirements,
- Etc.

The Design Process

REPRESENTATION

PERCEPTION

KNOWLEDGE

INTUITION

CONCEPT

PURE CONCEPT

EMPIRICAL CONCEPT

NOTION

IDEA

- These are the basic requirements which are needed to create a design.
- All of these interact with your judgment, perhaps subconsciously.
- Your judgment must be trained in order to be able to perform solution- solving based thinking.
- Drawings assist you in achieving that goal.

The Design Process

- Designs are created after analysis, and a full understanding of requirements, constraints and syntheses.
- Two separate individuals may not come with the same solution to the exact same problem.
 - Example: Connect two straight pipes ND 4" to avoid leaking of the gas and to permit easy maintenance of the segment.

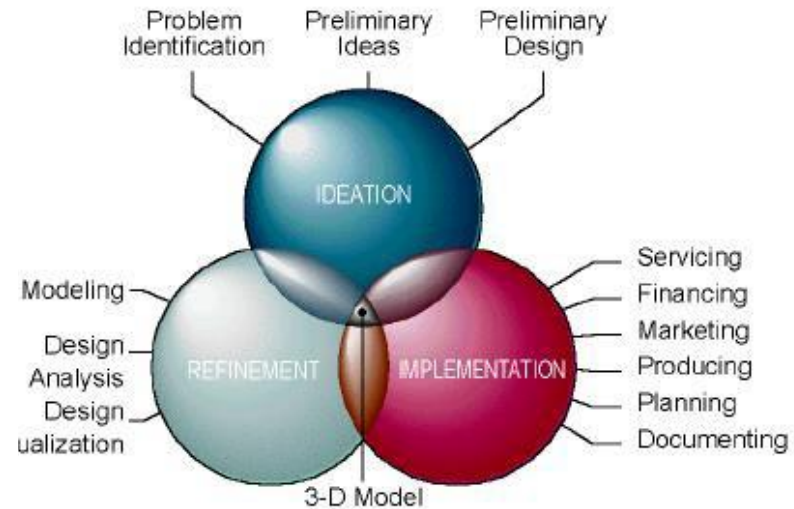
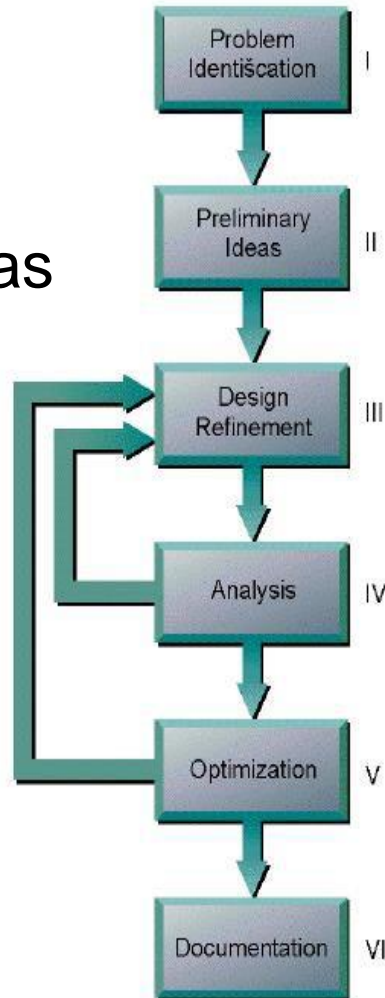
Solutions

Multiple: flanges, clips, clamps, seals, etc.



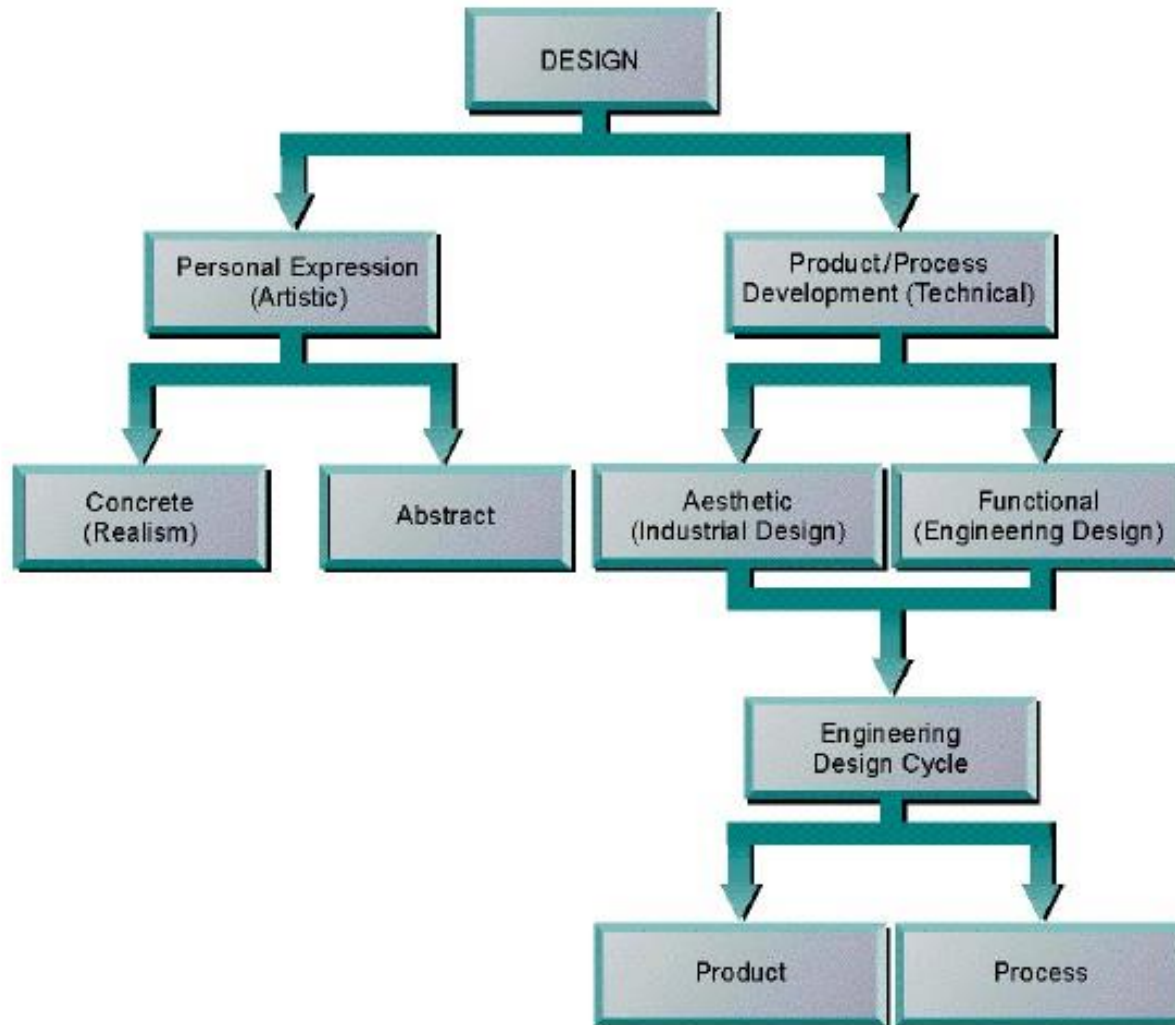
The Design Process

1. Problem Definition
2. Concept & ideas
3. Solutions
4. Models & Prototype
5. Production & working drawings

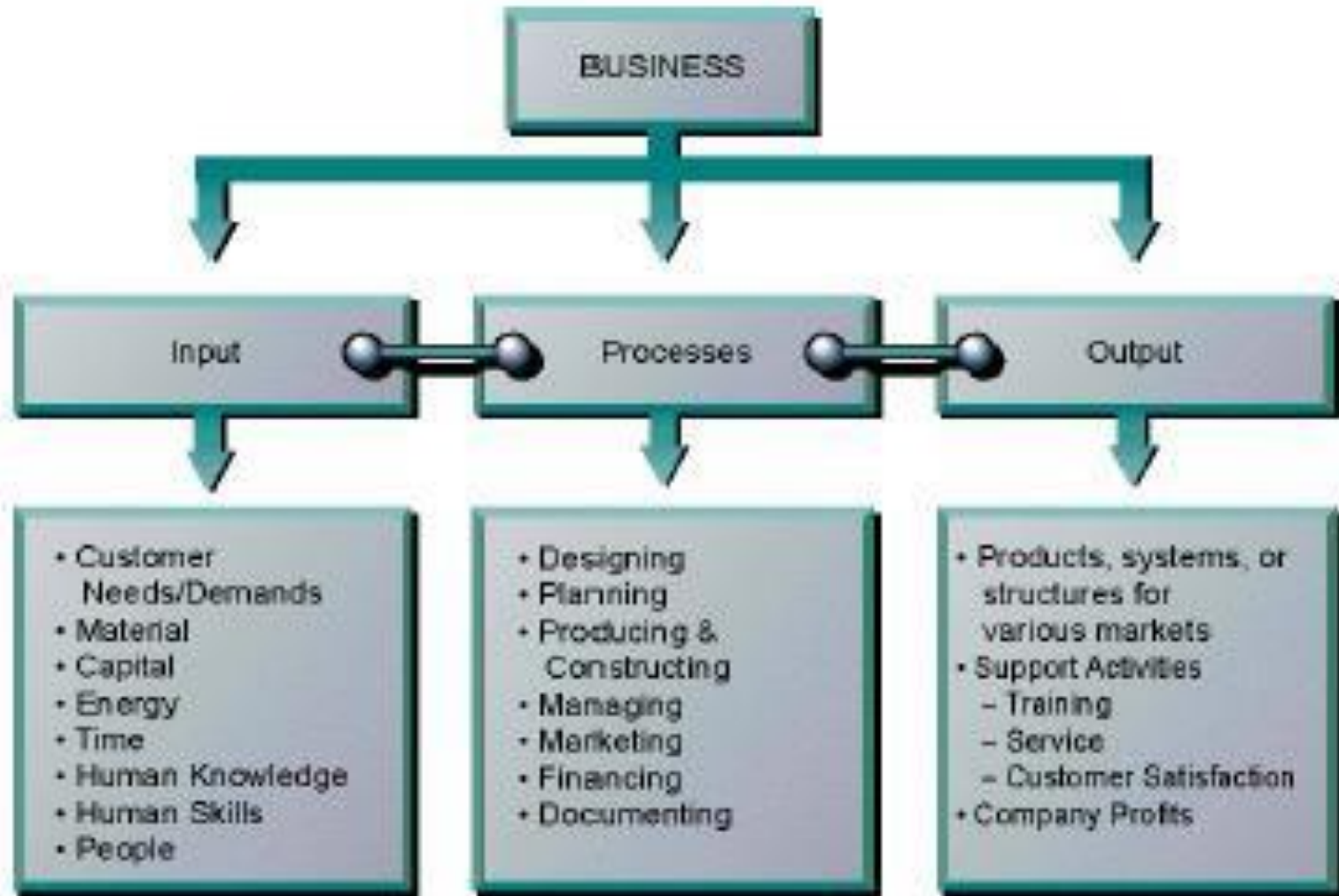


Concurrent engineering approach

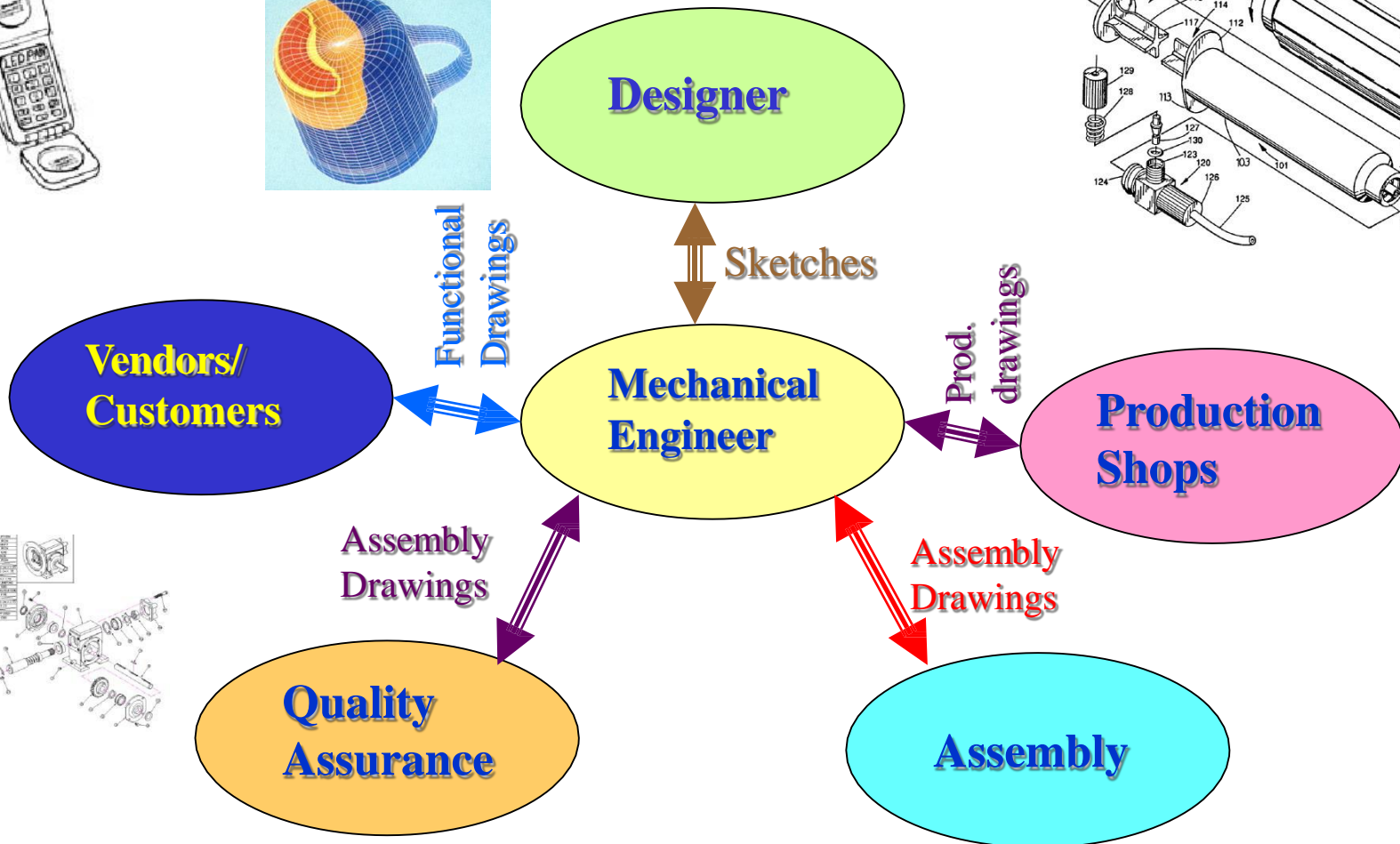
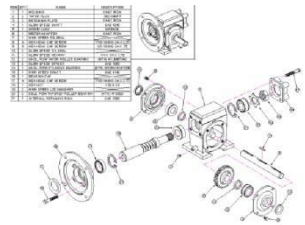
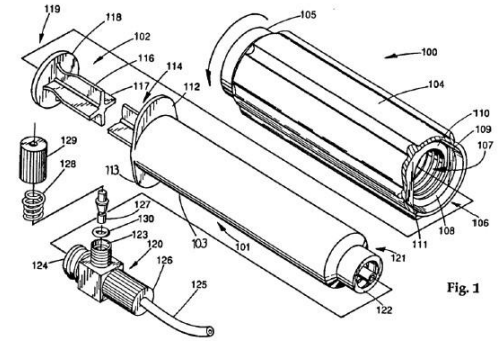
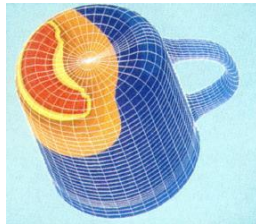
The Design Process



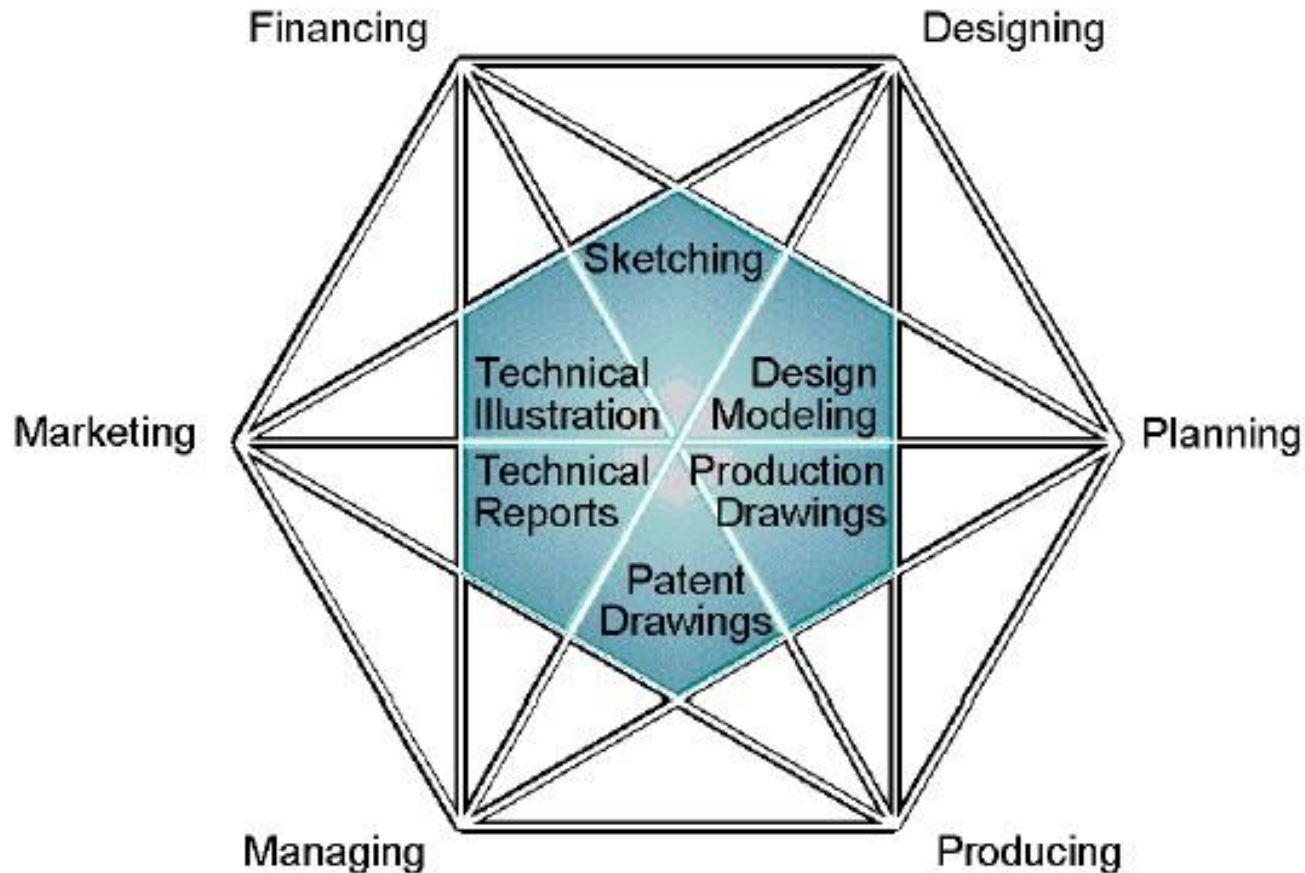
The Design Process



Drawings in Product Development



Drawings in Product Development



Other Graphic Communication Tools

