نقشه کشی صنعتی
Industrial Drawing

نمای کلی درس
Overview

Introduction

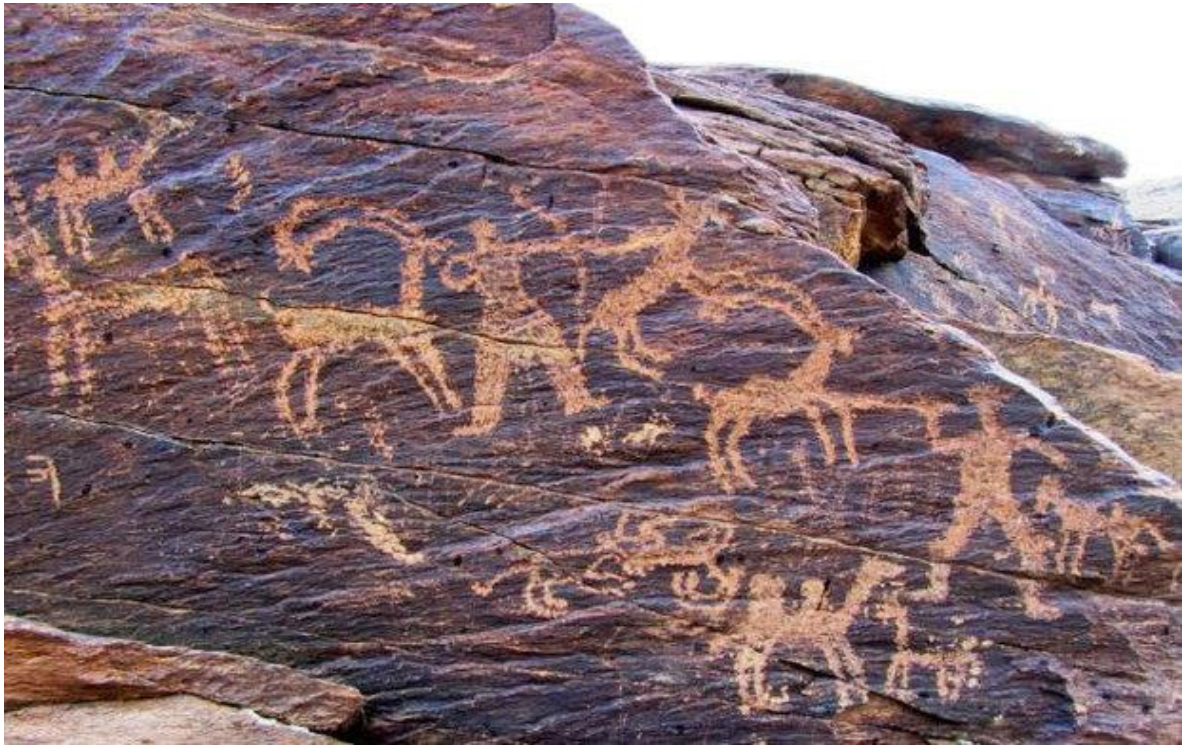
- What is Industrial Drawing (Technical Drawing)?
- One of the best ways to communicate one's ideas is through some form of picture or drawing.
- This is especially true for the engineer. The purpose of this course is to give you the basics of technical drawing.
- "Sketching" generally means freehand drawing. It also refers to artistic pictures.
- "Drawing" usually means using drawing instruments, from compasses to computers to bring precision to the drawings.

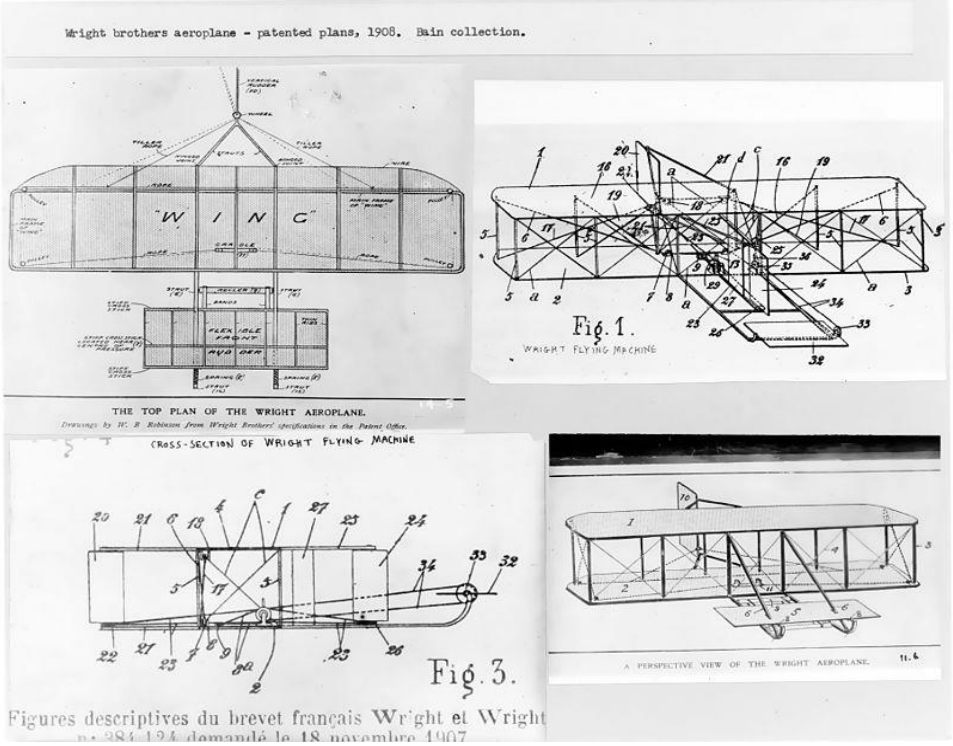
Introduction

- One of main basis of industry.
- A bright and live language to transfer the idea between designers and manufacturers in different aspects of engineering.

Introduction

- A powerful tool to describe things
- Between different cultures and languages
- From ancient times (25000 to 30000 years ago), before the invention of writing (3200 BC)





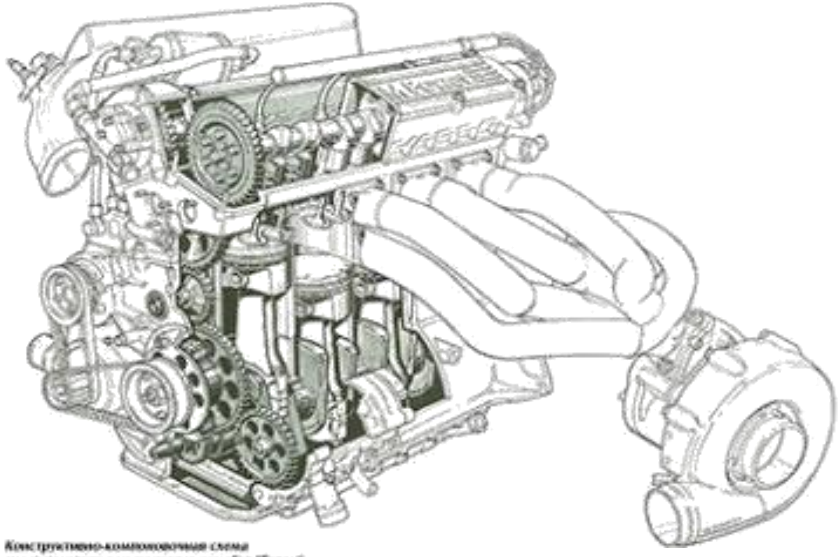
Introduction

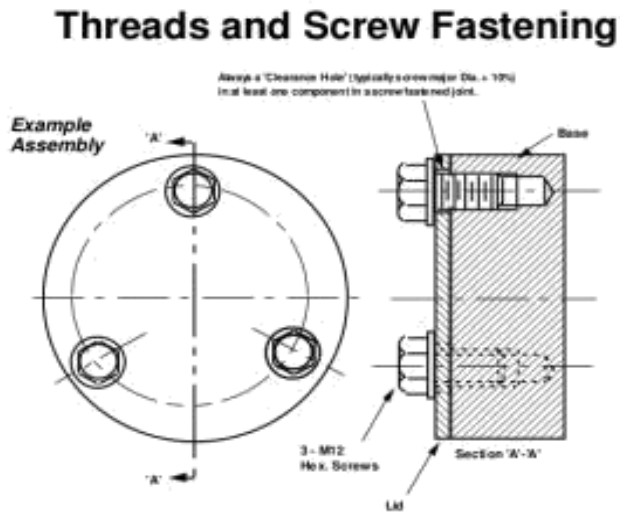
Sketching

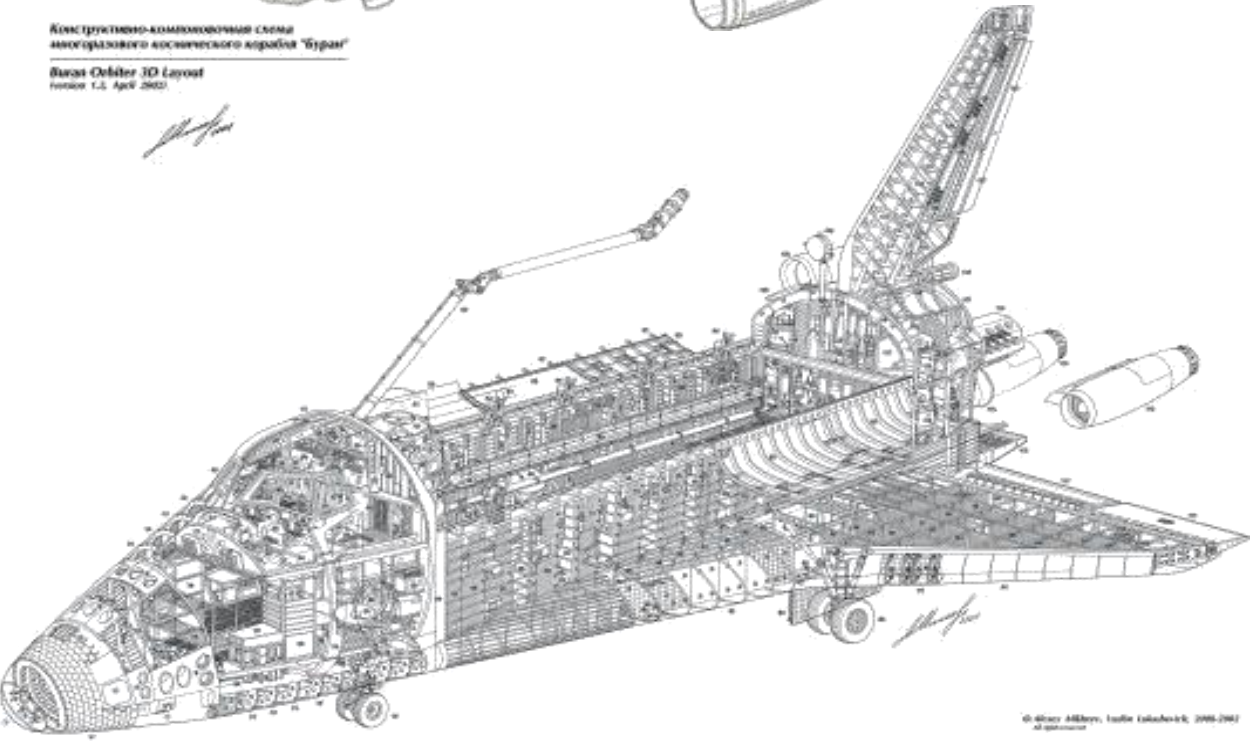
Introduction

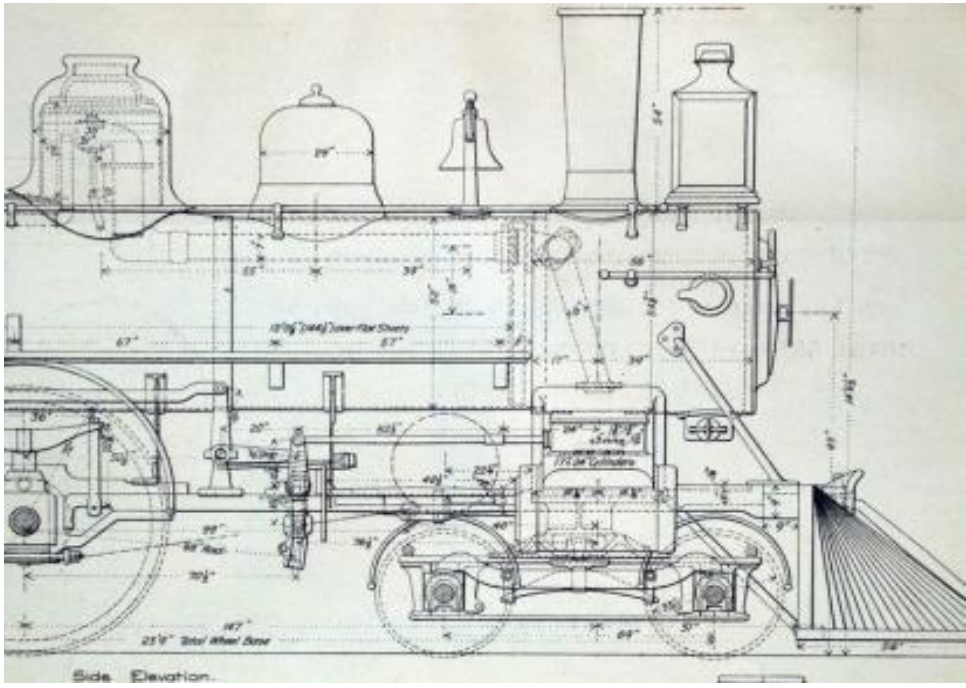
Technical Drawing

Razi University
دانشگاه رازی





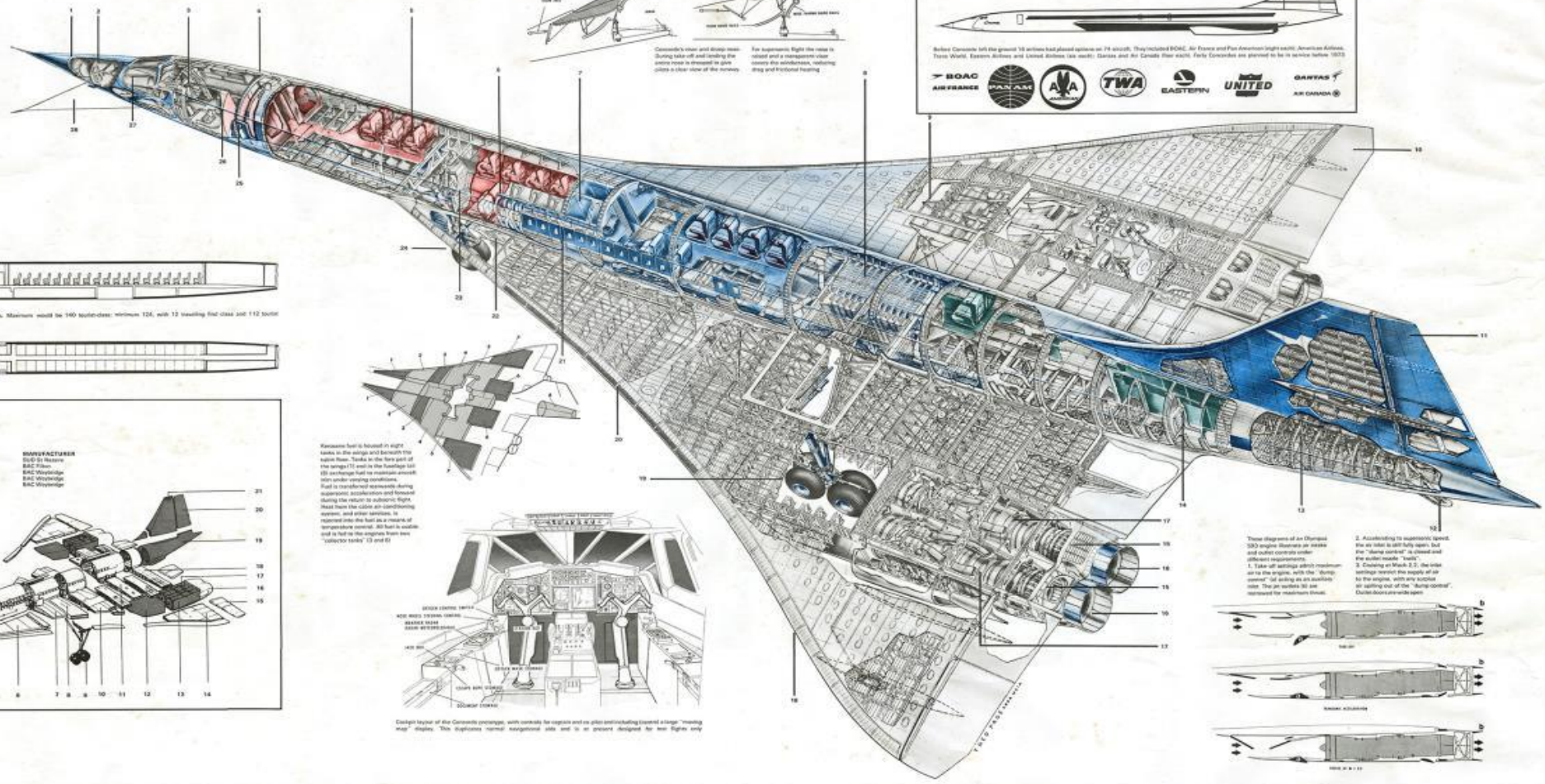




Concorde

The result of six years' unprecedented co-operation between Britain and France, the Western world's – perhaps the world's – first supersonic airliner is expected to be in service early in 1972. Flying at twice the speed of sound, it will cross the Atlantic in less than 3½ hours, making "day-returns" to New York a real possibility for British businessmen.

Exclusive drawing by THEO PAGE



Passenger accommodation will vary according to each airline's requirements. Maximum would be 140 tourist-class; minimum 124, with 12 travelling first class and 112 tourist

Cockpit layout of the Concorde passenger, with controls for captain and co-pilot (including inverted image "moving map" display. This duplicates normal navigational aids and is at present designed for test flights only

These diagrams of an Olympus 593 engine illustrate air intake and outlet controls under different requirements.
1. Take-off settings admit maximum air to the engine, with the "dump control" (at aiding as an auxiliary inlet. The jet outlets (b) are narrowed for maximum thrust.
2. Accelerating to supersonic speed, the air inlet is still fully open, but the "dump control" is closed and the outlet made "inefficient".
3. Cruising at Mach 2.2, the inlet settings restrict the supply of air to the engine, with any surplus air spilling out of the "dump control". Outlet doors are wide open

Concorde 001 nosed up to the safety rig designed to stop her if her brakes had failed during testing runs at Toulouse

The needle nose casts a supersonic shadow

Worm's-eye view of Concorde from the rear, showing the giant exhausts of the Rolls-Royce/SNECMA Olympus 593 turbojets

ANGLO-FRENCH CONCORDE—KEY TO DRAWING ABOVE

From the special metal alloy of the aircraft's skin down to the smallest rivet, everything in the Concorde is specially designed to withstand the huge stresses of supersonic flight. This exclusive drawing by THEO PAGE shows the engineering intricacies behind Concorde's gleaming exterior

Key

1. Cloud-collision radar
2. Variable-geometry "droop" nose
3. Flight deck (captain, second pilot and flight engineer)
4. Galley
5. Passenger cabin (128 seated and 12 in first class)
6. Air-conditioning system
7. Toilet (optional location)
8. Pressurised floor above wheel bay
9. Variable-geometry engine air intake
10. Elevon
11. Rudder
12. Retractable tail bumper
13. Aft trim tank
14. Rear baggage compartment
15. Thrust reverser louvres for braking on landing
16. Variable exhaust nozzle
17. Rolls-Royce (Bristol) SNECMA Olympus 593 turbojets in paired nacelles
18. Chemically milled leading-edge skin
19. Main undercarriage
20. Continually operating electric anti-icing slots and Speedbird de-icing
21. Machined window panel
22. Underfloor baggage hold
23. Forward main tanks
24. Nose-wheel undercarriage
25. Forward passenger door
26. Toilet
27. Windscreen with three-position wiper
28. Position of "droop" nose for take-off and landing visibility

Specifications

Length	193ft
Wing span	83ft 10in
Height	38ft
Gross weight	367,000lb
Max. payload	25,000lb
Passengers	124–140
Max. cruising	Mach 2.2 (1,450 m.p.h.)
Cruising altitude	55,000–62,000ft
Range	4,000 miles with full airline reserves
Max. usable fuel	190,000lb
Engines	Four Rolls-Royce (Bristol)/ SNECMA Olympus 593 turbojets
Wing area	3,860sq ft
Fin area	710sq ft
Rudder area	112sq ft

Concorde blasts along the runway under power from the engines which, at supersonic cruise, will consume 5,000 gallons of fuel an hour

BELL "MODERNISED AH-1S" HUEYCOBRA CUTAWAY

1. M65 Laser Augmented Airborne TOW (LAAT) sighting unit.
2. Sight visual position indicator.
3. Gimballed sight mounting.
4. Laser electronics unit.
5. Forward AN/APR-39 radar warning receiver, port and starboard.
6. Cannon barrels.
7. M197 20mm three-barrelled rotary cannon.
8. Cannon elevation control gear.
9. Swivelling gun turret mounting.
10. Azimuth control gear ring.
11. Ammunition feed chute.
12. Co-pilot/gunner's instrument panel.
13. AN/APX-100 lightweight IFF unit.
14. Instrument panel shroud.
15. Windscreen rain dispersal air ducts.
16. Flat plate windscreen panels.
17. Standby compass.
18. Rear view mirror.
19. Sighting system viewfinder.
20. Sight control handle and trigger.
21. Starboard side cyclic pitch control lever.

27. Port console mounted collective pitch control lever.
28. Energy absorbing seat mountings.
29. Boarding step.
30. Ammunition magazine, 750 rounds.
31. Ammunition bay access door, port and starboard.
32. Automatic flight control system equipment (AFCS).
33. Lateral equipment ducting.
34. Armoured cockpit sidewalling.
35. Control linkages.
36. Port side console panel.
37. Anti-torque rudder pedals.
38. Collective pitch control lever.
39. Cyclic pitch control column.
40. Pilot's instrument panel shroud.
41. Head-up display.
42. Co-pilot/gunner's helmet mounted sight attachment.
43. Low speed omni-directional air data sensor system probe.
44. Cockpit roof glazing.

45. Starboard TOW missile launchers.
46. Pilot's starboard side entry hatch.
47. Starboard side console panel.
48. Seat armour.
49. Pilot's seat.
50. HF aerial rail.
51. DF loop aerial.
52. Skin panelling coated with radar-absorbent material.
53. Upper fuselage equipment bay.
54. Generator.
55. Hydraulic system reservoir.
56. Control linkage mixing unit.
57. Position of refuelling connection on starboard side.
58. Forward fuselage self-sealing fuel tank, total fuel capacity 259 US gal. (980l).
59. Fuel tank access panel.
60. Crash-resistant, bag-type fuel tanks.
61. Landing skid front strut.
62. Ventral doppler antenna.
63. Fuel system equipment bay.

64. Port inboard stores pylon.
65. Port stub wing construction.
66. Stub wing attachment joints.
67. Gearbox oil sump.
68. Wing/fuselage/gearbox main frame.
69. Anti-vibration gearbox mounting.
70. Alternator.
71. Engine air intake.
72. Rotor head control jacks (3).
73. Gearbox input shaft.
74. Main gearbox.
75. Swash plate mechanism.
76. Rotor head torque link.
77. Pitot head.
78. Fresh air intake.
79. Starboard wing tip stores pylon.
80. Laser spot tracker housing.
81. Rotor head fairing.
82. Rotor blade root attachment joints.

83. Drag links.
84. Blade pitch control links.
85. Teetering rotor head attachment.
86. Blade pitch control rods.
87. Main rotor mast.
88. Anti-collision light.
89. Oil tank vent.
90. Main oil tank.
91. Oil filler cap.
92. Engine intake particle separation plenum.
93. Fireproof bulkhead.
94. Fuselage upper longeron.
95. Rear self-sealing crash-proof fuel tank.
96. Fireproof engine mounting deck.
97. Engine mounting struts.

98. Engine fuel control equipment.
99. Avco-Lycoming T53-L-703 turboshaft engine.
100. Engine turbine section.
101. Rotor head tail fairing.
102. Exhaust air mixing intake grille.
103. Infra-red jammer unit.
104. All-composite main rotor blade.
105. Laminated glass-fibre main spar.

106. Honeycomb core construction.
107. Laminated glass-fibre skin panelling.
108. Exhaust mixer air plug.

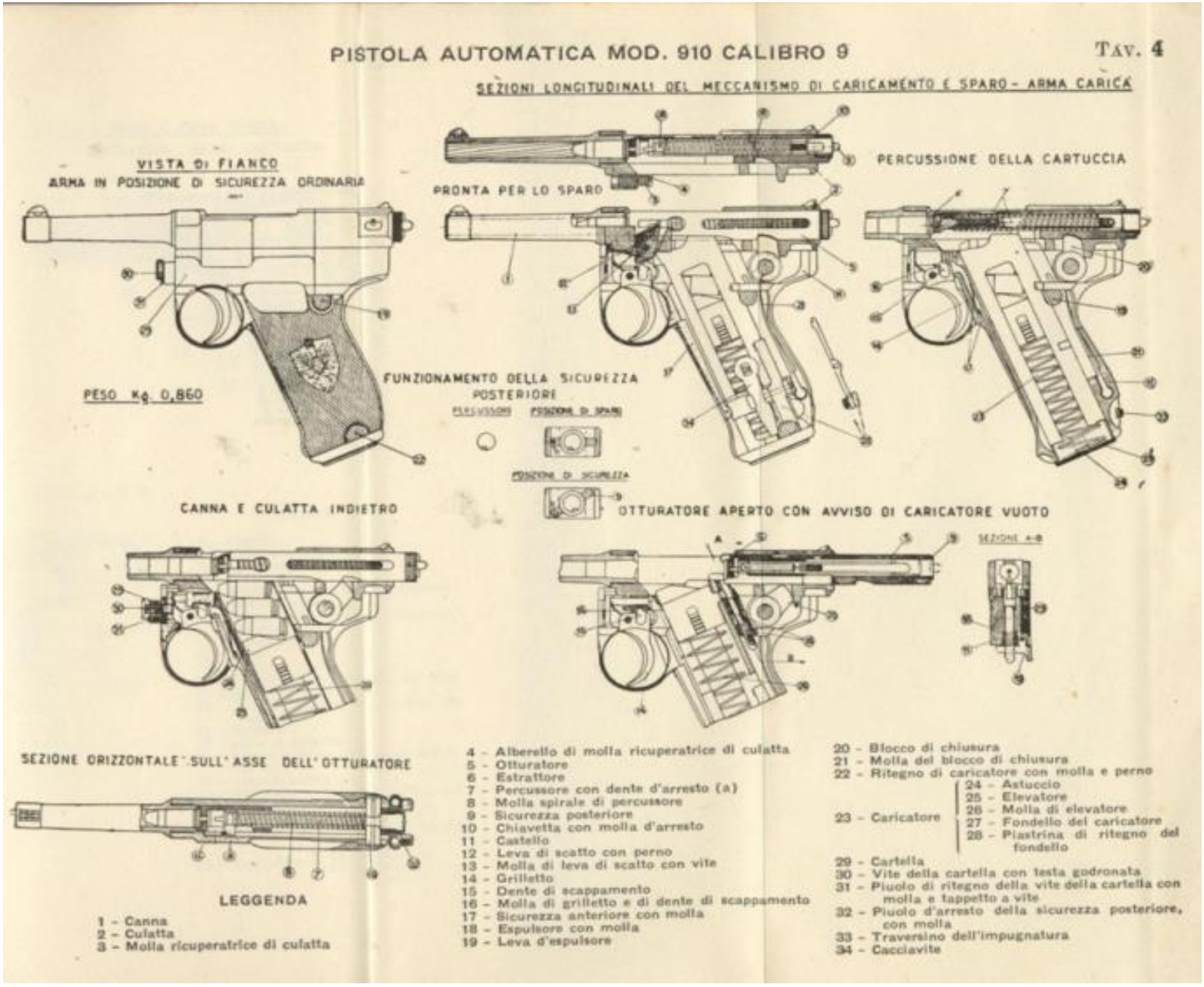
109. Infra-red suppression exhaust nozzle.
110. Tail rotor transmission shaft.
111. Shaft bearings.
112. Starboard all-moving tailplane.
113. Dorsal spine fairing.

114. Bevel drive gearbox.
115. Tail rotor drive shaft.
116. Final drive right-angle gearbox.
117. Blade root attachment.

118. Blade pitch control linkages.
119. Feathering counterweights.
120. Tail rotor blade construction.
121. Tail navigation light.
122. Cambered trailing edge panel.
123. Tail rotor pylon construction.
124. Rotor protecting tail skid.
125. Tail position light.
126. Rotor pylon sloping frame.
127. Aft AN/APR-39 radar warning antenna, port and starboard.
128. VOR aerial, port and starboard.
129. Port all-moving tailplane construction.
130. Tailplane torque shaft.
131. All-moving tailplane control linkage.
132. Tailboom longerons.

133. Avionics equipment bays.
134. Avionics bay access doors.

135. Tailboom attachment joint frame.
136. UHF aerial.
137. Radar altimeter aerial.
138. Electrical equipment bay.
139. Rear fuselage equipment bay.
140. Ground power socket.
141. Environmental control system air intake.
142. Port navigation light.
143. Port wing-tip stores pylon.
144. Four-round TOW missile carriage unit.
145. Seven tube 2.75in (7cm) rocket launcher.
146. 2.75in folding-fin aircraft rockets (FFAR).
147. M18 Minigun pod, 7.62mm six-barrelled rotary minigun.
148. Hughes TOW air to surface missile.
149. Folding missile fins.
150. Detachable TOW missile launcher/transportation tubes.
151. Nineteen-tube rocket launcher.
152. 2.75in (7cm) FFAR.
153. Wing skid strut fairing.
154. Port landing skid.
155. Skid tie-down point.



PISTOLA AUTOMATICA MOD. 910 CALIBRO 9

TAV. 4

SEZIONI LONGITUDINALI DEL MECCANISMO DI CARICAMENTO E SPARO - ARMA CARICA

VISTA DI FIANCO
ARMA IN POSIZIONE DI SICUREZZA ORDINARIA

PESO Kg. 0,860

PRONTA PER LO SPARO

PERCUSSIONE DELLA CARTUCCIA

FUNZIONAMENTO DELLA SICUREZZA POSTERIORE

CANNA E CULATTA INDIETRO

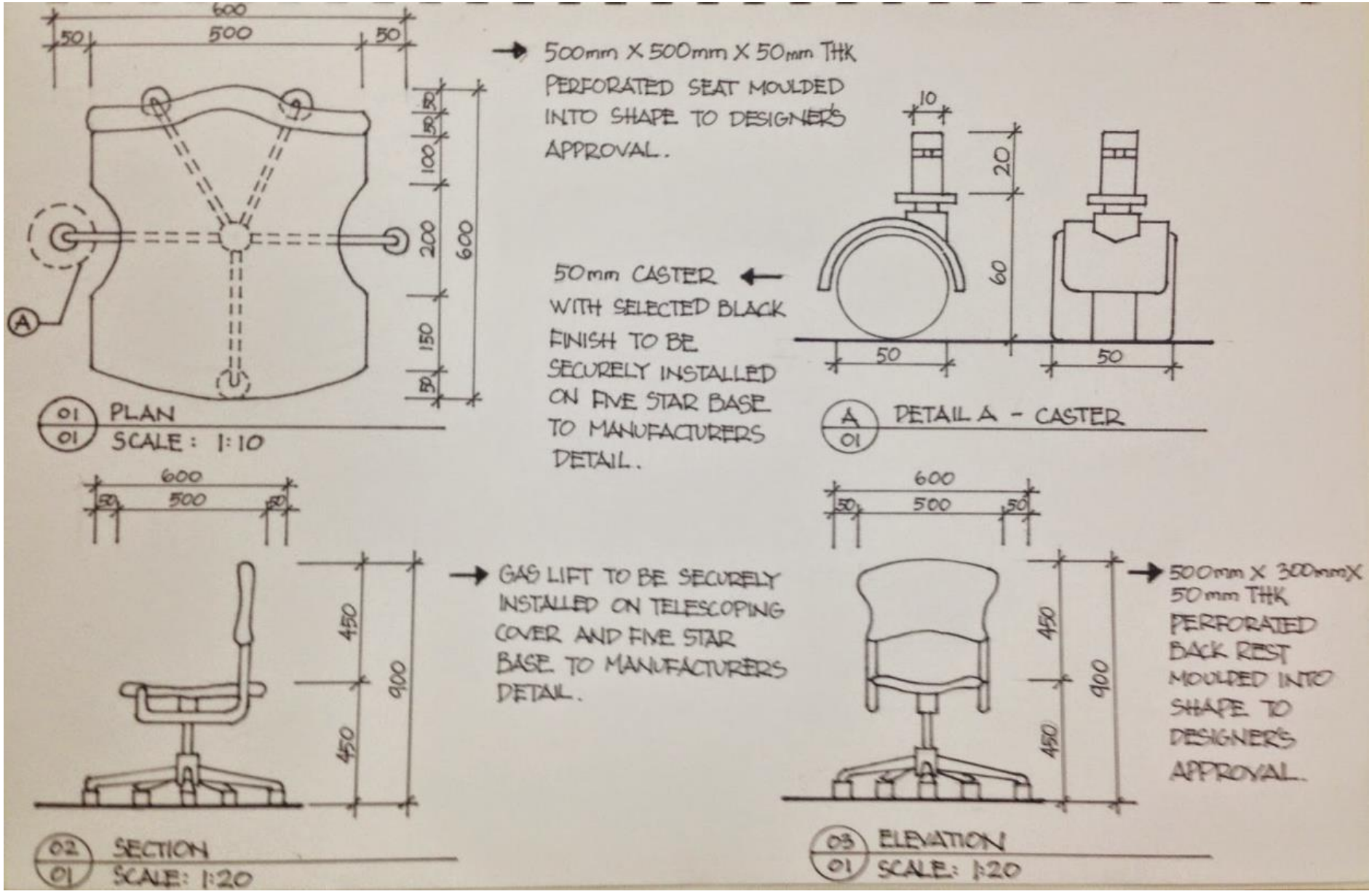
OTTURATORE APERTO CON AVVISO DI CARICATORE VUOTO

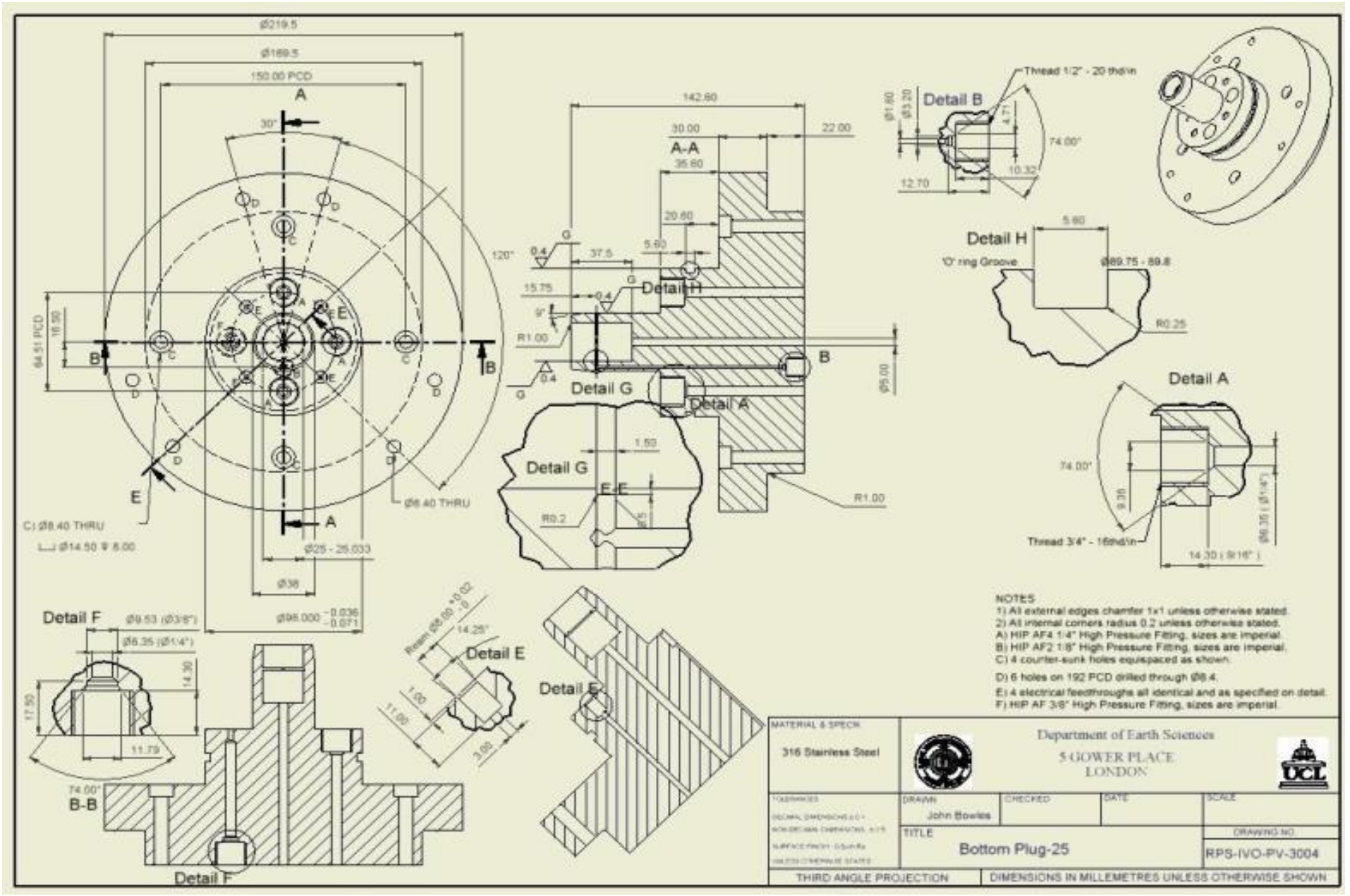
SEZIONE A-B

SEZIONE ORIZZONTALE SULL'ASSE DELL'OTTURATORE

LEGGENDA

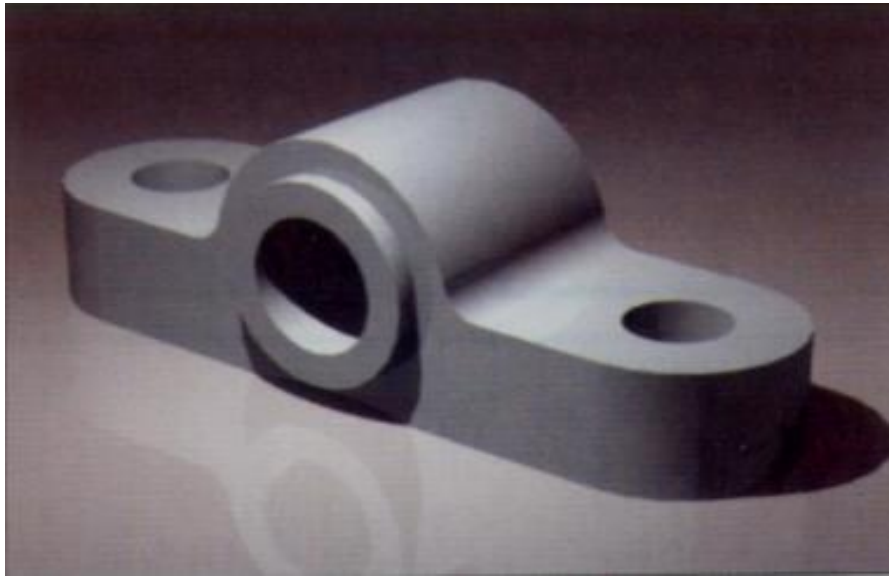
1 - Canna
2 - Culatta
3 - Molla ricuperatrice di culatta
4 - Alberello di molla ricuperatrice di culatta
5 - Otturatore
6 - Estrattore
7 - Percussore con dente d'arresto (a)
8 - Molla spirale di percussore
9 - Sicurezza posteriore
10 - Chiavetta con molla d'arresto
11 - Castello
12 - Leva di scatto con perno
13 - Molla di leva di scatto con vite
14 - Grilletto
15 - Dente di scappamento
16 - Molla di grilletto e di dente di scappamento
17 - Sicurezza anteriore con molla
18 - Espulsore con molla
19 - Leva d'espulsore
20 - Blocco di chiusura
21 - Molla del blocco di chiusura
22 - Ritegno di caricatore con molla e perno
23 - Caricatore
24 - Astuccio
25 - Elevatore
26 - Molla di elevatore
27 - Fondello del caricatore
28 - Piastrina di ritegno del fondello
29 - Cartella
30 - Vite della cartella con testa godronata
31 - Piuolo di ritegno della vite della cartella con molla e tappetto a vite
32 - Piuolo d'arresto della sicurezza posteriore, con molla
33 - Traversino dell'impugnatura
34 - Cacciavite


600
50
500
50
100
200
150
600
A
01 PLAN
01 SCALE : 1:10
500mm X 500mm X 50mm THK PERFORATED SEAT MOULDED INTO SHAPE TO DESIGNER'S APPROVAL.
50mm CASTER WITH SELECTED BLACK FINISH TO BE SECURELY INSTALLED ON FIVE STAR BASE TO MANUFACTURERS DETAIL.
10
20
60
50
50
A 01 DETAIL A - CASTER
600
500
450
900
450
02 01 SECTION SCALE: 1:20
GAS LIFT TO BE SECURELY INSTALLED ON TELESCOPING COVER AND FIVE STAR BASE TO MANUFACTURERS DETAIL.
500mm X 300mmX 50mm THK PERFORATED BACK REST MOULDED INTO SHAPE TO DESIGNER'S APPROVAL.
03 01 ELEVATION SCALE: 1:20


Ø219.5
Ø169.5
150.00 PCD
A
30°
B
B
E
E
A
Ø64.51 PCD
16.50
C) Ø8.40 THRU
Ø14.50 ↧ 8.00
Ø6.40 THRU
Ø25 - 25.033
Ø38
Ø95.000 -0.036 -0.071
142.60
30.00
22.00
A-A
35.60
20.60
5.60
37.5
15.75
9°
R1.00
120°
0.4
G
Detail H
Detail G
Detail A
B
B
Ø5.00
1.50
E-E
R0.2
R1.00
Thread 1/2" - 20 thd\in
Detail B
Ø1.60
Ø3.20
4.71
74.00°
12.70
10.32
5.60
Detail H
'O' ring Groove
Ø89.75 - 89.8
R0.25
Detail A
74.00°
9.35
Ø6.35 (Ø1/4")
Thread 3/4" - 16thd\in
14.30 (9/16")
Detail F
Ø9.53 (Ø3/8")
Ø6.35 (Ø1/4")
14.30
17.50
11.79
74.00°
B-B
Detail F
Detail E
Detail E
Detail E
Ø8.00 +0.02 -0
14.25°
1.00
11.00
3.00
NOTES
1) All external edges chamfer 1x1 unless otherwise stated.
2) All internal corners radius 0.2 unless otherwise stated.
A) HIP AF4 1/4" High Pressure Fitting, sizes are imperial.
B) HIP AF2 1/8" High Pressure Fitting, sizes are imperial.
C) 4 counter-sunk holes equispaced as shown.
D) 6 holes on 192 PCD drilled through Ø6.4.
E) 4 electrical feedthroughs all identical and as specified on detail.
F) HIP AF 3/8" High Pressure Fitting, sizes are imperial.
MATERIAL & SPECN.
316 Stainless Steel
Department of Earth Sciences
5 GOWER PLACE
LONDON
UCL
DRAWN
John Bowles
CHECKED
DATE
SCALE
TITLE
Bottom Plug-25
DRAWING NO.
RPS-IVO-PV-3004
THIRD ANGLE PROJECTION
DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN

Drawing vs. Writing

1. Try to write a description of this object.
2. Test your written description by having someone attempt to make a sketch from your description.



You can easily understand that …

The word languages are <u>inadequate</u> for describing the ***size***, ***shape*** and ***features*** completely as well as concisely.

Introduction

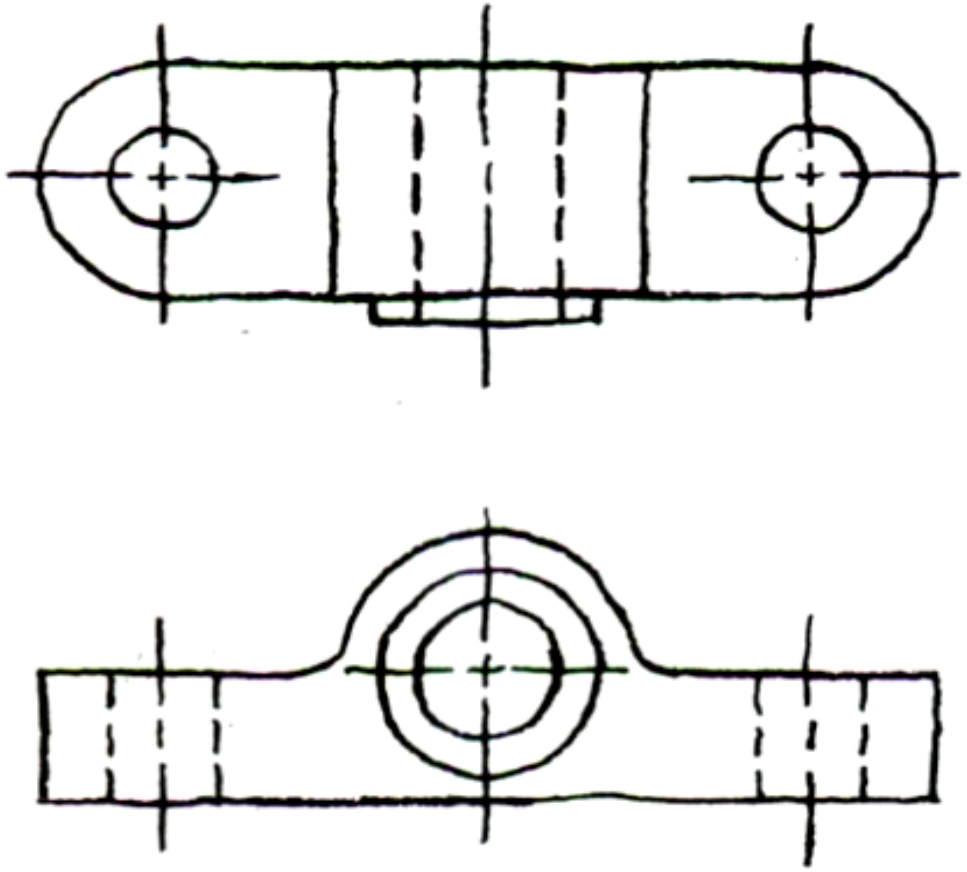
Graphic language in **"engineering application"** uses ***lines*** to represent the ***surfaces***, ***edges*** and ***contours*** of objects.

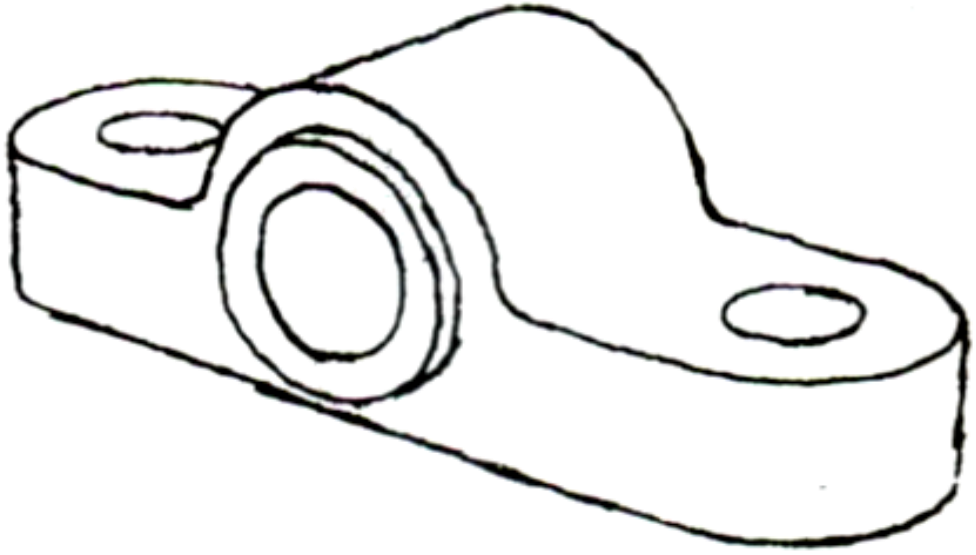
The language is known as: "***drawing***" or "***drafting***"

A drawing can be done using ***freehand***, ***instruments*** or ***computer*** methods.

Freehand drawing

The lines are sketched without using instruments other than pencils and erasers.

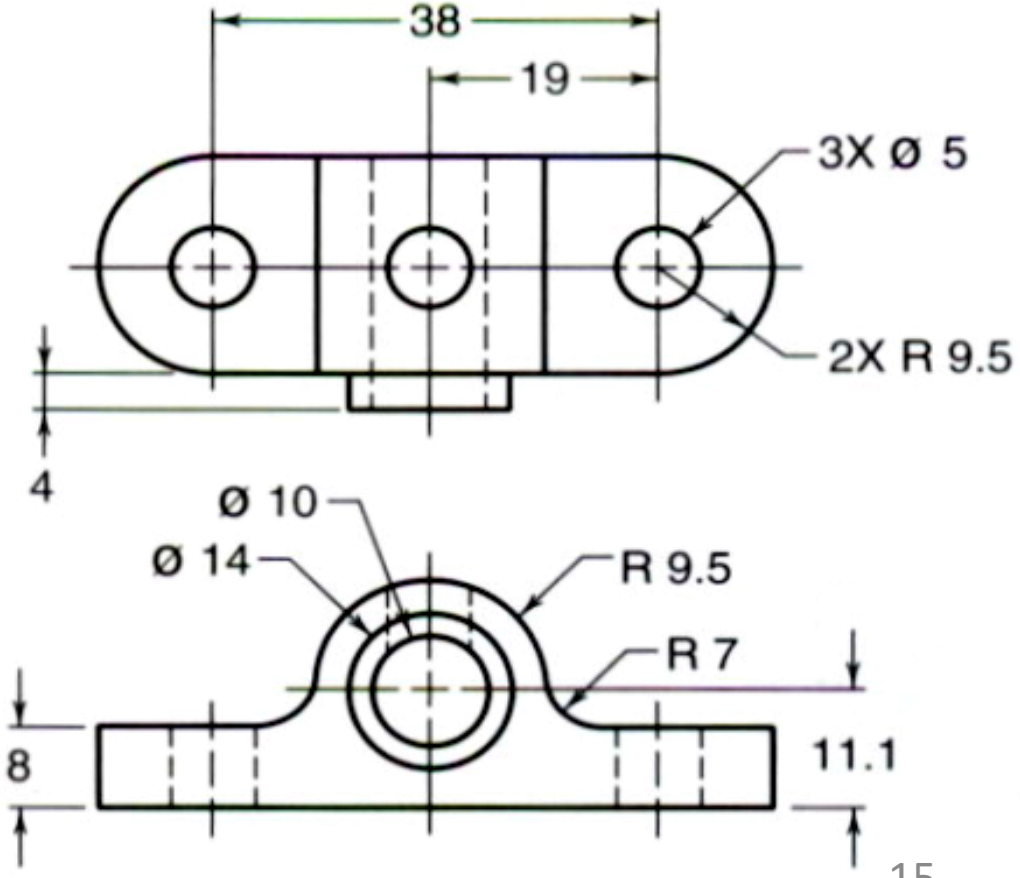




Instrumental drawing

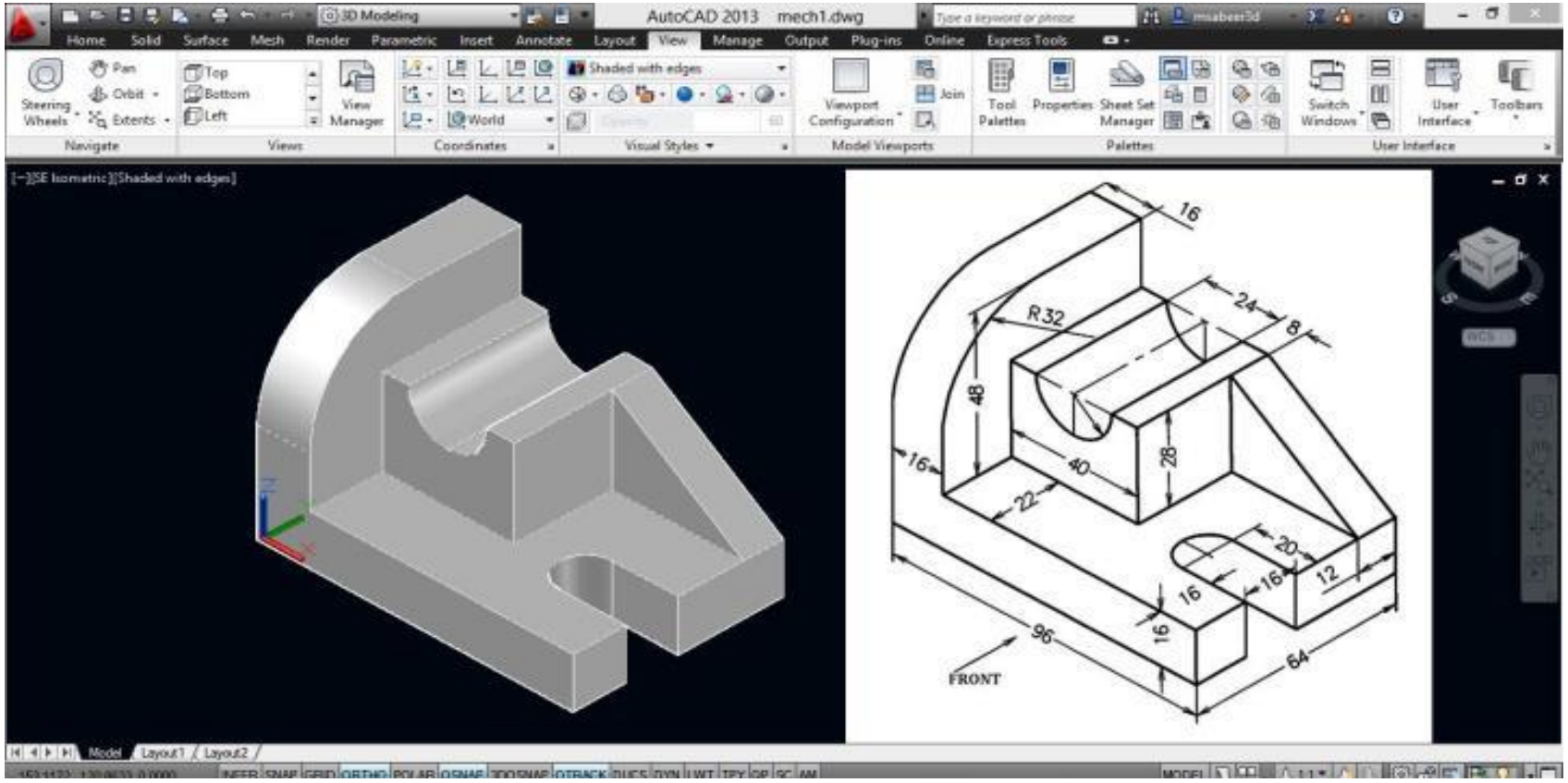
Razi University
دانشگاه رازی

Instruments are used to draw straight lines, circles, and curves concisely and accurately. The drawings are usually made to scale.



Computer drawing

The drawings are usually made by commercial software such as AutoCAD, Solid works, etc.



Introduction

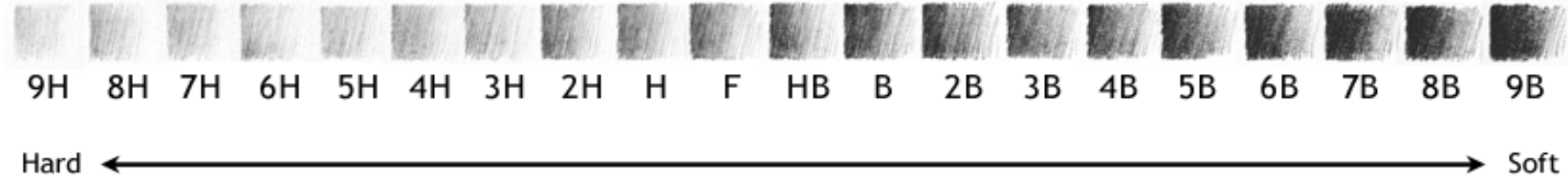
Drawing before CAD!

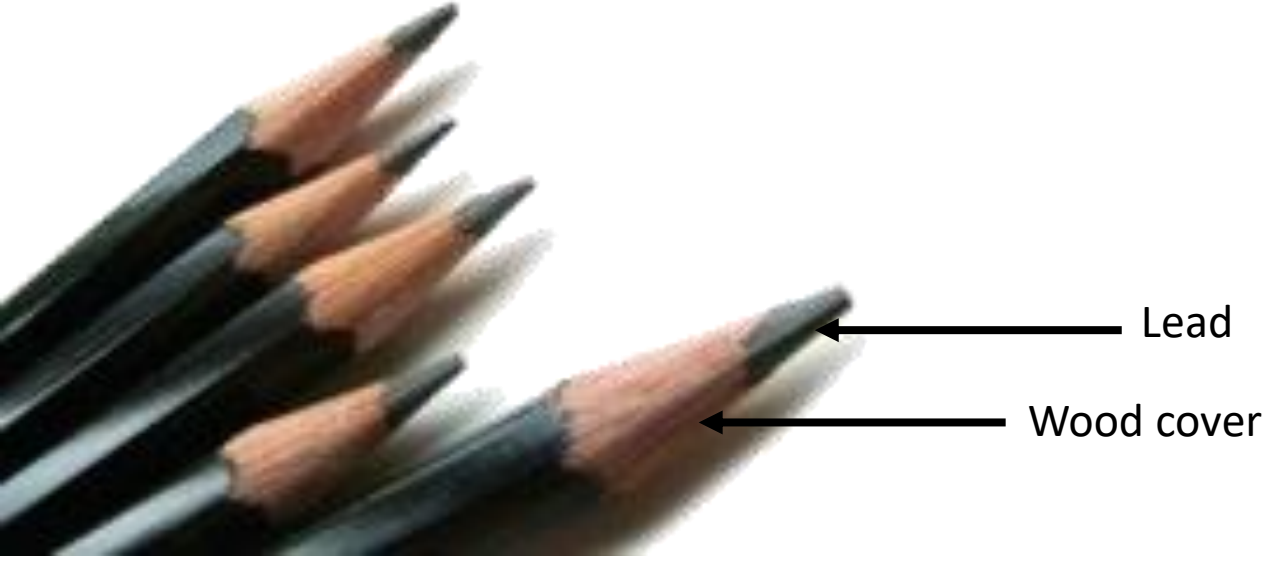
ابزار رسم و استانداردها

Drawing instruments and standards

Drawing pencil

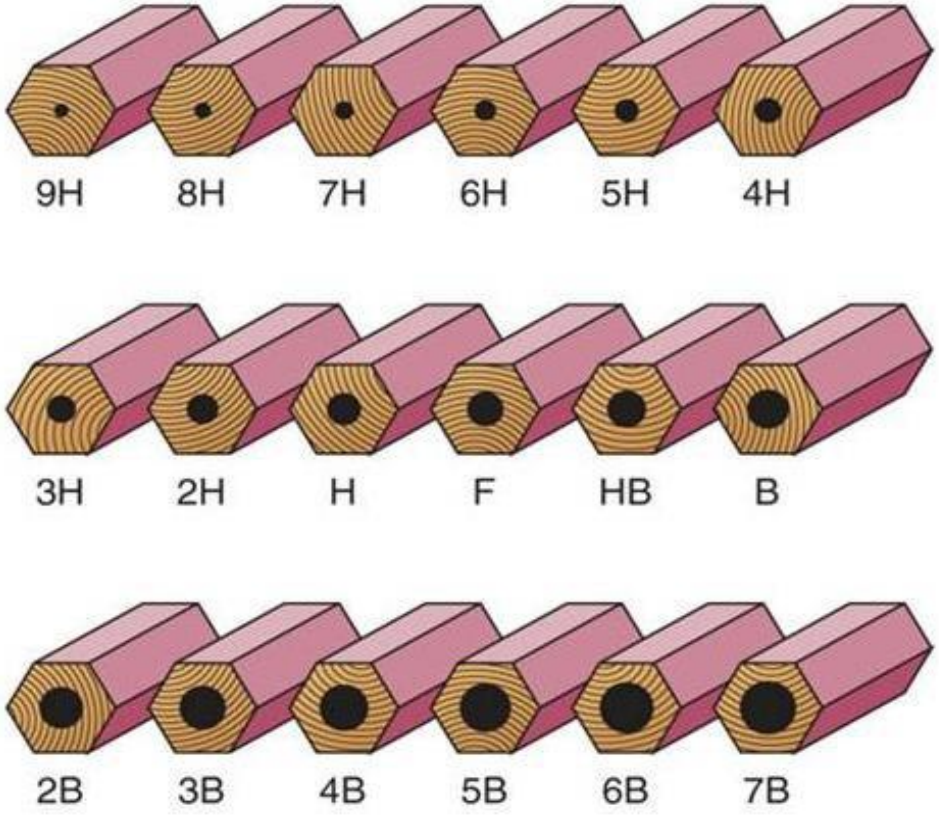
- Drawing Pencil is the most important tool used in engineering drawing.
- A pencil has a lead covered with wood. The lead is made with graphite and clay.
- Lower proportions of clay makes the core softer.





Drawing pencil

- The "HB" grade pencil is medium soft and dark in black color, whereas 1H, 2H, grade pencils hard and light in black color.



HARD

The hard leads are used for construction lines on technical drawings.

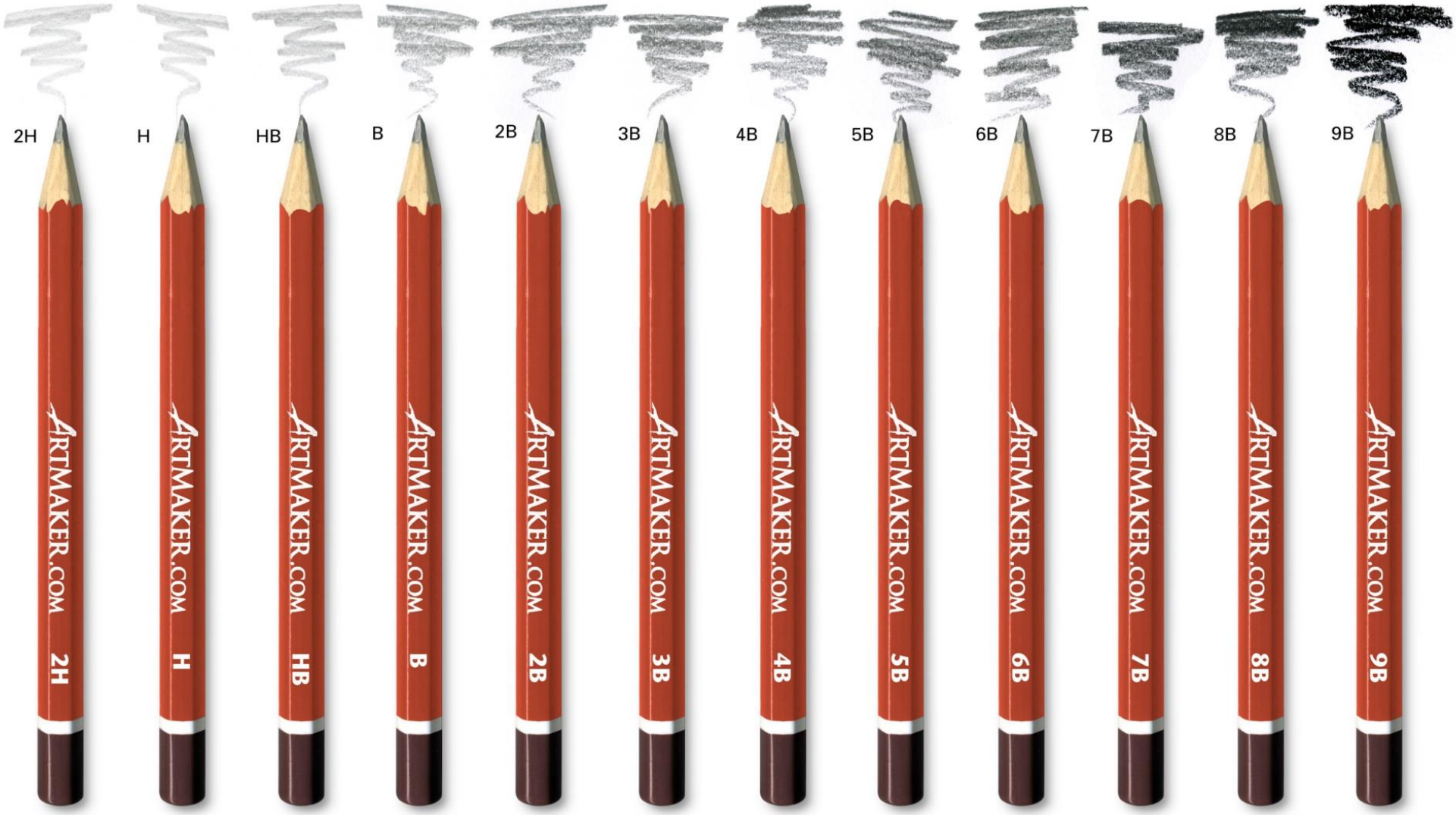
MEDIUM

The medium grades are used for general use on technical drawings. The harder grades are for instrument drawings and the softer for sketching.

SOFT

Soft leads are used for technical sketching and artwork but are too soft for instrument drawings.

Drawing pencil



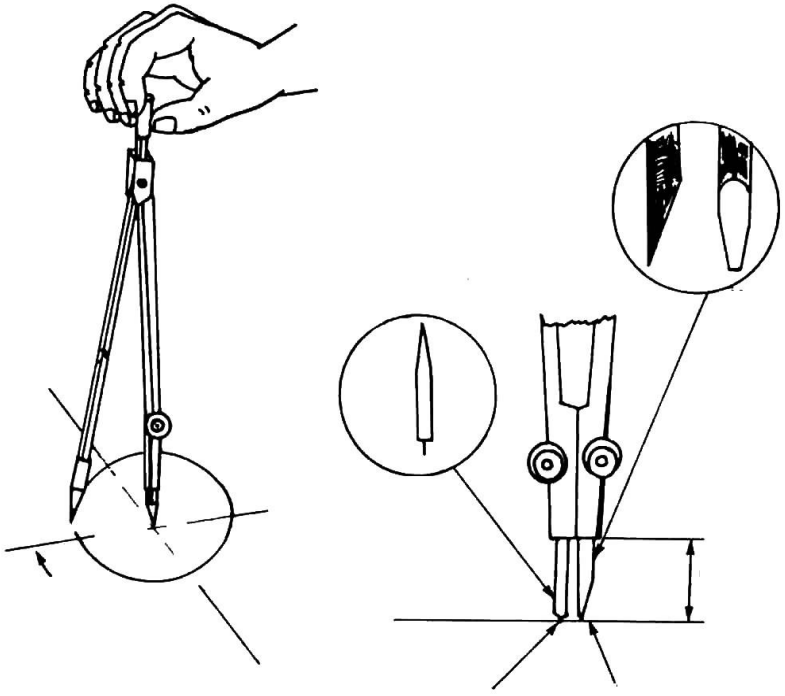
Mechanical pencil

- Standard sizes:
  0.3, 0.5, 0.7, 0.9

Eraser & Sharpener

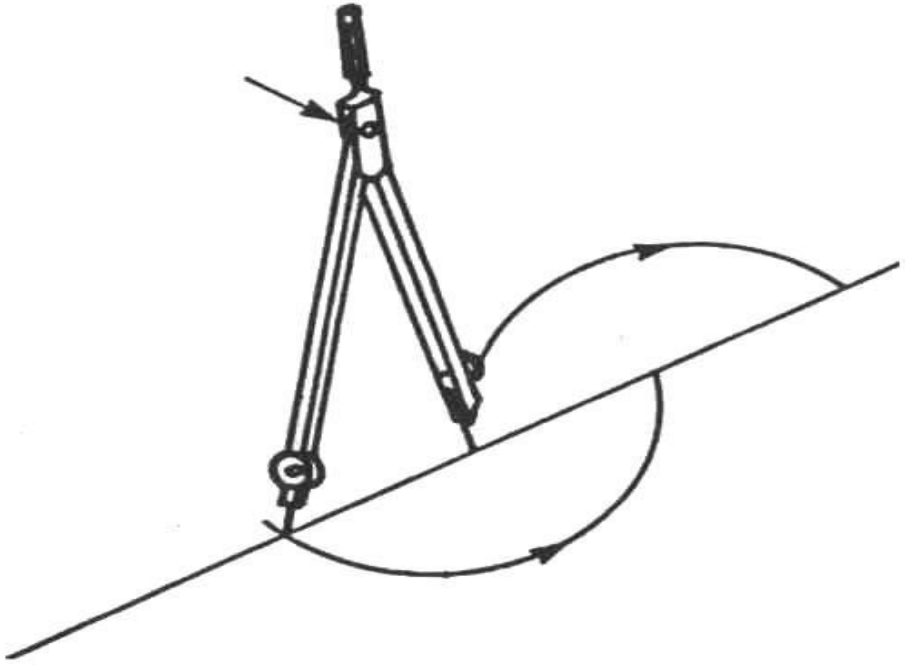
Compasses

A pair of compasses, also known simply as a compass, is a technical drawing instrument that can be used for inscribing circles or arcs. As dividers, they can also be used as tools to measure distances, in particular on maps.



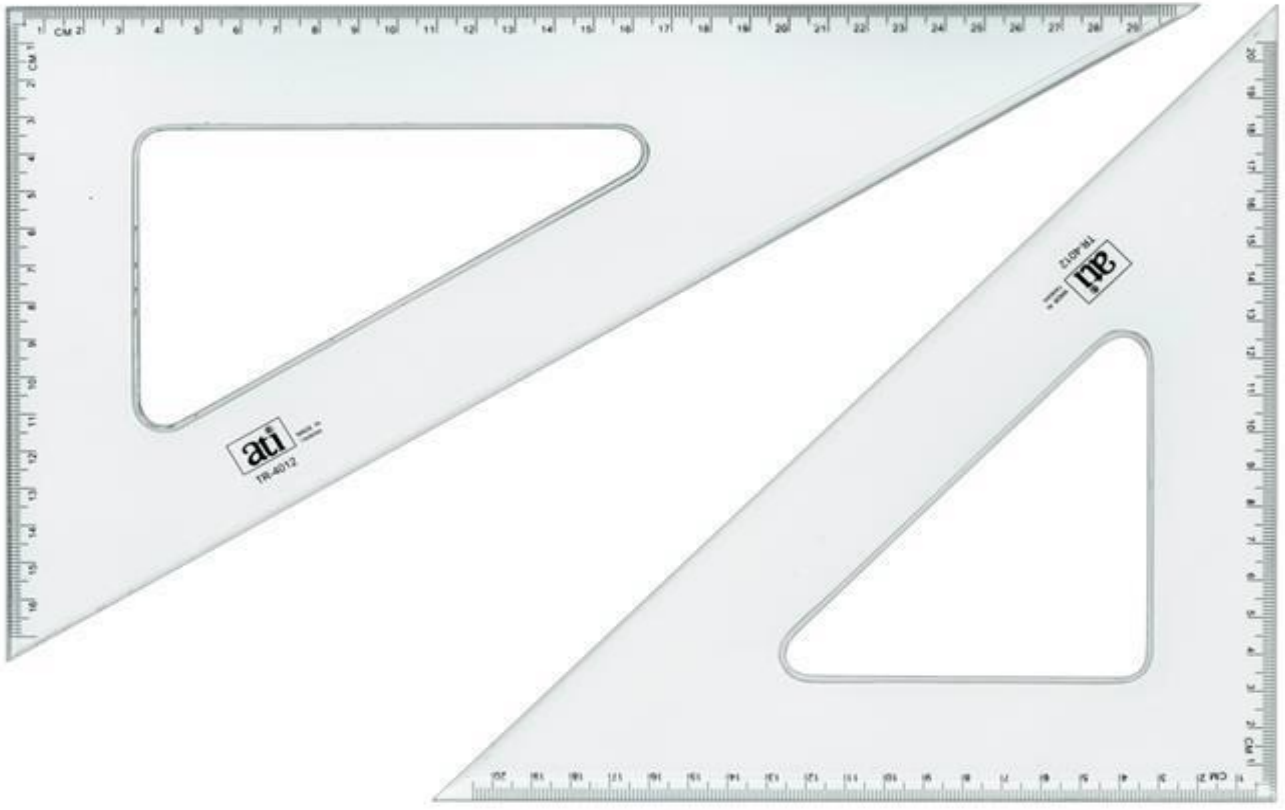
Divider

- Nearly identical with compass, the difference divider have two needle points.
- Divider used to divide something distance to several same division too or to move something distance once or repeat.



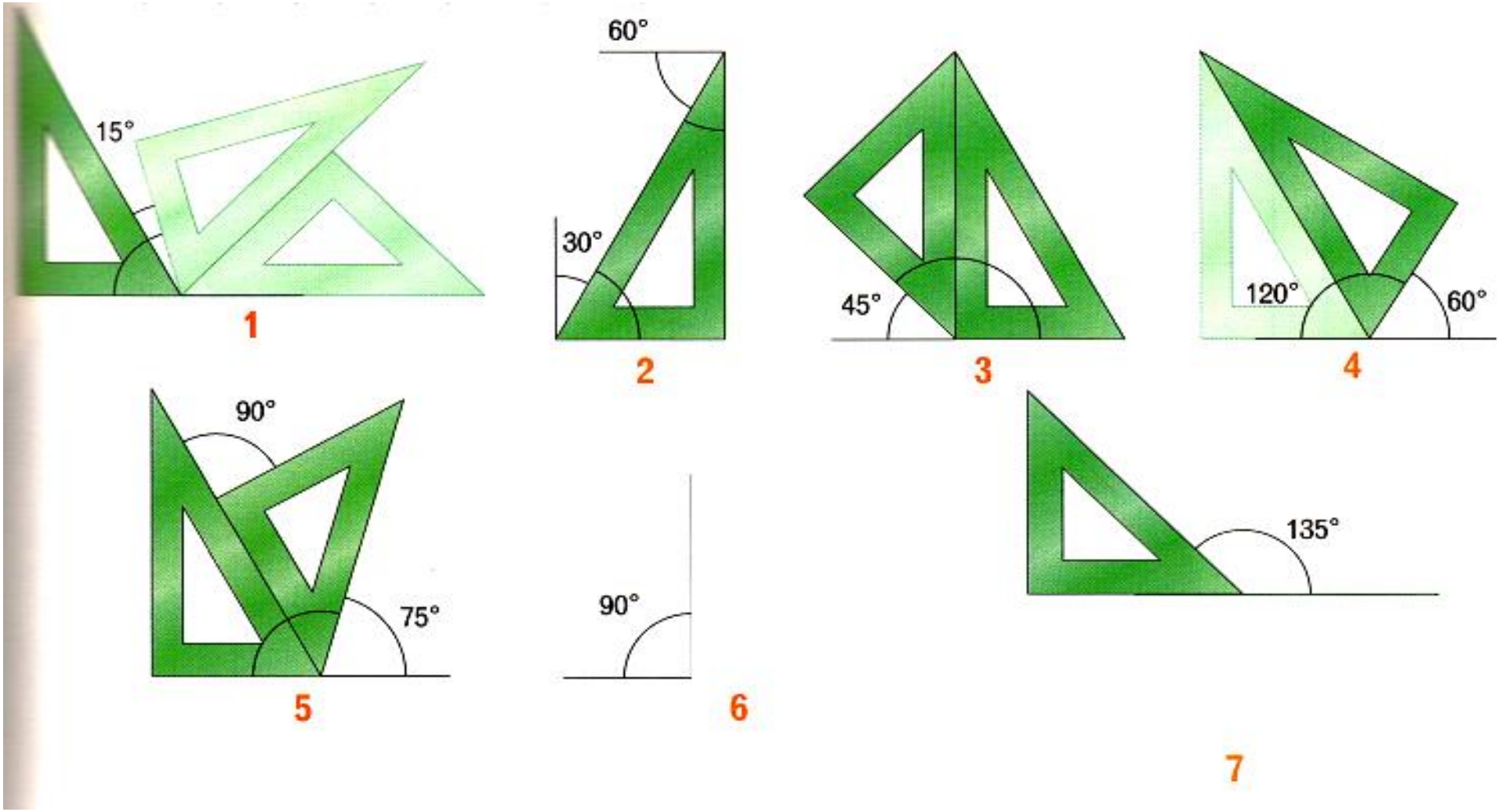
Set square

- To get point of angle or to measure the angle
- Set square can give some degree of angle.

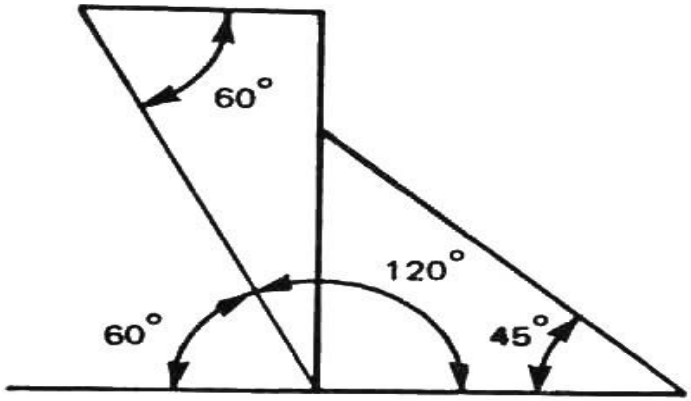


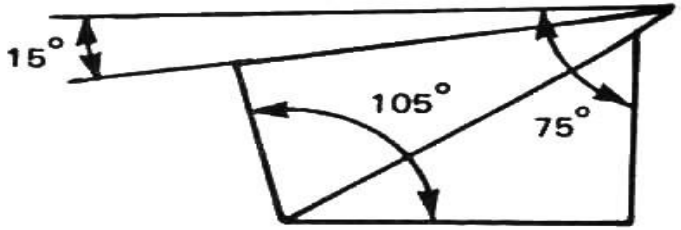
Set square

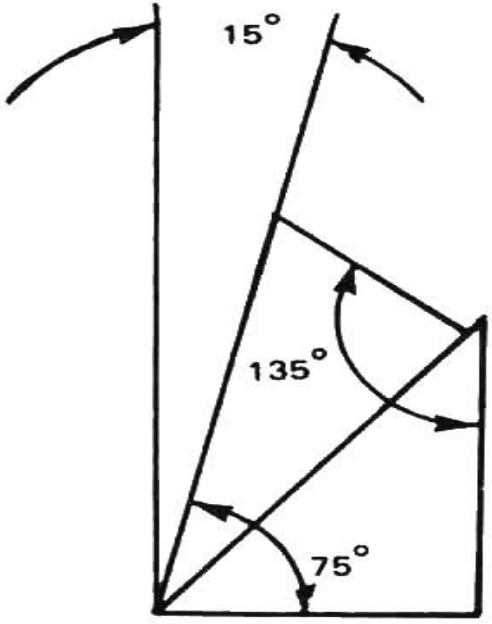
Drawing angles: we can get 15º, 30º, 45º, 60º, 75º, 90º, 120º, 135º…angles combining the 30º, 45º , 60º and the 90º angles from the set squares

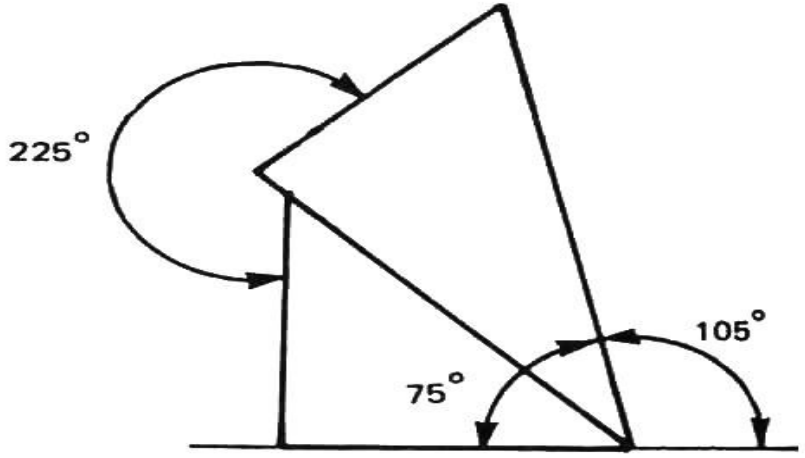


Set square



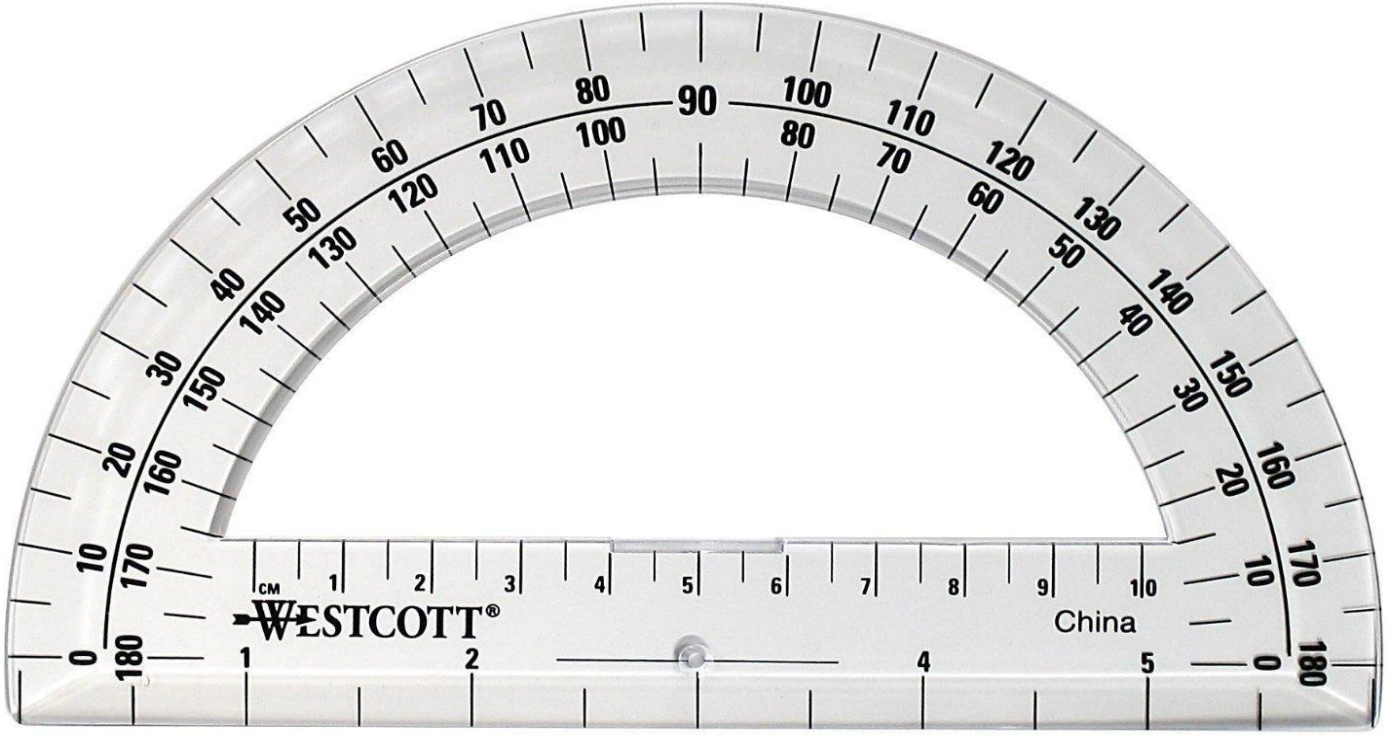






Protractor

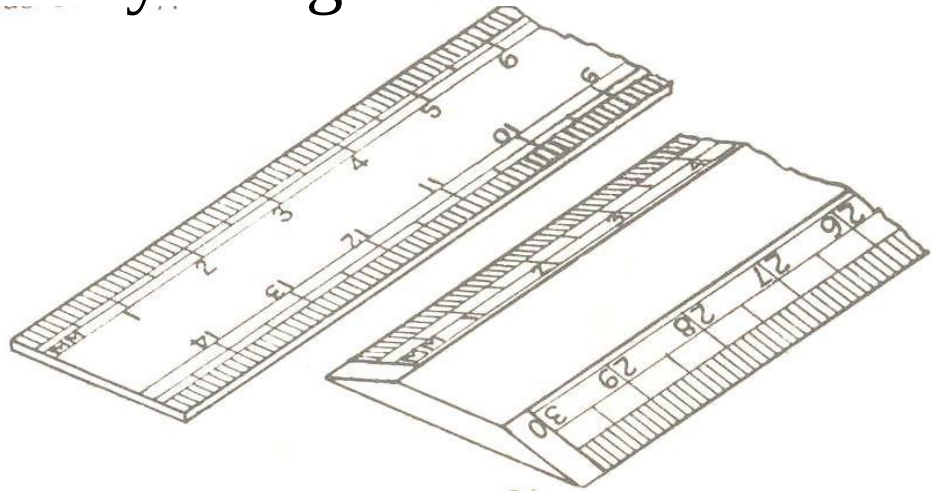
To get point of angle or to measure the angle



Ruler

A precision tool that makes it possible to measure and to transfer a distance.

- Scale that used must be in a unit only to avoid confusion or mistake when making measurement.
- After we get some measure, pencil used as marker to that measure.
- More accurate marking can be gained by using divider or compass.

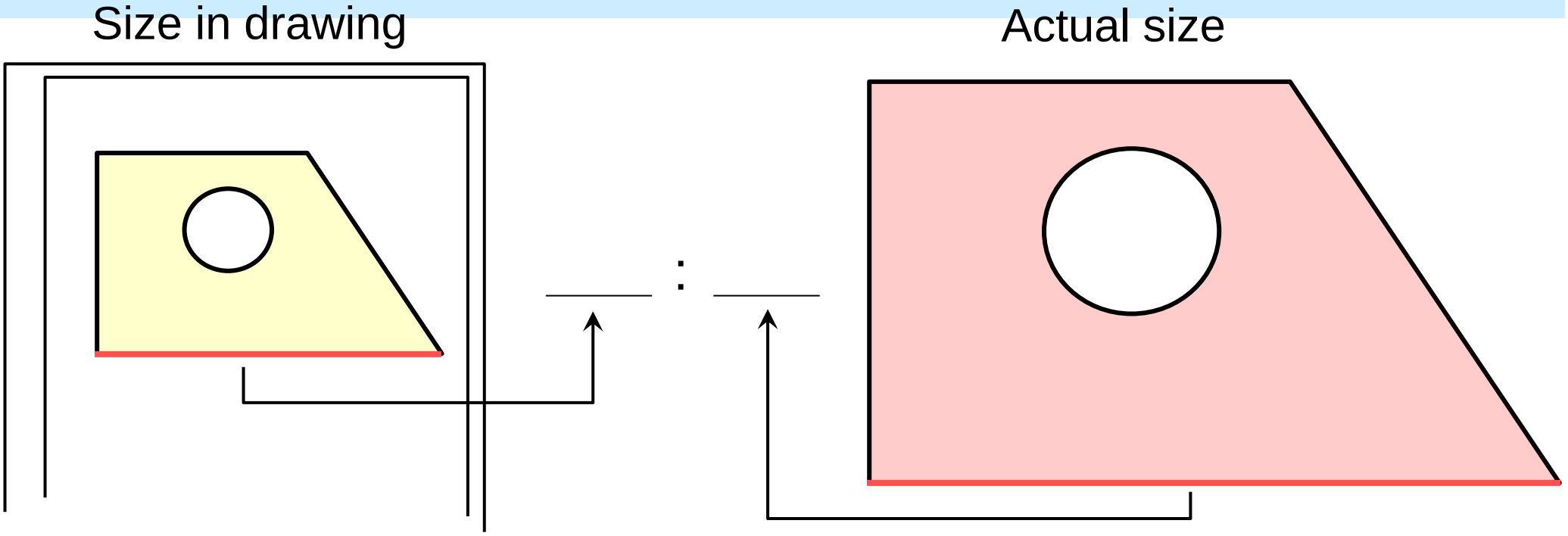


Drawing Scales

Razi University
دانشگاه رازی

Length, size

Scale is the ratio of the linear dimension of an element of an object shown in the drawing to the real linear dimension of the same element of the object.



Drawing Scales

- Designation of a scale consists of the word "SCALE" followed by the indication of its ratio, as follow

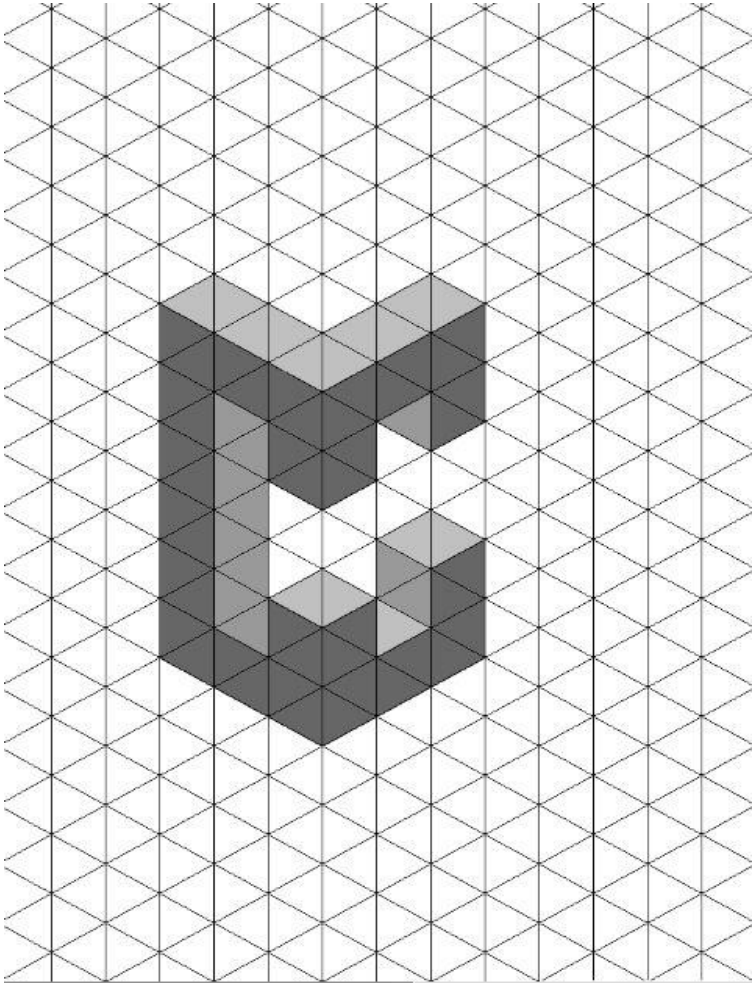
  SCALE 1:1 for full size

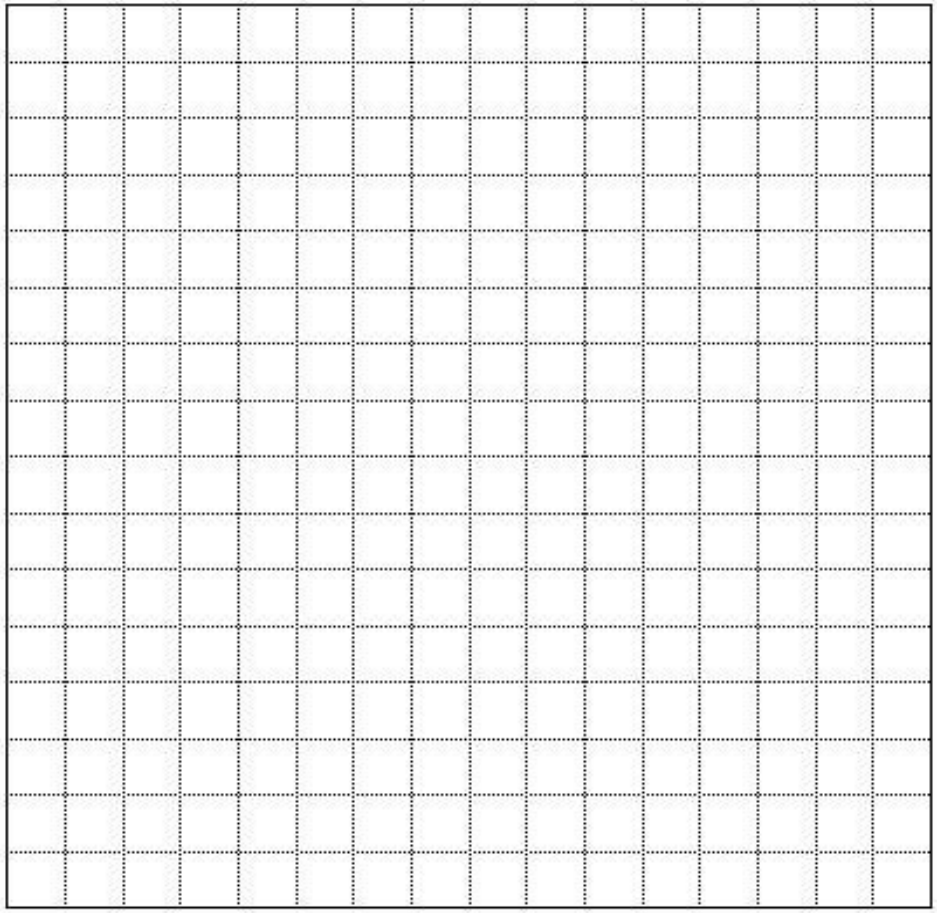
  SCALE **X**:1 for ***enlargement*** scales (X > 1)

  SCALE 1:**X** for ***reduction*** scales (X > 1)

- Dimension numbers shown in the drawing are correspond to "true size" of the object and they are independent of the scale used in creating that drawing.

Paper





Paper

Though other paper size standards exist, there are two predominant systems in use today. They are the international and North American systems.

As the term implies, the international standard, also known as the ISO 216 standard, is used throughout the world. It is based on an aspect ratio of the square root of two.

ISO

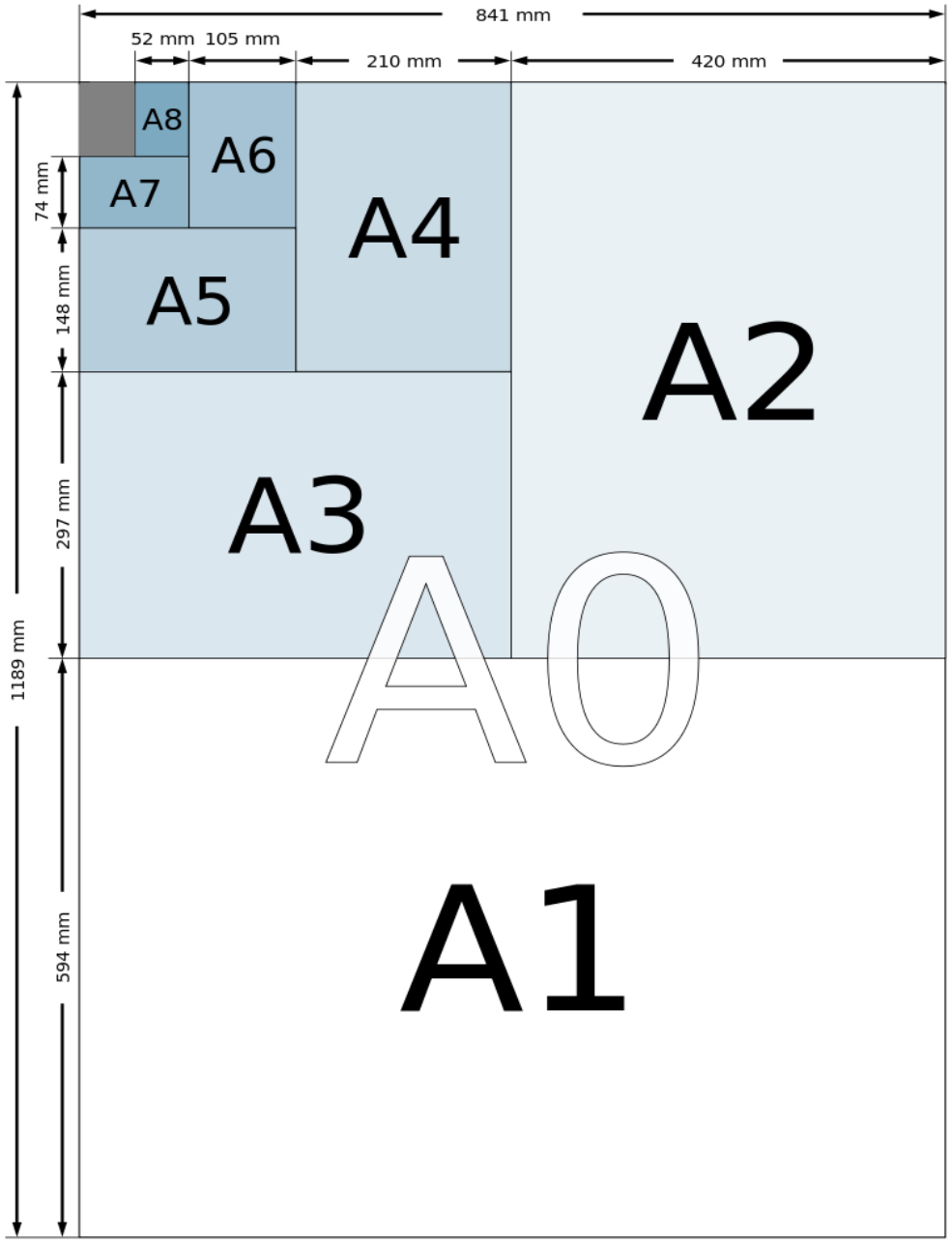
International Organization for Standardization

Paper

The North American system is used primarily in the USA and Canada. The current sizes are based on traditional sizes such as Letter (8.5 in x 11 in) and Legal (8.5 in x 14 in). The names of North American sizes have started with ANSI ever since the adoption of ANSI/ASME Y14.1 by the American National Standards Institute in 1995.

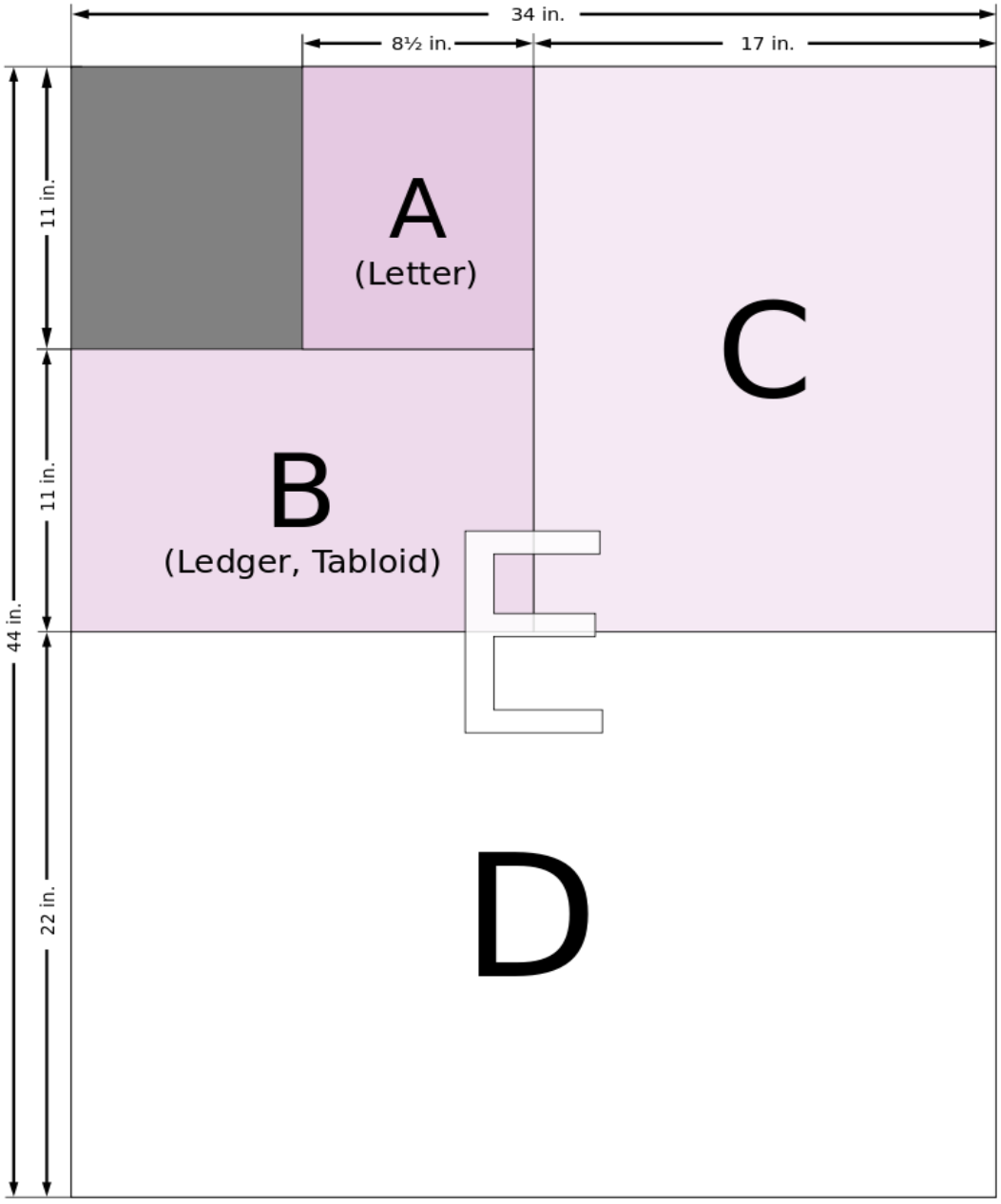
American National Standards Institute

Paper



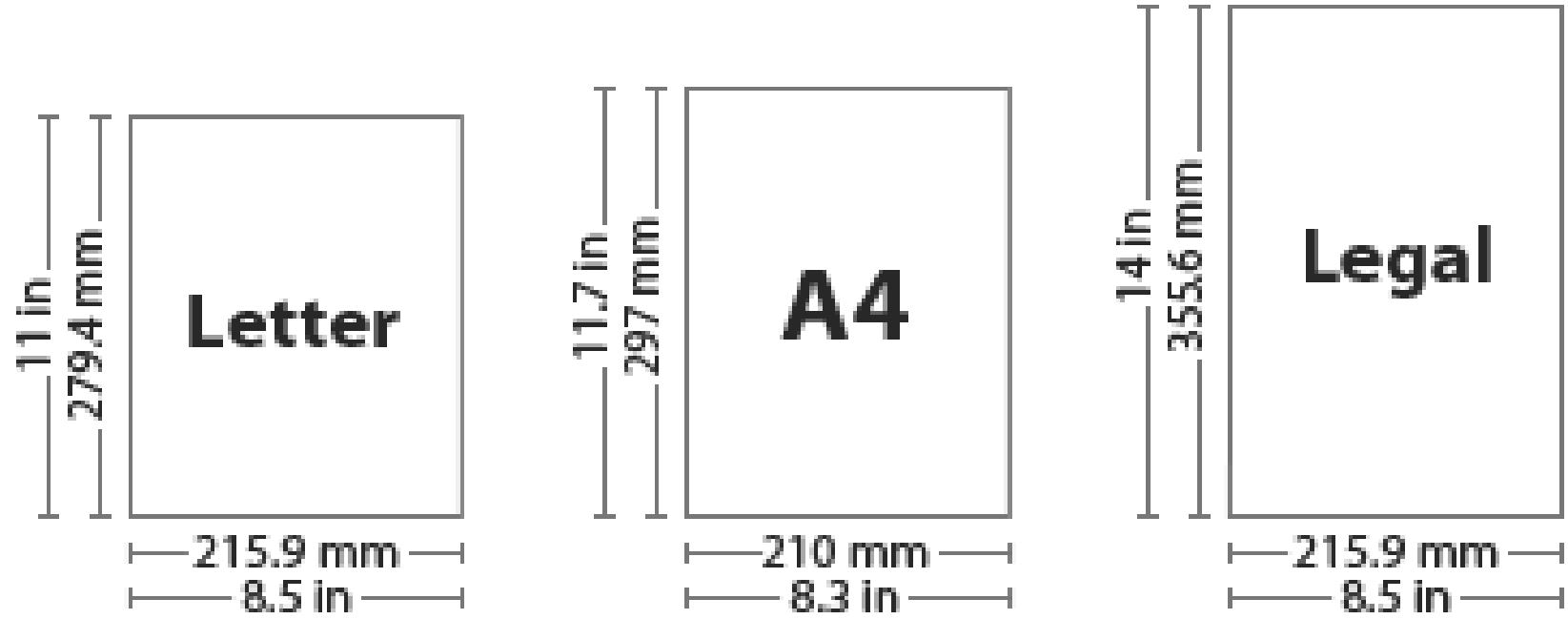
A Series		
Format	Size in Millimeters	Size in Inches
A0	841 x 1189	33.1 x 46.8
A1	594 x 841	23.4 x 33.1
A2	420 x 594	16.5 x 23.4
A3	297 x 420	11.7 x 16.5
A4	210 x 297	8.3 x 11.7
A5	148 x 210	5.8 x 8.3
A6	105 x 148	4.1 x 5.8
A7	74 x 105	2.9 x 4.1
A8	52 x 74	2.0 x 2.9
A9	37 x 52	1.5 x 2.0
A10	26 x 37	1.0 x 1.5

Paper

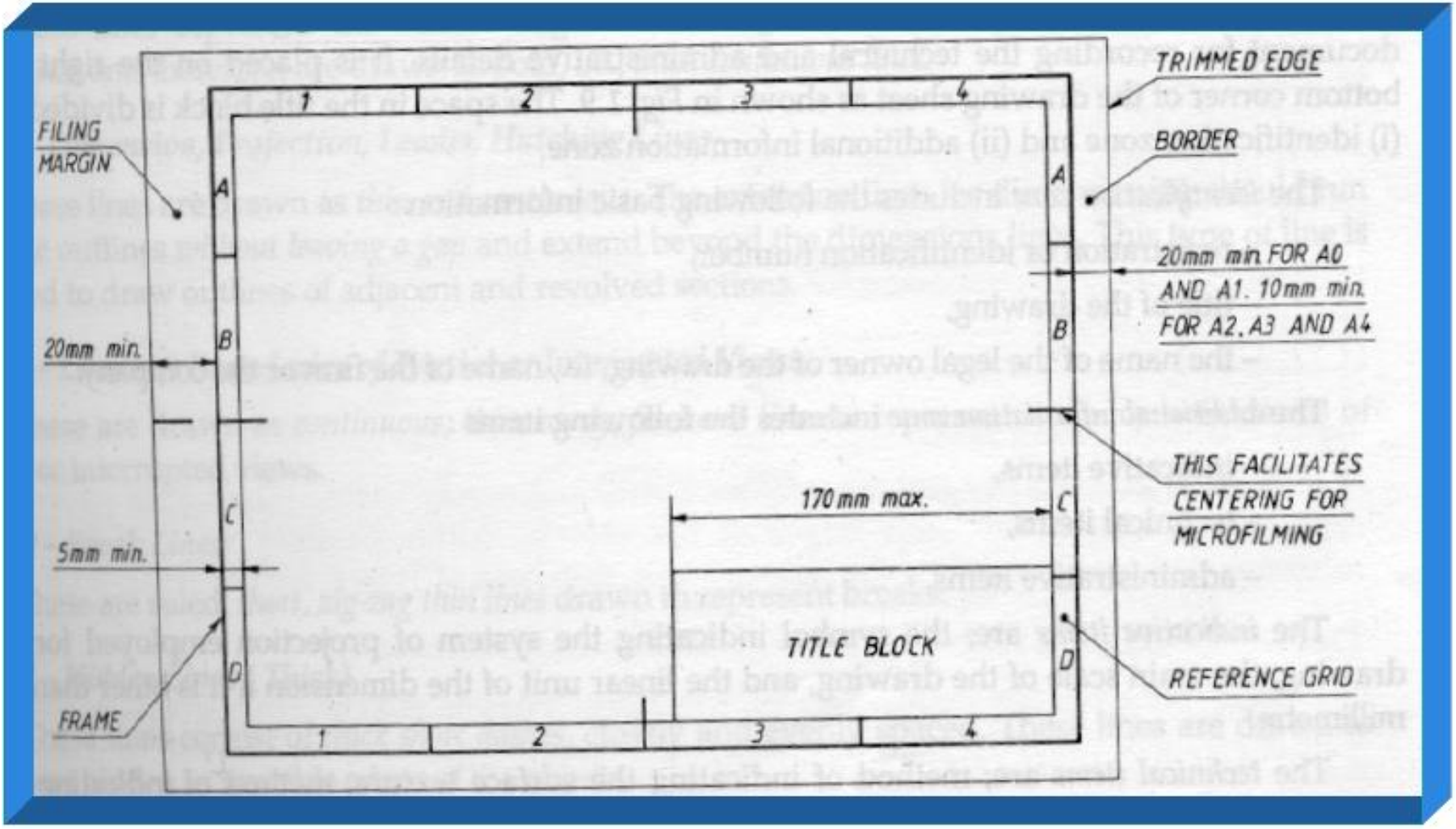


ANSI Paper Sizes			
Format	Size in Inches	Size in Millimeters	Ratio
ANSI A	8.5 x 11	216 x 279	1.2941
ANSI B	11 x 17	279 x 432	1.5455
ANSI C	17 x 22	432 x 559	1.2941
ANSI D	22 x 34	559 x 864	1.5455
ANSI E	34 x 44	864 x 1118	1.2941

Paper


11 in
279.4 mm
Letter
215.9 mm
8.5 in
11.7 in
297 mm
A4
210 mm
8.3 in
14 in
355.6 mm
Legal
215.9 mm
8.5 in

Layout example



Drawing sheet layout

- Standard form of arrangement
- Important particulars are included
- Facilitate quick reading of important particulars – quick references are located easily – **drawings are prepared at various locations and shared**
- Grids along the horizontal edges – Numerals
- Grids along vertical edges – Capital letters

Drawing sheet layout

- Numbering and lettering start from the corner of the sheet opposite to the title box and are repeated on the opposite sides
- Numbers and letters are written upright
- Repetition of letters or numbers like AA, BB, etc., if they exceed that of the alphabets.

- **Borders** – space left all around in between the trimmed edges of the sheet- A minimum of 10 mm

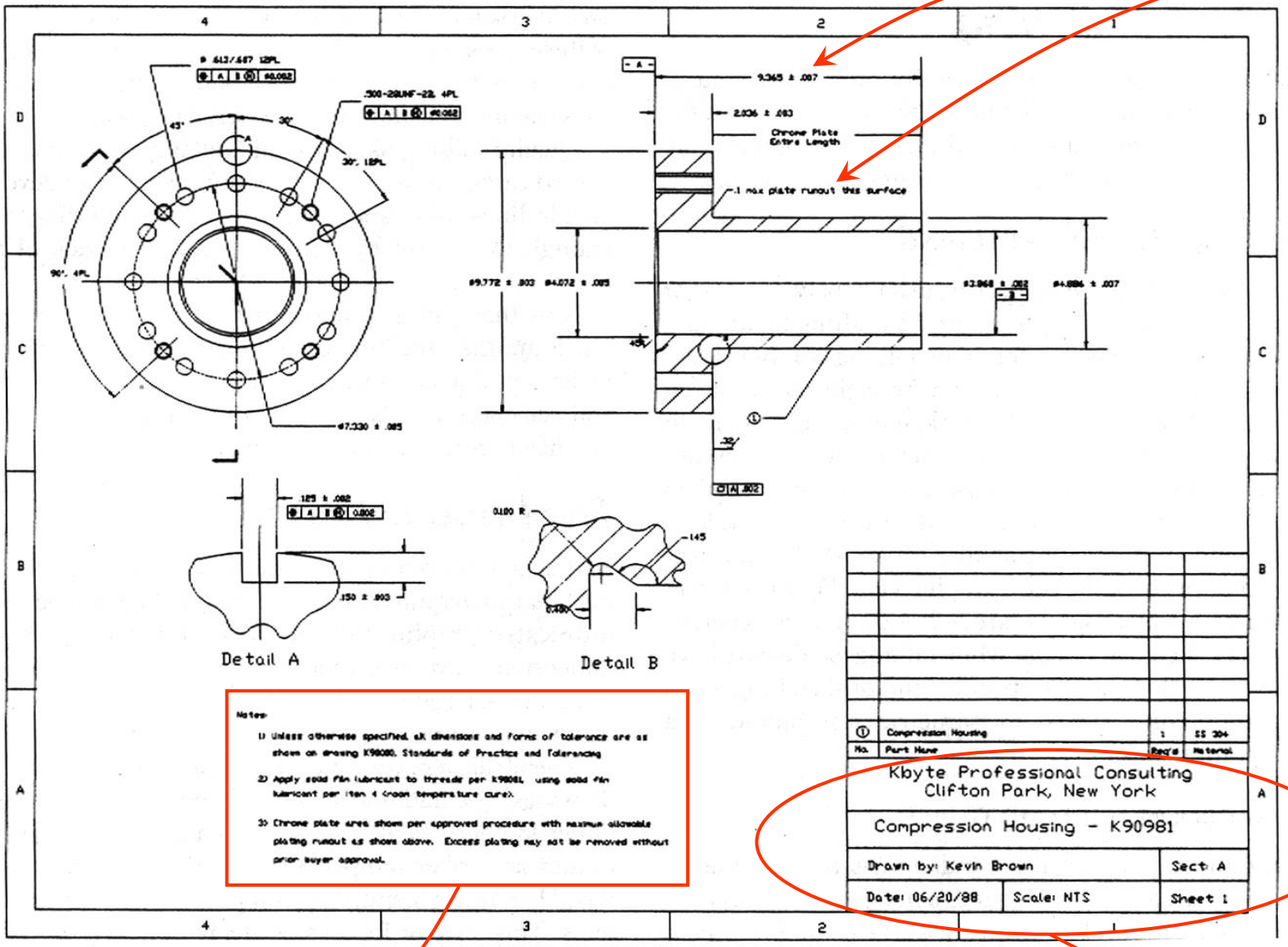
Drawing sheet layout

- **Title box** – An important feature – a must in every drawing sheet – for technical and administrative details
- Location - Bottom right corner

Divided into two zones:

- **1- Identification zone**
- Registration or identification number
- Drawing title
- Name of the legal owner of the drawing, i.e., name of the company
- **2- Additional information zone**
- Indicative items –symbol indicating the system of projection, main scale of drawing, etc.
- Technical items – method of indicating surface texture, geometric tolerances, etc.
- Administrative items

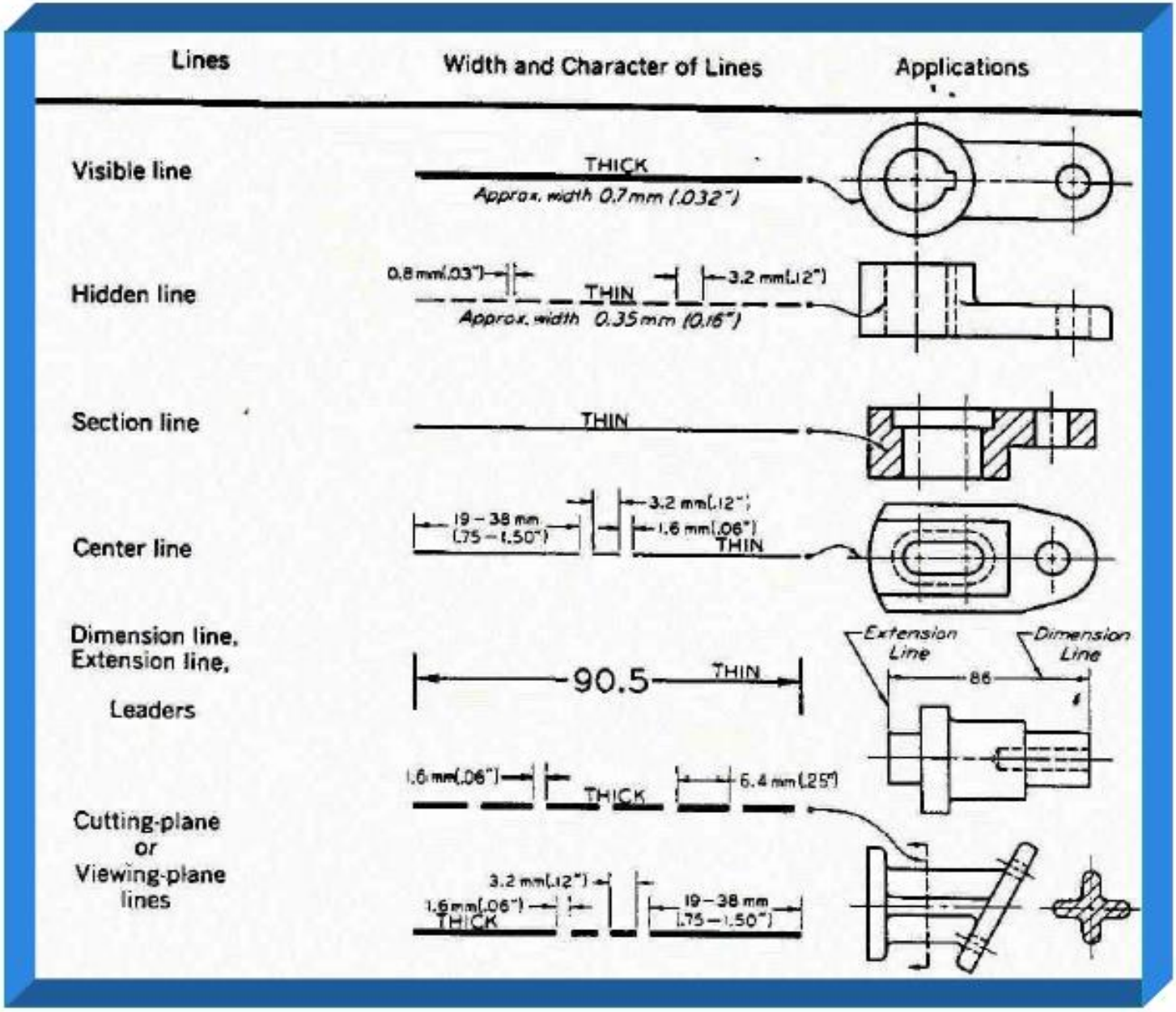
Layout example



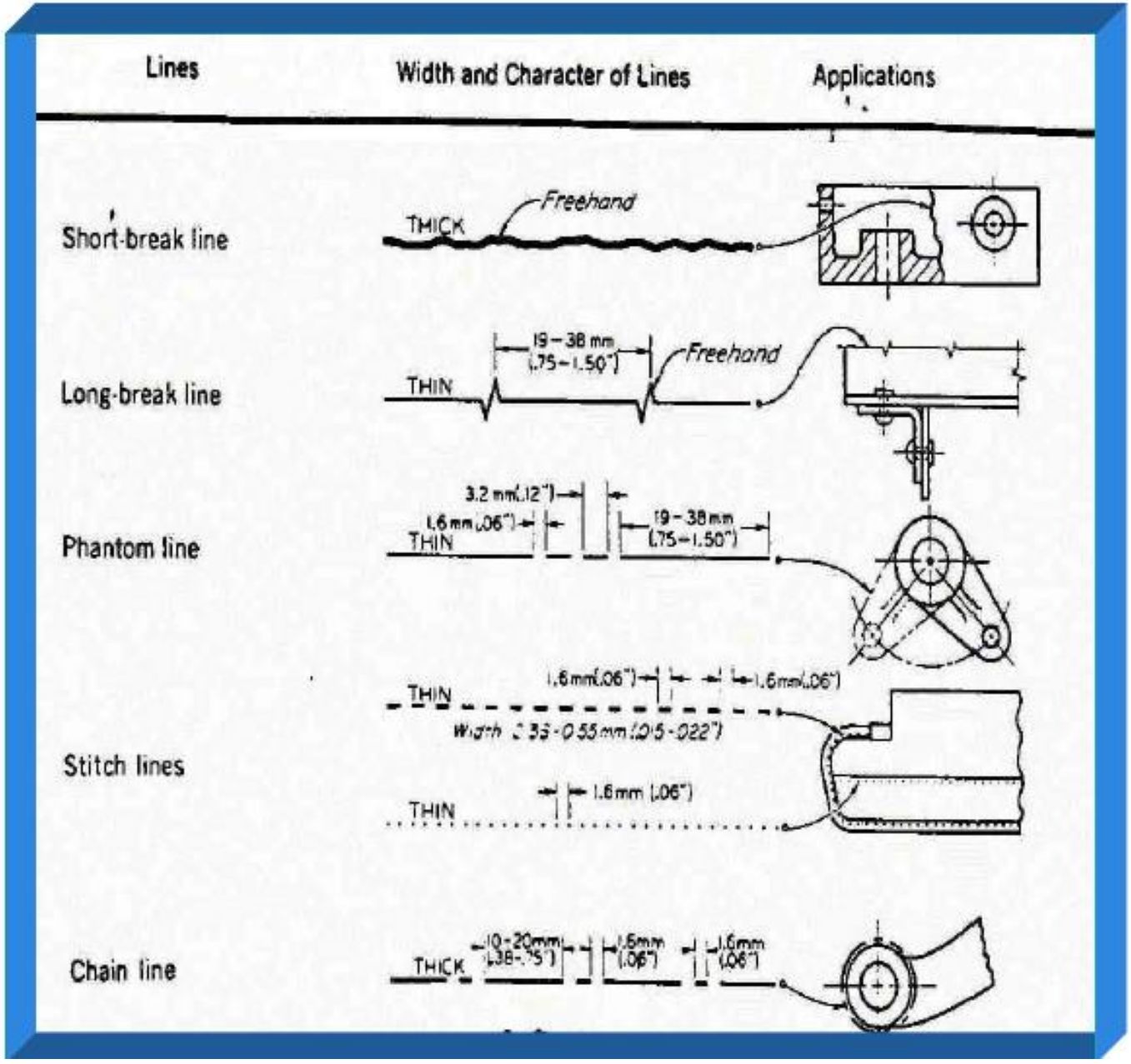
Line types

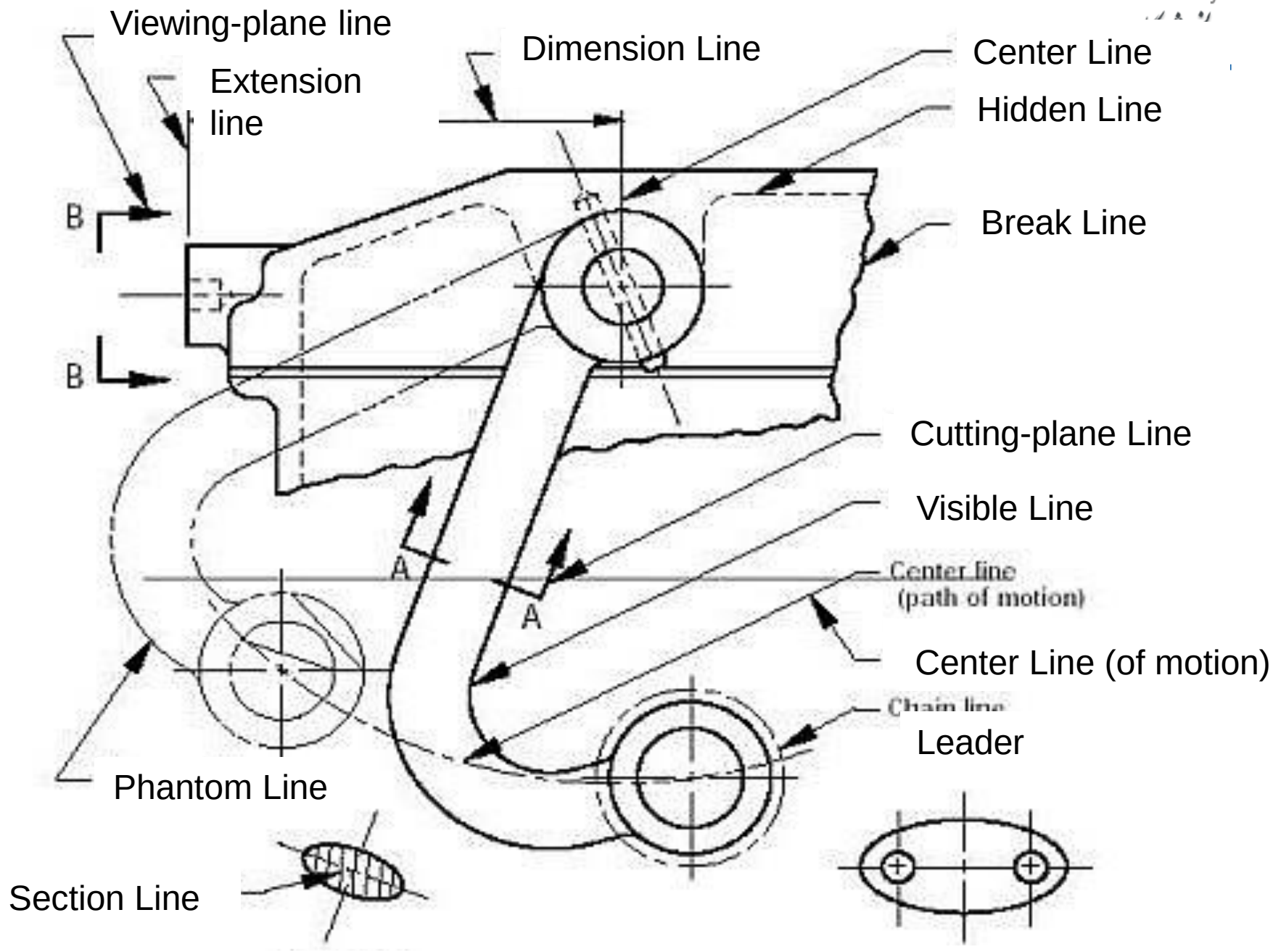
Illustration	Application	Pencil
Thick	Outlines, visible edges, surface boundaries of objects, margin lines	H
Continuous thin	Dimension lines, extension lines, section lines leader or pointer lines, construction lines, boarder lines	2H
Continuous thin wavy 	Short break lines or irregular boundary lines – drawn freehand	2H
Continuous thin with zig-zag 	Long break lines	2H
Short dashes, gap 1, length 3 mm	Invisible or interior surfaces	H
Short dashes	Center lines, locus lines Alternate long and short dashes in a proportion of 6:1,	2H
Long chain thick at end and thin elsewhere	Cutting plane lines	H / 2H
Continuous thick border line	Border	HB

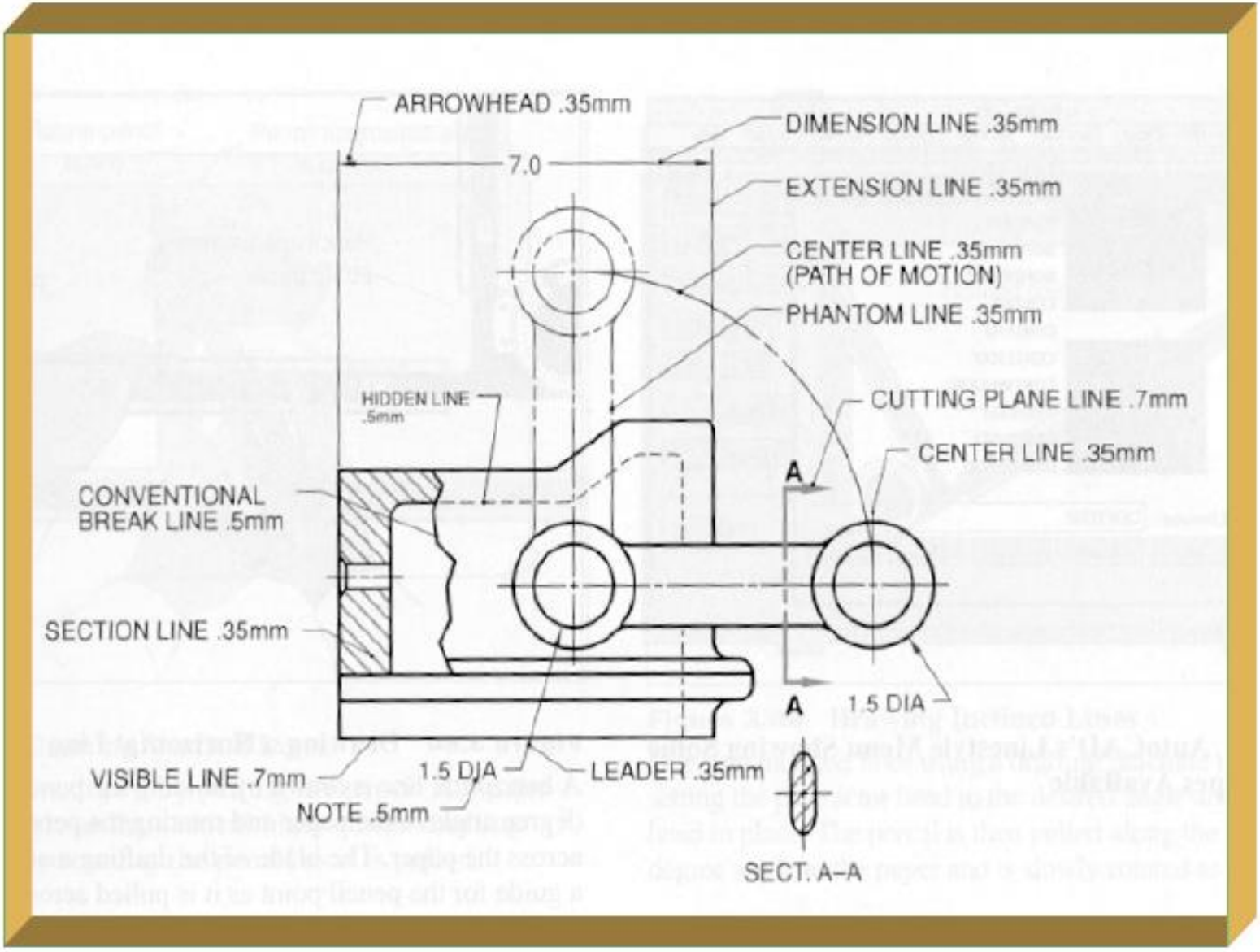
Line types


Lines
Width and Character of Lines
Applications
Visible line
THICK
Approx. width 0.7 mm (.032")
Hidden line
0.8 mm(.03")
THIN
3.2 mm(.12")
Approx. width 0.35 mm (0.16")
Section line
THIN
Center line
19 – 38 mm (.75 – 1.50")
3.2 mm(.12")
1.6 mm(.06")
THIN
Dimension line, Extension line, Leaders
90.5
THIN
Extension Line
Dimension Line
86
Cutting-plane or Viewing-plane lines
1.6 mm(.06")
THICK
6.4 mm(.25")
3.2 mm(.12")
1.6 mm(.06")
THICK
19 – 38 mm (.75 – 1.50")

Line types

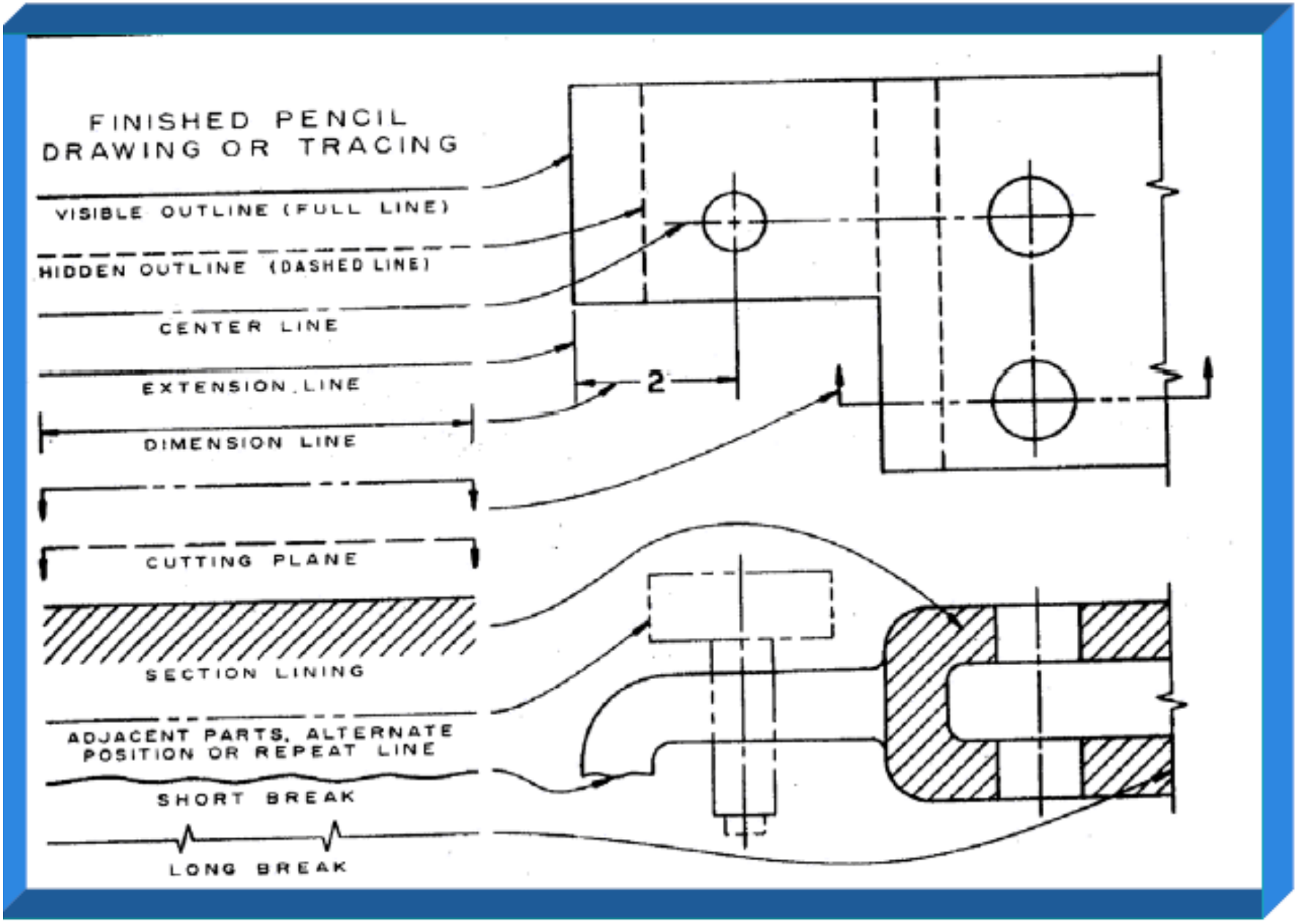

Lines
Width and Character of Lines
Applications
Short-break line
THICK
Freehand
Long-break line
THIN
19 – 38 mm (.75 – 1.50")
Freehand
Phantom line
3.2 mm (.12")
1.6 mm (.06")
THIN
19 – 38 mm (.75 – 1.50")
Stitch lines
THIN
1.6 mm (.06")
1.6 mm (.06")
THIN
1.6 mm (.06")
Chain line
THICK
10 – 20 mm
1.6 mm (.06")
1.6 mm (.06")


Viewing-plane line
Extension line
Dimension Line
Center Line
Hidden Line
Break Line
B
B
Cutting-plane Line
Visible Line
A
A
Center line
(path of motion)
Center Line (of motion)
Chain line
Leader
Phantom Line
Section Line
SECTION A-A
VIEW B-B

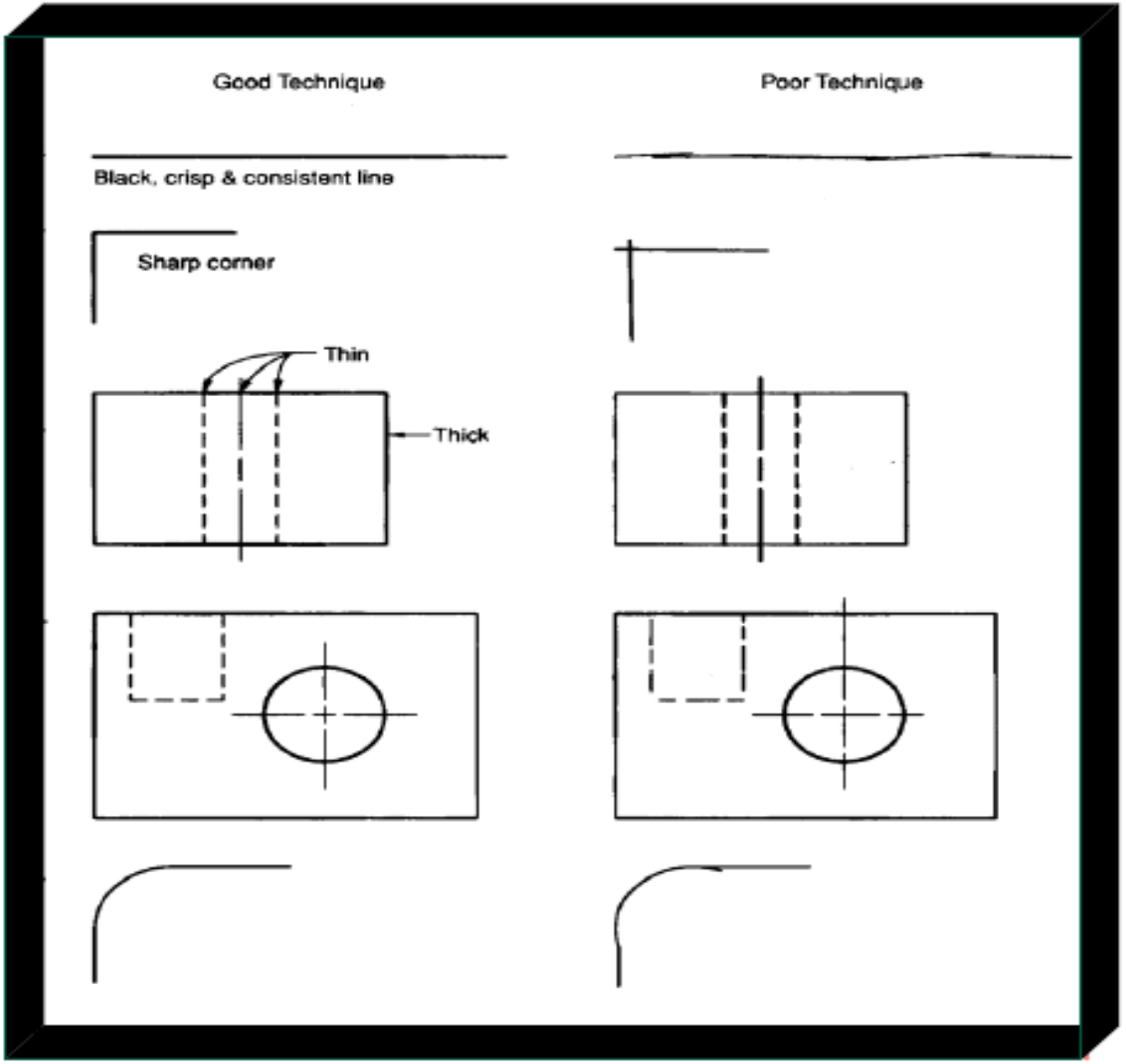


Uses of different types of lines in a given drawing

Line types


FINISHED PENCIL DRAWING OR TRACING
VISIBLE OUTLINE (FULL LINE)
HIDDEN OUTLINE (DASHED LINE)
CENTER LINE
EXTENSION LINE
DIMENSION LINE
CUTTING PLANE
SECTION LINING
ADJACENT PARTS, ALTERNATE POSITION OR REPEAT LINE
SHORT BREAK
LONG BREAK
2

Examples


Good Technique
Poor Technique
Black, crisp & consistent line
Sharp corner
Thin
Thick

مرور کلی درس با یک مثال
Course overview with an example

Introduction

- This is just an introduction. Don't worry about understanding every detail right now - just get a general feel for the language of graphics.
- Hope you like the object in Figure 1, because you'll be seeing a lot of it. Before we get started on any technical drawings, let's get a good look at this strange block from several angles.

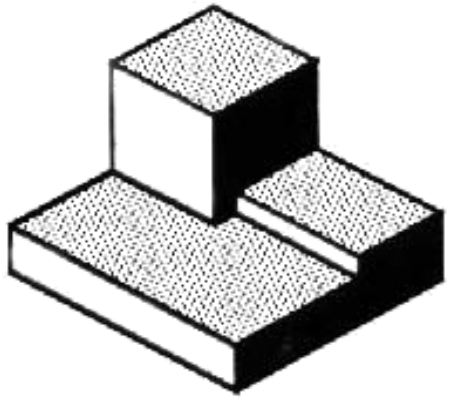


Figure 1- A Machined Block

Isometric Drawing

- The representation of the object in figure 2 is called an isometric drawing. This is one of a family of three-dimensional views called pictorial drawings.
- In an isometric drawing, the object's vertical lines are drawn vertically, and the horizontal lines in the width and depth planes are shown at 30 degrees to the horizontal.

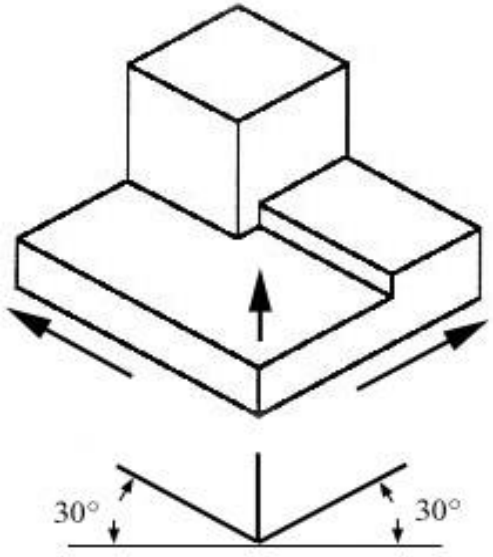


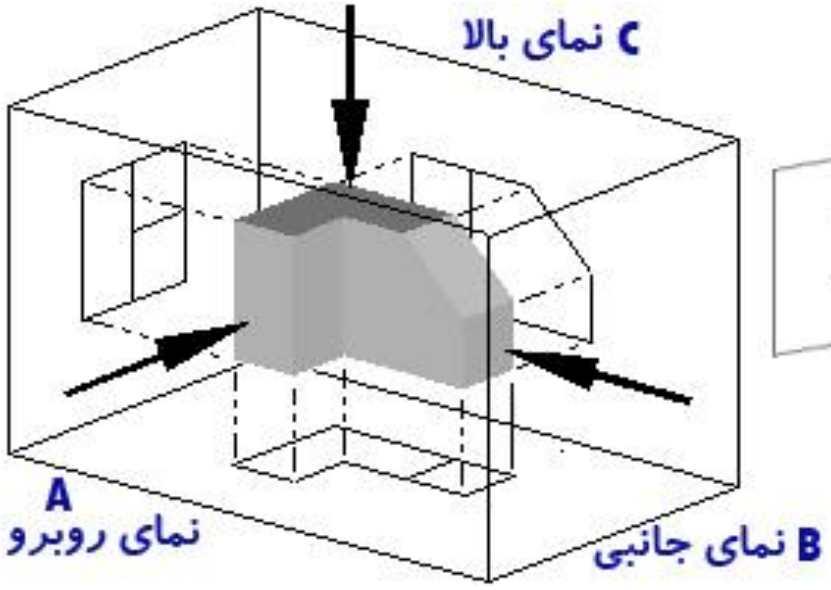
Figure 2 - An Isometric Drawing

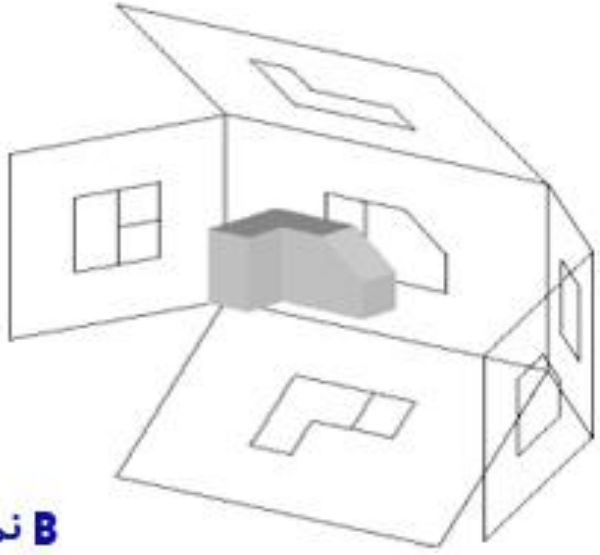
Isometric Drawing

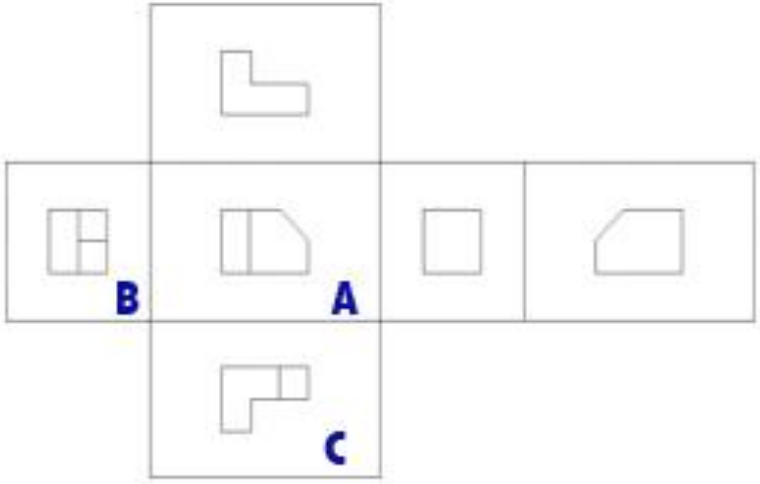
- When drawn under these guidelines, the lines parallel to these three axes are at their true (scale) lengths. Lines that are not parallel to these axes will not be of their true length.
- Any engineering drawing should show everything: a complete understanding of the object should be possible from the drawing. If the isometric drawing can show all details and all dimensions on one drawing, it is ideal. One can pack a great deal of information into an isometric drawing.

Orthographic or Multiview Drawing

- However, if the object in figure 2 had a hole on the back side, it would not be visible using a single isometric drawing. In order to get a more complete view of the object, an **orthographic projection** may be used.
- Orthographic projection (or orthogonal projection) is a means of representing a three-dimensional object in two dimensions. It is a form of parallel projection, where all the projection lines are orthogonal to the projection plane, resulting in every plane of the scene appearing in affine transformation on the viewing surface


C نمای بالا
A
نمای روبرو
B نمای جانبی




B
A
C

Orthographic or Multiview Drawing

- Imagine that you have an object suspended by transparent threads inside a glass box, as in figure 3.

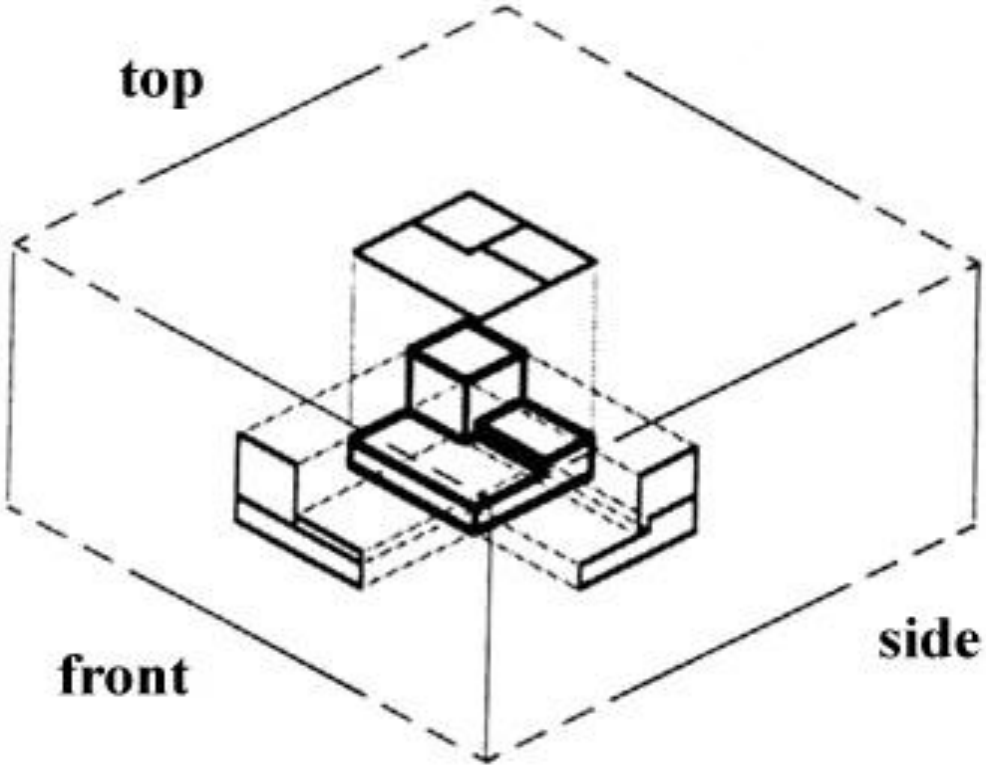


Figure 3 - The block suspended in a glass box

Orthographic or Multiview Drawing

- Then draw the object on each of three faces as seen from that direction. Unfold the box (figure 4) and you have the three views. We call this an "orthographic" or "multiview" drawing.

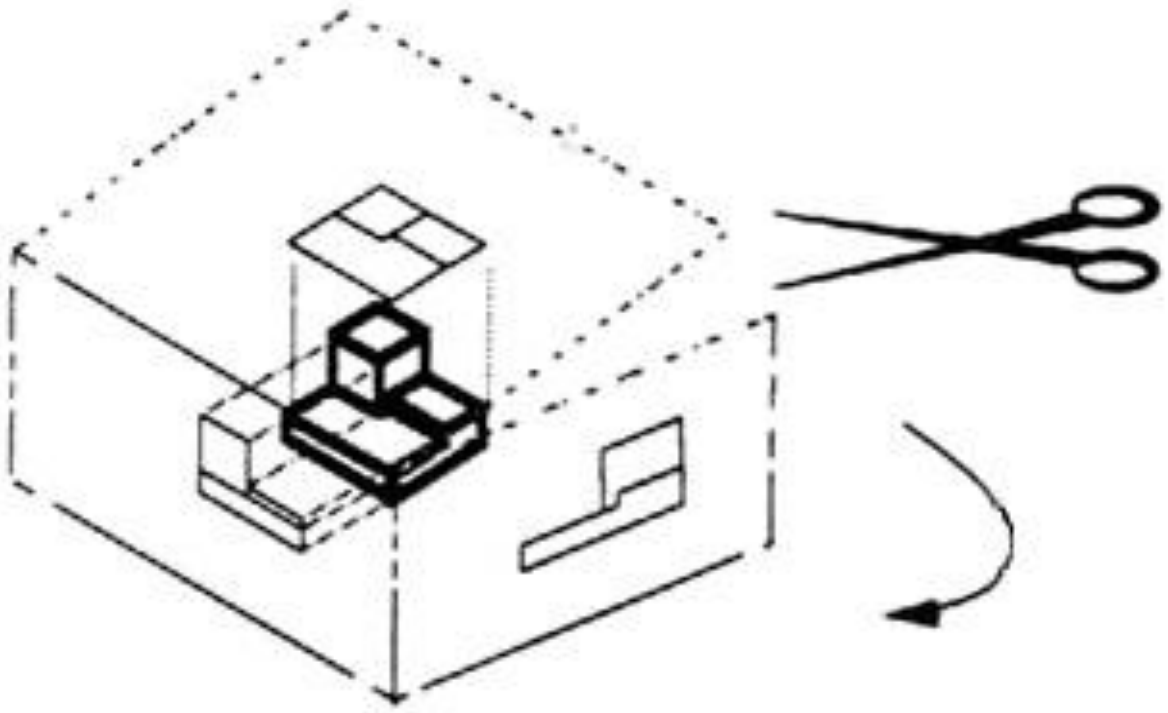


Figure 4 - The creation of an orthographic multiview drawing

Orthographic or Multiview Drawing

- Figure 5 shows how the three views appear on a piece of paper after unfolding the box.

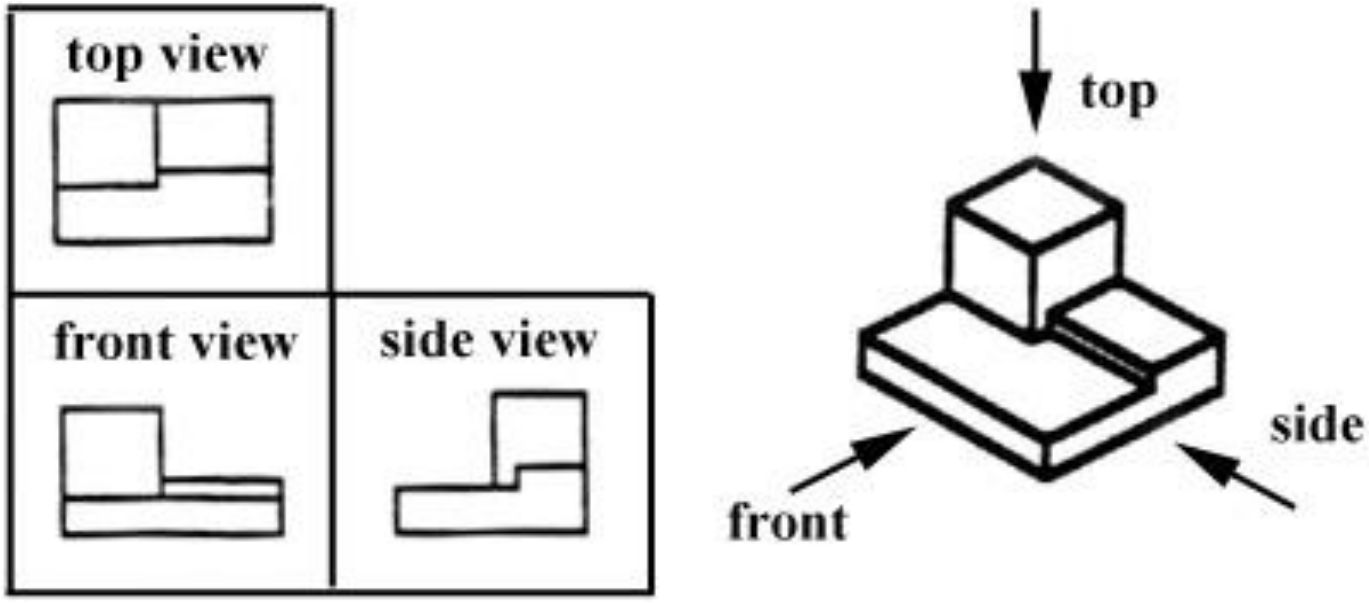


Figure 5 - A multiview drawing and its explanation

Orthographic or Multiview Drawing

- Which views should one choose for a multiview drawing?
- The views that reveal every detail about the object. Three views are not always necessary; we need only as many views as are required to describe the object fully.
- For example, some objects need only two views, while others need four. The circular object in figure 6 requires only two views.

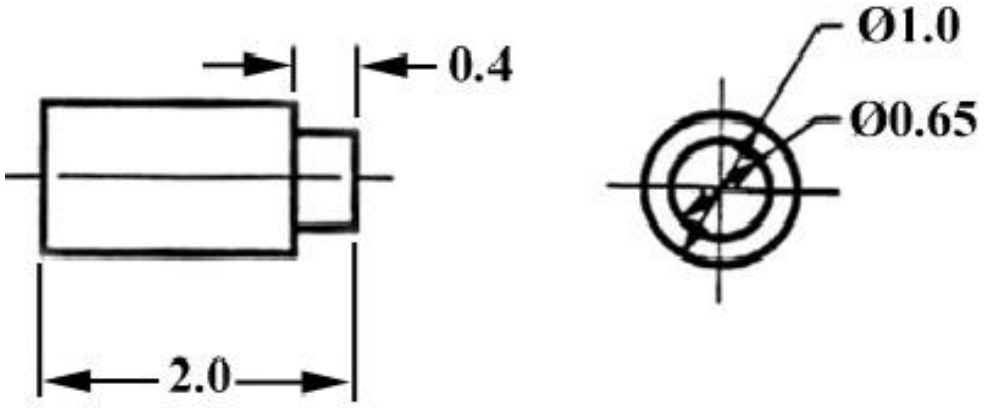


Figure 6 - An object needing only two orthogonal views

Dimensioning

We have "dimensioned" the object in the isometric drawing in figure 7. As a general guideline to dimensioning, try to think that you would make an object and dimension it in the most useful way.

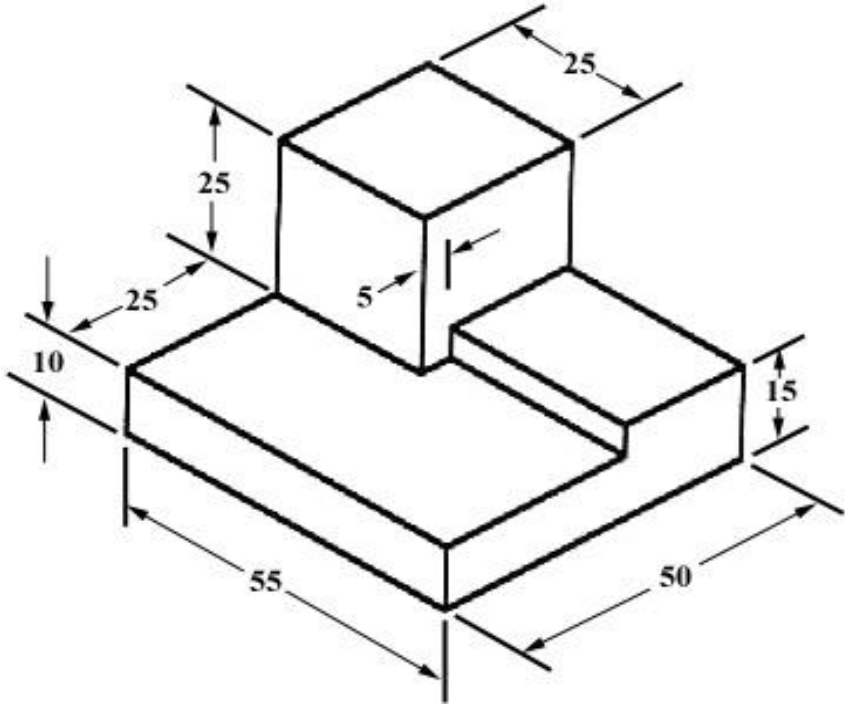


Figure 7 - An isometric view with dimensions

Dimensioning

- Put in exactly as many dimensions as are necessary for the craftsperson to make it -no more, no less.
- Do not put in redundant dimensions. Not only will these clutter the drawing, but if "tolerances" or accuracy levels have been included, the redundant dimensions often lead to conflicts when the tolerance allowances can be added in different ways.
- Repeatedly measuring from one point to another will lead to inaccuracies. It is often better to measure from one end to various points. This gives the dimensions a reference standard.
- It is helpful to choose the placement of the dimension in the order in which a machinist would create the part. This convention may take some experience.

Sectioning

- There are many times when the interior details of an object cannot be seen from the outside (figure 8).

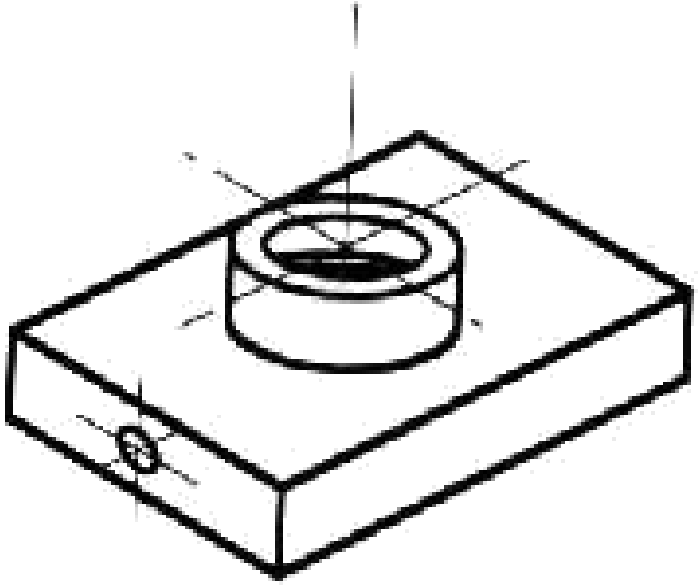


Figure 8 - An isometric drawing that does not show all details

Sectioning

- We can get around this by pretending to cut the object on a plane and showing the "sectional view". The sectional view is applicable to objects like engine blocks, where the interior details are intricate and would be very difficult to understand through the use of "hidden" lines (hidden lines are, by convention, dotted) on an orthographic or isometric drawing.
- Imagine slicing the object in the middle (figure 9):

Sectioning

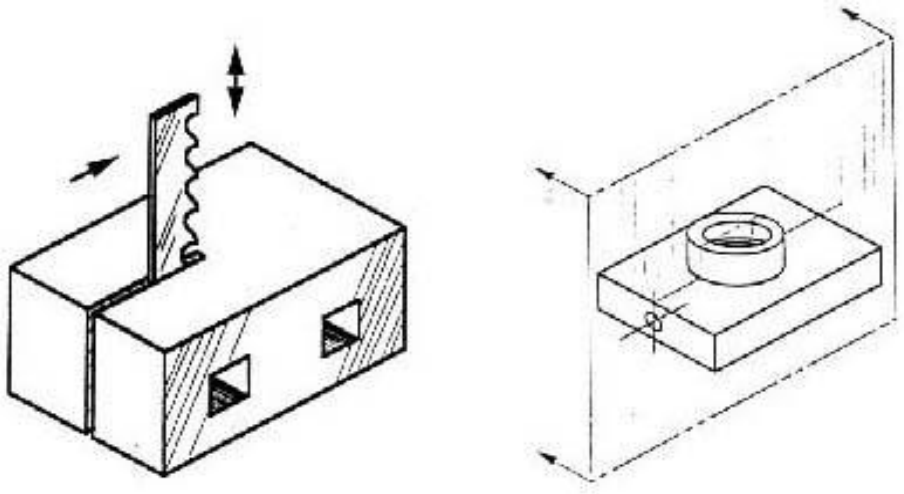


Figure 9 - "Sectioning" an object

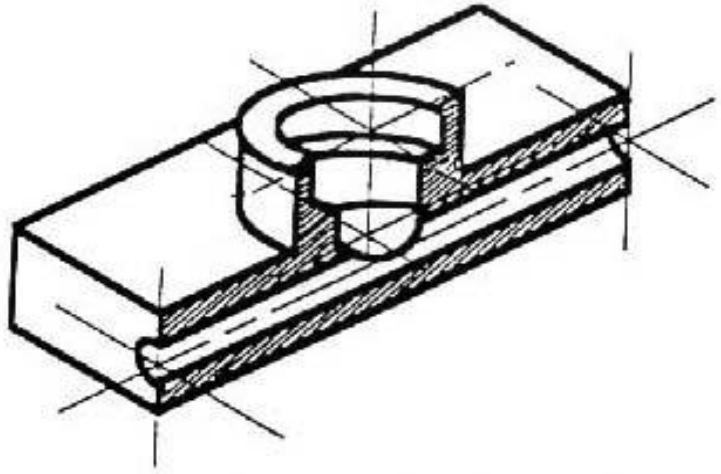
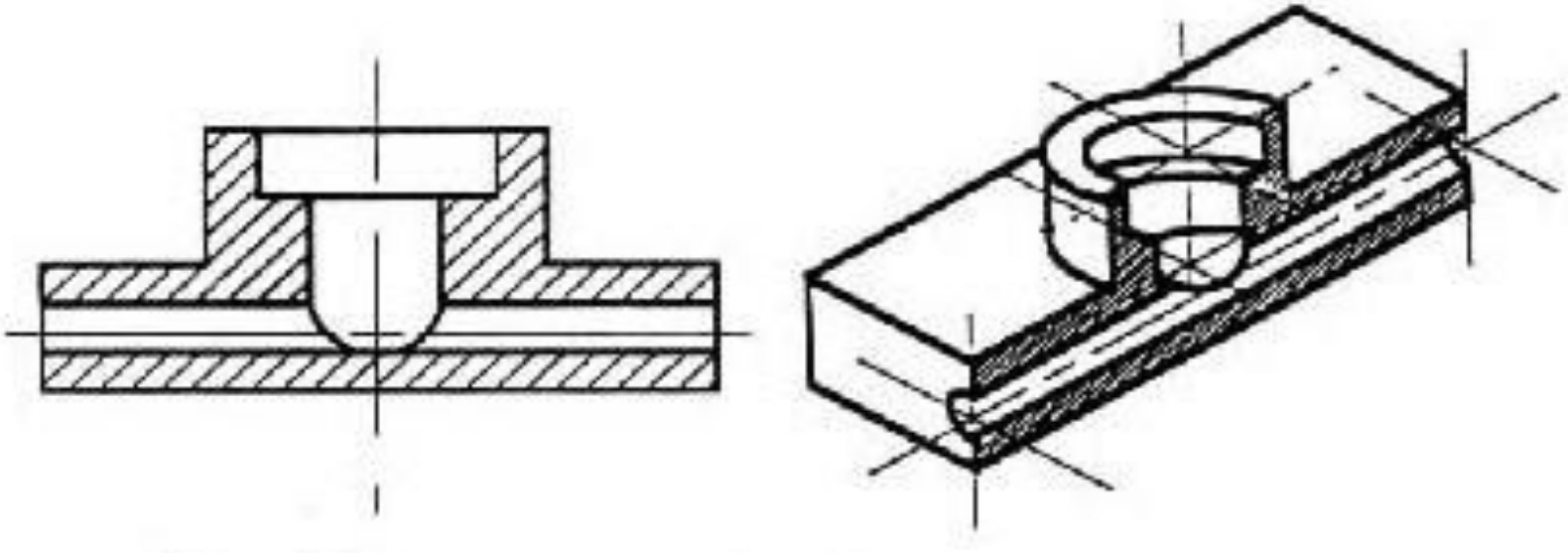


Figure 10 - Sectioning the object in figure 8

Sectioning

- The cross-section looks like figure 11 when it is viewed from straight ahead.



Drawing Tools

- To prepare a drawing, one can use manual drafting instruments (figure 12) or computer-aided drafting or design, or CAD. The basic drawing standards and conventions are the same regardless of what design tool you use to make the drawings. In learning drafting, we will approach it from the perspective of manual drafting. If the drawing is made without either instruments or CAD, it is called a freehand sketch.

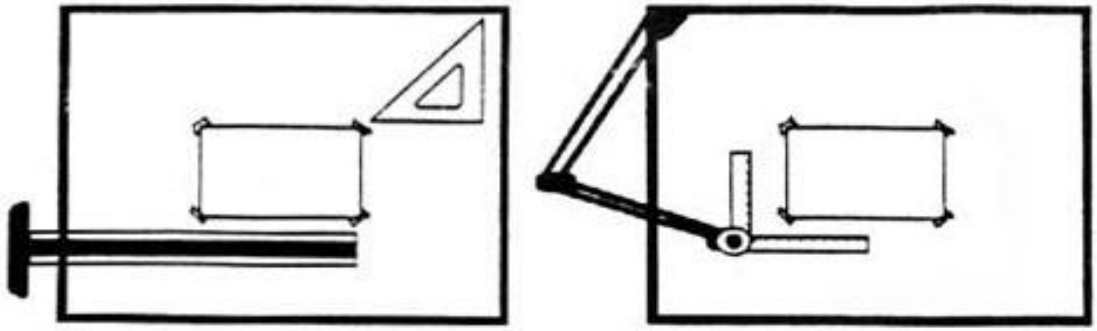


Figure 12 - Drawing Tools

Assembly Drawings

- An isometric view of an "assembled" pillow-block bearing system is shown in figure 13. It corresponds closely to what you actually see when viewing the object from a particular angle. We cannot tell what the inside of the part looks like from this view.

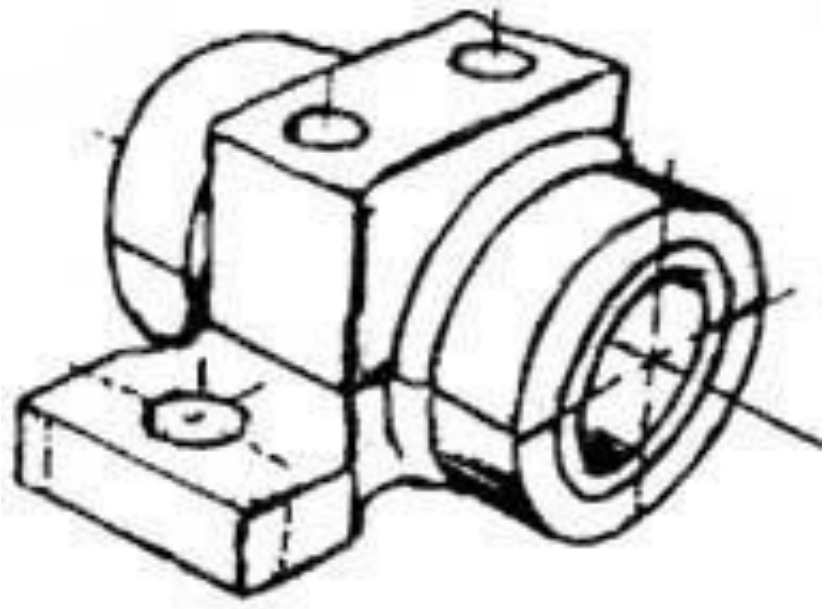


Figure 13 - Pillow-block (Freehand sketch)

Assembly Drawings

- We can also show isometric views of the pillow-block being taken apart or "disassembled" (figure 14). This allows you to see the inner components of the bearing system. Isometric drawings can show overall arrangement clearly, but not the details and the dimensions.

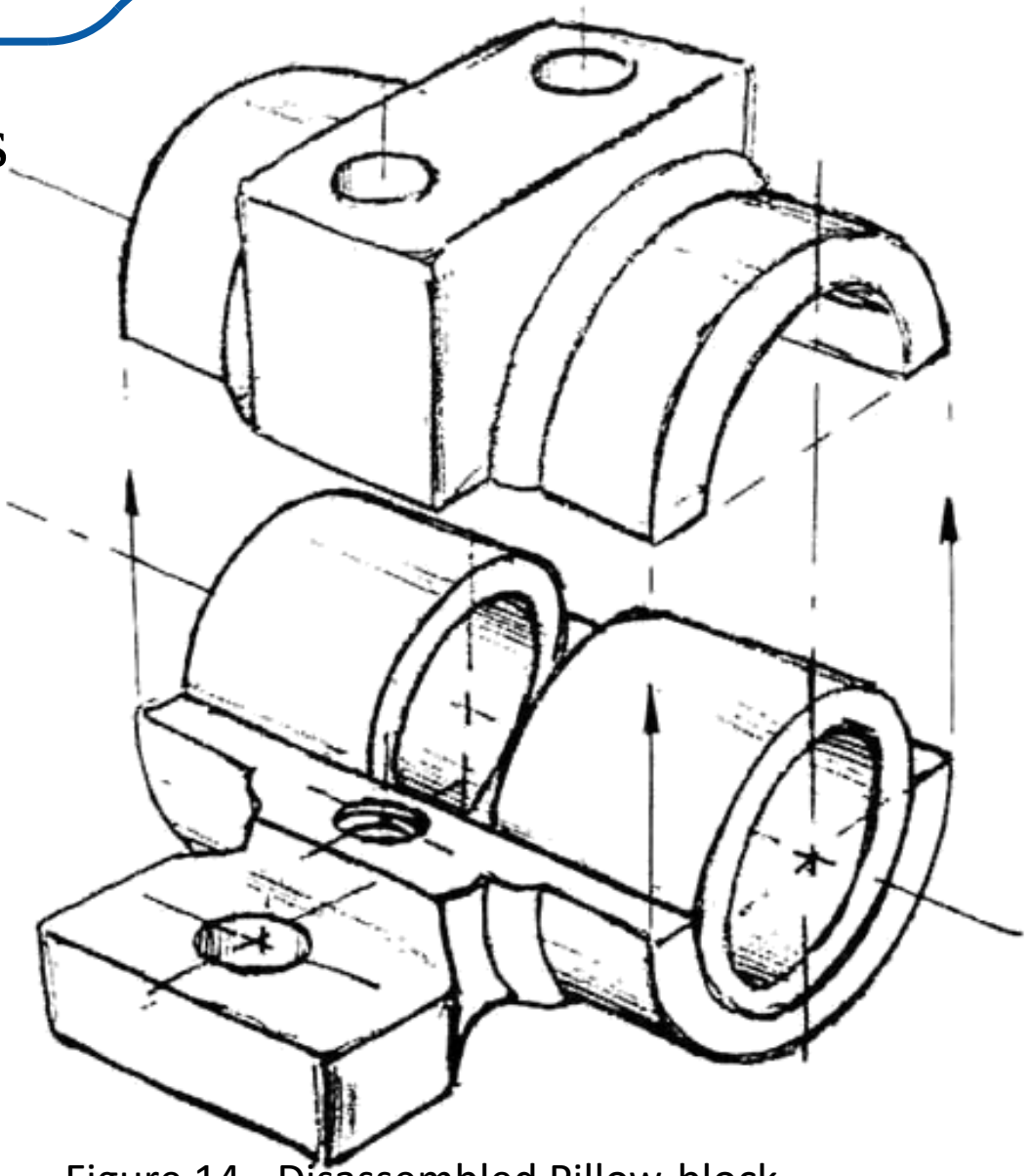


Figure 14 - Disassembled Pillow-block

Cross-Sectional Views

- A cross-sectional view portrays a cut-away portion of the object and is another way to show hidden components in a device.
- Imagine a plane that cuts vertically through the center of the pillow block as shown in figure 15. Then imagine removing the material from the front of this plane, as shown in figure 16.

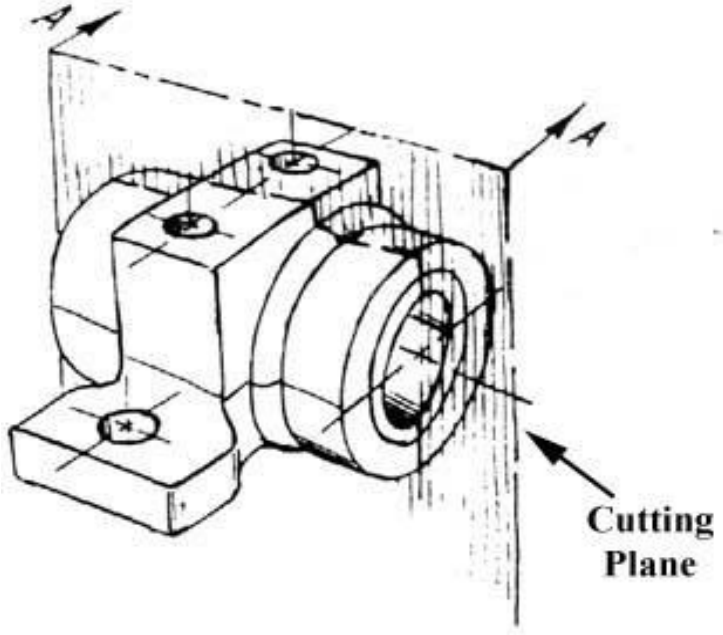


Figure 15 - Pillow Block

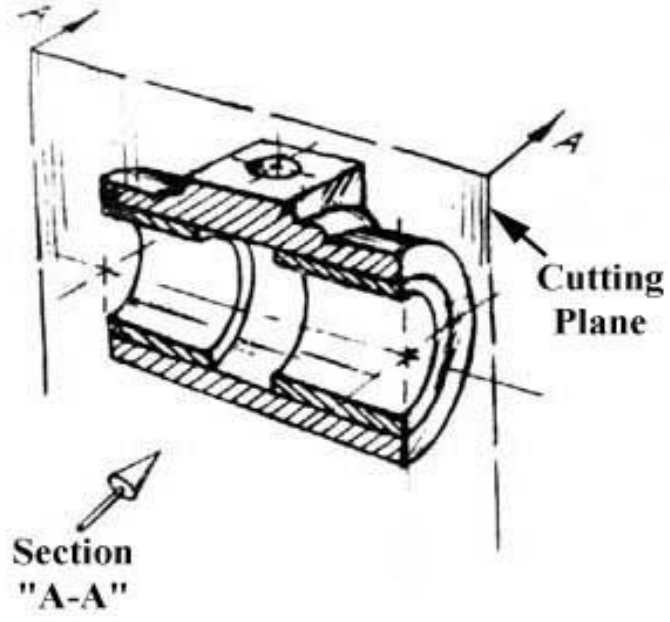


Figure 16 - Pillow Block

Cross-Sectional Views

- This is how the remaining rear section would look. Diagonal lines (cross-hatches) show regions where materials have been cut by the cutting plane.
- This cross-sectional view (section A-A, figure 17), one that is orthogonal to the viewing direction, shows the relationships of lengths and diameters better. These drawings are easier to make than isometric drawings.

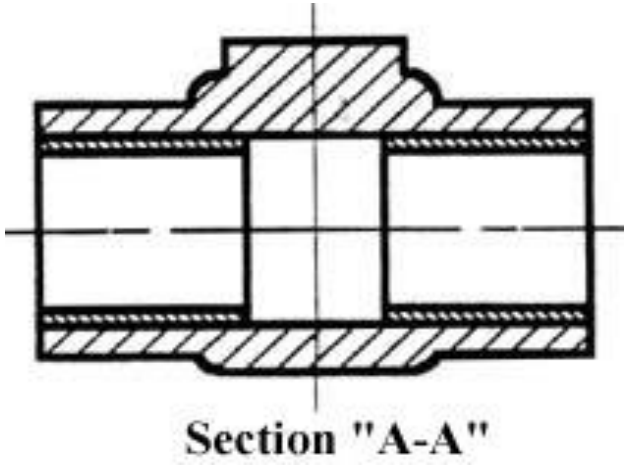


Figure 17 - Section "A-A"

Cross-Sectional Views

- The top "outside" view of the bearing is shown in figure 18. It is an orthogonal (perpendicular) projection. Notice the direction of the arrows for the "A-A" cutting plane.

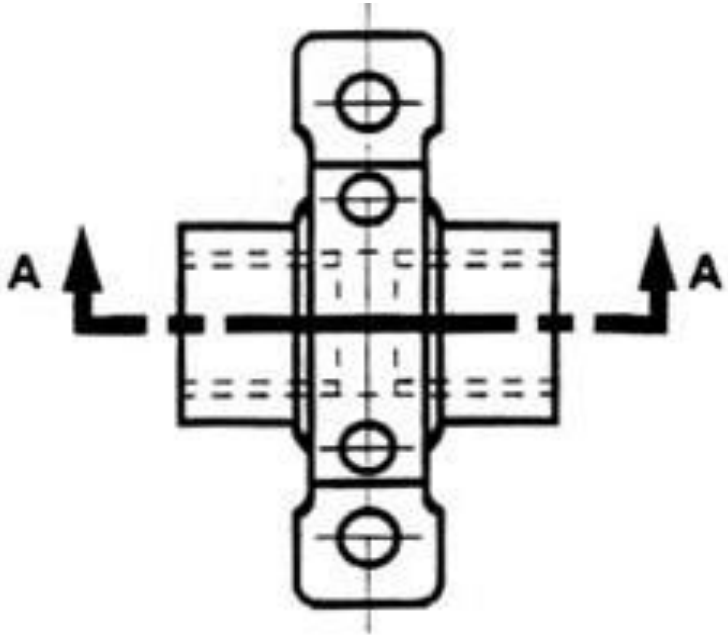


Figure 18 - The top "outside" view of the bearing

Half-Sections

- A half-section is a view of an object showing one-half of the view in section, as in figure 19 and 20.

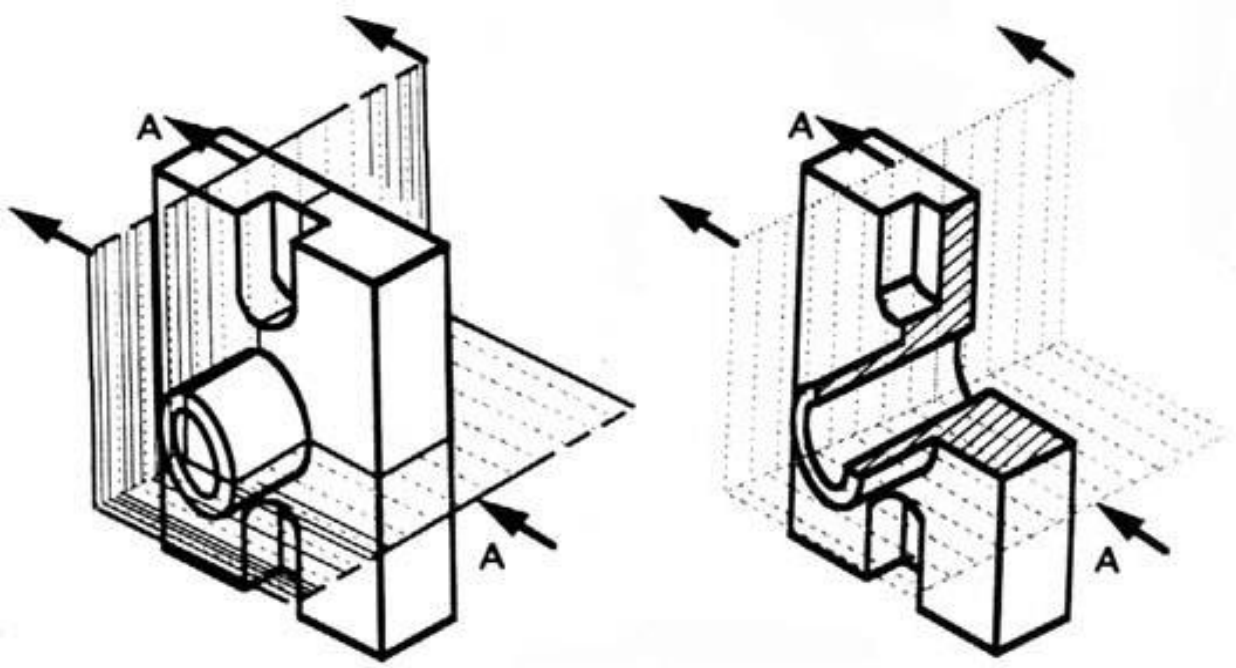


Figure 19 - Full and sectioned isometric views

Half-Sections

The diagonal lines on the section drawing are used to indicate the area that has been theoretically cut. These lines are called *section lining* or *cross-hatching*. The lines are thin and are usually drawn at a 45-degree angle to the major outline of the object. The spacing between lines should be uniform.

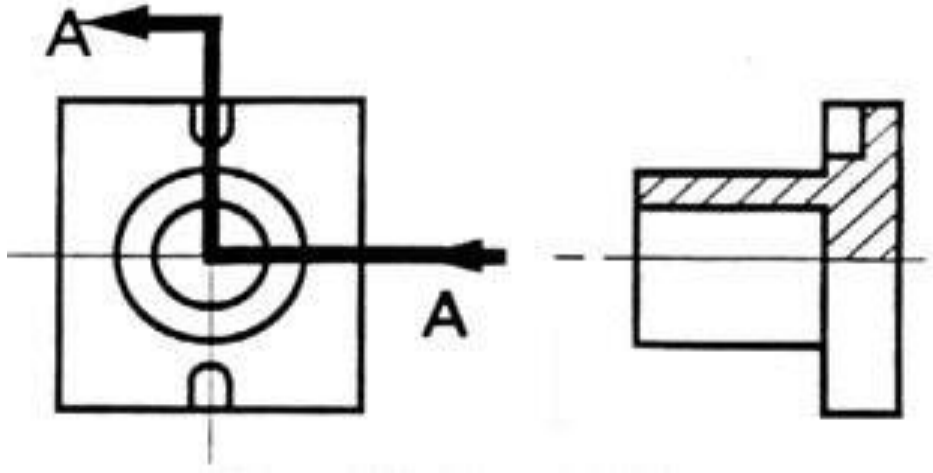


Figure 20 - Front view and half section

Half-Sections

- Usually hidden (dotted) lines are not used on the cross-section unless they are needed for dimensioning purposes. Also, some hidden lines on the non-sectioned part of the drawings are not needed (figure 21) since they become redundant information and may clutter the drawing.

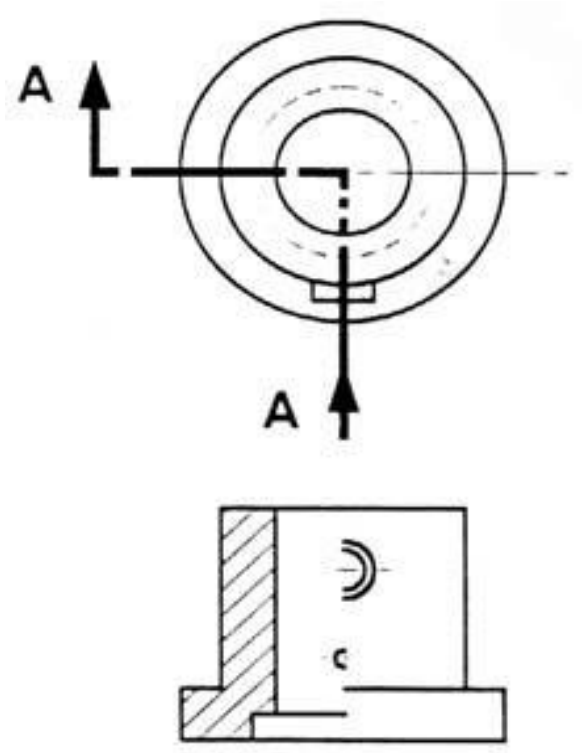


Figure 21 - Half section without hidden lines

Sectioning Objects with Holes, Ribs, etc.

The cross-section on the right of figure 22 is technically correct. However, the convention in a drawing is to show the view on the left as the preferred method for sectioning this type of object.

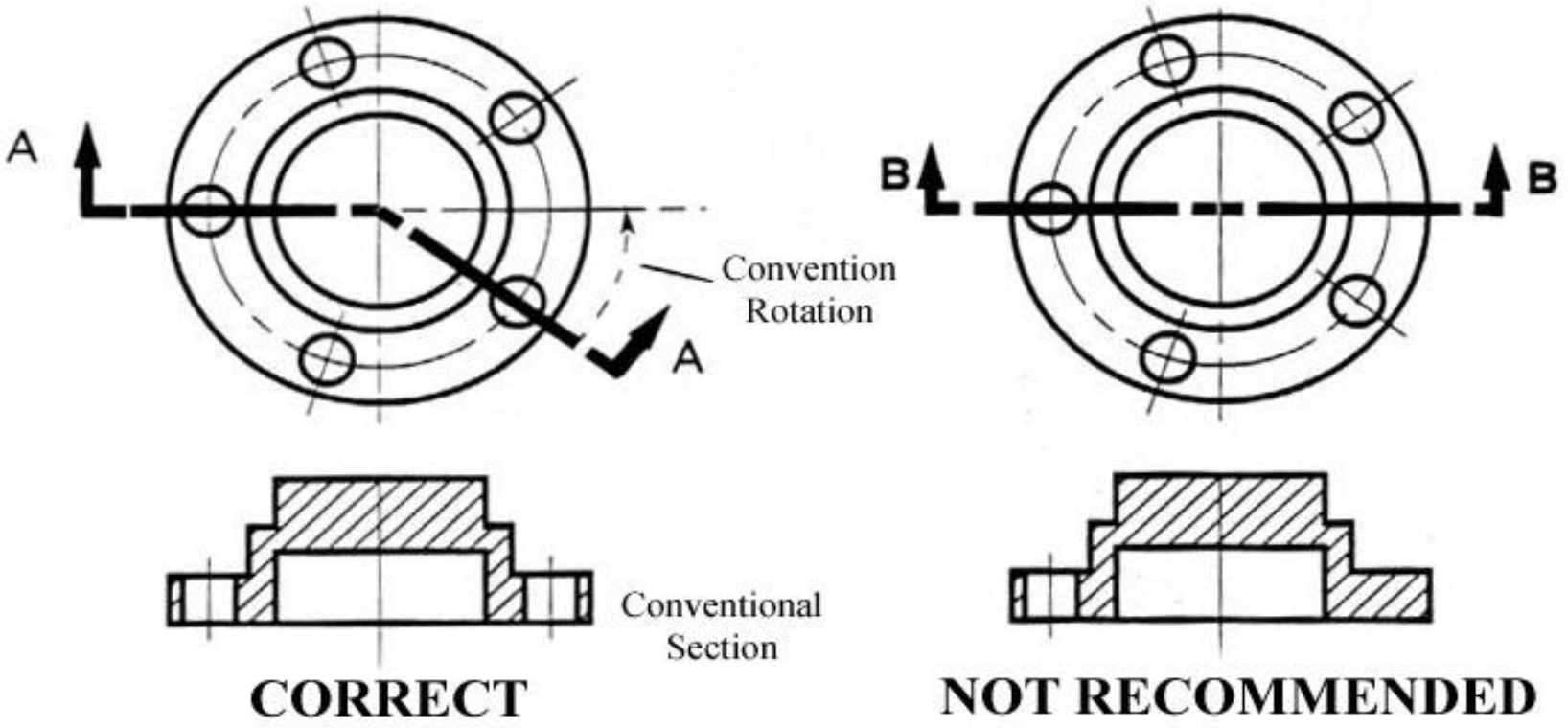


Figure 22 - Cross section

Dimensioning

- The purpose of dimensioning is to provide a clear and complete description of an object. A complete set of dimensions will permit only one interpretation needed to construct the part. Dimensioning should follow these guidelines:

Accuracy: correct values must be given.

Clearness: dimensions must be placed in appropriate positions.

Completeness: nothing must be left out, and nothing duplicated.

Readability: the appropriate line quality must be used for legibility.

The Basics: Definitions and Dimensions

- The **dimension line** is a thin line, broken in the middle to allow the placement of the dimension value, with arrowheads at each end (figure 23).

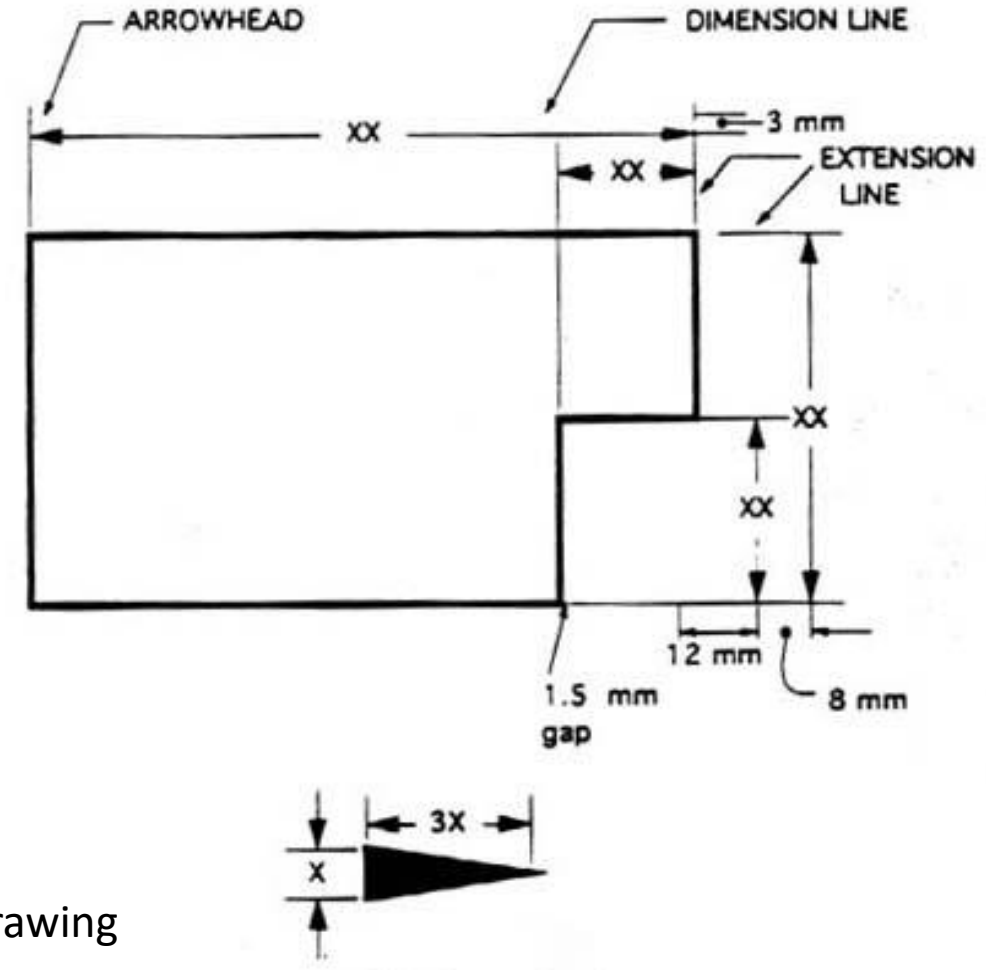


Figure 23 - Dimensioned Drawing

The Basics: Definitions and Dimensions

- A leader is a thin line used to connect a dimension with a particular area (figure 24).
- A leader may also be used to indicate a note or comment about a specific area. When there is limited space, a heavy black dot may be substituted for the arrows, as in figure 23. Also in this drawing, two holes are identical, allowing the "2x" notation to be used and the dimension to point to only one of the circles.

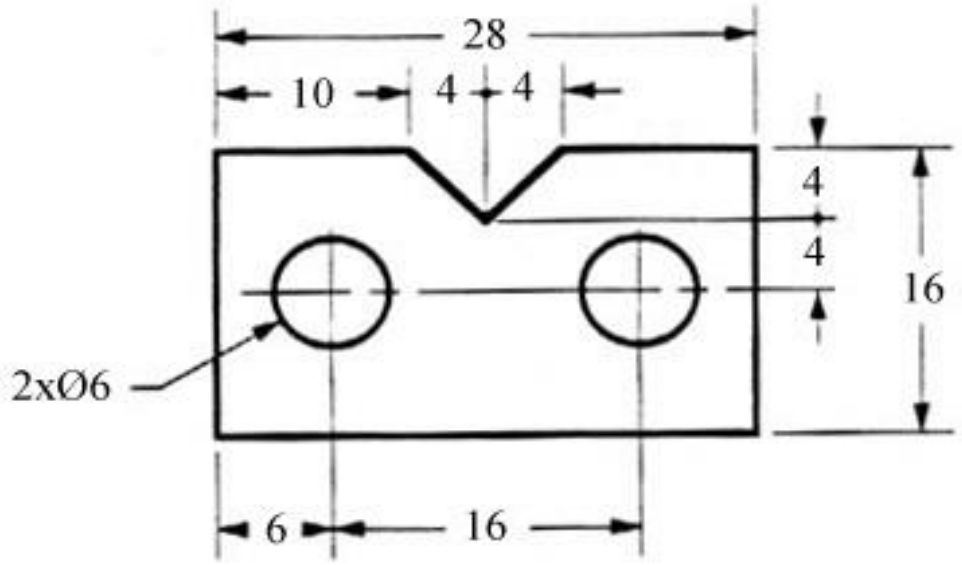


Figure 24 - Example drawing with a leader

Where To Put Dimensions

- The dimensions should be placed on the face that describes the feature most clearly. Examples of appropriate and inappropriate placing of dimensions are shown in figure 25.

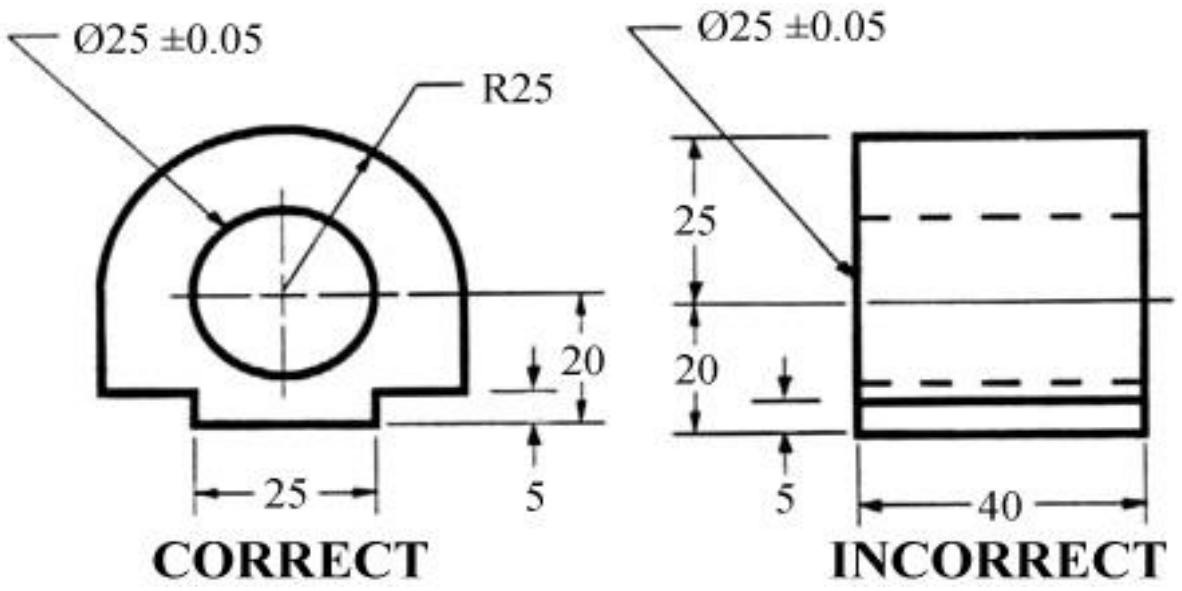


Figure 25 - Example of appropriate and inappropriate dimensioning

Dimensioning

- In order to get the feel of what dimensioning is all about, we can start with a simple rectangular block. With this simple object, only three dimensions are needed to describe it completely (figure 26). There is little choice on where to put its dimensions.

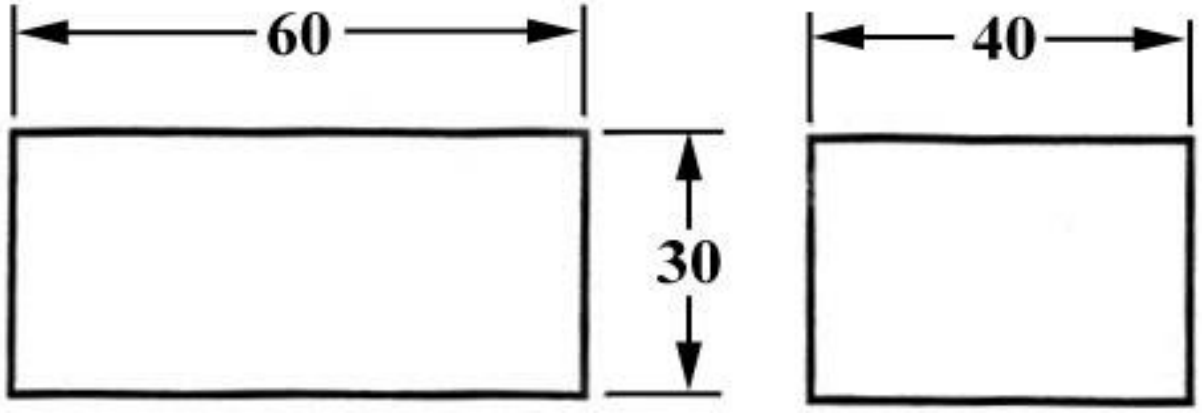


Figure 26 - Simple Object

Dimensioning

- We have to make some choices when we dimension a block with a notch or cutout (figure 27). It is usually best to dimension from a common line or surface. This can be called the datum line of surface. This eliminates the addition of measurement or machining inaccuracies that would come from "chain" or "series" dimensioning.

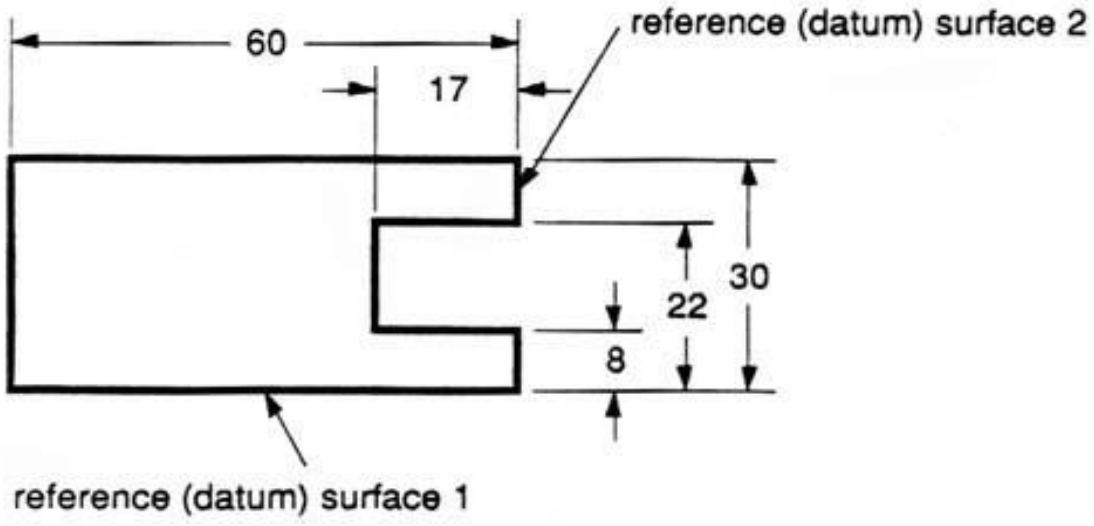


Figure 27 - Surface datum example

Dimensioning

- Notice how the dimensions originate on the datum surfaces. We chose one datum surface in figure 27, and another in figure 28. As long as we are consistent, it makes no difference. (We are just showing the top view).

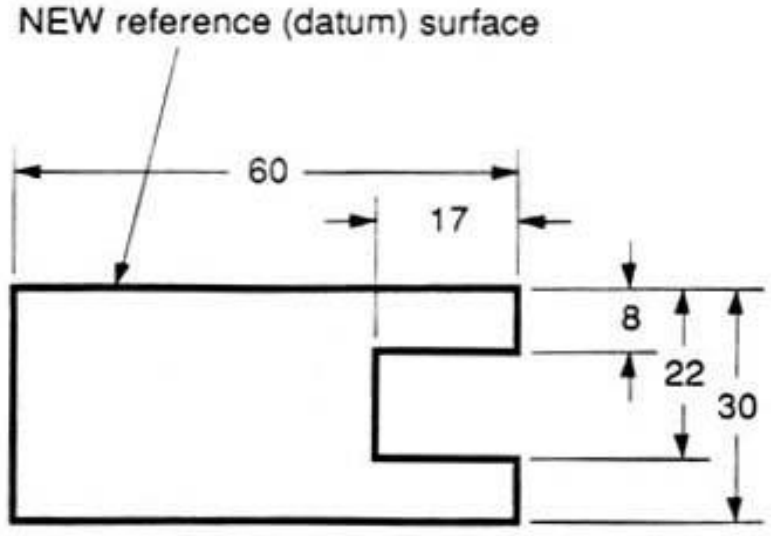


Figure 28 - Surface datum example

Dimensioning

- In figure 29 we have shown a hole that we have chosen to dimension on the left side of the object. The Ø stands for "diameter".

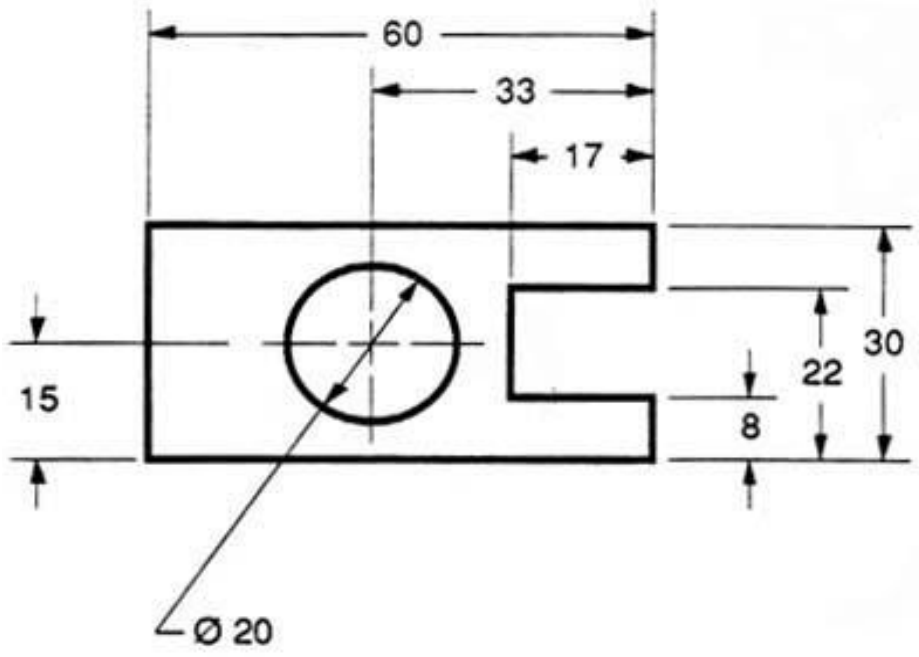


Figure 29 - Exampled of a dimensioned hole

Dimensioning

- When the left side of the block is "radiuses" as in figure 30, we break our rule that we should not duplicate dimensions. The total length is known because the radius of the curve on the left side is given. Then, for clarity, we add the overall length of 60 and we note that it is a reference (REF) dimension. This means that it is not really required.

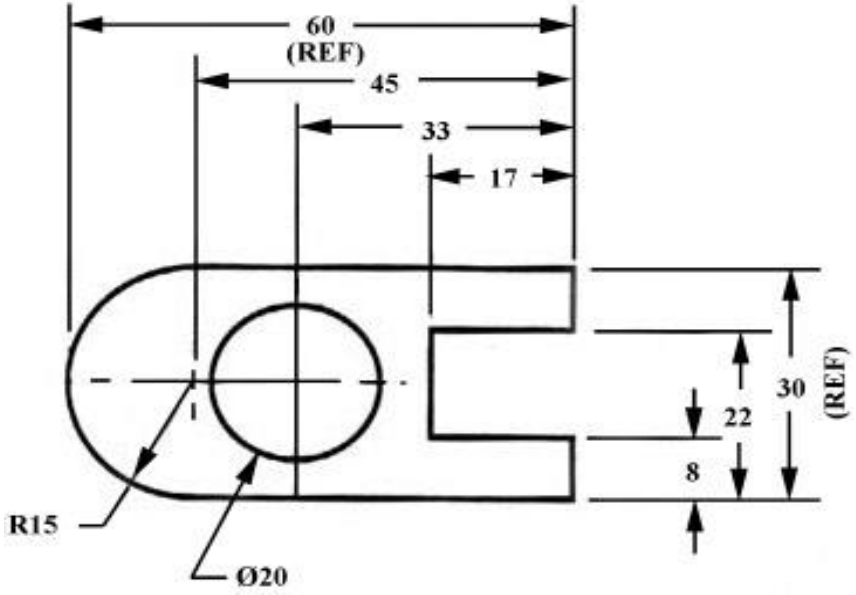


Figure 30 - Example of a directly dimensioned hole

Dimensioning

- This drawing is symmetric about the horizontal centerline. Centerlines (chain-dotted) are used for symmetric objects, and also for the center of circles and holes. We can dimension directly to the centerline, as in figure 31. In some cases this method can be clearer than just dimensioning between surfaces.

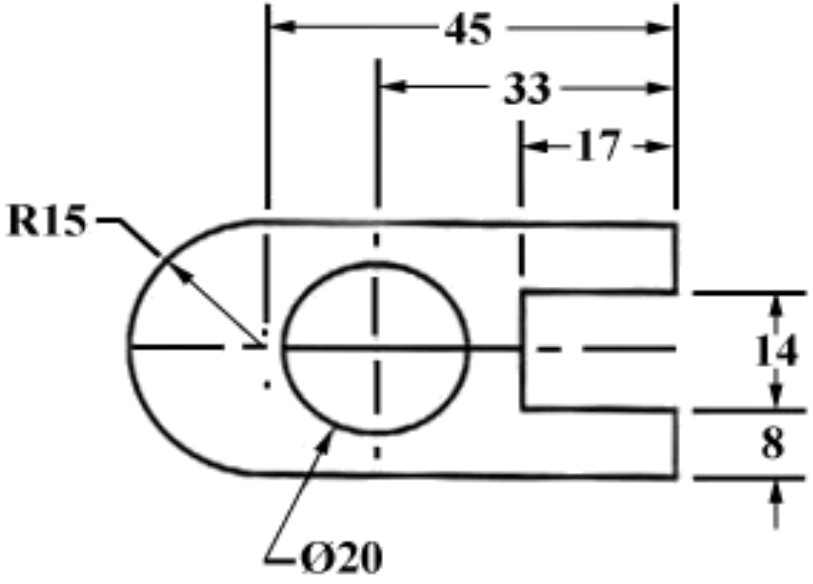


Figure 31 - Example of a directly dimensioned hole