



# Engineering Graphics

Class 2

Drafting Instruments

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# Drafting Instruments

A Design is as good as its instruments

A engineering drawing is a highly stylized graphic representation of an idea. The idea might be of something that we can see such a real or virtual object, space or environment. In some cases, such as an electronic schematic diagram for example, the drawing will bear no visual resemblance to the physical object that will be built from the information it provides.

# Drafting Instruments

A Design is as good as its instruments



Conventional



CAD

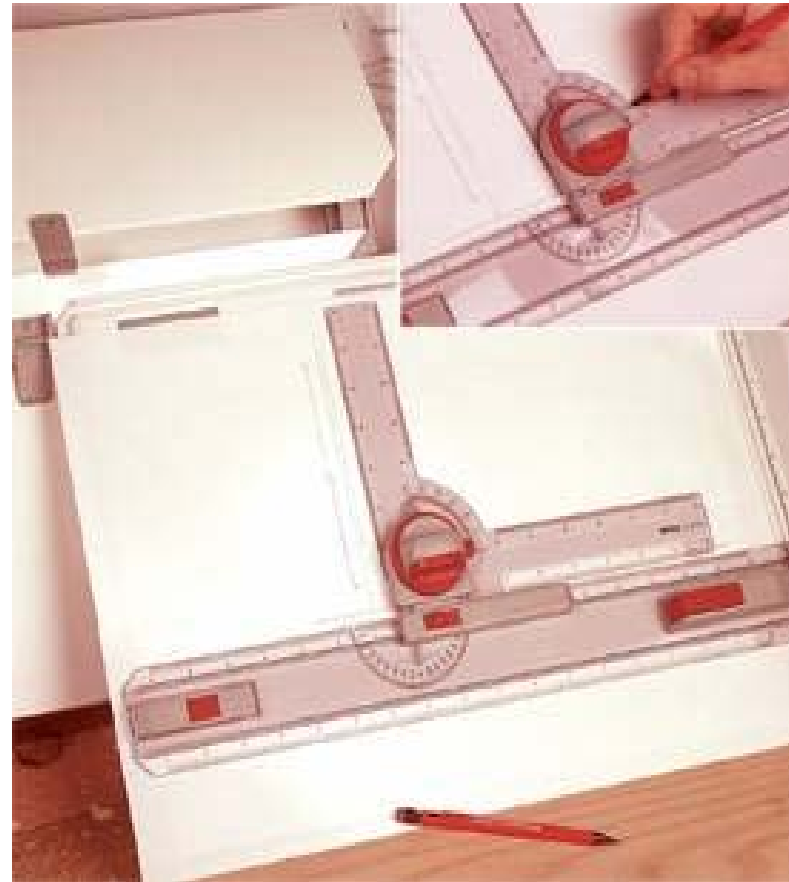
# Conventional Drafting Tools



# Drawing Board



Drawing Table



Drafting Board

# Drawing Board

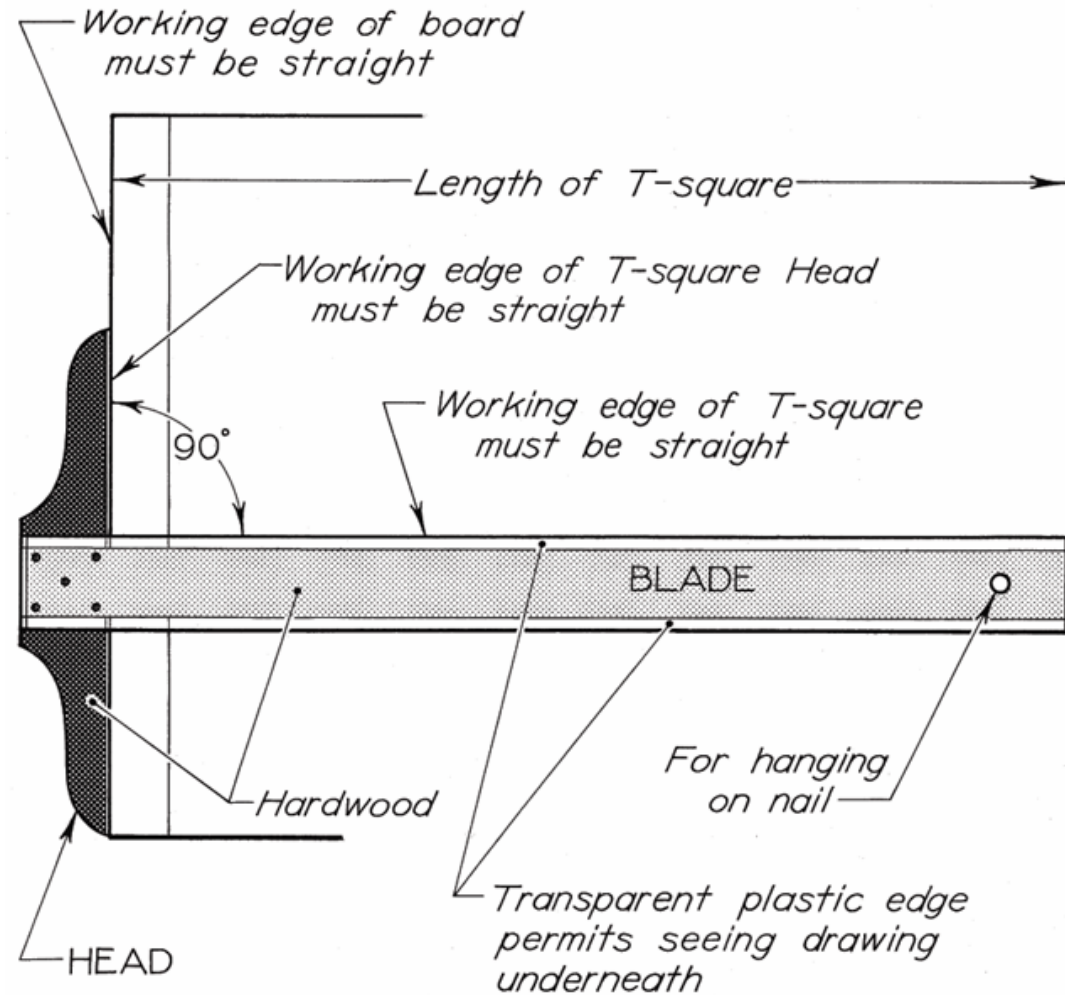
- ❑ Available in a variety of styles and sizes. Most are adjustable up and down, and can tilt to almost any angle from vertical  $90^\circ$  to horizontal
- ❑ The drawing surface must be clean, flat, smooth, and large enough to accommodate the drawing and some drafting equipment.
- ❑ If a T-square is to be used, at least one edge on the board must be absolutely true.
- ❑ Most quality boards have a metal edge to ensure against warping and to hold the T-square securely



Drawing Table with a  
Drafting machine

# T-Square

- ❑ It provides a parallel straight edge for the beginning drawing drafter.
- ❑ It is composed of two parts: the head and the blade. The two parts are fastened together at an exact right angle.
- ❑ The blade must be straight and free of any necks and imperfections.



# T-Square

- ❑ Used to draw horizontal lines on the drawing sheet.
- ❑ Used to draw vertical lines and slanted lines with the help of additional equipment basically  $45^\circ$  and  $60^\circ$  triangles.
- ❑ Draw lines only against the upper edge of the blade. Make sure the head is held against the left edge of the drawing board to guarantee parallel lines.
- ❑ Use a T-square to align the drawing paper to the drawing board, and to draw parallel horizontal lines on the paper.

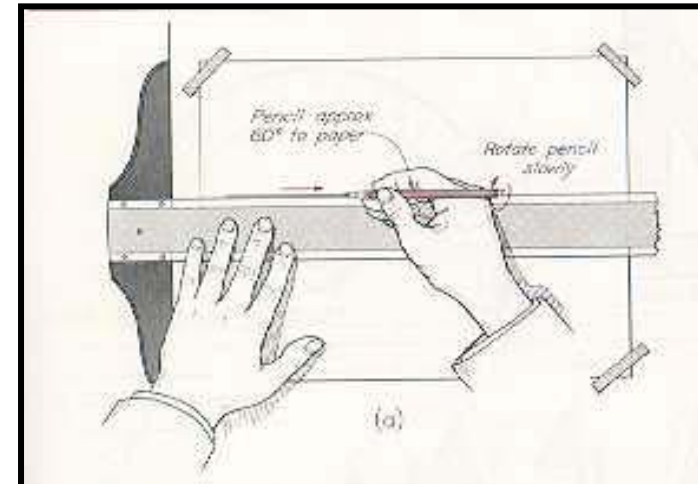


Fig. 2.20 Drawing a Horizontal Line.

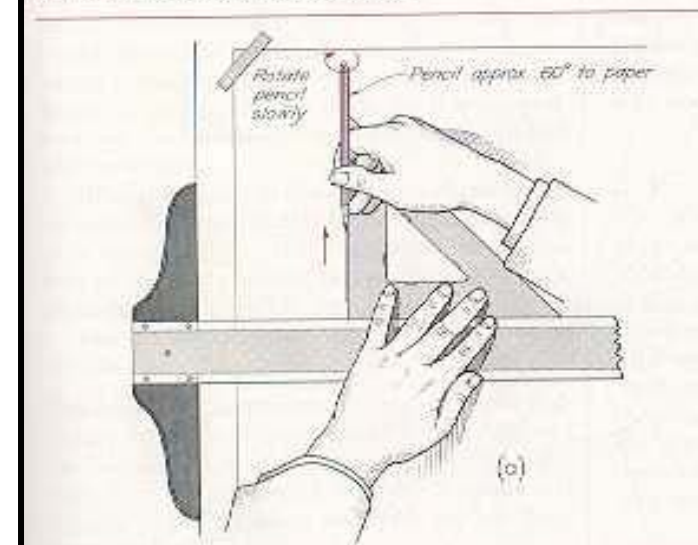
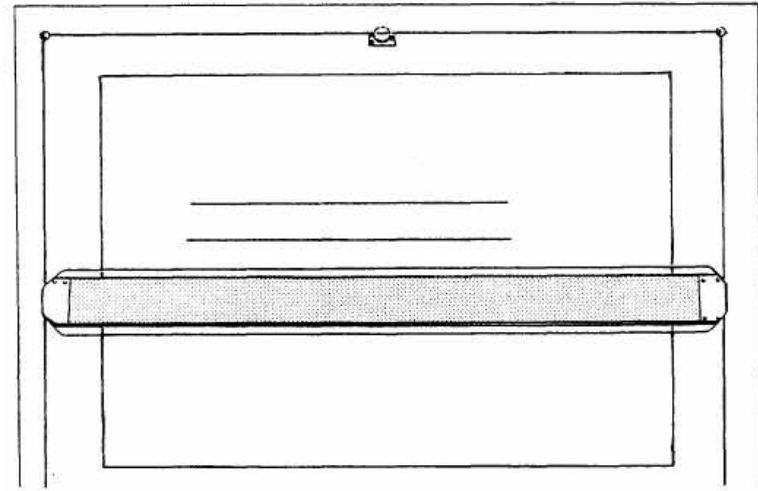


Fig. 2.21 Drawing a Vertical Line.

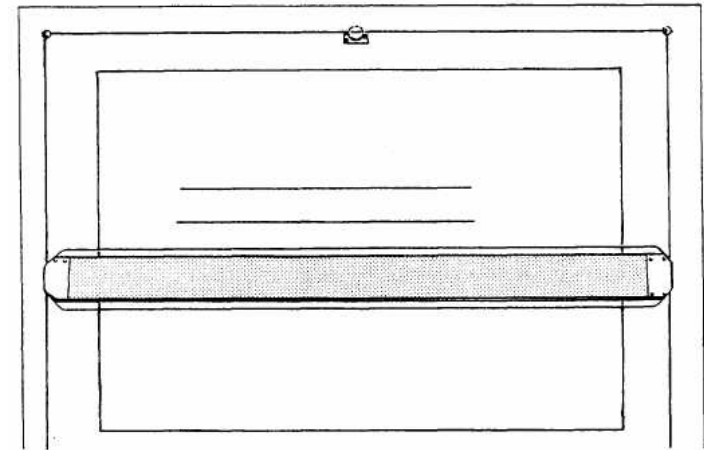
# Parallel Straight Edge

- ❑ A parallel straightedge is a laminated maple blade with transparent plastic edges similar to those on the T square. Its primary purpose is the same as the T square.
- ❑ The parallel straightedge uses a system of cords and pulleys so that it is supported at both ends by a cord tacked to the drawing board.
- ❑ You can move the straightedge up or down the board with pressure at any point along its length and maintain parallel motion automatically.



# Parallel Straight Edge

- ❑ The straightedge is locked into place by turning the cord lock clockwise. This permits use of the straightedge on an inclined board. It also prevents accidental movement when you are inking or using mechanical lettering devices.
- ❑ The advantages of the parallel straight-edge become particularly significant when you are working on large drawings. While the T square works well for small work, it becomes unwieldy and inaccurate when you are working on the far right-hand side of large drawings



# Drafting Machine

- ❑ The standard drafting machine combines the functions of a parallel ruler, protractor, scales, and triangles. Various drafting operations requiring straight and parallel lines may be performed advantageously with a drafting machine.
- ❑ The majority of drafting machines are constructed so that the protractor head may be moved over the surface of a drafting table without change in orientation by means of a parallel-motion linkage.

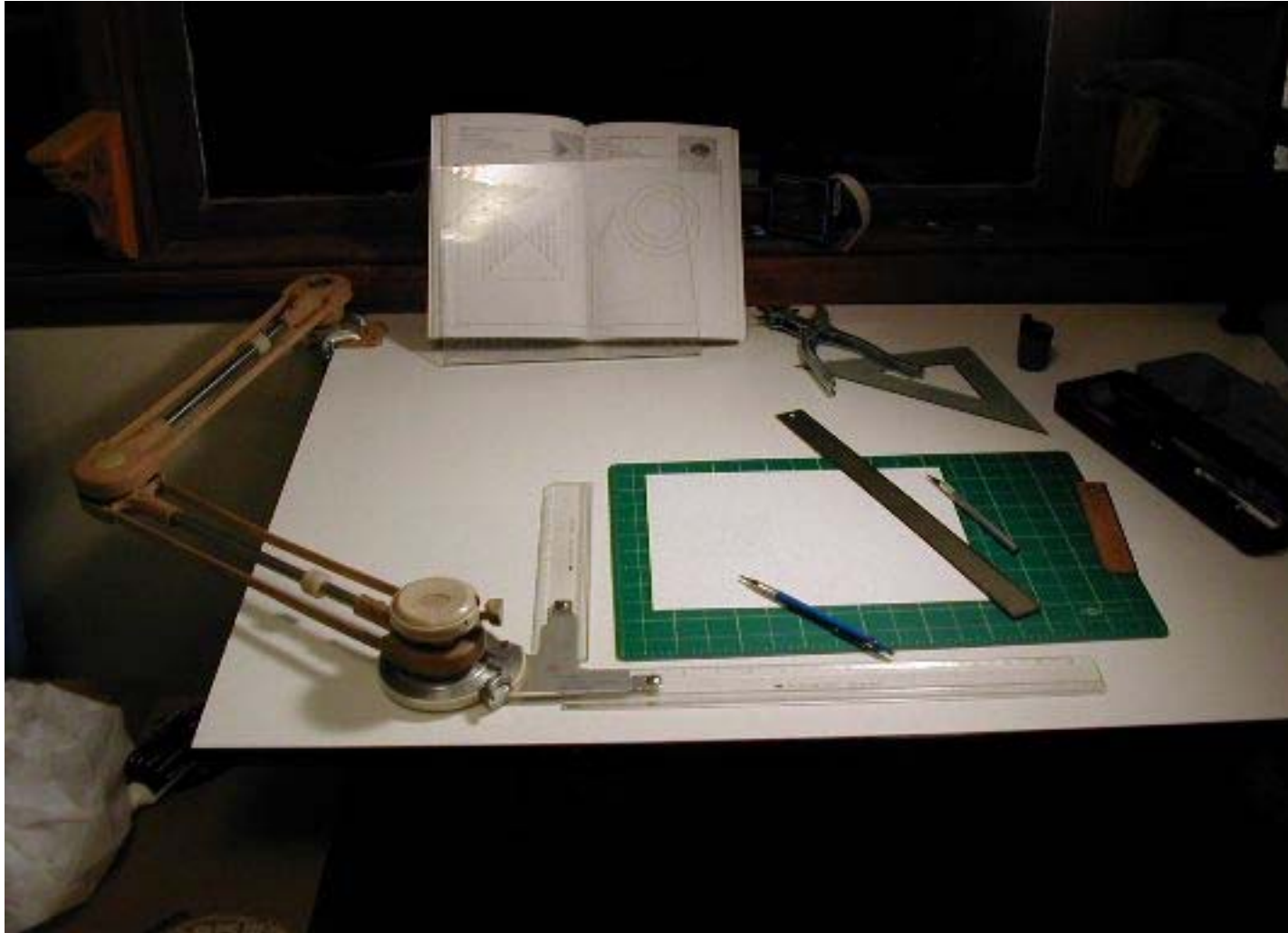


# Drafting Machine

- ❑ A drafting machine is a device that attaches to the drafting table and replaces the T-square, triangles and protractors.
- ❑ They increase the accuracy and greatly reduce drafting time.
- ❑ Most drafting machines have a protractor and a vernier which permits reading to 5 minutes of an arc.



# Drafting Machine



# Pivot Compass

- ❑ A compass is used mainly to draw circles and circular curves of relatively short radius .
- ❑ The large pivot joint compass is satisfactory for drawing circles of 25 mm to about 300 mm in diameter without an extension bar.
- ❑ The pivot joint provides enough friction to hold the legs of the compass in a set position. One of the legs is equipped with a setscrew for mounting either a pen or a pencil attachment on the compass.
- ❑ The metal point extends slightly more than the lead to compensate for the distance the point penetrates the paper.



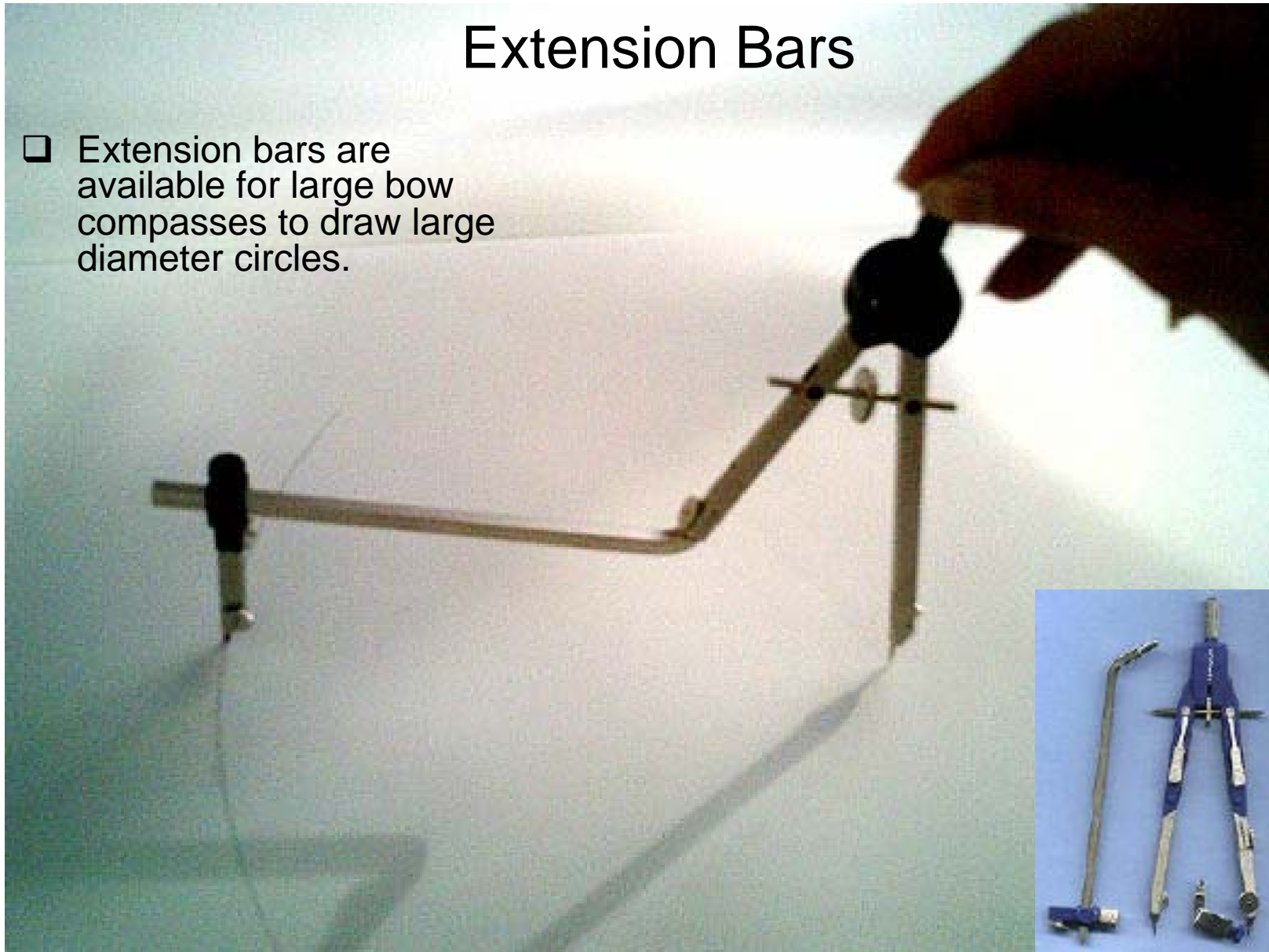
# Bow Compass

- ❑ The other type of compass is the bow compass. Many experienced draftsmen prefer the bow compass over the pivot joint compass.
- ❑ The bow compass is much sturdier and is capable of taking the heavy pressure necessary to produce opaque pencil lines without losing the radius setting.
- ❑ Most compasses have interchangeable needle-points. The conical or plain needlepoint is used when the compass is used as dividers.

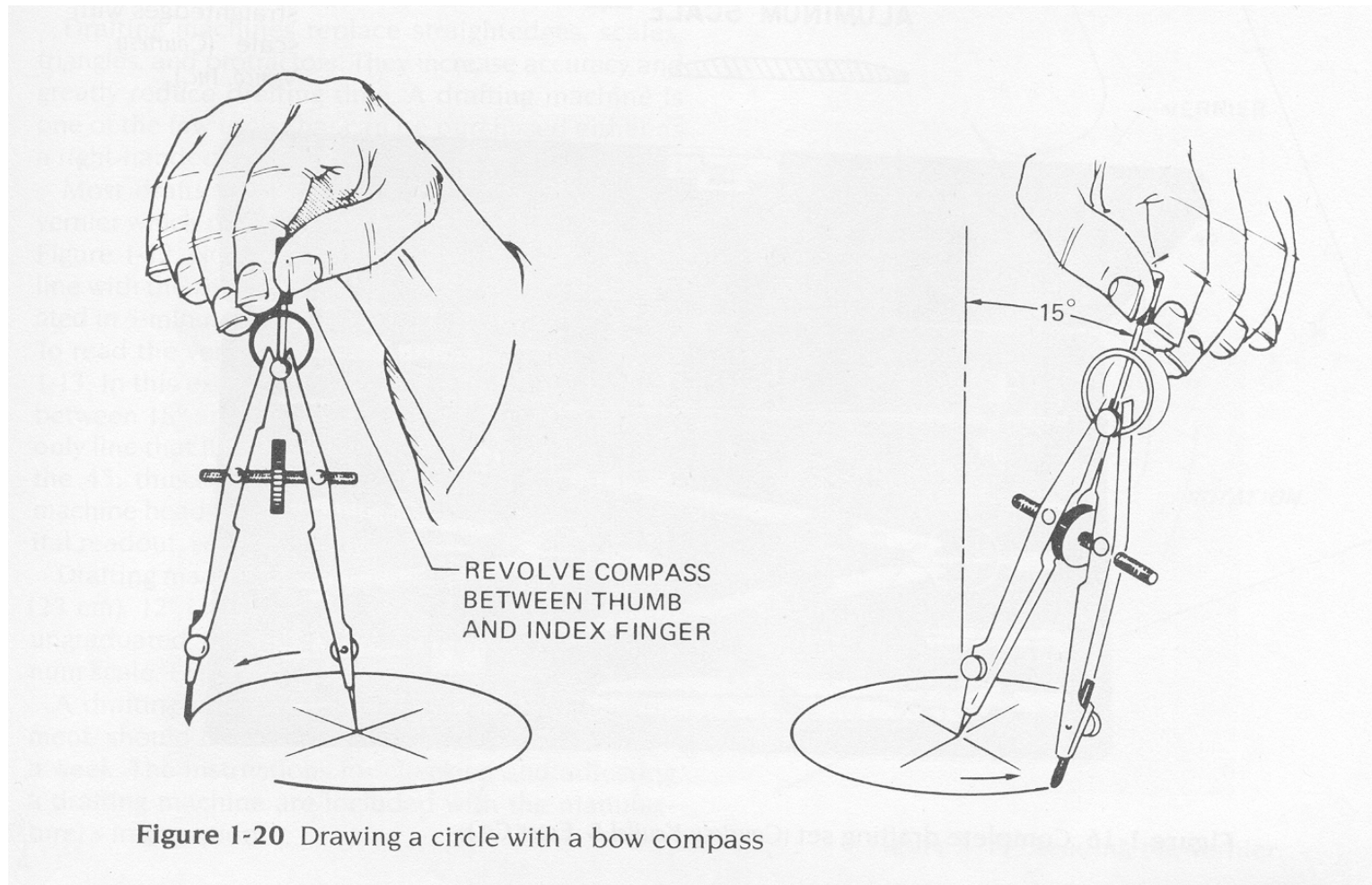


# Extension Bars

- ❑ Extension bars are available for large bow compasses to draw large diameter circles.



## Using the compass to draw a circle



To draw a circle with the bow compass, the compass is revolved between the thumb and the index finger.

# Compass Center Disk

- ❑ When many circles are drawn using the same center, the compass needle may tend to bore an oversized hole in the drawing. To prevent these holes, use a device called a horn center or center disk. This disk is placed over the center point. The point of the compass needle is then placed into the hole in its center



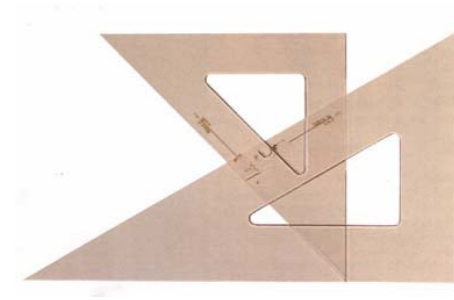
# Divider

- ❑ Dividers are similar to compasses, except that both legs are provided with needle points.
- ❑ As with compasses, dividers are available in large and small sizes, and in pivot joint, and bow types.
- ❑ Pivot joint dividers are used for measurements of approximately 20 mm or more.
- ❑ For measurements of less than 20 mm, bow dividers should be used.
- ❑ Dividers are used to transfer measurements. to step off a series of equal distances, and to divide lines into a number of equal parts
- ❑ A divider is similar to a compass, except that it has a metal point on each leg.
- ❑ It is used to lay off distances and to transfer measurements.



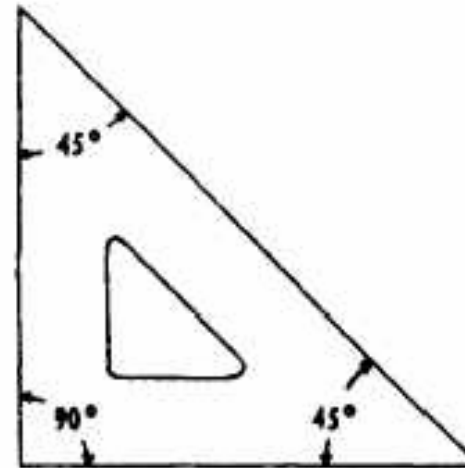
# Triangles

- ❑ Triangles are used in combination with the T square or straightedge to draw vertical and inclined lines. They are usually made of transparent plastic, which allows you to see your work underneath the triangles.
- ❑ Two standard triangles are used by the drafters. One is the 30-60-degree triangle. The other is the 45-degree triangle.
- ❑ When laying out lines, triangles are placed firmly against the upper edge of the T-square. Pencils are placed against the left edge of the triangle, and lines drawn upwards, away from the edge.
- ❑ Parallel angular lines are made by moving the triangle to the right after each new line has been drawn.

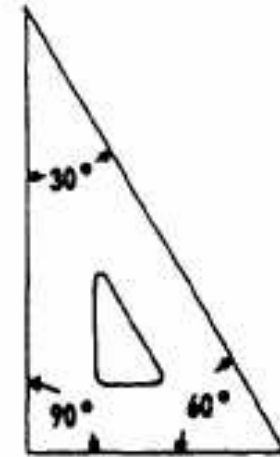


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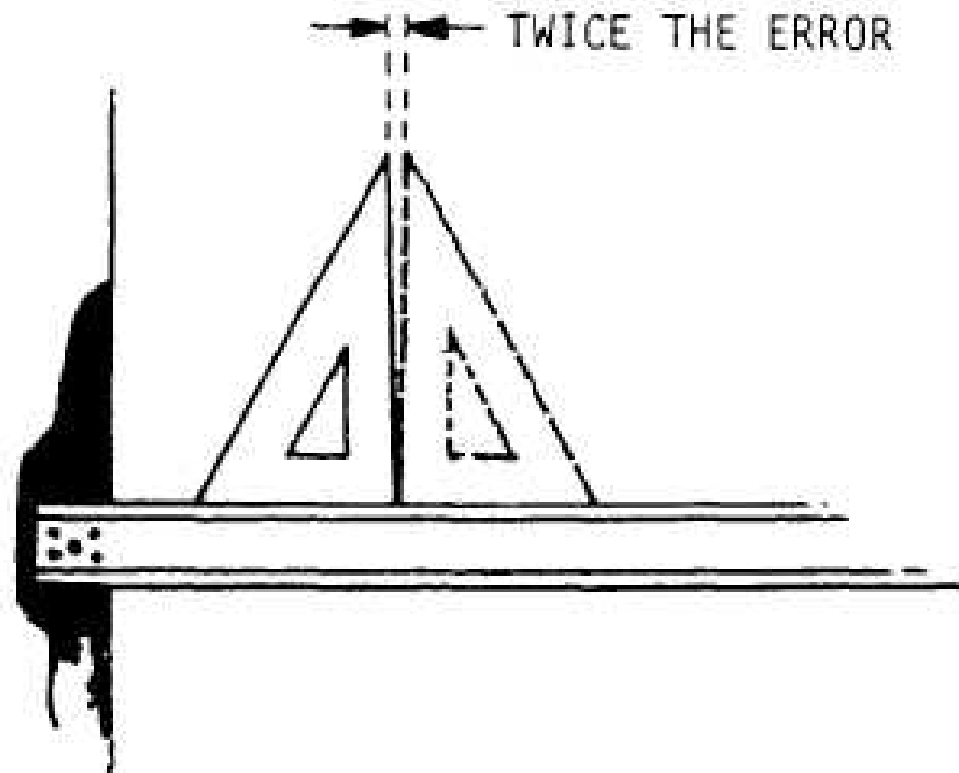
**45° TRIANGLE**



**30°/60° TRIANGLE**

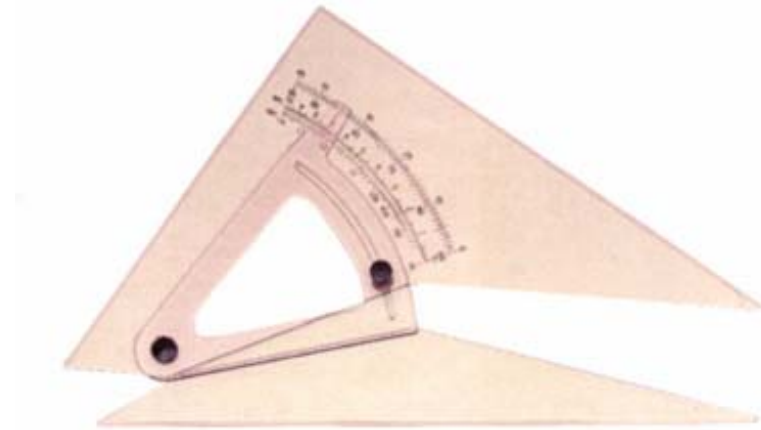
# Triangles

- ❑ To test the straightness of a triangle, place it against the T square and draw a vertical line, then reverse the triangle and draw another line along the same edge. If the triangle is straight, the two lines will coincide; if they don't coincide, the error is half the resulting space



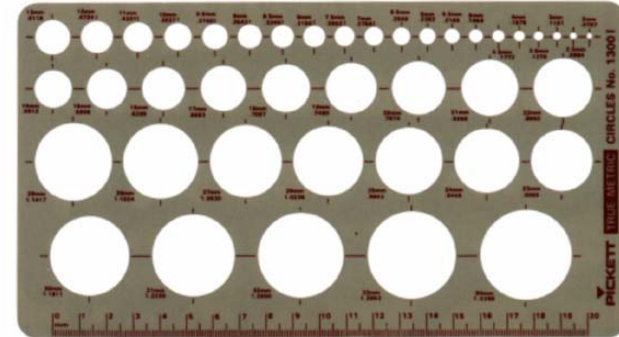
# Adjustable Triangle

- ❑ The adjustable triangle combines the functions of the triangle and the protractor. When it is used as a right triangle, the hypotenuse can be set and locked at any desired angle to one of the bases.
- ❑ The transparent protractor portion is equivalent to a protractor graduated in  $1/2^\circ$  increments.
- ❑ By holding either base against a T-square, you can measure or draw any angle between  $0^\circ$  and  $90^\circ$ .
- ❑ The adjustable triangle allows you to transfer parallel inclined lines by sliding the base along the T square or straightedge. An adjustable triangle may take place of both the  $30^\circ$ - $60^\circ$  and  $45^\circ$  triangles.
- ❑ It is recommended that this tool be used for drawing angular lines that can not be made with the two standard triangles. The adjustable triangle is not as accurate as the solid triangle.

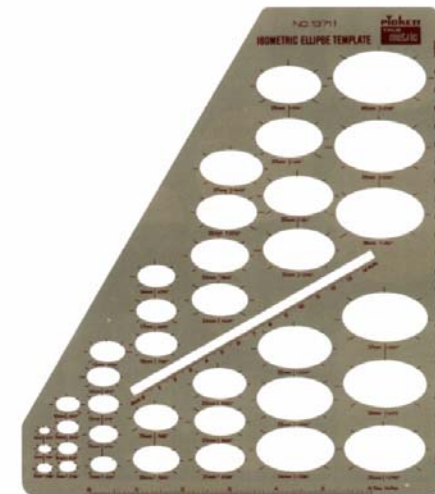


# Drawing Templates

- ❑ A template is a thin, flat piece of plastic containing various cutout shapes. It is designed to increase the speed and accuracy of the drafter.
- ❑ Templates are available for drawing circles, ellipses, plumbing fixtures, bolts, nuts, screw threads, electronic symbols, springs, gears and much more.
- ❑ A template should be used whenever possible to increase the accuracy and the speed.

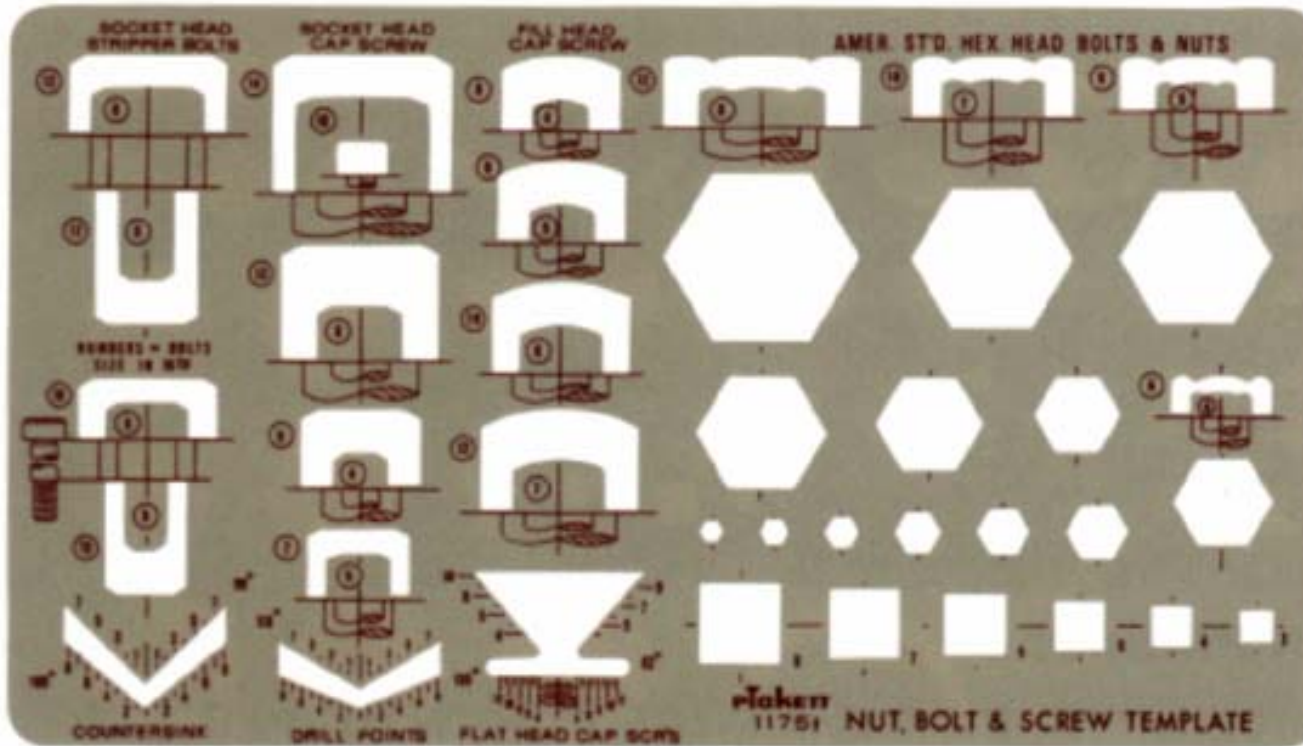


Circle Template



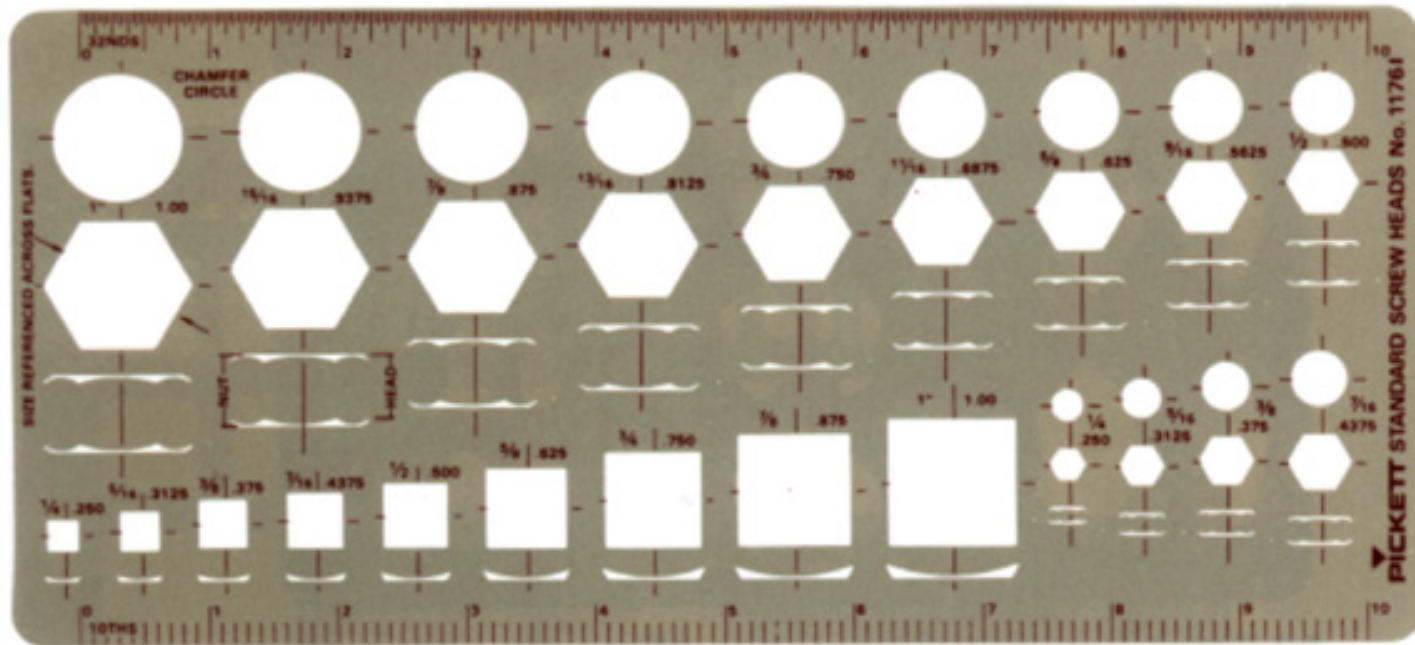
Ellipse Template

# Drawing Templates



Nut, Bolt and Screw Template

# Drawing Templates



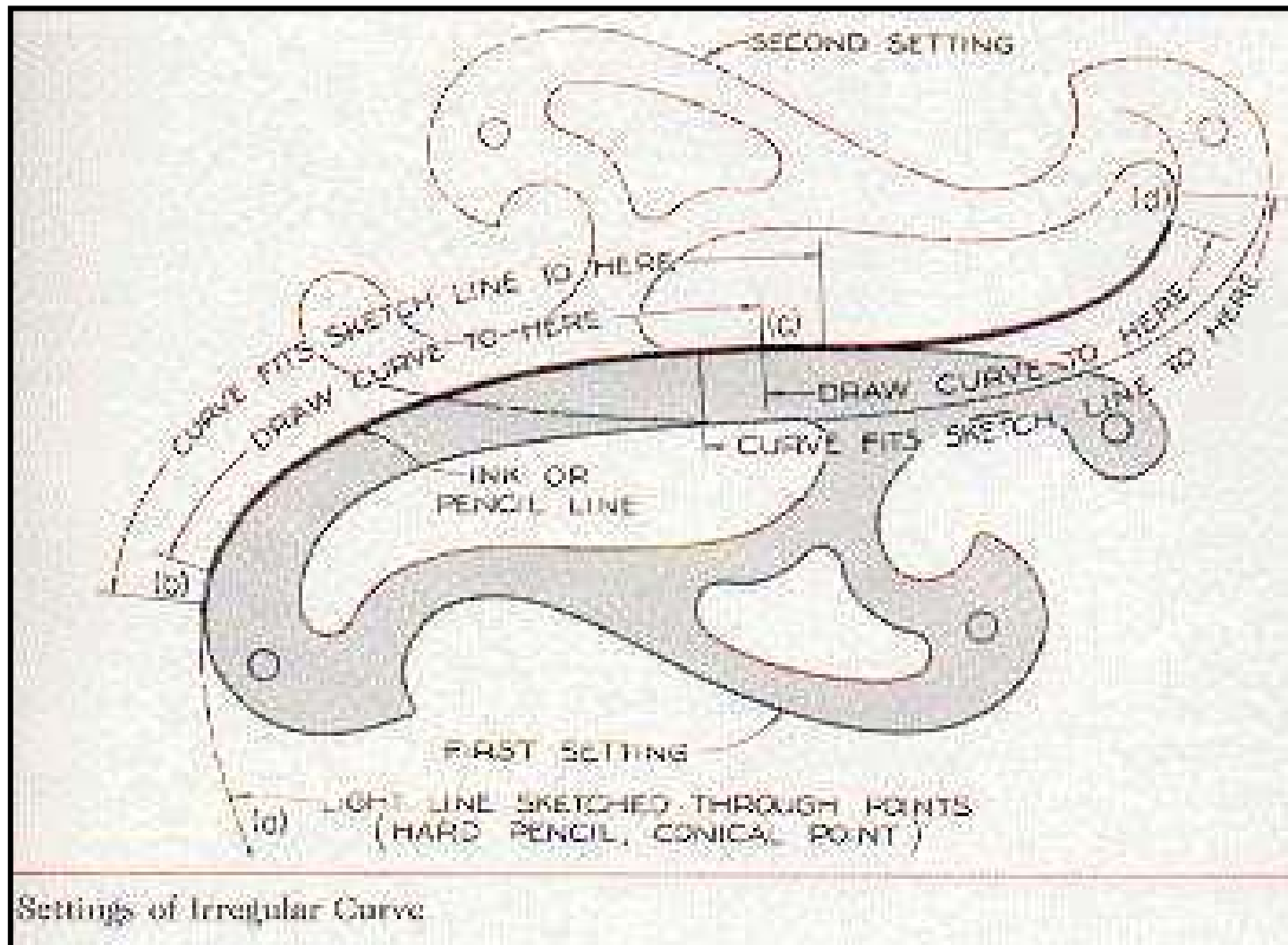
Screw Heads Template

# French Curves and Flex Curves

- ❑ French curves are thin plastic tools that come in assortment of curved surfaces. They are used to produce curved lines that cannot be made by a compass.
- ❑ Most common French curves are actually segments of ellipses, parabolas and hyperbolas.
- ❑ Adjustable curves may also be used to create a smooth curve between a set of points.

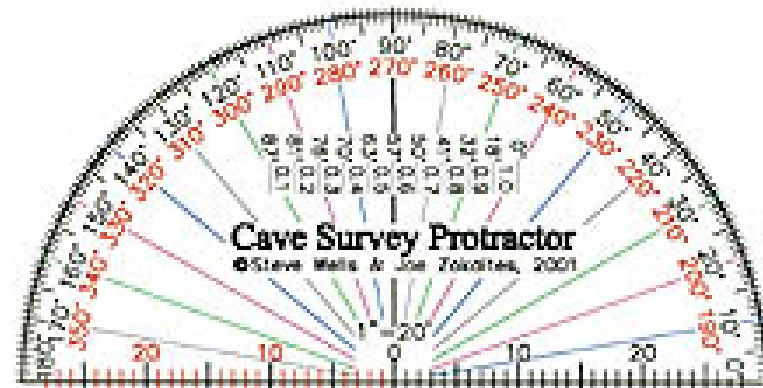
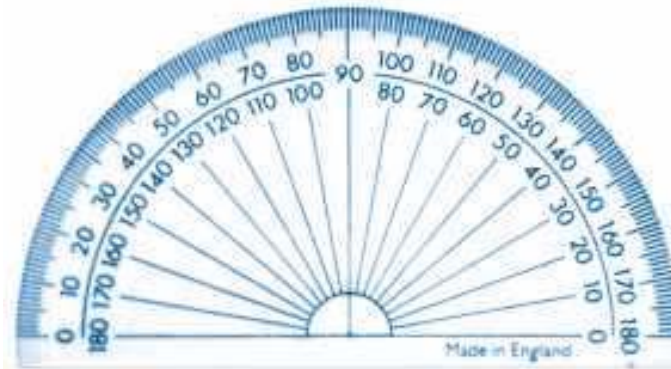


# French Curves and Flex Curves



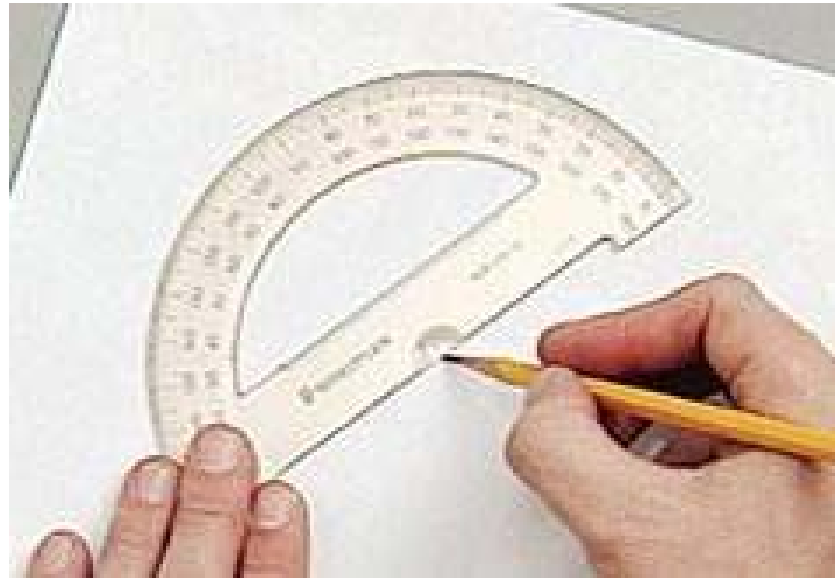
# French Curves and Flex Curves

- ❑ Protractors are used for measuring and laying off angles other than those that may be drawn with the triangle or a combination of triangles.
- ❑ Like the triangle, most protractors are made of transparent plastic. They are either circular or semicircular in shape.



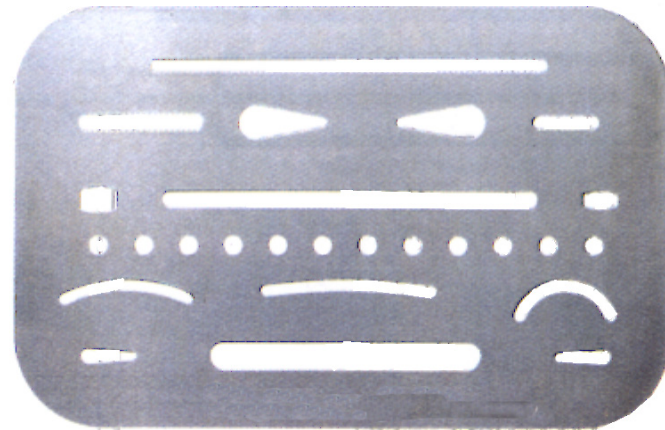
# French Curves and Flex Curves

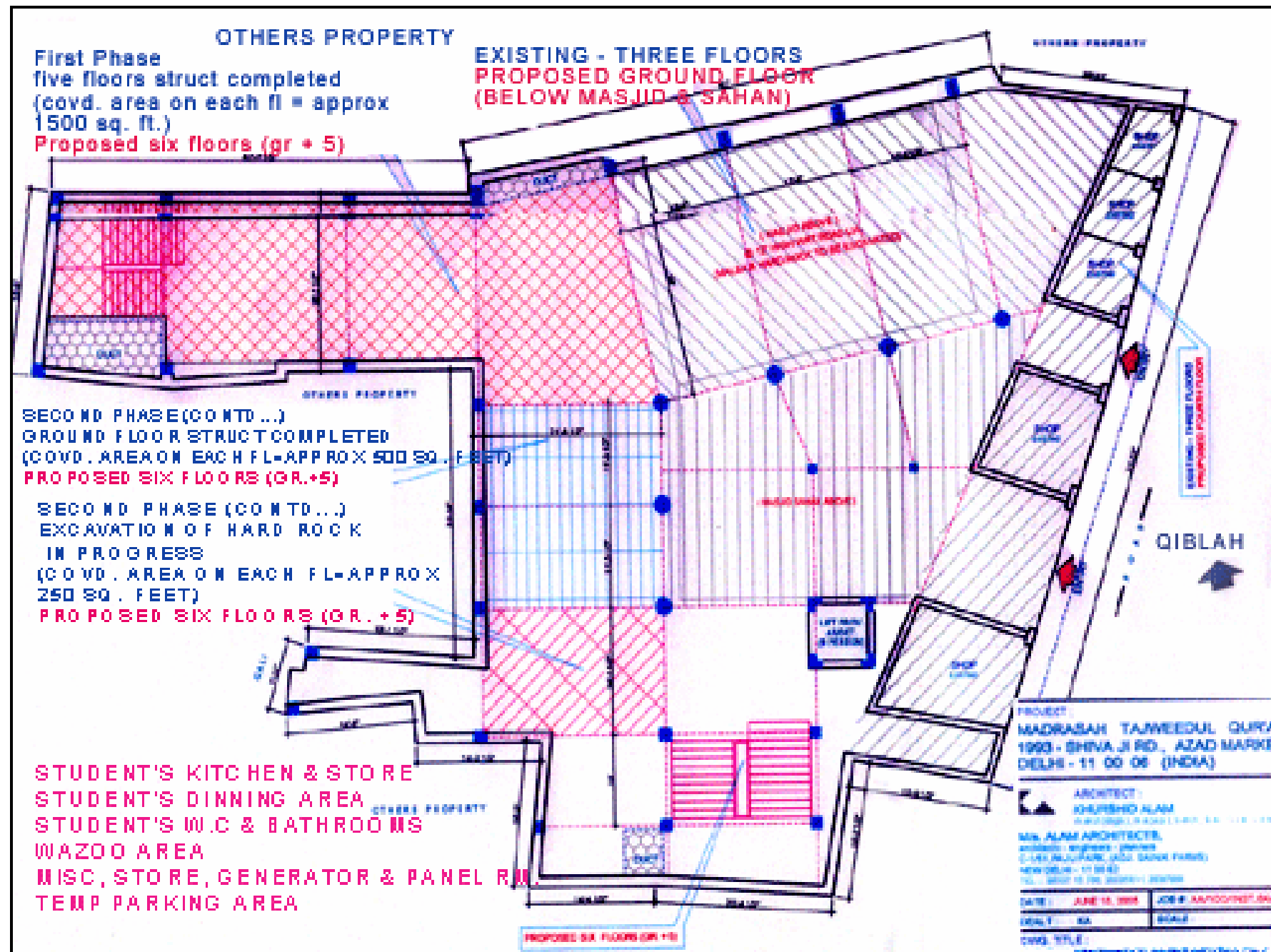
- ❑ To use a protractor, place the center point on the corner point of the angle. Align the base of the protractor along one side of the angle. The degrees are read along the semicircular edge.

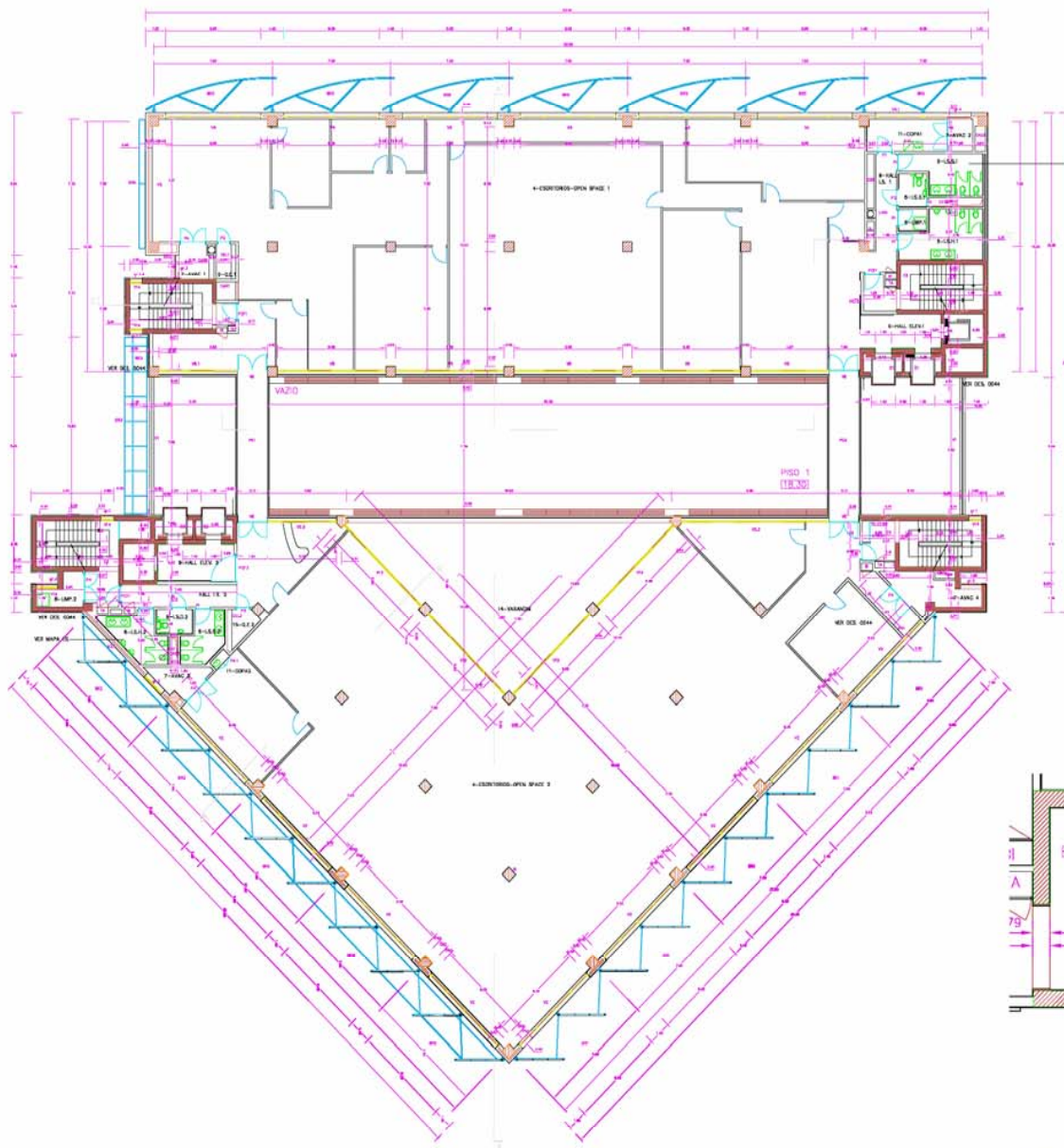


# Erasing Shield

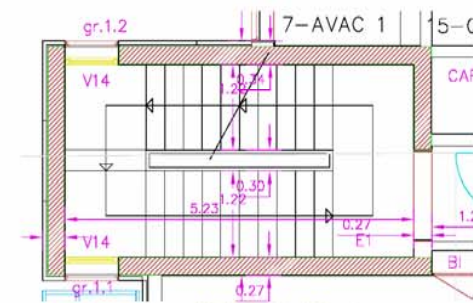
- ❑ An erasing shield restricts the erasing area so that the correctly drawn lines will not be disturbed during the erasing procedure.
- ❑ It is made from a thin flat piece of metal with variously sized cutouts.
- ❑ The shield is used by placing it over the line to be erased and erasing through the cutout.



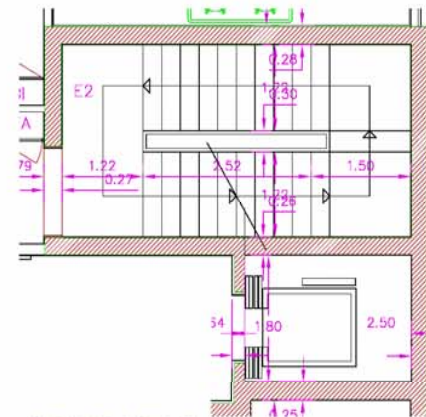




FIRST FLOOR  
ESCALA 1:10



STAIRCASE 1  
FLOOR 1 SCALE 1:40  
NOTE: VER DES. 624 A 626



STAIRCASE 2  
FLOOR 1 SCALE 1:40  
NOTE: VER DES. 624 A 626

Colégio Afonso de Albuquerque S.R.L. (Rua 18 de Maio de 1910, 1810-001, Lisboa, Portugal)

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Contratado: AFONSO DE ALBUQUERQUE S.R.L. (Rua 18 de Maio de 1910, 1810-001, Lisboa, Portugal)

Revisão: Descrição: Data: 18/03/2016

Elaborado: João de Almeida

Projectado/Elaborado: arquitectura ANDRÉ DE ALMEIDA

Autor do Projecto: JOÃO DE ALMEIDA Ref. do Autor: Proj.: Des.: Ver.: Aprov.: 18/03/2016

Título do Projecto: SUBSTITUIÇÃO DE ESCALAS DO EDIFÍCIO DOS SERVIÇOS ADMINISTRATIVOS

Nome do Cliente: EXPO'88

Endereço: ARQUITECTURA Tipo: D.E.S.

Zona: EDIFÍCIO DOS SERVIÇOS ADMINISTRATIVOS Escala: 1:100

Título: PROJECTO DE EXECUÇÃO PLANTA DO PISO 1 Data: 18/03/2016

Nome do Escalante: Escalante: 0005.1 Revisão: E.D.B.

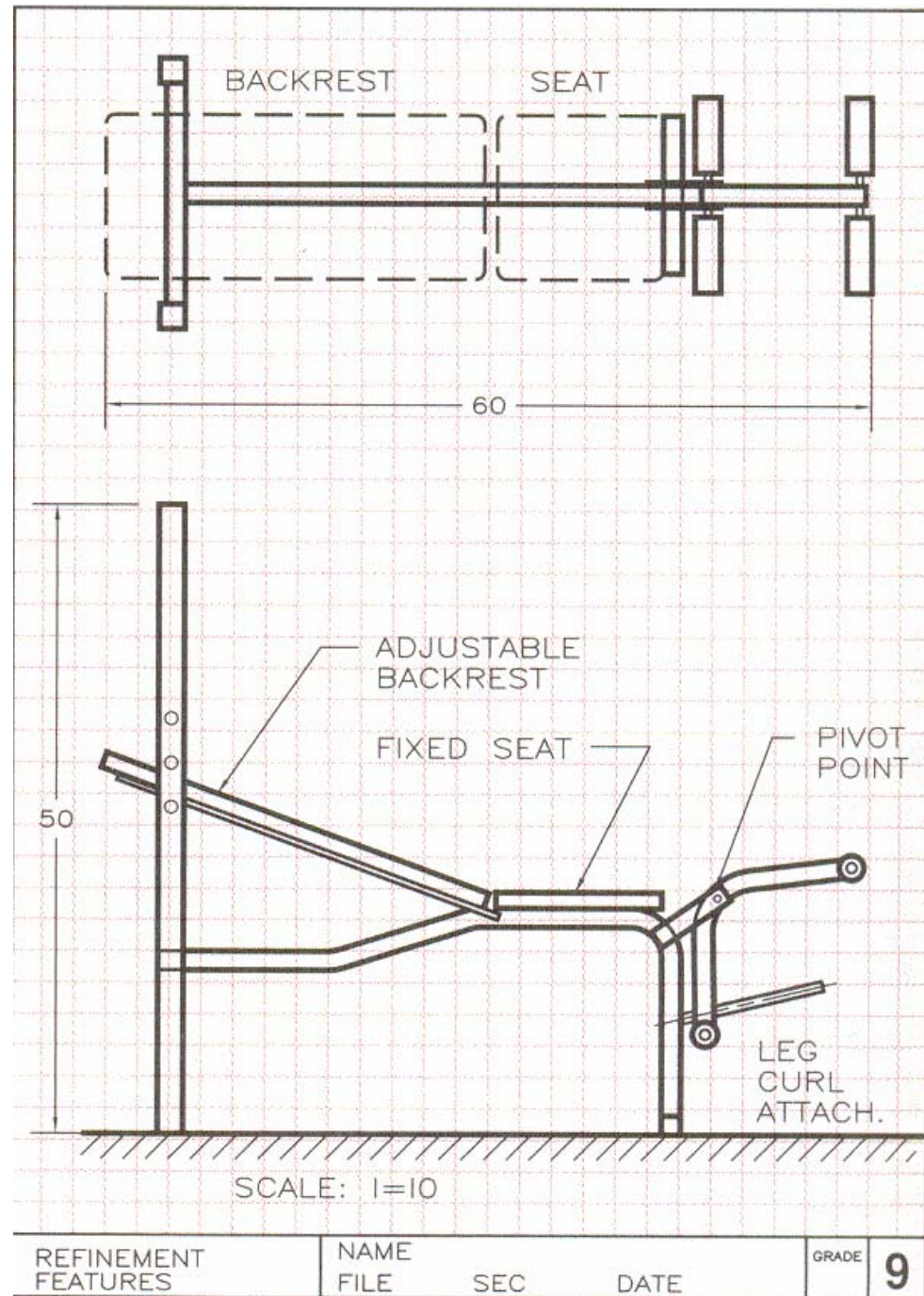
# Scales in Engineering Drawing

On drawing

On Site

Scale: 1=10

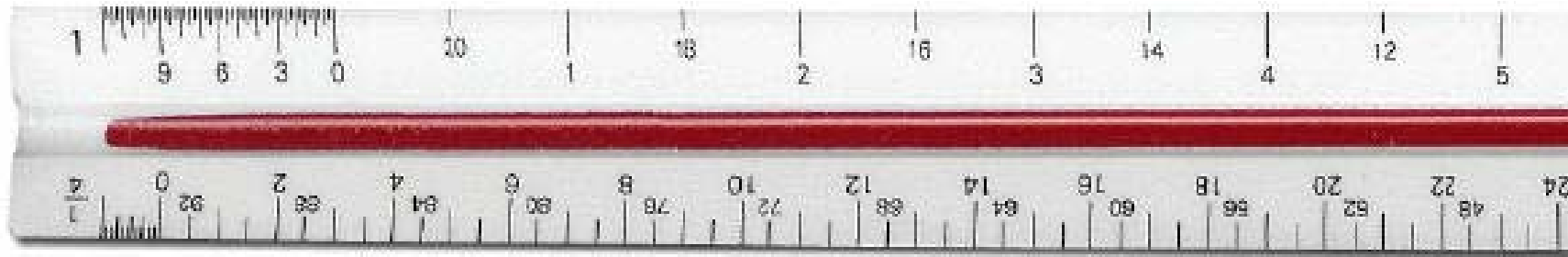
Scale 1:10



# Metric Scales



# Inches Scales



# Wooden Pencils Grades



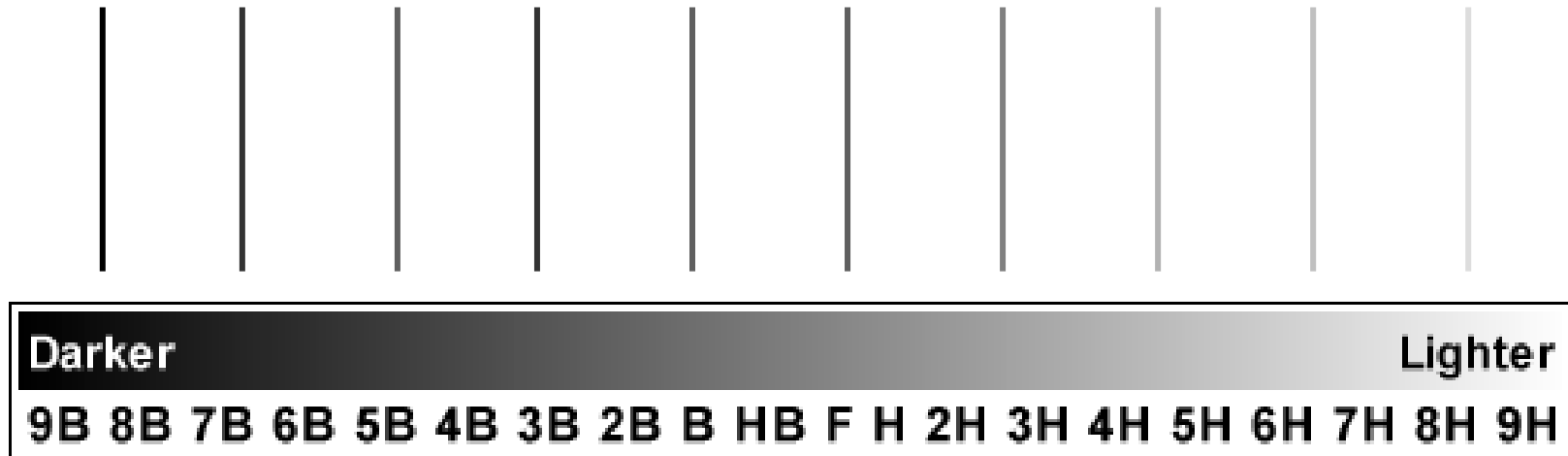
Softest

Hardest

SOFT						MEDIUM					HARD					
6B	5B	4B	3B	2B	B	HB	F	H	2H	3H	4H	5H	6H	7H	8H	9H



# Pencil Grades



Softest

Hardest



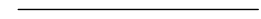
# Pen Sizes and Line Weights

Line weights are a vital part of conventional technical graphics language. They are embodied to the extent of being defined in national and international standards. In manual drafting, different pen sizes allow the drafter to give different line weights to the lines in the drawing.

Line types and line weights allow drawings to communicate information that would otherwise be very difficult to convey. For example:

- Hidden outlines
- Paths of motion
- Planes of symmetry
- Fictitious outlines such as major and minor diameters of screw threads
- Dimensions and projections
- Materials (hatching)
- Centers and imaginary intersections

0.13



0.18



0.25



0.3



0.5



0.7



1.0



1.2



1.4












2.0



# Pen Sizes

Conventional practice is that only two different line weights be used on any one drawing. This is subject to discretion and some disciplines regularly use three, and occasionally four.

Different line weights. Consistency and clarity of communication are the deciding factors. You could use 10 line weights in a drawing provided everyone understood what they all meant and the document was consistent.








0.18	
0.25	
0.3	
0.5	
0.7	
1.0	
1.2	
1.4	
2.0	


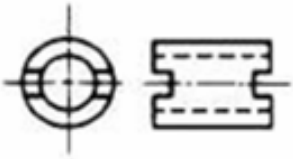

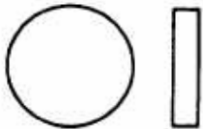



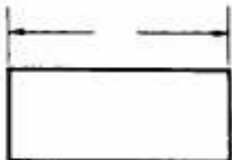

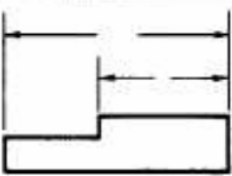
# Pen Sizes

Line weight groups chosen for most engineering drawings are selected from adjacent pen thicknesses (in mm). The table below indicates line weight groups for various sheet sizes. Pen thickness are shown in mm.

0.18	A4, A2, A3		
0.25		A1	
0.35			A0
0.50			
0.70			
1.00			
1.40			
2.00			

# Line Types

Line type	Thickness		Example	Application
	Fine	Thick		
Continuous thick	0.35	0.50		Visible outlines, existing features, cut edges, general line work
Continuous medium	0.25	0.35		Used where another level of line weight would assist the delineation e.g. internal line work, notes
Continuous thin	0.18	0.25		Fictitious outlines, imaginary intersections and projections, hatching, dimensions, break lines
Dashed thick	0.35	0.50		Hidden outlines and edges
Dashed thin	0.18	0.25		
Chain thick	0.35	0.50		Indication of special surface requirements or (sometimes with a text component) to indicate pipelines and services
Chain thin	0.18	0.25		Center lines, motion paths, indication of repeated detail

LINE STANDARDS			
NAME	CONVENTION	DESCRIPTION AND APPLICATION	SAMPLE
CENTER LINES		<p>THIN LINES MADE UP OF LONG AND SHORT DASHES ALTERNATELY SPACED AND CONSISTENT IN LENGTH</p> <p>USED TO INDICATE SYMMETRY ABOUT AN AXIS AND LOCATION OF CENTERS</p>	
VISIBLE LINES		<p>HEAVY UNBROKEN LINES</p> <p>USED TO INDICATE VISIBLE EDGES OF AN OBJECT</p>	
HIDDEN LINES		<p>MEDIUM LINES WITH SHORT EVENLY SPACED DASHES</p> <p>USED TO INDICATE CONCEALED EDGES</p>	
EXTENSION LINES		<p>THIN UNBROKEN LINES</p> <p>USED TO INDICATE EXTENT OF DIMENSIONS</p>	
DIMENSION LINES		<p>THIN LINES TERMINATED WITH ARROWS HEADS AT EACH END</p> <p>USED TO INDICATE DISTANCE MEASURED</p>	

## Scales



Drawing Table



Adjustable Triangle