Blueprint Reading

Section 3

Introduction

Course Description:

This course provides a review and experiential exercises in interpreting technical drawings since they function as an important language in the manufacturing world. This course introduces students to the various sources of information found within technical drawings and provides practice interpreting various projections. Functions and application of linear dimensioning, tolerancing, lines and symbols, will be explored. Basic vocabulary, conversions between metric and inch/pound measurements, as well as scales and datums will be explored.

Course Objectives:

By successfully completing this course, participants will be able to:

- Identify orthographic, isometric, and sectional views and interpret key information on technical drawings
- Interpret mechanical/manufacturing blueprints per ASME Y14.5 Standards
- Demonstrate practical applications of this standard as applied to reading, interpreting, updating, and troubleshooting engineering production drawings
- Demonstrate an understanding of concepts learned through development of a hands on project (flute)

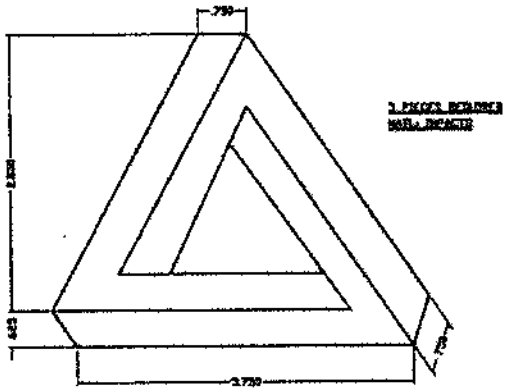
Course Prerequisites: Manufacturing Basics Unit 1

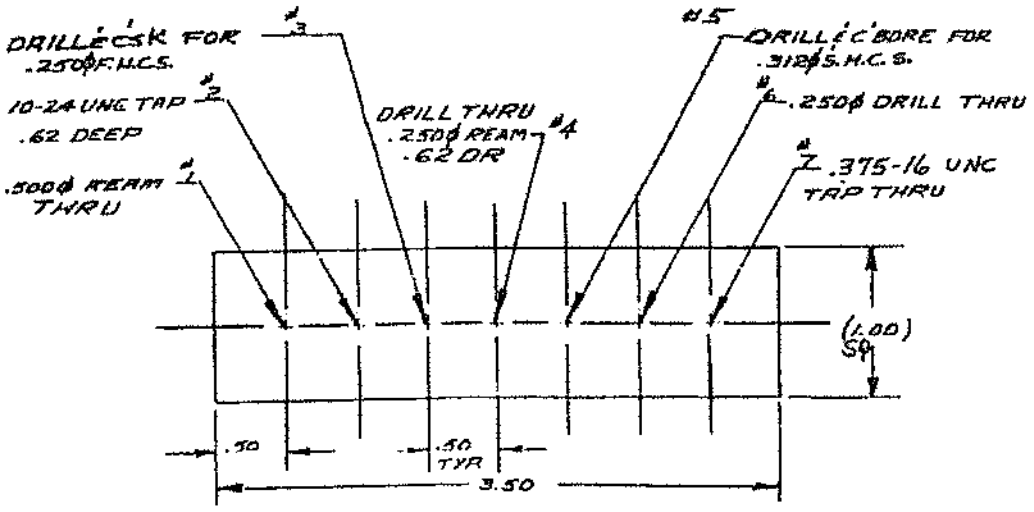
1 • What are Blueprints?

What are Blueprints?:

BLUEPRINTS

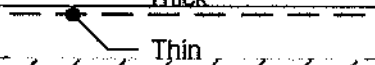
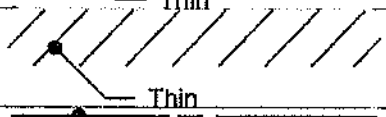
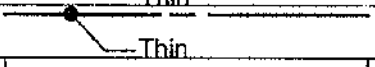
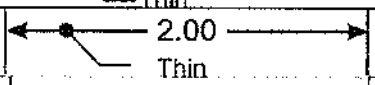
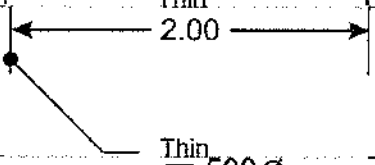
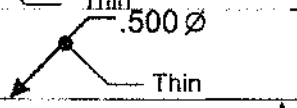
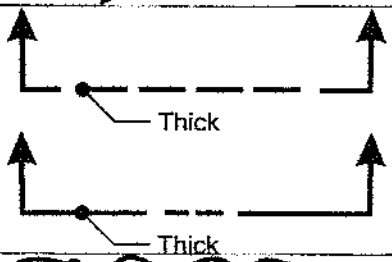
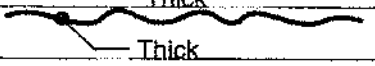
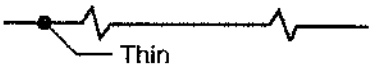
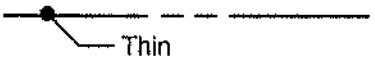
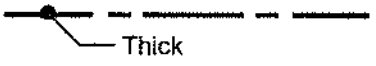
Most of us continue to use the term "blueprint" when referring to prints of engineering drawings, although today the majority of prints produced are actually "whiteprints." The true blueprint contained white lines on a blue background. Today the term "blueprint" can be interpreted as a drawing or picture of a part to be made along with the required sizes, tolerances, essential requirements, notes, and instructions necessary to produce the part. No matter how the drawing is created, whether by the latest CAD process or sketched on a piece of paper, if the drawing does not contain the correct information about the part to be made, then the part cannot be made. From the information contained on the drawings shown below, could you make these two parts?





1 • What are Blueprints?

Types of Lines used in Prints

Line Type	Definition	Drawing
Visible Lines	Represents visible edges	
Hidden Lines	Represents edges not visible in a given view	
Section Lines	Appears where the surface has been cut	
Center Line?	Indicates symmetry, center points, or axes	
Dimension Line	Denotes the extent of a dimension between arrowheads	
Extension Line	Extends the surface or point away from the view so dimensions can be added	
Leader Line	Drawn diagonally to direct a dimension or note to area where it applies	
Cutting- or Viewing-Plane Lines	Shows where imaginary cutting takes place to create a sectional view	
	Used with removed views to show where the view would normally appear	
Short break line	Terminates a view to conserve space	
Long break line	Allows removal of a long central portion of an object to shorten view. Usually used in pairs	
Phantom Line	Represents outline of an adjacent part; shows alternate position of a given part; or replaces repetiative detail	
Chain Line	Used to indicate the area or portion of surface to receive special treatment.	

1 • What are Blueprints?

Interpreting lines

Purpose: Introduce students to the types of lines used in technical drawings.

Equipment/Materials:

- Blue Print Reading Text
- Graph paper or blank paper
- Pencils
- Ruler with Inches and Centimeters

Instructions: Follow the PPT slides and introduce types of lines by having students draw the simple shapes on the slides. Discuss each line as they are introduced in the drawing activity. Divide class into small groups and have them fill in the blanks on the Identifying Lines page. Answers are posted on the PPT slide.

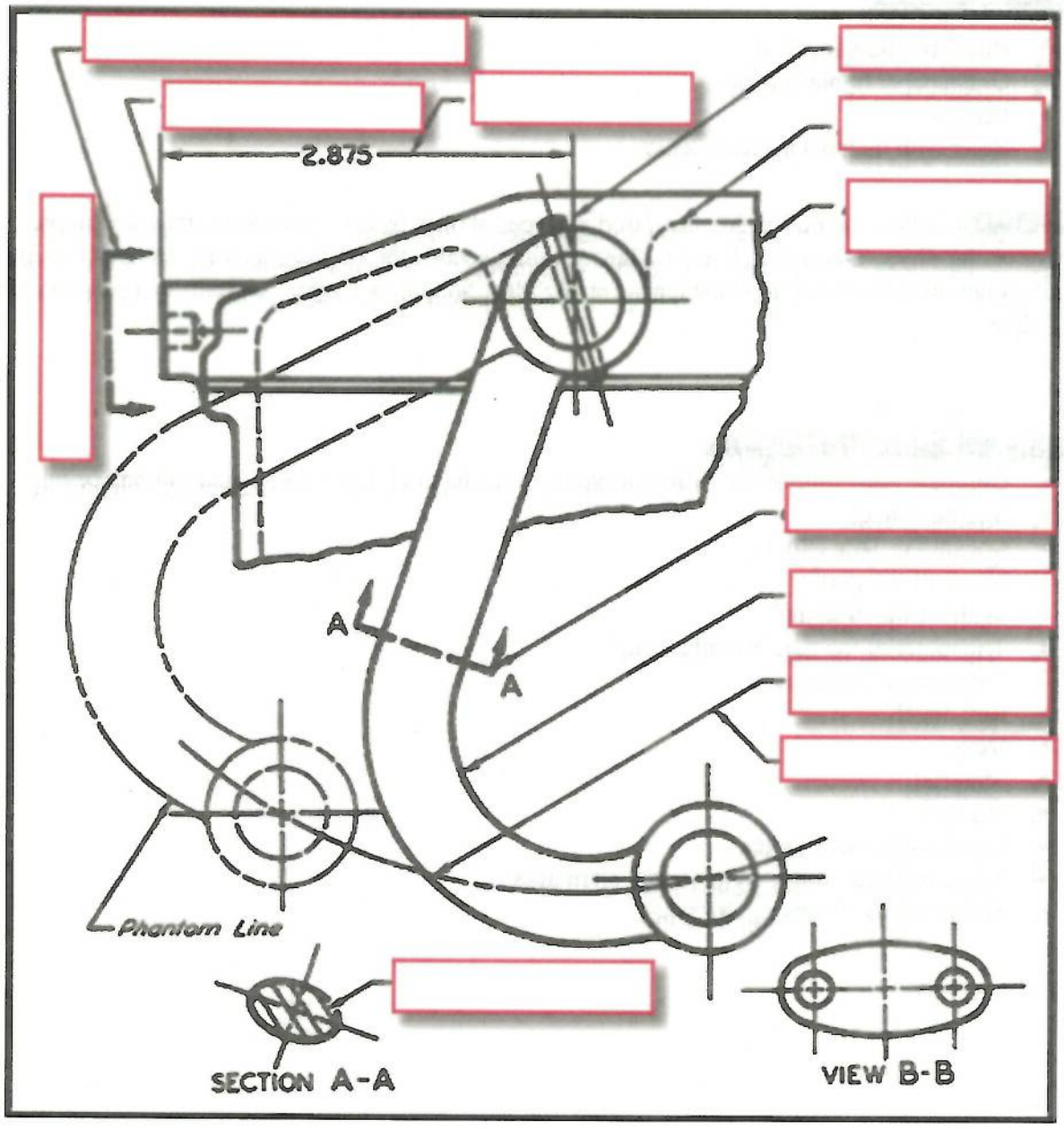
Identify and discuss the following:

- Compare and contrast the different types of mechanical, hydraulic, electrical blueprints
- Standard sizes
- Locate the Title Block
- Name of the part?
- Scale of the drawing?
- The material the part is made from?
- Tolerances for the part?
- Rev. level
- Date
- Material
- Drawn by
- Local and general notes
- Types of lines: radii, center lines, diameters
- Single views, 'working drawing'

1 • What are Blueprints?

Identifying Lines

Pictured below is a simple blueprint of a machine part. Label the correct line type in the boxes provided. Use your handouts and notes to help you.



1 • What are Blueprints?

Interpreting Technical Drawings

Purpose: Introduce students to technical drawings and how to read and find items on the drawings. Build upon the previous activities of vocabulary, abbreviations and lines.

Equipment/Materials:

- Blue Print Reading Text
- Copies of 3-4 different drawings from instructor's personal collection
    - o Mechanical prints
    - o Electrical prints
    - o Hydraulic prints

Instructions: Have students refer to their text and search for the following information listed below. When a student has found an item, ask them to explain to the class where it is to be found. Instructor should explain the meaning and importance of each item. Explain that not all of this information will be in all title blocks; some may be in notes on the drawing. Review the parts list for the drawing. Repeat this exercise with copies of blueprints from person collection.

Identify and discuss the following:

- Compare and contrast the different types of mechanical, hydraulic, electrical blueprints
- Standard sizes
- Locate the Title Block
- Name of the part?
- Scale of the drawing?
- The material the part is made from?
- Tolerances for the part?
- Rev. level
- Date
- Material
- Drawn by
- Local and general notes
- Types of lines: radii, center lines, diameters
- Single views, 'working drawing'

1 • What are Blueprints?

Technical Drawing Sample 1

NOTES:
1. BREAK ALL SHARP EDGES

MK 1A 1-REQD
FIXED JAW SCALE= 1:1

NOTES:
1. BREAK ALL SHARP EDGES

MK 1B 1-REQD
FLOATING JAW SCALE= 1:1

NOTES:
1. BREAK ALL SHARP EDGES

MK 1C 2-REQD
DOWEL PIN SCALE= 1:1

BILL OF MATERIALS

SHIP MARK	SUB MARK	QUAN	DESCRIPTION	FEET	INCHES	LBS
1A		1	3/8x3/4 ALUMINUM		1 1/2	
1B		1	3/8x3/4 ALUMINUM		1 1/2	
1C		2	1/4" DIA CS BAR		2 1/2	
			HARDWARE REQD			
1D		1	1/4" STEEL E-RING			
1E		1	1/4-20 HEX HEAD; BRASS		2	

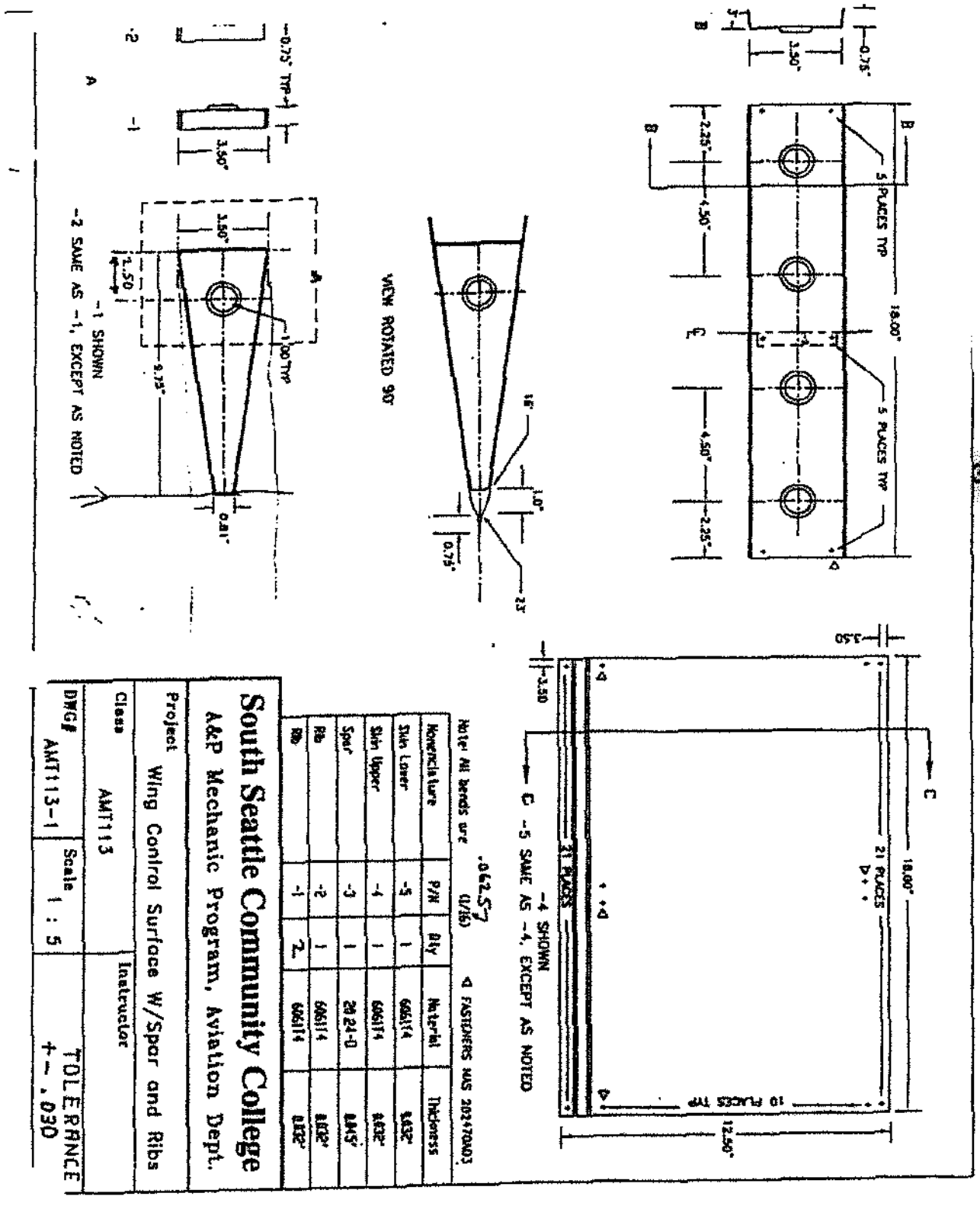
MTAG MODULARIZED CURRICULUM

DESCRIPTION
MINIATURE VISE PROJECT, FABRICATION DRAWING

TOLERANCES U.N.O.	DWG BY:	CHKD BY:
LINEAR DIMS:	SCALE: AS SHOWN	
X ±1	DATE:	
XX ±.01		
XXX ±.005		
ANGLES ±5°		
REV: 0	DRAWING 1 of 2	

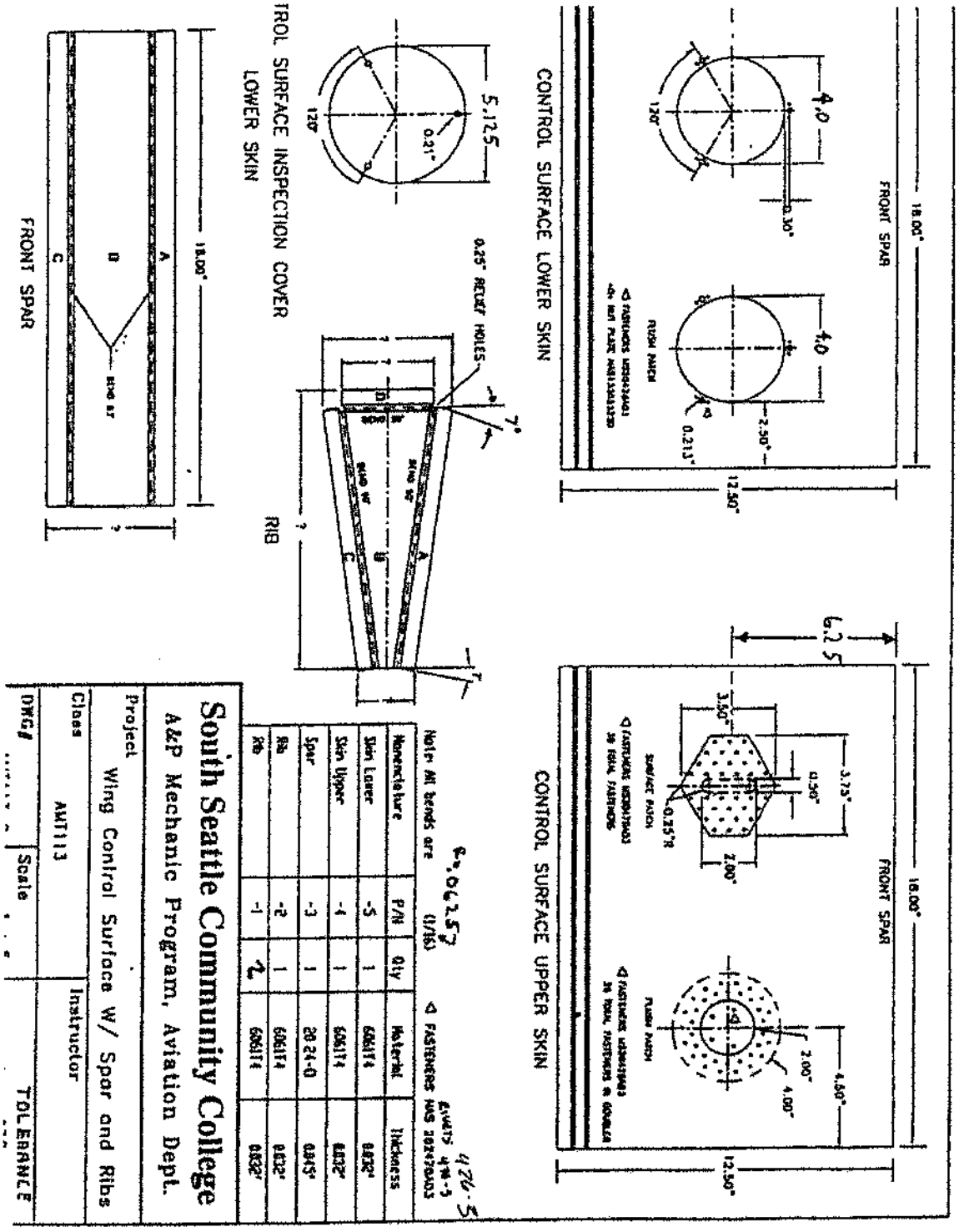
1 • What are Blueprints?

Technical Drawing Sample 2



1 • What are Blueprints?

Technical Drawing Sample 3



2 • Dimensioning

Tolerances

Purpose: To measure the lengths of nails in a box to observe the production variation, and use these measures at the conclusion of the lesson to make some guesses about the tolerance used to manufacture the nails.

Equipment/Materials:

- Box of 6d nails (enough for 4 nails per group)
- Pencils
- Metal rule, 6-inch or greater, 0.02" or 1mm gradations, one per group

Instructions: Distribute a rule and 4 randomly selected nails to each apprentice group. Participants should measure their nail lengths with a metal rule, to the nearest 1mm or 0.02". Each group should identify the shortest and longest nail measurements, and the average of all for nails. Have each group post their results on the table. See sample below.

Group #	min length	average length	max length

2 • Dimensioning

Fractional Dimensioning

Fractional Dimensioning

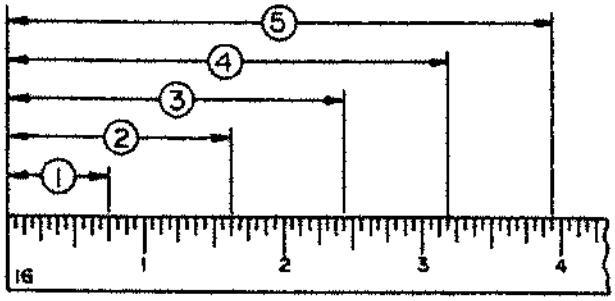
Although the majority of prints in this workbook will be decimally dimensioned, there are still a great number of industrial blueprints that are fractionally dimensioned. A machine operator should become skilled at reading the fractional scale and metric scale as well as the decimal scale.

Most fractional-type steel rules (scales) are subdivided into units of 1/16, 1/32, or 1/64 in. Major graduations along the rule are accented by longer lines. Some have small numbers printed adjacent to the lines that correspond with the number of graduations. *Example:* The number 16 on a scale graduated into 32's would represent 16/32, which would reduce to 1/2 in. Always reduce a fraction to its lowest terms. If the numerator is an even number, you know that it can be further reduced. It is often quicker to begin your count from a major graduation close to the reading, rather than to begin from a full inch. *Example:* A reading of 2⅞ could be read faster by starting at 2½" instead of 2". (See no. ③ below.)

(Courtesy The L. S. Starrett Co.)

Scale Reading Quiz 1

INSTRUCTIONS: Determine the readings from the illustrations shown below and enter your answers in the appropriate spaces.



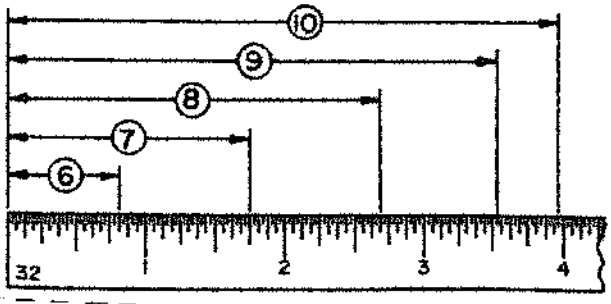
① _____

② _____

③ _____

④ _____

⑤ _____



⑥ _____

⑦ _____

⑧ _____

⑨ _____

⑩ _____

2 • Dimensioning

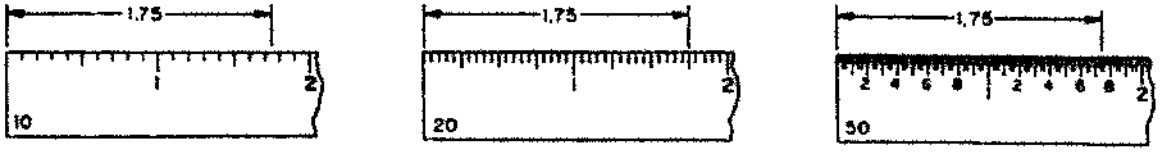
Decimal Dimensioning

Decimal Scales

Most decimal-type scales (steel rules) are subdivided into units of 1/10, 1/20, 1/50, or 1/100 in. The 1/50 will provide sufficiently accurate readings for most applications. This scale can usually be recognized by the number 50 stamped near the left edge. With 50 increments to the inch, each increment then represents .02 in. By reading between these increments, the machinist is capable of determining the closest .01 measurement (ten thousandths of an inch). Closer measurements require the use of other instruments, such as the micrometer, vernier calipers, and so on.

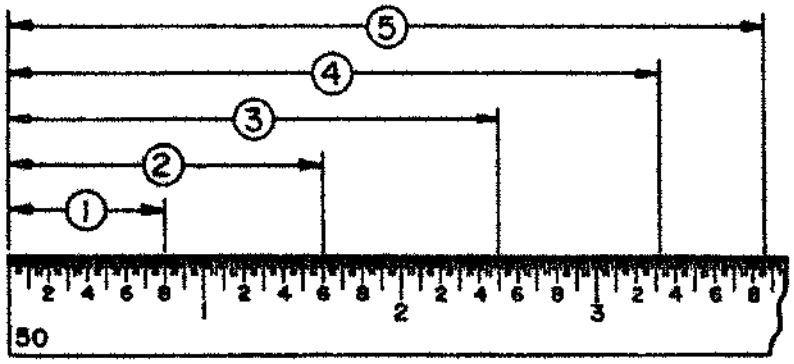
Major graduations along the scale are accented by longer lines, usually every 1/10 in. (.10). In addition, they may include numbers as shown in the illustration below. A popular graduation style has the .04 and .06 increment lines slightly longer than the .02 and .08 increment lines. This allows for quicker reading of the commonly used .05 increment.

(Courtesy The L. S. Starrett Co.)



Scale Reading Quiz 2

INSTRUCTIONS: Determine the readings from the illustration shown below, and enter your answers to the closest .01 in.



① _____

② _____

③ _____

④ _____

⑤ _____

2 • Dimensioning

Metric Dimensioning

Metric Dimensioning

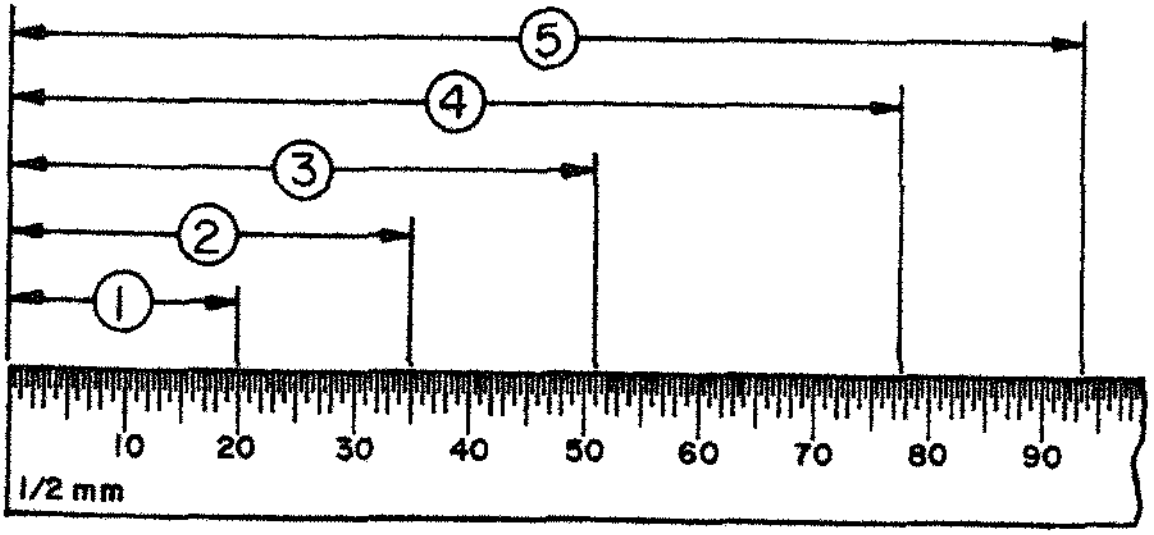
The increment of measurement on metric drawings for the machine trade is the millimeter, unless otherwise specified. A note to this effect is normally located in the area of the title block on a drawing. Many industries in the United States and Canada that use the metric system of dimensioning also include the inch equivalent in decimal form. The dual dimensioning system and the SI metric system are illustrated on page 21, "Dimensioning Systems."

If you encounter a drawing dimensioned only in millimeters, you may convert each dimension to inches by multiplying it times .03937, or you may use a conversion chart. However, metric scales are available to eliminate the need for conversion. These scales have graduations every millimeter or half-millimeter, and may be recognized by the designation "mm" or "1/2 mm" stamped near the left edge. Normally, every fifth millimeter is accented by a longer line and every tenth millimeter is identified by number, as shown below.

(Courtesy The L. S. Starrett Co.)

Scale Reading Quiz 3

INSTRUCTIONS: Determine the readings from the illustration shown below, and enter your answers to the closest 0.5 mm.



① _____ ③ _____ ⑤ _____

② _____ ④ _____

2 • Dimensioning

Dimensions on Drawings

Purpose: To practice identifying various dimensions on a drawing.

Equipment/Materials:

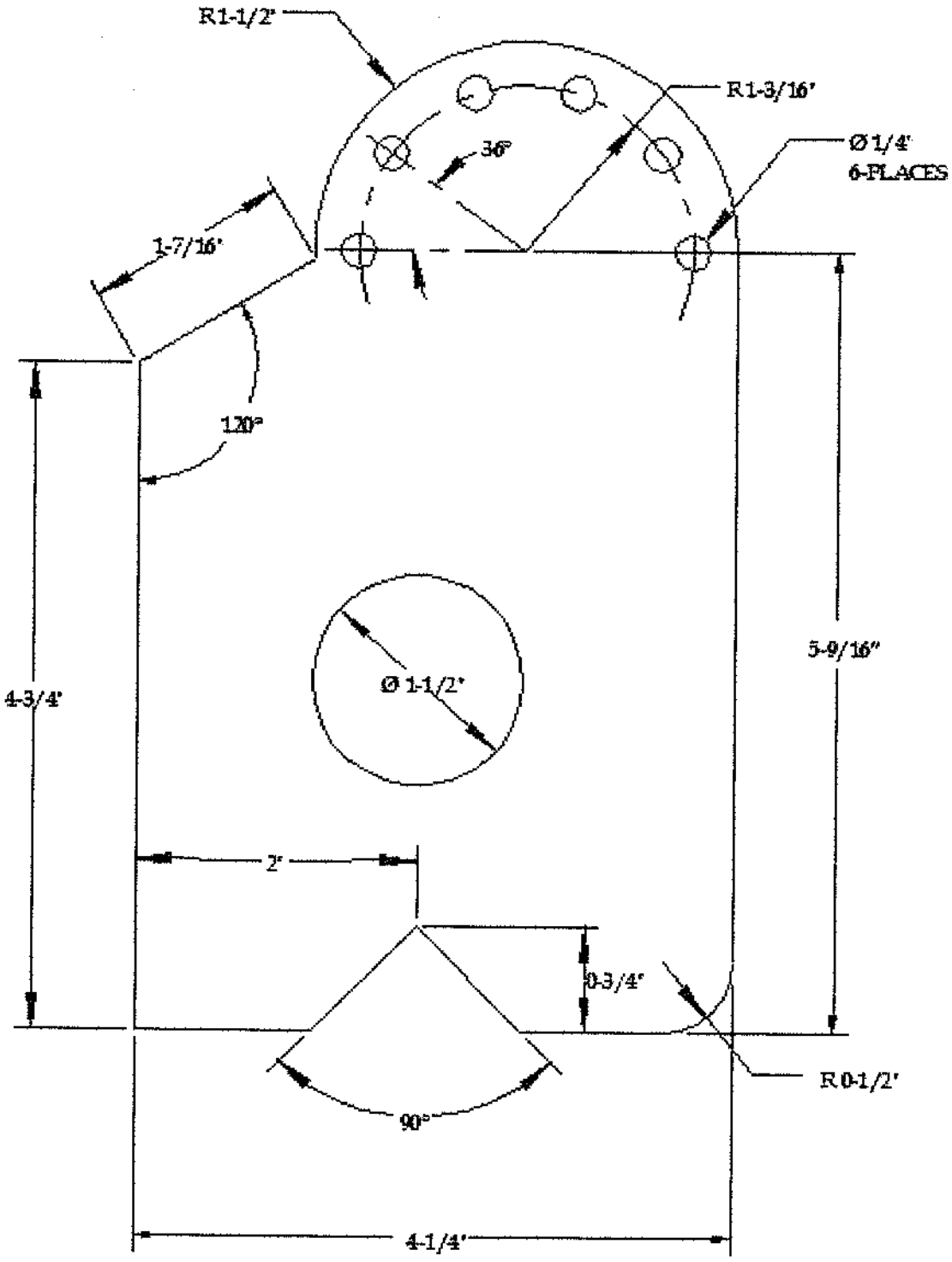
- Blue Print Reading Text
- Pencils
- Rulers

Instructions: Discuss the dimensions and symbols displayed in the drawing. Discuss angle and radius measurements and symbols too.

Note: Explain that dimensions on drawings need to be adequate, but not overdone. Extension lines are used to make clear where the measurements end. It is important not to have measurements overlap to where it isn't clear which measurement is most important.

2 • Dimensioning

Dimensions on Drawings



2 • Dimensioning

Creating Cutouts

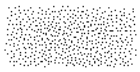
Purpose: Create 3D cutouts that will be used for viewing activities.

Equipment/Materials:

- Blue Print Reading Text
- Scissor, ruler, glue stick for each student

Instructions: Pass out supplies listed above. Have students cut on solid lines and fold on dotted lines. Then glue each shape together to create 3-dimensional objects. When done, have a volunteer show the class the finished products. Explain to the class that they are essentially creating a product from a technical drawing.

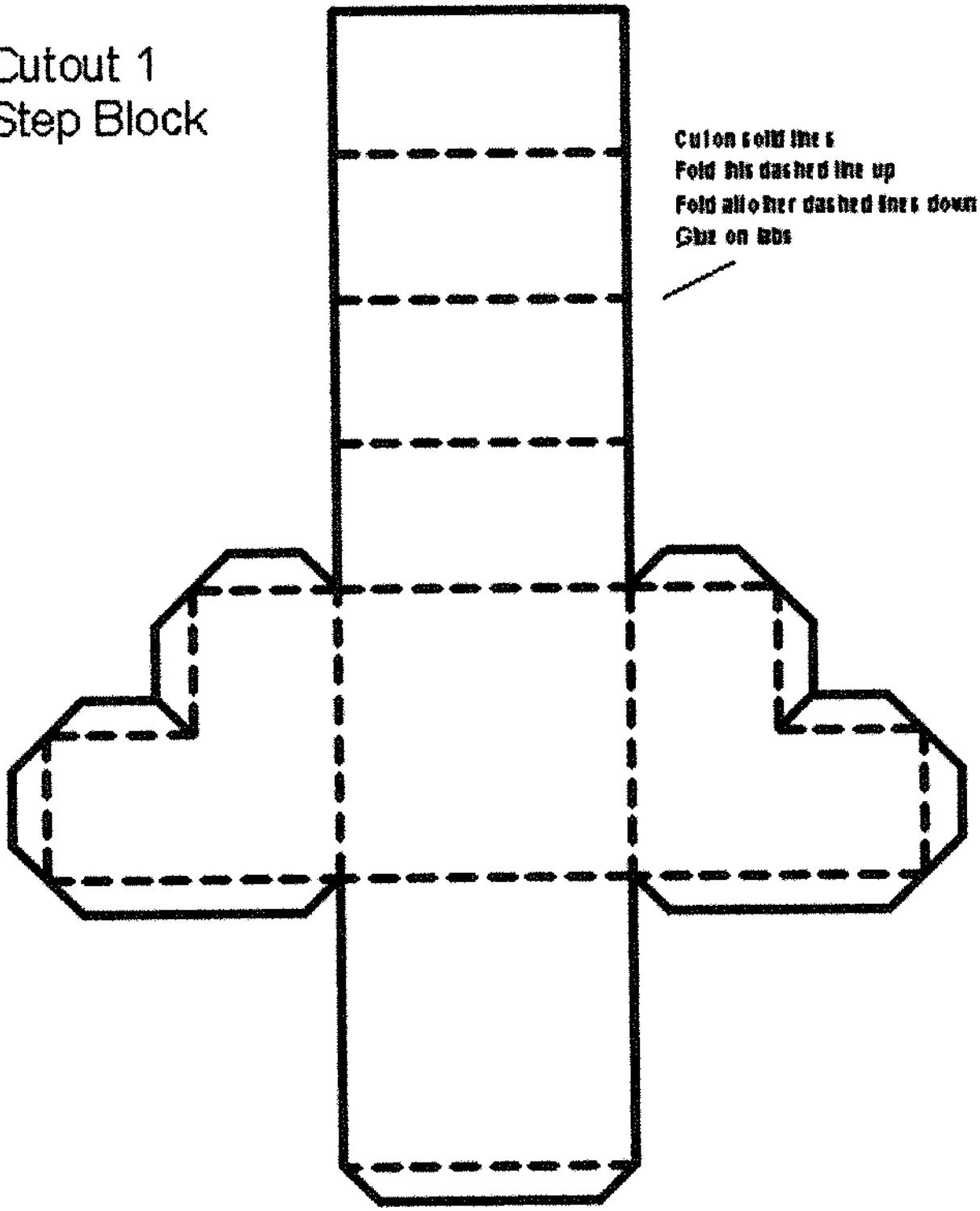
Note: This activity is best done prior to a break period to allow those who finish early to go on break first.

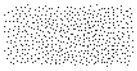


2 • Dimensioning

Step Block Cutout

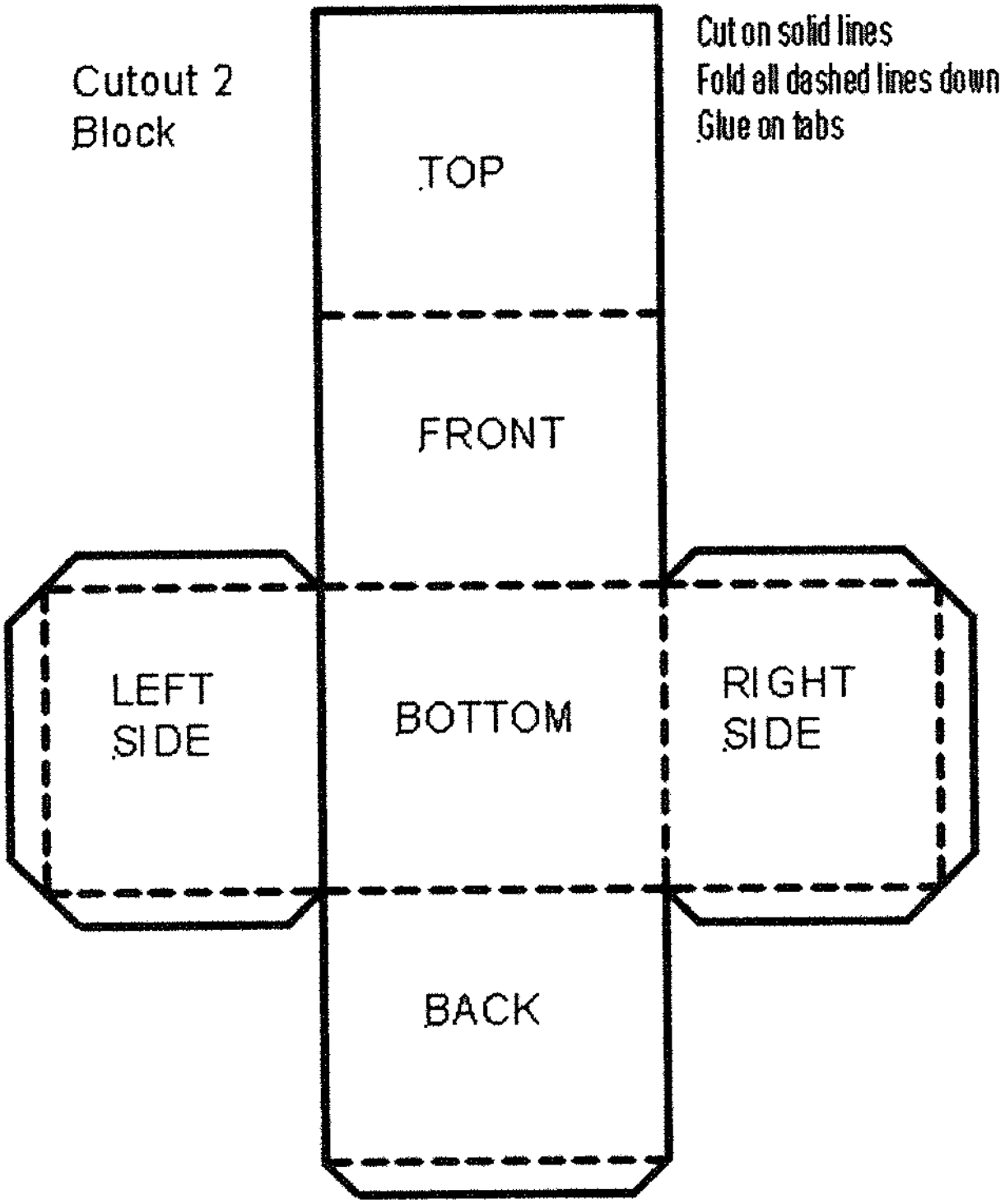
Cutout 1
Step Block





2 • Dimensioning

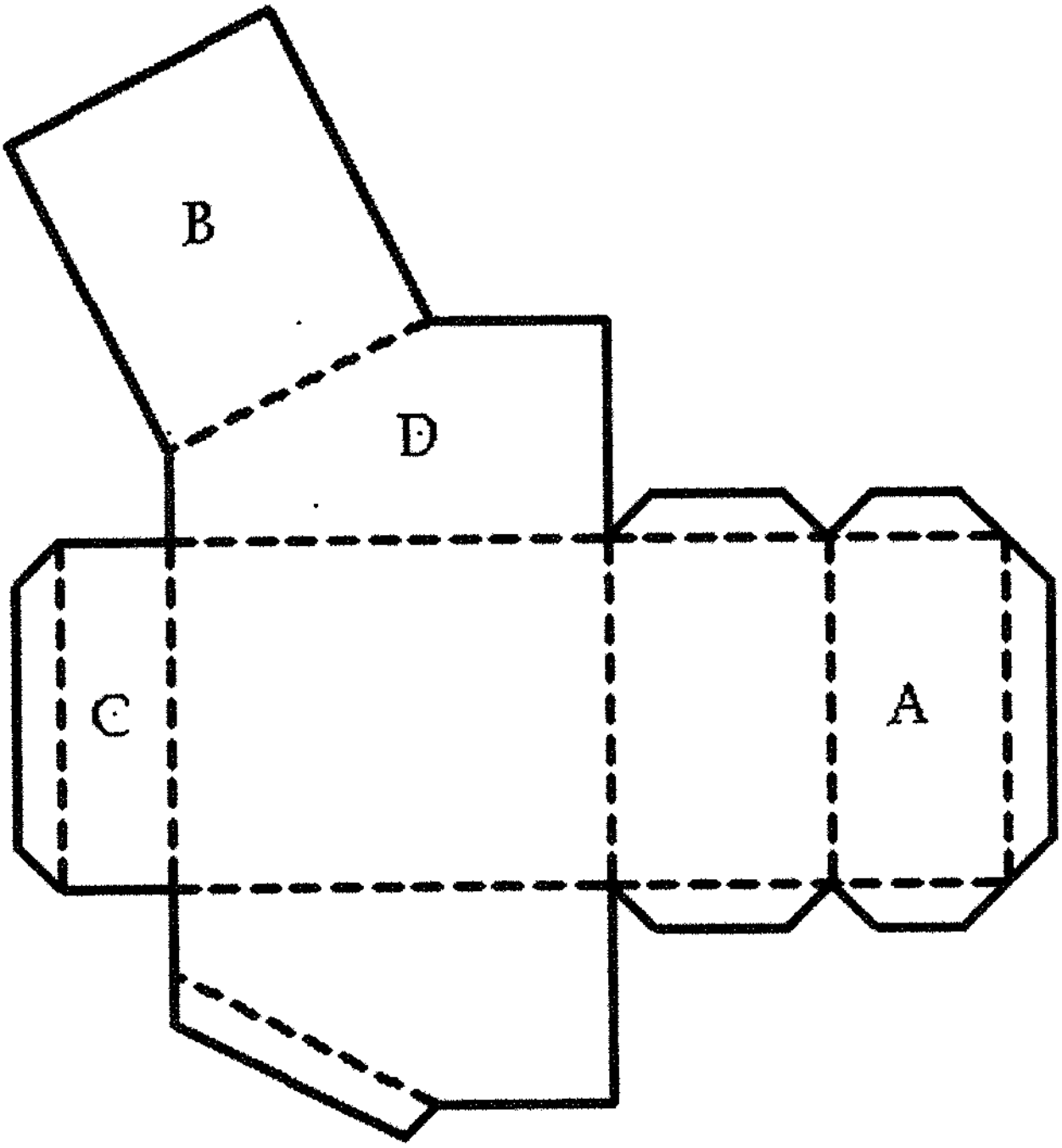
Block Cutout



2 • Dimensioning

2 • Dimensioning

Tapered Block Cutout



3 • Views

Orthographic & Pictorial Views

Purpose: Identify and sketch pictorial and orthographic views of 3D objects.

Equipment/Materials:

- Blue Print Reading Text
- Pencils

Instructions: Read and discuss the text with the class. Ask them: How many views it would take to define a ball? A cube? What kind of objects could be described with just two views? (a cylinder, a square brick, a cone, etc.) Then have students sketch pictorial and orthographic views of the three cutout objects they previously assembled.

Let students know that views must be in the proper relationship and aligned with each other, so remember that the top view needs to be exactly above the front view, the side view exactly to the side of the front view, etc.

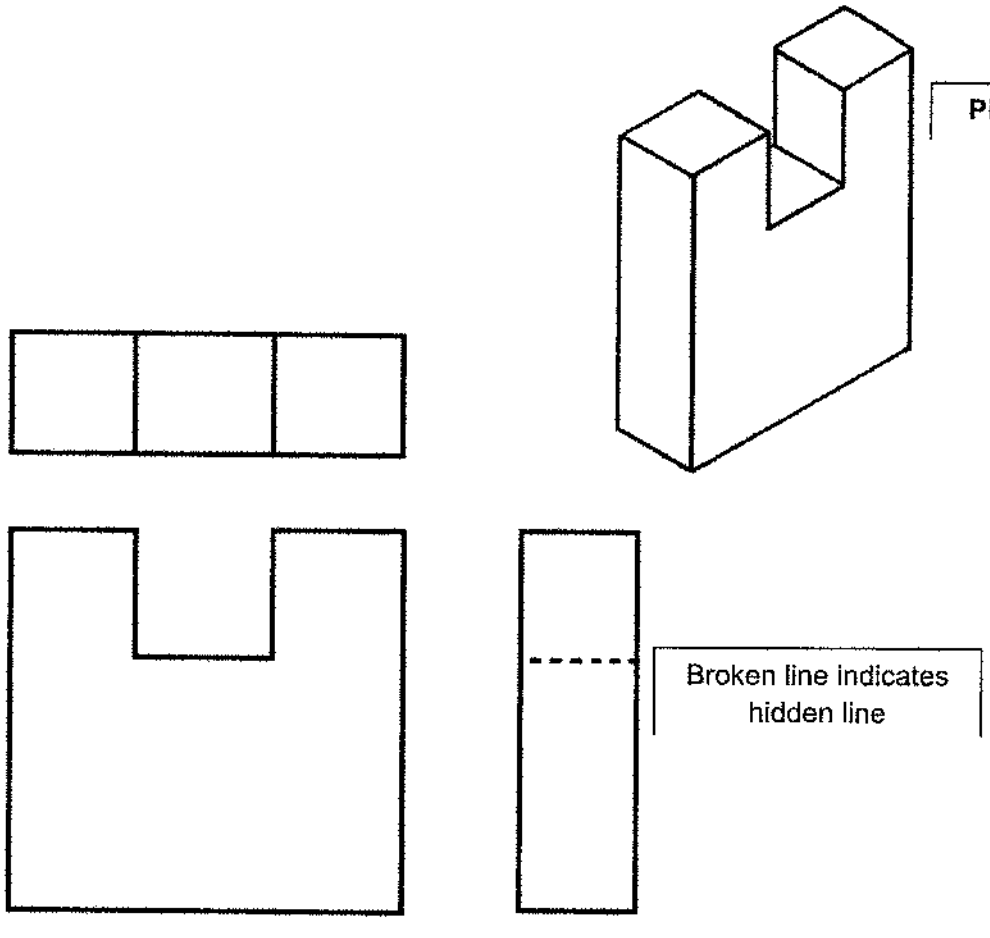
Instructor's Note: It may be difficult for some students to visualize this viewing concept. Extra help may be needed. Showing animated videos may help students get a better visual representation. Look in the references and resources section for links to YouTube videos that you can use for this activity.

3 • Views

Orthographic & Pictorial Views

The **orthographic view** is one of the most common ways that three-dimensional objects are shown in drawings.

- It shows what we would see if we took three photographs of a part – one from the front, one from the top and the third from the side.
- Remember that drawings are usually done before the part is made. At that time, there is nothing to photograph, so you need to create the pictures that define what the object is. Typically, you create as many views as you need to define the object.
- Sometimes we need to use broken lines to represent hidden lines that are not visible from a certain face. See below to illustrate.



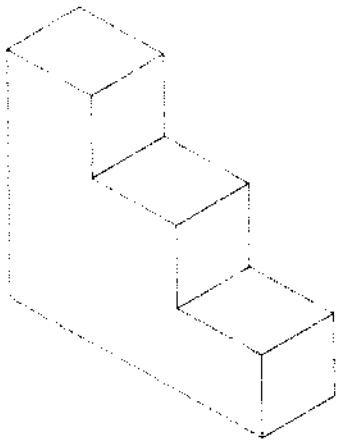
Orthographical Views

3 • Views

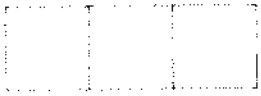
Pictorial & Orthographical Views

Pictorial views are very often used to show a complete assembly. If you have ever purchased something that required assembly, most likely the drawing provided by the seller was a pictorial view showing all of the parts put together in the final assembly.

- The pictorial illustration shown below is a pictorial view that depicts what the finished product should look like that is described by the orthographic views below.
- People who don't read orthographic drawings can often assemble certain parts and see the position of each part by following the pictorial illustrations.
- Another purpose of pictorial drawings is to use them as beginning freehand sketches to determine which orthographic views will be required for the final drawings. A quick pictorial sketch can often help in selecting the proper orthographic views, determining the space required to complete the orthographic drawing and help in visualizing the final set of drawings.
- Lack of artistic ability should not be an obstacle to those wishing to develop a sketch containing the kinds of information suitable to plan and layout the orthographic drawing.



Pictorial View



Orthographical Views

3 • Views

Isometric Views

Purpose: Identify isometric views of 3D objects.

Equipment/Materials:

- Blue Print Reading Text
- Pencils
- Paper

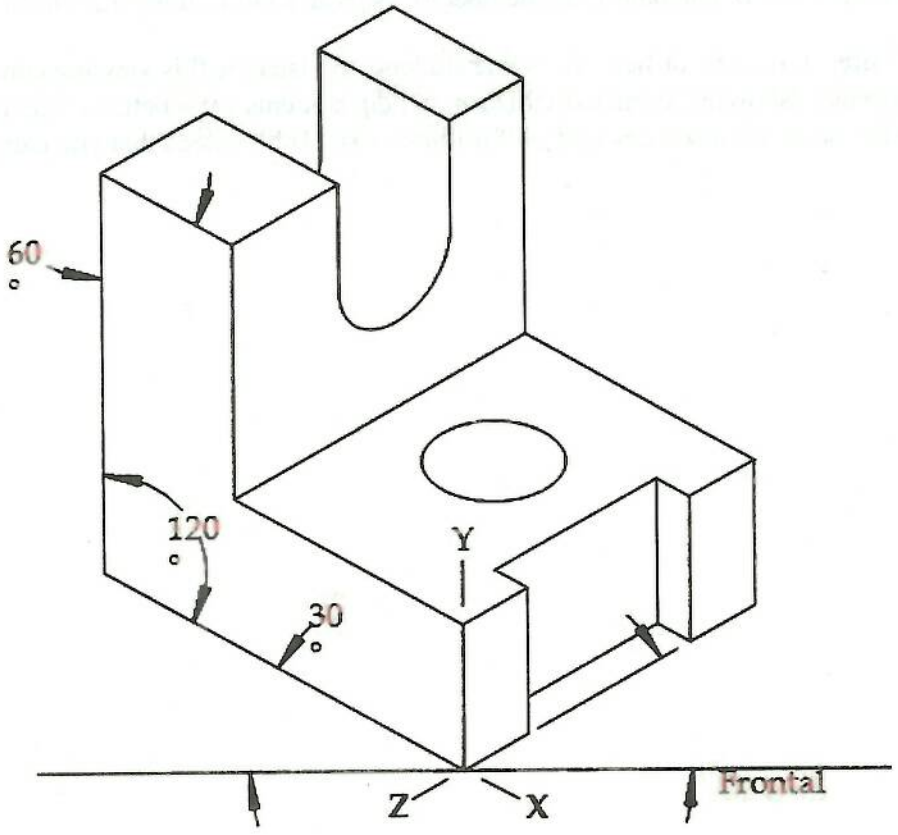
Instructions: Read and discuss the text with the class. Then have students choose one of their 3D objects and draw an Isometric view of that object.

Instructor's Note: It may be difficult for some students to visualize this viewing concept. Extra help may be needed. Showing animated videos may help students get a better visual representation. Look in the references and resources section for links to YouTube videos that you can use for this activity.

3 • Views

Isometric Views

Isometric views are unquestionably the most common of the pictorial views. The X- and Z-axes (width and depth respectively) are drawn at 30° from the frontal plane. The height of the object (Y-axis) is 90° to that plane. The result is that true 90° angles are represented by both 60° and 120° angles, but never are they shown as what they are. Try to find a true 90° angle in the drawing above.



Isometric View

3 • Views

Sectional Views

Purpose: Introduce the concept of sectional views and identify sectional views of 3D objects.

Equipment/Materials:

- Blue Print Reading Text
- Pencils
- Paper

Instructions: Read and discuss the text with the class. Then have students choose one of their 3D objects and draw a sectional view of that object. Remember to visualize a knife cutting the object.

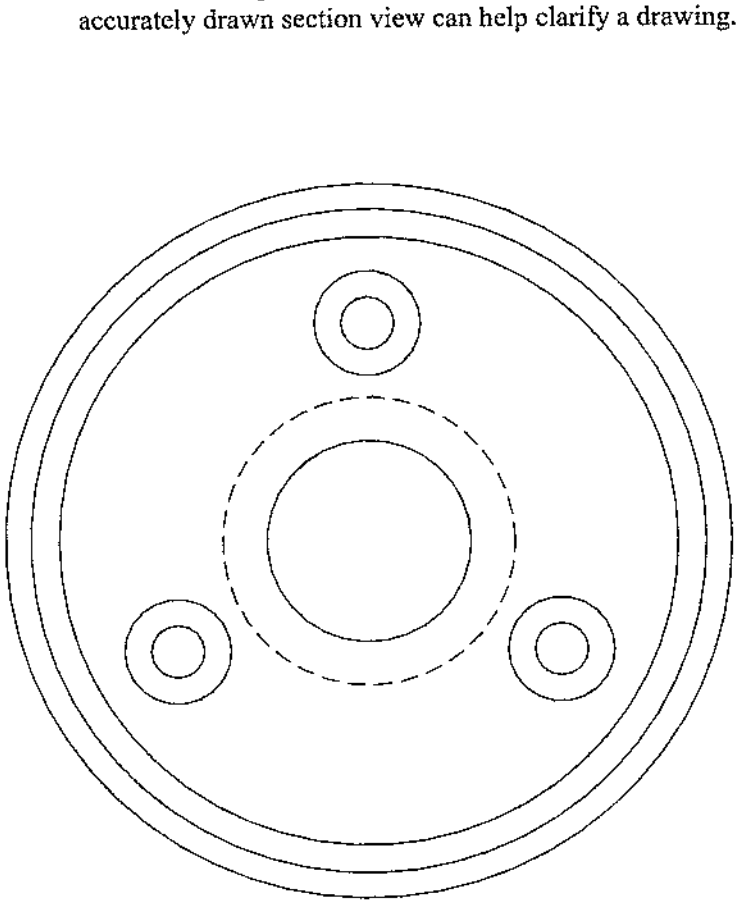
Instructor's Note: It may be difficult for some students to visualize this viewing concept. Extra help may be needed. Showing animated videos may help students get a better visual representation. Look in the references and resources section for links to YouTube videos that you can use for this activity.

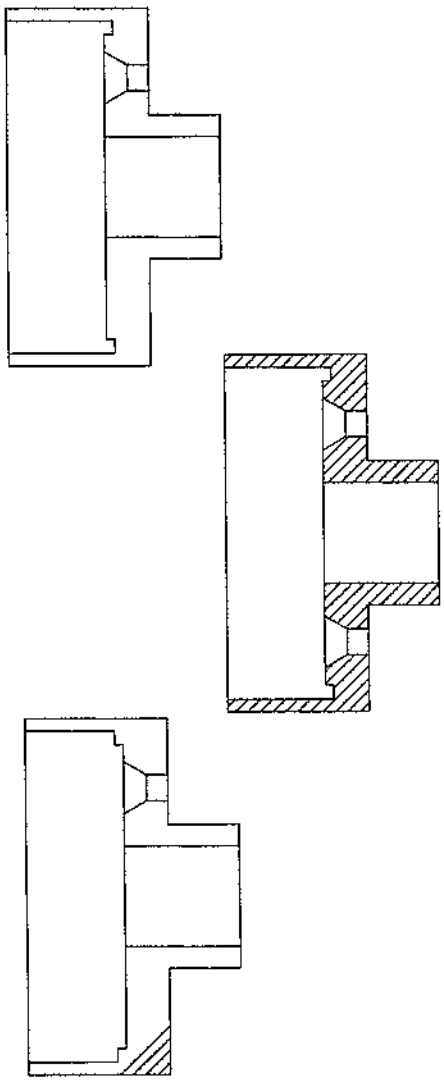
3 • Views

Sectional Views

In order to fabricate an accurate part, it must be fully described and dimensioned in one or more drawings. Usually this means that all surfaces of the part must be shown and visible in one of the drawings.

- Even if another view on a drawing shows the surface in question, a sectional view is often called for to provide clarity and eliminate (reduce) possible questions.
- A sectional view may be visualized as taking a knife and slicing through the object in an orthographic drawing to show the inside of the object. (Think of it as cutting an apple in half to see the inside of the apple.)
- The sectional view can represent a slice taken through an object at any point. Assuming that the slice is made through the center of the object below (from 12 to 6 o'clock), which of the three sectional views would be correct?
- **Note**: either the top or bottom section views are accurate representations of what the section might look like. This provides a good opportunity for discussion with the students and proves how an accurately drawn section view can help clarify a drawing.





Circle the correct sectional view

3 • Views

Identifying Sectional Views

Purpose: Practice identifying sectional views of objects.

Equipment/Materials:

- Blue Print Reading Text
- Pencils
- Paper

Instructions: Match the individual section to its corresponding region. In this activity, the student's task is to decide which slice each sectional view corresponds to. Have the students label the sectional views with the correct letters, A, B, or C. Notice that a sectional view can angle across a part so that it includes important details.

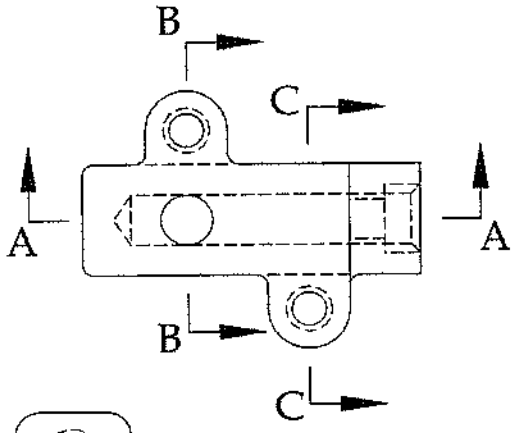
Instructor's Note: It may be difficult for some students to visualize this viewing concept. Extra help may be needed. Showing animated videos may help students get a better visual representation. Look in the references and resources section for links to YouTube videos that you can use for this activity.

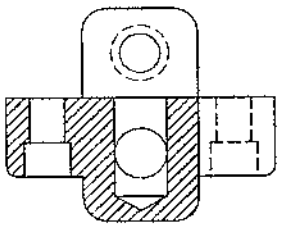
3 • Views

Identifying Sectional Views

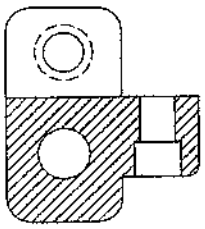
Review the part below. Analyze the three cutting planes on the image. Then correctly label each of the three sectional views below with the corresponding letters, A, B, or C.

Correctly lable each of the three sectional views.

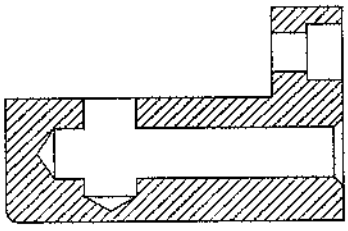




SECT _____

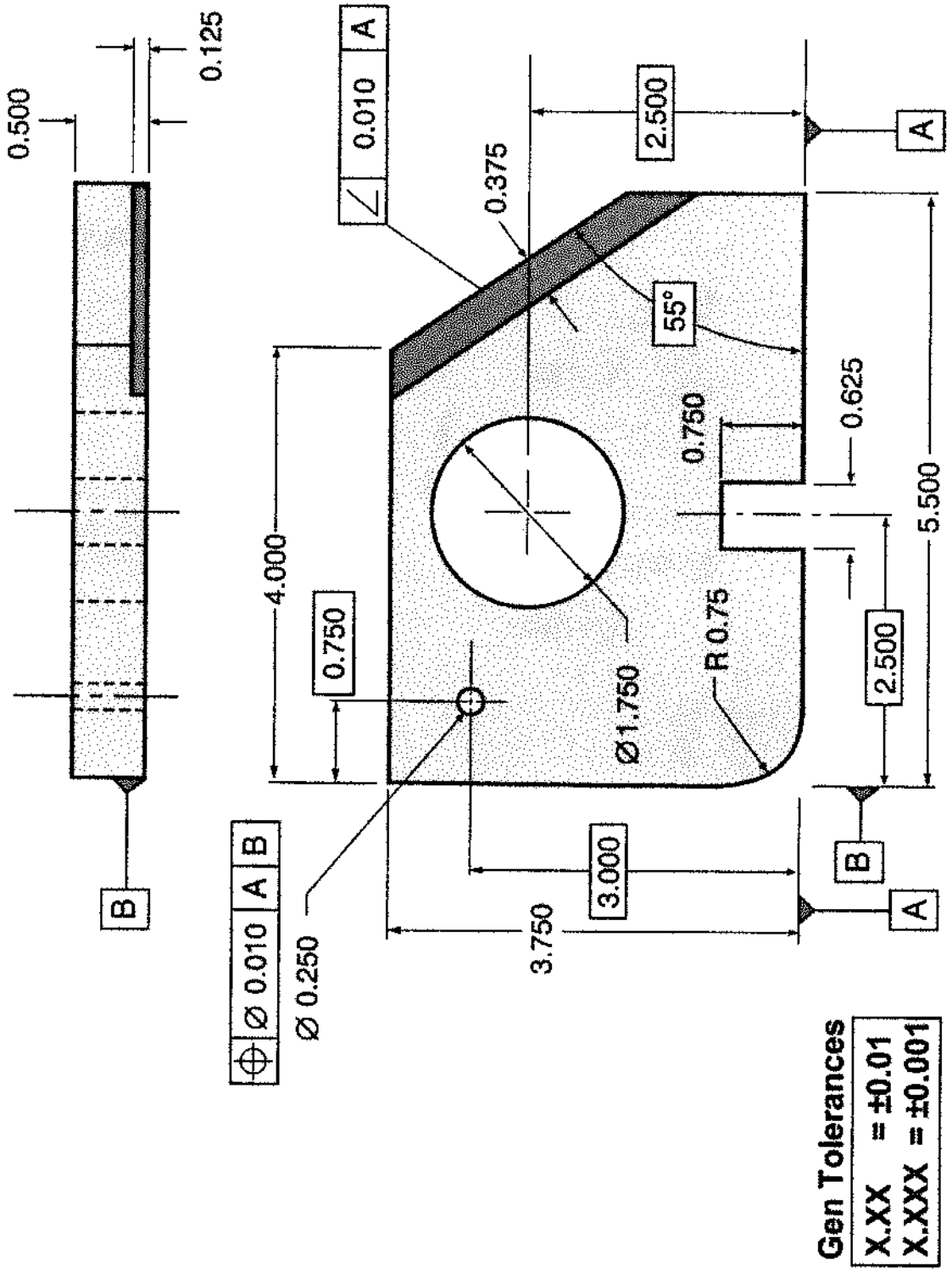


SECT _____



SECT _____

Drawing for Measurements



4 • Holes and Finish

Counterbores and Casting

Purpose: To learn the definitions of these selected terms. Apply critical thinking to make educated guesses on the purpose or usage of each item.

Equipment/Materials:

- Blue Print Reading Text

Instructions: Allow class time to read over the definitions. Ask students to give examples of how they can apply these concepts in manufacturing. Guessing is fine. Call on your knowledge to augment their learning.

4 • Holes and Finish

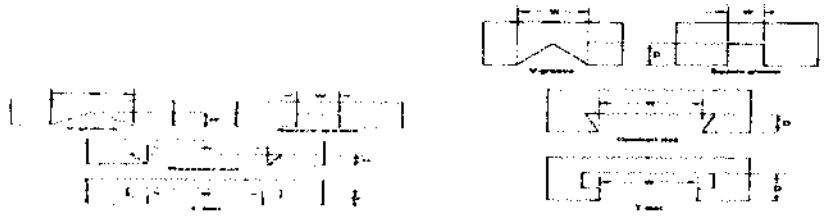
Various Definitions

Casting Metal object (cast iron/cast aluminum). Process by which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify.

Counterbore To enlarge a hole cylindrically at the end.

Countersink To enlarge a hole conically at the end to accept a flat head fastener.

Slots & Grooves Techniques in cutting commonly used to produce reciprocating movement.



Surface Finish Surface finish, by definition, is the allowable deviation from a perfectly flat surface that is made by some manufacturing process. Whenever any process is used to manufacture a part, there will be some roughness on the surface.

Surface finish may be denoted by a roughness grade number. Here is a table that specifies the Ra values for roughness grade numbers

4 • Holes and Finish

Orthographic View Drawing Sheet

Purpose:

(Only the 2nd page of this document is for student use.) This hand out can be used to learn the relationship of the three main views used in manufacturing.

A good activity is to find an object in the room such as a book. Have the students place there book on the floor and stand over the top of it.

Instructions:

Have the students imagine there in an airplane flying over a bridge. If you're high up in an airplane all you can make out of the bridge is what you can see from the point of view you have.

What do they see?—It should just look like a rectangle from their point of view, stand the book on end and look at it, on the other edge. These are all possible **top views** of the book. Pick one view to use and have everyone draw the same view in the top view area on the sheet. Keep the lines of the book parallel with the page and in general scale to how the book looks. (I usually use the front cover of the book as a top view)

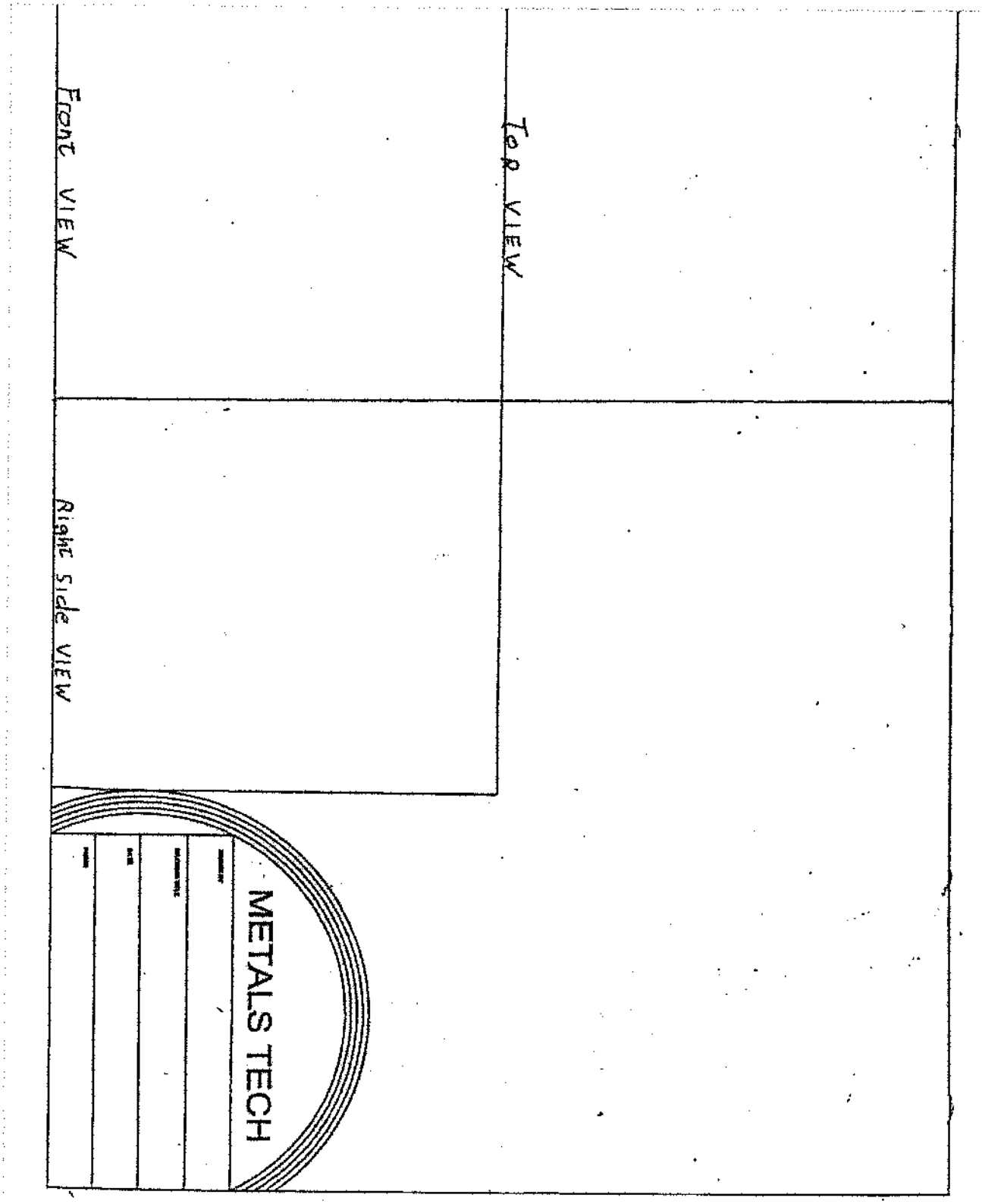
To go from the **Top view to the front view** you would rotate the object toward you from the bottom. Using the book, hold the book out in front of you so that you're looking at in as a top view. Grab the bottom edge of the book and rotate it toward you 90 degrees. This would be the **front view**. Notice that the width of the book is exactly the same

To go from the **Front view to the Right side** view you would rotate the object toward you from the right edge. Using the book, hold the book out in front of you so that you're looking at in as a Front view. Grab the Right edge of the book with your Right hand and rotate it toward you 90 degrees. This would be the Right side view. Notice that the height of the book is exactly the same

This is a good filler activity if you need to add more time to the day.

This is a good activity for students to do quietly if they finish up with an assignment or test.

4 • Holes and Finish



4 • Holes and Finish

Orthographic Drawing Worksheet

½ point for each matching
2 points for each view
1 point for labeling the views correctly
Total of 10 points possible

Date_____

Match the type of line with the correct description

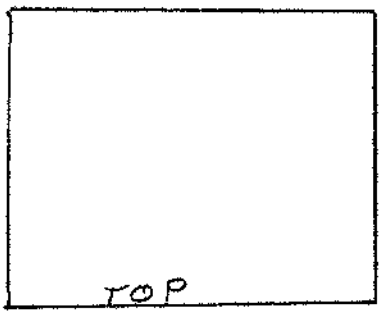
A	Visible	H	
B	Hidden	I	
C	Extension	J	
D	Dimension	K	2½
E	Centerline	L	
F	Leader	M	
G	Brake	N	2½

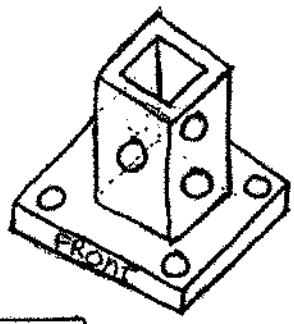
Example: C = H = = =
= = =

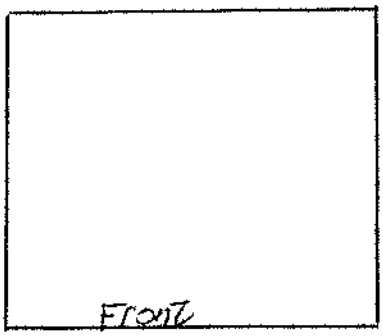
Draw and label the three views for this object

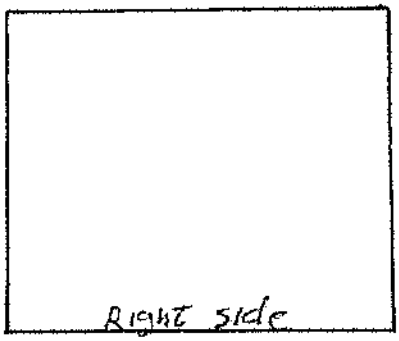
3-39

Assume the edges are strait
All holes are thru the object (so that a pencil would pass completely thru)









5 • Blueprint Vocabulary

Glossary of Terms

Abrasive--A material used to cut other materials softer than itself.

Allowance--The minimum clearance (or maximum interference) between two mating parts, such as a shaft and a hole.

Alloy--A mixture of two or more elements, at least one of which is metallic, melted together to form a new metal.

Angular Dimension--A dimension measured in degrees, minutes, and seconds.

Anneal--The process of slowly cooling hot iron--base metals to remove stresses and reduce the hardness

Arbor--A shaft upon which a cutting tool is mounted, or a spindle for holding the workpiece.

Assembly Drawing--A drawing that shows the relationship of the various components as they fit together.

Auxiliary View--An orthographic view projected angularly, used to show features appearing on inclined or oblique surfaces.

Axis--A central line about which parts are symmetrically arranged that may or may not revolve upon it.

Baseline Dimensioning--A system of dimensioning used to locate features of a part from a common set of datums.

Basic Dimension--An exact value used to describe the size, shape, or location of a feature without tolerance.

Basic Size--The exact theoretical size from which limits of size are derived by the application of allowances and tolerances.

Bevel--A flat, slanted surface between two other surfaces at right angles to one another.

Bilateral--Since "bi" means two, it is used to indicate that two sides are involved.

Blind Hole--A hole that does not pass all the way through.

Bolt Circle--A circular center line upon which two or more hole centers are located.

Bore--To enlarge a hole to an accurate size. Held to close tolerances, it is usually specified with limit dimensions.

Boss--A raised, cylindrical projection used to provide extra metal around a hole in casting or forging. The boss and the pad are similar, except that the boss is always circular, and the pad may be any other shape.

Broach--To produce a desired shape inside a cylindrical hole, such as a keyway or hexagon. The broaching tool has a series of teeth, gradually increasing in size, that do the cutting as the tool is pushed or pulled through the hole

Burnish--To finish or polish metal by rolling or sliding a tool over the surface under pressure.

5 • Blueprint Vocabulary

Burr--A jagged edge of metal produced by working the metal. A common note on a blueprint is to "remove all burrs."

Bushing--A replaceable insert to provide metal with better wearing quality.

Cad Drawing--A drawing created by computer--aided drafting methods.

Cam--A mechanical device used to change rotary motion to some other motion, such as reciprocating or sliding.

Carburize--Heating low-carbon steel to a temperature below its melting point in carbonaceous solids, liquids, or gases to raise the level of carbon in the exterior, then cooling slowly in preparation for heat--treating. Abbreviated CARB.

Case Hardening--To harden ferrous alloy so that the surface layer is harder than the interior core.

Casting--A metal object made by pouring molten metal into a mold.

Chain Dimensioning--Successive dimensions that extend from one feature to another, rather than each originating at a datum. Tolerances accumulate with chain dimensions.

Chamfer--A corner that has been removed from the end of a cylindrical surface, at an angle to the face. Used to facilitate assembly.

Clearance Hole--A hole slightly larger than the bolt or fastener that is intended to pass through it.

Coaxiality--Coaxiality of cylindrical features exists when two or more cylindrical features have a common axis.

Collar--A projecting ring around a shaft.

Concentric--Circles sharing a common center and cylinders sharing a common axis are said to be concentric. Concentricity is a relationship between two or more diameters.

Concentricity--The condition where the median points of a feature's diametrically opposed elements are located within a cylindrical zone that is equally centered about a datum axis.

Core--The part of a mold that shapes the interior of a casting.

Counterbore--To enlarge a hole cylindrically at the end. A drawing specification will include its diameter and depth.

Countersink--To enlarge a hold conically at the end to accept a flatheaded fastener. A drawing specification will include its diameter and included angle.

Datum--A point, line, surface, or plane from which the location of other features is established.

Degree--A unit of angular measurement. (There are 360 degrees in a circle.)

Detail Drawing--A drawing of a single object, complete with dimensions and all other information necessary to produce the part.

Die--A tool used to cut external threads. Also a tool used to shape, mold, stamp, or cut metal.

5 • Blueprint Vocabulary

Eccentric--The term means off center. Unlike concentric, eccentric diameters do not share a common axis.

Extrusion--A metal object made by forcing hot or cold material through dies of the desired shape.

Face--To machine a flat surface perpendicular to the axis, such as the end of a shaft.

Fastener--A connector used to secure two or more parts. Bolts, nuts, screws, and rivetsare types of fasteners.

Ferrous--Metals that contain iron as their base material, such as steel.

Fillet--A concave surface (interior radius) at the intersection of two surfaces of an object.

Fin--A thin projecting edge on cast or molded parts.

Finish Marks--Symbols appearing on the edge view of surfaces to be machined. Usually confined to drawings of castings and forgings.

Fixture--A device designed to position and hold a part in a machine tool. It does not guide the cutting tool.

Flame Hardening--A process of hardening steel by heading with an oxyacetylene torch and quenching.

Flange--A projecting rim or collar on an object. It may include mounting holes to secure it in place.

Forge--To force hot metal into a desired shape by hammering or squeezing.

Gage--A measuring instrument such as a gage block or a height gage.

Gauge--The thickness of sheet metal or the diameter of wire designated by a number rather than dimension.

Geometric Tolerancing--Tolerances on drawing with emphasis on the actual function or relationship of part features where interchangeability is critical.

Gusset--An angular piece of metal fastened in the angle of a metal frame to give strength or stiffness.

Hardness Test--A test that measures the degree of hardness of metals.

Heat Treatment--The application of heat to metals to produce desired properties.

Horizontal--Parallel to the horizon.

Hub--The central part of a wheel, such as the part into which the spokes are inserted.

Inclined Surface--A flat surface slanting in one direction. It will appear as an edge in one principal view, distorted in others.

Included Angle--The angle formed between one side and another, always less than 180°.

Isometric Drawing--A three--dimensional pictorial drawing that has its horizontal surfaces drawn on 30° axes from horizontal.

5 • Blueprint Vocabulary

Jig--A device designed to hold a part to be machined. It also positions and guides the cutting tool.

Key--A metal bar or wedge used to secure gears or pulleys to a shaft and prevent rotary motion between the two pieces.

Keyseat--An axially located groove in a shaft that positions the key.

Knurl--A term that refers to surfaces that are cut or rolled with a tool to produce a better hand grip.

Least Material Condition--When a feature contains the minimum amount of material (maximum hole diameter and minimum shaft diameter). Abbreviated LMC.

Limits--The maximum and minimum permissible dimensions. Arrived at by applying tolerances to basic dimension.

Linear Dimension--A dimension measured in a straight line.

Maximum Material Condition--When a feature contains the maximum amount of material (minimum hole diameter and maximum shaft diameter). Abbreviated MMC.

Neck--An external groove cut in a cylindrical piece at a change in diameter, usually where another part is to fit against a shoulder.

Nominal Size--A term used for the purpose of general identification (3/4--in. plate, 1--in pipe, etc.).

Nonferrous--Metals that do not contain iron, such as brass, bronze, and aluminum.

Normalizing--The process of heating steel, then cooling in still air to room temperature to restore uniform grain structure and relieve internal stresses.

Oblique Surface--A flat surface slanting in two directions. It will appear distorted in all principal views.

Orthographic Projection--The process of projecting the essential views of a three dimensional object onto a flat plane, such as a piece of paper. This process is used for machinist's blueprints.

Pad--A raised projection on a casting. Used to provide extra metal around a series of holes or a slotted hole. See BOSS for comparison.

Parallel--Extending in the same direction, such as two lines, everywhere equidistant, and not meeting.

Pattern--A model, made of wood, metal, or other material, used to form a cavity in the sand for pouring castings.

Perpendicular--Being at a right angle (90°) to a given line or plane.

Pickle--To remove stains or oxide scale from parts by immersion in an acid solutions.

Pinion--The smaller of two mating gears.

Pitch--The distance from a point on a thread to a corresponding point on the next adjacent thread measured parallel to the axis.

Profile View--The view that most clearly illustrates the shape of a feature is considered the profile view of that feature. With a hole it would be the view showing that it is round.

5 • Blueprint Vocabulary

Quenching--Cooling metals rapidly by immersing them in water, oil, brine, or air.

Radius--The distance from the center of a circle or an arc to its circumference. Equal to one--half diameter. The plural of radius is "radii."

Ream--A machine operation consisting of enlarging a hole slightly with a rotating fluted tool to provide greater accuracy, and better finish.

Reciprocation--A straight--line, back--and--forth motion. To move in alternate directions.

Reference Dimension--Used only for informational purposes. Does not receive the standard print tolerance and should not be used for production or inspection.

Regardless of Size Feature--The condition where tolerance of position or form must be met irrespective of where the feature lies within its size tolerance. Abbreviated RFS.

Relief--The amount one plane surface of a piece is set below another plane, usually for clearance.

Rib--A relatively thin, flat member acting as a brace or support.

Round--A convex surface (exterior radius) at the intersection of two surfaces of a casting or forging.

Scale--Refers to the relative size of the drawing and the size of the part. The first number represents the size of the drawing and second number the size of the part. Dimensions always represent the size of the part, not the print.

Section--An interior view of an object, drawn to expose features not otherwise visible.

Serrated--A surface or edge having notches or sharp teeth is said to be serrated.

Shim--A thin piece of metal or other material placed between two parts to adjust the fit.

Shoulder--A plane surface on a shaft, normal to the axis and formed by a difference in diameter.

Spline--A raised area on a shaft (external) or hub (internal) parallel to the axis and designed to fit into a recessed area of a mating part.

Spotface--To machine a round spot on a rough surface, usually around a hole, to give a good seat to a nut or bolthead. Abbreviated SF or SFACE.

6 • Blueprint Standard Abbreviations

ACCESS.	accessory
ADJ	Adjustable, Adjust
ADPT	Adapter
ADV	Advance
AL	Aluminum
ALLOW.	Allowance
ALT	Alternate
ALY	Alloy
AMT	Amount
ANL	Anneal
ANSI	Amer. Natl Stds Inst
APPROX	Approximate
ASME	Amer Society Of Mech Engrs
ASSY	Assembly
AUTH	Authorized
AUTO.	Automatic
AUX	Auxiliary
AVG	Average
AWG	American Wire Guage
BC	Bolt Circle
BET.	Between
BEV	Bevel
BHN	Brinell Hardness Number
BLK	Blank, Block
B/M	Bill of Material
BOT	Bottom
BP or B/P	Blueprint
BRG	Bearing
BRK	Break
BRKT	Bracket
BRO	broach
BRS	Brass
BRZ	Bronz
B&S	Brown & Sharp
BSC	Basic
BUSH.	Bushing
BWG	Birmingham Wire Guage
C to C	Center-to-Center
CAD	Computer-Aided Drafting
CAM	Computer-Aided Mfg.
CAP.	Capacity
CAPSCR	cap screw
CARB	carburize
CBORE	coounterbore
CCW	counter clockwise
CDRILL	counter drill
CDS	cold-drawn steel
CFS	cold-finished steel
CH	Case Harden
CHAM	Chamfer
CHAN	Channel
CHG	Change
CHK	Check
CI	Cast Iron
CIR	Circle, Circular
CIRC	Circumference
CL	Center Line
CLP	Clamp
CNC	Computer Numerical Control
COMB.	Combination
CONC	Concentric
CONN	Connect, Connector
COV	Cover
CPLG	Coupling
CRS	Cold-Rolled Steel
CS	Cast Steel
CSA	Canadian Stds Association
CSK	Countersink
CSTG	Casting
CTR	Center
CU	Cubic
CW	Clockwise
CYL	Cylinder, Cylindrical
DBL	Double
DEC	Decimal
DEG	Degree
DET	Detail
DEV	Develop
DFT	Draft
DIA	Diameter
DIM	Dimension
DIST	Distance
DN	Down
DP	Deep, Diametral Pitch
DR	Drill, Drill Rod
DSGN	Design
DVTL	Dovetail
DWG	Drawing
DWL	Dowel
DWN	Drawn
EA	Each
ECC	Eccentric
EFF	Effective
ENG	Engine
ENGR	Engineer
ENGRG	Engineering
EQL SP	Equally Spaced
EQUIV	Equivalent
EST	Estimate
EX	Extra
EXP	Experimental
EXT	Extension, Exteral
FAB	Fabricate
FAO	Finish All Over
FDRY	Foundry
FIG.	Figure
FIL	Fillet, Fillister
FIM	Full Indicator Movement
FIN.	Finish
FIX.	Fixture
FLEX.	Flexible
FLG	Flange
FORG	Forging
FR	Frame, Front
FTG	Fitting
FWD	Forward
GA	Gage, Guage
GALV	Galvanized
GR	Grade
GRD-G	Grind
GRV	Groove
GSKT	Gasket
H&G	Harden & Grind
HD	Head
HDL	Handle
HDLS	Headless
HDN	Harden
HDW	Hardware
HEX	Hexagon
HGR	Hanger
HGT	Height
HOR	Horizontal
HRS	Hot-Rolled Steel
HSG	Housing
HT TR	Heat Treat
HVY	Heavy
HYD	Hydraulic
ID	Inside Diameter

6 • Blueprint Standard Abbreviations

INDENT	Identification
ILLUS	Illustration
IN.	Inch
INCL	Include, Including
INCR	Increase
INFO	Information
INSP	Inspect
INSTL	Install
INST	Instruct, Instrument
INT	Interior, Internal
IR	Inside Radius
ISO	Intl. Stds Organization
JCT	Junction
JNL	Journal
JT	Joint
K	Key
KNRL	Knurl
KST	Keyseat
KWY	Keyway
LB	Pound
LBL	Label
LG	Length, Long
LH	Left Hand
LMC	Least Material Condition
LOC	Locate
LT	Light
LTR	Letter
LUB	Lubricate
MACH	Machine
MAINT	Maintenance
MATL	Material
MAX	Maximum
MECH	Mechanical
MED	Medium
MFG	Manufacturing
MI	Malleable Iron
MIN	Minimum, Minute
MISC	Miscellaneous
mm	Millimeter
MMC	Max Material Condition
MS	Machine Steel
MTG	Mounting
MULT	Multiple
MWG	Music Wire Gauge
NA	Not Applicable
NC	Numerical Control
NEG	Negative
NO.	Number
NOM	Nominal
NPSM	Natl Pipe Straight Mech
NPT	Natl Pipe Tapered
NTS	Not to Scale
OA	Over All
OBS	Obsolete
OC	On Center
OD	Outside Diameter
OPP	Opposite
OPTL	Optional
OR	Outside Radius
ORIG	Original
PATT	Pattern
PC	Piece, Pitch Circle
PCH	Punch
PD	Pitch Diameter
PERF	Perforate
PERM	Permanent
PERP	Perpendicular
PF	Press Fit
PFD	Preferred
PKG	Package, Packing
PL	Parting Line, Plate
PNEU	Pneumatic
PNL	Panel
POL	Polish
POS	Position, Positive
PR	Pair
PRI	Primary
PROC	Process
PROD	Product, Production
PSI	Pounds Per Square Inch
PT	Part, Point
QTR	Quarter
QTY	Quantity
QUAL	Quality
R	Radius
RA	Rockwell Hardness A-Scale
RB	Rockwell Hardness B-Scale
RC	Rockwell Hardness C-Scale
RECD	Received
RECT	Rectangle
REF	Reference
REINF	Reinforce
REL	Release, Relief
REM	Remove
REQD	Required
RET.	Retainer, Return
REV	Reverse, Revision, Revolution
RFS	Regardless of Feature Size
RGH	Rough
RH	Right Hand
RIV	Rivet
RM	Ream
RND	Round
RPM	Revolutions Per Minute
RPW	Resistance Projection Weld
SAE	Society Of Automotive Engrs
SCH	Schedule
SCR	Screw
SEC	Second
SECT	Section
SEP	Seperate
SEQ	Sequence
SER	Serial, Series
SERR	Serrate
SF	Slip Fit, Spotface
SFT	Shaft
SGL	Single
SH	Sheet
SI	Intl Systems Unit
SL	Slide
SLV	Sleeve
SOC	Socket
SP	Space
SPL	Special
SPEC	Specification
SPG	Spring
SPHER	Spherical
SPRKT	Sproket
SQ	Square
SST	Stainless Steel
STD	Standard
STK	Stock
STL	Steel

6 • Blueprint Standard Abbreviations

STR	Straight, Strip
SUB	Substitute
SUP.	Supply, Support
SURF	Surface
SYM	Symmetrical
SYS	System
T	Teeth, Tooth
TECH	Technical
TEMP	Template, Temporary
THD	Thread
THK	Thick
TIR	Total Indicator Reading
TOL	Tolerance
TOT	Total
TPF	Taper per Foot
TPI	Taper (or Threads) per Inch
TPR	Taper
TS	Tool Steel
TYP	Typical
UNC	Unified Natl Coarse
UNEF	Unified Natl Extra Fine
UNF	Unified Natl Fine
UNIV	Universal
UOS	Unless Otherwise Specified
VAR	Variable
VERT	Vertical
VOL	Volume
VS	Versus
W	Wide, Width
WASH.	Washer
WDF	Woodruff
WI	Wrought Iron
WT	Weight