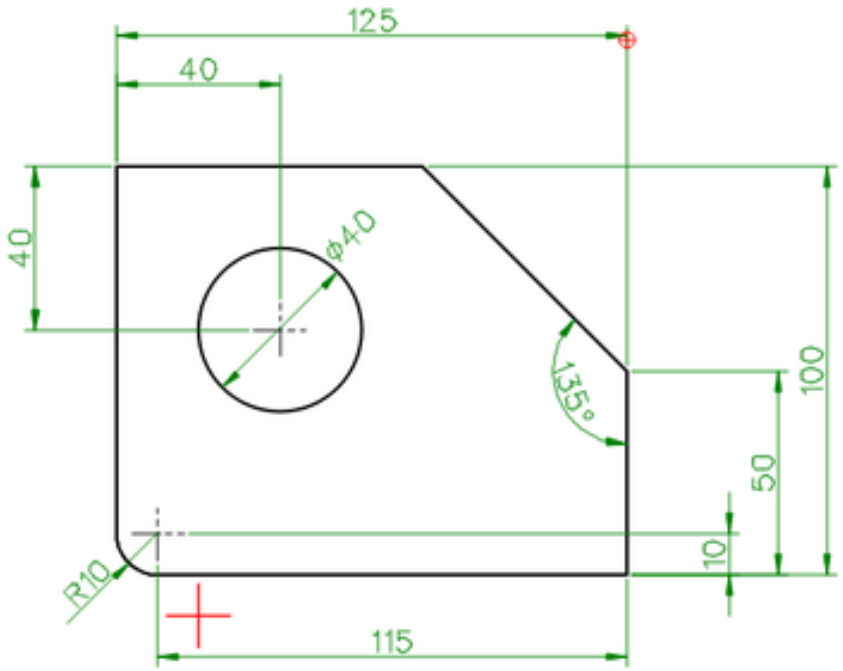
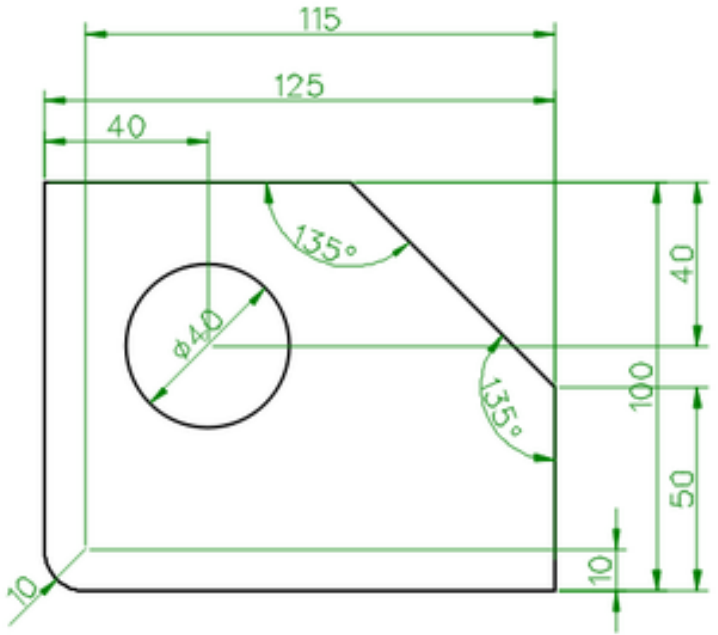
Drawing Dimensioning



Good Dimensioning

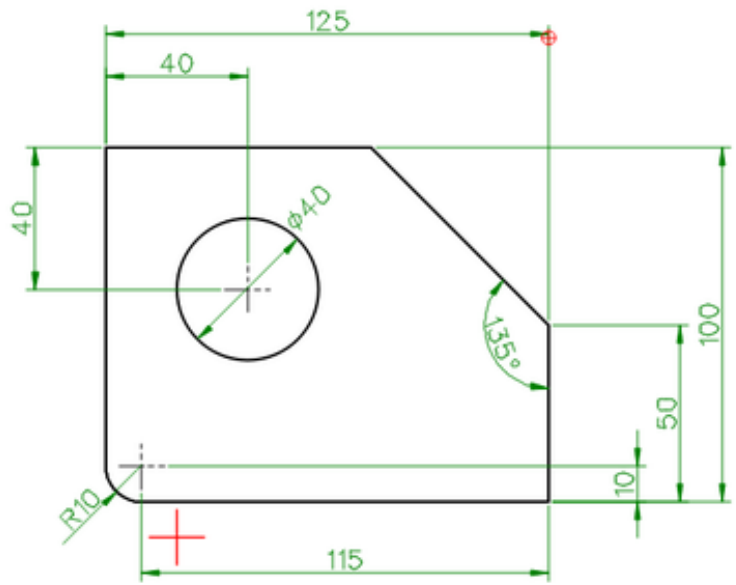


Bad Dimensioning

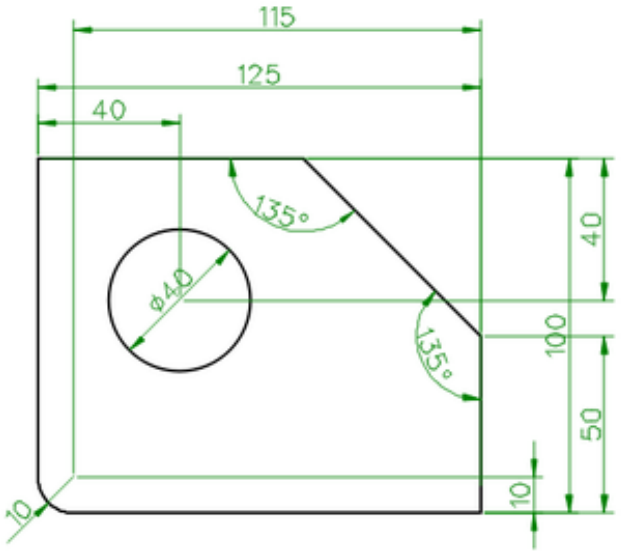
Dimensioning

- A dimension is a numerical value shown on a drawing to define the size and location of an object.

- To promote clarity, accuracy, and uniformity, they developed standard dimensioning practices.



Good Dimensioning



Bad Dimensioning

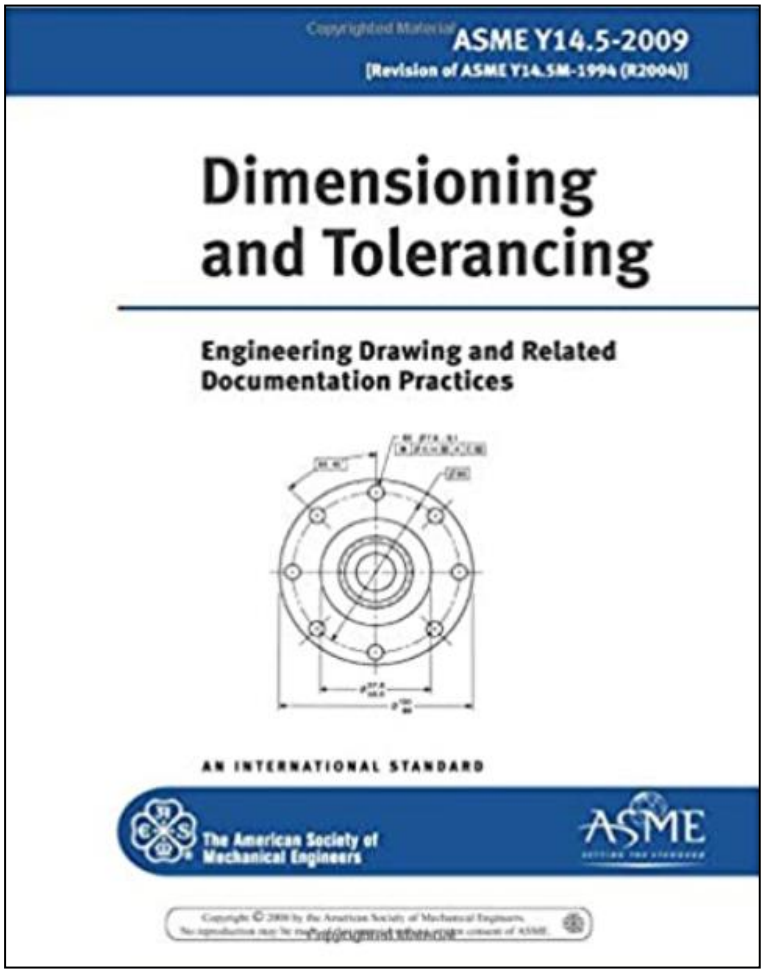
Who are “they”?

ANSI & ASME !

(American National Standards Institute & American Society of Mechanical Engineers)

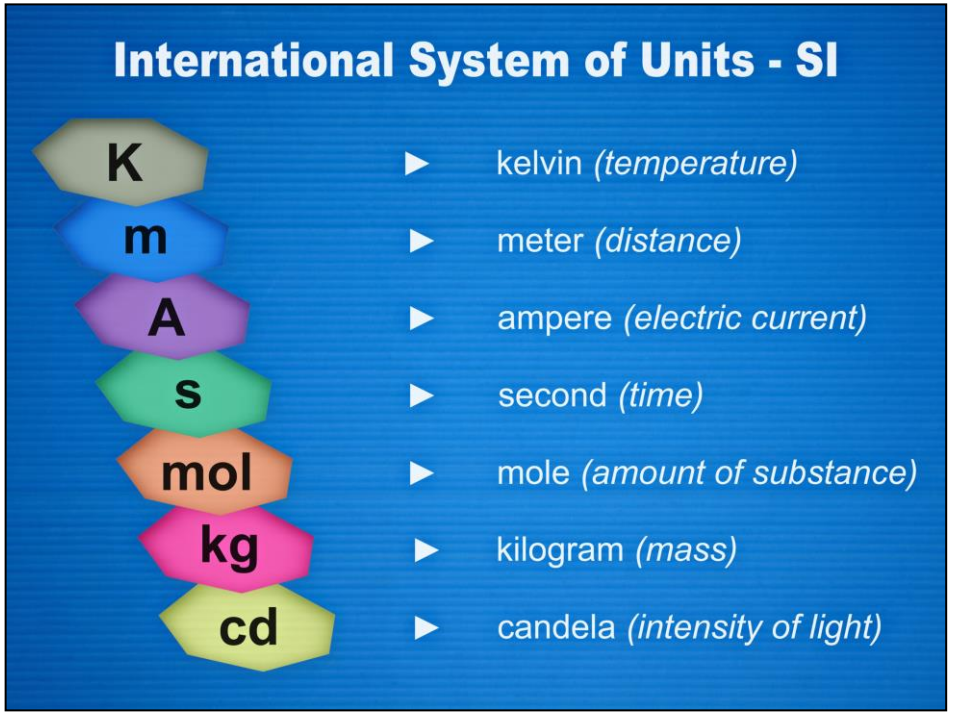
ASME Y14.5 - 2009
Dimensioning Standards

- Developed by ANSI and published by ASME.
- These standards define the language of drafting that is used in the U.S.



Physical Quantities, Measurement, Units

- Recall: There are only 7 basic physical quantities in the universe!

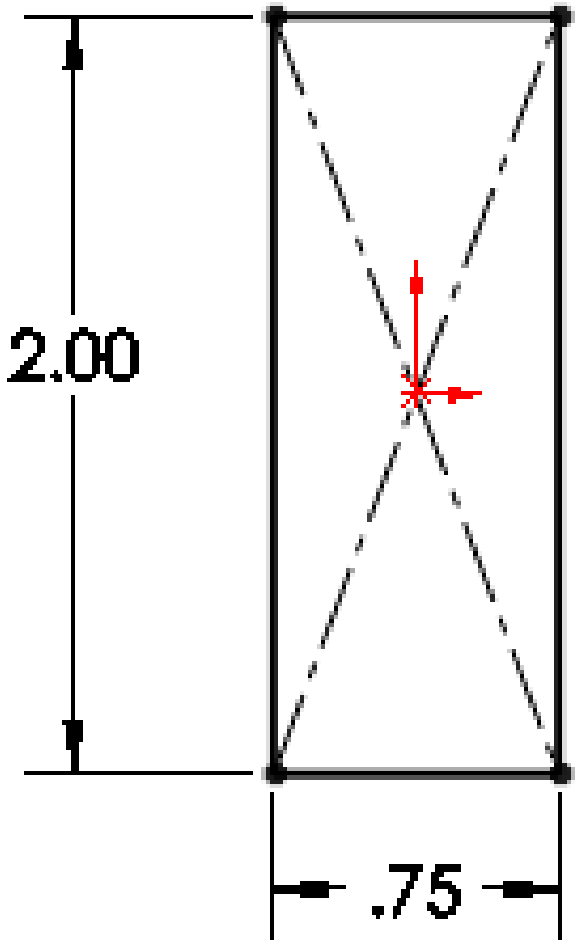


- Measurement is the process that determines the ratio of a physical quantity, such as temperature, length, current, time, etc. to a standard unit of measurement, such as degree Kelvin, meter, ampere, second, etc.

- Two common systems of units:
  U.S. (inch, pound, second) & **Metric** (millimeter, gram, second)

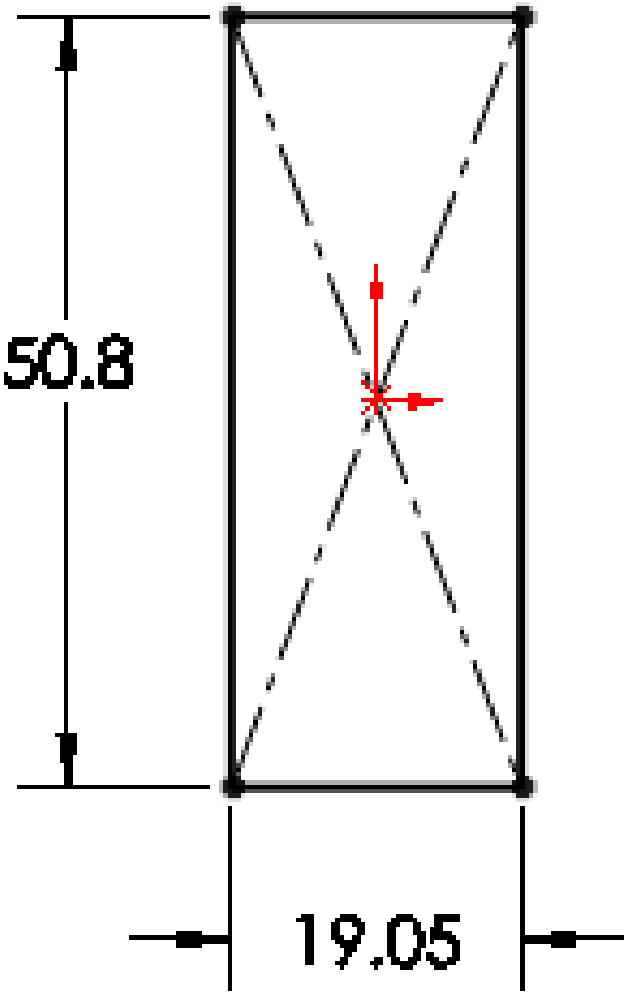
Dimensioning – Systems of Units

- The U.S. unit system is also known as the Inch, Pound, Second (IPS) unit system.
- ANSI standard for U.S. dimensioning use the decimal inch value.
- The (inch) is not needed on each dimension, but it is used when a dimension is used in a notation.
- Whole numbers show the decimal point and zeros.
  Leading zeros are not used for values less than one.
  Trailing zeros are used.



Dimensioning – Systems of Units

- The Metric or International System of Units (S.I.) unit system is also known as the Millimeter, Gram, Second (MMGS) unit system.
- ASME standard for metric dimensioning use millimeters (mm).
- The (mm) is not needed on each dimension, but it is used when a dimension is used in a notation.
- Whole numbers omit the decimal point and zeros.
  Leading zeros are used for values less than one.
  Trailing zeros are not used.

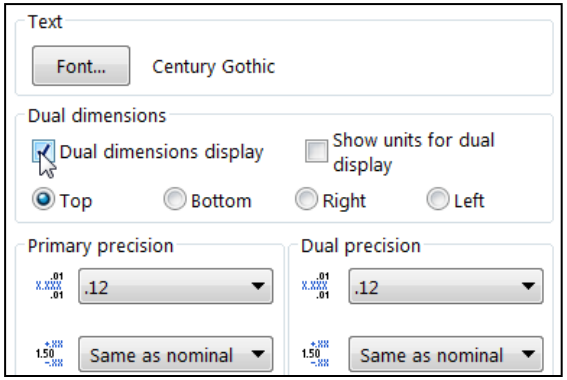


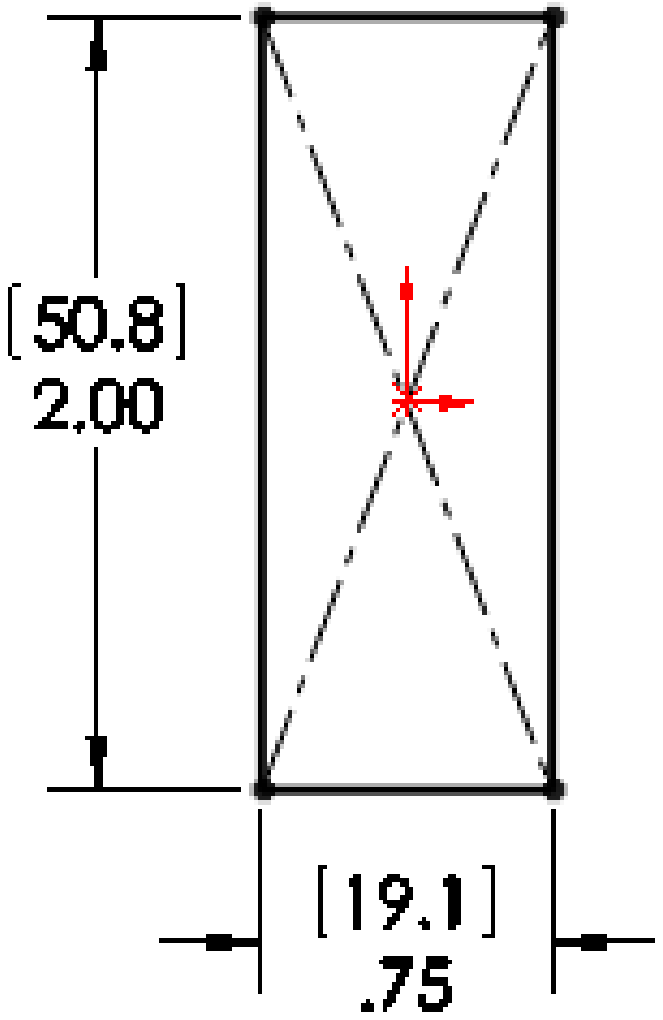
Dimensioning – Systems of Units

Dual Dimensioning

- Sometimes the object manufactured requires using both the U.S. and metric measuring system.

- In this illustration, the primary units are inches and the secondary units (mm) are displayed in parenthesis.





Principles of Good Dimensioning

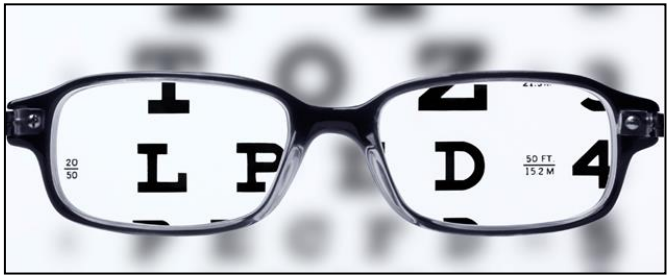
Overriding principle is clarity!

- All drawings should be dimensioned completely so that the part can be built with a minimum of computation.

- Dimensions should not be duplicated or the same information given in two different ways, unless it gives ease and clarity to read.
  If used, the redundant dimension is called a **reference dimension** and the size value is placed in parentheses.

Principles of Good Dimensioning

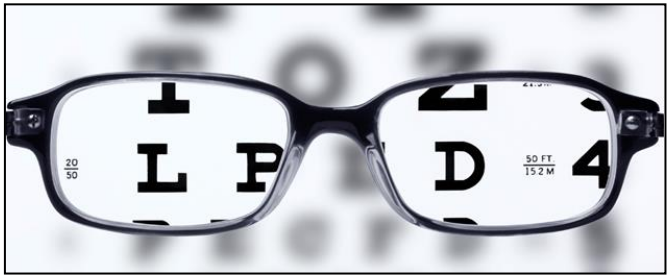
Overriding principle is clarity!



- Dimensions should be placed in the most descriptive view of the feature.
  For example dimension a slot in a view where the contour of the slot is visible.
- Dimensions should be located outside the boundaries of a view.
- The spacing of dimension lines should be uniform throughout the drawing.
- Avoid dimension lines crossing.
- Avoid dimensioning to hidden lines.
- Avoid overlapping extension lines and object lines.
- Avoid crowding and misinterpretation.

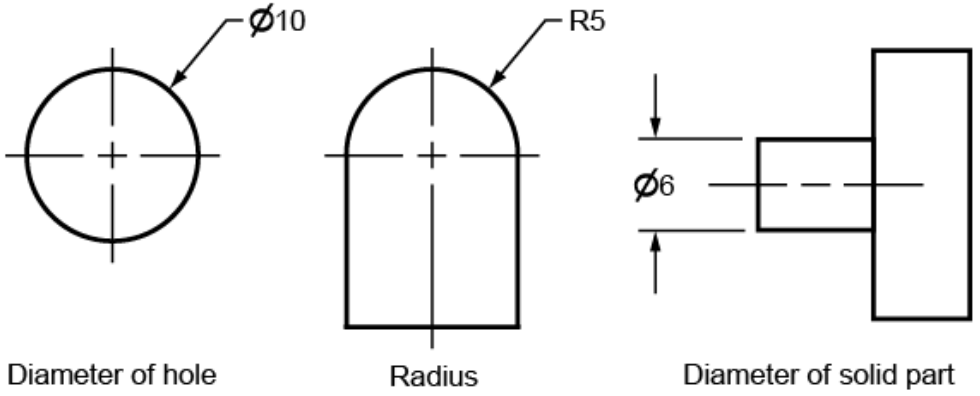
Principles of Good Dimensioning

Overriding principle is clarity!



- A leader line for a diameter or radius should be radial. (i.e. one that passes through the center of the circle or arc if extended.

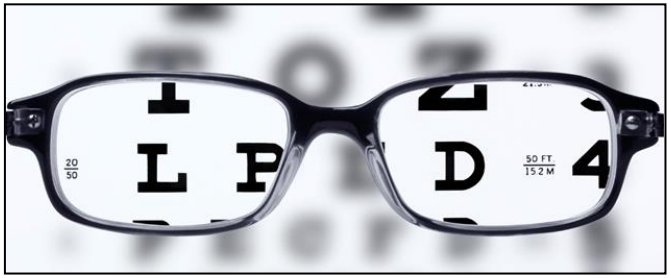
- Diameters are dimensioned with a numerical value preceded by the diameter symbol. Radii are dimensioned with a numerical value preceded by the radius symbol.



- When a dimension is given to the center of an arc or radius, a small cross (center mark) should be displayed.

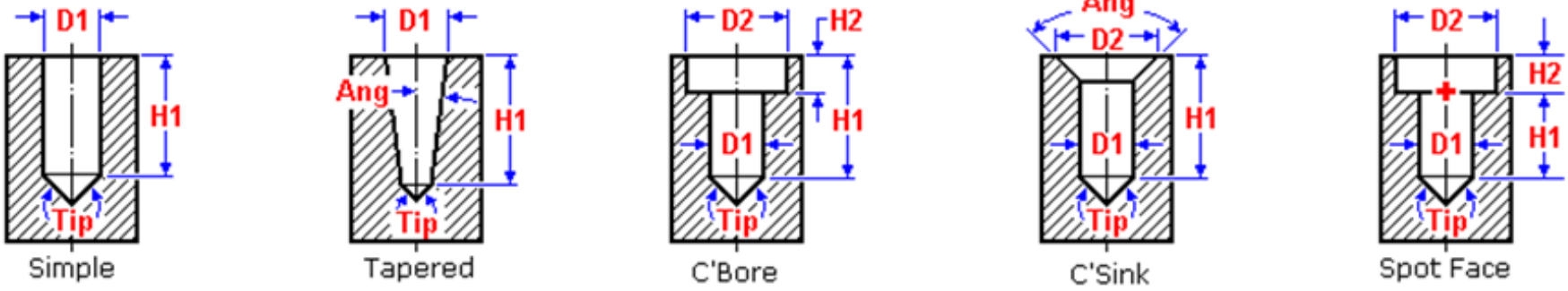
Principles of Good Dimensioning

Overriding principle is clarity!



- The depth of a blind hole may be specified in a note. The depth is measured from the surface of the object to the deepest point where the hole still measures a full diameter.

- Counter bored, spot-faced, or countersunk holes should be specified in a note.



Standards for Dimensioning

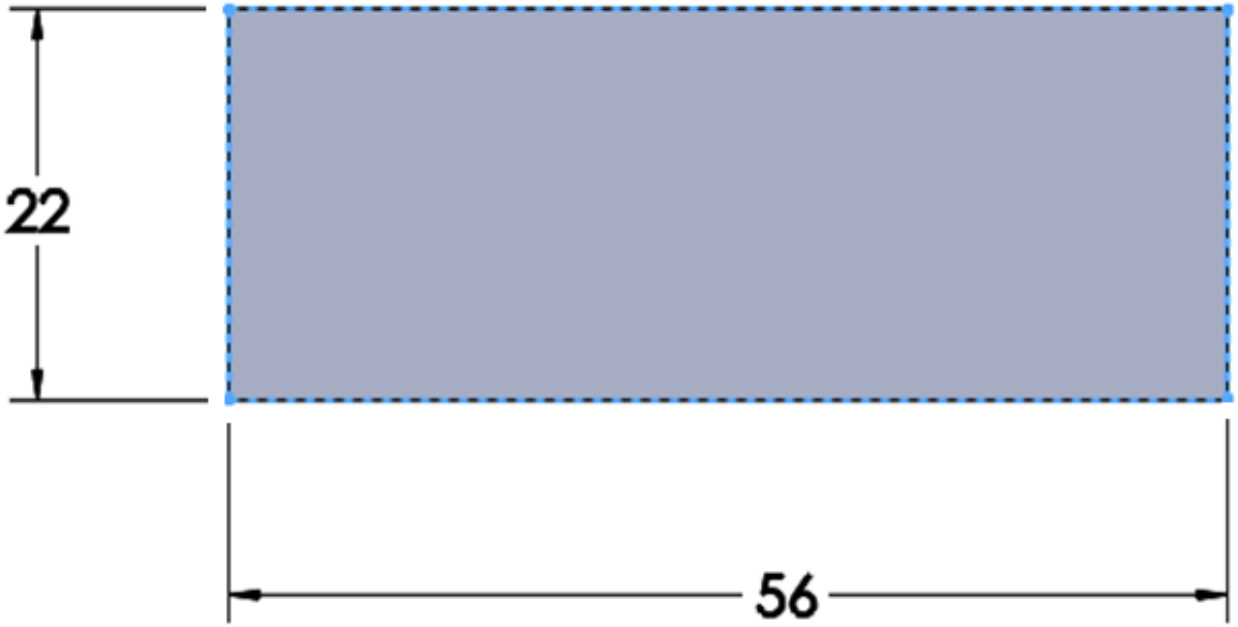
A drawing dimension consists of

- Dimension line
- Dimension arrowheads (to terminate dimension lines)
- Dimension value
- Extensions lines

There is a visible gap ~1.5mm between the object (feature) line and the each extension line.

The point of the arrowheads must make contact with the feature line.

The standard size ratio for arrowheads on mechanical drawings is ~2.5:1

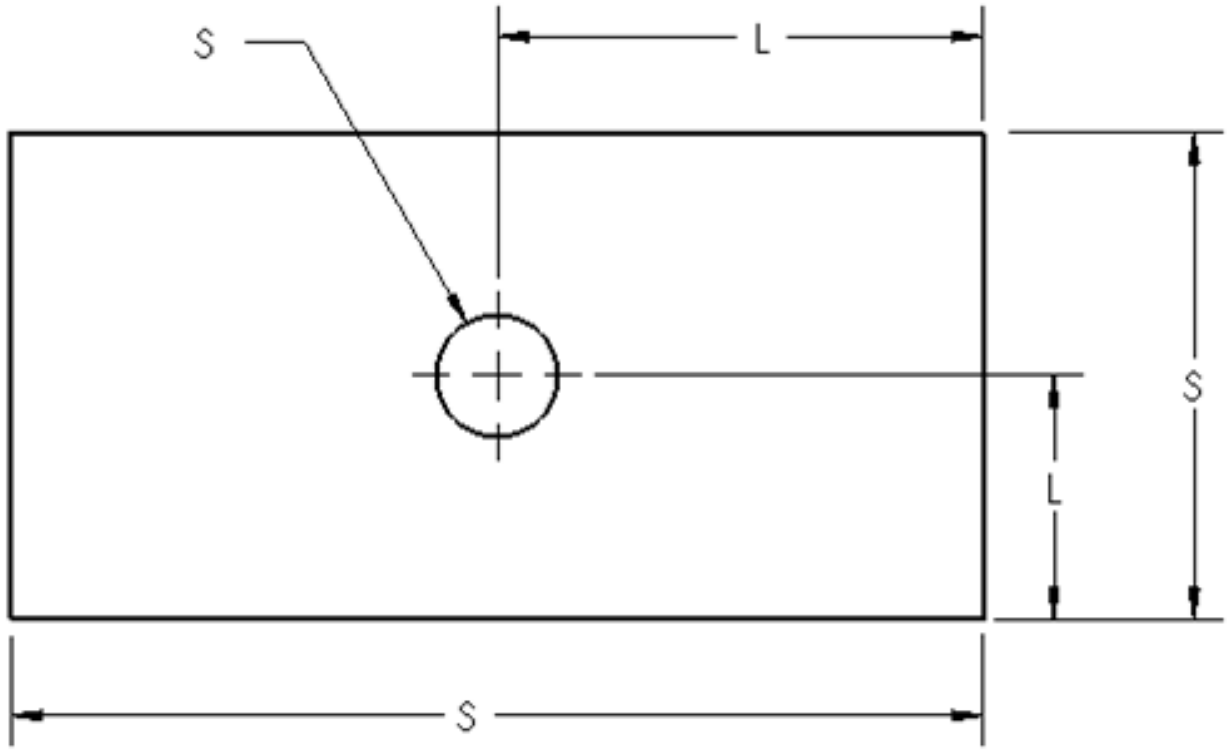


Standards for Dimensioning

Two key types of dimensions:

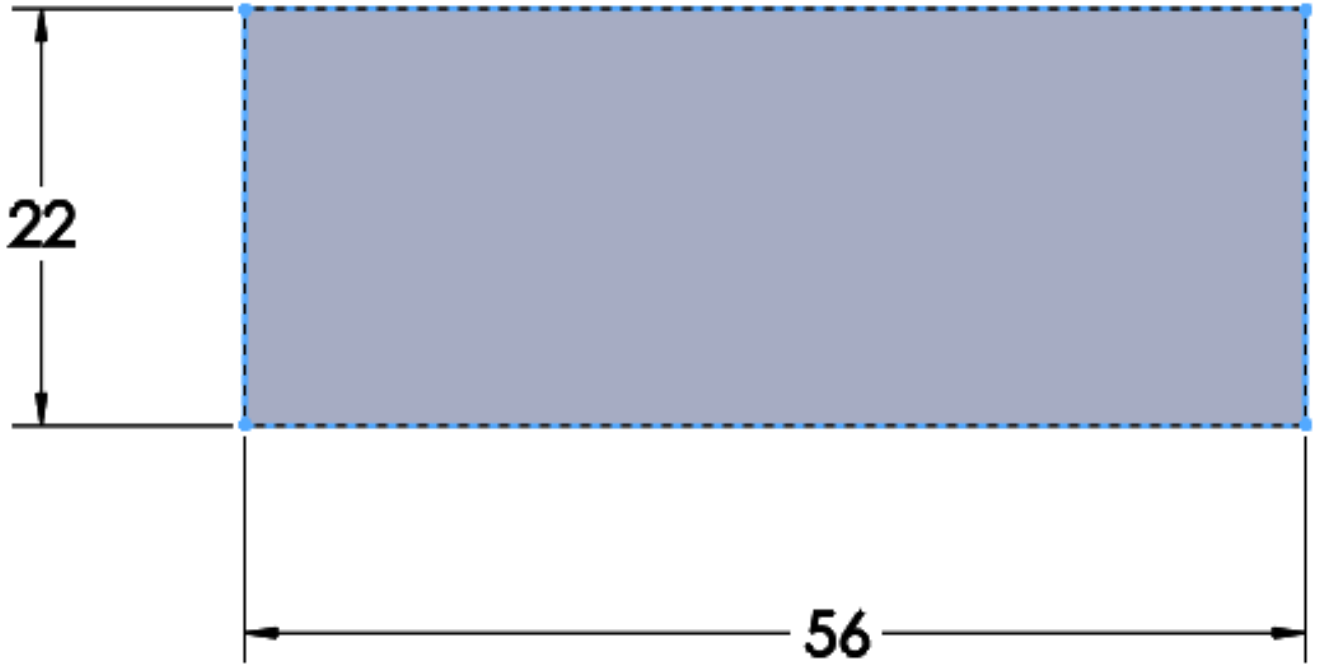
Location dimension
locates a horizontal or vertical position, center of a hole, slot, etc.

Size dimension
provides length of an edge, angle, diameter, radius, etc.



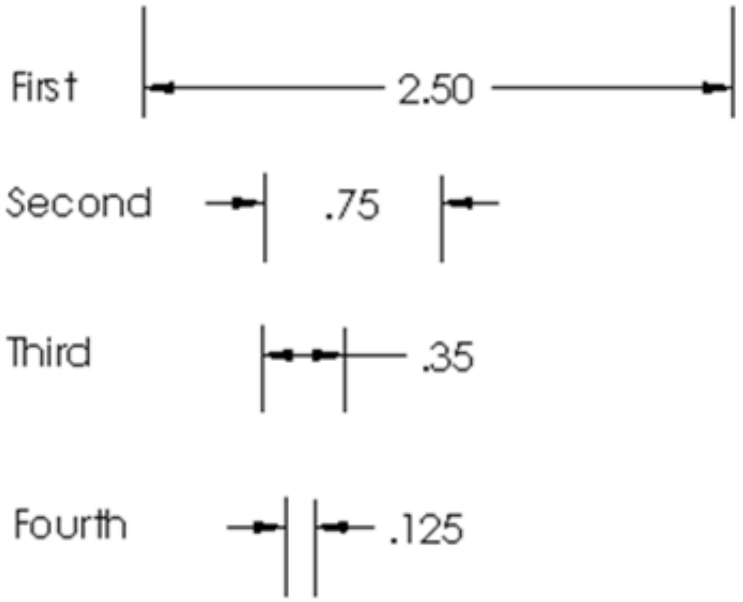
Standards for Dimensioning

A Linear dimension
measures a length of the object and is either horizontal or vertical in the dimensioning plane.



Standards for Dimensioning

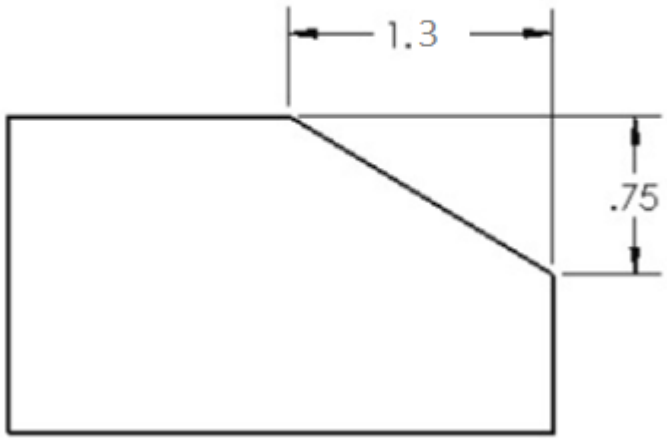
Linear dimension styles
Order of preference

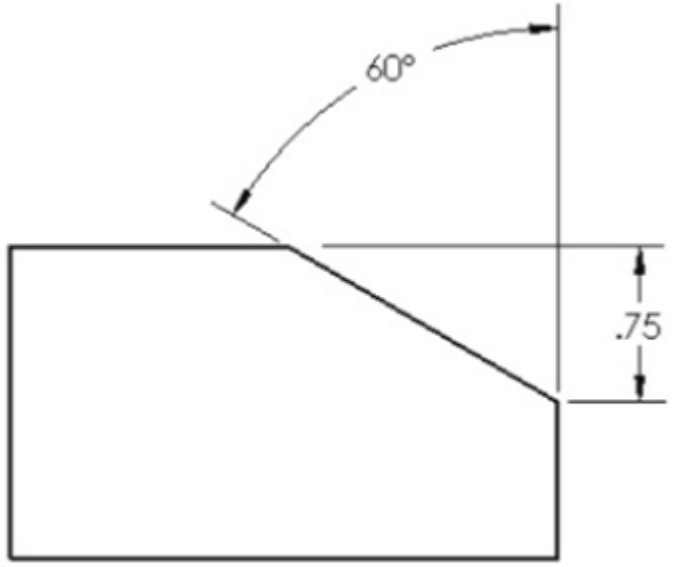


1. Arrows in / dimension in
2. Arrows out / dimension in
3. Arrows in / dimension out
4. Arrows out / dimension out

Standards for Dimensioning

Two methods to dimension angles





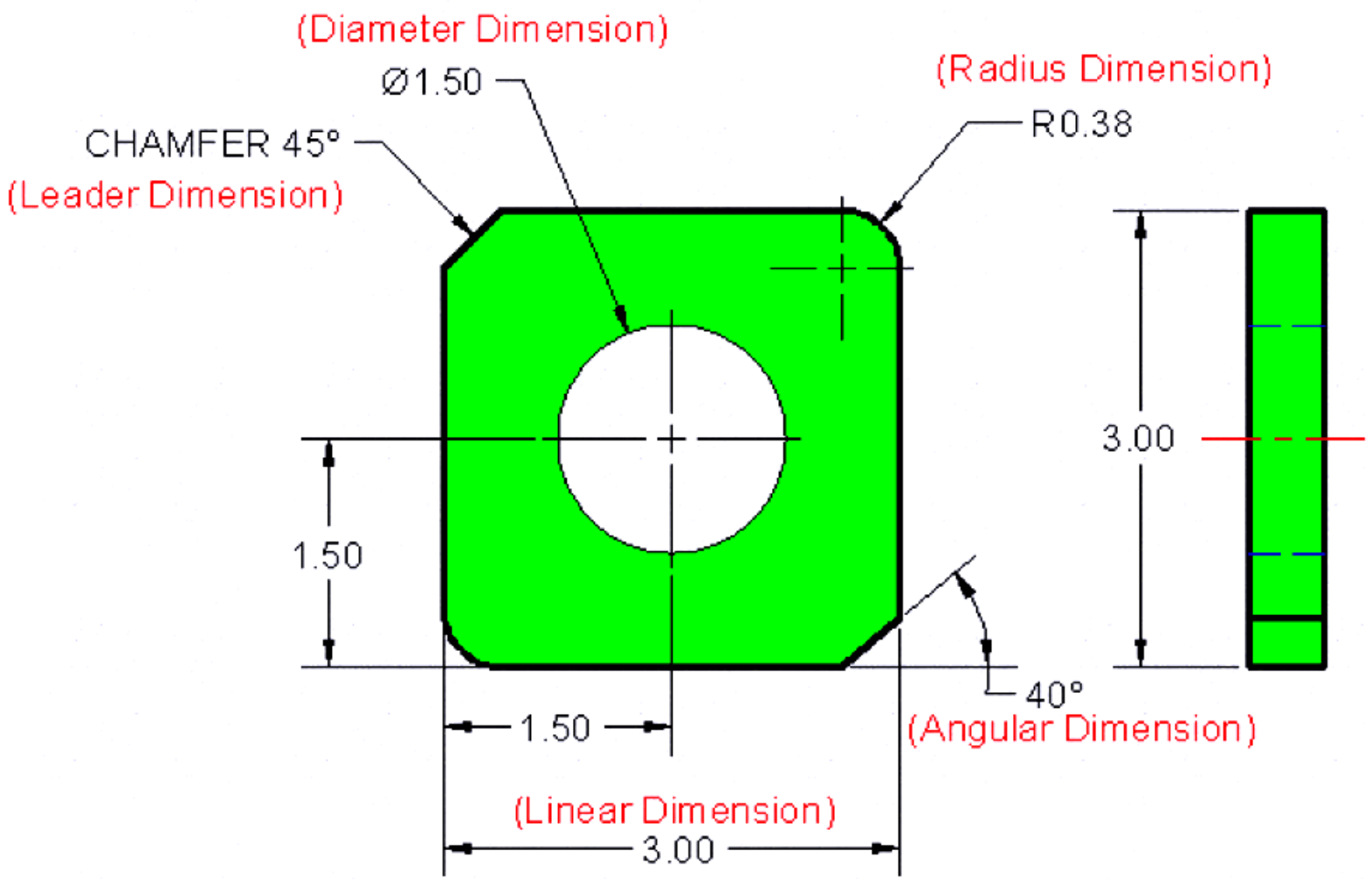
The angular dimension units can be:

decimal degrees: 60.00º

degrees, minutes and seconds: 60º0'0"

Standards for Dimensioning

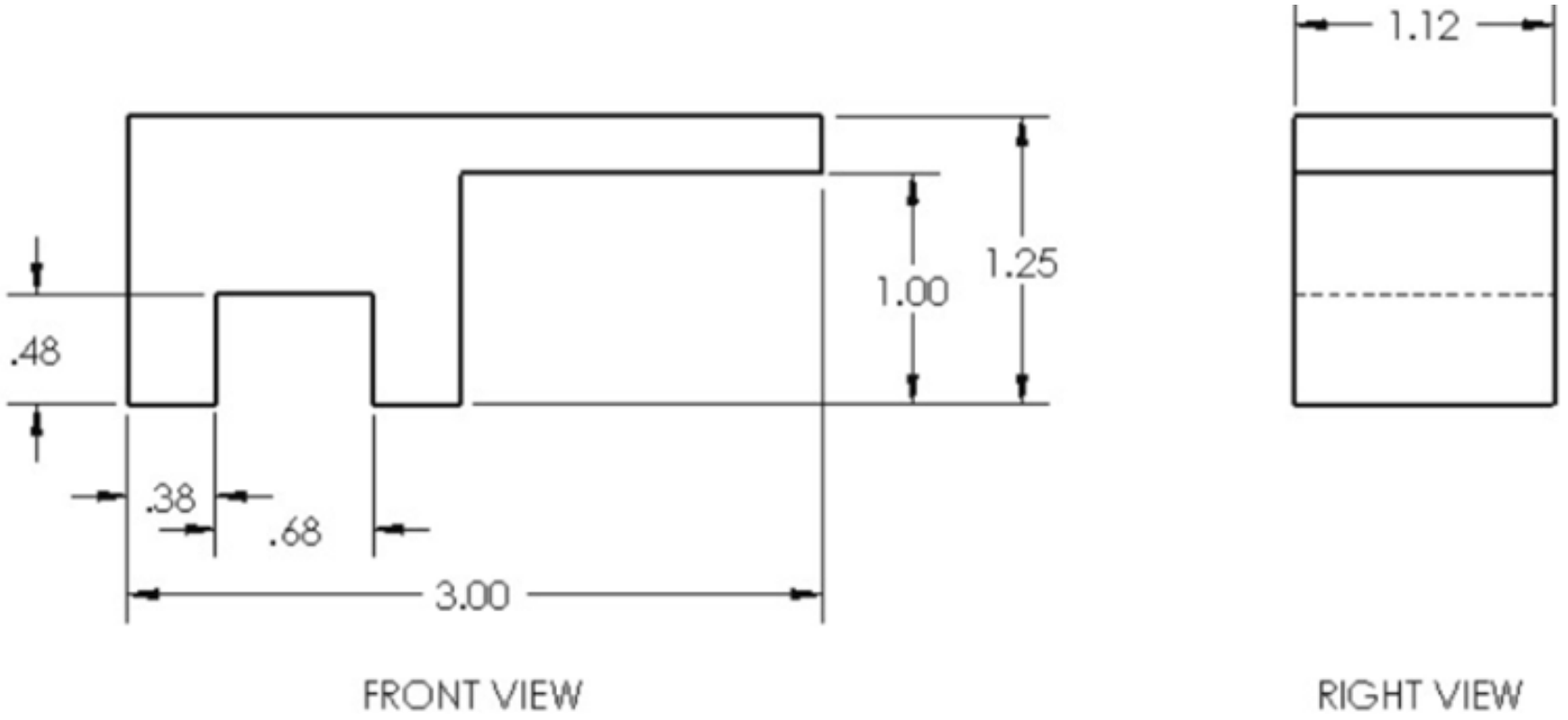
Other types of dimensions



Standards for Dimensioning

Size dimensions

Two of the three dimensions (width, height and depth) are placed on the principal view and the third dimension is located on one of the other views.
(Note the subtle difference in the meaning of the word “dimension” in this sentence.)

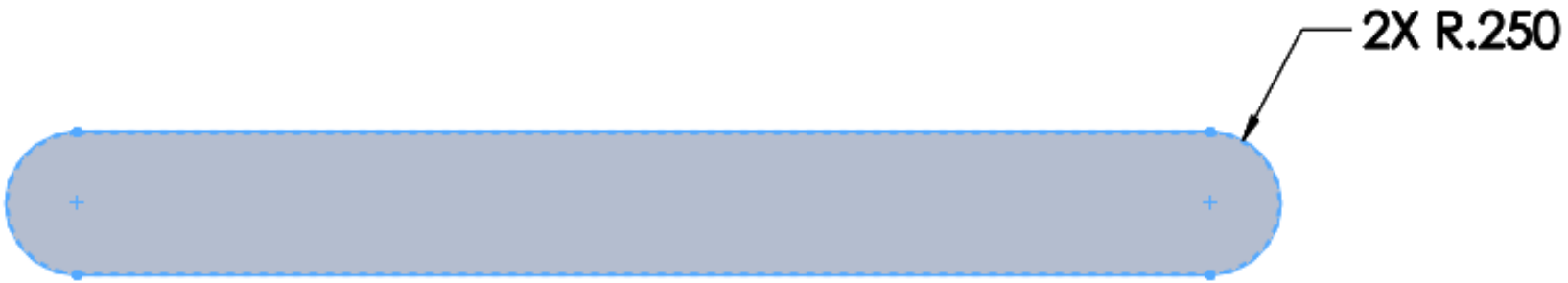


Standards for Dimensioning

Radius dimension (uses leader line)

If an arc is less than half a circle, the radius is specified.

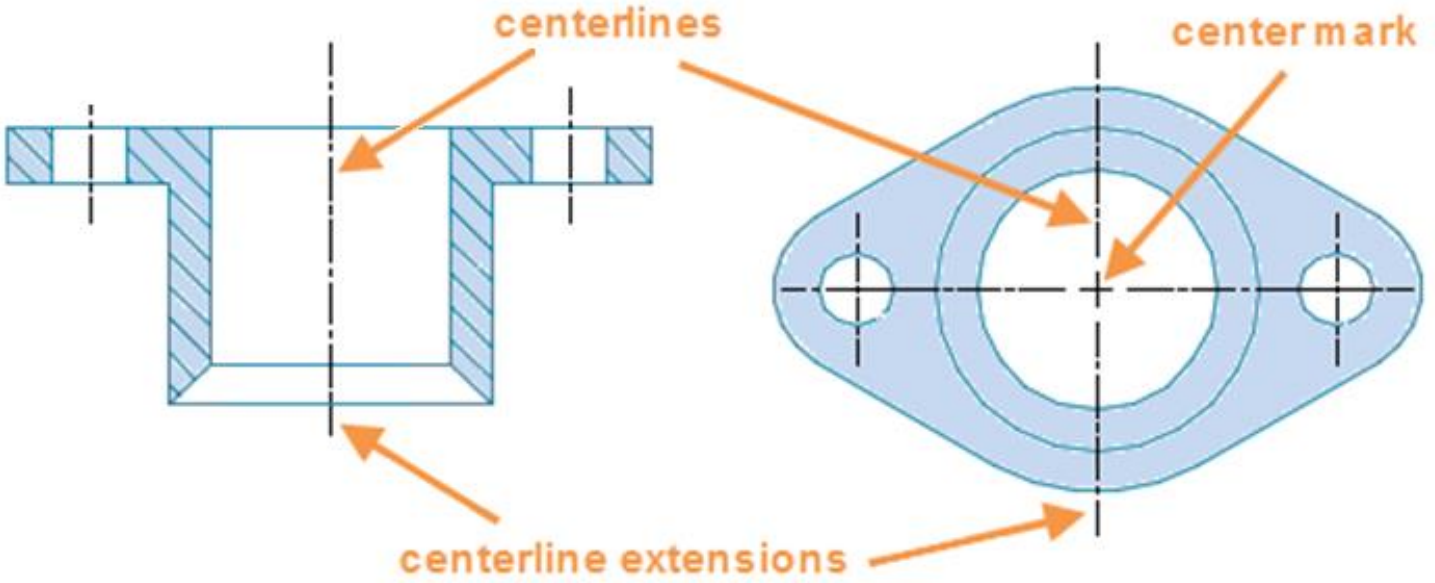
The leader dimension line has a single arrowhead touching the arc.



Standards for Dimensioning

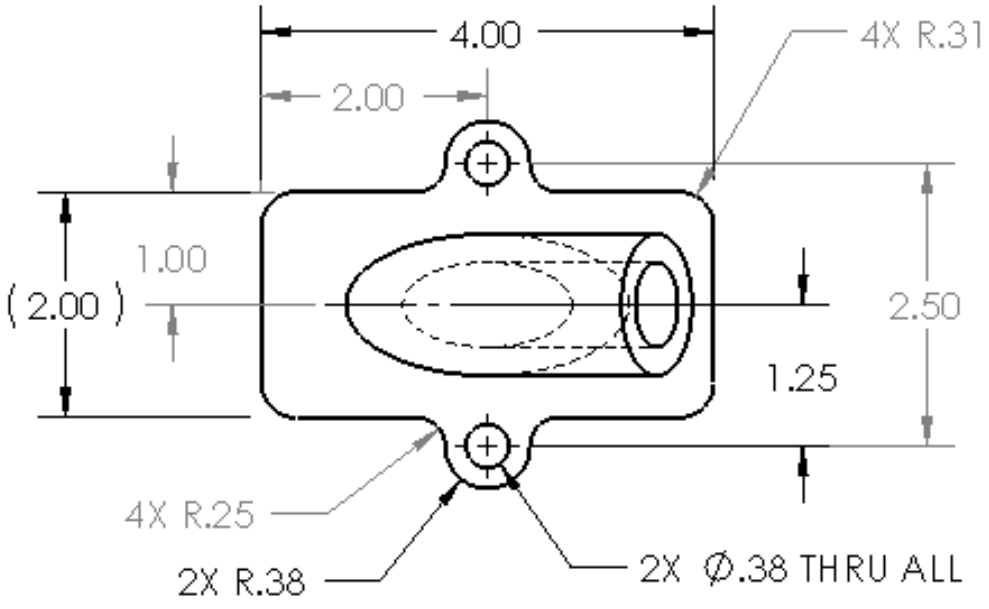
Center lines

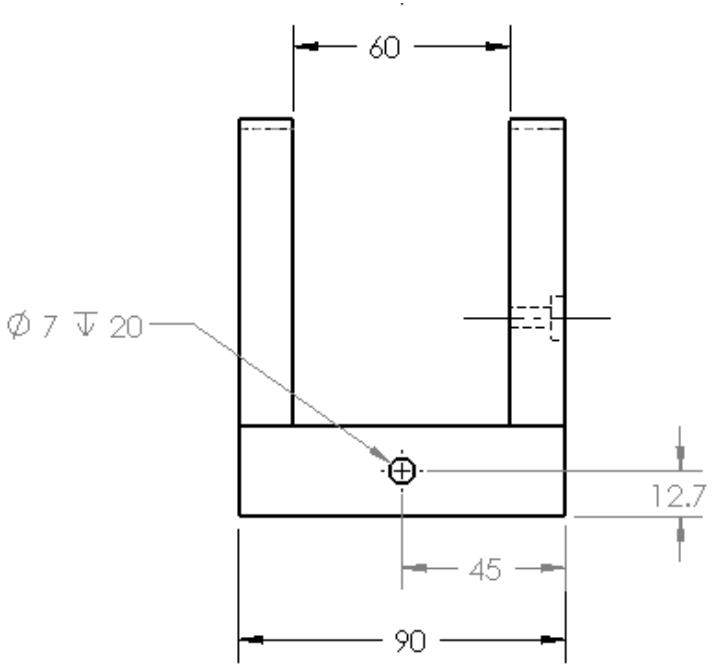
- used to indicate the symmetry of shapes
  (eliminates the need for a positioning dimension)
- may be used as extension lines
- should extend about 6mm (0.25in) beyond the shape
  (unless they are carried further to serve as extension lines)
- should not be continued between views.



Standards for Dimensioning

Center lines or Center marks should be used on all circles, holes and slots.

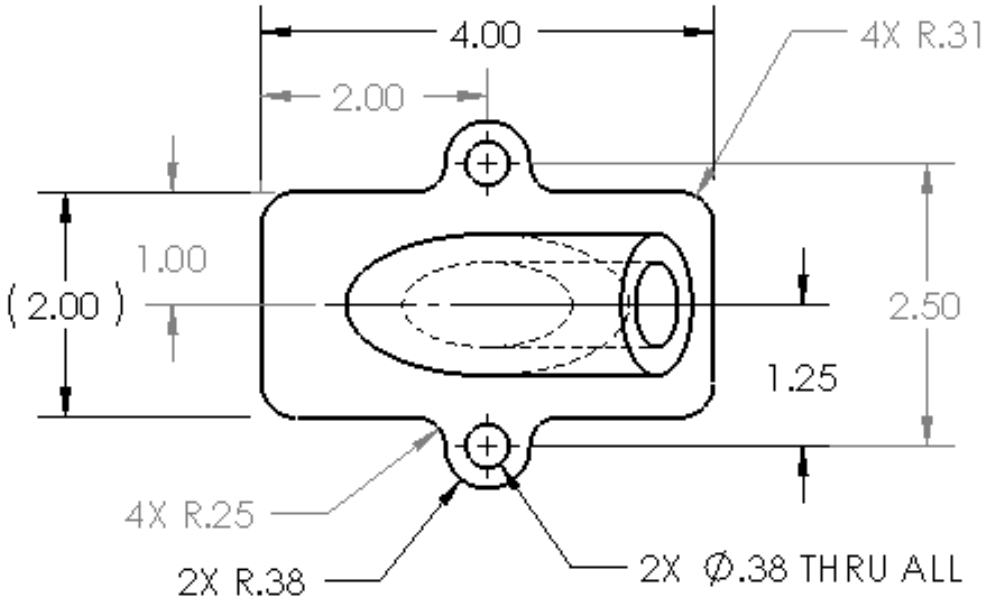


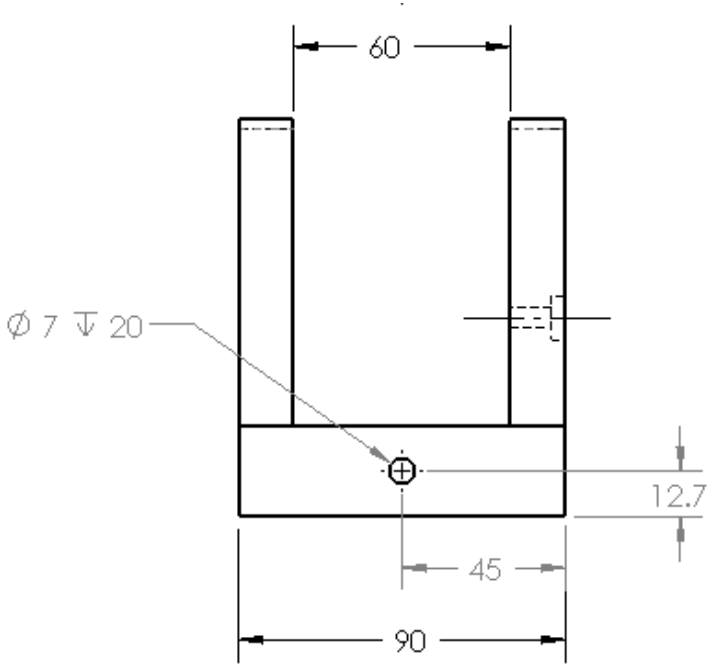


Standards for Dimensioning

Dimensions nearest to the feature line should be at least .375 inches or (10mm) away from the model.

Succeeding parallel dimension lines should be at least .250 inches (6mm) apart.

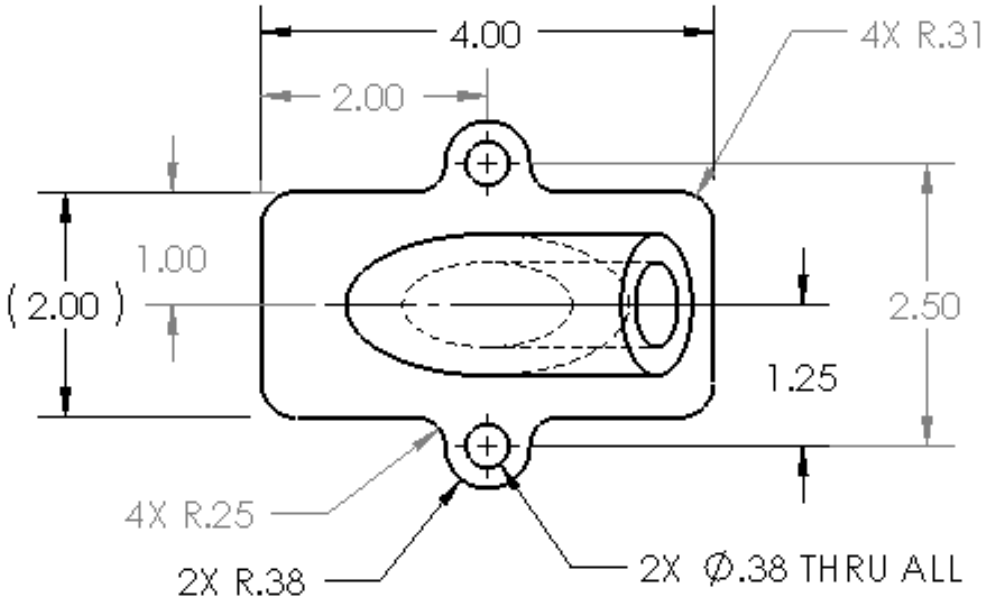


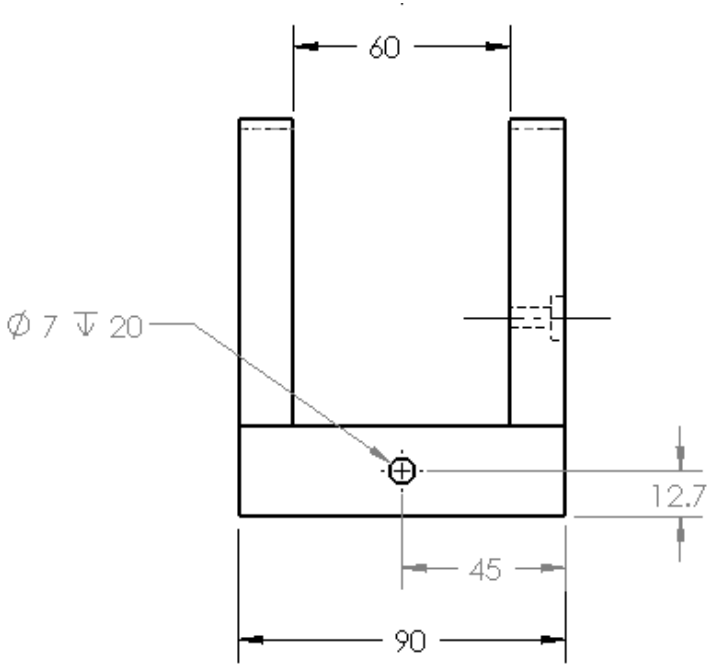


Standards for Dimensioning

Stager dimensions

Smaller (shorter) dimensions are located closest to the feature line, followed by larger dimensions of length.





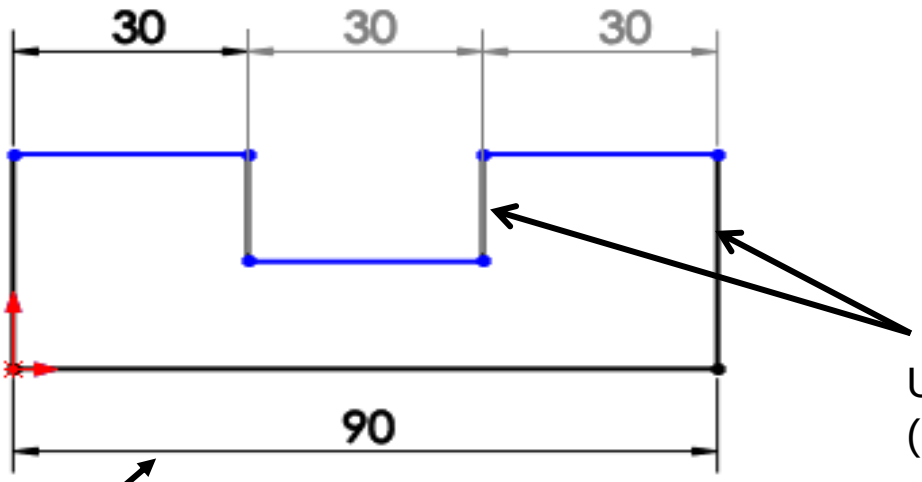
Standards for Dimensioning

Do not under dimension a drawing.

Ensure that all dimensions are accounted for.

Do not over dimension a drawing.

Dimensions should not be duplicated or the same information given in two different ways.



Under dimensioned
(in terms of depth)

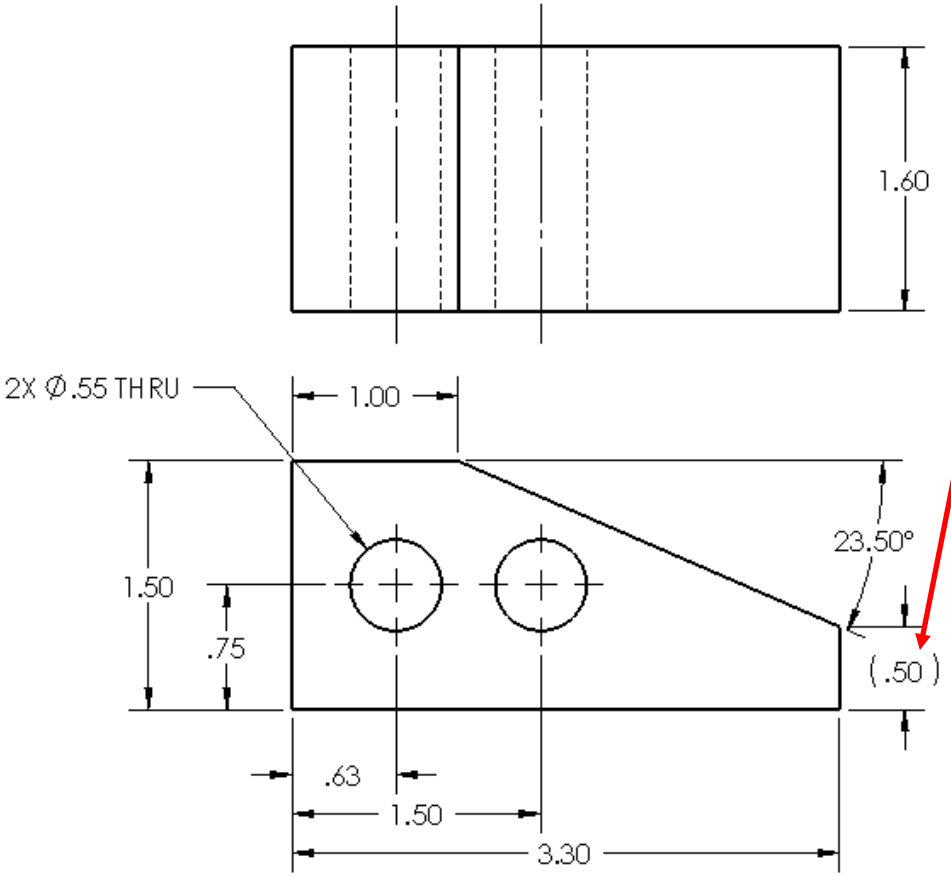
Over dimensioned
(in terms of width)

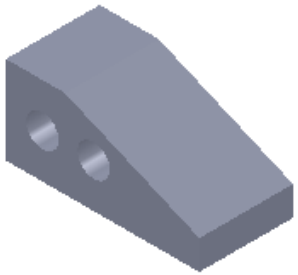
FRONT

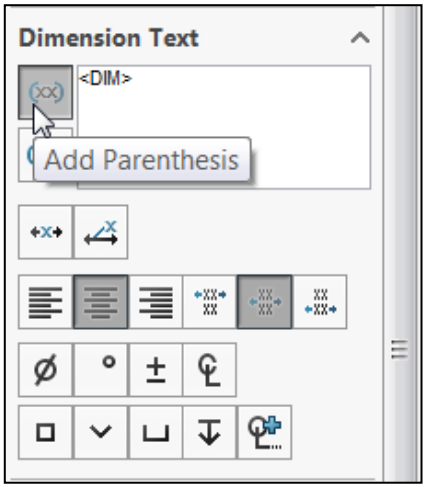
Standards for Dimensioning

It is allowable to over dimension when such dimensions make the drawing clearer and easier to read.

In that case the redundant dimension is called a **reference dimension** and is placed in parentheses.



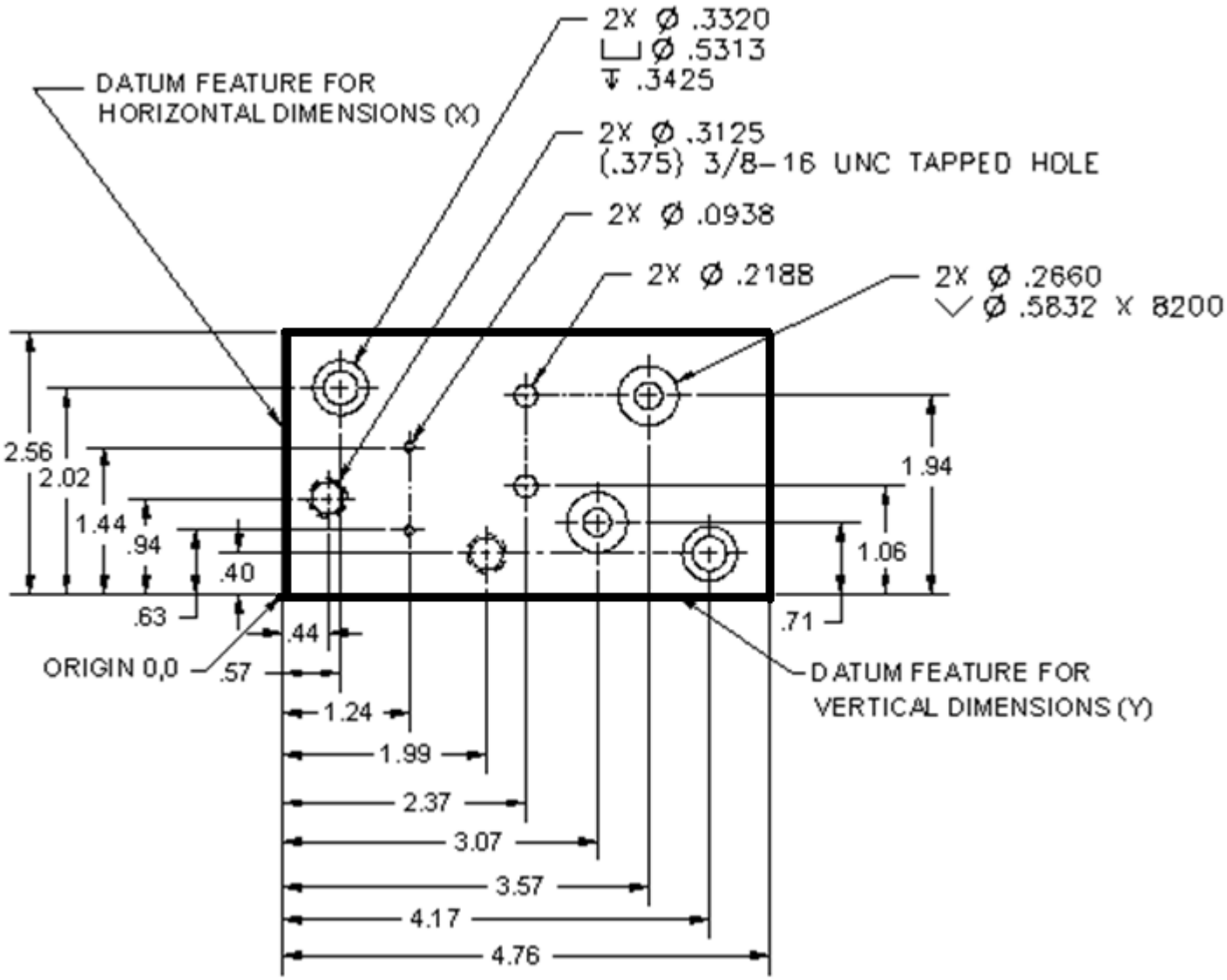




Standards for Dimensioning

Chain Dimensions

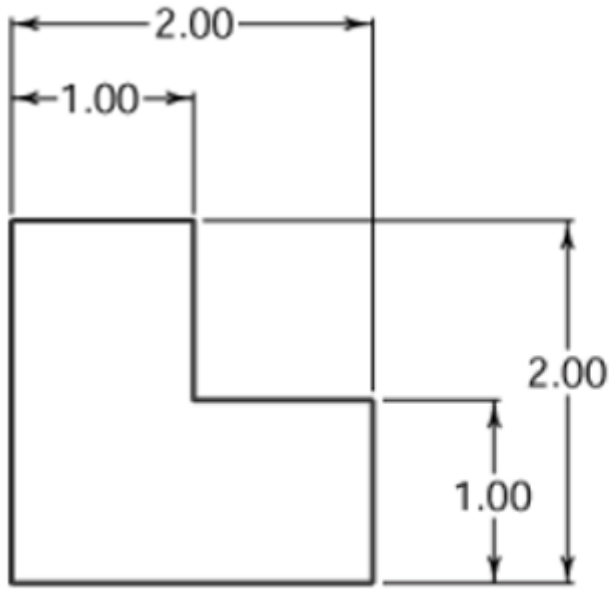
are measured from a datum



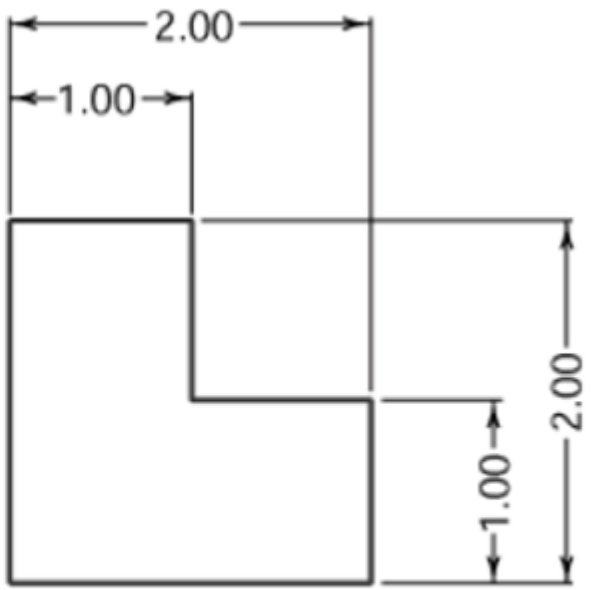
Standards for Dimensioning

Aligned vs. Unidirectional Dimension

Text is placed parallel to the dimension line or all in the same orientation.



Unidirectional
Current standard

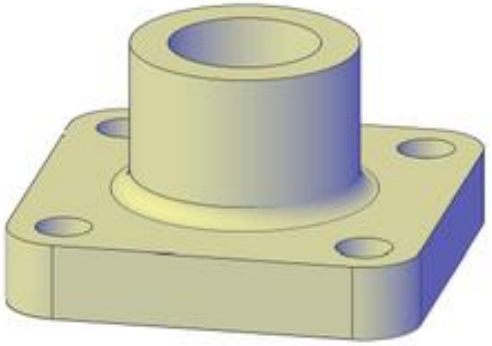


Aligned
Old standard

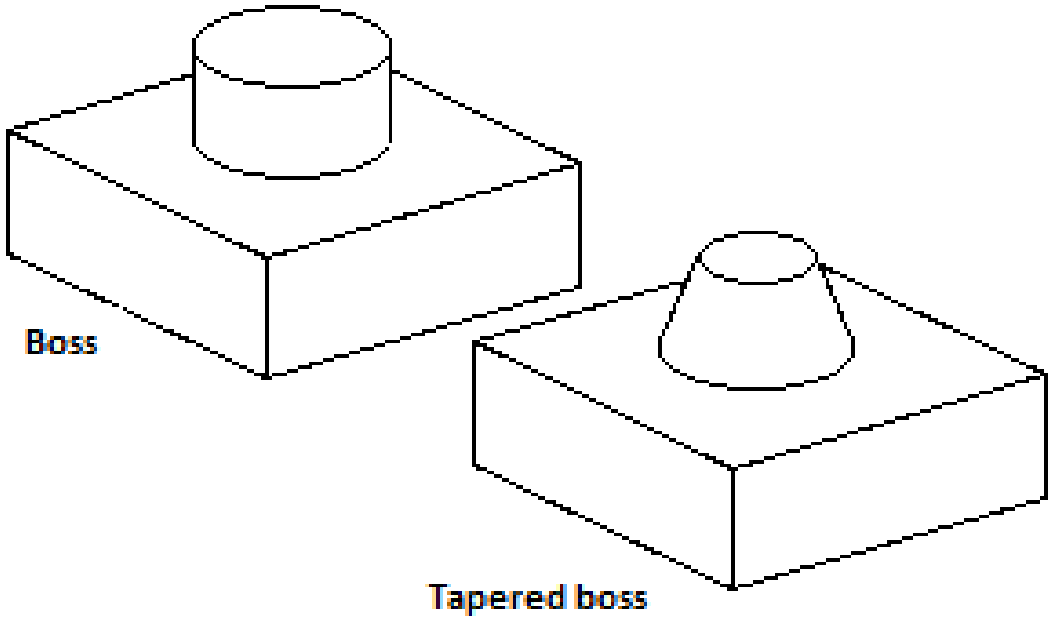
The aligned method of dimensioning is *not approved by the current ANSI standards* but may be seen on older drawings.

Some Definitions

- **Holes** are cylindrical cuts into an object. They are one of the most frequently used features in engineering design. They are often used to mount other components or to support shafts.



- A **boss** is a protruding feature on a work piece. A common use for a boss is to locate one object within a pocket or hole of another object. For instance, some motors use a precisely machined boss on the front face to locate it on the mating part.



Some Definitions

- A **countersink** (symbol: ⌵) is a conical hole cut into a manufactured object, or the cutter used to cut such a hole.

Countersunk hole

- A **counterbore** (symbol: ⌴) is a cylindrical flat-bottomed hole that enlarges another coaxial hole, or the tool used to create that feature. A counterbore hole is typically used when a fastener, such as a socket head cap screw, is required to sit flush with or below the level of a workpiece's surface.

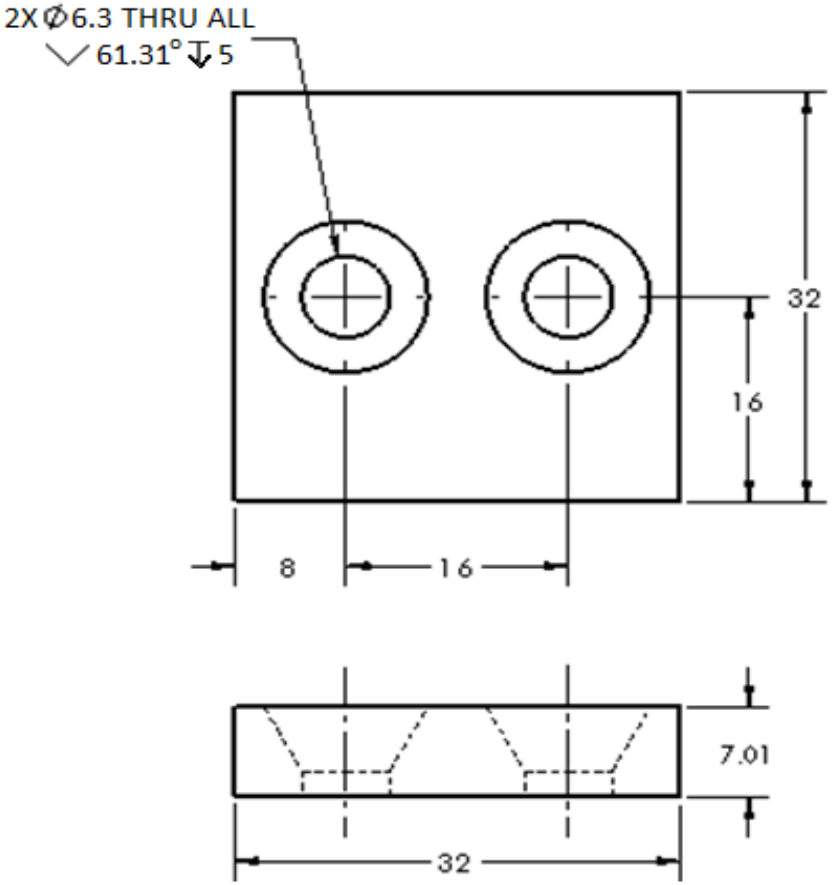
Counterbore hole

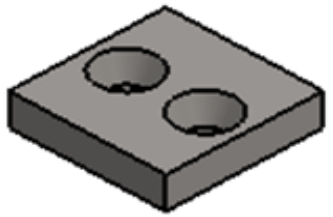
These symbols are not yet in the ISO standard. They have been proposed.

Standards for Dimensioning

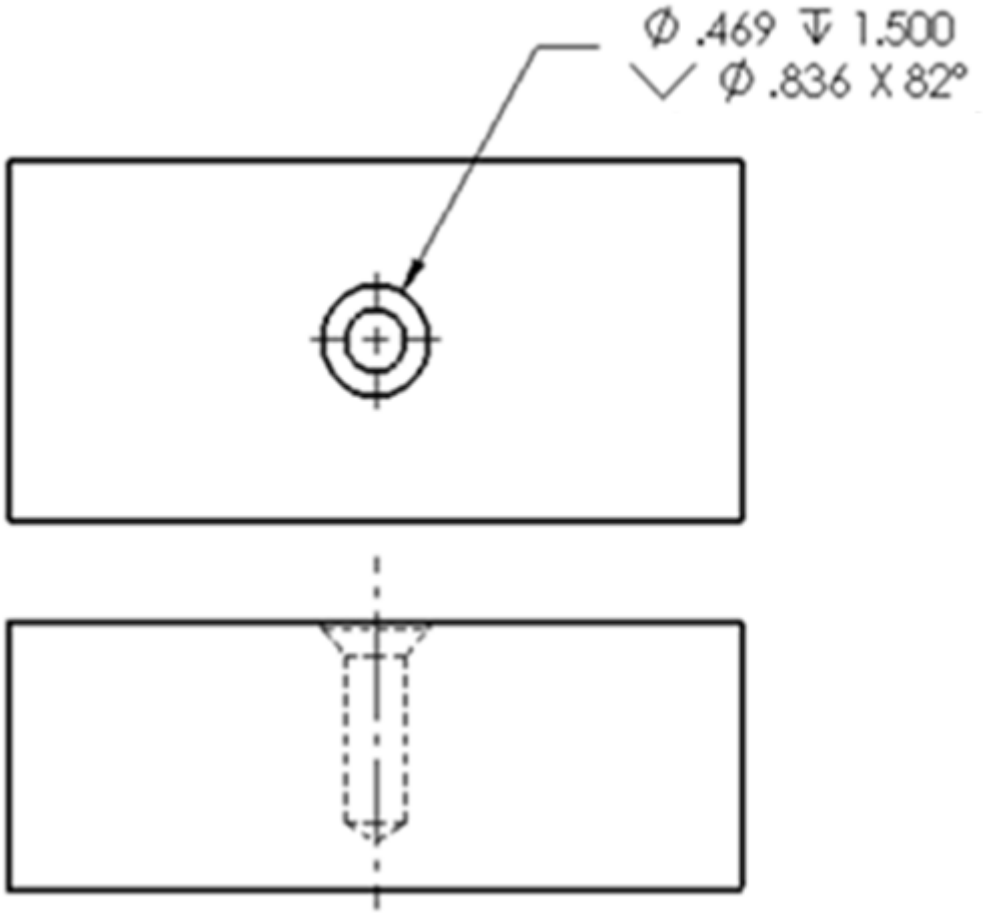
ANSI Hole Depth Symbol ↧

Features, such as blind holes and counterbores, must have a depth called out to fully describe their geometry.





Using Depth, Countersink, & Counterbore Symbols

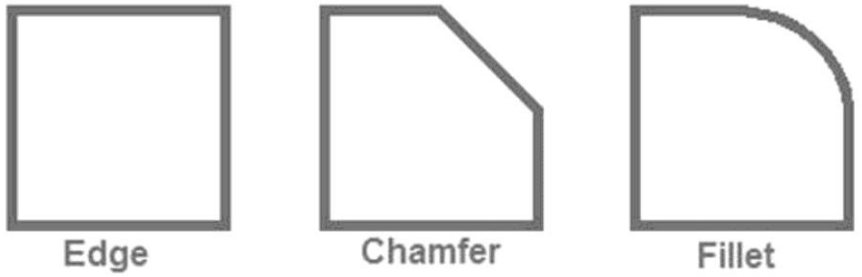


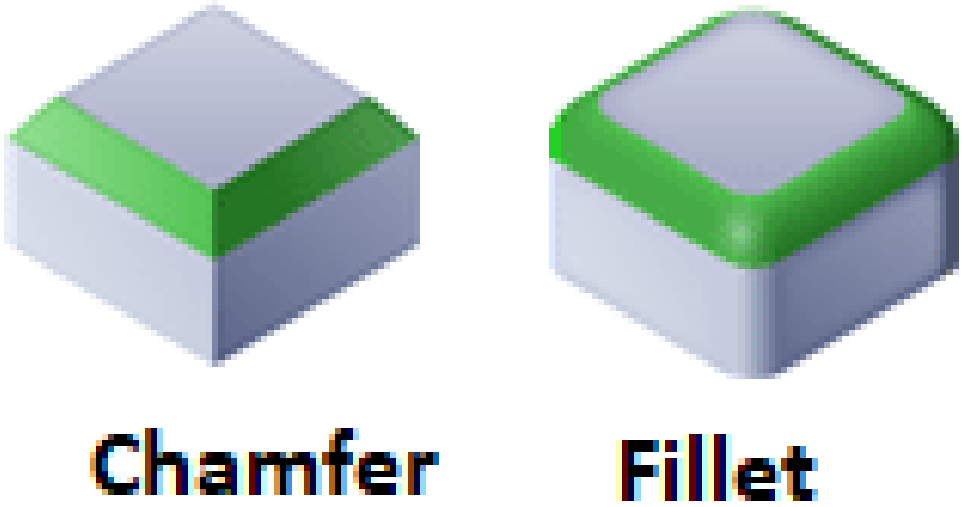
Drill size: .469, Depth 1.500
Countersunk Drill size: .836 x 82°

Solidworks provides the ability to insert Head clearance for the Counter Sink hole

Some Definitions

- A **chamfer** is a sloped or angled corner or edge, located on either the interior or the exterior of a part.
- A **fillet** is a rounded corner or edge, located on either the interior or the exterior of a part. (When on the exterior, fillets are typically referred to as **rounds**.)

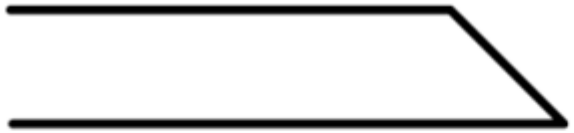




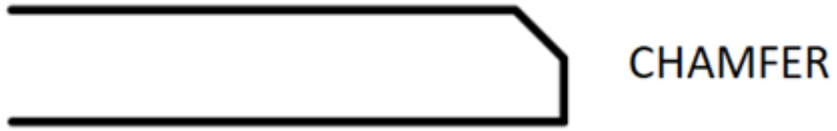
- Fillets generally give a lower stress concentration factor than chamfers.
- Chamfers are more forgiving when fitting mating parts. i.e. even if there are inaccuracies in a chamfer mating parts might fit together.

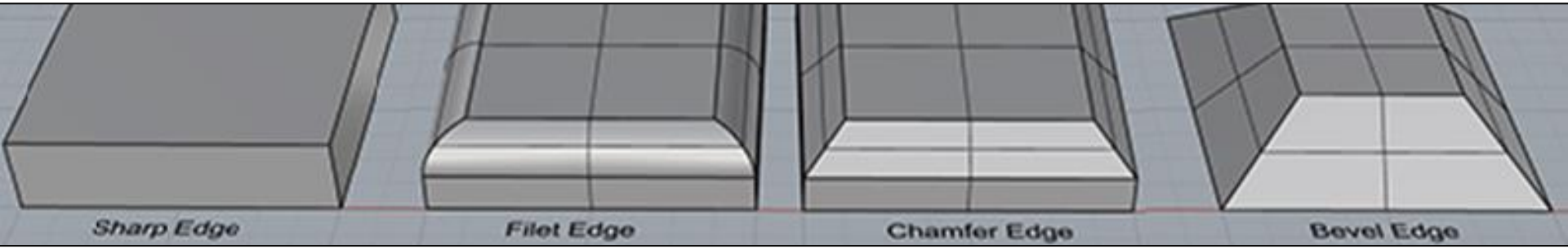
Some Definitions

- A **beveled edge** is an edge of a structure that is not perpendicular to the faces of the piece.



- The words bevel and chamfer are often interchanged. Technically they are differentiated as shown.

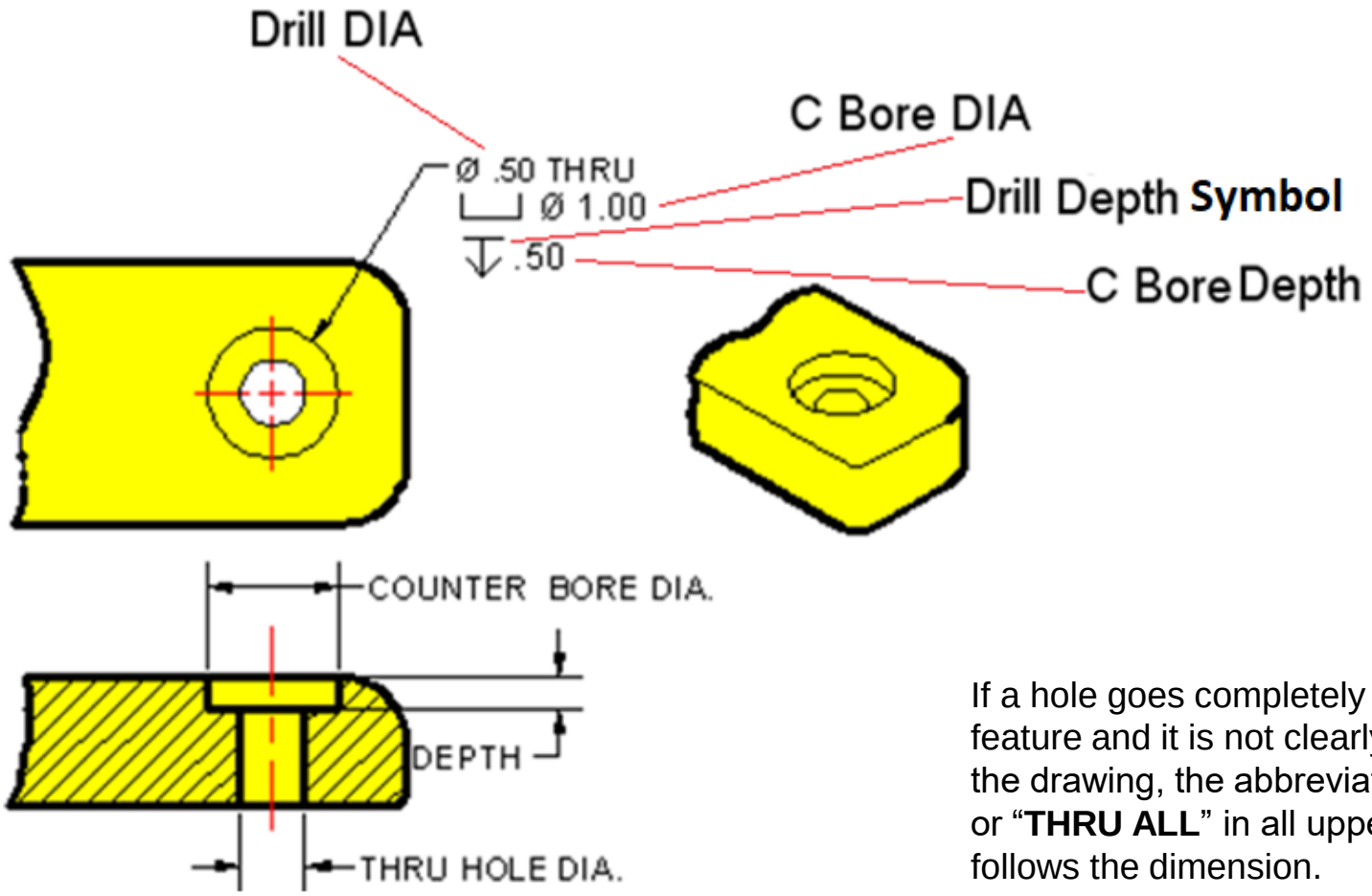




Standards for Dimensioning

Fastener Hole dimension

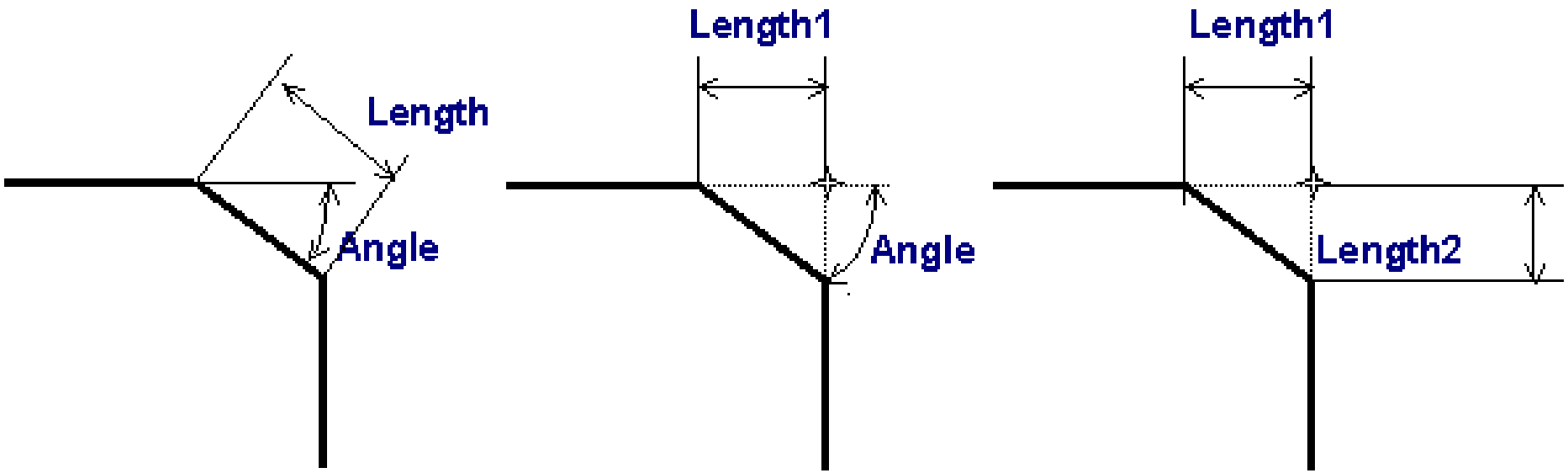
Denote drilled hole information by a bent leader line as illustrated.



If a hole goes completely through the feature and it is not clearly shown on the drawing, the abbreviation "**THRU**" or "**THRU ALL**" in all upper case follows the dimension.

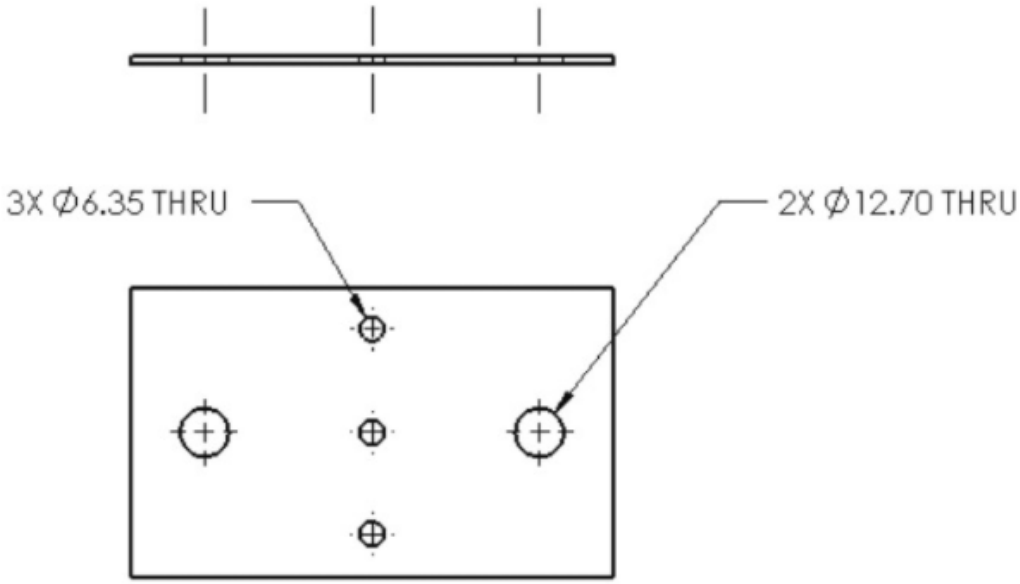
Standards for Dimensioning

Chamfer dimensioning options

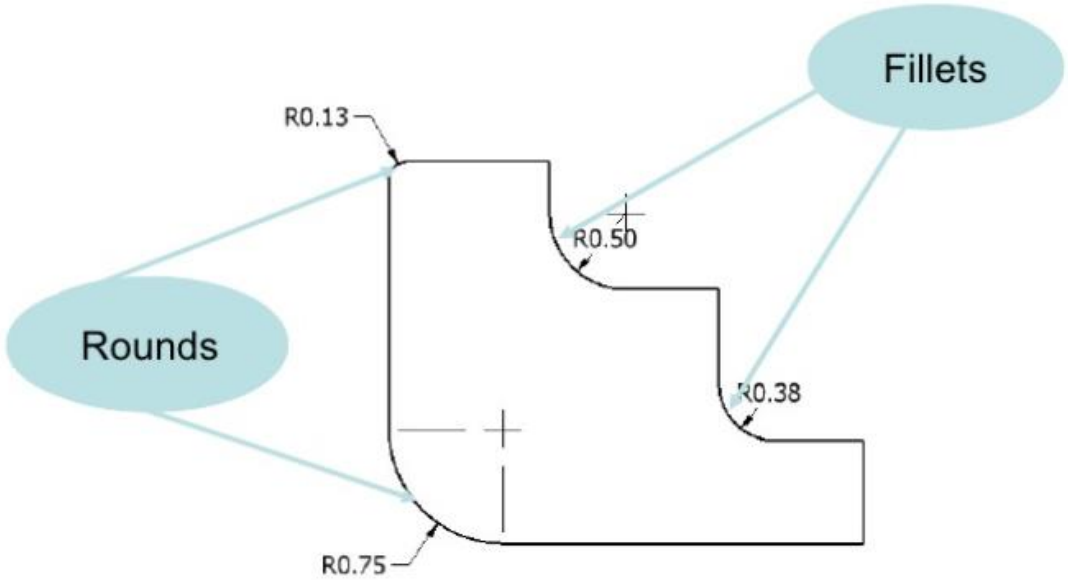


Standards for Dimensioning

Holes are dimensioned with a diameter symbol Ø in front



Arcs, fillets, and rounds are dimensioned with letter R in front

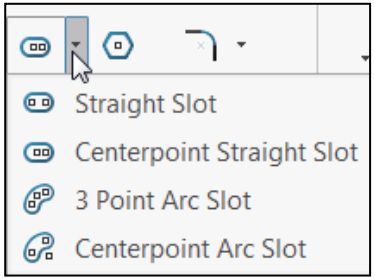


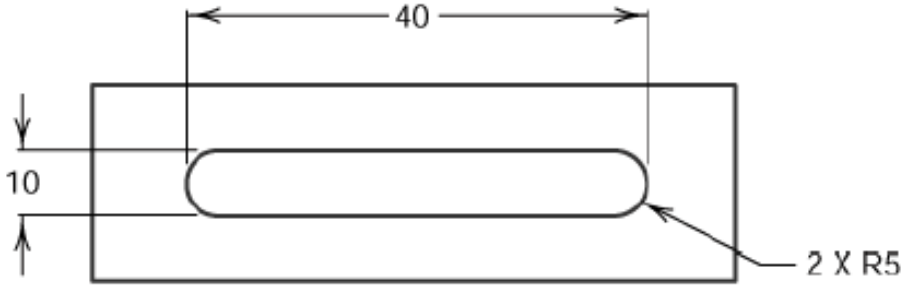
Standards for Dimensioning

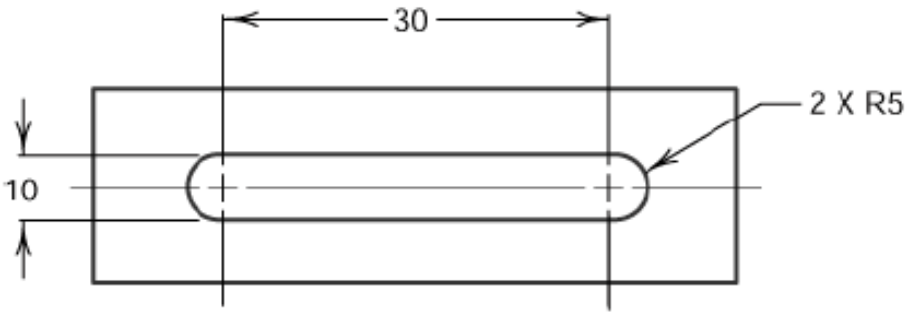
Slot Dimension

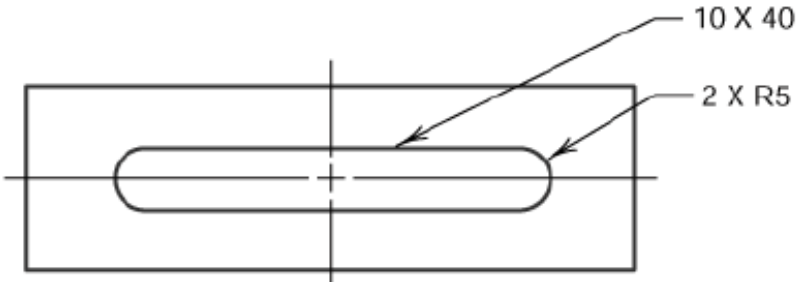
Create a slot dimension with a combination of radii, linear dimensions and annotations.

SOLIDWORKS has a Slot Sketch tool with various options.





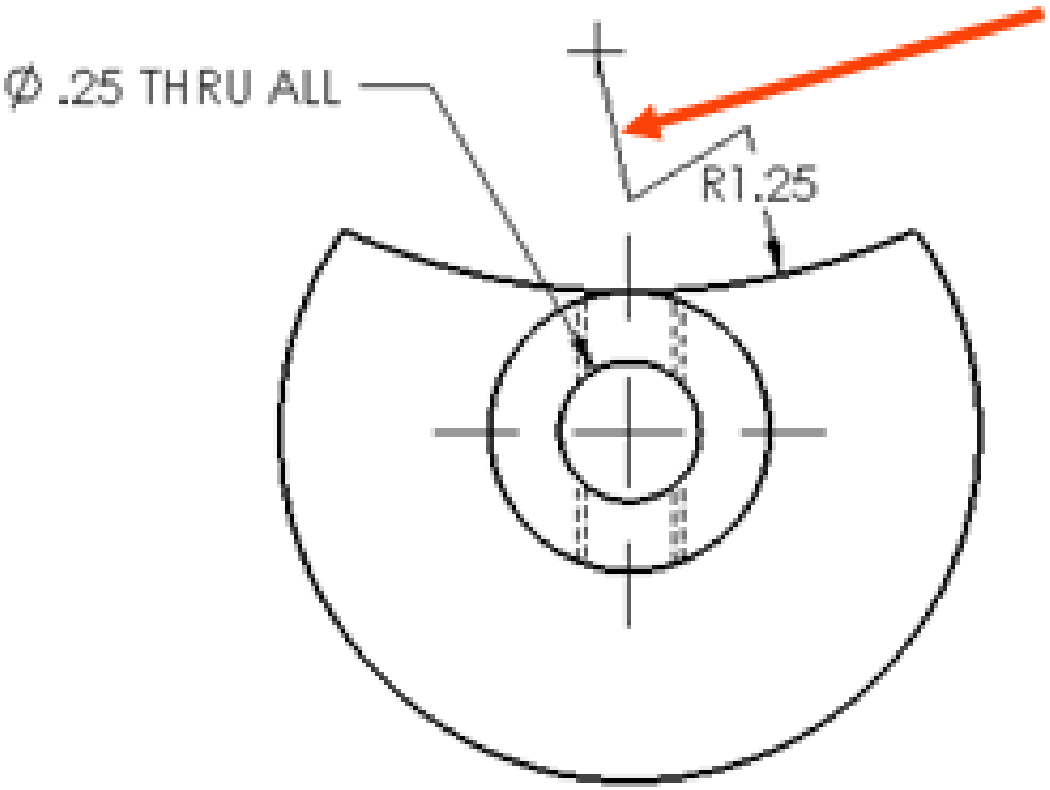


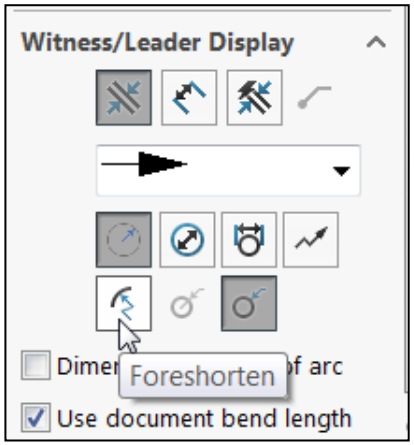


Standards for Dimensioning

Arc dimension

Apply foreshortened leader lines for large arcs as illustrated.





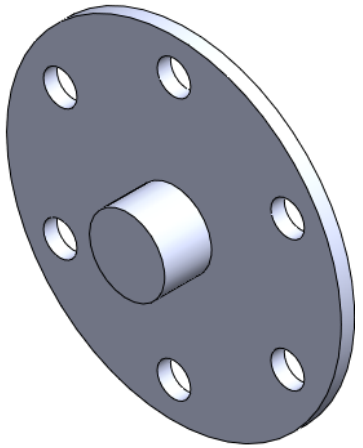
Standards for Dimensioning

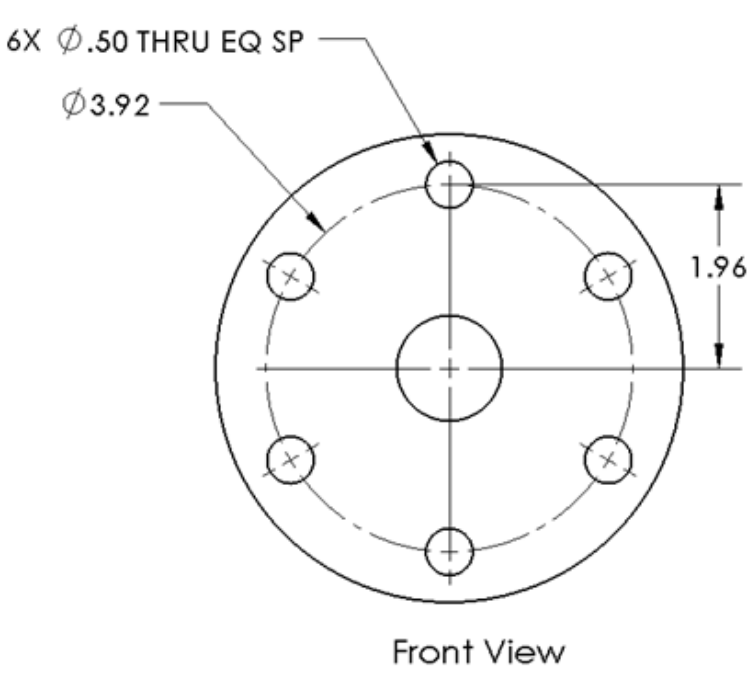
Equally spaced holes on a circle

The location of the first hole is given by a location dimension.

The remaining holes are located and sized with just one note indicating:

1. number of holes (note the capital X here means “times”)
2. diameter of the holes
3. the notation “EQUALLY SPACED” or “EQ SP”

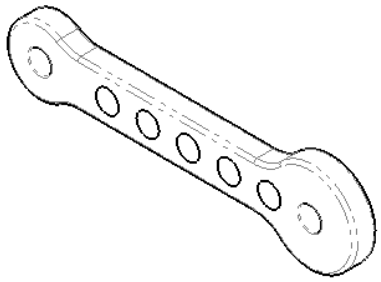


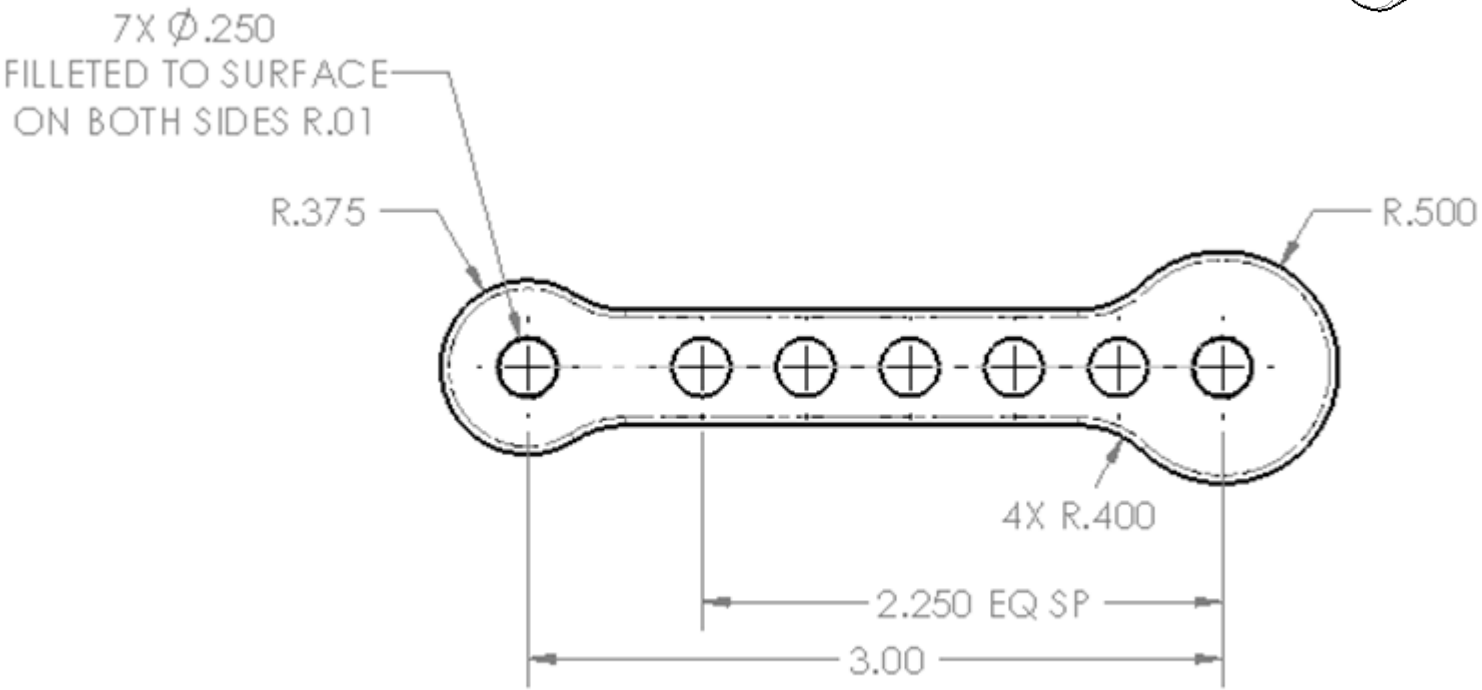


Standards for Dimensioning

Annotation (Notes)

All letters should be upper case.



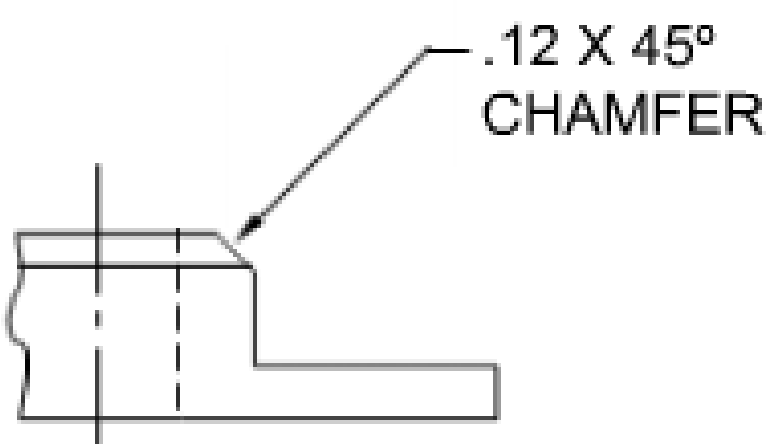


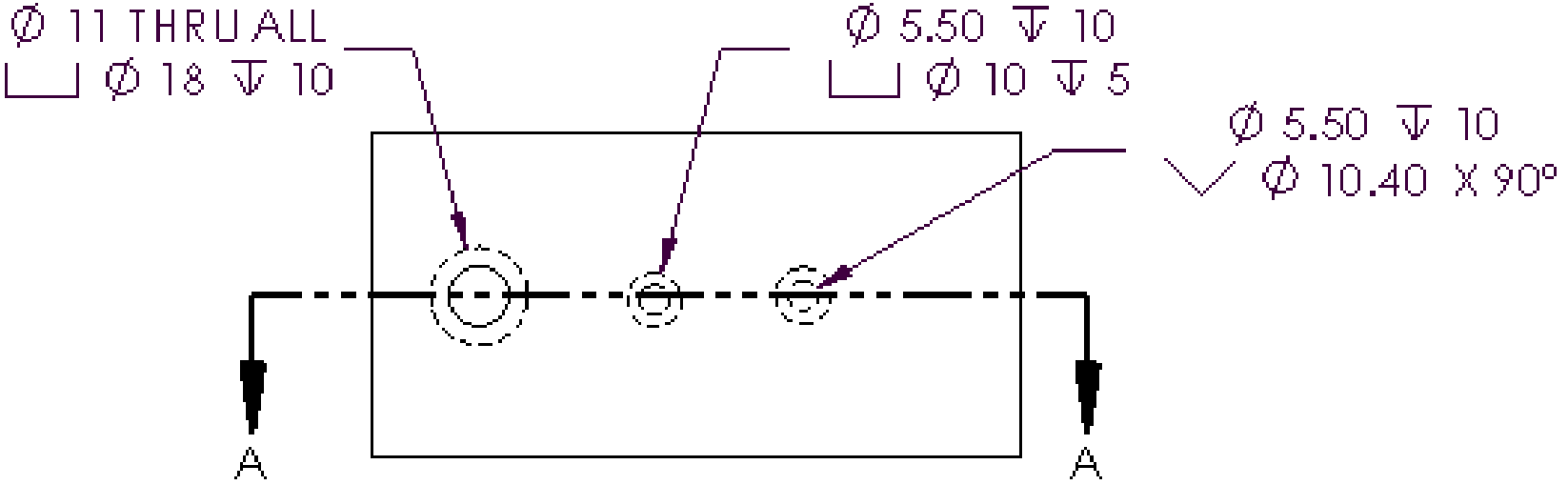
Standards for Dimensioning

Annotation

The symbol capital X in a drawing can also be used to indicate the word “by”.

When used to imply the word “by” a space must precede and follow the X symbol.

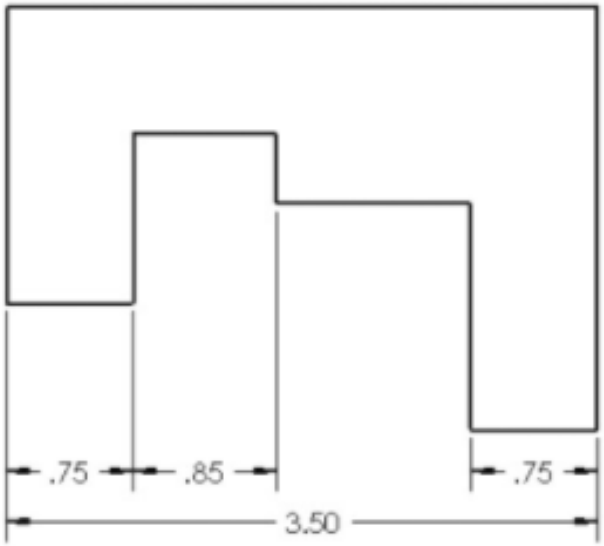




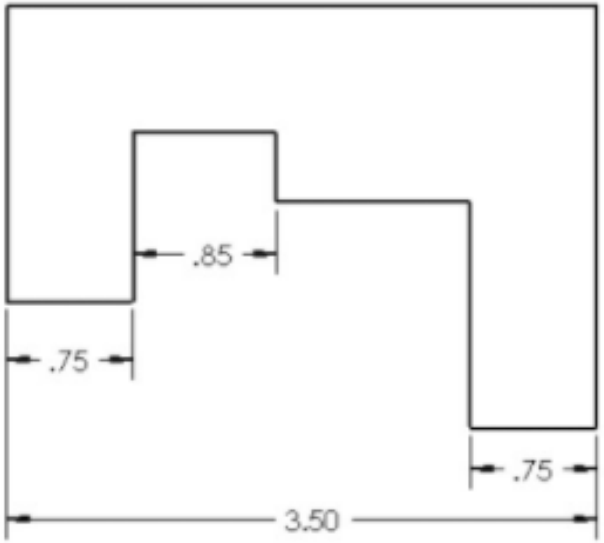
Standards for Dimensioning

Continuous Dimensions

- If several dimensions are along the same direction, they should be placed along the same line
- AKA chain dimensioning or point-to-point dimensioning
- This method is preferred over the staggering of dimensions
- Note: Tolerance stack-up can be an issue with this method



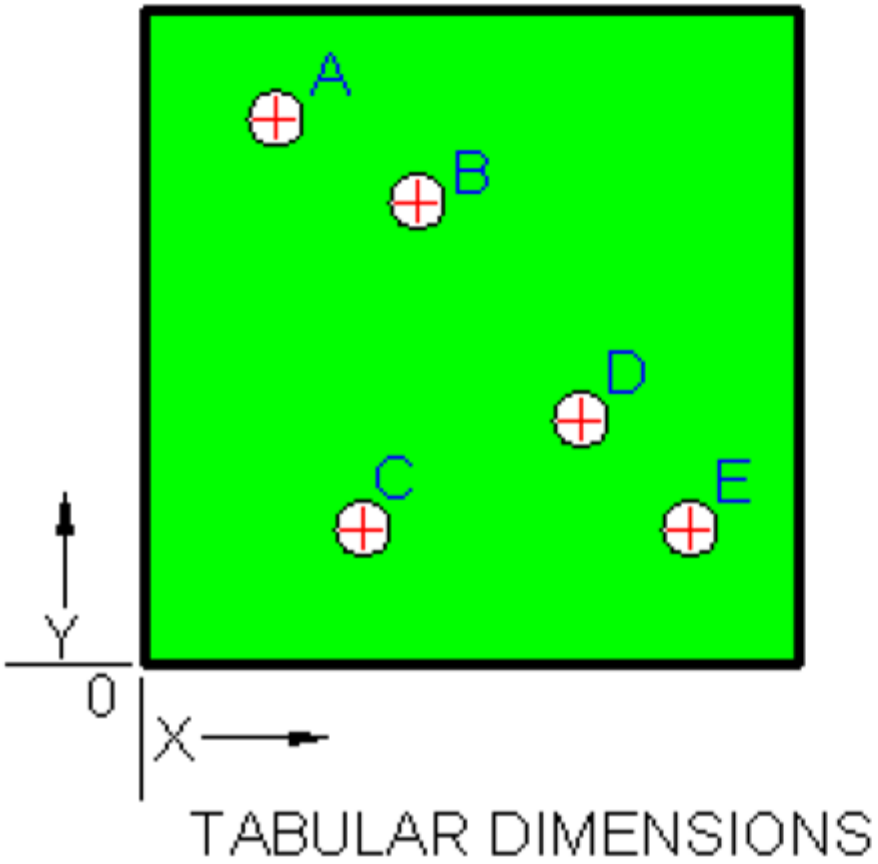
PREFERRED METHOD
CONTINUOUS DIMENSIONS



NOT RECOMMENDED
STAGGERED DIMENSIONS

Standards for Dimensioning

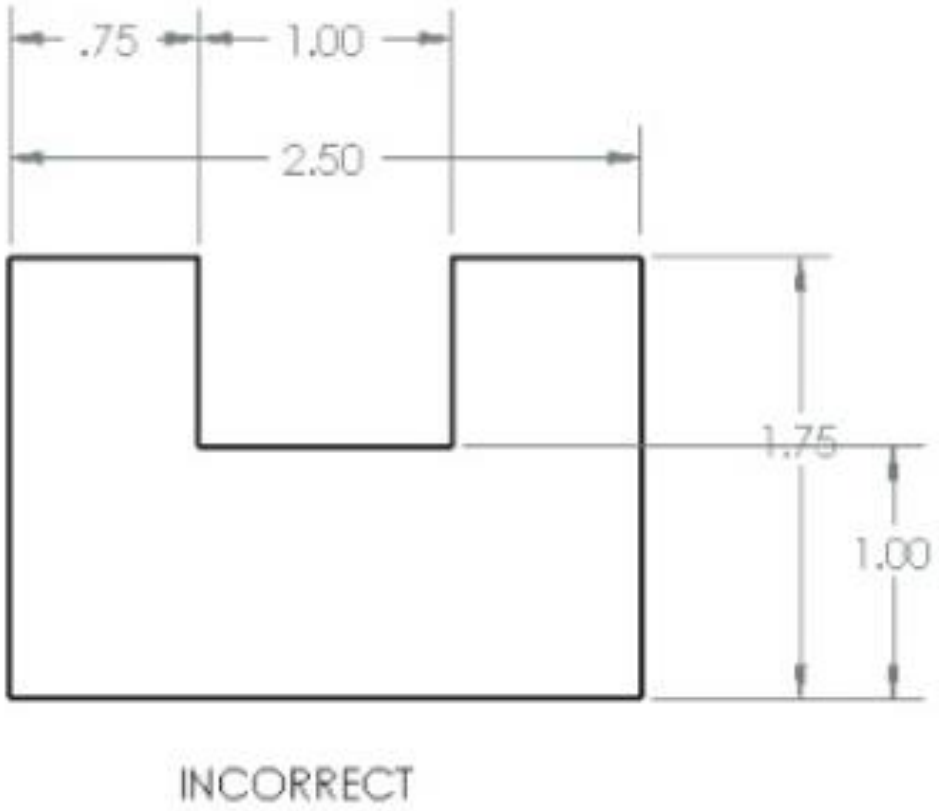
Tabular dimensions



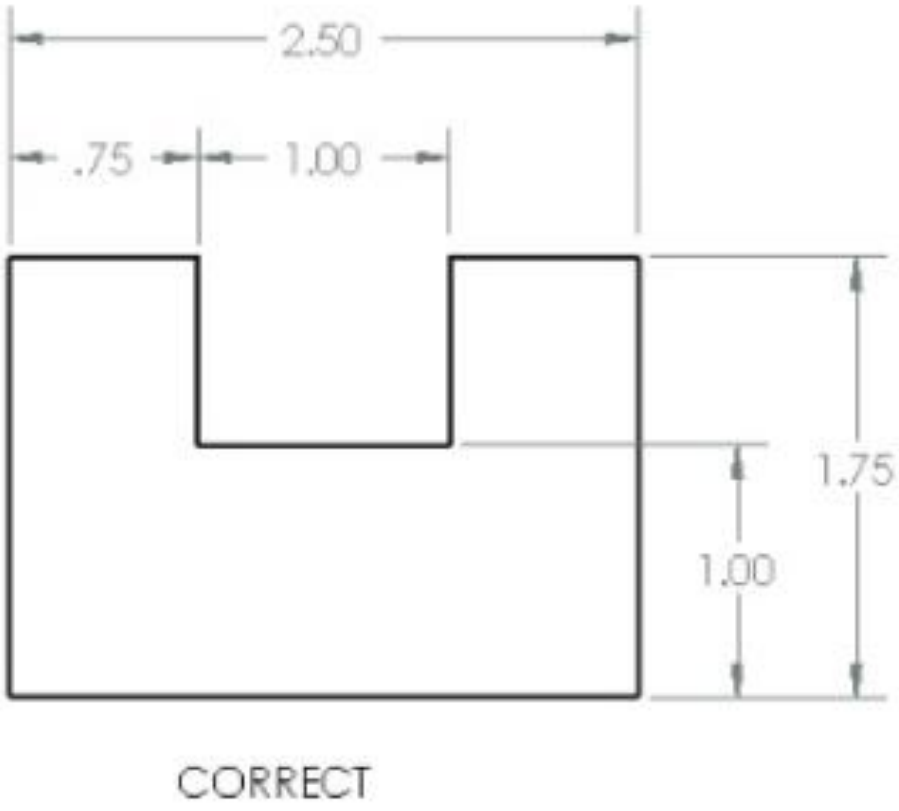
TABULAR DIMENSIONS

HOLE NO.	X	Y
A	.480	3.120
B	1.080	2.500
C	1.600	0.800
D	2.060	1.900
E	3.100	1.380

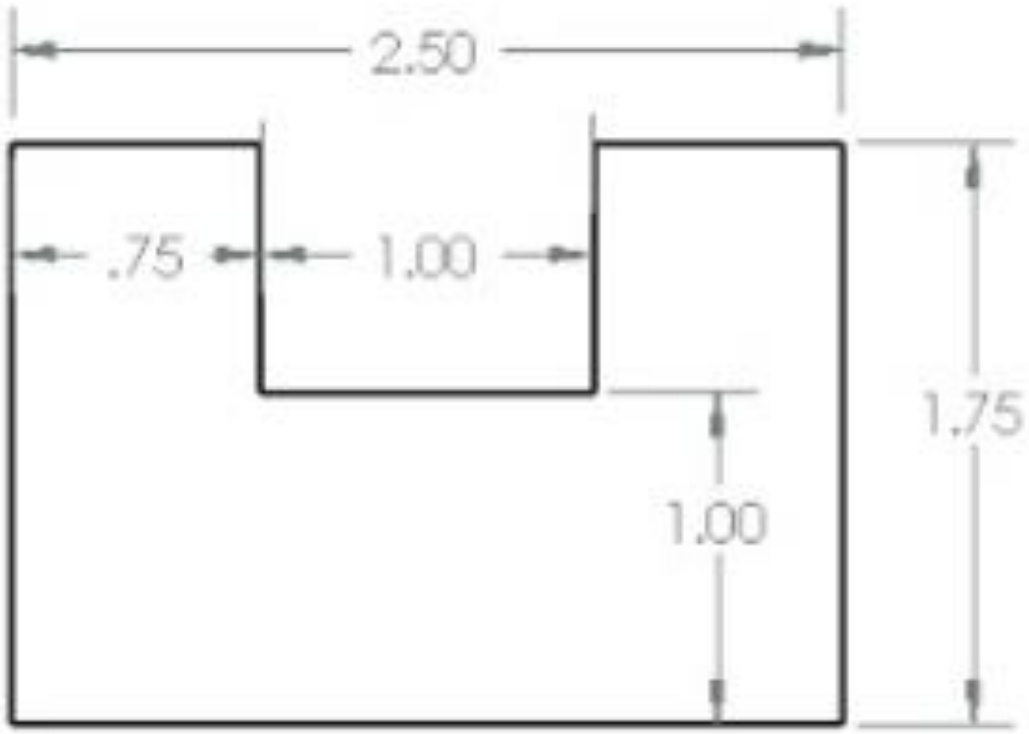
What's Wrong?



Fixed!

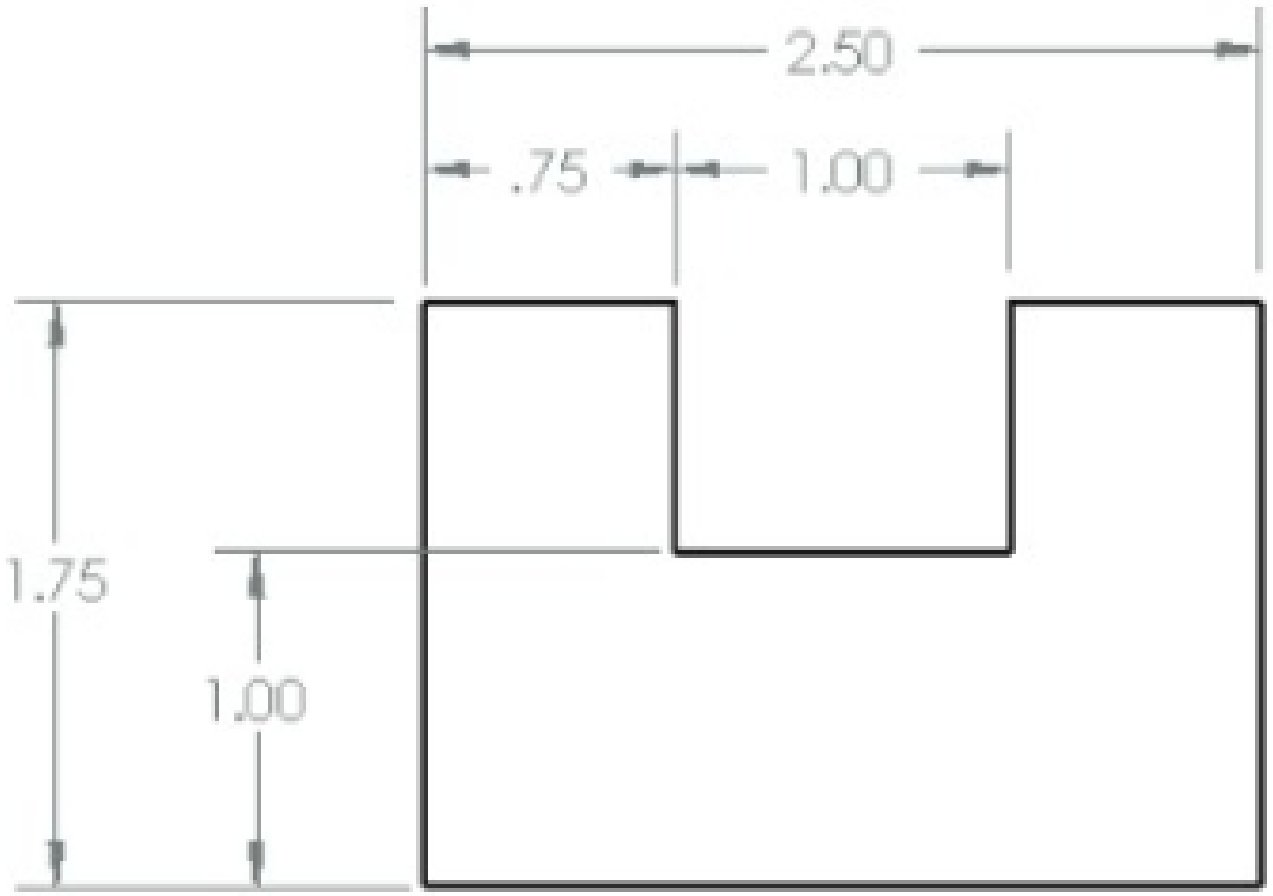


What's Wrong?



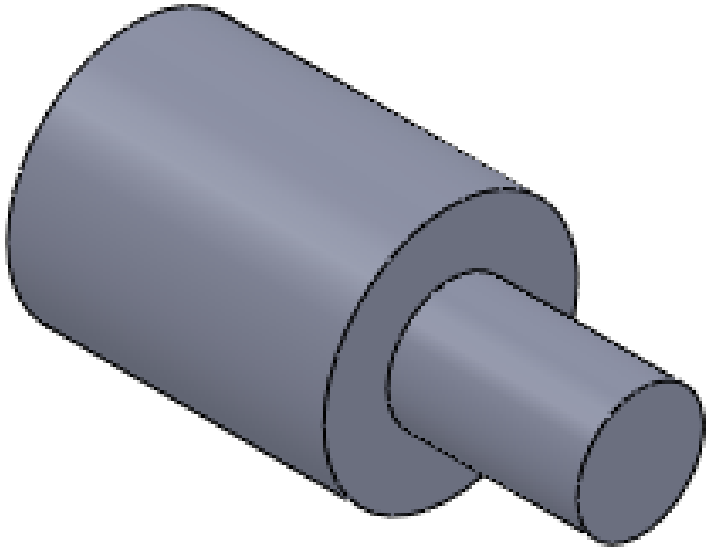
INCORRECT

Fixed!



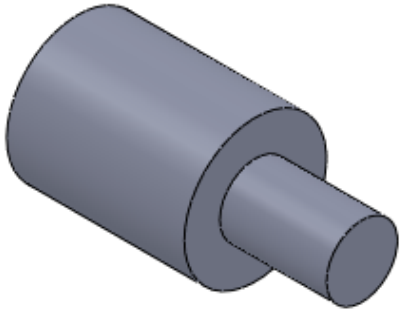
CORRECT

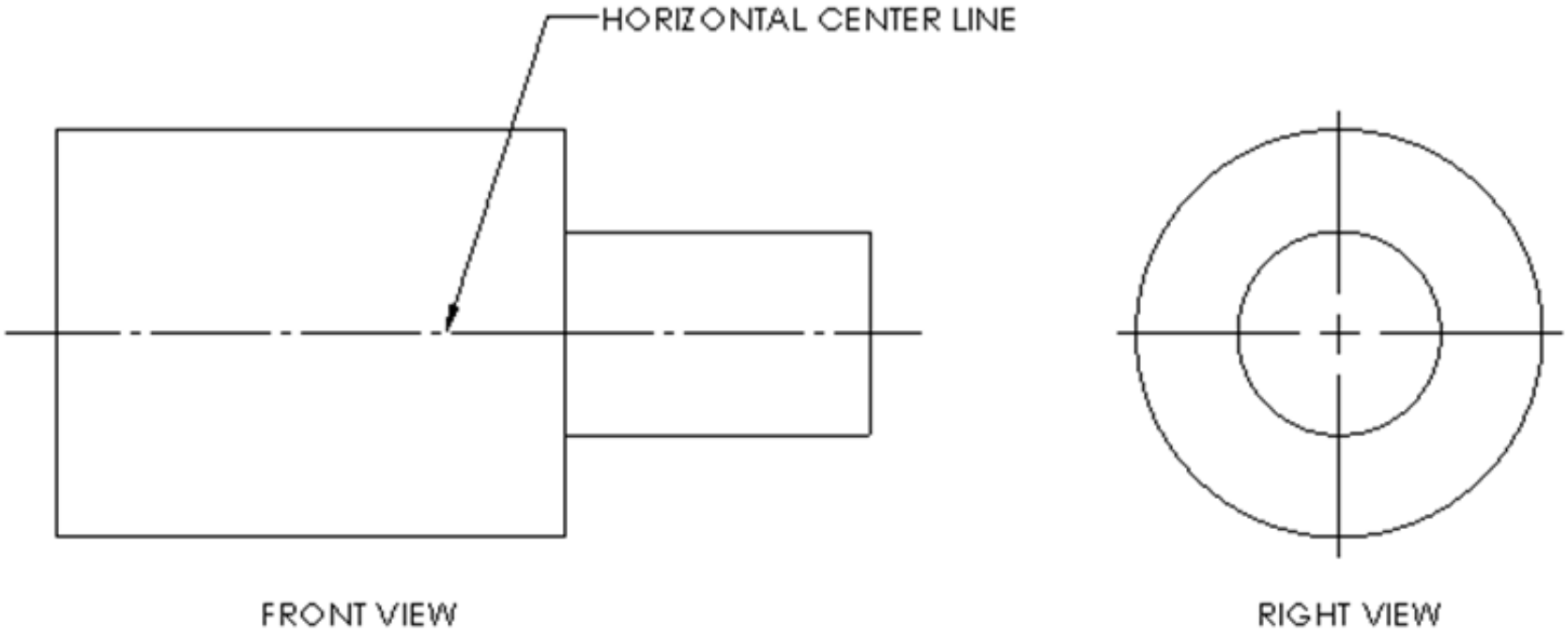
Dimensioning a Cylinder



1. What is the **Base Sketch Plane**?
2. What would the **Front view** look like?
3. What would the **Right view** look like?

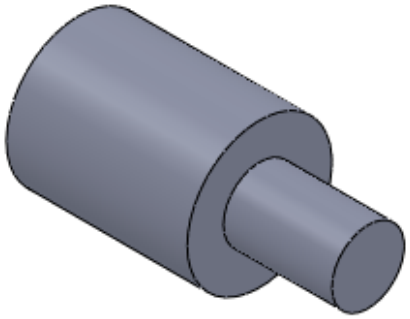
Dimensioning a Cylinder

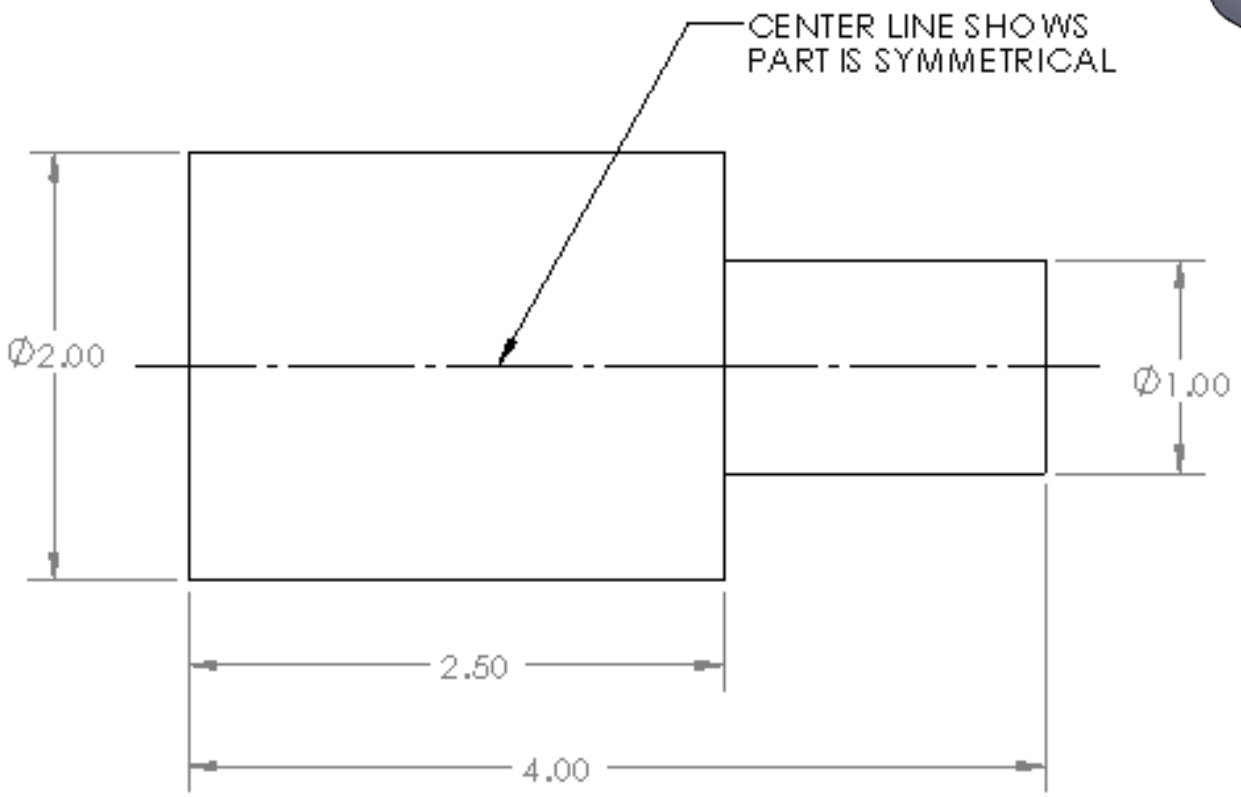




4. In which views would you place the model feature dimensions?
5. How many view(s) do you need to correctly display and dimension this part?

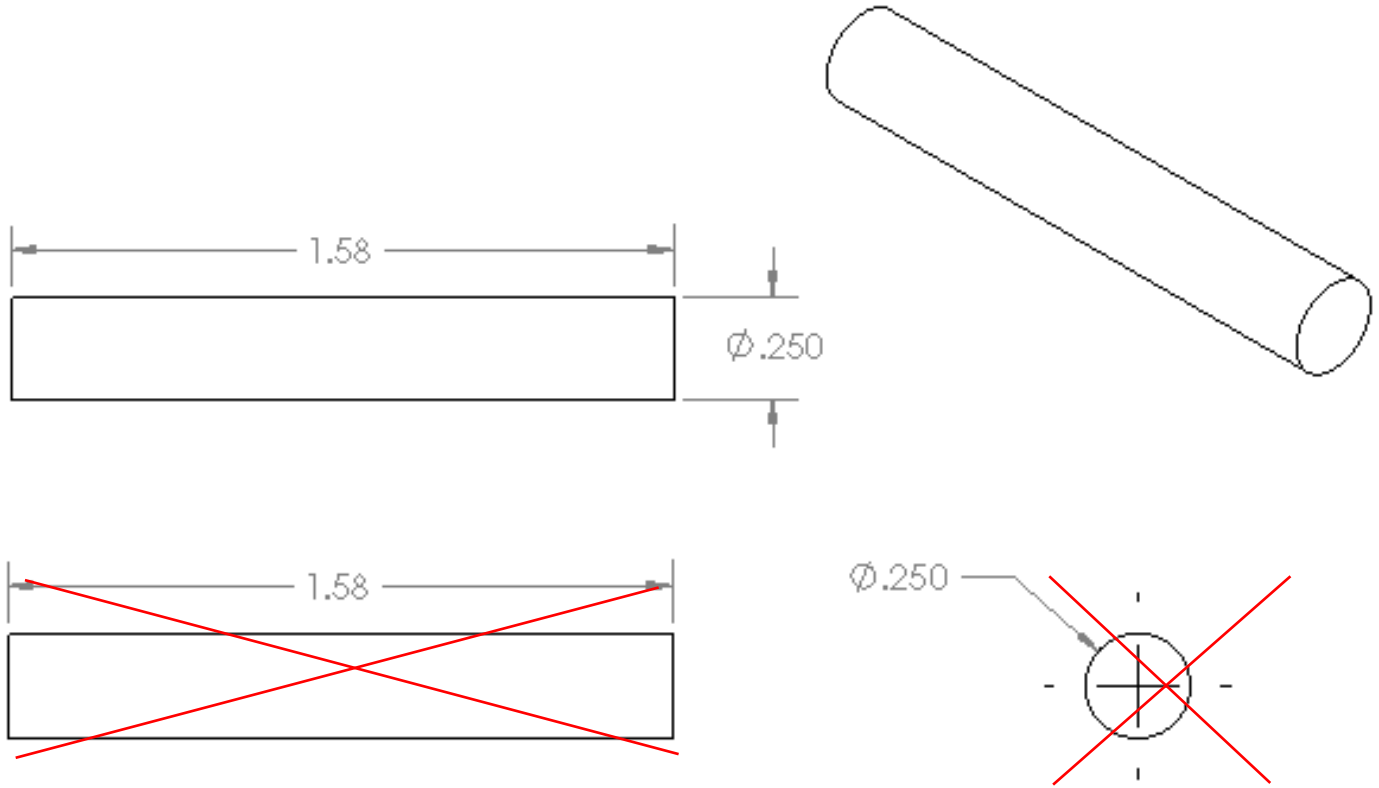
Dimensioning a Cylinder





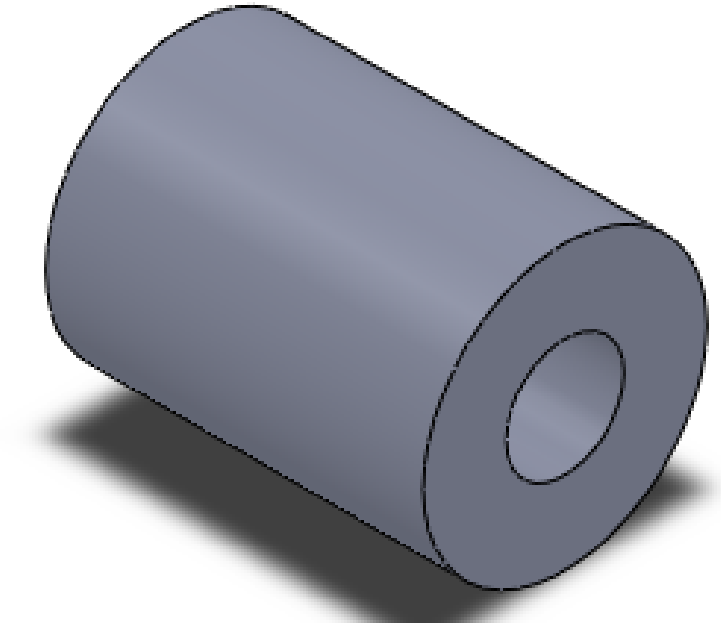
One!

Dimensioning a Cylinder



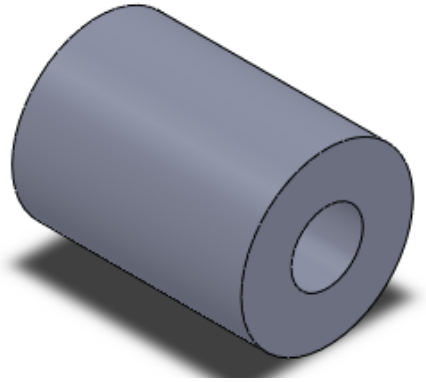
What is wrong with the location of the diameter dimension in the Right view?

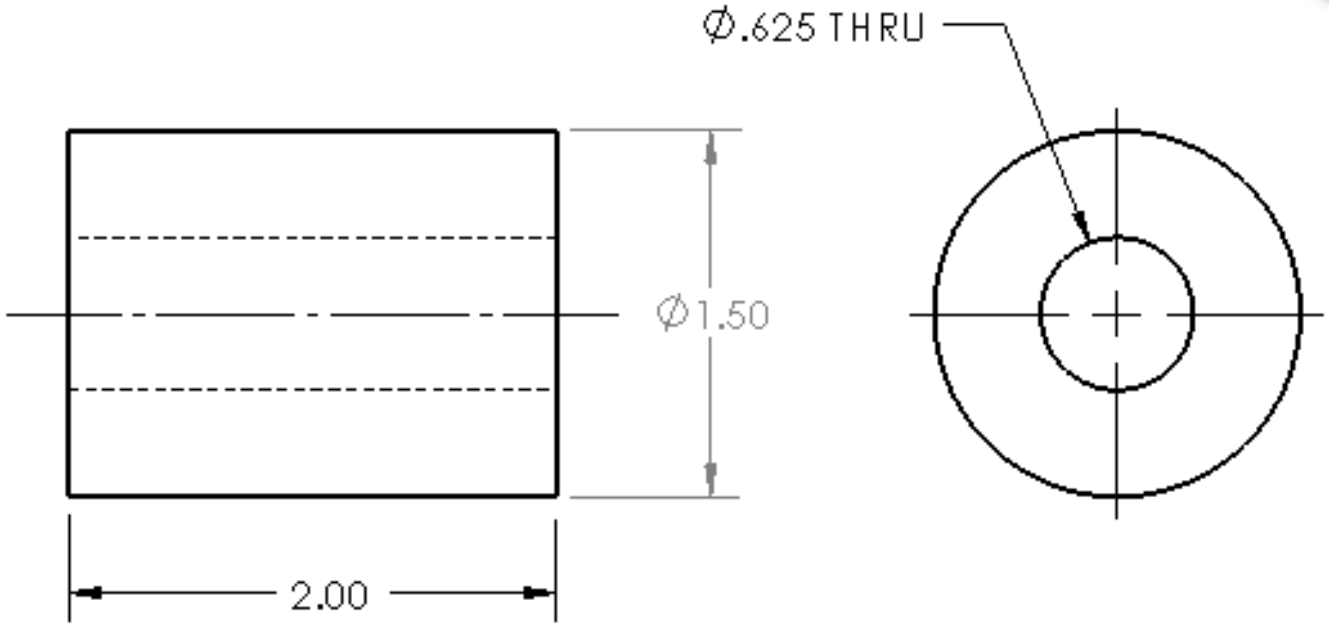
Dimensioning a Cylinder with a Hole



1. What is the **Base Sketch Plane**?
2. What would the **Front view** look like?
3. What would the **Right view** look like?
4. In which views would you place the model feature dimensions?
5. How many view(s) do you need to correctly display and dimension this part?

Dimensioning a Cylinder with a Hole

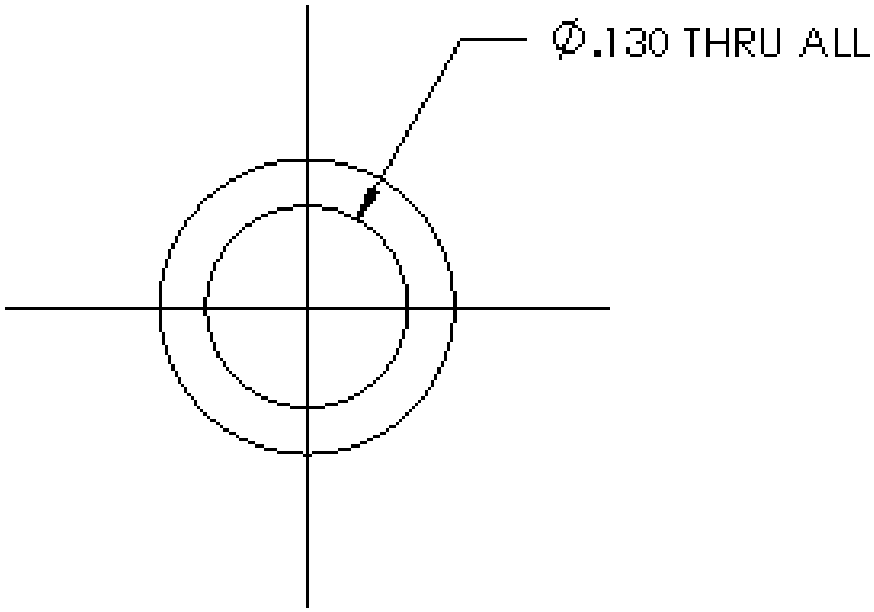


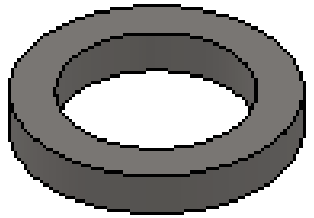


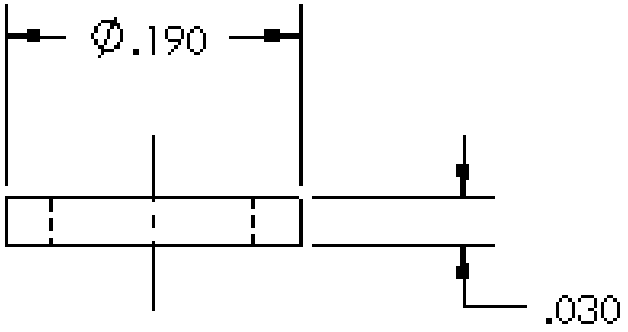
DIMENSIONING CYLINDERS

Two!

Dimensioning a Cylinder with a Hole

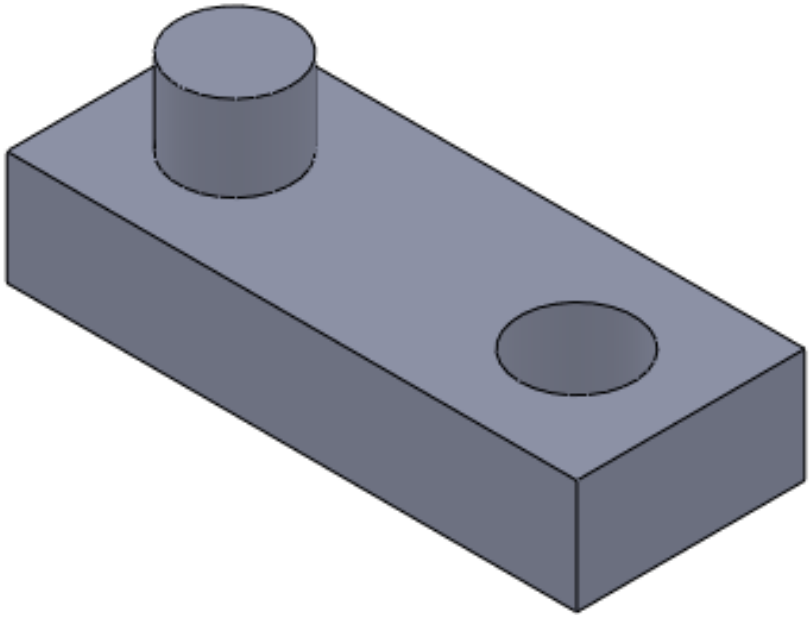






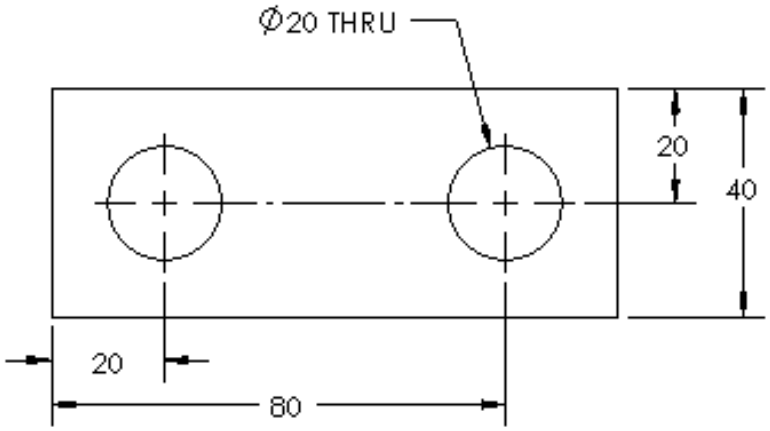
Holes are dimensioned by giving their diameter and location in a circular view.

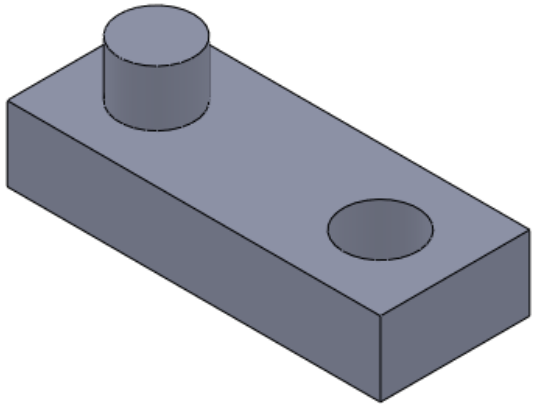
Dimensioning a Cylinder and a Hole

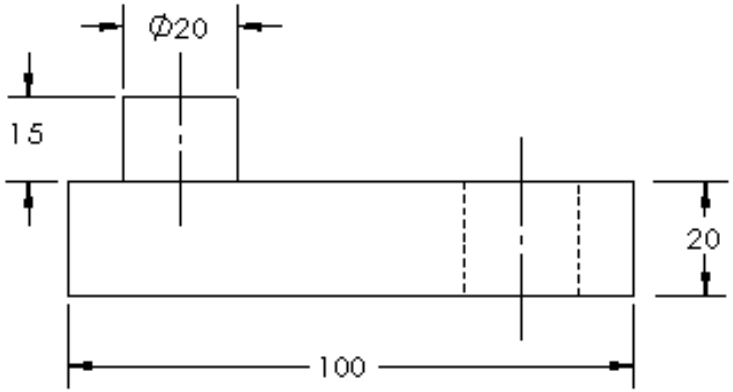


1. What is the **Base Sketch Plane**?
2. What would the **Front view** look like?
3. What would the **Right view** look like?
4. In which views would you place the model feature dimensions?
5. How many view(s) do you need to correctly display and dimension this part?

Dimensioning a Cylinder and a Hole



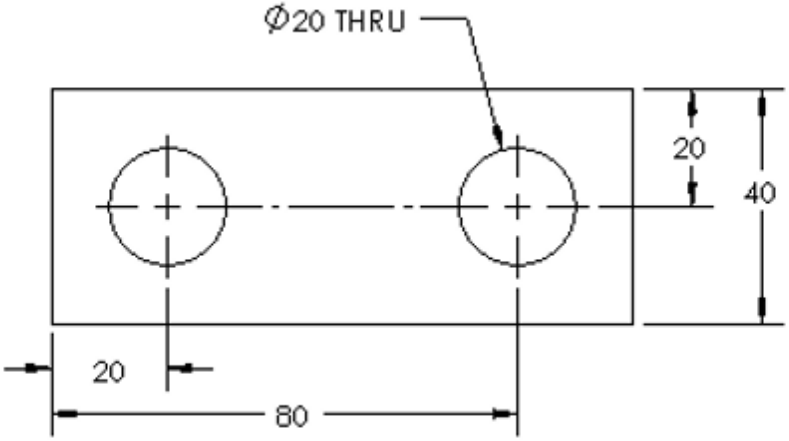


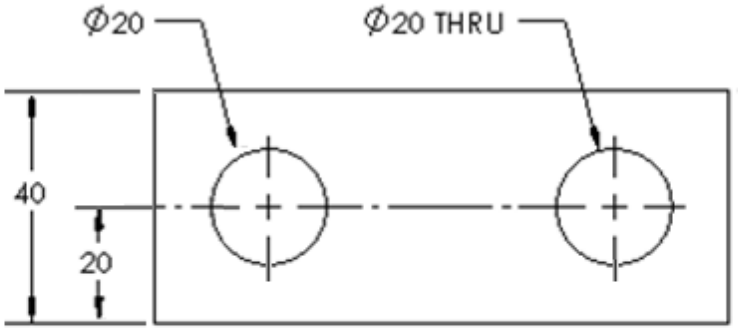


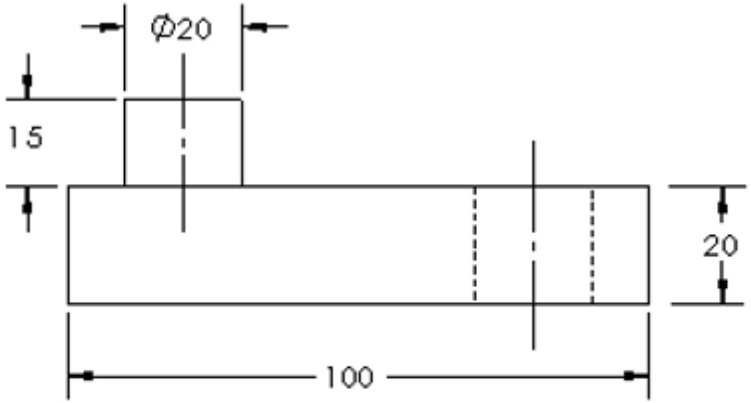
Note: The center mark of a hole is used to locate the hole within the object. The center mark must be located in both the **horizontal** and **vertical** directions.

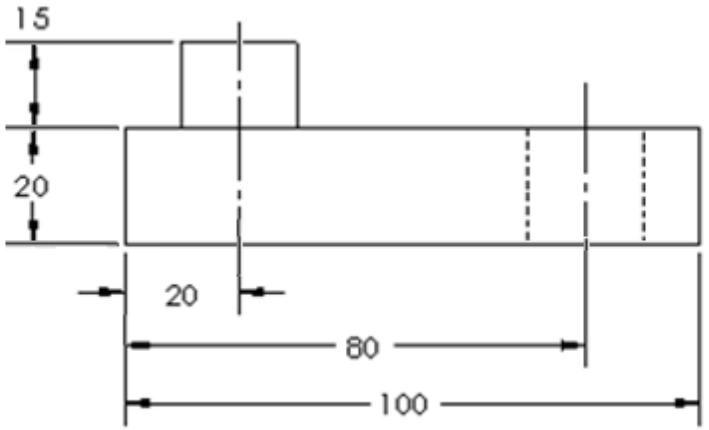
Two!

Dimensioning a Cylinder and a Hole



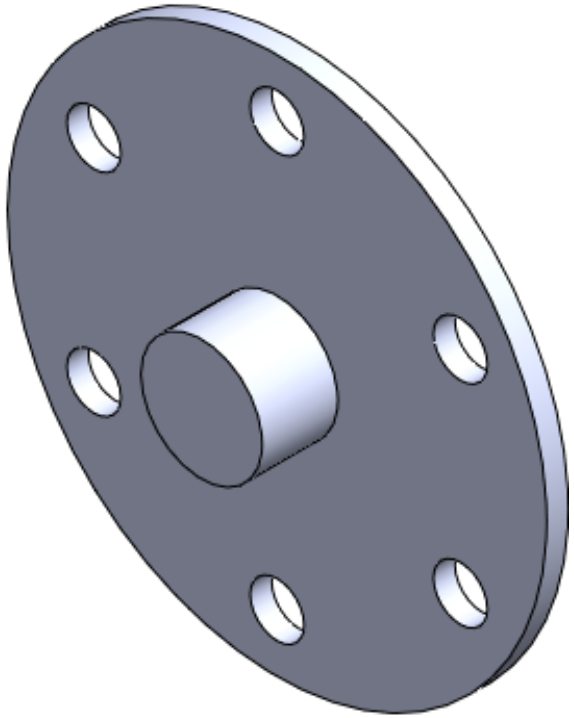






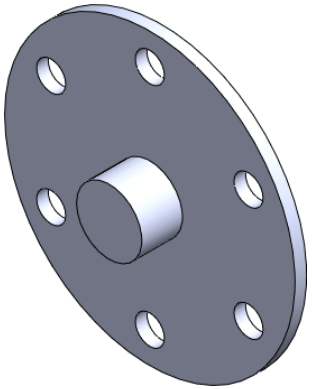
Better?

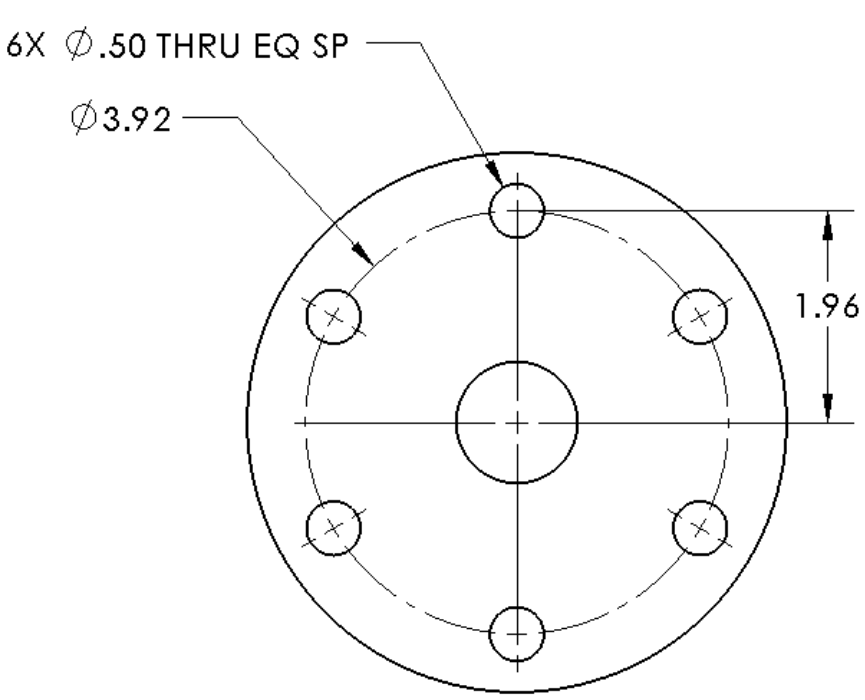
Dimensioning a Cylinder and Holes



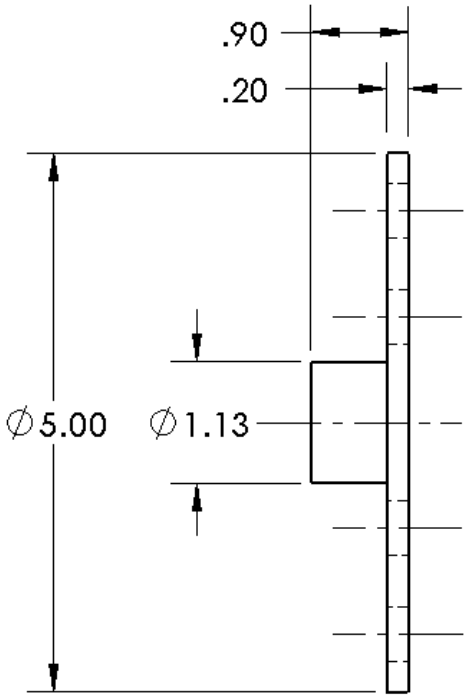
1. What is the **Base Sketch Plane**?
2. What would the **Front view** look like?
3. What would the **Right view** look like?
4. In which views would you place the model feature dimensions?
5. How many view(s) do you need to correctly display and dimension this part?

Dimensioning a Cylinder and Holes





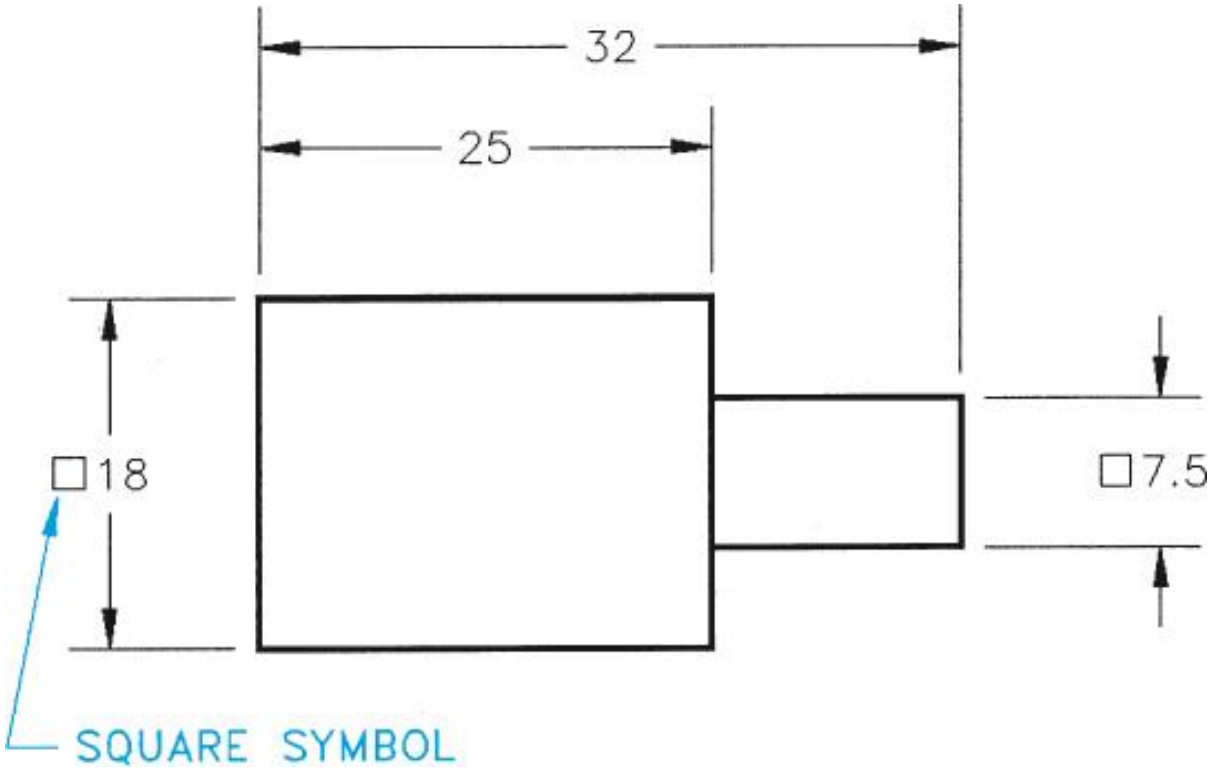
Front View

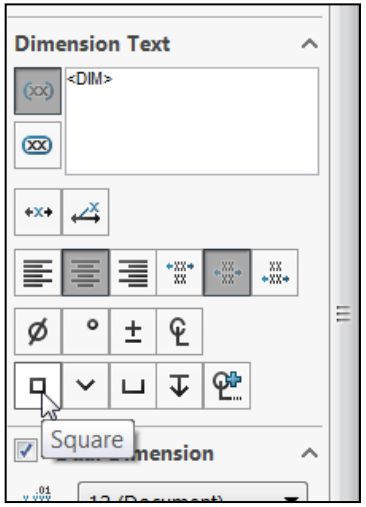


Right View

Two!

Dimensioning a Square Feature





Insert the Square □ symbol if the part is square.

END