# LESSON 13

Parametric Drawing

Parametric drawing is a method of assigning a constraint to an object that is controlled by another object. For example, you could put a constraint on line #1 to always be parallel to line #2. Or you could put a constraint on diameter #1 to always be the same size as diameter #2. If you make a change to #1 AutoCAD automatically makes the change to #2 depending on which constraint has been assigned.

<u>There are two general types of constraints:</u>

> ## Geometric: Controls the relationship of objects with respect to each other.
> The Geometric constraints that will be discussed in this workbook are coincident, collinear, concentric, fix, parallel, perpendicular, horizontal, vertical, tangent, symmetrical and equal.
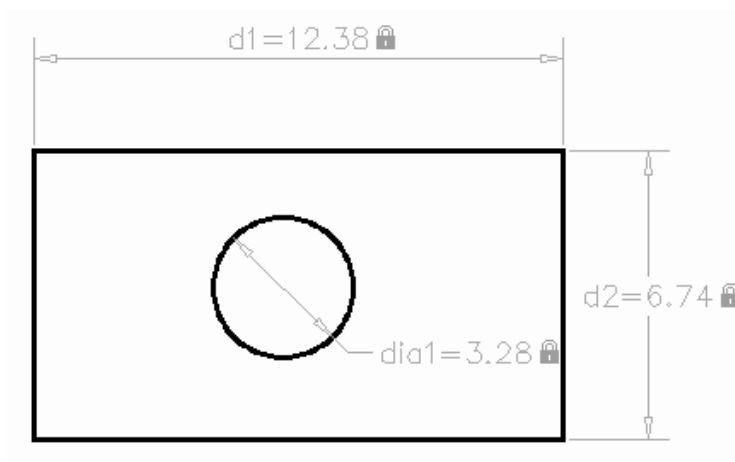
> **Example:**
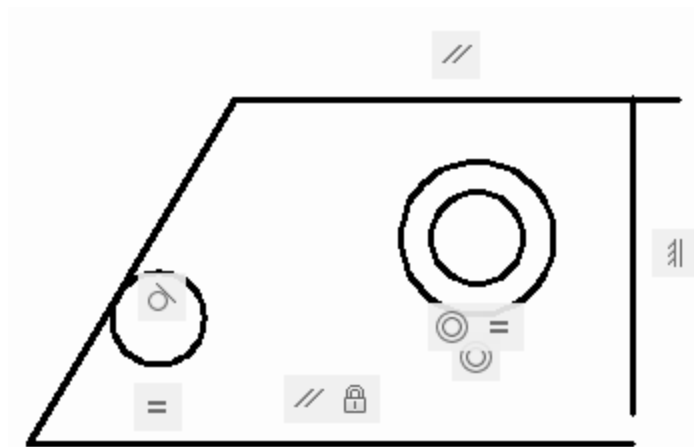
> ## Dimensional: Dimensional constraints control the size and proportions of objects. They can constrain:
> A. Distances between objects or between points on objects
> B. Angles between objects or between points on objects
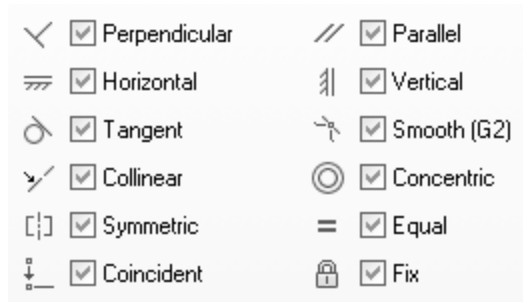> C. Sizes of arcs and circles.

> **Example:**

Geometric Constraints

Overview of Geometric Constraints.
Geometric constraints control the relationship of objects with respect to each other. For example, you could assign the parallel constraint to 2 individual lines to assure that they would always remain parallel.

The following is a list of Geometric Constraints available and their icons:

✕	☑ Perpendicular	⁄⁄	☑ Parallel
⟶	☑ Horizontal	⫽	☑ Vertical
◠	☑ Tangent	↘	☑ Smooth (G2)
y⟋	☑ Collinear	◎	☑ Concentric
[ː]	☑ Symmetric	=	☑ Equal
⤓	☑ Coincident	🔒	☑ Fix

You can apply geometric constraints to 2D geometric objects only. Objects cannot be constrained between model space and paper space.
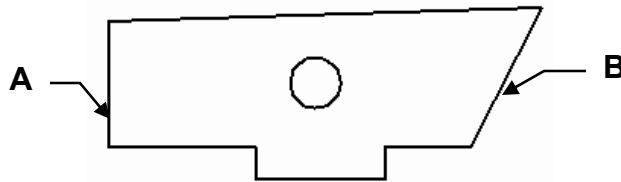
When you apply a constraint, two things happen:
1. The object that you select adjusts automatically to conform to the specified constraint.
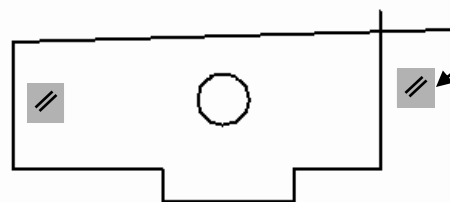2. A gray constraint icon displays near the constrained object.

Example:
If you apply the **Parallel** constraint to lines A and B you can insure that line B will always be parallel to line A.
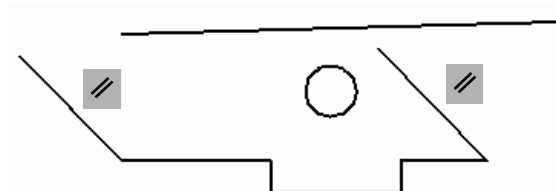
Before

**After Parallel
Constraint applied**

Notice Parallel
Constrain icon
displayed by each
object constrained.

**Line A rotated
and Line B
rotates also to
remain parallel**

Geometric Constraints....continued
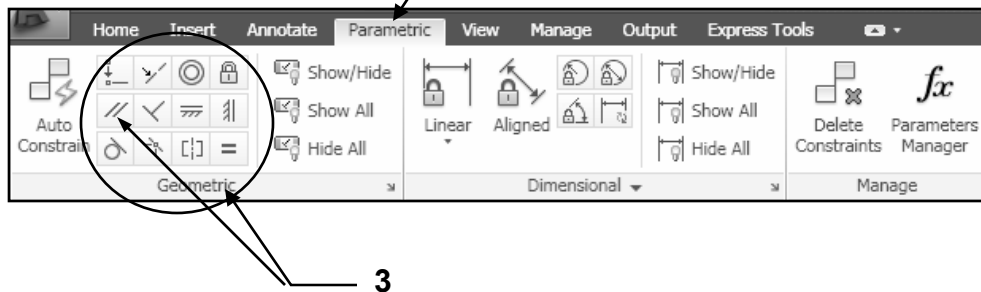
How to apply Geometric Constraints

The following is an example of how to apply the Geometric Constraint **Parallel** to 2D objects.
   The remaining Geometric Constraints are described on the following pages.

1. Draw the objects.
   Geometric constraints must be applied to <u>existing</u> geometric objects.
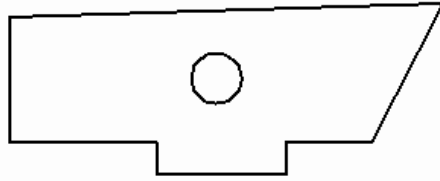
2. Select the **Parametric** tab.

3. Select a Geometric constraint tool from the Geometric panel.
    (In this example the parallel constraint has been selected.)

4. Select the objects that you want to constrain.
    In most cases the order in which you select two objects is important. Normally the second object you select adjusts to the first object. In the example shown below Line A is selected first and Line B is selected second. As a result Line B adjusts to Line A.
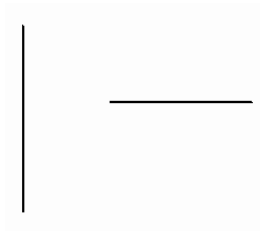

Notice Parallel Constrain icon displayed by each object constrained.
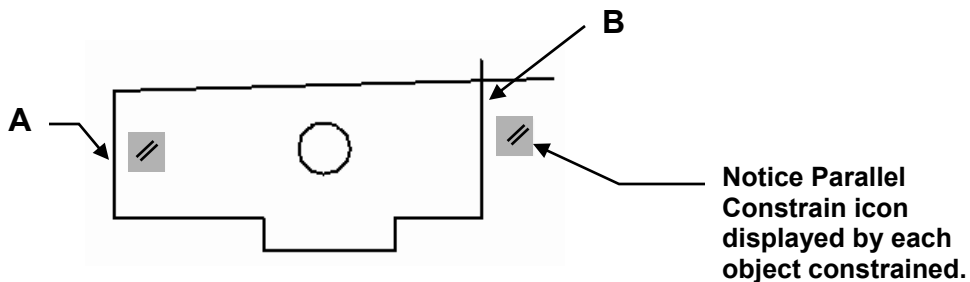
Geometric Constraints….continued

Coincident Constraint
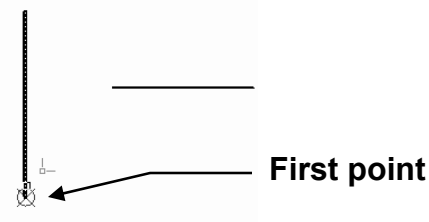A coincident constraint forces two points to coincide.

1. Draw the objects.

2. Select the Coincident tool from the Geometric panel.

3. Select the first Point.
   (Remember it is important to select the points in the correct order. The first point
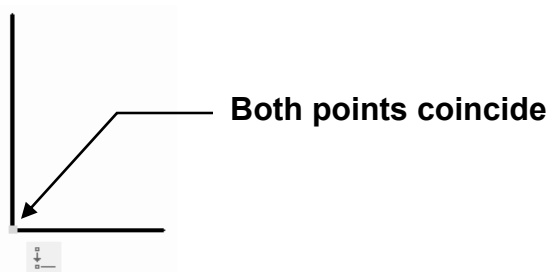   will be the base location for the second point)

First point

4. Select the second Point.
   (Remember it is important to select the points in the correct order. The second
   point will move to the first point)

Second point
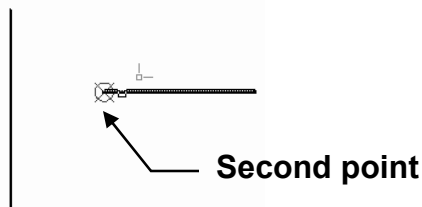
The points are now locked together. If you move one object the other object will move
also and the points will remain together.

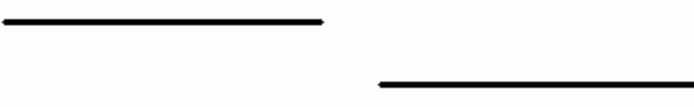**Both points coincide**

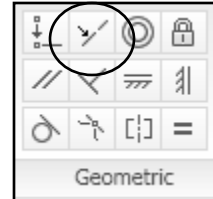# Geometric Constraints….continued

Collinear Constraint
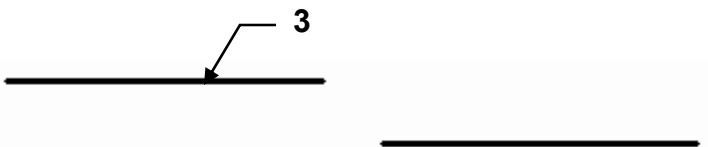A collinear constraint forces two lines to follow the same infinite line.
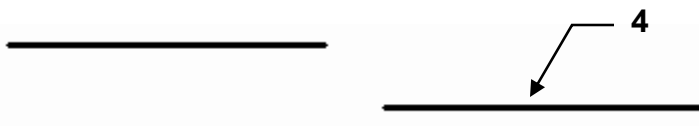
1. Draw the objects.

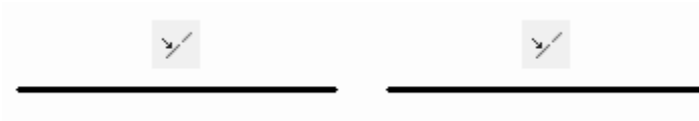2. Select the Collinear tool from the Geometric panel.

3. Select the first line.
   (The first line selected will be the base and the second line will move.)

   3

4. Select the second line.
   (The second line will move in line with the first line selected)

   4

The two lines are now locked in line. If you move one line the other line will move also and they will remain collinear.
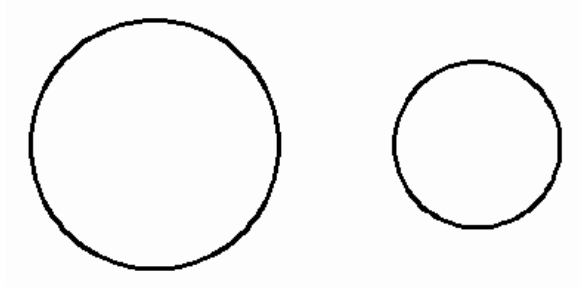
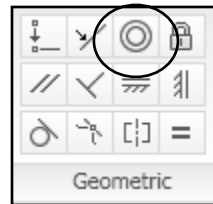# Geometric Constraints….continued

Concentric Constraint

A concentric constraint forces selected circles, arcs, or ellipses to maintain the same center point.
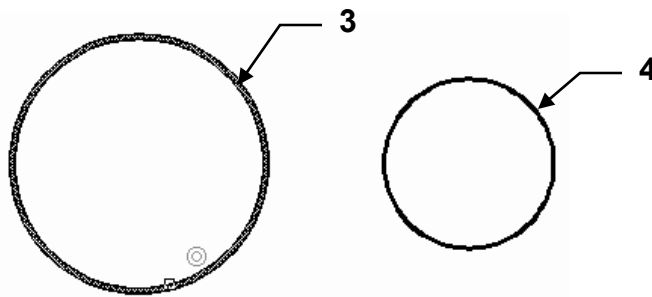
1. Draw the objects.

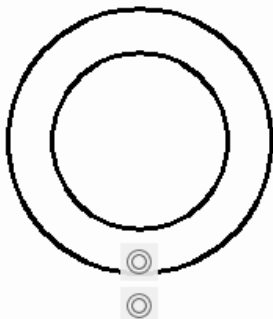2. Select the Concentric tool from the Geometric panel.

3. Select the first circle.
   (The first circle selected will be the base and the second circle will move.)

4. Select the second circle.

The second circle moves to have the same center point as the first object.

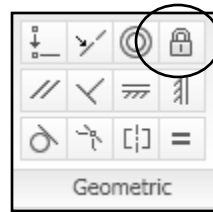# Geometric Constraints….continued

Fixed Constraint

A Fixed constraint fixes a point or curve to a specified location and orientation relative to the Origin (World Coordinate System, WCS).
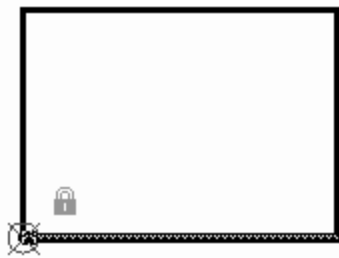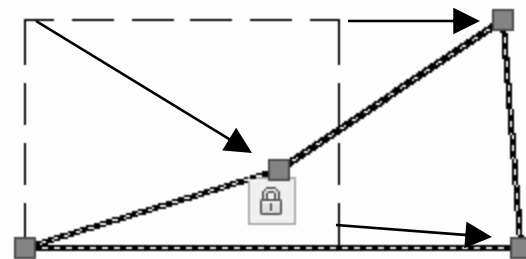
1. Draw the object.

2. Select the Fixed tool from the Geometric panel.

3. Select the Fixed location.

The bottom left corner is now fixed to the specified location but the other three corners can move. (Note: the "lock" symbol may appear in a slightly different location)
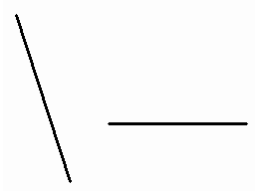
Fixed corner but the other corners can move using grips
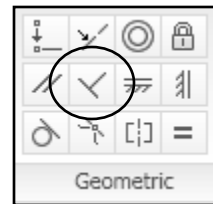
Geometric Constraints….continued

Perpendicular Constraint
A Perpendicular constraint forces two lines or polyline segments to maintain a 90 degree angle to each other.
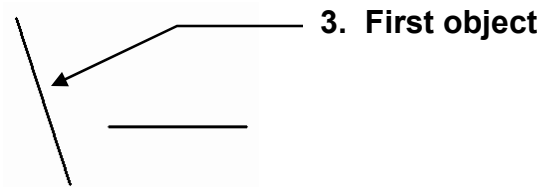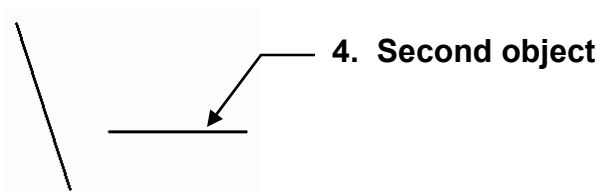
1. Draw the objects.
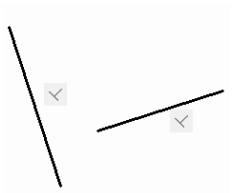
2. Select the Perpendicular tool from the Geometric panel.

3. Select the First object.
    (The first object will be the base angle and the second will rotate to become perpendicular to the first)

3. First object

4. Select the Second object.

4. Second object

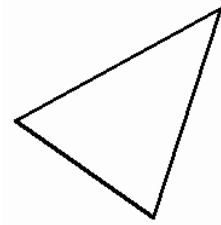The second object rotated to become perpendicular to the first object.
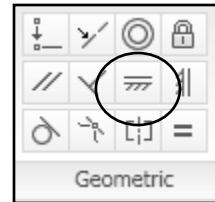
Geometric Constraints….continued

Horizontal Constraint
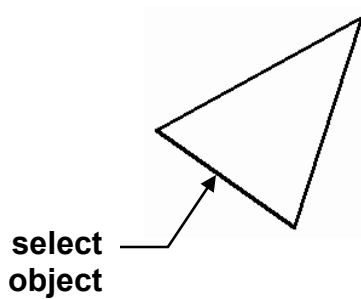The Horizontal constraint forces a line to remain <u>parallel to the **X-axis**</u> of the current UCS.

1. Draw the objects.

2. Select the Horizontal tool from the Geometric panel.

3. Select the <u>object</u> .

**select
object**

The object selected become horizontal to the X-Axis of the current UCS.

Note: If the object is a Polyline or Polygon use the "2 point" option. The first point will be the pivot point.

2nd Point

**1st point
(Pivot point)**

**1st point
(Pivot point)**

2nd point

Geometric Constraints….continued

Vertical Constraint
The Vertical constraint forces a line to remain <u>parallel to the **Y-axis**</u> of the current UCS.
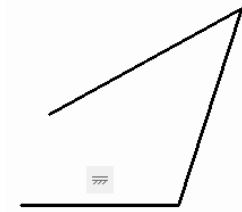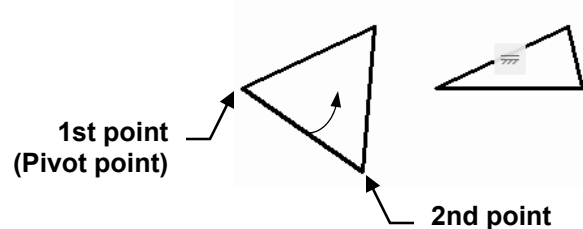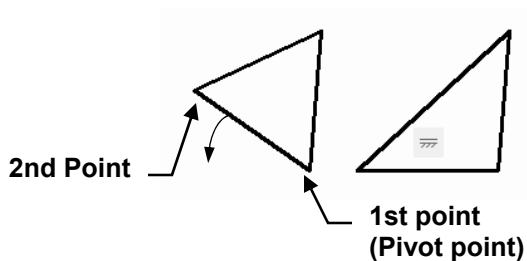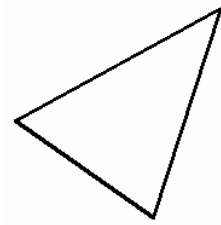
1. Draw the objects.

2. Select the Vertical tool from the Geometric panel.

Geometric
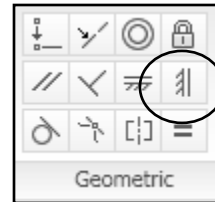
3. Select the <u>object</u> .
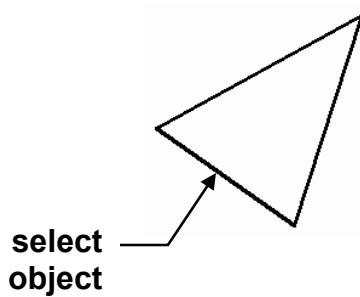
select object

The object selected become <u>vertical to the Y-Axis of the current UCS</u>.
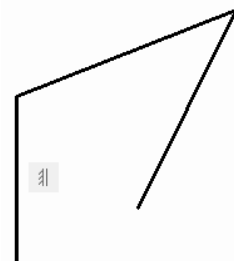
Note: If the object is a Polyline or Polygon use the "2 point" option. The first point will define the pivot point.

2nd Point

1st point (Pivot point)

1st point (Pivot point)

2nd point
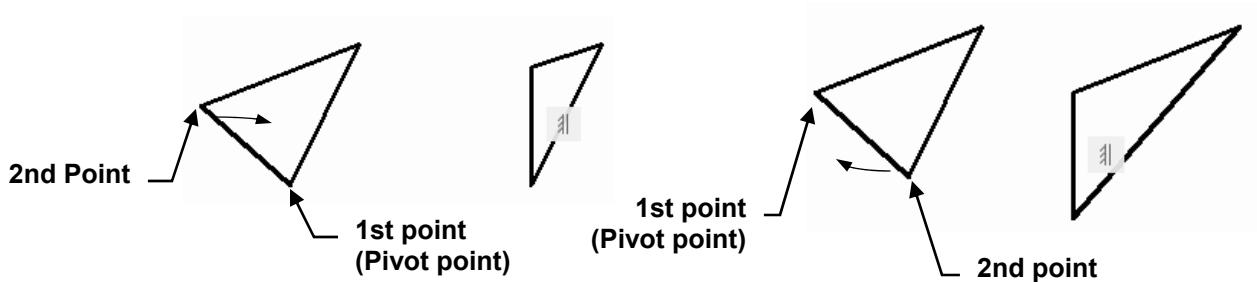
Geometric Constraints....continued

Tangent Constraint
The Tangent constraint forces two objects to maintain <u>a point of tangency</u> to each other.

1. Draw the objects.

2. Select the Tangent tool from the Geometric panel.
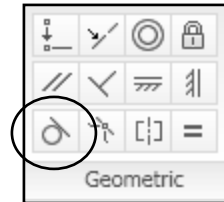
3. Select the base object (Large Circle) and then the object (Line) to be tangent.
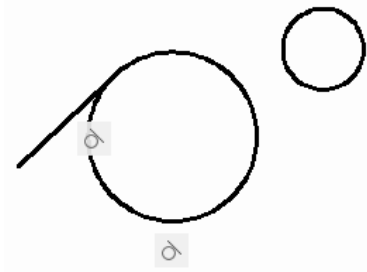
4. Select the base object (Large Circle) and then the object (Small Circle) to be tangent.
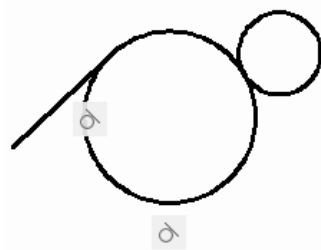
Geometric Constraints....continued

Symmetric Constraint
The Symmetric constraint forces two objects on a object to maintain <u>symmetry about a selected line.</u>

1. Draw the objects.
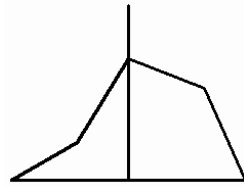
2. Select the Tangent tool from the Geometric panel.
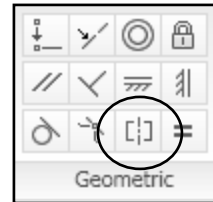
3. Select the base line (1) then the Line (2) to be symmetrical and then the line (3) to be symmetrical about.
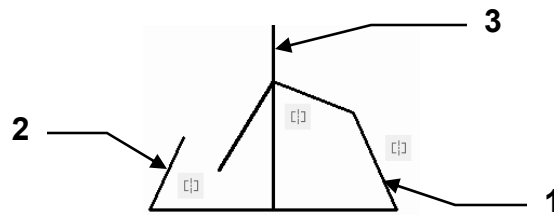
4. Select the base line (1) then the Line (2) to be symmetrical and then the line (3) to be symmetrical about..
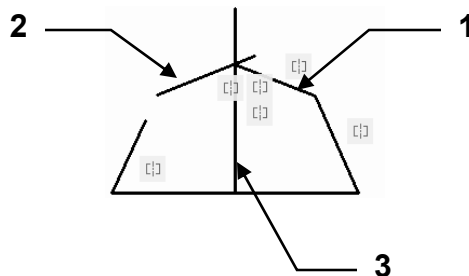
Geometric Constraints….continued

Equal Constraint

The Equal constraint forces two objects to be <u>equal in size</u>. (Properties are not changed)

1. Draw the objects.

2. Select the Equals tool from the Geometric panel.
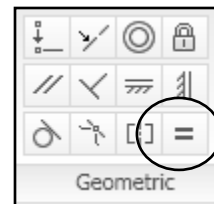
3. Select the base object (A) then select the object (B) to equal the selected base object.
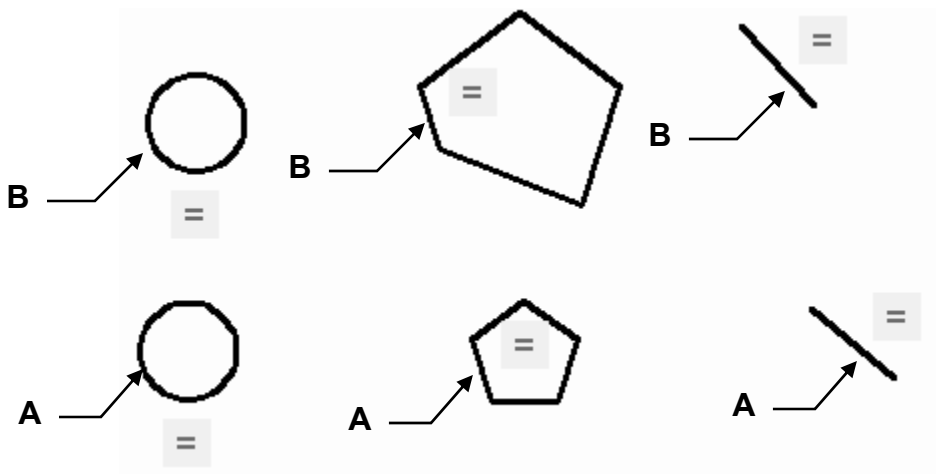
Geometric Constraints….continued

Controlling the display of Geometric constraint icons

You may temporarily Hide the Geometric constraints or you may show individually selected constraints using the Show and Hide tools.
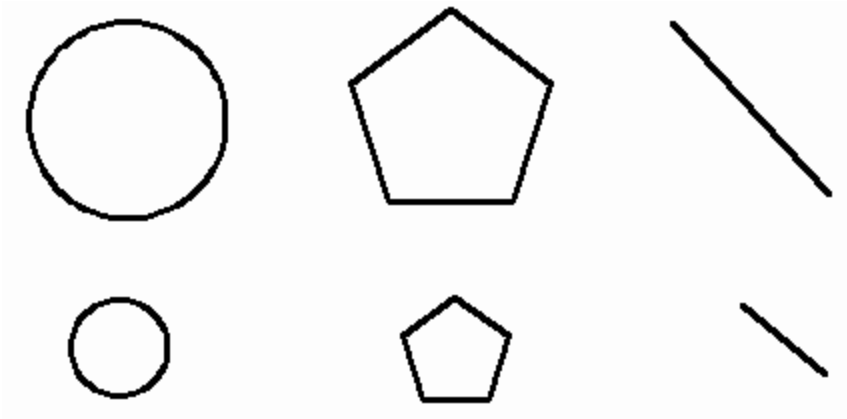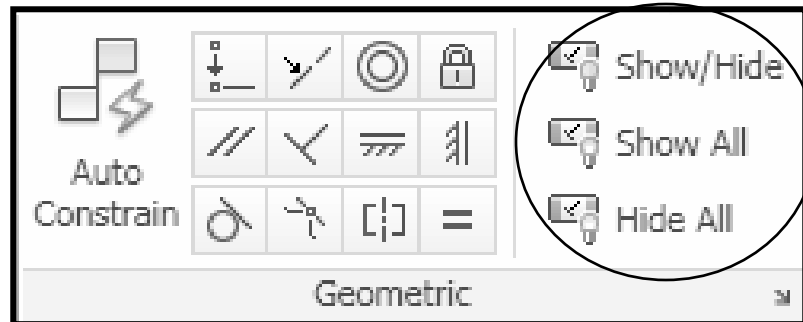

Show All
This tool displays all geometric constraints.
Click on the tool and the constraints appear.

Hide All
This tool hides all geometric constraints.
Click on the tool and the constraints disappear.

Show / Hide
After you have selected the Hide All tool to make the constraints disappear, you may display individually selected geometric constraints.
1. Select the Show tool
2. Select the object
3. <enter>
4. <enter>
The geometric constraints for only the selected objects will appear.

Dimensional Constraints

Overview of Dimensional Constraints
Dimensional constraints determine the distances or angles between objects, points on objects, or the size of objects.

Dimensional constraints include both a name and a value.

Dynamic constraints have the following characteristics:
    A. Remain the same size when zooming in or out
    B. Can easily be turned on or off
    C. Display using a fixed dimension style
    D. Provide limited grip capabilities
    E. Do not display on a plot

There are 7 types of dimensional constraints. (They are similar to dimensions)
    1. Linear
    2. Aligned
    3. Horizontal
    4. Vertical
    5. Angular
    6. Radial
    7. Diameter

The following is an example of a drawing with dimensional constraints. The following pages will show you how to add dimensional constraints and how to edit them.
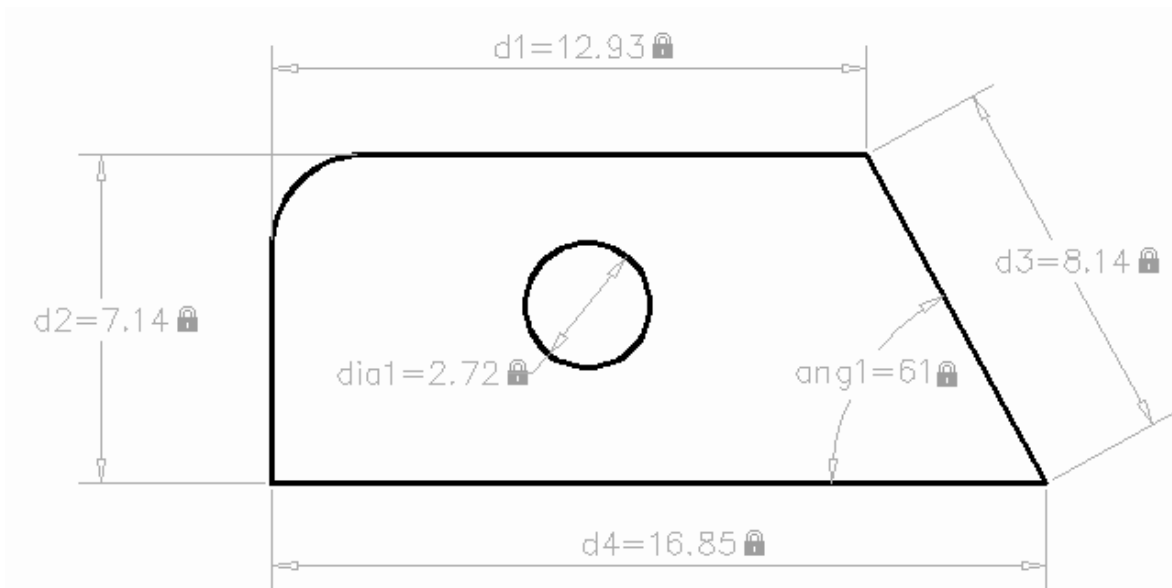
Dimensional Constraints….continued

How to apply Dimensional Constraints

The following is an example of how to apply the dimensional constraint Linear to a 2D object.

1. Draw the objects.

2. Select the Parametric tab.

2

3

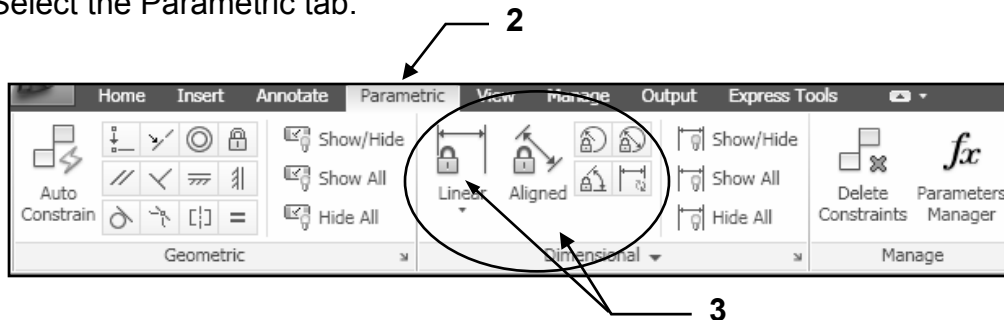3. Select a Dimensional Constraint tool from the Dimensional panel.
    (In this example the Linear tool has been selected)

4. Apply the "Linear" dimensional constraint as you would place a linear dimension.
    a. Place the first point
    b. Place the second point
    c. Place the dimension line location

5. Enter the desired value or <enter> to accept the displayed value.
    (Notice the constraint is highlighted until you entered the value)

4C. dimension line location

5. Value highlighted temporarily

4A. First Point

4B. Second Point
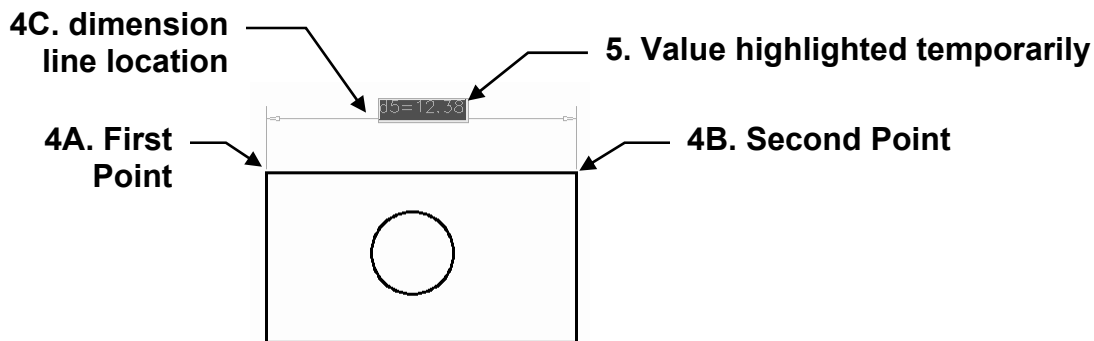
6. The Dimensional constraint is then displayed with Name (d1) and Value (12.38).

6
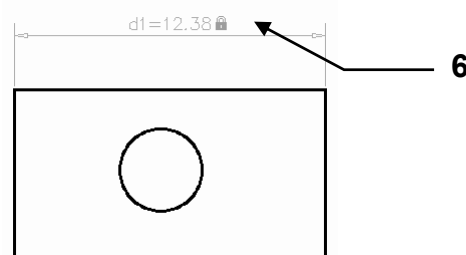
Dimensional Constraints….continued

How to use Dimensional Constraints

The following is an example of how to use dimensional constraint to change the dimensions of a 2D object.

1. Draw the objects.
    (Size is not important. The size will be changed using the dimensional constraints.)
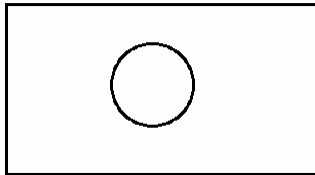
2. Apply Dimensional constraints
    Linear and Diameter.

Note:
Dimensional constraints are very faint and will not print. If you want them to print refer to page 13-24

Dimensional Constraints….continued

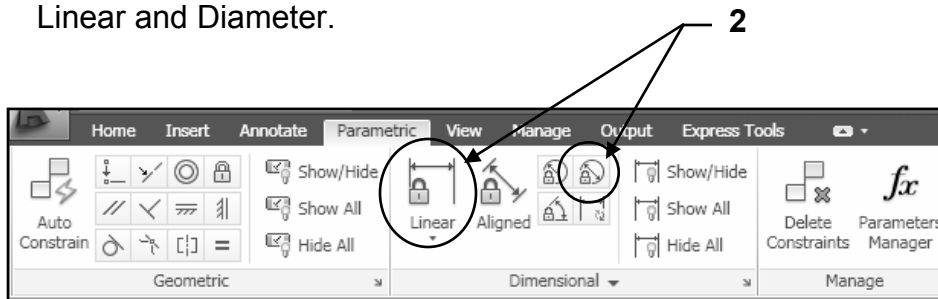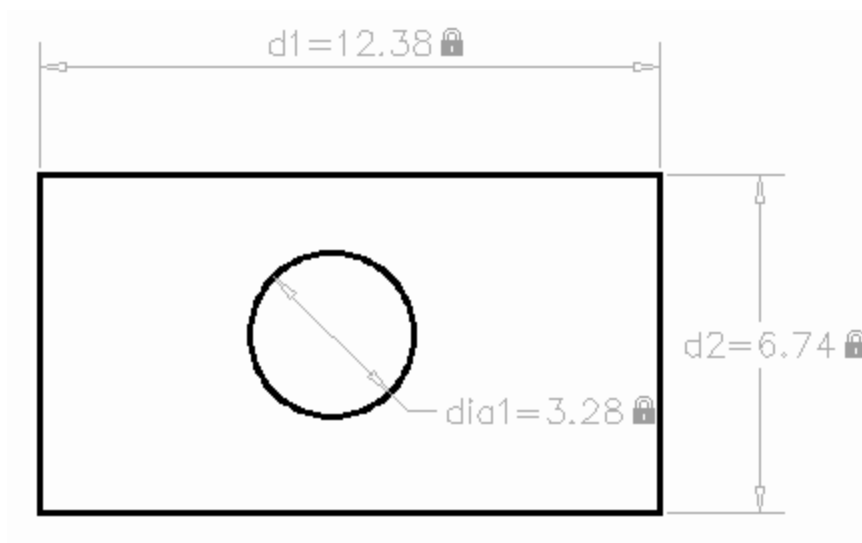Now adjust the length and width using the dimensional constraints.

1. Double click on the d1 dimensional constraint.
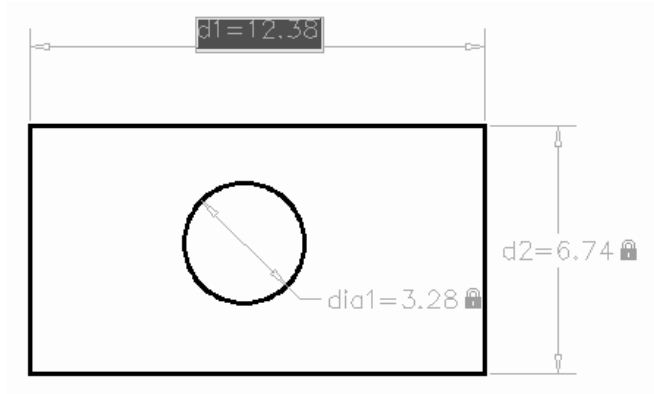
2. Enter the new value for the length then <enter>

Note: The length increased automatically in the direction of the "2nd endpoint". If you want the length to change in the other direction you must apply the "geometric constraint Fixed" to the right hand corners. (See page 13-8)
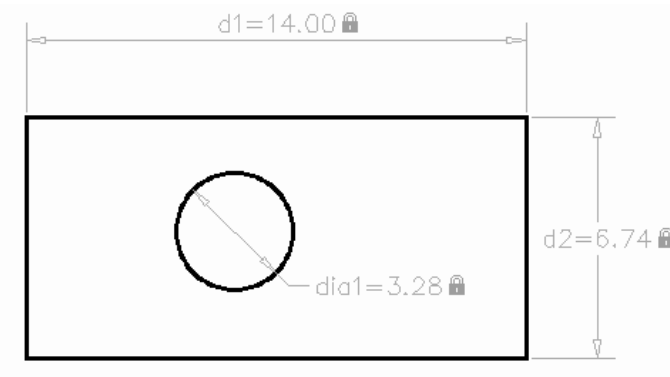
3. Double click on the d2 dimensional constraint and enter the new value for the width then <enter>

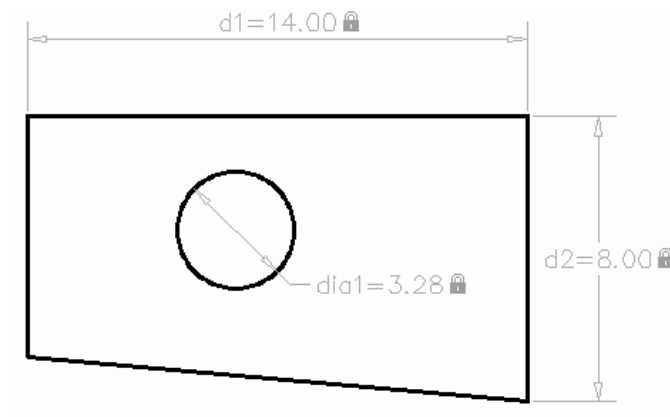# Dimensional Constraints….continued

Parameter Manager

The Parameter Manager enables you to manage dimensional parameters. You can change the name, assign a numeric value or add a formula as its expression.

1.   Select the Parameter Manager from the Parametric tab / Manage Panel
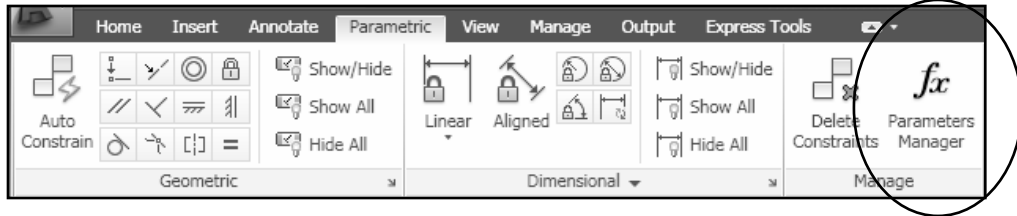
Column descriptions:

Name: Lists all of the dimensional constraints. The order can be changed to ascending or descending by clicking on the up or down arrow.

Expression: Displays the numeric value or formula for the dimension.

Value: Displays the current numeric value.
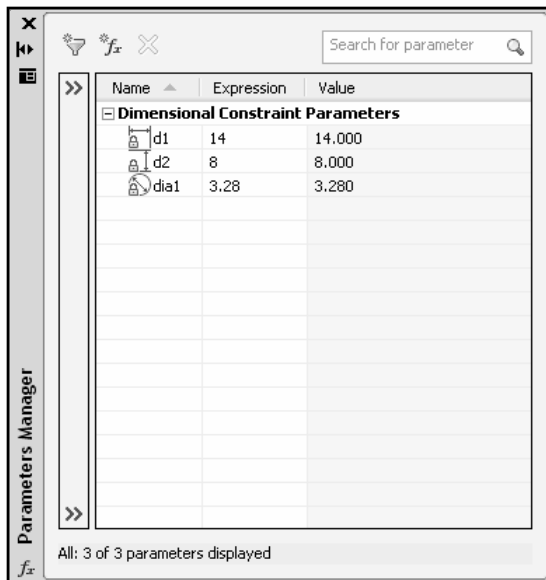
Dimensional Constraints….continued

Parameter Manager Name cell

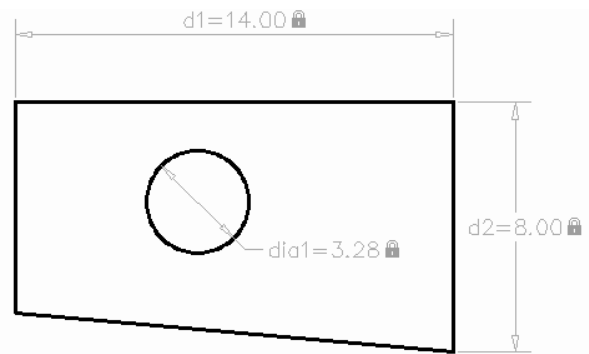You may change the name of the dimension to something more meaningful. For example you might change the name to Length and width rather than d1 and d2.

1. Double click in the name cell that you want to change.

2. Type the new name and <enter>

Example:

The names in the Parameter Manager shown below have been changed. Notice the dimensional constraints in the drawing changed also.

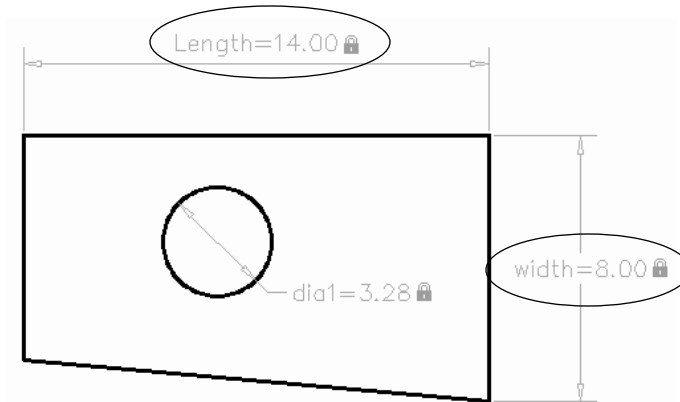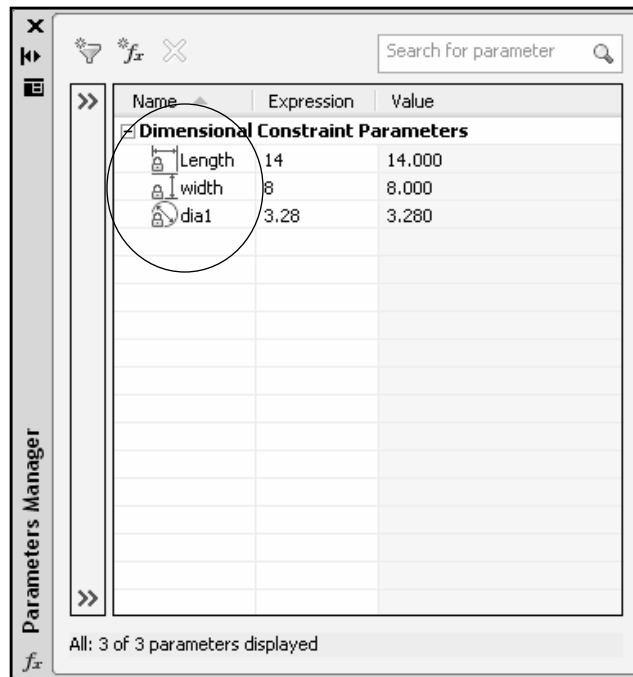# Dimensional Constraints….continued

Parameter Manager Expression cell
You may change the value of a dimensional constraint by clicking on the Expression cell and entering a new value or formula.

1. Open the Parameter Manager.

2. Double click in the Expression cell to change (dia1 in this example)
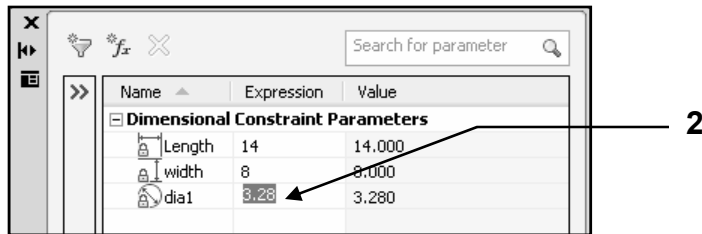
3. Enter new value or formula.
   For this example: **width / 2**
   This means the diameter will always be half the value of d2 (width)

Notice the Value cell displays the current value
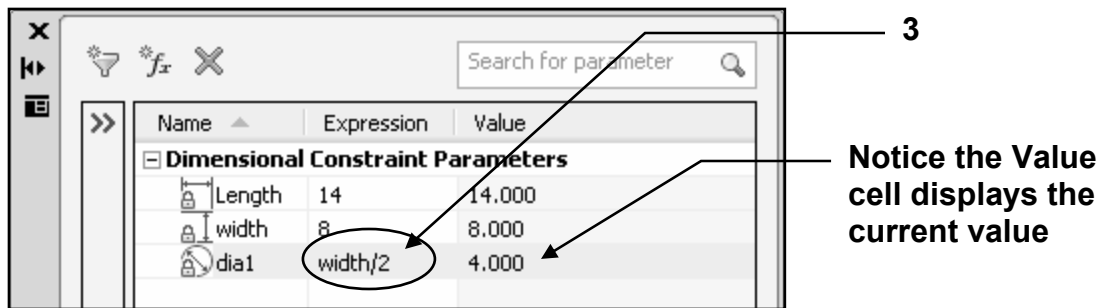
Now whenever the width is changed the diameter will adjust also.

Dimensional Constraints….continued

Adding User-defined parameters
You may create and manage parameters that you define.

1. Open the Parameter Manager

2. Select the "New user parameter" button.
    A "**User Parameters**" will appear.
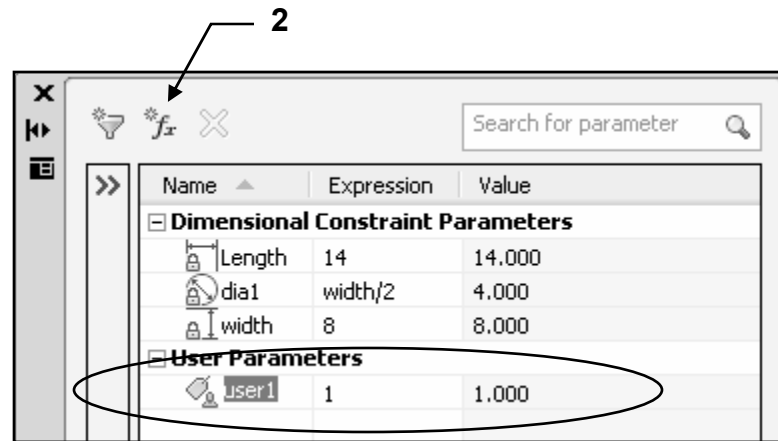
3. Enter a **Name** desired for the expression.
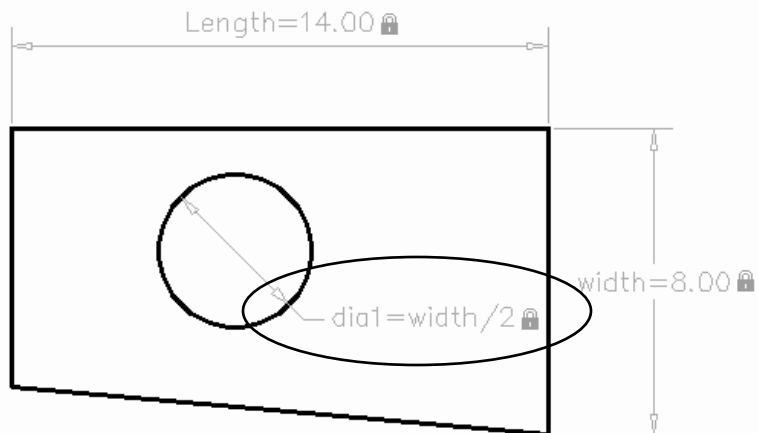
4. Enter an **Expression**.

The <u>Value cell</u> updates to display the current value.
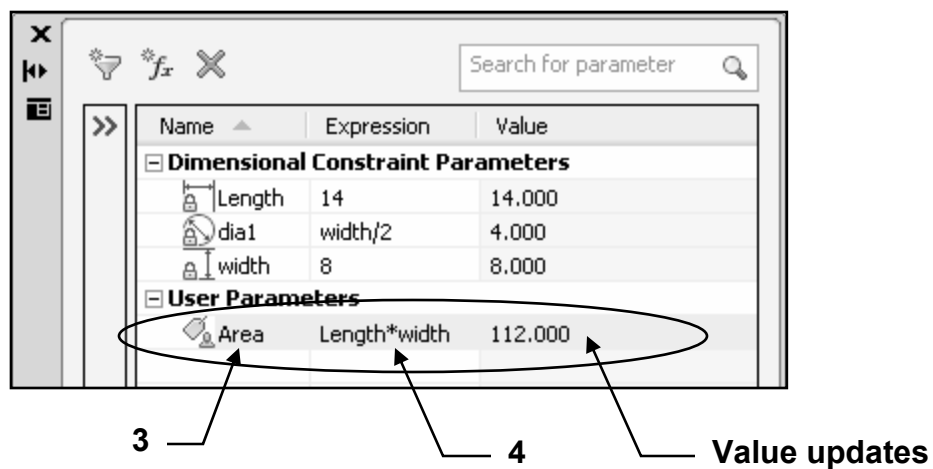
Note: With Imperial Units, the parameter manager interprets a minus or a dash (-) as a unit separator rather than a subtraction operation. To specify subtraction, include at least one space before or after the minus sign.
For example: to subtract 9" from 5', enter **5' -9"** rather than **5'-9"**

Dimensional Constraints….continued

Convert Dimensional constraint to an Annotational constraint

Geometric and Dimensional constraints do not plot. If you would like to plot them you must convert them to an Annotational constraint.
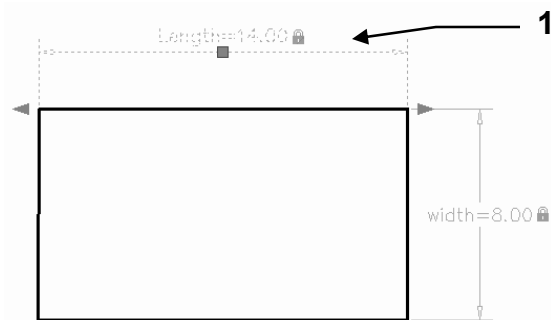
1. Select the constraint to convert. (Click on it once)

2. Right click and select **properties** from the list.
.
3. Select the Constraint Form down arrow and select Annotational
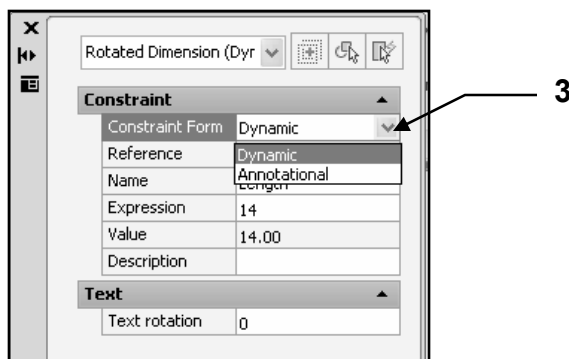
4. The Properties palette is populated with additional properties as the constraint is now an annotational constraint.
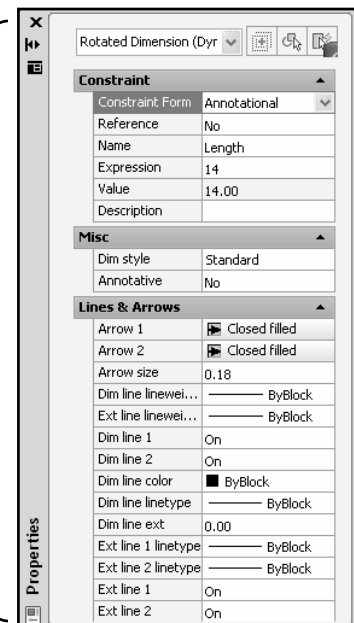
5. The annotational constraint will now plot.
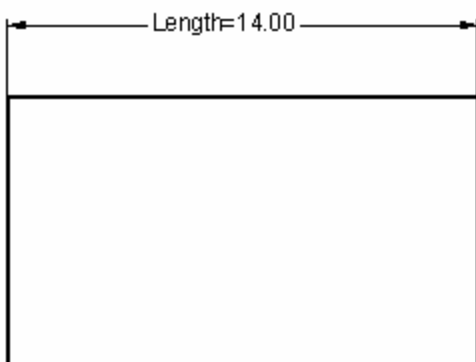
Dimensional Constraints....continued

Control the Display of Dimensional constraints

You may turn off the display of Dimensional constraints using the **Show** and **Hide** tools. (Refer to page 13-15).

Delete a Dimensional constraint.

To permanently delete a dimensional constraint select the **Delete Constraints** button and then select the constraint to delete.

EXERCISE 13A

INSTRUCTIONS:

1. Start a **NEW** file using **My Decimal Setup.**

2. **Draw** the Lines shown below on the left using random lengths and angles.
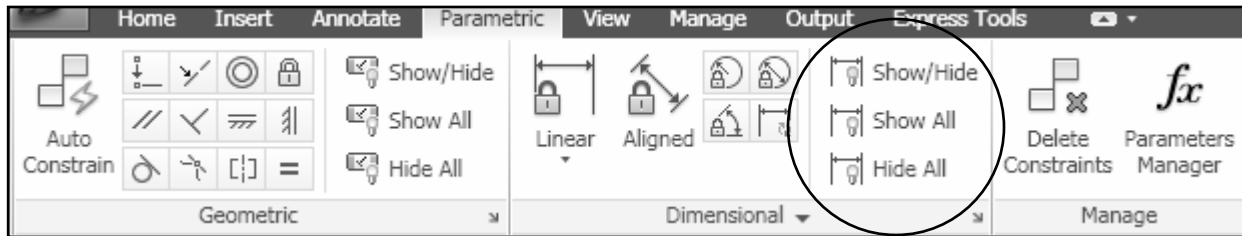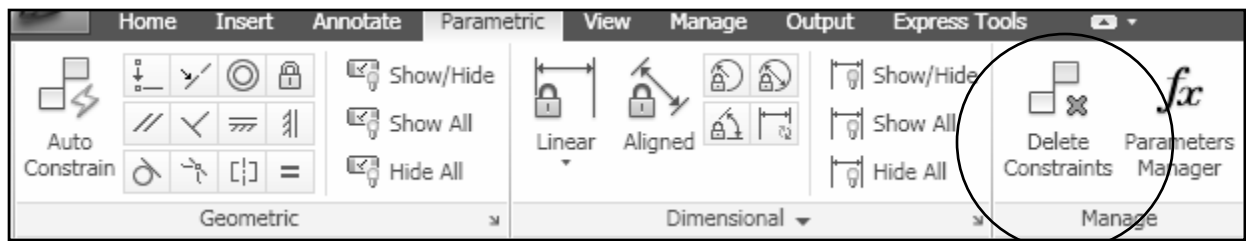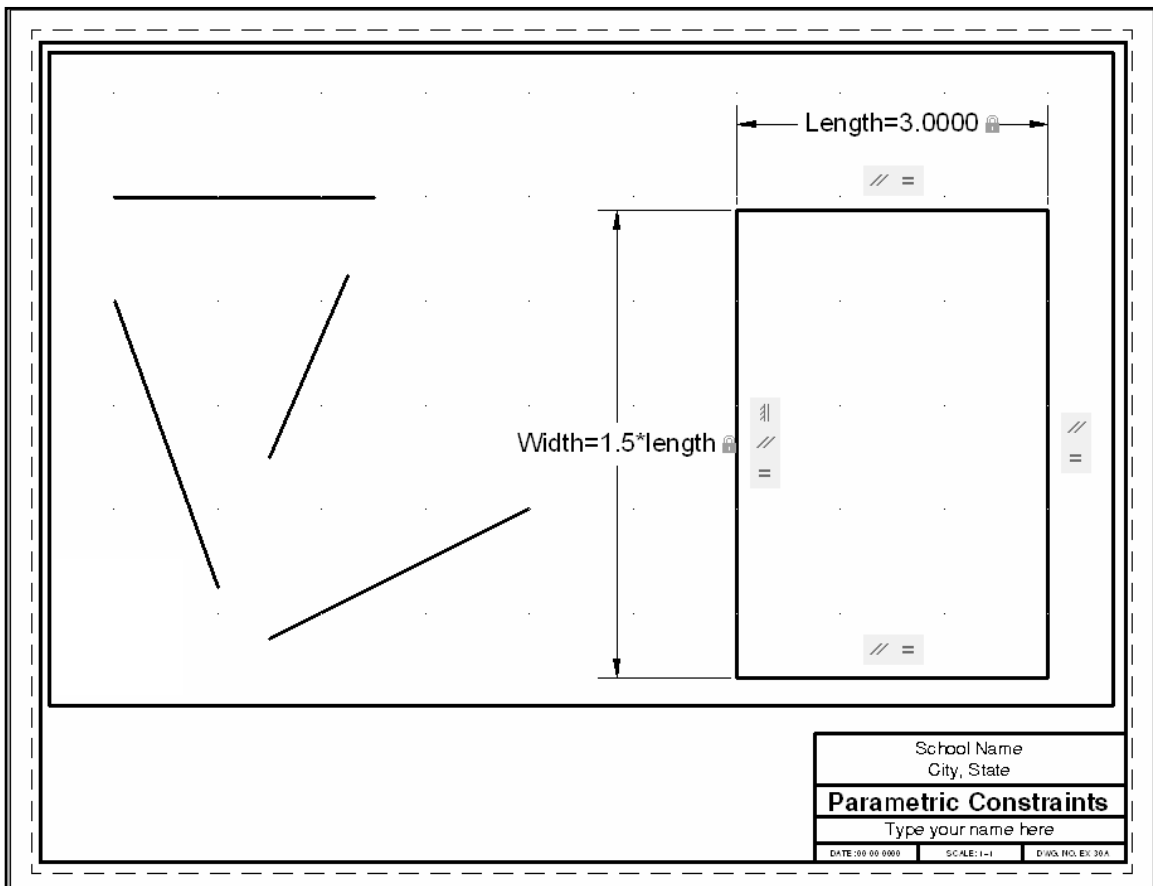
3. Create the shape on the right using the lines on the left and Geometric constraints.

4. Add the two Dimensional constraints.

5. Change the Dimensional constraints name as shown.

6. Create an Expression formula for the Width.
   (pg 13-22)

7. Add a <u>User defined parameter</u> **Area**

8. Change the Dimensional Constraints to
   Annotational. (pg. 13-24)

9. **Save** the drawing as: **EX13A**

Name ▲	Expression	Value
⊟ **Dimensi...**		
🔒 Length	3	3.0000
🔒 Width	1.5*length	4.5000
⊟ **User Va...**		
Area	length*width	13.5000

5

6

7

Length=3.0000 🔒

Width=1.5*length 🔒

School Name
City, State

Parametric Constraints

Type your name here

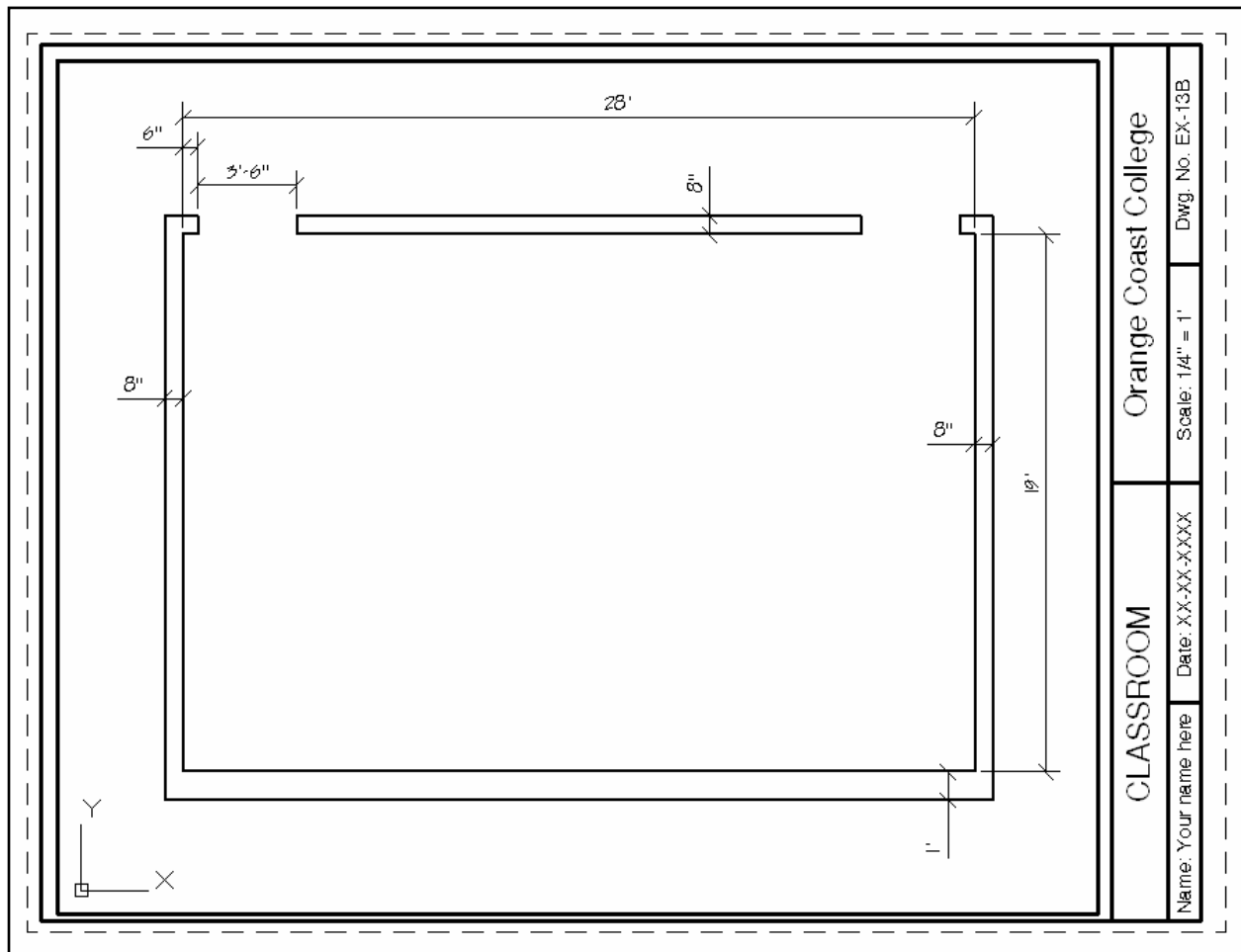DATE:00 00 0000 | SCALE:1-1 | DWG. NO. EX 30A

EXERCISE 13B

INSTRUCTIONS:

Step 1

1. Draw the Floor plan shown below.

2. Do not dimension.

3. **Save** the drawing as: **EX13B**
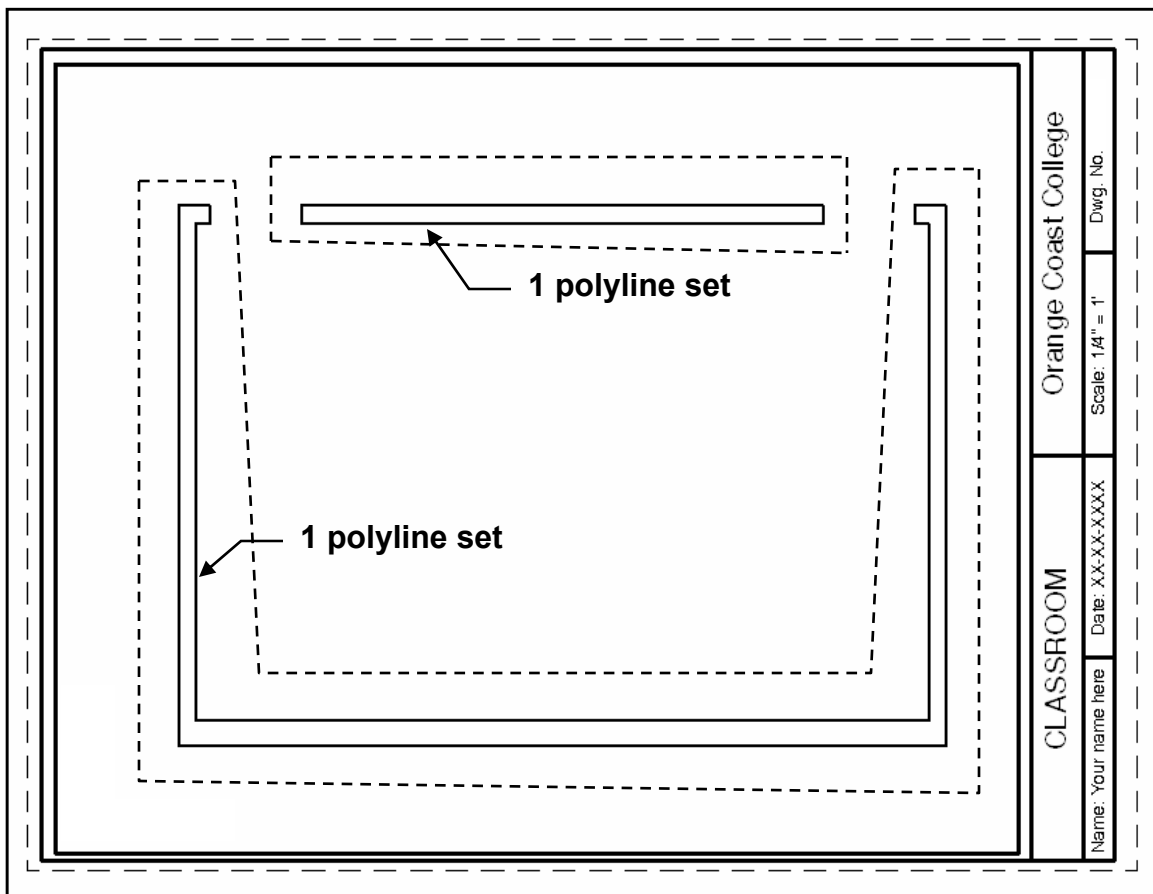
Continue on to Step 2 on the next page

EXERCISE 13B….continued

INSTRUCTIONS:

Step 2

1. Using the **Polyedit / Join** command, join the lines that form the walls into 2 sets of polylines.

2. **Save** the drawing again as: **EX13B**

Continue on to Step 3 on the next page

1 polyline set

1 polyline set

EXERCISE 13B....continued
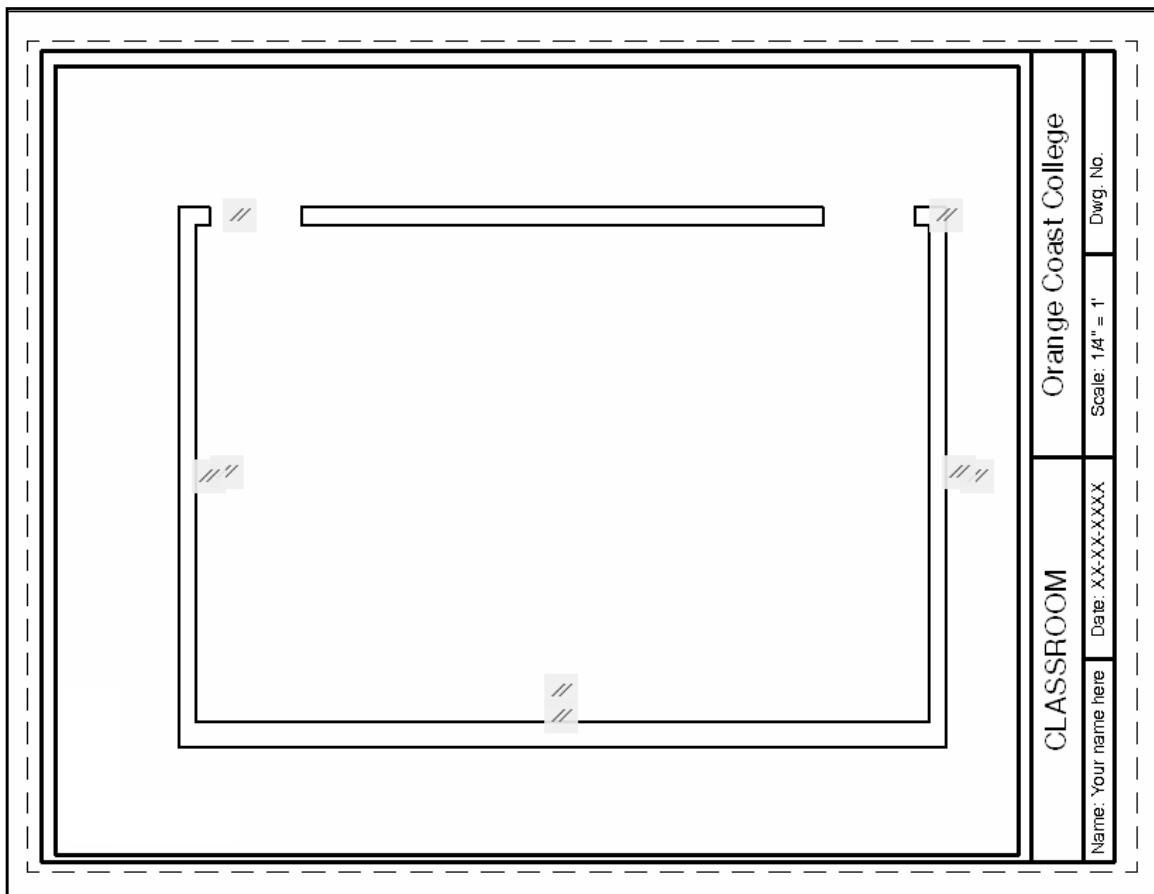
INSTRUCTIONS:

Step 3

1. Using Geometric constraints, make **all** inside lines **Parallel** to the outside lines.

   (Refer to page 13-3)

Note:

Your geometric icons may appear in different locations than the illustration below.

2. **Save** the drawing as: **EX13B**

Continue on to Step 4 on the next page

EXERCISE 13B....continued
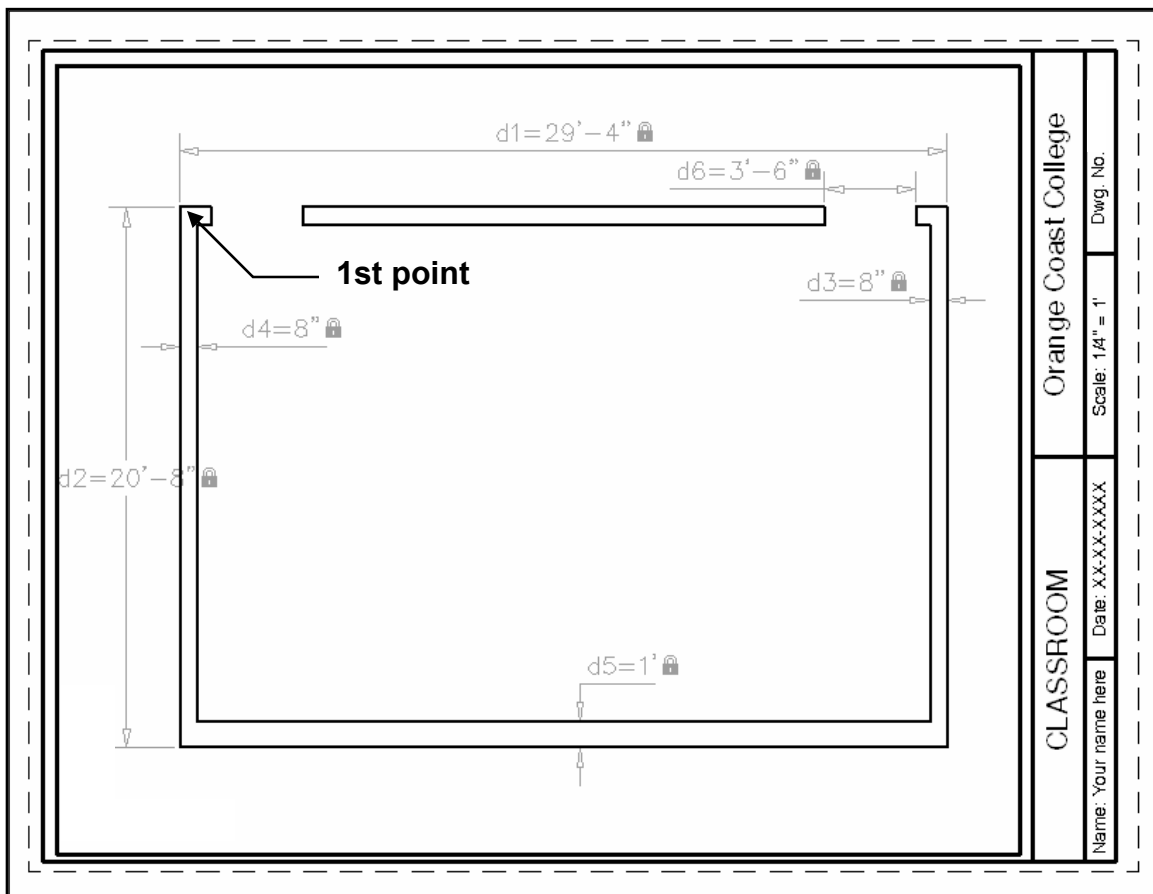
INSTRUCTIONS:

Step 4.

1. Apply Dimensional constraints as shown below.

Note:

Notice where the 1st point is located. When placing the Length and Width dimensional constraints, it is important to select the 1st and 2nd points in the correct order. The objects will change size in the direction of the 2nd point.

2. **Save** the drawing as: **EX13B**

Continue on to Step 5 on the next page

1st point

EXERCISE 13B....continued
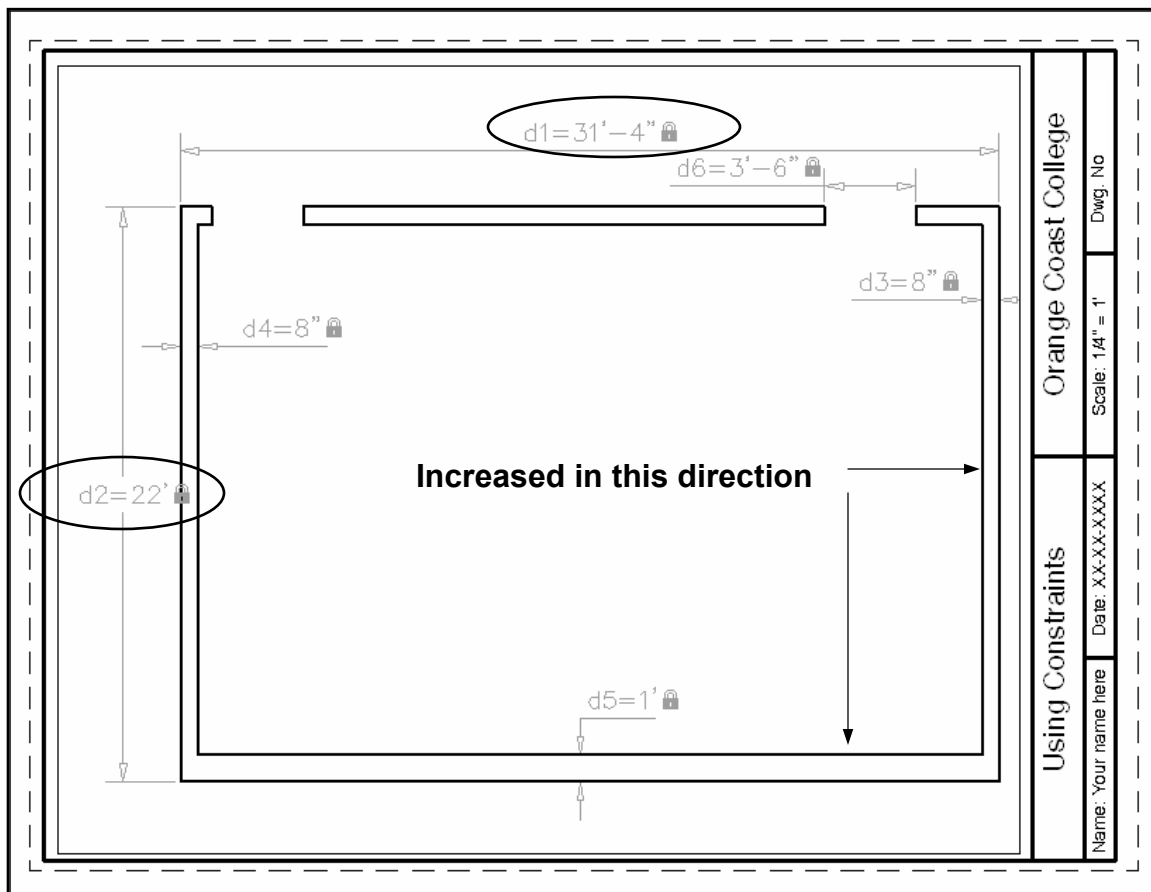
INSTRUCTIONS:

Step 5.

1. Change d1 to 31' -4" (refer to page 13-19)

2. Change d2 to 22'

Note:

If you placed everything correctly d1 should have increased to the right and d2 down.
Do not be surprise if it does not work correctly the first time. If it did not, try to figure out
what you did wrong. You may not have made all of the lines parallel to each other or
maybe you did not place the 1st points of the dimensional constraints in the correct
location. If you master Geometric and Dimensional constraints it could be very helpful
in the future.

3. **Save** the drawing as: **EX13B**

Notes: