


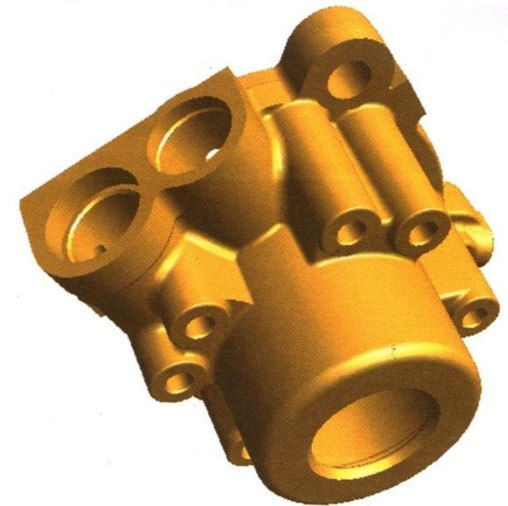
2. Fundamentals of Technical Graphical Visualization and Communication

Please read [Fundamentals of Graphics Communication](#) notes on the course web site!

Applying Constraints & Dimensioning in 3D

 This week you will learn to apply constraints and dimension in solid modeling . The steps to follow are:

- What are Constraints?
- Variational geometry
- Types of constraints
Geometric , dimensional , ground
- Applying constraints to sketches on 3D geometry





Applying Constraints & Dimensioning in 3D

What are Constraints ?



The solid model stores more than just the final geometry— it stores the “design intent” rules that govern what will happen when geometry changes. This makes it easy to make flexible design changes to part models.

These rules are described as “**constraints**” on wireframe geometry used to extrude and revolve parts, and as “relations” when parts are cut, joined, or intersected.

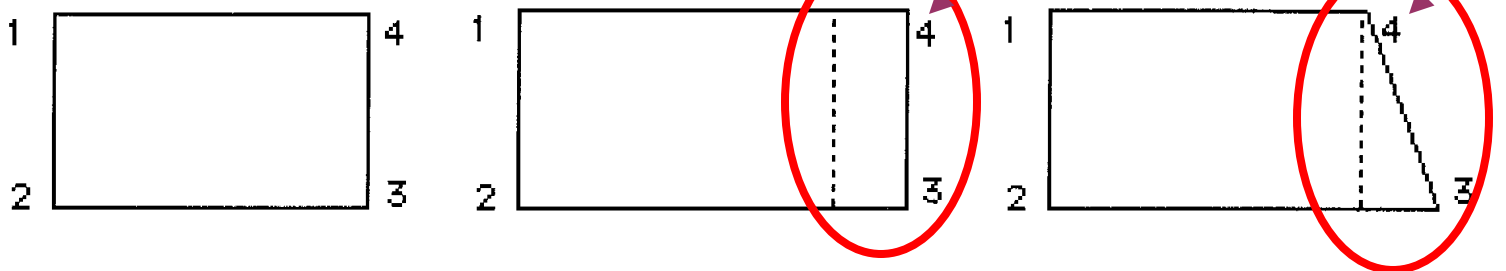
There are two major types of constraint-based modeling systems available on the market today: **variational geometry** and **parametric modeling**.

Applying Constraints & Dimensioning in 3D

Variational Geometry

With *variational geometry*, constraints are applied to the 2-D shape in terms of degrees of freedom. A *degree of freedom* exists if there is currently no constraint applied to control a specific feature of the geometry of your sketch.

This concept is best described by a simple example. Start with a simple 4-sided polygon, defined by 4 points, 1 through 4, as shown below. What do we want to happen if point 3 is translated to the right?



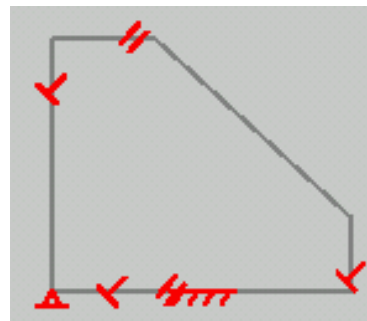
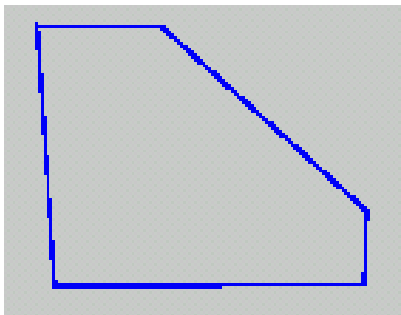


Applying Constraints & Dimensioning in 3D

Uses of Variational Geometry

How Many Constraints do You Need?

Some mathematically-inclined readers may have a question at this point about how many constraints can be applied to a section. Normally, to solve a set of simultaneous equations, the number of equations must equal the number of unknowns.





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Uses of Variational Geometry

What happens if fewer than this number are applied, and a change is made to a value?

There could be more than one possible solution. If you were using a general-purpose symbolic math package, it might not let you try to solve a set of equations where there were more unknowns than there were equations. The solver used to solve variational geometry is not just a simple simultaneous-equation solver. It looks at the geometry, and attempts to make the minimum change if more than one solution is possible.



Applying Constraints & Dimensioning in 3D

Parametric Modeling

Parametric modeling is a subset of variational geometry. Parametric modeling allows for a flexible design in much the same way that variational modeling does. That is, you are able to add constraints to your sketch to control how the geometry will behave as modifications are made.

In general, you need to have a fully constrained shape before you can use parametric modeling to create a 3-D solid.



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Type of Constraints

Constraints enable you to preserve the original design intent even as changes are made to the model you have created. Constraints allow for a great deal of flexibility in the design, but it is important that you apply the constraints properly so that the integrity of the design is maintained.

There are three major categories of constraints:

- Geometric

- Dimensional

- Ground



Applying Constraints & Dimensioning in 3D

Geometric Constraints

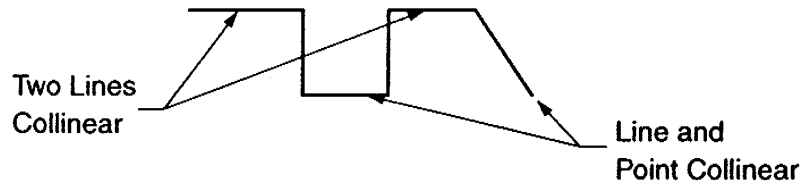
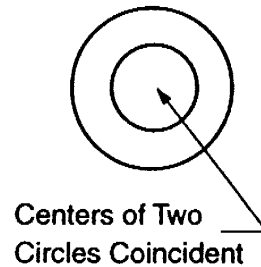
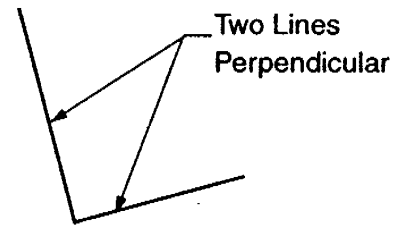
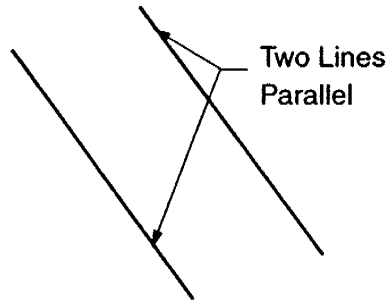
Geometric constraints control the shape of the profile. When you profile your sketch, the sketch is analyzed and geometric constraints are added to suit the sketch.

Geometric constraints are used to define the *shape* of your 2-D geometry.

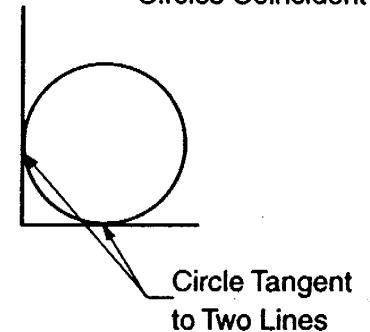
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Geometric Constraints

Parallel
Perpendicular
Collinear
Coincident
Tangent
Horizontal
Vertical
Project
Join
Xvalue
Yvalue
Radius

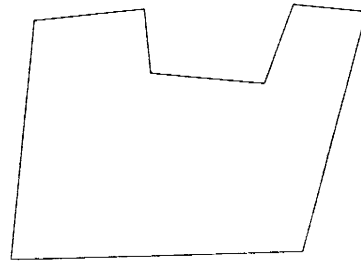


Line and Point Collinear

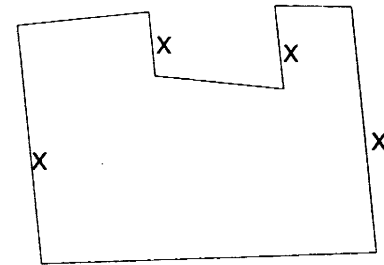


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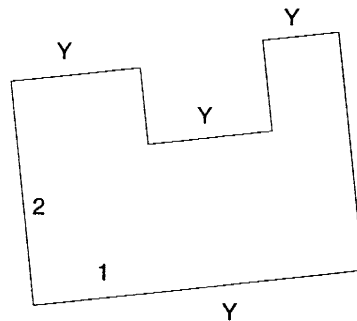
Application of geometric constraints to a 2D shape



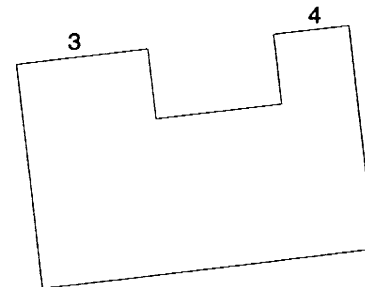
Original sketch of 2-D geometry



Parallel constraints applied between lines labeled with an "X."



Parallel constraints applied between lines labeled with a "Y." Perpendicular constraint applied between lines 1 and 2.



Collinear constraint applied between lines 3 and 4.



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Dimensional Constraints

Dimensional constraints specify the length, radius, or rotation angle of the geometric elements in your sketch. Geometric constraints force the profile to conform to a specific shape.

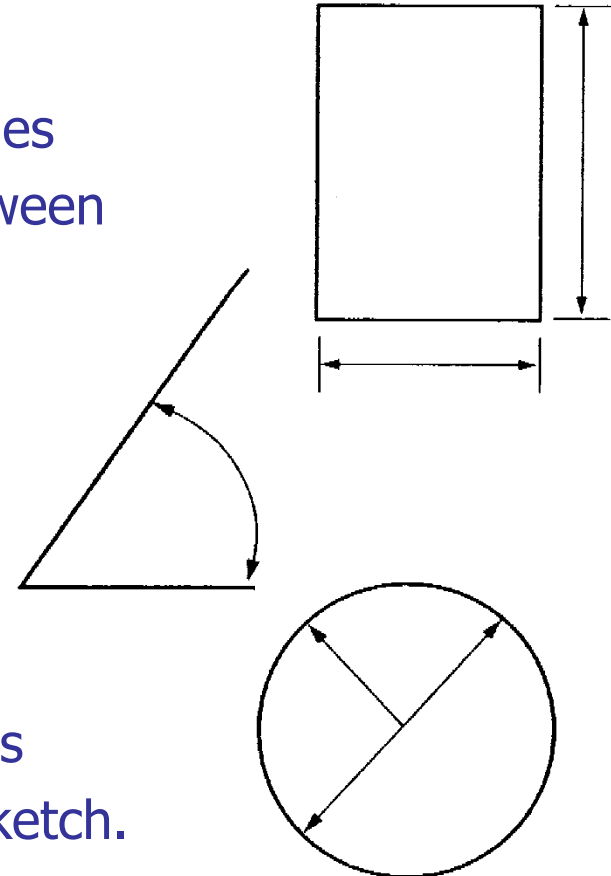
Dimensional constraints, on the other hand, add the parametric characteristic to the profile. You can change a dimension at any time and its new value will be immediately reflected in the design.

Applying Constraints & Dimensioning in 3D

Linear This constraint is used to define – the linear distance between two lines between a line and a point, or between two points.

Angular Angular dimensions are used to define the angle between two lines on your sketch.

Diametral & Radial Diametral constraints are used to control the diameter of any circles on your sketch. Radial dimensions control the radius of any arcs on your sketch.

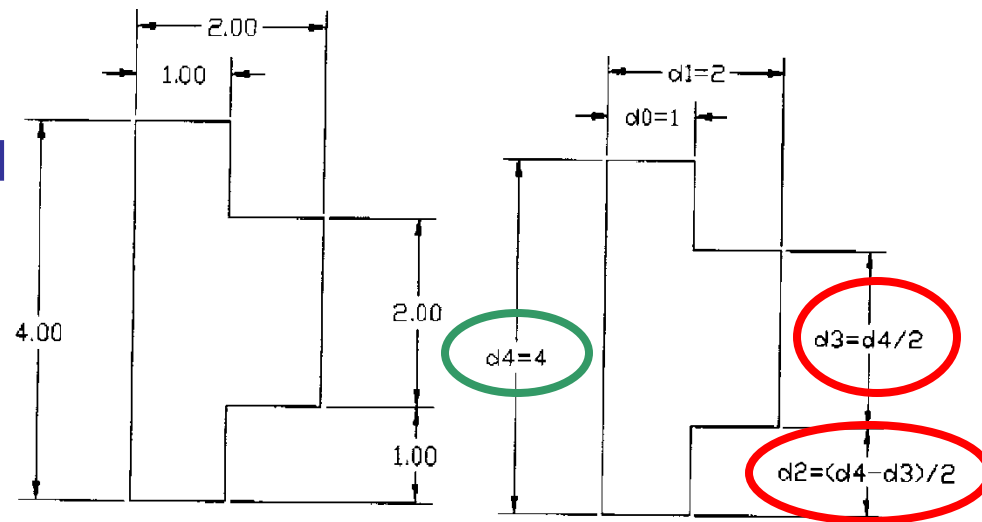


Applying Constraints & Dimensioning in 3D

Method of Entry

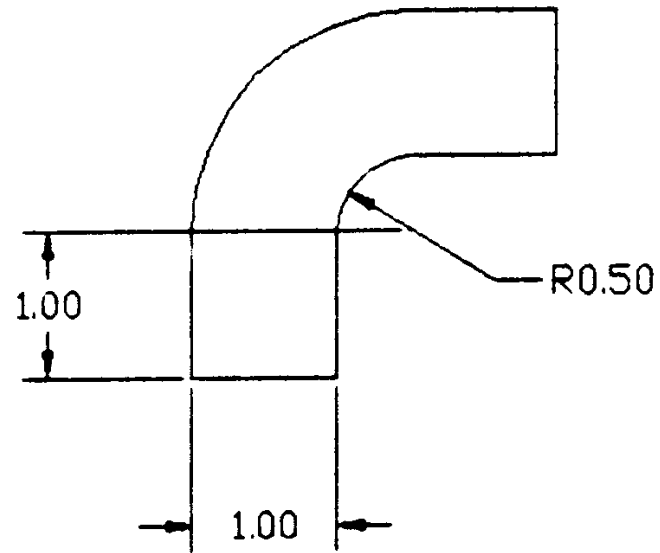
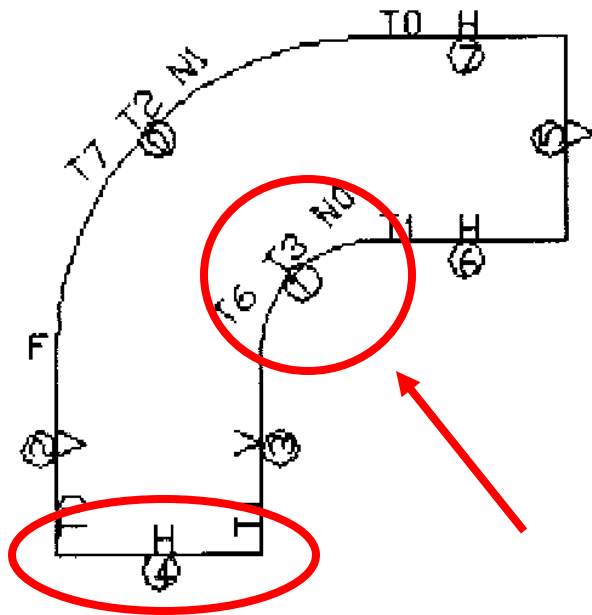
Dimensions can be shown and entered as either numeric constants or as equations.

Use numeric values when the size of an object is not related to another object and use an equation when the size of an object is directly related to another object.



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Dimensioned Profile & Its Constraints



Applying Constraints & Dimensioning in 3D

Ground Constraints

When you constrain your sketch, you establish relationships that must be maintained as modifications are made to its geometry.

Ground constraints are added to your sketch to define which of the pair of lines involved is the movable line. There are basically four types of ground constraints:

▶ **Vertical**

▶ **Horizontal**

▶ **Angular**

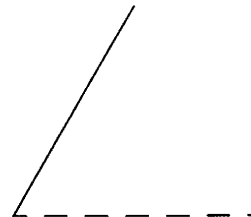
▶ **X,Y**



Vertical
Line



Horizontal
Line



Angled
Line



(X,Y) Location
Fixed

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Applying Constraints to 3D Geometry

It is possible sketch directly on a surface of a 3-D object.
When constraining 2-D geometry on 3-D objects, remember to add the dimensions *before* extruding to cutout or to protrude because constraints cannot be added as a portion of the definition of the 3-D part.

