Join the Part Builder Skull and Bones Society

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CV223-1: Be the first to be in the know as we release the secrets of AutoCAD® Civil 3D® Part Builder. We will talk about size parameters, model parameters, user-defined parameters, parameter data storage, and everything that controls the sizing and fitting of a structure to local conditions and connecting pipes. In this class, we will expose what happens when a junction structure is created versus an inlet-outlet structure part. We will solve the mysteries around the creation of these junction structures and how to control a part's dimensions by defining calculations with related size parameters.

About the Speakers:

Cyndy has worked for engineering firms in the Norfolk-Virginia Beach area for 17 years. Thereafter, she spent 6 years working for one of the largest resellers in North America. Beginning with a focus on engineering design, she soon transitioned into IT and CAD management support when CAD workstations were integrated into the design process in the late '80s. Cyndy has provided design visualization consulting services concerning AutoCAD Civil 3D for civil engineering/survey firms. Training, support, and customization on implementation projects nationwide have been her primary focus. She collaborated on the AutoCAD Civil 3D 2007 Implementation Certified Expert training materials for Autodesk® Vault, and has been speaker at Autodesk University, CAD Camps, and seminar events on the East Coast. Cyndy spent six years with serving as the project manager for infrastructure solutions, fulfilling and managing countless implementation projects across the country.

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Rad has been providing consulting services in the areas of design systems automation to the infrastructure design industry for 15+ years. He has been using Autodesk® and Softdesk® software since 1989. As a civil engineer, he has worked on both public and private sector projects. In addition, as an applications engineer and industry expert with the Australian Distributor of Autodesk software, he developed implementation plans, provided training, customization, programming, and support services to professionals across Europe, Australia, New Zealand, India, and the U.S
Rad has also worked as a CAD manager for civil engineering and telecommunications companies.

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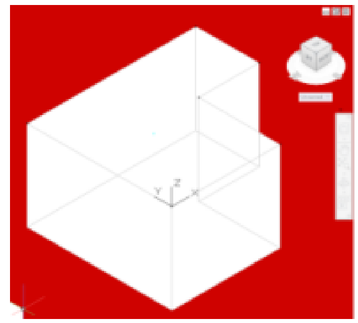
A New Beginning

Modeling in Part Builder is not at all like modeling in AutoCAD Civil 3D. Although you have access to the same commands, you are not using arcs, lines, and circles to model a part. All commands are launched from the Content Builder which is the palette that appears on the left after launching Part Builder and then opening or creating a new part.

The workflow for building parts consists of the following phases:



1. Define
2. Profile
3. Constrain
4. Dimension
5. Apply Modifiers
6. Set Parameters
7. Validate
8. Test Part
9. Repeat 2 - 8 for additional part features

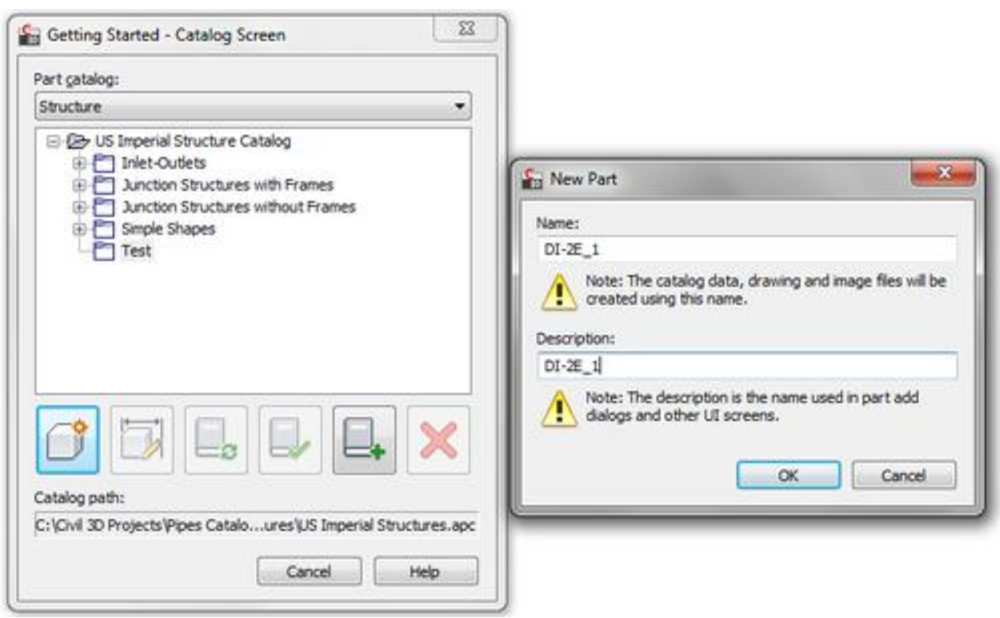
Therefore, we will be discussing these nine phases of work flow for the duration of this class. We will conclude with a discussion on Part Planning because it is very important that each step of the part modeling project is planned and designed before building.

Step I: Define

The type of part we will focus on for this class will be a box-like junction structure, specifically a curb inlet.

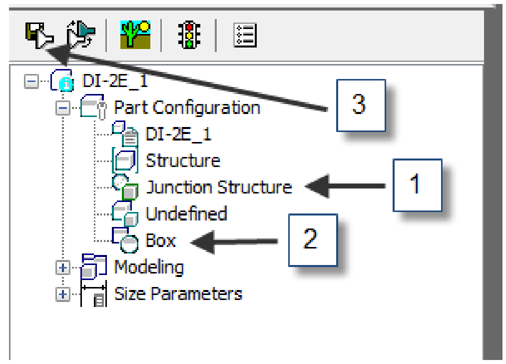
Typing “Partbuilder” at the command line will open up the Catalog Screen. To create a new part, select a chapter to store it in and then hit the New Parametric Part button.

A personal preference is to store my parts that are under construction in a “Test” chapter to avoid littering the functional folders. Also, I like to attach version numbers to the end of my part name so that I have a version of the part each time it was tested which makes it easier to go back in time if you need to redesign your approach.



And also, this may be a no-brainer, but be sure you are working in a folder where you have write permissions.

Once in the Part Builder environment, immediately go to the Content Builder palette and expand Part Configuration.



1. Configure the Part Type as a Junction Structure.
2. Configure the Bounding Shape as a Box.
3. Hit the Save the Part button. This will bring in the model parameters needed to define your part.

The model parameters brought in are basic parameters which are to be configured in inches:

- SVPC = Vertical Pipe Clearance i.e. depth between rim and top of pipe if structure geometry requires this.
- SRS = Rim to Sump Height i.e. depth between rim and floor of structure.
- WTh = Wall Thickness
- FTh = Floor Thickness
- SBSL = Structure Length
- SBSW = Structure Width
- SBSH = Structure Height

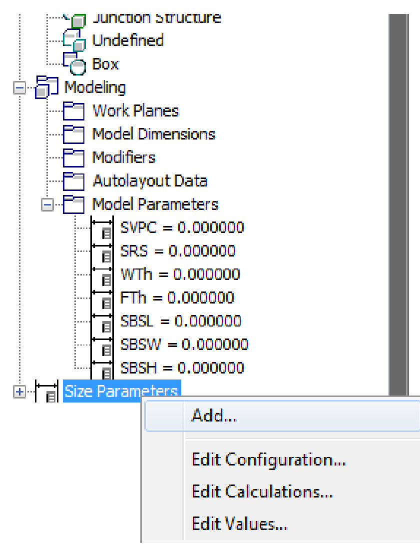
Depending on your end result you may need to bring in additional parameters. Typically, for a rectangular junction structure, we bring in the following:

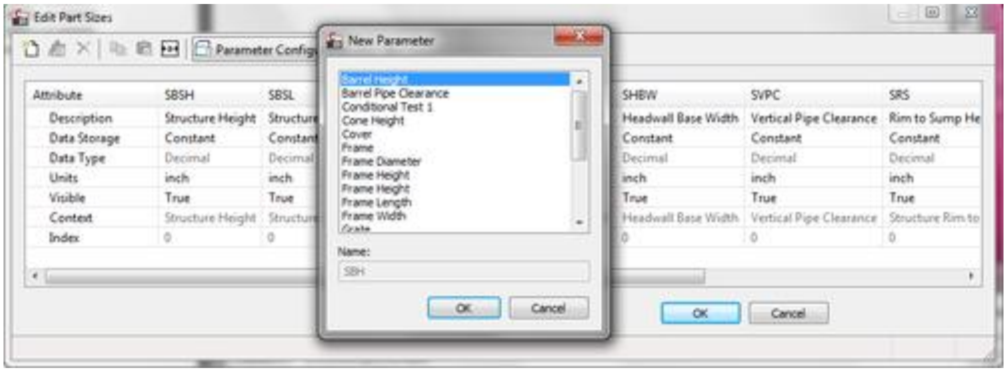
- SIL = Inside Structure Length
- SIW = Inside Structure Width

There are additional parameters for frames, cones, tiered structures, and round structures that can be brought in as well.

You can bring in additional parameters by right-clicking on Size Parameters and hitting Add.

Choose the parameters you need from the list. You can only add one parameter at a time.





Once the desired parameters are added, hit OK to close any open dialog boxes and save the part.

Step II: Profile

Next you must get your mind out of the grade line because when we profile in Part Builder, we are creating a closed 2-dimensional shape around the outside of a feature which can be projected away from a plane to a certain distance and/or to a certain shape for the purpose of creating a 3-dimensional figure. Think of the profile of your face defining the 2-dimensional shape of your head; if we extrude away from this profile and transition to your ear we've created half the shape of your head. Sculpting… parametric style.

Here are your definitions for Profiles:

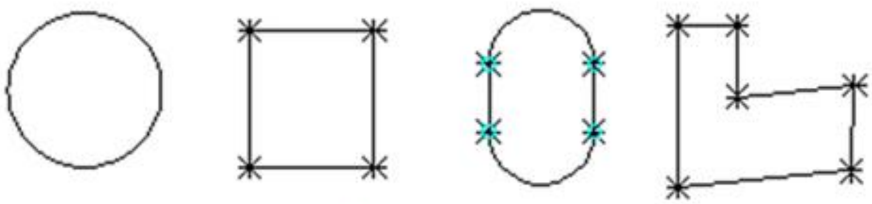
Work Planes: Use work planes to model critical areas of your structure. Any area where a change in geometry occurs should have a work plane assigned to it. For example, a manhole with a conical riser could have a work plane at the top of the frame, one at the intersection of the frame and riser, and one that occurs where the riser meets the barrel of the structure.

Geometry: Within work planes, you would add geometry. Any type of geometry you would draw with an endpoint i.e. a line or arc will come in with its endpoints constrained to points. Think of this as a type of marriage between the points themselves and these endpoints. Geometry used to model parts must be of type AECCU_COL_GEOMETRY which simply means it must be drawn using the tools from the Add Geometry menu. If geometry from one work plane must be used in another work plane, there are commands that will reference that geometry.

Constraints: To set up physical relationships between geometry, constraints are applied. Constraints are used to maintain perpendicular, parallel, concentric, tangent relationships between geometry. Equal dimensional and symmetrical relationships can be set up as well. Coincident constraints ensure that points and endpoints of geometry stay with each other. Normal constraints are applied when the tangent of a curve must remain perpendicular to another curve or line. Midpoint constraints locate the midpoint between two entities. Although we will be addressing the application of constraints in Step III, the terminology will be mentioned in this step.

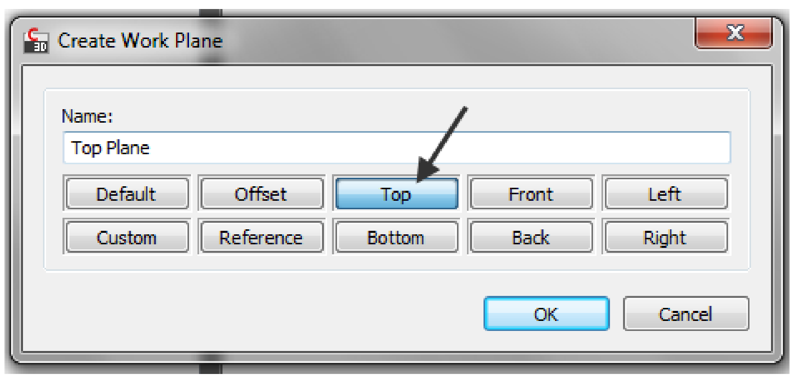
Profiles: When modeling in work planes, geometry is used to create closed areas called profiles. These profiles are then projected away from the work plan for the purpose of creating a 3-dimensional portion of the structure. We create custom profiles by selecting the individual geometry that forms these shapes.

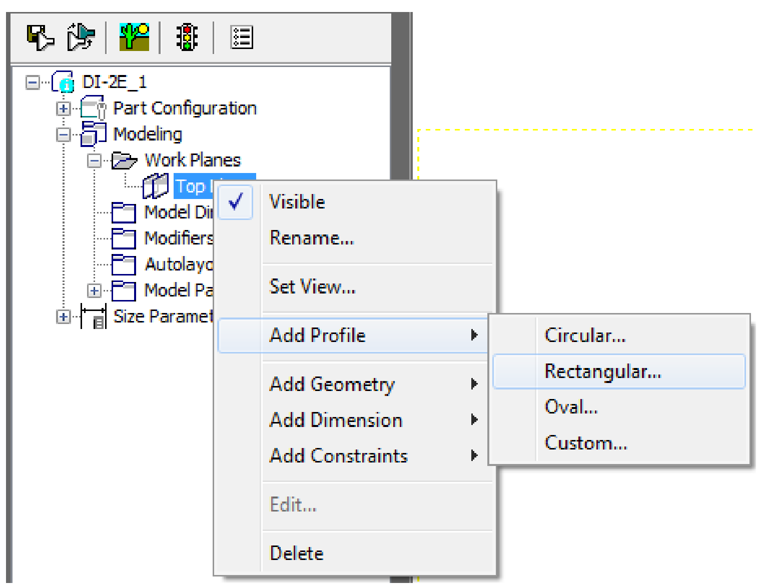
However, there are three "quickie" profile tools which define geometry, constraints, and the profile at the same time: circular, rectangular, and oval.



Circular – no constraints. | Rectangular – perpendicular, parallel, and coincident constraints. | Oval – tangent, parallel and coincident constraints. | Custom – shape and constraints drawn and assigned manually.

Before creating a profile, we create a work plane for it. It makes a lot of sense to start working in the Top Plane when you are creating a box-like junction structure; then place a rectangular profile in that plane that defines the outer edges of the structure.





To make a work plane current so you can create geometry in it, you can right click on the work plane in Content Builder and hit Set View. Also, all the content creation tools for the work plane are located in the right click menu of the work plane. We will begin by creating a rectangular profile in the Top Plane.

The actual size of the square representing the work plane is 30x30. In situations like this, I prefer to attach the front and left edge of the rectangular profile to the lower left corner of the Top Plane. This way I can utilize the Front and Left Planes if needed without creating offset views. Again, this is my preference, but I find it helpful.

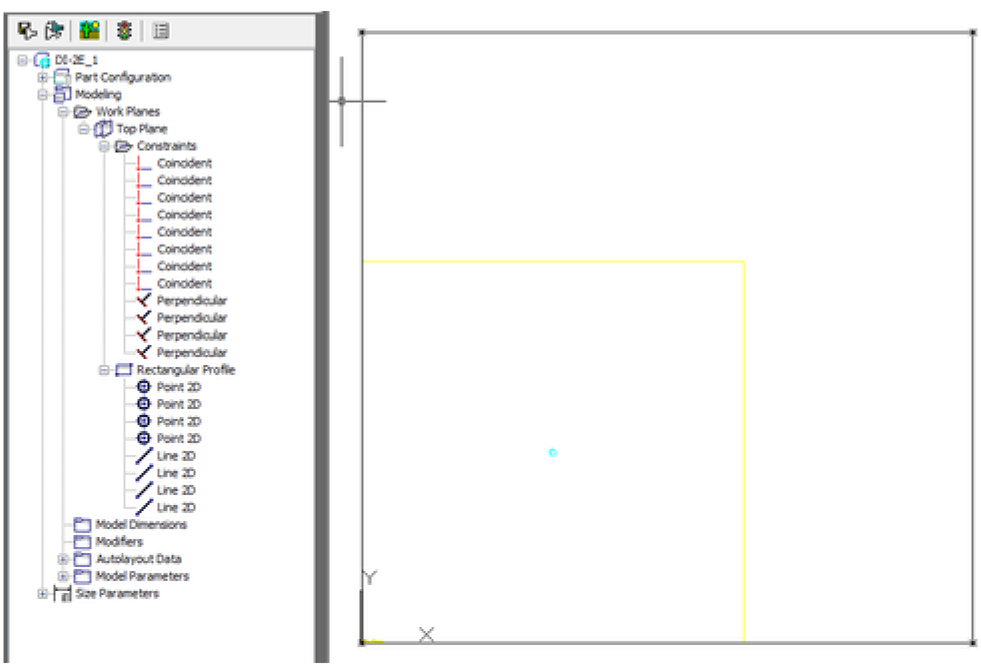
When drawing your geometry or creating your profile with the "quicky" commands, there are two schools of thought:

1. Draw to scale
2. Draw approximate and address parameters values relating to size later.

I prefer to draw to scale because I am happier that way. I think beginners should definitely draw to scale. If you are not used to the way the geometry responds when corresponding parameter values are changed, you may find a corner of your box lengthening to the right instead of the left (refer to Step VI: Set Parameters). If drawing to scale, relative or absolute coordinate entry will be a helpful drawing aide.

In this example the rectangular profile will be 48x48 so we can OSNAP to the lower left corner of the work plane and specify the location of the opposite corner with relative coordinates.

After defining two opposite corners, a rectangular profile is created. In the Content Builder, notice that when the Top Plane is expanded, geometry consisting of four lines and four points is displayed. Also, coincident and perpendicular constraints are displayed.



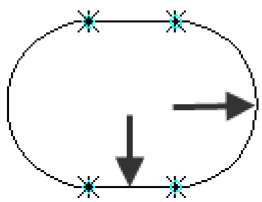
Step III: Constrain

When we constrain, we fix geometry and relate its orientation and position to other geometry in a particular work plane. This ensures appropriate behavior when geometry resizes. Certain constraints are automatically applied.

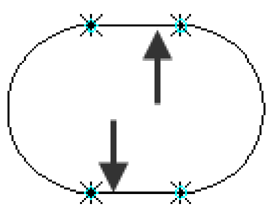
- When creating line or arc geometry using the Content Builder, points are placed at endpoints along with coincident constraints which keep the point and end of line always in the same location.
- When creating rectangular profiles, coincident constraints are placed where the endpoints and points coincide and perpendicular constraints are placed on the lines forming corners.
- When oval profiles are created, parallel constraints are placed between the two parallel lines, tangent constraints are placed where the arcs and lines intersect and coincident constraints are placed on endpoints and points.

We can also apply constraints manually when we create custom profiles. The following constraints are available:

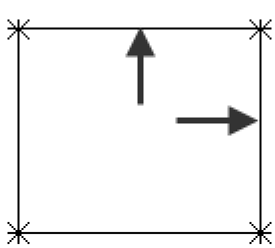
Tangent - Maintains tangency between two arcs, or an arc and a line.



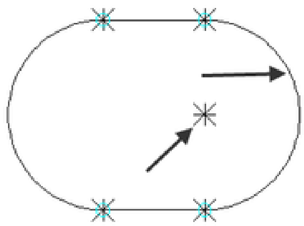
Parallel - Forces two lines to remain parallel.



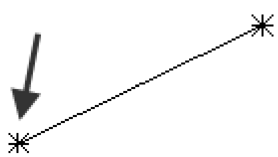
Perpendicular - Forces two lines to remain perpendicular



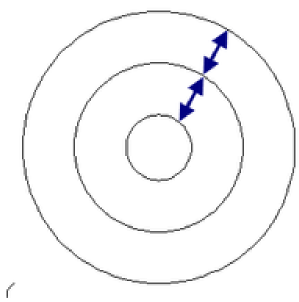
Concentric - Maintains location of a point at the center of an arc or circle. Will also force arcs and circles to maintain the same center point.



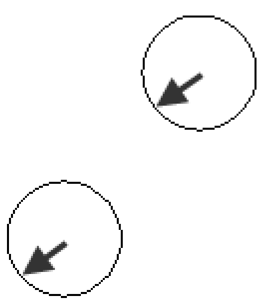
Coincident - Forces two types of geometry to occupy the same position.



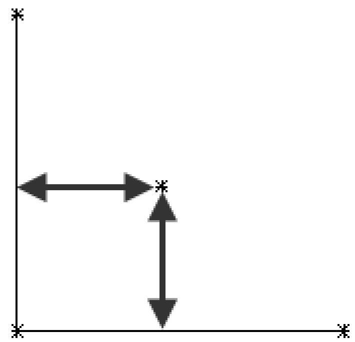
Equal Distance - Maintains an equal distance between three points.



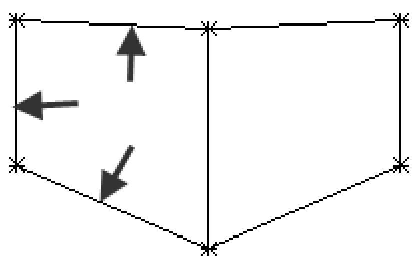
Equal Radius - Maintains an equal radius between arcs and circles.



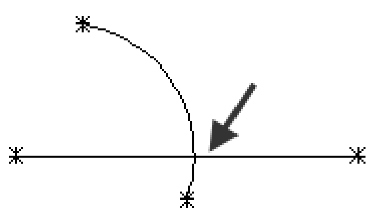
Midpoint - Forces the position of a point to be equidistant between two lines.



Symmetric - Maintains symmetry about a line.



Normal - Forces a curve to intersect a line or curve where its tangent is perpendicular.

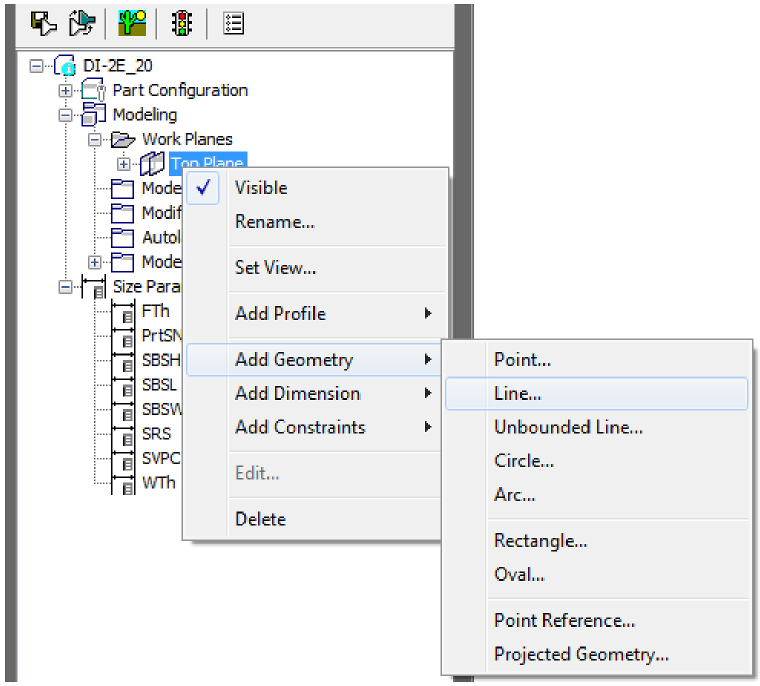


With each constraint placed, Part Builder will notify you at the command line how many dimensions will be required to constrain your geometry properly.

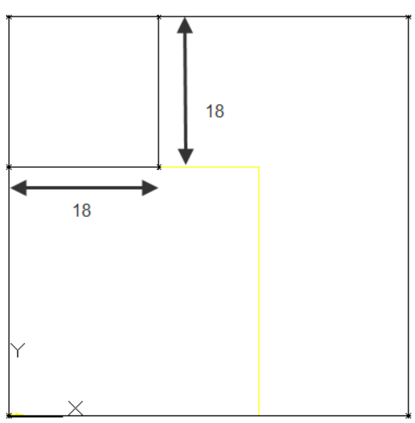
At this point in time in the Part Builder workflow, I setup the location for the "insertion base point" for the structure. This is referred to as the Placement point. The location of this point also determines where the pipes will converge at the structure. This is done by creating two perpendicular lines running from the edge of the structure to this location. Since we created the rectangular profile using the "quickie" command, no further restraints are needed for this geometry.

In this example, this point will be located 18 units to the right of the top left corner and 18 units below.

Right click on the Top Plane and select Add Geometry>Line.

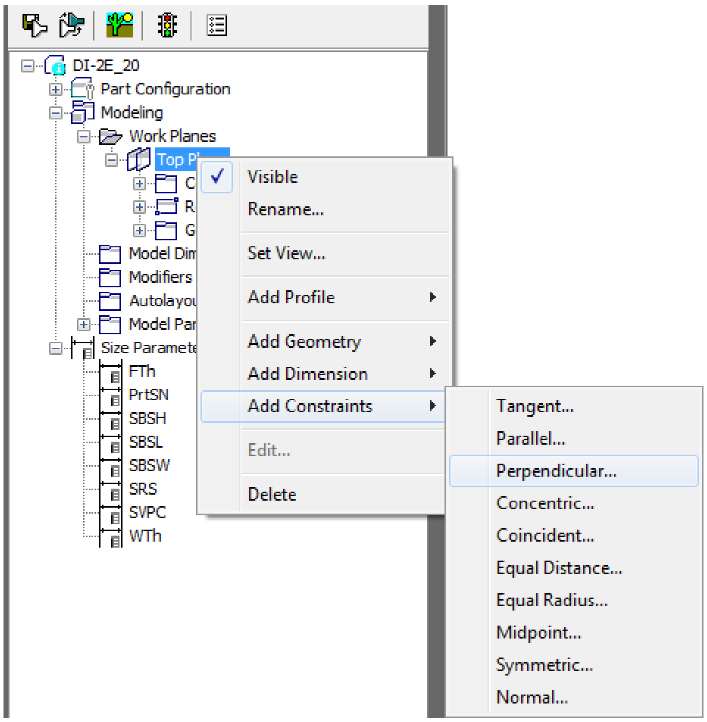


Create two lines as shown in the illustration below:

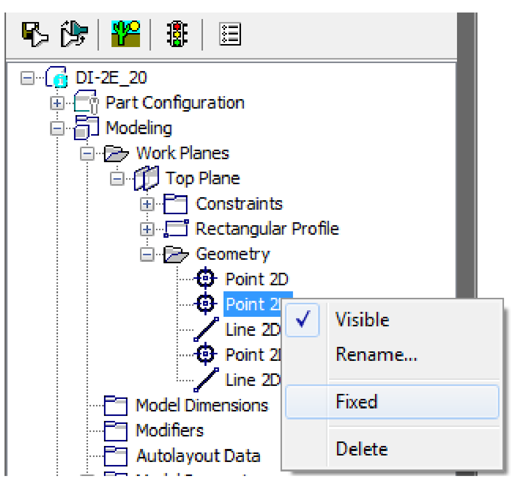


The following constraints will be applied:

- Each line will be perpendicular to the larger line attached to.
- Each line will be perpendicular to each other.
- Points coinciding with the larger lines will be coincident to those lines.



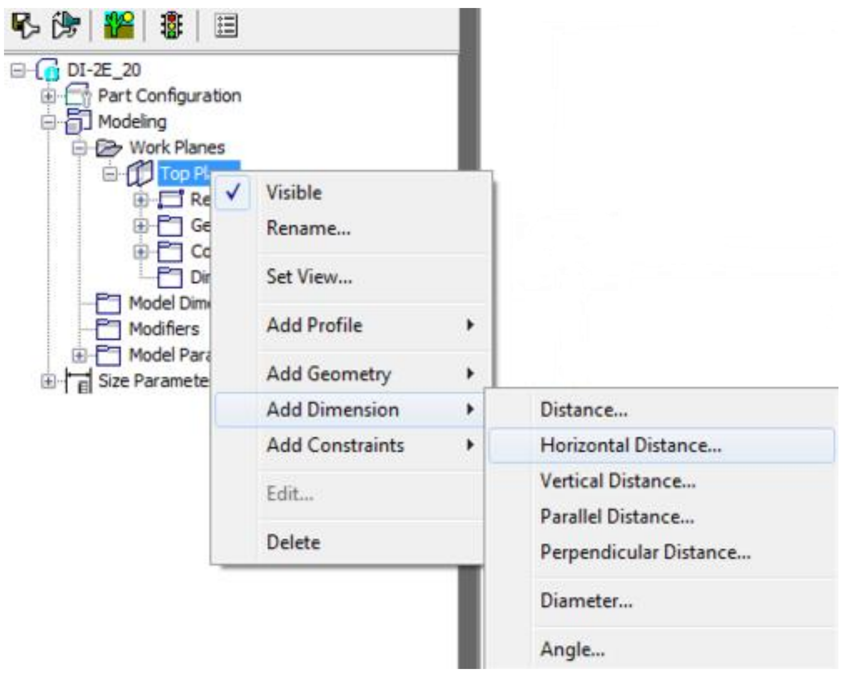
Finally, expand Top Plane>Geometry section in Content Builder. Select the point representing the Placement Point for the structure. Notice that the point in the model area will auto-preview when selected. Right click and select Fix to lock the location of this point.



The Placement Point definition can be finished after modifiers such as extrusions or transitions have been created. Therefore, we will wrap up defining this point during the Apply Modifiers part of the work flow.

Step IV: Dimension

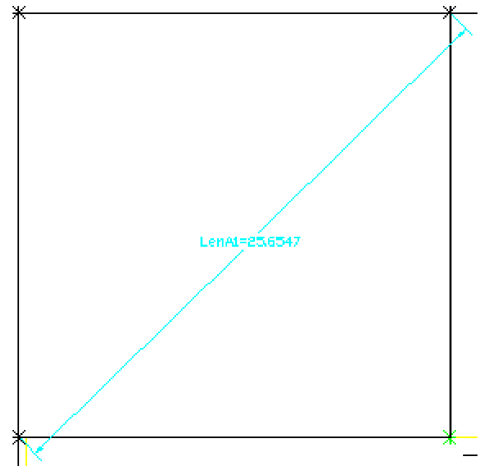
There are two types of dimensioning we can apply in Part Builder: work plane dimensions and model dimensions. We will look at model dimensioning when we discuss Apply Modifiers. The commands for work plane dimensioning are available on the right click menu of the work plane.



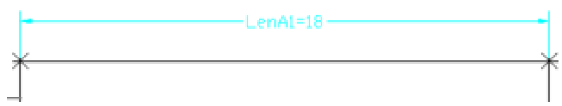
The purpose for applying dimensions in Part Builder is a bit different then the reason why we apply dimensions in AutoCAD. Dimensions in AutoCAD display measurements. Dimensions in Part Builder are responsible for causing aspects of the part to resize and for defining measurements usually in terms of parameter values. Dimensions can only be applied to AECCU_COL_GEOMETRY objects.

The types of dimensions we can define are:

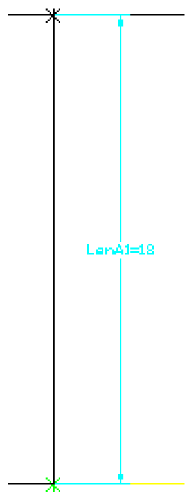
<u>Distance</u>: Defines the distance measurement between any two objects. This measurement can be at any orientation. You will be prompted to select two entities and then the location of the dimension line. The actual measurement from the model will appear in the dimension. If you edit this dimension and change its value, you will cause a size change in the model.



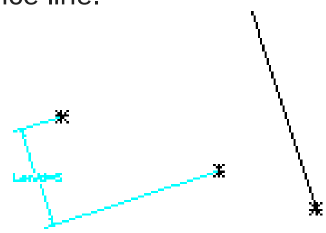
<u>Horizontal Distance</u>: Same as a distance dimension but the dimension is constrained to a horizontal orientation in the work plane. However, unlike the distance dimension, you are prompted for a distance value before the command exits. If you specify a value different than actual, you will cause a size change in the model.



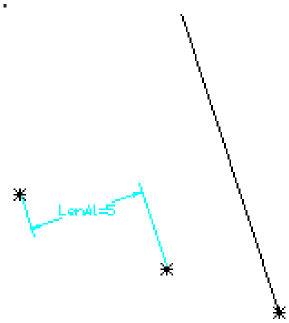
<u>Vertical Distance</u>: Same as a horizontal dimension, but the dimension is constrained to a vertical orientation in the work plane.



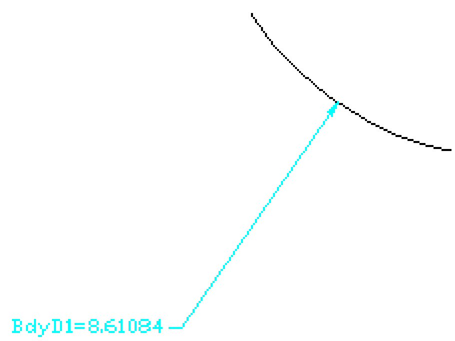
Parallel Distance: Defines the distance measurement between any two objects. You will be prompted to select two objects to dimension and then for a reference line. The dimension line will be oriented parallel to the reference line.



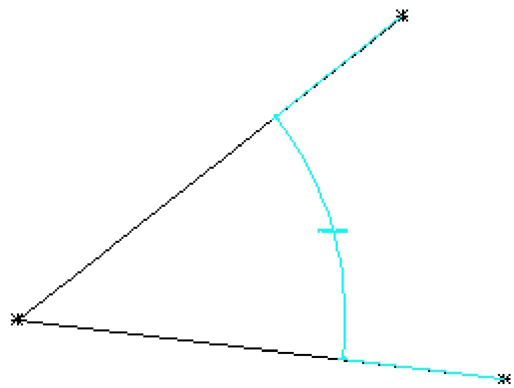
Perpendicular Distance: Same as parallel dimension, but the dimension line will be oriented perpendicular to the reference line.



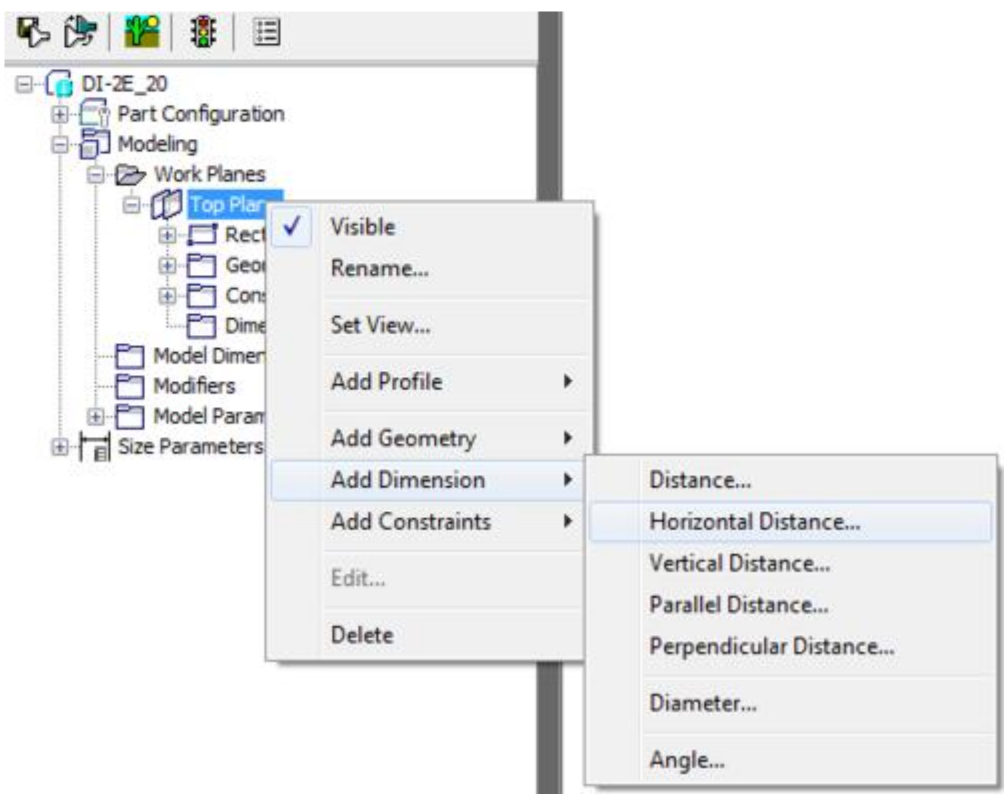
Diameter: Measures the diameter of a circle. The actual measurement from the model will appear in the dimension. If you edit this dimension and change its value, you will cause a size change in the model.



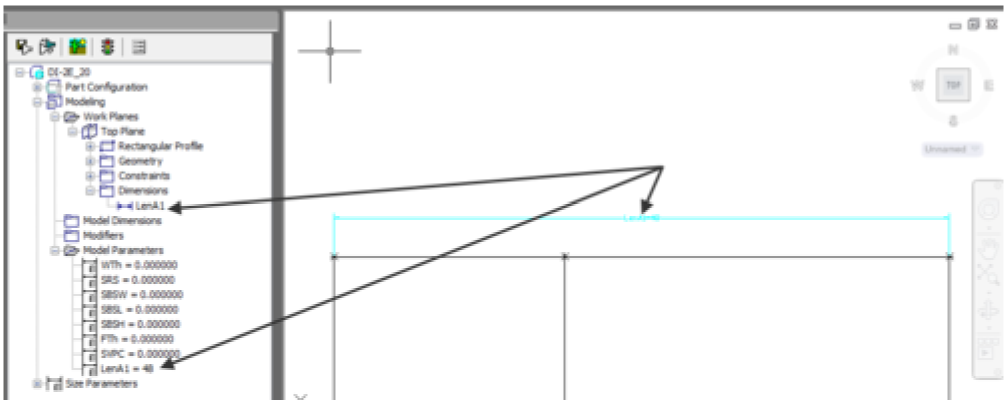
Angle: Measures the angle between two converging lines. You will be prompted to select two lines and the location of the dimension arc. You will then be prompted for the measurement of the angle in degrees before the command exits. If you specify a value different than actual, you will cause a size change in the model. Note, as unusual as this may seem, if the lines do not meet at their endpoints, this dimension may change your geometry.



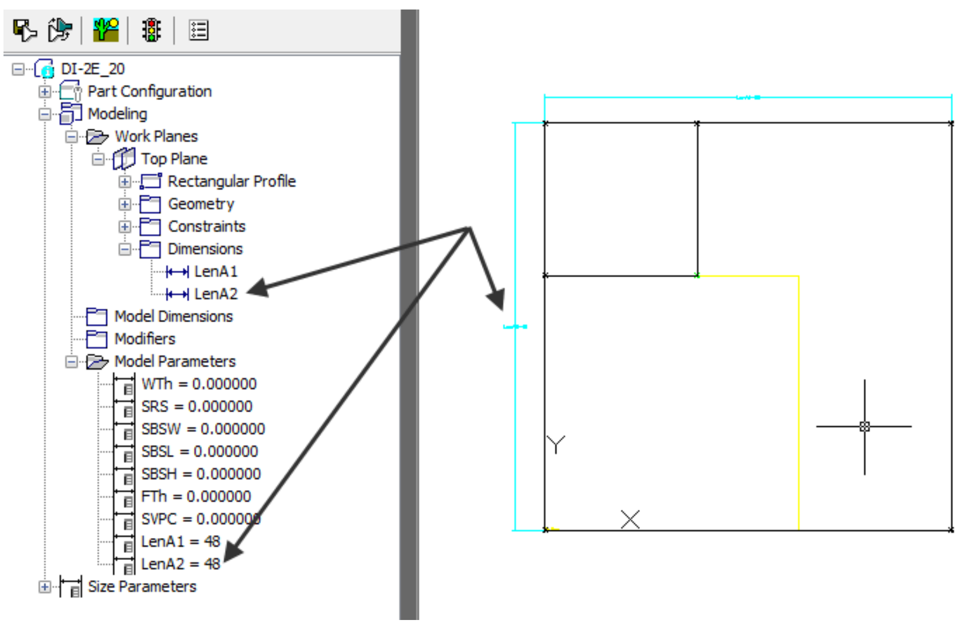
In our current work plane, the top plane, we want to add dimensions so we can control the length and width of this structure. We also want to add dimensions to further constrain our placement point.



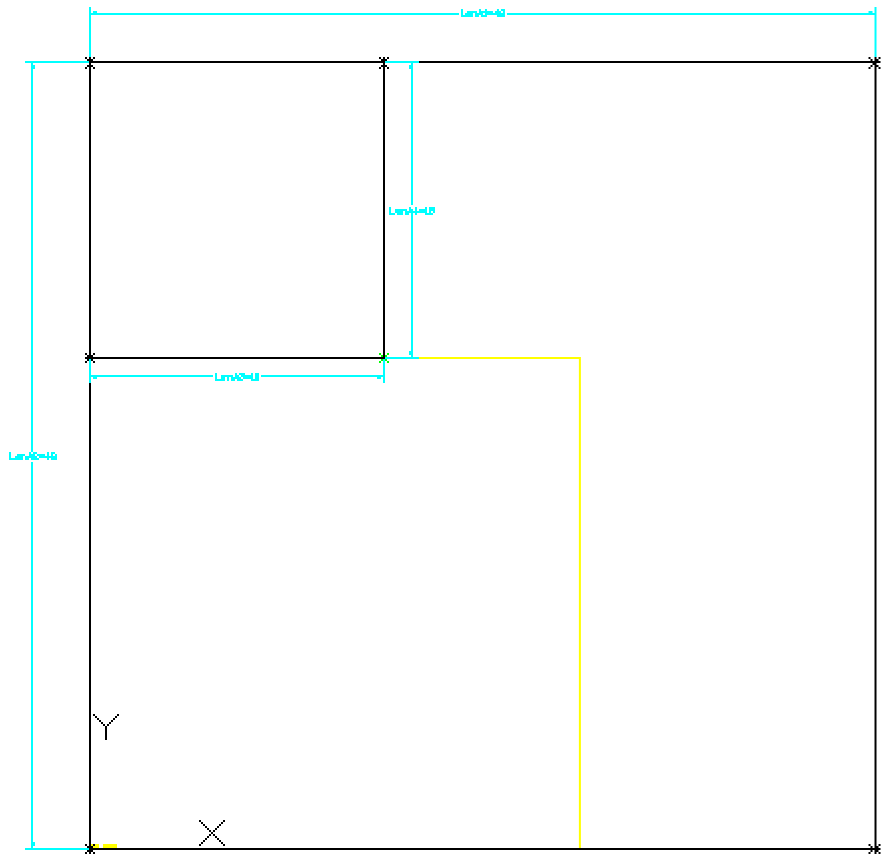
The length measurement of the structure will be assigned by a horizontal distance dimension. We can place this dimension by selecting the two points coinciding at the endpoints of the top line. The value of this measurement will be 48. After placing this dimension, notice that the new dimension not only appears in the Dimensions category of the Top Plane, it appears within our Model Parameters as well.



The width measurement of the structure will be assigned by a vertical distance dimension. We can place this dimension by selecting the two points coinciding at the endpoints of the left line. The value of this measurement will be 48.



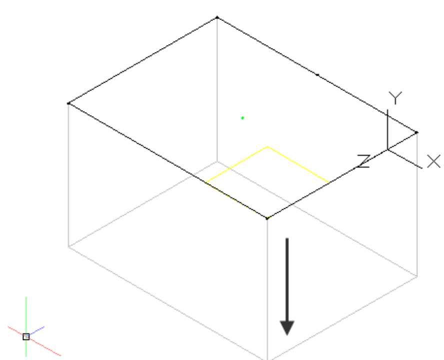
We can dimension the smaller box in the same manner using 18 as the value for the horizontal and vertical distance dimensions.



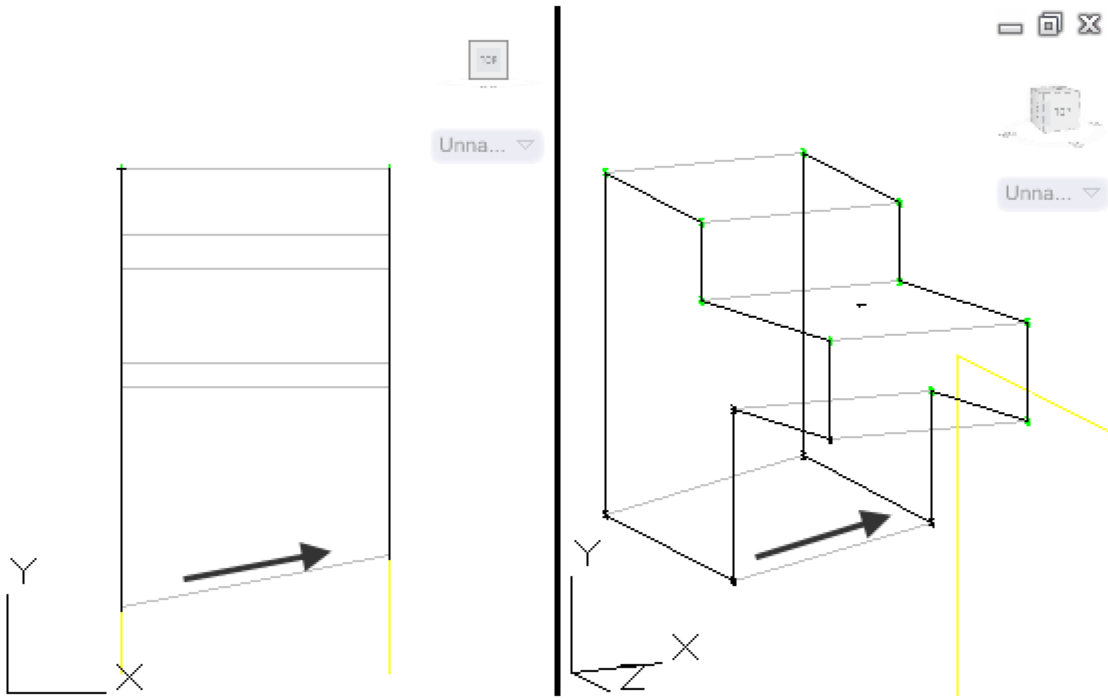
Step V: Apply Modifiers

When we apply modifiers, we are modifying the profile from a 2D shape to a 3D feature. There are a few ways to do this:

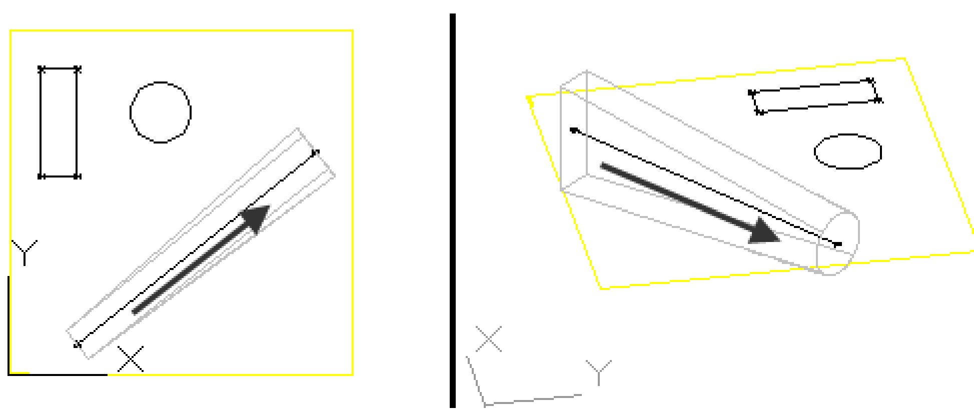
<u>Extrusion</u>: The profile is swept or projected from its work plane for a distance or to a location relative to another work plane.



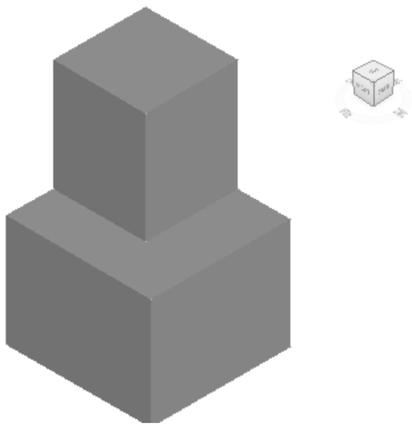
Transition: The profile is swept or projected to meet another profile that may differ in either size or shape.



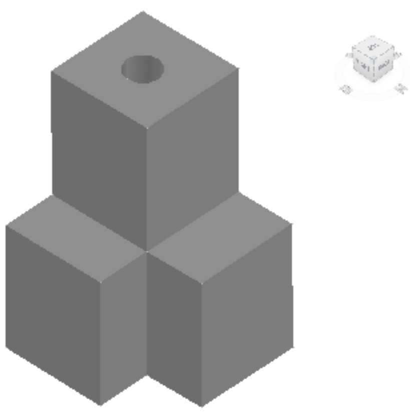
Path: This is like a transition if you think of one shape sweeping into another shape. However, this modeling occurs in one work plane. The two profiles are created as “samples” in the current work plane. Then a line or arc is drawn in the work plane which represents the path that the first profile transitions into the second profile. The profiles placed on opposite ends of the segment transverse to the work plane and the transitioning occurs as illustrated below.



Boolean Add: Groups more than one modifier together to create one object.



Boolean Subtract: Deducts one or more modifiers from the overall object.

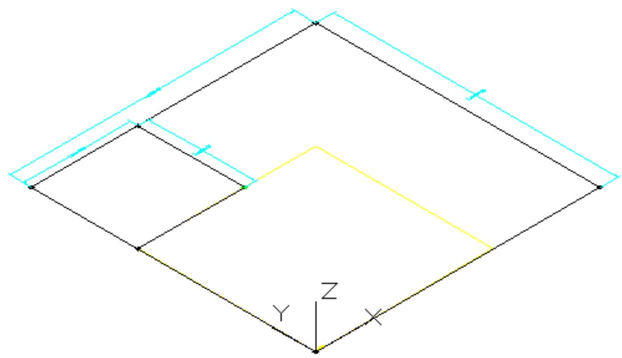


Cut Plane: Maybe cut planes worked in a previous release or another vertical but not in Civil 3D's Part Builder.

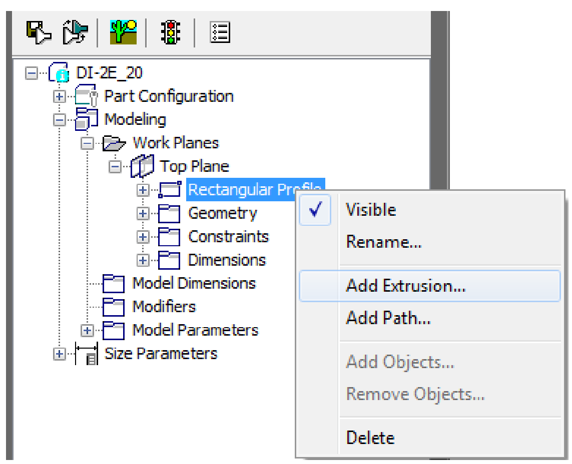
After you apply a modifier, it is important that you add a model dimension to the direction of the extrusion. Model dimensions, like work plane dimensions, will be related to model size parameters therefore enabling the part to resize when necessary.

When the first model dimension is placed, the Placement Point then appears. At this time we will osnap that point onto the planned location we constrained earlier.

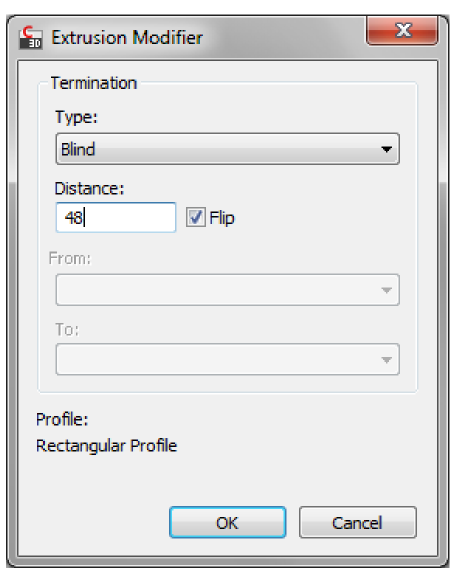
Back in our model, if we set our view to SW Isometric, we'll have a great vantage point for the extrusions we are about to create.



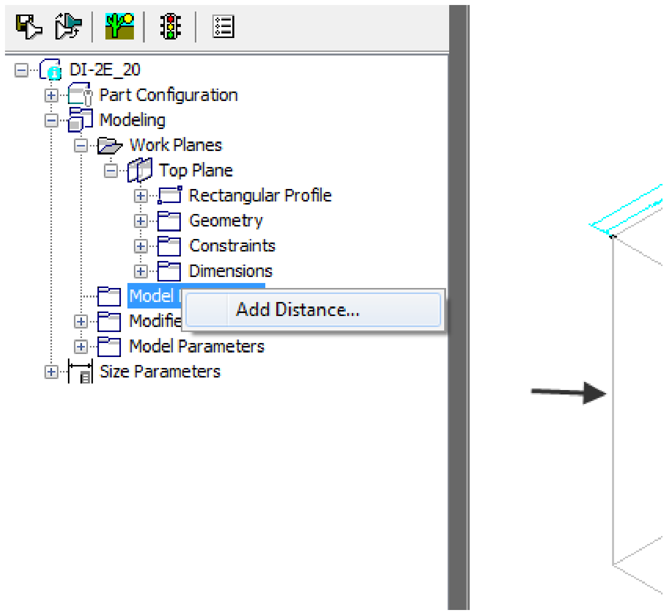
Next we will apply an extrusion to create our box. We will extrude 48 units away from the Top Plane in the downward direction.



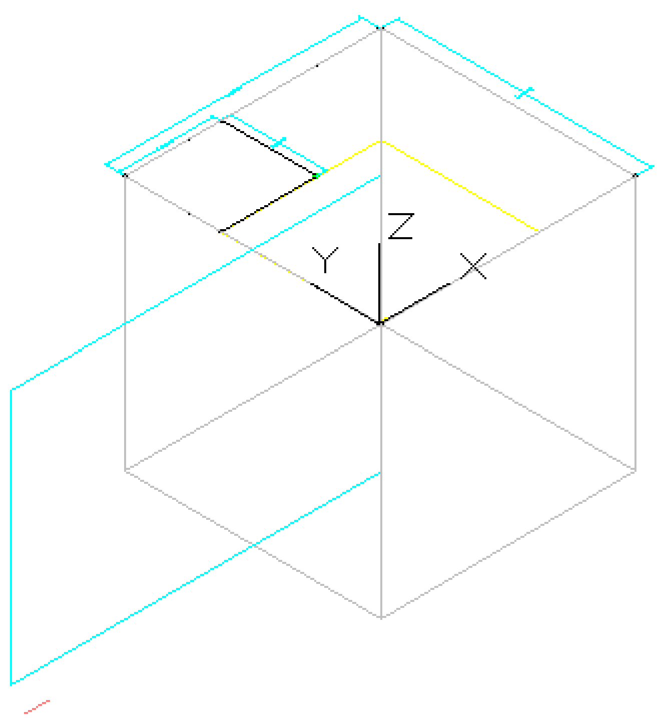
Since we are creating this extrusion at a given distance this will be a blind extrusion. We fill in the check box for Flip since we are extruding in a direction away from us relative to the plane instead of towards us.



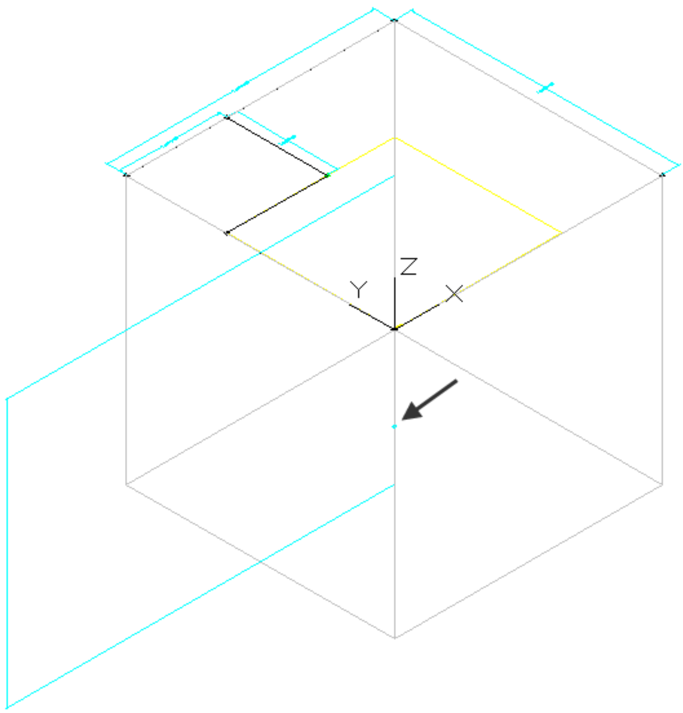
Next, we will add a model dimension to define the depth of the box.



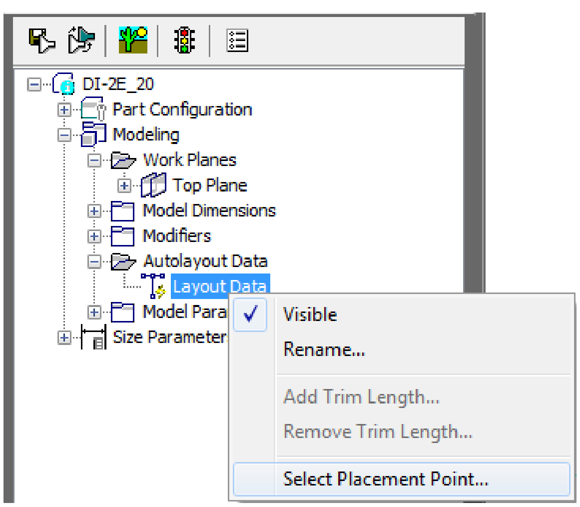
Select the extrusion then pick a general location for the dimension line.

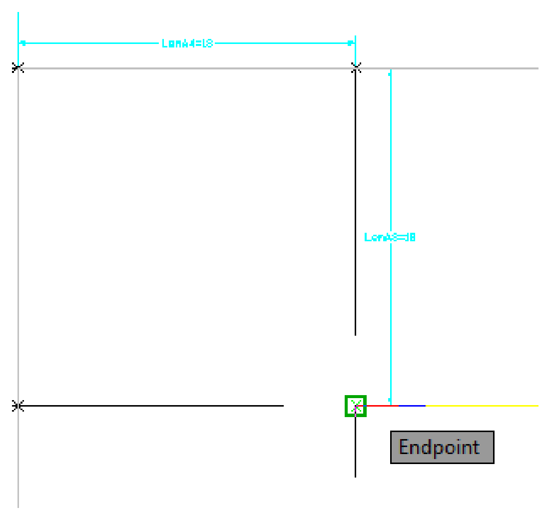


The Placement Point will appear as a small cyan circle when we save our part. If it does not appear, close and then reopen the part.



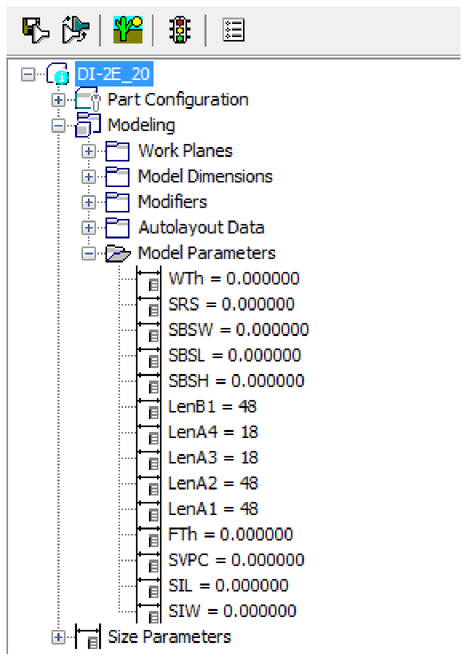
If we set our view on the Top Plane, we can relocate the Placement Point to the constrained location with our endpoint osnap.





Step VI: Set Parameters

By setting the parameters, we are instructing the part how it determines size. We can assign values that are constant, calculated by an expression, or selected from a list. If you expand the Model Parameters section on Content Builder, we can observe a list of parameters that must be configured in order to get our part working.



Junction structures have certain predefined parameters that must be understood. Let's look at some common parameters:

<u>Overall Dimensions</u>:

- Structure height = floor thickness + rim to sump height i.e. SBSH = FTh + SRS.
- Structure width = inner width + (2 * wall thickness) i.e. SBSW = SIW + (2 * WTh).
- Structure length = inner length + (2 * wall thickness) i.e. SBSL = SIL + (2 * WTh).
- Structure diameter = inner diameter + (2 * wall thickness) i.e SBSD = SID + (2 * WTh).

<u>Thicknesses</u>:

- Wall thickness = WTh
- Floor thickness = FTh
- Slab Thickness, thickness for top of lower tier of structure = SSTh

<u>Frame</u>:

- Frame height = SFH
- Frame width = SFW
- Frame length = SFL
- Frame diameter = SFD

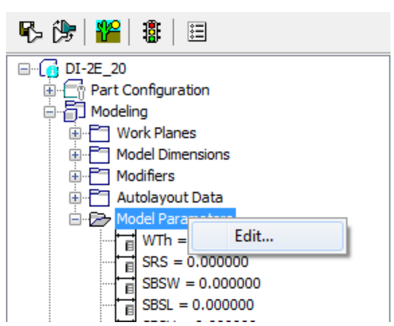
<u>Pipe Clearance Control</u>:

- Vertical pipe clearance, clearance between top of structure and top of pipe = SVPC.
- Barrell pipe clearance, clearance between top lower tier of a structure and top of pipe = SBPC.

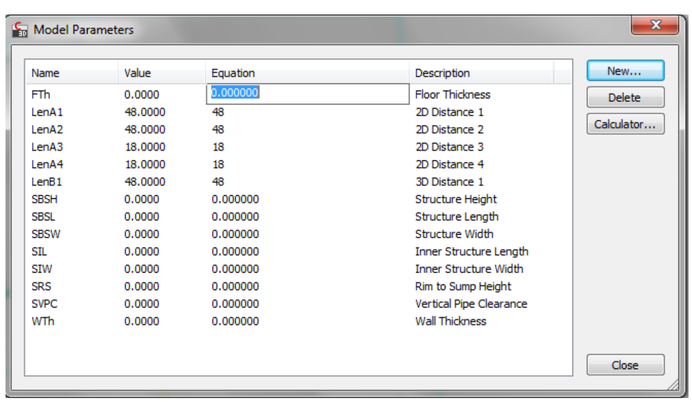
<u>Miscellaneous</u>:

- Cone height, conical riser section height = SCH

Back in our model, we need to edit our parameters.



By clicking into the Equation column, we can overwrite any of the current values. If the overwrite affects the size in the model, we will be able to see the change immediately.

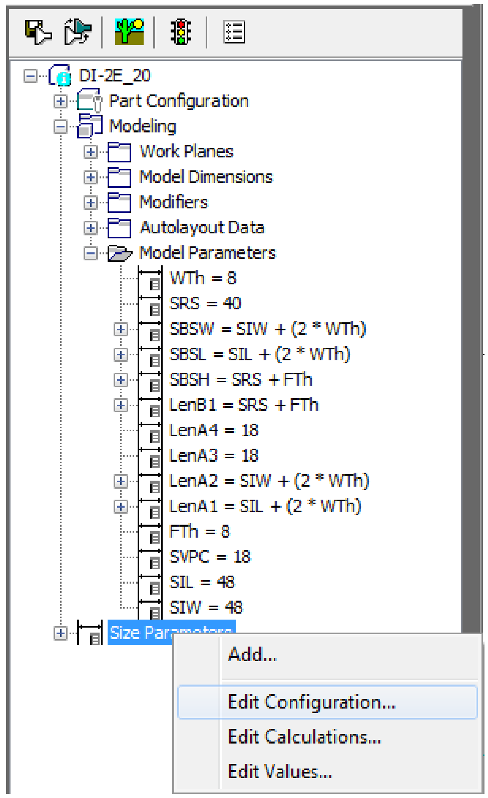


Next we will modify the model parameters with the values in the table below.

Name	Equation	Description
FTh	8	Floor Thickness
LenA1	SIL + (2 * WTh)	2D Distance 1
LenA2	SIW + (2 * WTh)	2D Distance 2
LenA3	18	2D Distance 3
LenA4	18	2D Distance 4
LenB1	SRS + FTh	3D Distance 1
SBSH	SRS + FTh	Structure Height
SBSL	SIL + (2 * WTh)	Structure Length
SBSW	SIW + (2 * WTh)	Structure Width
SIL	32	Inner Structure Length
SIW	32	Inner Structure Width
SRS	40	Rim to Sump Height
SVPC	18	Vertical Pipe Clearance
WTh	8	Wall Thickness

Although it appears that SIL, SIW, and SRS are constant according to the table, under size parameters, we will configure SIL and SIW to refer to a list of values. SRS will always inherit the depth calculated between the surface and the floor of the structure once the structure has been inserted into a pipe network.

Next we configure Size Parameters. Think of this step as setting the properties of each Model Parameter.

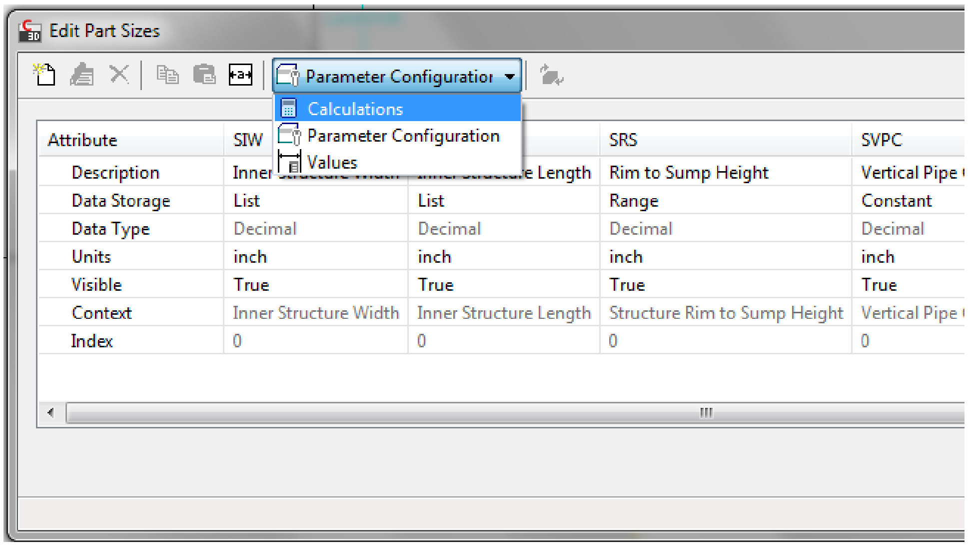


There are three views we can set for size parameters:

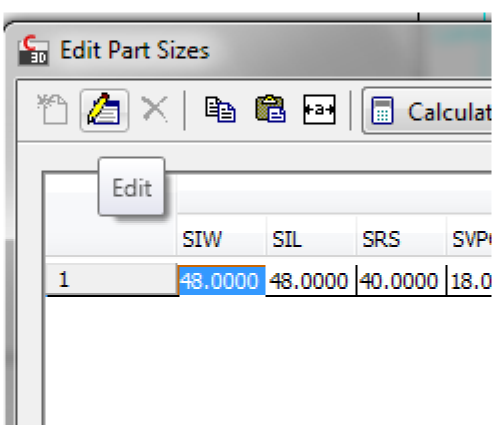
- Edit Configuration
- Edit Calculations
- Edit Values

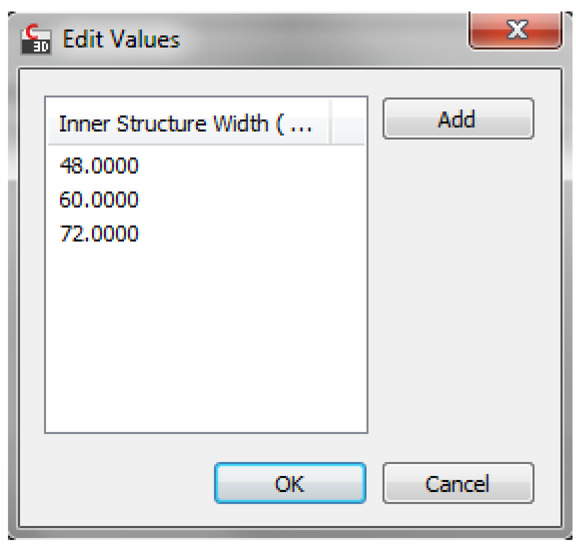
If we first go to Edit Configuration, we can check out the values for Data Storage. Each parameter that was configured with an expression has its Data Storage setting configured to Calculation. Each parameter that was configured with a numeric value has its Data Storage setting configured to Constant. We want to reconfigure that setting for SIL, SIW, and SRS.

Start by clicking on the Data Storage value for SRS and setting it to Range. Click on the Data Storage value for SIL and set it to List, then do the same for SIW. Next change the view to Calculations.

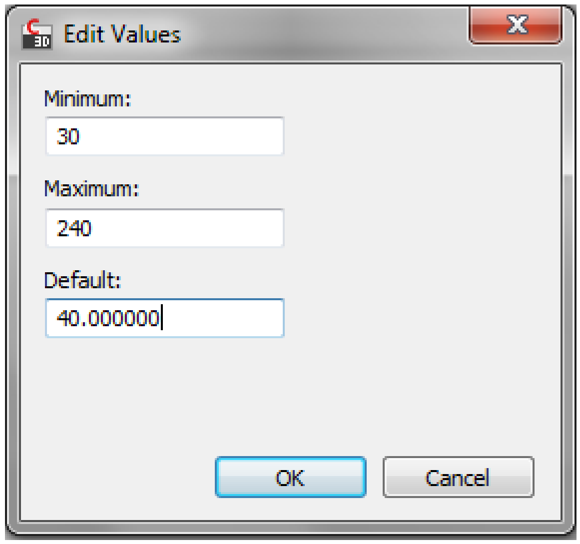


Edit the SIW value. Here is where additional sizes can be added to this parameter's list. The same can be done for the SIL value.



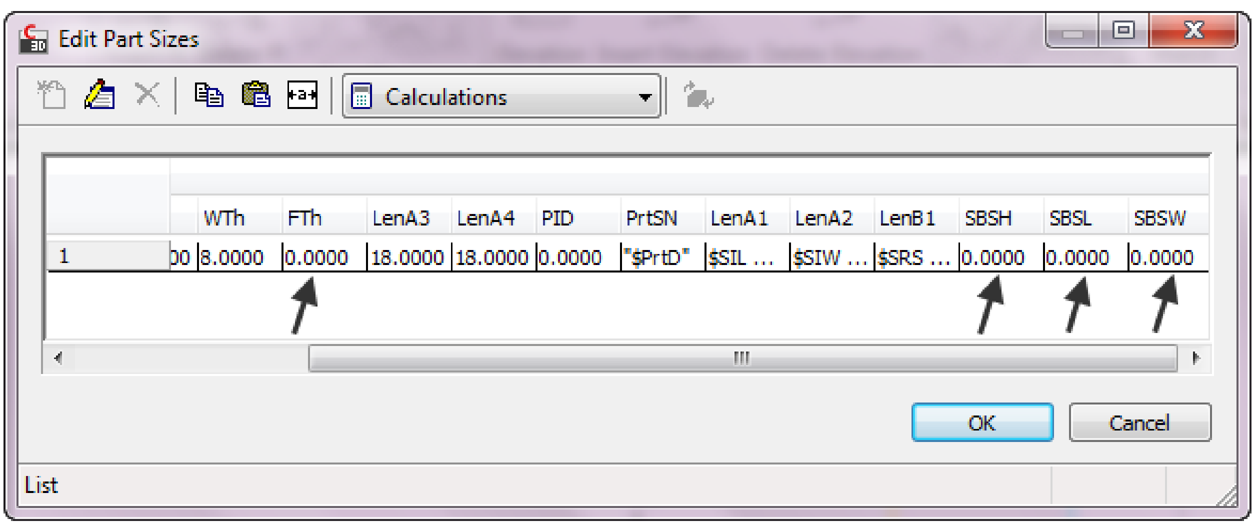


Edit the SRS value. We configured this to be a range value so that we could specify minimum and maximum allowable depths for this structure. Remember that this actual value is calculated when the structure is added to the pipe network.



Step VII: Validate

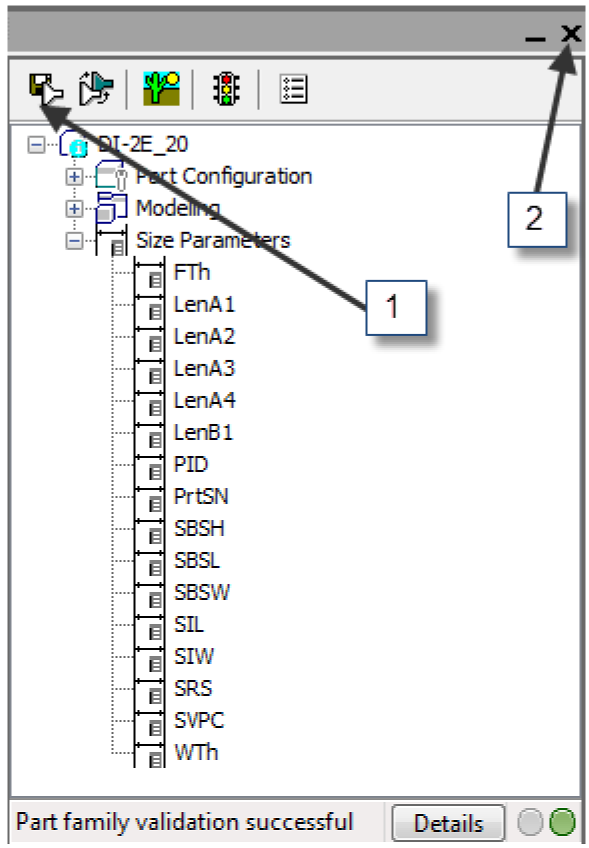
This step has mixed meaning. Of course there is the little button at the top of the Content Builder that "validates", checks the part for mistakes. This button isn't entirely reliable. Before closing the Edit Part Sizes dialog box, you should take a look at the following values in the Calculation view:



Unfortunately the values we typed in for FTh, SBSH, SBSL, and SBSW do not transfer out of the Model Parameters dialog box. This means we will have to manually edit these values in the XML file.

With all dialog boxes closed in Part Builder:

1. Save the part.
2. Close Part Builder. This is done by clicking the X in the upper right corner of the Content Builder.



If you are running Windows 7 or Vista, by default the Pipe Catalog is installed here:

C:\ProgramData\Autodesk\C3D 2011\enu\Pipes Catalog

If you are running Windows XP, by default the pipe catalog is installed here:

C:\Documents and Settings\All Users\Application Data\Autodesk\C3D 2011\enu\Pipes Catalog

I prefer to copy the folder to a location that provides easier access and point Civil 3D to this location. For instance, a shared resource drive is the perfect location when working in a team environment.

To edit that XML file we need to browse to the location of Pipe Catalog\US Imperial Structures, jump into the chapter containing our part, and edit its corresponding XML file. This can be a tedious task and although Notepad can be used, I prefer XML Marker. It is a free utility and provides a tidier interface for working with XML.

Editing the XML file:

- In the XML file, we must type in a value of 8 for FTh:

```
<ColumnConst desc="Floor Thickness" dataType="float" unit="inch" name="FTh" id="CC12" visible="1" context="FloorThickness" index="0">8</ColumnConst>
```

- We type in the following expression for SBSH: $SRS + $FTh

```
<ColumnCalc desc="Structure Height" dataType="float" unit="inch" name="SBSH" id="CCA4" visible="1" context="StructHeight" index="0">$SRS + $FTh</ColumnCalc>
```

- We type in the following expression for SBSL: $SIL + (2 * $WTh)

```
<ColumnCalc desc="Structure Length" dataType="float" unit="inch" name="SBSL" id="CCA5" visible="1" context="StructLength" index="0">$SIL + (2 * $WTh)</ColumnCalc>
```

- We type in the following expression for SBSW: $SIW + (2 * $WTh)

```
<ColumnCalc desc="Structure Width" dataType="float" unit="inch" name="SBSW" id="CCA6" visible="1" context="StructWidth" index="0">$SIW + (2 * $WTh)</ColumnCalc>
```

Notice that the parameter names are prefixed with “$”.

Step VIII: Test Part

Before I add any additional extrusions, transitions, or Boolean operations to my part, I test it. Do this to make sure the parameters, placement point, and XML file are working together as expected. Please note that a part cannot be tested if it is open in Part Builder.

Part testing requires a Civil 3D file with a surface model and a pipe with structures. If the part swaps out with no issue, we will be able to proceed with developing our next modifier for this structure.

Partcatalogregen is an often misunderstood command. It is not necessary to run this before trying out a new part. This command updates the following files per catalog:

- AeccSharedPropertyLists.xml
- US Imperial Structures.apc

These files do have a purpose but they do not affect what we are doing.

Ideally, follow these steps to test your part:

- Bring structure into part list. Configure with style that shows outer part boundary in plan.
- When adding sizes, check to make sure the named parameters are listing. If some are missing, there may be a problem with the parameter configuration.
- Create a pipe with your structure at both ends.
- Inspect placement point.
- Inspect structure in object viewer.

Hopefully, things will go perfect the first time and you can jump into creating your next model modifier. If there are problems, you will have to clean them up before proceeding to further develop the part.

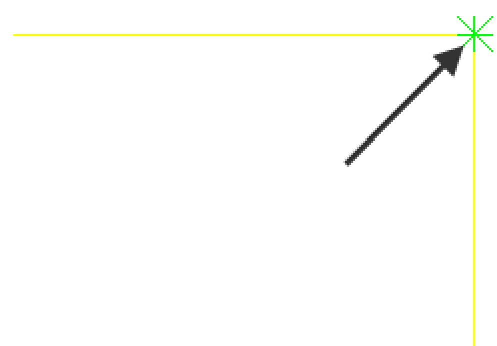
Step IX: Repeat Steps 2 – 8 for Additional Part Features

This box we just created is like a block of wood. We can now start whittling away add it until our structure takes shape.

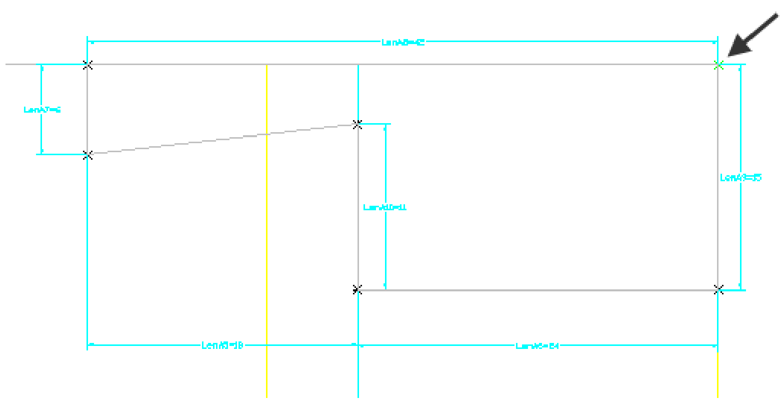
This is where I start versioning the part. When I open the part up I will use the Save Part Family As button to create a copy of the next generation.

You will choose or create a work plane to create your profiles in. One piece of geometry you will find very useful is a Point Reference.

You cannot use geometry from another work plane in the current work plane. However, you can reference points from other work planes. The great thing about the referenced version is that they will remain constrained according to how things were set up in their original work plane. There is a geometry command called Projected Geometry which allows you to project line work out of extrusions, but I find they cause transitions to twist and warp.

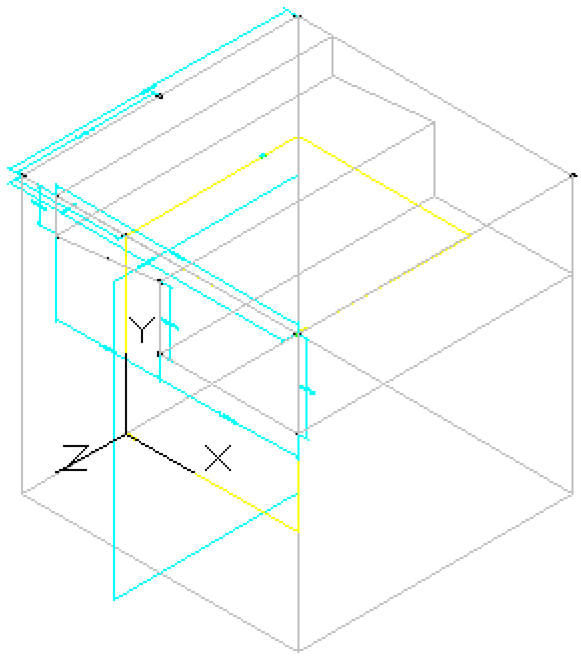


I created the following geometry using the left plane:



- The arrow points to a referenced point.
- Line geometry was used.
- Parallel and perpendicular constraints were applied.
- Horizontal and vertical distance dimensions were applied.
- A custom profile was created.
- The profile was extruded the length of the box.

Here are the results:



The plan is to use a Boolean Subtraction to remove the region just created from the original structure. However, I prefer to test the part before doing that. If I do the Boolean Subtract first, test the part, and then find that I still have a cube, I will have no way of knowing where the subtracted piece went for troubleshooting purposes.

Conclusion

Help file and Web content are good resources to exploit on your own Part Builder mission. Stick to the work flow and things will begin to make sense. Build and break, change the approach then, try again. Train yourself to always know what work plane you're on and to keep the constraints, dimensions and size parameters on your mind at the same time. Remember, focus and attention to detail will save the day. Start from simple shapes and build from there. Practice, practice, practice and with a little luck, you will be able to build your custom libraries…

You have just been inducted into the Part Builder Skull & Bones Society.