Parametric Fitting and Equipment Content Creation for AutoCAD® MEP

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MP304-3 This class will walk you through the process of creating a parametric fitting and a MvPart by utilizing AutoCAD MEP Content Builder. Learn how to leverage this powerful functionality to create your own customized parts quickly and easily. The class will focus on two types of parametric creation, work-plane-based and extrusion-based creation. We will also look at assigning constraints, parametric dimensions, and formula-based parameters while adhering to the best practices of content creation. In addition, there will be discussions on how to leverage these capabilities to maximize the potential of parametric content with a smart modeling approach. Attendees should have an intermediate to advanced level of knowledge and an understanding of AutoCAD MEP. This class will not be for the fainthearted or weak-kneed individual. Are you up for the challenge?

Key Learning

Step through the process of creating a parametric fitting and a MvPart…

Be able to build Parametric Content…

Understand Parametric Work Planes and Paths…

Learn the best practices for creating parametric content…

Learn to create formula-based properties…

About the Speakers:

Darryl has spent 25 years in the MEP industry. He has served a project manager where he was responsible for $150,000,000 - $200,000,000 of project design and construction per year. Although his primary focus was the design of mechanical systems, he spent 11 of those 25 years designing electrical and plumbing systems as well. He also ran his own engineering business for eight years. His design experience ranges from complex research laboratories and institutional facilities to medical and professional office buildings, and everything in-between. He is a graduate of Purdue University.

Gregg is a Quality Assurance Analyst for AutoCAD® MEP and has been an Autodesk software user since 1984. His entire career is based on using Autodesk-based products to produce contract drawings for the water/wastewater treatment engineering industry as a mechanical process designer.

Darryl and Gregg are co-authors of the book *Mastering AutoCAD MEP 2010*.

Parametric Content creation approach

To ease your pain in creating parametric content you should put some forethought into the design of the content before you even begin building the part. This class will cover 2 different types of parametric content creation. The first will be a reducing pipe elbow and the second will be a parametric air handling unit.

Planning on how the part will be built and defining the expectation of the part is essential to your success with Content Builder. You should consider the following steps to assure proper part creation:

1. Sketch the part.
2. Add dimensions.
3. Determine which dimensions can be the same (equal constraints).
4. Determine if any pieces of the part need to be parallel, perpendicular, tangent, etc. (Constraints).
5. Do you want specific names for the parameters? (Defaults are LenA1, BodyD1, Center to End (CtoE), Outside Diameter 1 (OD1), etc.)
6. What dimensions are available from the Manufacturer?
7. What dimensions are really needed to replicate the part? (Not all dimensions from the manufacturer are needed and some are commonly missing.)
8. What dimensions should be calculations?
9. What do you want the part description to be?
10. Map up default parameters to preferred names.
11. Determine order of creation. (How should the part be built? The order of creation is important since dimensions and constraints added to the parametric content will react differently based on order. First one in generally wins).
12. Do you want to include additional information in the Part? (Manufacturer, cost, etc.)

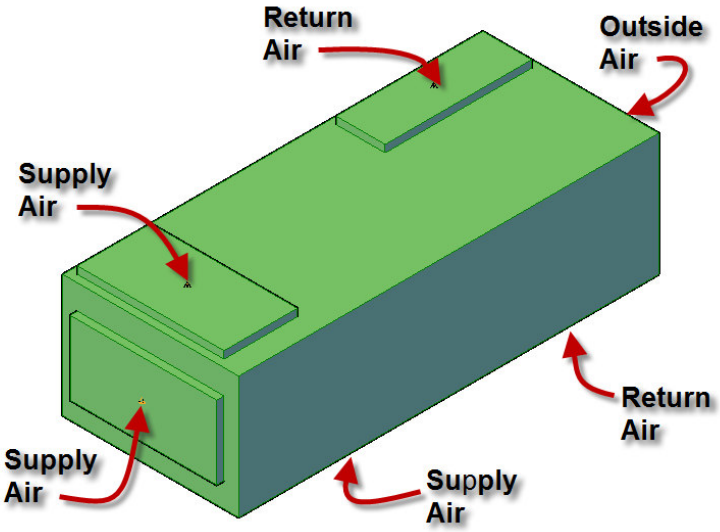
Parametric AHU Unit

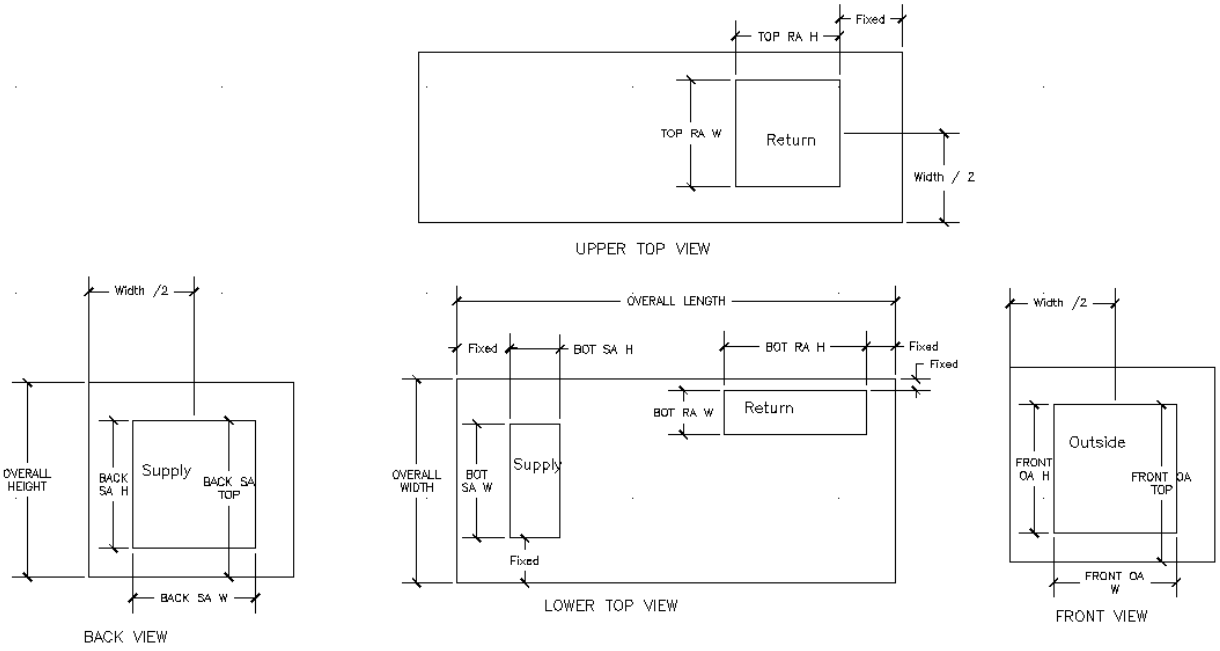
Getting Started

This section covers the how to and the why you would want to create a basic parametric air handling unit. The main reason is that simple content improves model performance and typically mechanical specifications generally list three vendors allowing the contractor to select one of the three listed manufacturer's equipment to be installed. Therefore construction documents and 3D Models only needs to "represent" a basic outline of the equipment.

The initial approach to creating this content is to sketch it out to identify all the required dimensions needed to create a parametric part in all the views required.

For example a quick sketch of your air handling unit might look something like this.





Adding dimensions and constraints will help determine the information needed in addition to the overall length, width and depth dimensions of the unit.

Once this is complete you will need to determine how many work surfaces are needed to build the part.

A work plane is required to add a connector and an extrusion is required to support the body of the connection. An offset work plane will be created for each face of the part. For this part we

will need 4 work planes to support the geometry and 4 additional offset work planes for the connections. This part will have a 2 inch body extrusion for each connection.

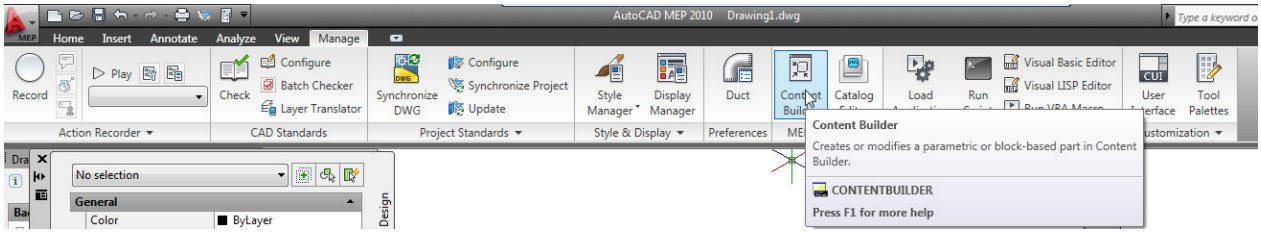
Work planes are necessary to control the movement of the objects associated to a work plane. For example, the 3 pipe connections on the side need to be associated with a work plane to host the connections. This work plane is required to adjust to changes made to the dimensions of the equipment so that the pipe connectors are properly accessible on the outside of the equipment.

Looking at our 3D sketch above provides a better indication of where work planes (surfaces) are needed to host connections

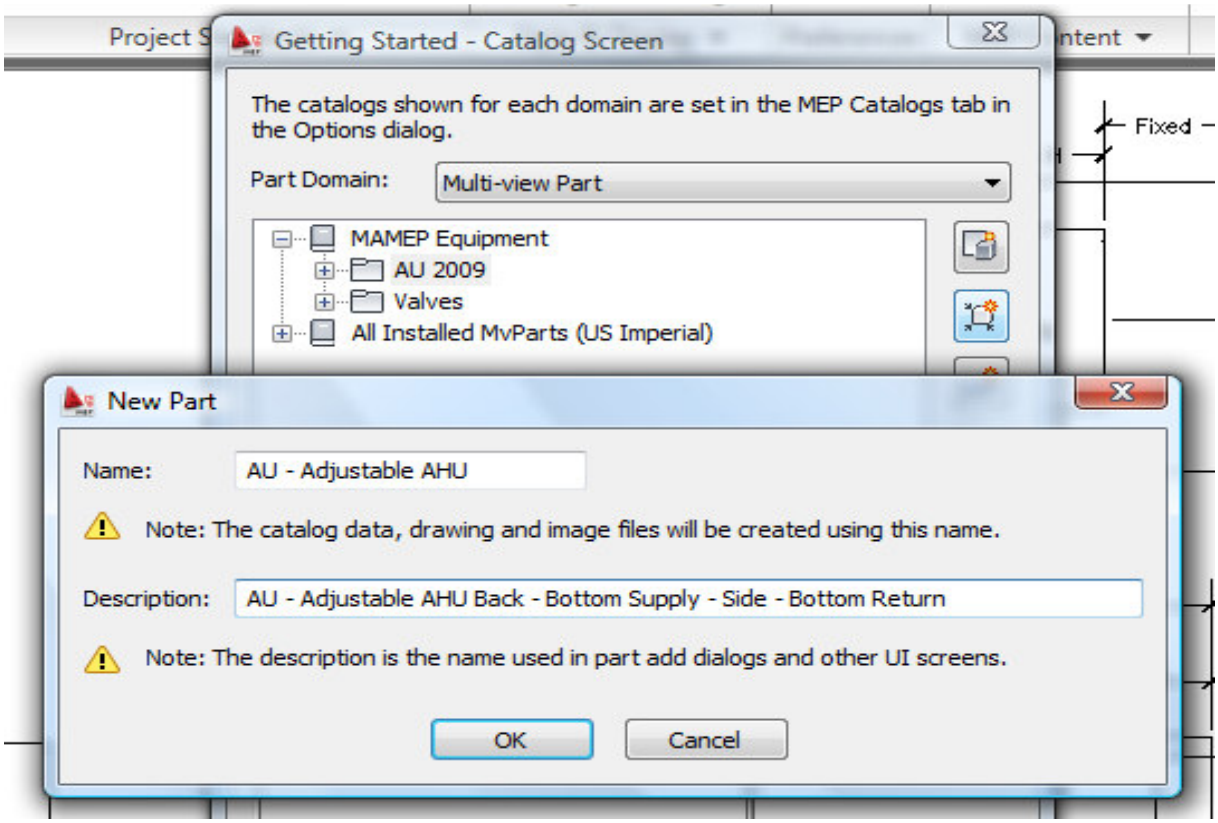
The sketch also shows the back and bottom sides need to host connections and therefore require work planes.

Accessing the Content Builder

To access Content Builder go to the Manage Tab and select the Content Builder Icon on the Content panel.



Content Creation



Once inside Content Builder select the new Parametric Part Icon.

Add a unique name and a description.

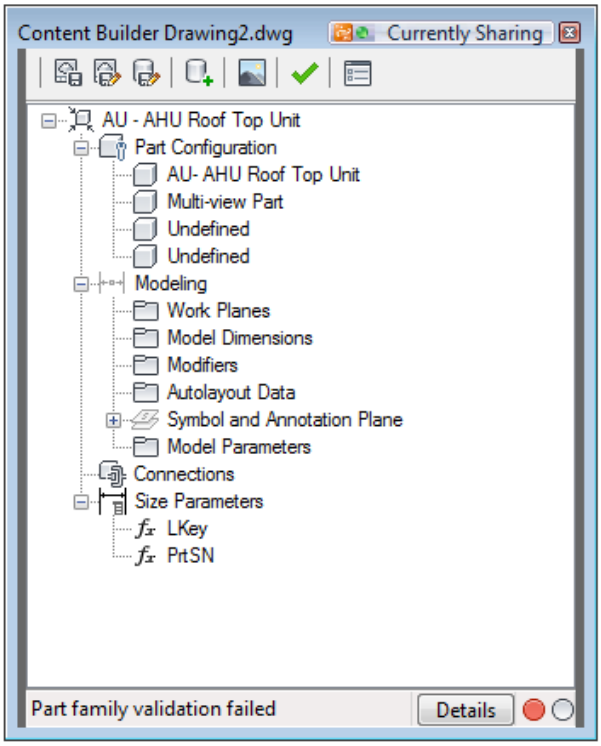
> **Note**: The Name indicates which files are associated with this part and the Description is displayed inside of AutoCAD MEP.

Content Builder is now active. The Palette on the left contains all the controls to work within content builder. All commands are accessible via the Right Click Menu.

The process of building a part begins at the top and generally follows the Top to Bottom rule. To begin defining your part, simply expand the Part Configuration control and Select the type of part in the 3rd drop list (Elbow).

Part Configuration

General information regarding the Part Configuration controls are as follows:



Description: Describes the part family. You cannot edit the part description in the part browser. When you create and name a new part, you enter the description in the New Part dialog. By default, the description is the same as the part name unless a different description is entered.

Domain: Defines the family of parts, such as duct components, pipe components, cable tray components, conduit components, or MvPart components. You cannot edit the part domain in the part browser. The part domain is predefined based on the part catalog you selected in the Getting Started dialog of Content Builder. The part domain is selected from a list of predefined domains for AutoCAD MEP.

Part Type: The actual type of par such as an elbow, a tee, a fan, a damper, or a tank. From the list of predefined part types in the part browser, you specify the part type, which is based on the building system and loaded part catalogs. The part type is helpful during part selection.

Part Sub Type: Categorizes part types. In the part browser, you specify the part subtype from the list of predefined subtypes. You can also enter a custom part subtype if you wish. The part subtype is helpful during part selection to filter a large group of parts of similar type.

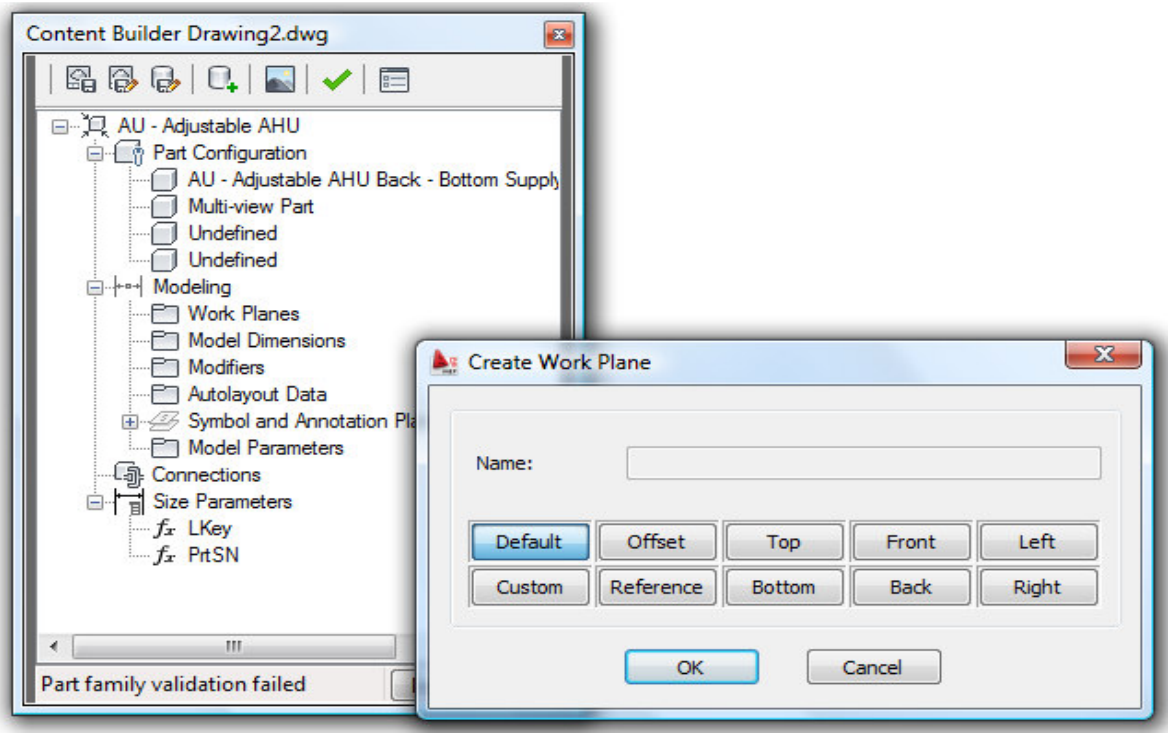
Modeling

The Modeling control is used for creating the parametric content, constraints and dimensions. These commands are accessible via right click and can only be accessed after creating a Work Plane.

To create a Work Plane, simply expand the Modeling group then right click on Work Plane and select Add Work Plane.

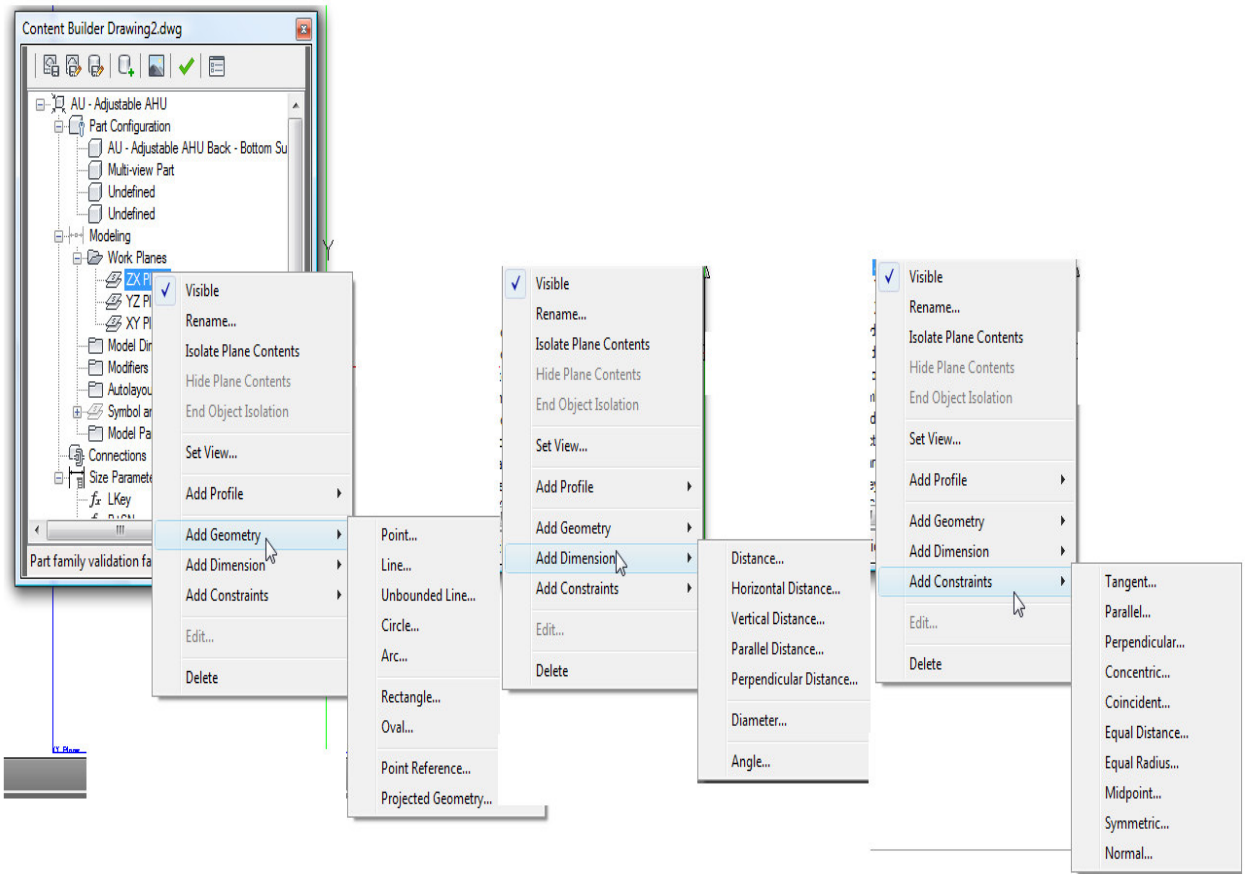
The Create Work Plane dialog box will appear. From there you can select your preferred configuration.

We will be using the Default configuration to generate the bottom back and right side planes.



From these planes offset work planes will be generated.

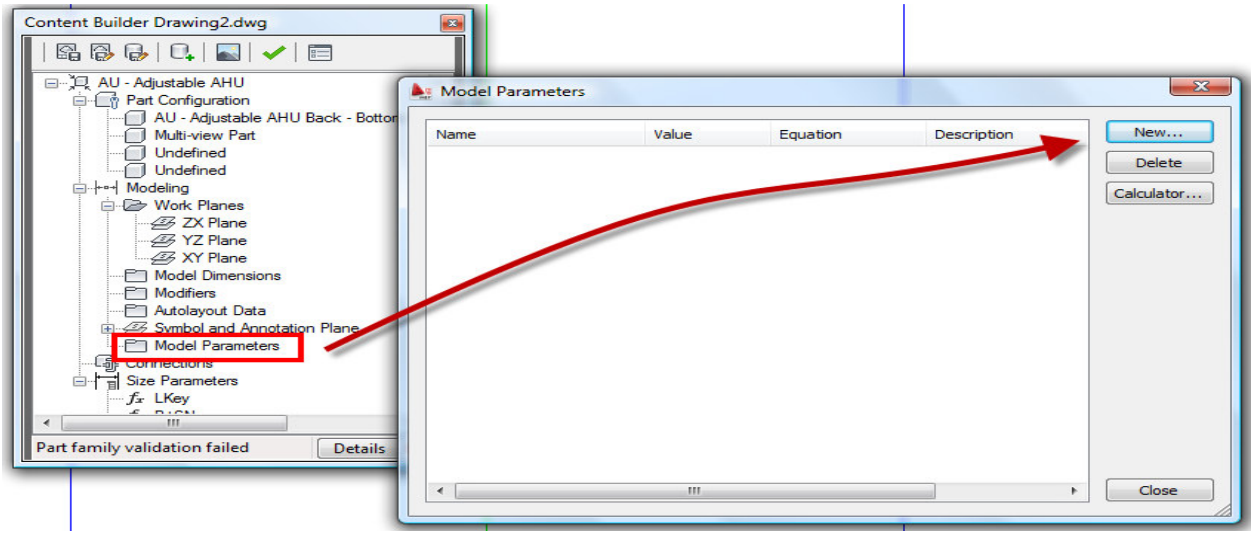
Once the Work Plane is created you now have access to the parametric drawing controls



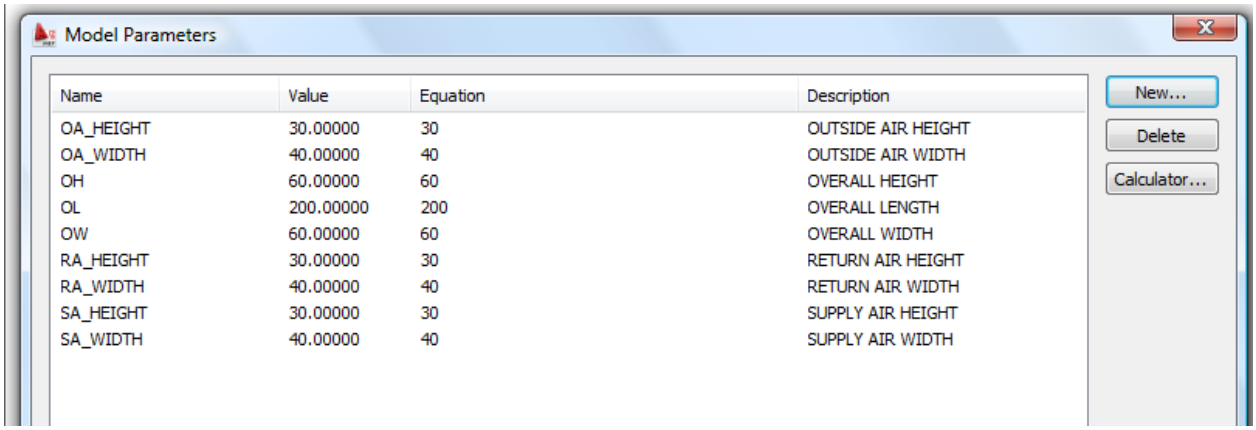
These controls create the geometry, paths and constraints necessary to build a parametric fitting.

> **Note**: Work Planes define what view or orientation you are working in and are required to access front, side, top, etc., views for the purpose of creating the content. Content Builder does not recognize the UCS command for creating content.

The controls for creating a Parametric part is similar to basic AutoCAD Commands. However, the controls are unique to Content Builder. The commands allow Model Parameters to be assigned to Dimensions including formulas. To edit formulas, right click on the Model Parameters and Select edit to access the Model Properties dialog box. In this dialog box you can define custom parameters to meet the needs of the model. As listed above we can define parameters to meet the dimension names in the sketch. This can be done at any point during creation. This is also where you assign the custom parameter to become the value of a dimension.

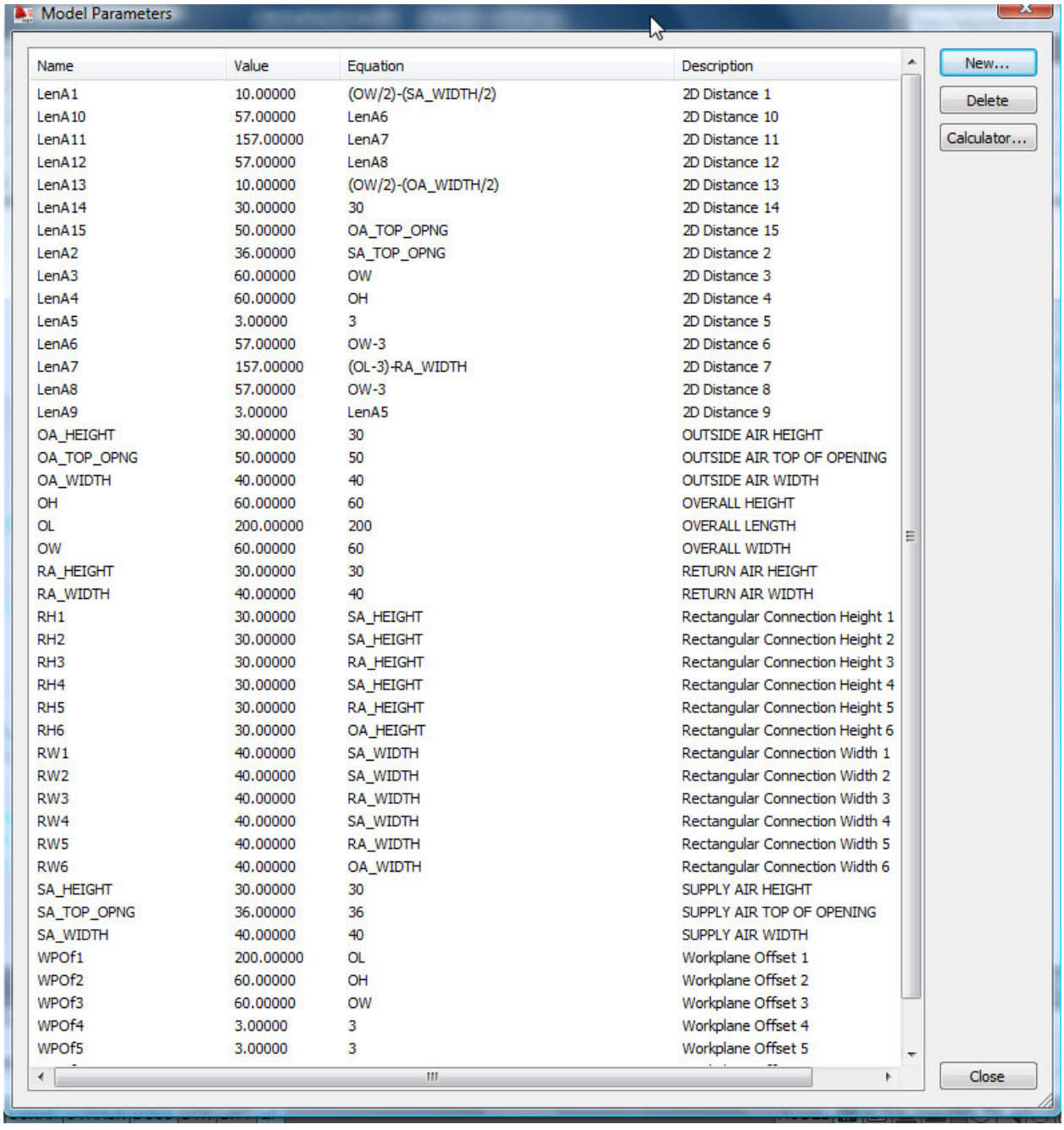


By adding all the required parameters, you can begin assigning these as the dimensional values as the dimensions are created.



Note: Fixed dimension can be added as custom parameters or the value can simply be assigned during creation of the dimension. If you want to change the fixed dimension you will need to define the value as a Table or a List value. For this class we are using Constants.

You can assign model parameters to any dimension and you can create formula based values to assign to dimensions instead of creating new parameters.



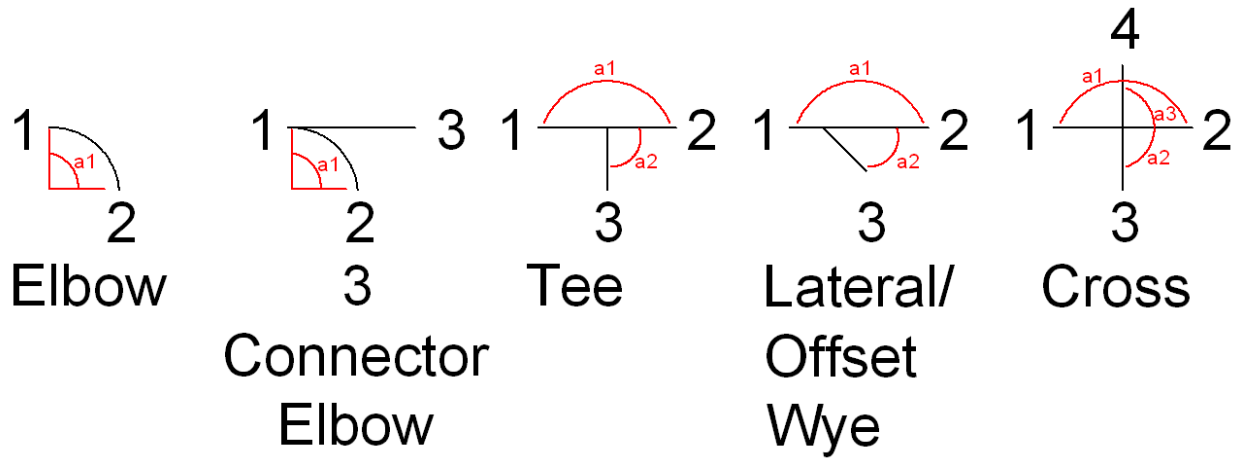
Name	Value	Equation	Description
LenA1	10.00000	(OW/2)-(SA_WIDTH/2)	2D Distance 1
LenA10	57.00000	LenA6	2D Distance 10
LenA11	157.00000	LenA7	2D Distance 11
LenA12	57.00000	LenA8	2D Distance 12
LenA13	10.00000	(OW/2)-(OA_WIDTH/2)	2D Distance 13
LenA14	30.00000	30	2D Distance 14
LenA15	50.00000	OA_TOP_OPNG	2D Distance 15
LenA2	36.00000	SA_TOP_OPNG	2D Distance 2
LenA3	60.00000	OW	2D Distance 3
LenA4	60.00000	OH	2D Distance 4
LenA5	3.00000	3	2D Distance 5
LenA6	57.00000	OW-3	2D Distance 6
LenA7	157.00000	(OL-3)-RA_WIDTH	2D Distance 7
LenA8	57.00000	OW-3	2D Distance 8
LenA9	3.00000	LenA5	2D Distance 9
OA_HEIGHT	30.00000	30	OUTSIDE AIR HEIGHT
OA_TOP_OPNG	50.00000	50	OUTSIDE AIR TOP OF OPENING
OA_WIDTH	40.00000	40	OUTSIDE AIR WIDTH
OH	60.00000	60	OVERALL HEIGHT
OL	200.00000	200	OVERALL LENGTH
OW	60.00000	60	OVERALL WIDTH
RA_HEIGHT	30.00000	30	RETURN AIR HEIGHT
RA_WIDTH	40.00000	40	RETURN AIR WIDTH
RH1	30.00000	SA_HEIGHT	Rectangular Connection Height 1
RH2	30.00000	SA_HEIGHT	Rectangular Connection Height 2
RH3	30.00000	RA_HEIGHT	Rectangular Connection Height 3
RH4	30.00000	SA_HEIGHT	Rectangular Connection Height 4
RH5	30.00000	RA_HEIGHT	Rectangular Connection Height 5
RH6	30.00000	OA_HEIGHT	Rectangular Connection Height 6
RW1	40.00000	SA_WIDTH	Rectangular Connection Width 1
RW2	40.00000	SA_WIDTH	Rectangular Connection Width 2
RW3	40.00000	RA_WIDTH	Rectangular Connection Width 3
RW4	40.00000	SA_WIDTH	Rectangular Connection Width 4
RW5	40.00000	RA_WIDTH	Rectangular Connection Width 5
RW6	40.00000	OA_WIDTH	Rectangular Connection Width 6
SA_HEIGHT	30.00000	30	SUPPLY AIR HEIGHT
SA_TOP_OPNG	36.00000	36	SUPPLY AIR TOP OF OPENING
SA_WIDTH	40.00000	40	SUPPLY AIR WIDTH
WPOf1	200.00000	OL	Workplane Offset 1
WPOf2	60.00000	OH	Workplane Offset 2
WPOf3	60.00000	OW	Workplane Offset 3
WPOf4	3.00000	3	Workplane Offset 4
WPOf5	3.00000	3	Workplane Offset 5

Parametric Fitting

Fitting Creation Rules

AutoLayout requires that fittings are built with connectors in a specific order. In addition to this each part must have path angles (A1, A2, A3) defined in a specific order as shown.

Male x Female Fittings require the Male Connector to be located at Connector 1.



Content Builder

Content Builder allows for additional construction lines/constraints within the content file which are not visible or accessible within AutoCAD MEP. The geometry drawn is being used to properly constrain the Elbow and will not be visible within AutoCAD MEP.

Lines and arcs in Content Builder are Content Builder objects and are used to define paths of geometry. Dimensions and Constraints are used to control the behavior of these objects to allow for parametric control.

Angle Dimensions will constrain the 2 lines based on the angle value in the Catalog table.

> **Note**: Refer to right click Context menus above to locate commands in menus.

Lines need to be constrained to reference angle lines with a Perpendicular Constraint and arcs need to be constrained to the lines with a Tangent Constraint.

Dimensions are available for Horizontal Only, Vertical Only and for Aligned. The dimension should always be either a Horizontal or Vertical reference. If alignment to the object is preferred use the Aligned dimension.

Constraints can be used in place of dimensions where the rules are uniform such as Equal distance, Perpendicular, Parallel, etc.

Profiles are used to create the 3D body and follow the paths defined by the lines and arcs or can be extruded to opposing work planes. Connectors are then added to the extruded body that was created and the properties of the connectors are added under the connectors section of the palette.

Parameters can then be edited thru the Parameters dialog box.

Additional Information and Resources…

Updates and Hot Fixes

- AutoCAD MEP 2010 has a Web Update and several hot fixes posted on www.Autodesk.com please remember to install all service packs and hotfixes.

Subscription Advantage Packs for AutoCAD based products

- AutoCAD MEP also has Subscription Advantage Packs available for Subscription customers. For more information see www.autodesk.com/advantagepacks
  - Time Saver Tools (AutoCAD)
  - Renovation Extension (Architecture)
  - Productivity Extension (Architecture)
  - Duct Transition Extension (MEP)

Subscription Extensions

- AutoCAD MEP also has Subscription Extensions available for Subscription customers.
  - Piping Content Extension

Additional Resources

- The book "Mastering AutoCAD MEP 2010" from Paul Aubin, Darryl McClelland, Martin Schmid and Gregg Stanley is now available at www.paulaubin.com and book stores everywhere.