Creating Parametric Families in Autodesk Revit Architecture 2011
Parametric Families – Conceptual Overview

Families are the heart of the internal data structure of Autodesk Revit. Every object, whether it is a geometric component, an annotation component, a View or any other component in Revit, is part of a Family. Families come in three “flavors”:

- **System Families** are managed by Revit, and cannot be created or deleted. They typically are not shared between Projects. Views, dimensions, text, etc. all belong to System families, as do geometric objects such as ducts and pipes (anything that would be assembled on the job site).

- **Component Families** (the focus of this class) can be created and customized, and can be stored in an external library, to be loaded into your Revit project on an “as needed” basis. Examples of Component Families are equipment, fixtures, devices and fittings, as well as custom annotation tags and callouts. When considering geometry, Component Families are objects that might be ordered out of a catalog and installed or placed on the job site.

- **In-Place Families** represent “one-off” items; custom geometry that is not meant to be re-used or shared between projects.

One of the strengths of component families is that they can be controlled by parameters, which allow for a great deal of flexibility. For example a table family can be created to have several sizes, all based on parameters that can be set by the user, allowing for a single family definition to accommodate several different kinds of tables. Parameters can control more than just sizes and distances, however. They can control materials, visibility states and non-graphical information (such as catalog number, voltage, cost, etc.).

Revit Component Families are a unique file type, with an extension of *RFA*. To create a family, you begin a new file by selecting **File->New->Family** from the Revit application menu. After selecting the appropriate family template, you'll be placed in the Revit Family Editor. The Family Editor looks just like the normal Revit interface, except that it has a different set of ribbons that include all of the tools that you will need to create your family.

Component Family Creation Process

While each family will vary in complexity and features, the basic process to create a component family will be the same:

1. **Select the family template.** This is the most important part of creating a family. The template will determine not only the category (and therefore the available default parameters) of the family, but also how it will behave and interact with other Revit components.

2. **Plan the major parameters.** Parameters are what control any variable values (sizes, materials, informational elements, etc. of the family). In addition to deciding what the parameters need to be, you will also need to consider whether they will need to be used in schedules or tags, and whether they will be *type* or *instance* parameters.

3. **Create and constrain model geometry.** This will entail laying out critical reference planes and constraining geometry with parameters. We will look at this more closely in the “Modeling Tools and Methods” and “Parameters and Constraints” sections of this paper.

4. **Assign Object Subcategories if necessary.** This will allow you to have independent control of the component in visibility graphics overrides, object styles and material assignments. If necessary, you can create new subcategories within your Revit Family.
5. **Set visibility rules.** Some geometry may not be appropriate in all views or detail levels. Using the visibility tools in Revit families, you can control when each component will be visible.

6. **Create Family Types.** Many component families contain multiple type definitions. An example of family types is found with Door families. The door size is defined by type definitions. Family types make it easy to change multiple parameters simply by selecting an overall type definition.

### Family Templates

As stated previously, the most important step in creating a component family is to choose the family template. The template will determine not only which object category the component will be a part of, but also how the family will act when it comes in contact with other components. In some cases you will also need to determine whether a family will be hosted or not, and if so, what type of object will serve as the host. For example, if you are creating a toilet fixture, you can choose from the non-hosted *Plumbing Fixture.rft* template or the hosted *Plumbing Fixture wall based.rft* template. If your fixture is a wall-mounted toilet, then you would choose the wall-based template, meaning that the family can only be placed on a wall. Another example of hosted families are light fixtures. A ceiling-hosted light fixture can only be inserted on a ceiling object. Hosted components will be attached to their hosts, “following” them wherever the host goes.

You should consider carefully which template to use. Once you’ve chosen the template and begun your family, you cannot change it. There are templates provided for virtually every object type, and in some cases multiple templates are provided for a single object type to accommodate a variety of behaviors (see Figure 1).

![Family Template List](Figure 1: There are several templates provided that will determine not only what the object category will be, but also how the family will behave when placed in a project. Note that there are six family templates provided for lights alone.

There will be times when you can’t find an appropriate template or when one of the provided templates doesn’t quite fit the bill. For example, you may be creating a mechanical equipment family to be hosted in a linked model. You can only host to faces in a linked model, not walls or ceilings. If there is not a face-based template for the specific family type that you’re trying to create you can use a Generic Model template instead (in this case the *Generic Model face based.rft* template). As soon as you are in the Family Editor, select **Family Category and Parameters** from the “Home” ribbon and set the family to the correct category (see Figure 2).
Figure 2: When using a Generic Model family template, it is important to set the Family Category and Parameters.

Modeling Tools

Revit modeling tools can be divided into two main groups: “Helpers” and “Methods”.

A *Helper* is geometry that in and of itself does not make up the model in the family, but instead can be used to generate the actual model geometry. Typical helpers in Revit Families are:

- **Reference Planes** – These can be used to constrain Revit Geometry (we’ll explore this in just a bit). Reference Planes can also be used as Work Planes.

- **Work Planes** – Every component of 3D geometry in a Revit Family is based to some extent on a 2D sketch. The Work Plane is the actual plane that the sketch is created on. Work Planes can be generated from existing faces on 3D geometry, lines that were already drawn using another plane, or from Reference Planes.

*Note: When a Reference Plane to be used as a Work Plane, you can name it in its element properties, then use the “Name” option from the Work Plane dialog box to select it. (See Figure 3).*
A “Method” is a technique used to create model geometry. In Revit there are only five Methods used, and the resulting geometry is either a solid or a void (a void will remove geometry from an existing solid). The five methods used will be the same, whether you are modeling a solid or a void, and whether you are creating an In-Place Family or a Component Family:

- **Extrusion** – Comprised of a 2D Sketch Profile that is extruded in the Z axis of the Work Plane that the sketch was created in.
- **Blend** – Consists of a 2D Sketch Profile for the bottom of the shape and a 2D Sketch Profile for the top. The actual 3D shape is extrapolated from the bottom shape, the top shape, and the blend depth.
- **Revolve** – Created from a 2D Sketch Profile that is revolved around an axis. The revolved shape can be revolved through a complete circle or any fraction of a circle.
- **Sweep** – Created from a 2D Sketch Profile that is driven along a 2D Sketch Path. The sketch path must exist in a single plane.
- **Swept Blend** – Created from two 2D Sketch Profiles, one at each end of a 2D Sketch Path. The resulting shape will be interpolated along the path between the two profiles. Like the Sweep Path, the Sketch Path must exist in a single plane.
Parameters and Constraints

Parameters are at the heart of a successful Revit Family. While you don’t have to make a family parametric, doing so will allow for a single family to be flexible enough to address issues that otherwise may take multiple families to handle. For example, by creating a parameter to control the height of a wall-mounted toilet, you can accommodate both an ADA-compliant toilet's dimensions with those of a standard toilet with a single family definition. In addition to controlling the dimensions of an object, parameters can control visibility and materials, as well as a host of other types of data, including user-defined text properties for scheduling and annotation.

Parameters are typically created in the Family Types Editor (see Figure 5). The Family Types Editor actually has three purposes:

1. Create, manage and modify parameters.
2. Create, manage and modify family types (more on this later)
3. Flex the family (test parameter values against the model geometry).
Figure 5. The Family Types Editor.

*Note:* You can also create a parameter "on the fly" by modifying a dimension and choosing to add a new parameter from the "Label" box on the options toolbar. This will create the parameter and link it to the selected dimension at the same time.

When creating a parameter, there are several items that you need to consider carefully:

- **Will the parameter need to be reported in a schedule or will it need to be part of an intelligent annotation tag?** If so, it will need to be a *shared parameter*. Shared parameters are stored in an external text file so that they can be accessible to multiple projects (you can edit the shared parameter file from within the Revit Family Editor).

- **What type of parameter is it?** Length parameters are applied to dimensions. Material parameters can control the material assigned to a piece of model geometry. Yes/No parameters will provide a checkbox ("on/off") type of parameter, etc. The parameter type is crucial to the behavior of the parameter.

- **The parameter discipline will control what types of units are available for the parameter.** In the case of an architectural application, virtually all of your parameters could very well be of the "Common" discipline (comprising of units for length, volume, area, etc.), however if you are an MEP engineer, you will need to choose HVAC, Electric, Plumbing, etc. to gain access to unit types for airflow, velocity, friction, voltage, etc.

- **Will the parameter be type-based or instance-based?** In other words, will the parameter actually define a new type within the family or will it be able to be edited on an element-by-element basis?
Note: Revit 2011 introduced a new kind of parameter. Instance-based parameters can also be reporting parameters. While outside the scope of this introductory tutorial, this new type of parameter provides powerful new capabilities. You should research and experiment with these once you have become more comfortable with the basics of creating custom component families.

Figure 6. Consider carefully the properties of the parameters that you create.

Guidelines for Geometric Parameters and Constraints

When using parameters and constraints to control physical geometry, there are some simple but definite do’s and dont’s:

- When applying a dimension parameter always dimension to reference planes. Never, under any circumstances, should you dimension to an actual piece of geometry or a sketch line if you are going to use a parameter to control the dimension. Doing so will result in a “Constraints not satisfied” error message. After assigning parameter dimensions to your reference planes, you can constrain (lock) the sketch geometry to the reference planes. The dimension parameter will actually control the position of the reference planes, which will in turn control the position of the model geometry.

- When using an equality constraint to make geometry symmetrical about a center line while allowing it to grow or shrink about the centerline with an overall parametric constraint, create the reference planes with the desired symmetry before applying the equality constraint. This will remove any possible ambiguities from the equality constraint and will ensure proper behavior when the family is flexed later on. (See Figure 7).
Flex the family often. Each time you apply a new geometric constraint you should test it by flexing the family. It is much easier to fix a problem with conflicting constraints if you know within one or two parameters where the problem may lie. If you wait until you have created and applied four or five parameters before you flex the family and then you have an error, you have a lot more possible conflicts to investigate.

3D Model Component Creation Process

A common mistake that users make when creating families is to begin modeling 3D geometry before the “up front” work is done. In the case of a parametric family especially, the actual modeling of extrusions, revolves, blends and sweeps is a small part of the overall process. First, take care to plan, define and test the parameters that you are going to use to control the geometry. Only after you have confirmed that all of the underlying rules and constraints are working and properly configured should you actually create the model geometry.

Combining the modeling tools provided by Revit and the parametric tools and constraints, a typical process for modeling a 3D family object will include the following steps:

1. Define all Reference Planes needed to define the geometry in three dimensions. Consider providing names for any that may need to be used as Work Planes in the future.
2. Constrain the Reference Planes with dimensions and parameters.
3. Flex the Family to test the behavior of the Reference Planes against the parameters and constraints.
4. Begin the creation of the Solid or Void geometry using either an extrusion, revolve, blend, sweep or swept blend.
5. Check and set the Work Plane for the sketch geometry. It is important to do this first, if for no other reason than to ensure that you’re drawing the sketch where you think you are (see Figure 8). Note that you can also set the current Work Plane at any time by selecting the Work Plane.
tool on the “Home” ribbon, and you can display the current Work Plane using the Work Plane Display toggle on the ribbon as well (see Figure 8).

![Diagram of Work Plane](image)

**Figure 8.** Setting the current Work Plane and toggling display.

6. Create the sketch geometry. Lock the geometry to your reference planes.

7. Set the object’s properties. Specific properties that you are interested in include the depth (in the case of an extrusion or blend), the material of the object, visibility and sub-category (if necessary). You can also set the properties after the object has been created and you have exited sketch mode. It is also important to note that you can link properties to parameters. For example, if you have created a Yes/No parameter, that parameter can be used to control the Visibility property of the object (see Figure 9).

![Parameter link to Visibility](image)

**Figure 9.** Object properties in families can be linked to parameters of the appropriate type.
8. Finish the Sketch, which will complete the object and apply the 3D properties to the 2D Sketch geometry.

9. Flex the Family, testing both the dimensional constraints and parameters again as well as any parameters that you linked to object properties. If there are any errors, you can either edit the sketch or modify any parameter-based properties to resolve the issue before going on to the next geometric component.

Detail Component and Annotation Families

The focus of this document is 3D Model Component Families, however there are other kinds of families in Revit as well, in particular Detail Component and Annotation Families. These are typically very easy to create; if you can successfully create a 3D Model Component Family, then you will have no trouble creating detail components and annotation.

- Detail Component Family creation has a similar overall process to the 3D Model Component Family Creation process outlined on pages 1 and 2. Instead of creating Solids or Voids, however, you will be working with lines, filled regions and masking regions. These can also be parametric if necessary to control variations in geometry, and the rules for assigning dimensional parameters are the same as in 3D Model Component Families. If you are creating a Detail Component that has an extremely large number of types, you can associate it with a catalog file. This is nothing more than a text file that is formatted to list the parameters and types to allow the user to only load specific types of the family into their project rather than several types at once. An example of a detail component with a catalog can be found in the structural metal framing families that are provided with the default content libraries that ship with Revit. For information on how to format a family catalog, you should refer to the Revit Help Utility.

- Annotation Families are usually even easier still. They typically contain minimal 2D geometry, maybe some text, and most likely a label. The label will link to a parameter of the object type that the annotation tag is meant to be associated with.

Tutorial

The following tutorial will walk you through the process of creating a parametric window family using the techniques and processes discussed in the previous pages. You will create a family for a fixed glass window with muntins, a lintel and a sill. First you will create the physical geometry, providing parametric dimensions to allow for different window sizes, then you will add material parameters and fine tune the display characteristics for different levels of detail. Finally, you will create the various window types and test them in a Revit Architecture project.
Introduction

Using the graphics in the image above, you will create a parametric window following the procedures and methods described in the first part of this document.

Start the Family

The first and most important step in creating any Family is to choose the proper template. Revit Architecture ships with a variety of templates for the various classes of objects. Take time to carefully consider which template is correct; once you have chosen the template there is no going back. If you decide later that you need a different template, you have to start over with your Family. For your Window it's pretty simple; you need to use a Window template. There are three templates for Window Families – Window.rft, Window with Trim.rft and Window-Curtainwall.rft. Your Window will not have trim and will need to be hosted by a Basic or Stacked wall, so you need to use the Window.rft template:
1. From the Recent Files window under Families, choose New.

2. In the file dialog box, choose the Window.rft file as the template and click Open.

Your screen should look similar Figure 10, with a sample wall host and an opening with preliminary parametric dimensions. (Note that in Figure 10, the properties dialog has been docked to the right side. Yours may be in a different location or not active at all – it is assumed in this tutorial that you are familiar with accessing and manipulating the element and type properties palettes in Revit 2011).

![Figure 10. The Window.rft template.](image)

Create the Model Geometry

The model geometry will be created in five stages:

- The Window opening. There is already an opening in the template, however it will need to be deleted and recreated, for reasons that will be explained a bit later in this document.
- The Window Sill and Lintel.
- The Window Frame.
- The Window Muntins.
- The Glass.

Modeling the Window Opening

Before beginning work, you should make the wall a bit more representative of the type of wall that this Window Family is intended to be hosted by, and remove the existing opening.

1. Pick the Wall. In the Element Properties dialog, click the Edit Type button.
2. In the Type Properties dialog, click **Edit** next to “Structure”.

3. In the Edit Assembly dialog, change the Thickness of the single material in the wall to 1'-2” as shown in Figure 11, then click **OK** until you exit all dialogs.

![Figure 11. Changing the thickness of the example host Wall.](image)

4. Select the opening (it is represented by a line on the interior side of the wall) and delete it.

   **Note:** Openings (not voids) have limitations that make them unusable for this family. First, you can only have one opening per family, and openings cannot exist in same wall host as voids. Since you need an opening for the window as well as an opening to host the Lintel and Sill, the opening will need be created by a void instead.

   Normally you would first create all of the Reference Planes that are needed to define the void for the window opening, and then assign them dimensions and parameters. In this template however, the reference planes defining the opening width and height are already in place and already have parameters assigned to them. For the opening then, you can immediately begin modeling.

5. Navigate to the **Ref Level** Floorplan View if you’re not already there. From the Home ribbon, click the **Void Forms** tool, then click **Void Extrusion** (see Figure 12).

![Figure 12. Beginning the opening void.](image)

6. Use the Rectangle tool to create the rectangle shown in Figure 13. Make sure and click all four locks to constrain the rectangle to the sides of the wall and the two reference planes.
Figure 13. Creating the void rectangle.

In the Properties dialog, note that the Work Plane is set to “Reference Plane: Sill”. This is the bottom of the window opening.

7. In the Properties dialog click the small button to the left of the value for “Extrusion End” as shown in Figure 14. This will allow you to link the value to a Parameter.

Figure 14. Establishing the height of the opening.

8. Select the “Height” parameter as shown in Figure 14 and click OK. Note the value for “Extrusion End” is now greyed out and set to 4'-0". It will now be driven by the “Height” parameter of the window.

9. Click Apply.

10. Click Finish (the green “check mark” on the “Modify | Create Void Extrusion” Ribbon) to finish defining the opening void.
Now that the void has been created, you can cut the wall with it to recreate the opening for the window.

**11.** From the Modify ribbon, click the **Cut** tool (see Figure 15). Pick the void (shown in orange in your graphics window), then click the wall.

![Figure 15. The Cut Geometry tool.](image)

**12.** Navigate to the **View 1 3D View** and flex the family by changing the “Width” and “Height” parameters in the **Family Types** dialog (see Figure 16). Once finished, return the window opening to its original size.

![Figure 16. Accessing the Family Types dialog.](image)

**13.** Save the file to **Window-Fixed with Sill and Lintel.rfa**.

**Modeling the Window Sill and Lintel**

To create the Sill and Lintel, you first need to create another void in the wall to accommodate them, then create the actual geometry that will represent them. Both the void and the solid geometry can be created from extrusions. Before creating them you should set up the reference planes and parametric dimensions that control them.

1. Navigate to the **Ref. Level** Floorplan view.

2. From the Home ribbon, click the **Reference Plane** tool. Draw a Reference Plane from left to right between the wall centerline and the exterior face of the wall. This will be the Work Plane for the extrusions that will form the Sill and the Lintel.

**Note:** Reference planes have a positive and a negative side, with the positive side being the left side of the Reference Plane. By drawing it left to right, you ensure that the positive side of the Reference Plane is toward the exterior of the wall. This will mean that when you create the extrusions using it as a Work Plane, a positive extrusion depth will cause them to extrude in the correct direction.
3. Click the **Modify** tool or press `<ESC>` to stop the Reference Plane tool.

While it is not absolutely necessary to name a Reference Plane that you plan on using as a Work Plane, it’s a good habit to get into, as it makes it easier to select it as the Work Plane when the time comes.

4. Select the Reference Plane you just drew. In the Properties dialog, enter “Back of Sill and Lintel” in the space next to “Name” and click **Apply**.

The lintel and sill depth will need to be controlled by a parameter to accommodate different conditions. To do this, you will add a dimension and then attach the dimension to a parameter which you will create.

5. From the Annotate ribbon, click the **Aligned** dimension tool and place the dimension shown in Figure 17, then click **Modify** from the ribbon.

   **Note:** Make sure you dimension from the Reference Plane you just created, not the wall centerline Reference Plane, to the face of the wall.

6. Select the dimension you just placed, then from the Options bar, click **Add Parameter** from the drop down list next to “Label” (see Figure 18.)

7. In the Parameter Properties dialog, leave the Parameter Type set to “Family parameter” (we will look at Family vs. Shared parameters a bit later). Enter “Veneer Thickness” for the Parameter Name, group the parameter under “Dimensions” and click **Instance**. Make sure your settings match Figure 18 and click **OK**.

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**Figure 17.** Creating the parametric dimension for the Lintel and Sill depth.

**Figure 18.** Establishing the “Veneer Thickness” parameter.
8. Flex the Family using the same process as before. In the Family Types dialog enter a value of 0’-3 5/8” for the Sill and Lintel Depth and click Apply. The Reference Plane that you just dimensioned should move to reflect the new value. Click OK to exit the dialog.

9. Navigate to the Exterior Elevation View

10. Draw the Reference Planes shown in Figure 19.

![Figure 19. Creating the Reference Planes for the top and bottoms of the sill and lintel.]

11. Create the aligned dimensions shown in Figure 20. Again, make sure that you dimension to the Reference Planes and not actual geometry.

![Figure 20. Dimensioning the sill and lintel Reference Planes.]

12. Using the same procedure in Steps 6 and 7, assign new parameters ”Lintel Height” and ”Sill Height” to the top and bottom dimensions respectively.
13. Flex the Family using the **Family Types** tool again, this time, assigning a value of 4” to the Sill Height and a value of 8” to the Lintel Height.

14. From the Home ribbon, Click the **Void Forms** tool, then click **Void Extrusion**.

15. Again from the ribbon, click the **Set Work Plane** tool (see Figure 21). In the Work Plane dialog, choose “Reference Plane: Back of Sill and Lintel” from the drop down list next to “Name” as shown in Figure 21 and click **OK**.

![Figure 21. Setting the Work Plane.](image)

16. From the ribbon, click on the **Rectangle** tool and create the rectangles shown in Figure 22, making sure to lock all lines to the appropriate Reference Planes so that they will move any time the window width, window height, sill height or lintel height changes.

![Figure 22. Creating the void sketch.](image)

17. In the Properties dialog, click the small button to the far right of the value for Extrusion End. In the Associate Family Parameter dialog, select the “Veneer Thickness” parameter and click **OK**. The Extrusion End property should now be tied to that parameter and should currently show a value of 0'-3 5/8”.
18. Click Finish from the ribbon (the green check mark).

19. Navigate to the View 1 3D View and spin the view so that you are looking at the exterior side of the wall and you can see the void represented by orange linework (it is not cutting the wall yet).

20. From the Modify ribbon, click the Cut tool, then select the Wall followed by the void. The void for the lintel and sill should now appear in the wall as shown in Figure 23.

![Figure 23. The finished lintel and sill voids.](image)

21. Flex the Family again, making sure to check all parameters that will affect the size of the sill and lintel, either directly or indirectly (this would include the "Width" and "Height" parameters).

22. Save the Family.

Finally, you will model the sill and lintel. You will find that creating a Section view will assist in creating the geometry. You need to create the view before creating the geometry.

23. Navigate to the Ref. Level Floorplan view.

24. Use the Section tool on the View ribbon to create the Section shown in Figure 24. It is important to put the section in the location and orientations shown in the figure for a later step in this tutorial.
Figure 24. Create a Section view.


26. From the Home ribbon, click the Extrusion tool.

27. Using the same procedure as that shown in Step 15, make sure your Work Plane is still set to “Back of Sill and Lintel”.

28. Using the same procedure you used to create the void sketch, create the sketch for the sill and lintel, again locking your lines to the appropriate Reference Planes as shown in Figure 22.

29. In the Properties dialog, set the value for “Extrusion End” to 0'-5” to establish an initial value for now.

30. Click Finish from the ribbon.

To control the depth of the sill and lintel, you will create a new parameter and use a formula based on the existing “Veneer Thickness” parameter.

31. Click the Family Types tool from the Home ribbon. In the Family Types dialog box, click Add. Provide a name of “Lintel and Sill Thickness”, group the parameter under Other, make it Instance-based and make it a Length parameter as shown in Figure 25.

Figure 25. Creating the “Lintel and Sill Thickness” parameter.
32. Click OK to exit the Parameter Properties dialog and return to the Types dialog. Scroll down to the "Lintel and Sill Thickness" parameter, and in the Formula column to the right enter "Veneer Thickness + 1\" so that your dialog looks like Figure 26. When you press <ENTER> the value for the parameter will turn grey and be changed to 0'-4 5/8\". Click OK to return to the Family Editor.

![Figure 26. Creating a formula parameter.](image)

33. Select the sill and lintel and in the Properties dialog, click the button to the right of the Extrusion End property, select the Lintel and Sill Thickness parameter as shown in Figure 27, then click OK to return to the Properties dialog. The Extrusion End property is now linked to the Lintel and Sill Thickness parameter.

![Figure 27. Linking the Extrusion End property to the Lintel and Sill Thickness parameter.](image)

34. Navigate to the **View 1** 3D View and flex the family to make sure that any changes that would affect the size and position of the sill and lintel work as intended.

35. Save the Family.
Modeling the Frame

To model the frame, you will define a sweep with the path following the boundary of the window opening. Before doing so, however, you need to define all of the Reference Planes and parameters necessary to control the frame geometry in the same general way that you defined the Reference Planes and parameters for the sill and lintel. First, you will create a Reference Plane that represents the center of the frame (between the front and back faces). This will serve as the Work Plane for the frame, the mullions and the glass.

1. Navigate to the Section 1 Section view.

2. Draw a Reference Plane from top to bottom to the right (interior) of the wall centerline Reference Plane, so that the positive side of the Reference Plane will be to the exterior of the wall, as shown in Figure 28.

3. Click the Modify tool and select the Reference Plane you just drew. In the Properties dialog enter a Name of “Frame Center”.

Next you need to create a series of Reference Planes to define the edges of the frame itself.

4. From the Home ribbon, click the Reference Plane tool and click Pick Lines as shown in Figure 29. In the Options bar, set the offset to 0'-2”. Pick the Reference Plane that you just created so that there is one new Reference Plane created on either side of it.

Figure 28. Creating the frame, muntin and glass Work Plane.

Figure 29. Using the Pick Lines tool to create a Reference Plane.
Note: If necessary, move all three Reference Planes so that they all fall between the interior face of the wall and the centerline Reference Plane. Make sure that the distance between them stays equal.

5. Using the Aligned tool from the Annotate ribbon, create the three dimensions shown in Figure 30.

![Figure 30. The frame depth dimensions.](image)

Note that the dimension between the three Reference Planes that you created in the previous steps has been assigned an equality constraint. Note also that the overall dimension and the dimension to the face of the wall are separate strings. This is important because you will be assigning parameters to them in the next few steps.

![Note: If you plan to assign an equality constraint to a dimension as in this case, you should make sure that the distances are already equal before actually placing the dimension. Failing to do so could result in a "Constraint not Satisfied" error when later trying to control the overall dimension with a parameter.](image)

The next parameter you will create will control the frame depth. Since this parameter will potentially be used in a schedule, you will need to make it a Shared Parameter. This will involve creating a shared parameter file.

Note: Steps 6-13 assume that you have not yet established a Shared Parameter File. If this is not the case, you may need to obtain help from an administrator or CAD Manager to gain access to the Shared Parameter File for your office (or you may want to have them help you create a new one for training purposes so that you don’t edit your office standards by mistake).

6. Select the 4” dimension for the frame depth that you created in the previous step. Click Add Parameter from the Label drop down list on the Options bar.

7. In the Parameter Properties dialog, click Shared Parameter, then Select to select a parameter file as shown in Figure 31.

8. In the warning dialog box that appears, click Yes to choose a parameter file.

9. In the Edit Shared Parameters dialog, click Create as shown in Figure 31.
10. In the file dialog that appears, navigate to the folder where you want to save the file, and enter a name of “RAC Training Parameters”, then click **Save**.

![Image](image1.png)

**Figure 31.** Creating the Shared Parameter File.

11. In the Edit Shared Parameters dialog, click **New** under Groups. Name the new parameter group “Window Parameters” and click **OK**.

12. Click **New** under Parameters to create the first window parameter. For the name, enter “Window Frame Depth” and set the Type to Length, as shown in Figure 32, then click **OK** to return to the Edit Shared Parameters dialog.

![Image](image2.png)

**Figure 32.** Creating the Window Frame Depth parameter.

13. Use the same process to create the following additional parameters, which will be used a bit later so that your dialog looks like Figure 33, then click **OK** (Note that some of the parameters are set to the “Material” type):

- **Window Frame Width**, Type = **Length**
- **Lintel and Sill Material**, Type = **Material**
- **Glazing Material**, Type = **Material**
- **Frame Material**, Type = **Material**
Now that the Shared Parameter File has been created, you simply need to select which parameter you need to use for the Dimension.

14. In the Shared Parameters dialog, select the Window Frame Depth parameter and click **OK**.

15. Make sure your Parameter Properties dialog looks like Figure 34 and click **OK** to return to the Family Editor.

![Figure 34](image-url) Finishing the Window Frame Depth parameter.

16. Select the dimension between the interior edge of the frame and the interior face of the wall and click **Add Parameter** from the Label drop down list in the Options bar. In the Parameter Properties dialog, leave the Parameter Type setting to Family and enter “Frame Offset” for the name. Group the parameter under Other and leave it Type based. Click **OK** to return to the Family Editor.

17. Flex the Family. Click the **Family Types** tool from the ribbon and change the value of the Frame Offset parameter to 0’-1”. Change the value of the Window Frame Depth parameter to something else and click **Apply**. Note the changes and if the Reference Planes react as expected, then set the values back to 0’-1” and 0’-4” respectively again. Click **OK**.
18. Save the Family.


20. Use the Pick Lines tool as done previously in Step 4 to create the Reference Planes to define the four inner edges of the window frame as shown in Figure 35. Use an offset of 1 ½”.

21. Use the Aligned tool from the Annotate ribbon to create the dimensions shown in Figure 35.

22. Select all four dimensions and click Add Parameter from the Label drop down list in the Options dialog. In the Parameter Properties dialog, click Shared, then click Select. In the Shared Parameters dialog, select the Window Frame Width parameter and click OK.

23. Back in the Parameter Properties dialog, group the parameter under Dimensions and leave it Type-based. Click OK to return to the Family Editor.

24. Flex the Family to make sure the Window Frame Width parameter is acting correctly.

25. Save the Family.

Now that the Reference Planes and parameters are in place, you can create the actual frame geometry.

26. Navigate to the Exterior Elevation View if you’re not already there.

27. From the Home ribbon, click Sweep.

28. Using the same procedure as that used for the lintel and sill, set the current Work Plane to Reference Plane: Frame Center.

29. Click Sketch Path from the Sweep ribbon, then click the Rectangle tool from the ribbon. Draw the rectangle by picking Point A in Figure 36, then Point B. Make sure that you lock all sketch lines to the appropriate Reference Planes.

Figure 35. The window frame width Reference Planes and dimensions (before assigning the Window Frame Width parameter).
30. Click **Finish** from the ribbon.

31. Navigate to the **Section 1** Section View, then click **Edit Profile** from the ribbon.

32. Use the Rectangle tool from the ribbon to create the sketch shown in Figure 37. Again, don’t forget to lock all sketch lines to the appropriate Reference Plane.

33. Click **Finish**, then **Finish** again from the ribbon.

34. Navigate to the **View 1** 3D View and flex the Family to make sure that the geometry is constrained to all Reference Planes.

35. Save the Family.

**Modeling the Muntins**

The muntins can be created with a simple extrusion. The Work Plane will be the same as that used for the frame.

1. Navigate to the **Exterior** Elevation View.
2. Create the Reference Planes shown in Figure 38, along with the equality constraint dimensions shown, using the procedures described earlier in this tutorial.

![Figure 38. Creating the muntin centerline Reference Planes.](image)

3. For each muntin centerline Reference Plane, create the Reference Planes, equality constraints and dimensions shown in Figure 39. Note that the overall dimension for the muntin width is locked at 1". Also, remember to make sure that the Reference Planes on either side of the centerlines are created using the **Pick Lines** tool with the offset pre-set to ½". As shown in Figure 39, you should have three sets of these Reference Planes: two horizontal and one vertical.

![Figure 39. Finishing the muntin Reference Planes and constraints.](image)

4. Flex the Family, changing the Window Width and Height to make sure that all of the muntin Reference Planes are acting as expected.

Again, now that all of the necessary Reference Planes and constraints are in place, you can create the model geometry.

5. Make sure the Work Plane is still set to **Reference Plane: Frame Center**.
6. Click **Extrusion** from the Home ribbon.

7. Create the sketch shown in Figure 40. Make sure that all sketch lines are locked to a Reference Plane.

![Figure 40. The muntin sketch.](image)

8. In the Properties dialog, set the Extrusion Start value to -0'-0 ¾" and the Extrusion End value to 0'-0 ¾" as shown in Figure 41. This will cause the muntins to be centered on the Work Plane.

![Figure 41. Establishing the muntin thickness so that it will be symmetrical about the Frame Center Work Plane.](image)

9. Click **Finish** from the ribbon.

10. Navigate to the **View 1** 3D View and flex the Family again to make sure that all frame and muntin geometry is properly constrained.

11. Save the Family.
Modeling the Glass

The final piece of geometry that needs to be modeled is the glazing. This will also be done as an extrusion. Since all of the Reference Planes and parameters needed for this are already in place, you can immediately begin the modeling process.

1. Navigate to the **Exterior** Elevation View.
2. Click **Extrusion** from the Home ribbon.
3. Make sure that the current Work Plane is still **Reference Plane: Frame Center**.
4. Create the sketch shown in Figure 42, making sure that all lines are locked to the appropriate Reference Plane.
5. In the Properties dialog, set the Extrusion Start value to -0'-0 ¼” and the Extrusion End value to 0'-0 ¼”.
6. Click **Finish** from the ribbon.
7. Flex the Family to make sure that all geometry is properly constrained.
8. Save the Family.

![Figure 42. The glazing sketch.](image)

Setting Wall Wrap Conditions

You can use Reference Planes in a window or door family to control the wrapping points for wall layers.

1. Navigate to the **Ref. Level** Floorplan View.
2. Select the Reference Planes that are attached to the exterior and interior faces of the frame as shown in Figure 43.
3. In the **Properties** dialog box, click the check box next to Wall Closure as shown in Figure 43.
Now the inner face of the frame will be the point that interior wall layers will wrap to, and the exterior face will be the wrap limit for the exterior wall layers. You could also have defined Reference Planes for the sole purpose of controlling wrapping, however in this exercise the frame will suffice as a control point. The only thing left to do is determine when wall components will wrap.

4. From the ribbon, click the Family Types tool. In the Family Types dialog, set the Wall Closure property to Both and click OK.

This will ensure that regardless of the settings on the wall itself, this Family will force wrapping when inserted into it. In this way, you can leave a wall set to not wrap by default when objects are inserted into it, but when the Family includes the proper wrapping controls that setting will be overridden and allow wrapping.

5. Save the Family

You will test the wall wrapping after assigning materials to the family components.

Assigning Materials

A common mistake when creating custom families is to leave all components on the main category of the family. For example, in this case, the family is categorized as a window, and will therefore act like a window when interacting with other objects, and will obey the settings for windows as specified in the Object Styles and Visibility / Graphics Overrides settings. However, none of the components in the family are currently assigned to a subcategory, so the glass does not “know” that it’s glass, the frame does not “know” that it’s a frame, etc. Once these components are assigned to subcategories (you can create new subcategories if necessary), they will then take on the material that is assigned to that subcategory in a given project’s Object Style settings. You will take it further however, providing parameters to control their materials independently of the Object Styles settings if the user desires.

1. Navigate to the View 1 3D View.

2. Select the lintel and sill, then. In the Properties dialog, set the Subcategory value to Sill/Head as shown in Figure 44.

3. Click the button to the far right of the Material property and click Add Parameter in the Associate Family Parameter dialog. In the Parameter Properties dialog, click Shared Parameter, then click Select. In the Shared Parameters dialog select Lintel and Sill Material, then click OK.
4. In the Parameter Properties dialog group the parameter under Materials and Finishes and leave it Type based. Click OK until you return to the Properties dialog. Double check your settings with Figure 44.

![Figure 44](image)

**Figure 44.** Setting the subcategory of the lintel and sill, and assigning it to the Lintel and Sill Material parameter. Note that the default value is still set to "<By Category>" but it can now be changed by simply changing the linked parameter.

5. Follow the same procedure as in Steps 2, 3 and 4 to assign the frame and muntins to the Frame/Mullion subcategory and link the material to the "Frame Material" Shared Parameter. Don't forget to group the parameter under Materials and Finishes and keep it type-based.

6. Follow the same steps to assign the glass component to the Glass subcategory and the "Glazing Material" Shared Parameter.

7. Save the Family.

Create Family Types

Once the geometry has been defined and tested and all parameters are in place, you should create multiple Family Types. This will prevent the user from having to repetitively create new types in each project that they use the Family in. In the case of Windows and Doors you should create Family Types that define the most commonly used sizes. For this example you will create 3 new types.

1. Navigate to the View 1 3D View if you're not already there.

2. Click Family Types from the ribbon. Click New under Family Types. Enter a name of 3’ x 4’ and click OK. Verify that the Width is already set to 3'-0" and the Height is 4'-0" and click Apply to create the type. Make sure you click Apply even if you don’t have to change any parameters.

3. Click New under Family Types again. Enter a name of 3’ x 5’ and click OK. Change the Height to 5'-0" and click Apply.

4. Click New under Family Types. Enter a name of 3’-6” x 5’ and click OK. Change the Width to 3’-6” and click Apply. Click OK to return to the Family Editor.

5. Save the Family.
Test the Family

While the Family is not quite finished yet, as you will soon see, now is a good time for some testing.

1. Start a new Project using the default template.
2. Create a wall using the *Exterior – Brick on Metal Stud* wall type.
3. Set the view to a scale of $\frac{1}{4}”=1’-0”$ and set the detail level to Medium.
4. Select the wall you just created and edit its Type properties. Edit the Structure and turn off the wrapping for all layers except for the interior and exterior finish layers. Make sure that the wrapping at inserts remains set to “Do not wrap” as shown in Figure 45.

[Image: Establishing the wrap properties of the wall type.]

5. Click OK until you return to the Project.
6. From the Insert ribbon, click **Load Family**. Navigate to the Family (.rfa) file that you have been editing, select it, and click **Open**.
7. Use the **Window** tool on the Home ribbon to place an instance of your new window Family in the wall you just created so your screen looks similar to Figure 46.
Note that the brick and gypsum board layers in the wall wrap to the edges of the frame, which is where the “Wall Closure” Reference Planes are located.

**8.** Set the detail level to Coarse and the scale to 1/8\"=1'-0\".
At this scale and detail level, the window looks a bit busy. There is too much detail in the plan representation.

**Fine-Tuning Visibility**
By controlling visibility of various components in your Family, you can accommodate among other things, different levels of detail.

**1.** Using the **Switch Windows** tool on the View ribbon, navigate to the **View 1** 3D View of your Window Family.

**2.** Select the frame component and Click the **Visibility Settings** tool from the ribbon as shown in Figure 47. Clear the check mark for the “Coarse” Detail Level as shown in Figure 47 and Click **OK**.

**Figure 46.** Testing the Window Family.

**Figure 47.** Setting the display of objects based on detail level.

**Note:** While in the Family Editor, you will still see objects that you have set to be invisible. The settings will not be evident until you actually test them in a Project.

**3.** Follow the same procedure to turn off the muntins and the glass in the coarse detail level.
Now that you have suppressed the display of the frame, muntins and glass in the course detail level, you need to replace them with *Symbolic Lines*, which are 2D lines that will only display when you are in a view that is perpendicular to the plane in which they are drawn.

4. Navigate to the **Ref. Level** Floorplan View.

5. From the Annotate ribbon, click **Symbolic Line**. From the ribbon, change the Subcategory to "Glass (Cut)". Draw the Symbolic Line shown in Figure 48 on top of the Frame Center Reference Plane.

![Figure 48. The Symbolic Line representing the glass.](image)

6. Use the **Align** tool from the Modify ribbon to lock the Symbolic Line to the Frame Center Reference Plane.

7. Select the Symbolic Line and click **Visibility Settings** from the ribbon. Turn off the visibility in the Medium and Fine detail levels. Place a check mark in the box for "Show only if instance is cut". Check your settings with Figure 49 and click OK.

![Figure 49. Setting the visibility of the Symbolic Line.](image)

8. Use Visibility/Graphics Overrides to turn on "Automatic Sketch Dimensions" in the Annotation tab. Note that Revit is "assuming" a constraint of 0” at the start and end points of the Symbolic Line. This will ensure that the line will change length when the width of the window changes.

9. Save the Family.

10. From the ribbon, use the **Load Into Project** tool to reload the Family into your Project. Choose to overwrite any existing versions and parameters.
11. Switch the detail level of the view from Coarse to Medium to Fine and back to Coarse again. Note that when you switch between Coarse and Medium or Fine, the 3D geometry is replaced by the Symbolic Line and back again.

12. Take a few minutes to test the rest of the parameters. Move to a 3D view and adjust the sizes of the window, the frame, etc. Also play with assigning different materials to the sill and lintel, the frame and mullions and the glass.

Summary

The preceding tutorial outlines the typical process for creating a custom Window Family. The same process would be used for a Door Family as well. While the geometry and parameters may differ, the process will remain the same. Other types of families will be created using the same workflow and similar processes. You might find it useful to open some existing Families and explore them to see if you can “reverse engineer” how some of them were created.