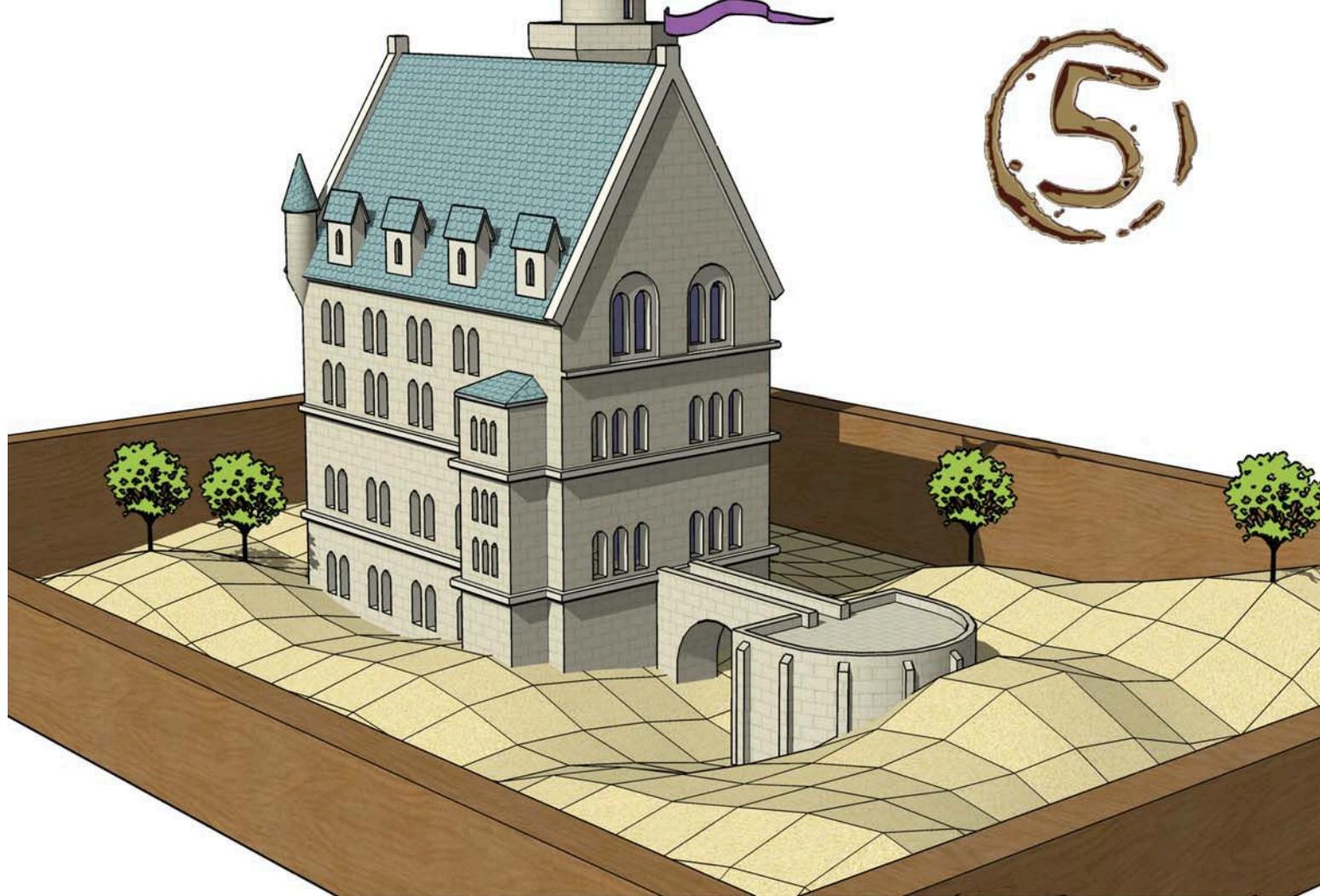


# the SketchUp® book



**Changing the way you think in 3D,  
from concept to model.**

Windows &  
Mac OSX

Bonnie Roskes, P.E.  
with Bob deWitt, MFA, MA

authorized by  
**@Last**  
SOFTWARE  
makers of  
**SketchUp®**  
[www.sketchup.com](http://www.sketchup.com)



# **the SketchUp® Book**

## **Version 5**

By Bonnie Roskes, P.E.  
with Bob deWitt, MFA, MA

A collection of exercises, tips and tricks that  
will maximize your investment in SketchUp.

Every effort has been made to ensure that all information contained within this book is complete and accurate. However, the authors assume no responsibility for the use of this information, nor for any infringement upon the intellectual property rights of third parties which would result from such use.

Third Edition.

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All technical illustrations and models in this book were produced using SketchUp.

Cover design by Bob deWitt.

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# 1 Introduction

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## How this Book Came About

While SketchUp® has one of the most user-friendly interfaces on the market today, there are still some things users need a little help with. The program's online help and the video tutorials on SketchUp's website are gems of information, but most people don't learn easily from watching a movie. I've taken most of the basic information from these tutorials and put them into printed form, for those who like to work alongside text. These exercises are designed to get you to perform the steps yourself, which is the best way for information to stick. If you read this book from start to finish, some things may seem repetitive. For each exercise I have assumed that you may not have done all the previous exercises, so certain steps may be explained repeatedly. So, if you already know how to use **Offset** and keep seeing reminders on how to use this tool, just ignore them.

The "Tips and Tricks" chapter outlines some of the handy methods devised by expert SketchUp users as well as some SketchUp developers. This information can be found by anyone on the SketchUp User Forum, but not everyone has hours to spend combing through the reams of text and links. I've done this work for you - sifting through all the posts, suggestions, links, and sample files, to come up with the short exercises that demonstrate these useful tidbits.

## How this Book is Set Up

I am not an architect by trade; I am a structural engineer and software documentation writer. Therefore, this book will not contain any guidance on design and planning of your models - that is up to you (and there are other books on this subject). The exercises presented in the following chapters are designed to completely familiarize you with every aspect of SketchUp itself.

Here is the chapter layout:

2. **Basics:** Short exercises on each of the drawing and manipulation tools (Line, Arc, Push/Pull, Protractor, Axes, etc.)
3. **Intersect and Follow Me:** These tools are often used together, so they get their own chapter.
4. **Multiple Copy:** Exercises on rows of copied objects, linear arrays, and angular (rotated) arrays.

5. **Roofs:** Everyone works with them, and they can sometimes get tricky. SketchUp enables you to create, modify, and resolve roofs easily.
6. **Groups and Components:** Groups are used to make a collection of objects that act as one object. This is useful for isolating geometry, and to keep things from sticking to one another. Components enable you to insert external objects into your model and use them multiple times. This is equivalent to external references used in other CAD packages.
7. **Materials:** Applying materials, colors, and textures to faces to enhance the display of your model.
8. **Sectioning:** Using section planes to cut into your model, to look inside, create floor plans, or produce a drawing to export to CAD.
9. **Presentation:** Usage of the walk-through tools, layers, pages (views) tour guide (slide show) and shadows.
10. **Sandbox:** Tools for creating and modifying TIN surfaces, used in terrain modeling.
11. **Exact Dimensions:** While SketchUp's strength lies in its simple, non-rigid modeling ability, you can also use it like a standard CAD application by working with known measurements. This chapter shows ways to specify exact values when using any tool.
12. **Tips and Tricks:** Exercises that show handy ways to solve typical problems.
13. **In Depth Exercises:** Two exercises that combine many of the concepts presented throughout this book. One exercise results in a steel building frame created from structural shapes that were saved as components. The second exercise is to create a simple log cabin.
14. **Program Settings:** General knowledge of the display tools, preferences, keyboard shortcuts, and import/export.
15. **Ruby Script:** Some basics on how to use Ruby programming to create macros.

## What's New in This Book

A lot has changed in SketchUp between Versions 4 and 5. The Mac and Windows versions have been brought closer together, though there are still some slight differences. Here is a list of the major improvements implemented in Version 5:

- **Sandbox:** Tools for creating TIN surfaces, used to model terrain. You can create a flat surface from scratch and bump out hills and valleys, or you can create a TIN from existing contours.
- **Component Outliner:** Provides a branched outline of all components and groups in the model. You can move, explode, edit, and rename objects directly in the Outliner.
- **Component selecting and replacing:** You can now select all instances of the same component. Plus you can select one or more components and replace them all with another component.
- **Stacking Windows:** Windows you use often, like Display Settings, Layers, Materials, etc. can be stacked on top of one another, docked anywhere, and minimized while leaving the title bar showing. This gives you easy access to these windows while not taking up too much space.
- **Rotate:** You can now set a rotation plane anywhere - not just on the standard planes or on an existing face.
- **Circle and Polygon:** You can now Shift-align them to a plane or face before selecting the center point.
- **Walk:** You can now walk up and down stairs, and are prevented from walking through walls and doors.
- **Non-photorealistic Rendering:** For a sketchy look, you can use depth cued edges and edge endpoints.
- **Alpha Transparency:** You can use a graphic that has alpha transparency defined.

## About the Authors

**Bonnie Roskes, P.E.** is a structural engineer by education and training, and has worked for several years in the software documentation arena, specializing in CAD, CAM, CAE, and engineering applications. She has written user guides, reference manuals, online help systems, tutorials, training guides, and software demos for a large client list. Her BSE and MSE are from Johns Hopkins University. In addition to this SketchUp book, there is one for Versions 2, 3, and 4 she has written books

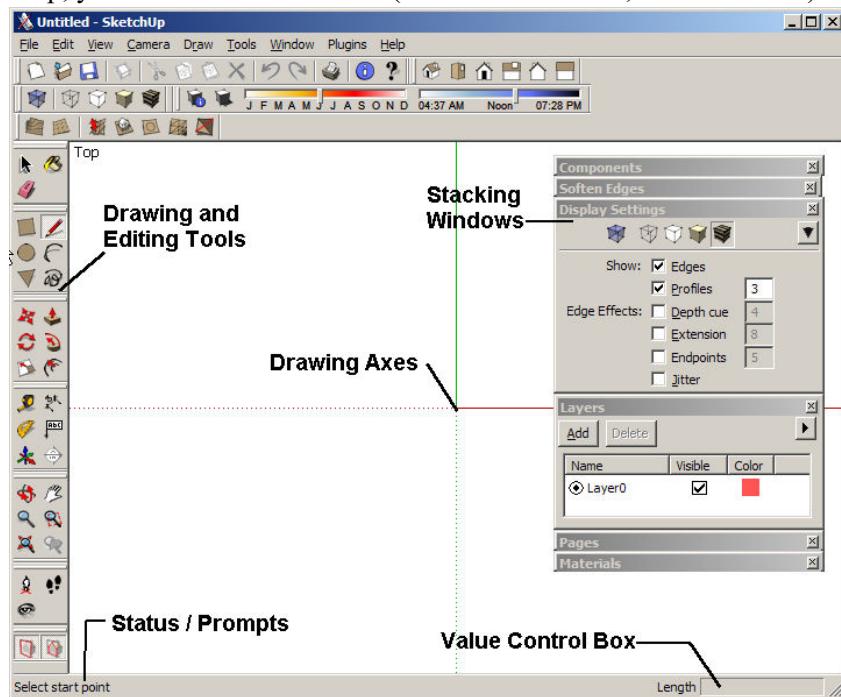
on the CAD/CAM application OneCNC. More books are in the works, including one on Piranesi. Comments, feedback, and suggestions are welcome - [bonnie@f1help.biz](mailto:bonnie@f1help.biz). Also, see her company website - [www.f1help.biz](http://www.f1help.biz).

**Bob deWitt** got his start working for 15 years doing freelance work in commercial art, illustration and film animation in Arizona, Utah, and California. After this, he pursued one of his first loves when, 18 years ago, he began teaching Fine Arts at Utah Valley State College in Orem, Utah. He holds degrees from Brigham Young University in both Studio Art and Art History. He long ago developed an abiding fascination for creating computerized imagery, and eagerly shares his enthusiasm for SketchUp through his participation in the preparation of this book. He also takes credit for the cover design, including the model.

## 2 The Basics

### SketchUp Screen

When you launch SketchUp, your screen looks like this (shown in Windows, Mac is similar):



**NOTE:** To adjust what toolbars and icons are displayed, select **View / Toolbars** (Mac: **View / Customize Toolbar**).

**Drawing and Editing Tools:** These tools create geometry (**Line**, **Arc**, **Rectangle**, etc.), construction objects (**Measure** and **Protractor**), and enable object manipulation (**Move**, **Rotate**, **Push/Pull**, etc.) They are all described in this chapter.

**Drawing Axes:** When you open a file, the model contains a set of red, green, and blue axes (you can see the blue axis once you orbit the model out of the red-green plane).

These are equivalent to the X, Y, Z axes used in traditional CAD software. You can turn off their display by selecting **View / Axes**, and the **Axes** tool can be used to relocate and reorient the axes (see "Axes" on page 70).

**Status / Prompts:** This area serves two purposes. When you hover the cursor over a tool, a description of the tool appears here. When you are using a tool, this area displays the relevant prompt such as "Select start point" or "Enter value."

**Value Control Box (VCB):** This box is used either to enter values or to display numerical information. If you are using a tool that can take numerical input (usually optional), such as line length or number of copies, all you have to do is type the number and press Enter, and the value appears in the VCB. If you are using a tool such as **Measure** or **Protractor**, the length or angle being measured appears in the VCB.

**Stacking Windows:** These are windows you might want to keep open as you work. They can be made to stick to one another, and you can keep them minimized while you work. See "Stacking Windows" on page 437.

## Viewing Tools

While creating objects, you need to know how to change your view and adjust what appears on the screen. You can familiarize yourself with these tools before starting to draw, or play with them after you've created some geometry.

**NOTE:** For information on ways to display the model itself (shaded, wireframe, etc.) see "Display Settings" on page 438. For display of edges, see "Displaying and Smoothing Edges" on page 72.

### Standard Views (Camera / Standard)



SketchUp has five standard orthographic views (**Top**, **Front**, **Left**, **Right**, **Back**) and one **Isometric** view. When an orthographic view is activated, its description appears in the top left corner of the display.

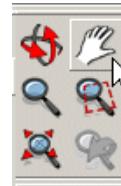
**NOTE:** If you are working in **Perspective** mode, the isometric view will not be a true isometric projection, although it may appear pretty close. For a true isometric view, work in **Paraline** mode. See "Perspective Mode" on page 444.

### Orbit (Mac: Orbit Camera) (Camera / Orbit)



Also known as dynamic rotation, this tool simulates holding an object and turning it around. To rotate your view, activate **Orbit** and hold and drag the mouse. Pressing Shift while orbiting will pan the view. If you have a three-button mouse, you can hold the middle mouse button while moving the mouse to rotate the view from within any other tool.

### Pan (Mac: Move Camera) (Camera / Pan)



Shifts the center of the model (up, down, left, right), while maintaining the model's orientation. To pan the view, activate **Pan** and hold and drag the mouse. If you have a three-button mouse, you can pan by pressing Shift while orbiting (dragging the mouse with the middle button pressed).

### Look Around (Camera / Look Around)



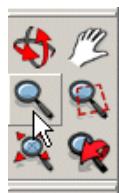
Pivots the camera around a stationary point, representing a person standing still and looking side to side or up and down. This tool is helpful when viewing the interior of a model. To look around, activate the tool and drag the mouse from side to side, or up and down. You can specify the eye height by typing it and pressing Enter; it will appear in the VCB.

### Walk (Camera / Walk)



Enables you to move around in a model as a simulation of walking. For more information, see "Walk and Look Around" on page 321.

**NOTE:** **Perspective** mode must be on for **Walk** to work. See "Perspective Mode" on page 444.

**Zoom (Camera / Zoom)**

In this tool, drag the mouse up to zoom in, down to zoom out. If you have a wheel mouse, you can scroll the wheel up or down to zoom. In this case, zooming is relative to the location of the cursor.

To change the camera lens (field of view), press Shift while zooming. This is handy for adjusting the perspective of your image. You can also enter an exact value, such as 45 deg (for field of view) or 35 mm (for focal length).

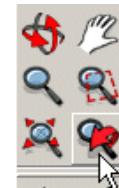
While in zoom, you can double-click on a point in the model to make it the new viewing center. This is equivalent to a one-click **Pan**.

**Zoom Window (Camera / Zoom Window)**

In this tool you simply click two points to define a rectangle, and the zoom adjusts to fit the window into the full screen. This is a good way to enlarge your view of a specific small area of the model.

**Zoom Extents (Camera / Zoom Extents)**

Click this tool to fit the entire model onto the screen, while centering it as well.

**Previous (Camera / Previous)**

Returns the view to the previous view.

**Shortcut Keys**

Also known as “hotkeys” or “accelerator keys,” keyboard shortcuts can be set up for quick access to tools you use often. A few shortcuts are provided for you (such as Ctrl/Cmd+Z for **Undo**), but the rest need to be added. See “Preferences > Shortcuts” on page 452.

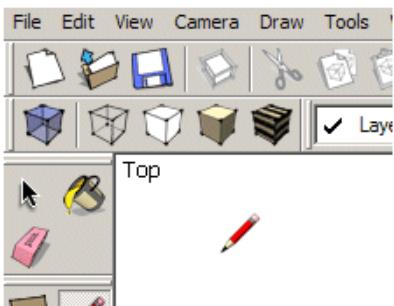
## Drawing Tools

Before you can create any forms in SketchUp, you need to first know how to draw a few things using 2D tools. The six basic drawing tools are **Line**, **Rectangle**, **Polygon**, **Arc**, **Circle**, and **Freehand**. While each of these creates a 2D object, you can use them in any 3D plane.

### Line

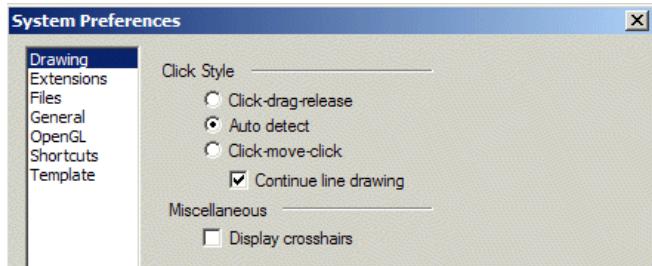
This tool creates lines that typically become edges. When lines (or other objects such as arcs, circles, or polygons) lie in the same plane and form a closed boundary, a face is automatically created.

1. Open SketchUp, and an empty file appears in **Top** view. You are looking at the red-green plane, and the blue axis (vertical) is pointing toward you. By default, you are in the **Line** tool, as indicated by the pencil-shaped cursor.



**NOTE:** If you don't see the axes displayed, select **View / Axes**. This is a toggle function - it can also turn off the axes.

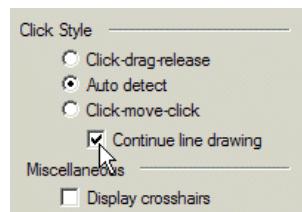
2. To control the way lines are drawn, open the **Preferences** window (**Window / Preferences**, Mac: **SketchUp / Preferences**). Open the **Drawing** page.



Three settings here affect line creation:

- **Click-drag-release** uses a mouse drag to create lines.
- **Click-move-click** will define a line by two points.
- **Auto detect** enables both methods, depending on how you use your mouse.

3. We want to enable both methods, so click **Auto detect**.
4. Also, be sure **Continue line drawing** is checked, in order to automatically start a new line after completing a line. If this is not checked, you create lines one at a time.

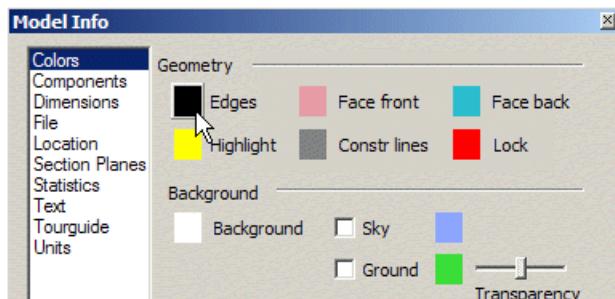


5. Close the **Preferences**.
6. Now open the **Model Info** window (if it is not already open), either by selecting **Window / Model Info** or by clicking the icon.



Mac: You can add this icon to your toolbar via **View / Customize Toolbar**.

7. Open the **Colors** page and check the color for **Edges**. By default, edges are drawn in black, but you can change this color if you like.



8. If you like to work with as much screen space as possible, close the **Model Info** window.

**NOTE:** **Model Info** is one of SketchUp's stacking windows, which means you can leave it open but minimized. See "Stacking Windows" on page 437.

9. Line should already be active, but if it isn't, click **Line**, or select **Draw / Line**.

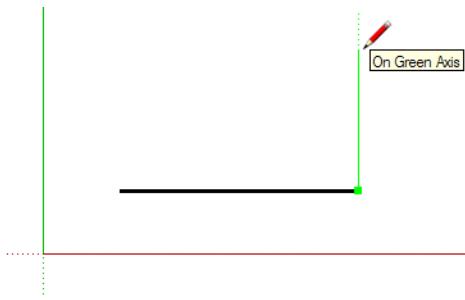


10. Click to place the first point (not on the origin), and move the cursor to the right. The **On Red Axis** inference tells you that the line will be parallel to the red axis. Click to locate the second point.

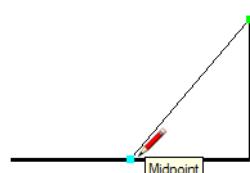


**TIP:** You could also click the first point, hold the mouse button, drag to the second point, and release.

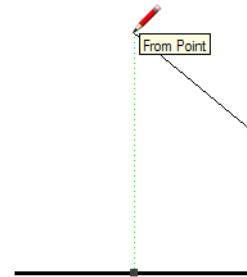
11. Because you selected **Continue line drawing**, you immediately start a new line. Locate the next point in the green direction from the last point.



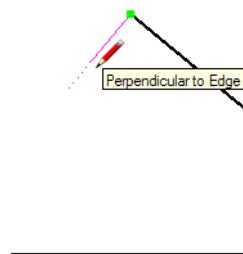
12. The next endpoint is to be located directly above the midpoint of the first line. Hover over this point; the midpoint is indicated by a cyan dot. Do not click yet!



13. Move the cursor up in the green direction from this point, and click to place the next point.

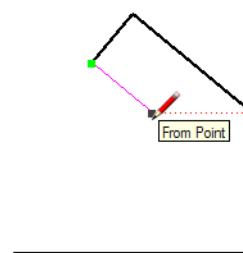


14. Move the cursor until you see the **Perpendicular** inference (the preview line is magenta). The perpendicular constraint is always available relative to the last line you drew. Click for the next point, trying to maintain the general proportions shown below.

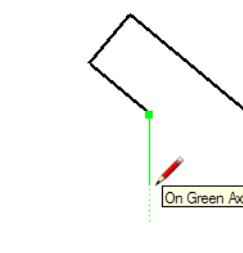


**NOTE:** You can also use the perpendicular and parallel constraints relative to **any** line, not just the one you just drew, as you will see in another few steps.

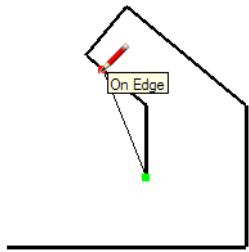
15. Make the next line perpendicular from the last line, stopping when the red direction constraint appears.



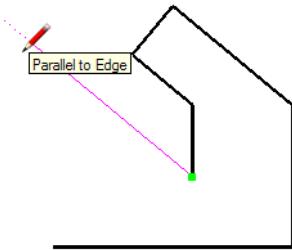
16. Draw the next line in the green direction.



17. You can make new lines parallel or perpendicular to any existing line, not just the most recent line. Hover over any point along the edge shown . . .

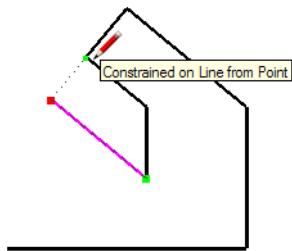


18. . . and move the cursor until you see the **Parallel** inference (be sure not to activate any other inferences). Do not click yet.

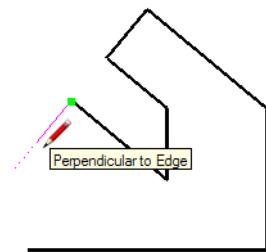


19. Now we use a double inference. With the **Parallel** inference still showing, press Shift. This ensures that no matter where you move the cursor, the line will always have this parallel orientation. When you press Shift, the magenta inference line turns thicker, indicating that this constraint is locked.

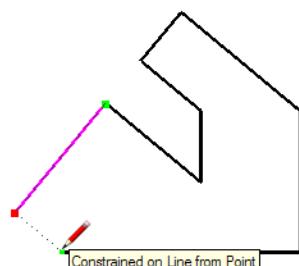
20. With Shift pressed, hover over the corner point shown to see the double inference. Click this point.



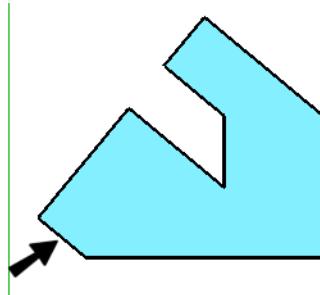
21. Similarly, press Shift when the next line is perpendicular to the previous one . . .



22. . . and constrain it to the start point.



23. Draw one more line to complete the face.




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**TIP:** If you want to create an open shape, you can press Esc to end the chain.

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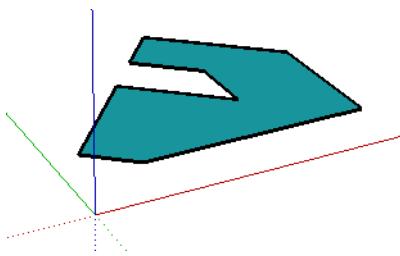
**NOTE:** Face colors are set in the **Color** page of the **Model Info** window. Each face has a front and back, and these are typically assigned different colors. You can reverse a face's front and back by right-clicking and selecting **Reverse**.

---

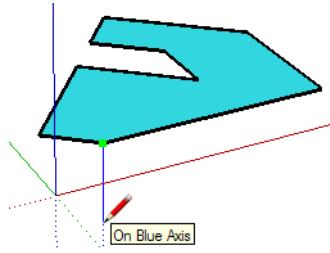
24. Like all drawing tools, **Line** can be used just as easily in 3D. Click **Orbit** (Mac: **Orbit Camera**) and move the mouse to spin the model around. (If you have a three-button or scroll wheel mouse, simply hold the middle button / scroll wheel and drag - no need to activate **Orbit**).



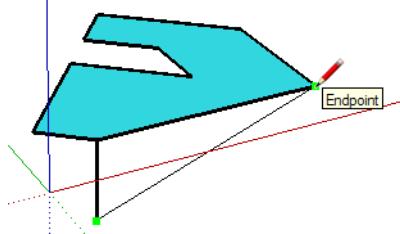
25. Orbit to the orientation shown below.



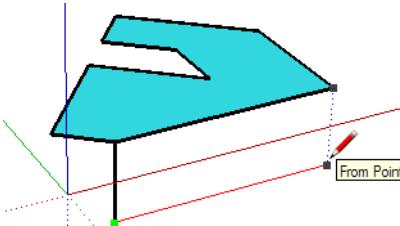
26. If it's not already active, activate **Line**, and draw a line from the point shown straight down, in the blue (vertical) direction.



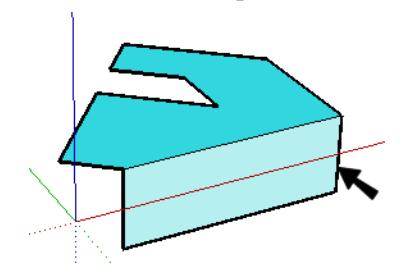
27. To draw a rectangular vertical face, hover over the desired corner point . . .



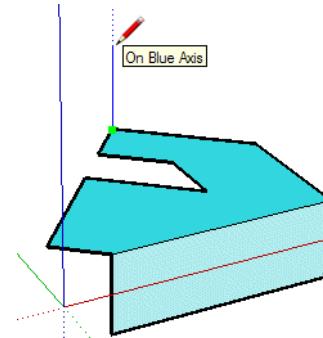
28. . . and move down (in blue) and click when the double constraint appears.



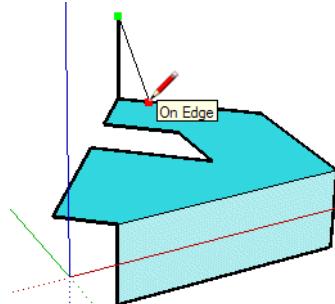
29. Draw the third line to complete the face.



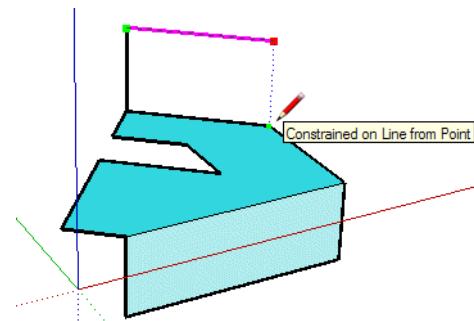
30. We will use a parallel constraint again. Draw a line up from the point shown.



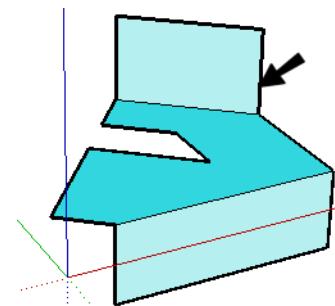
31. Hover over any point on the edge shown . . .



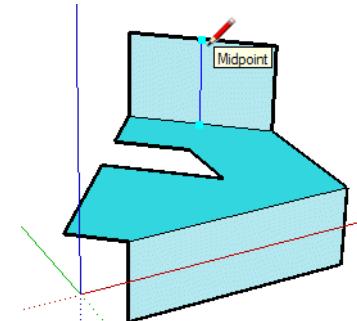
32. . . move the cursor until the **Parallel** inference appears. Press Shift to lock it and click the corner point.



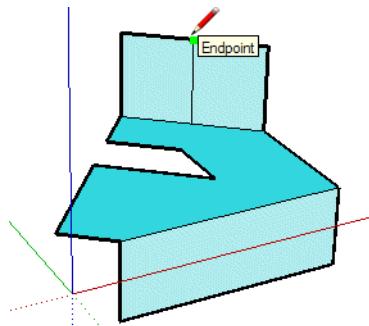
33. Complete the face.



34. Lines can also be used to divide faces. Draw a vertical line connecting the midpoints of the horizontal edges of the face you just completed.



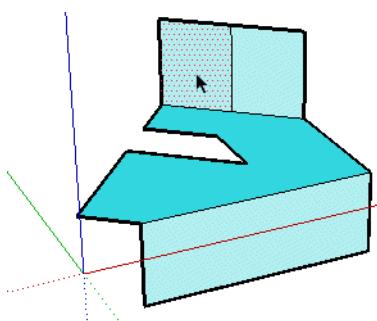
35. Both lines are now divided into two lines. To verify this, hover over what was the midpoint, and now it is an endpoint.



36. This line also divided the original face into two faces. To verify this, activate **Select (Tools / Select)**.



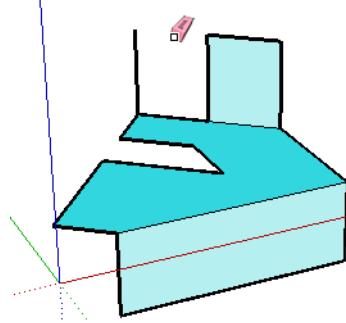
37. Click either face to see it highlighted.



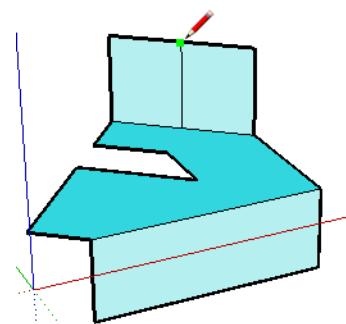
38. We will now see how lines can be used to heal faces. Click **Erase (Tools / Erase)**.



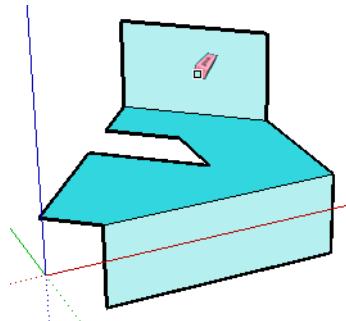
39. Erase one of the top edges. Because it no longer has a closed boundary, the face disappears.



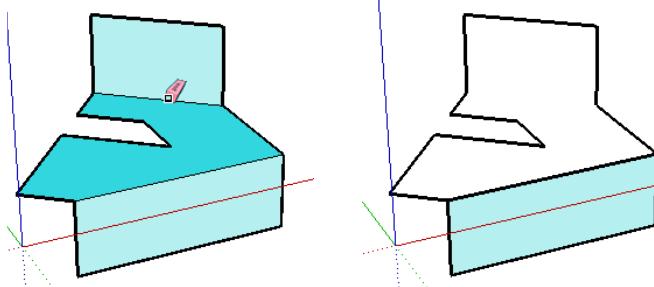
40. Recreate the face by simply replacing the line.



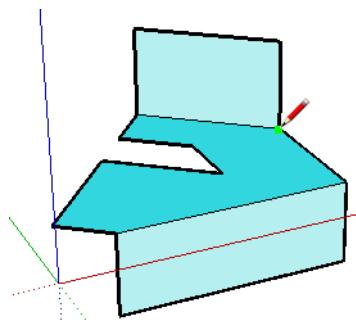
41. Erase the dividing line, and the two faces are healed - joined into one face.



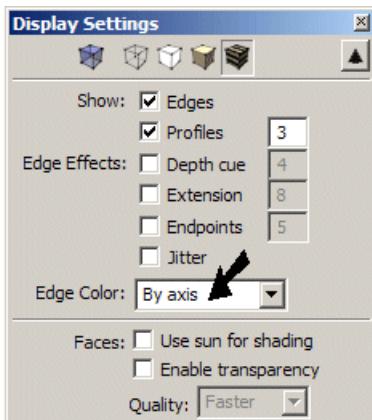
42. If you erase a line that is a boundary for more than one face, all affected faces will be deleted. Erase the common edge shown, and both faces sharing this edge disappear.



43. Redraw the line to recreate both faces.



44. Now open the **Display Settings** (Window / Display Settings) Set the edge display to **By Axis**.

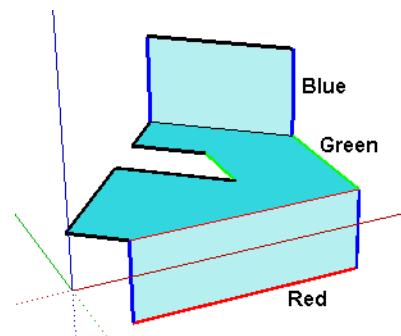



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**NOTE:** **Display Settings** is one of SketchUp's stacking windows, which means you can leave it open but minimized. See "Stacking Windows" on page 437.

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45. All edges parallel to one of the axes take on the axis color.

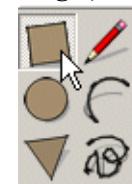


Some prefer to work with **By Axis** on, and some find it distracting. For the purposes of this book, black edges will be used.

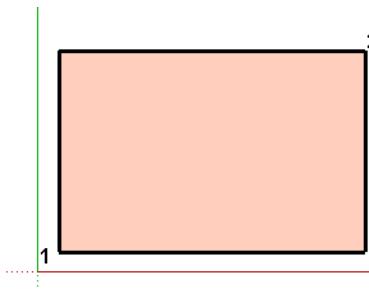
## Rectangle

If you need to draw a rectangular face, you don't need to use **Line** to draw four separate lines; **Rectangle** does it in one step.

1. Start a new file (Top view) and click **Rectangle** (or select **Draw / Rectangle**).



2. Draw a rectangle by clicking the two opposite points, or by clicking and dragging from the first point to the second.

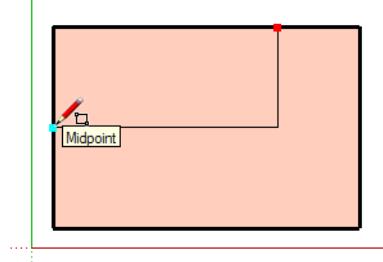



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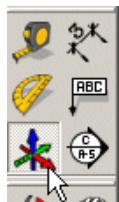
**NOTE:** While sizing the rectangle, you may see two indicators - "Square" and "Golden Section." See "Square and Golden Section" on page 14.

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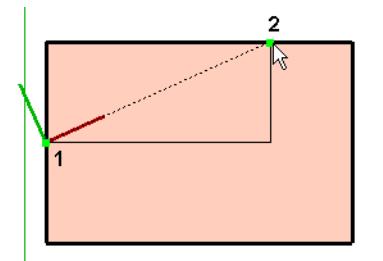
3. Draw another rectangle from a point on the top edge to the midpoint of the left edge.



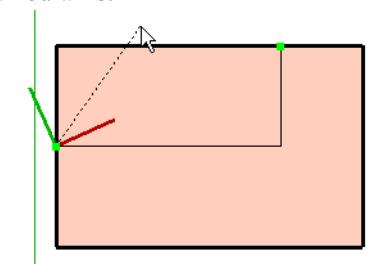
4. So far the rectangles have been parallel to the red and green axes. To draw a skewed rectangle in the red-green plane, you need to change the axes. Click **Axes**, or select **Tools / Axes**.



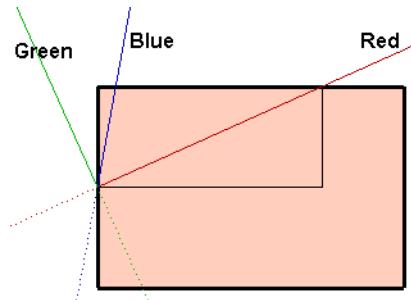
5. Locate the origin at Point 1, and click Point 2 to define the red axis.



6. For the green axis direction, click any point above the new red axis.

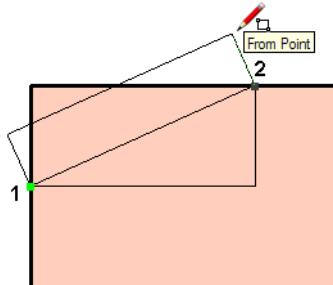


Here are the new axes - red and green in the horizontal plane, blue pointing up.

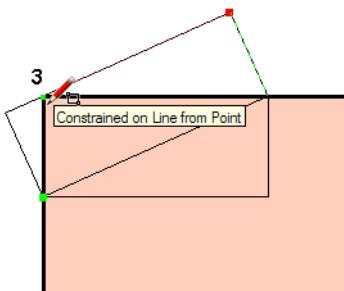


**NOTE:** You can see the blue axis, even though you are in Top view. This is because you are working in **Perspective** mode. If you turn this off (**Camera / Perspective**) the blue axis will point directly up and be invisible while in Top view. See "Perspective Mode" on page 444.

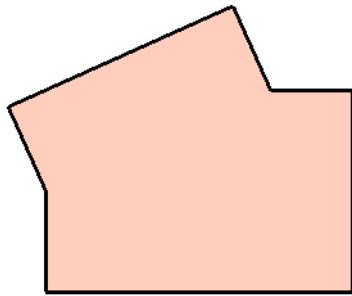
7. Because the axis display can be distracting, turn it off by selecting **View / Axes**. Exit the **Axes** tool by pressing Esc. **Rectangle** is once again active.
8. Draw the next rectangle by clicking on Point 1 and hovering over Point 2. Then move the cursor from Point 2 and press Shift to lock this width.



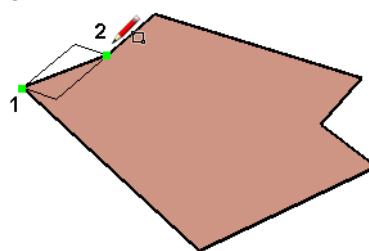
9. With Shift pressed, click Point 3. You have now used a double constraint to both lock the width and set the height to include a specific point.



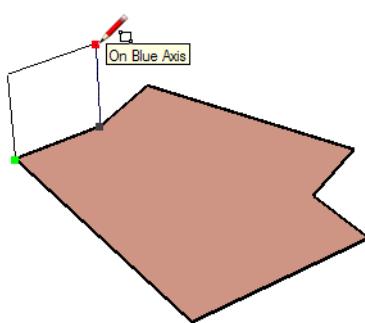
10. Erase all the extra lines in the middle to heal the face into one face.



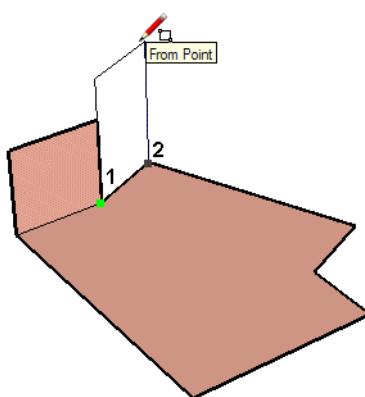
11. Orbit so that you can create some vertical faces. Create the first rectangle by clicking Point 1 and hovering over Point 2.



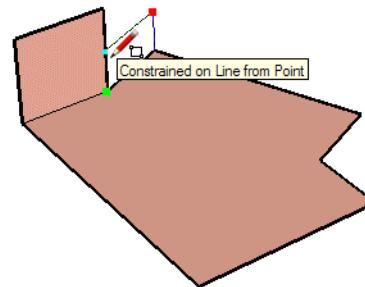
12. Pull up in the blue direction and click to create the rectangle.



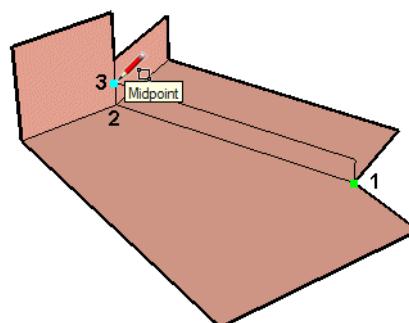
13. Click and hover again using the points shown, and press Shift to lock the width.



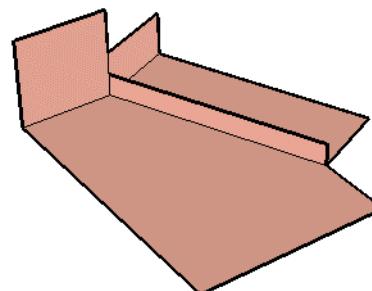
14. Click the midpoint shown to create the double-constrained vertical rectangle.



15. You do not need to use Shift in every case for a double constraint. Start at Point 1, hover over Point 2, and pull up to Point 3.



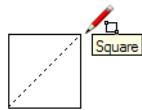
Here is the final set of walls.



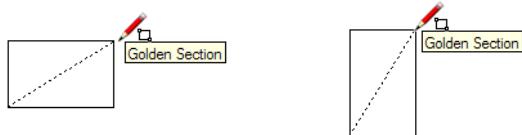
16. If you are planning to continue your work in the same file, you should reset the axes. Display the axes again, right-click on any axis, and select **Reset**.

## Square and Golden Section

While using **Rectangle**, it's easy to create two of the most commonly-used rectangles: squares and golden sections. First the square. Simply activate **Rectangle** and start drawing. SketchUp lets you know when the cursor is in a position to create a square. If you click when you see the indicator, you'll create a square.



Golden sections work the same way.

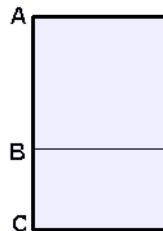



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**NOTE:** For a cool exercise that uses golden sections to create a *icosahedron*, see "Starting from a Golden Section" on page 402.

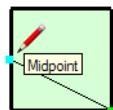
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For those unfamiliar with the golden section, it is a ratio used since the earliest days of architectural design. The ratio of AB to BC equals AC to AB.

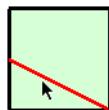


As you can see, it can be created automatically. But if you're curious, here's how to create it:

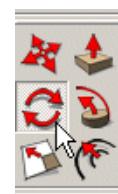
1. Use **Rectangle** to create a square. Then use **Line** to connect one of the corners to one of the midpoints.



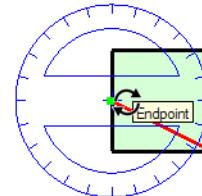
2. Activate **Select** and select only the diagonal line (no faces).



3. Activate **Rotate**.



4. Place the protractor at the this end of the diagonal line.

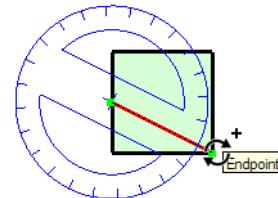



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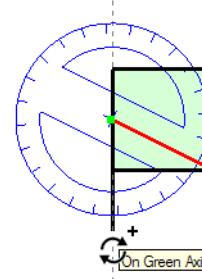
**NOTE:** For more information on rotating and copying, see "Rotate and Copy" on page 57.

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5. This line will be copied, so press **Ctrl/Option**. To set the zero angle, click the other endpoint of the diagonal line. (Note the plus sign on the cursor - this means a copy will be made.)



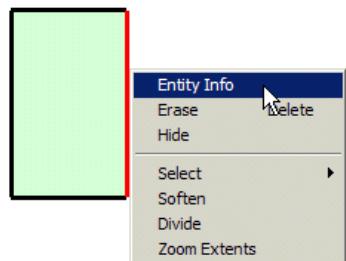
6. Finally, create the rotated copy by defining the rotation angle as shown here:



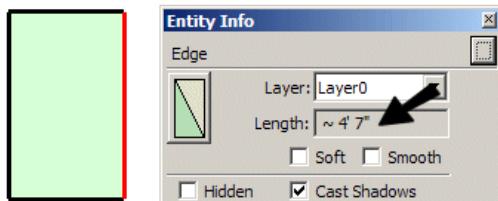
7. Use this copied line to complete the rectangle.



- Erase lines to heal the rectangle. To measure the length of the longer edge, right-click on it and select Entity Info. (If the **Entity Info** window is already open, just Select the edge.)



The length of the edge is listed in the **Entity Info** window.



- Measure the shorter edge as well. The ratio of the long edge to short edge should be 1.61803.

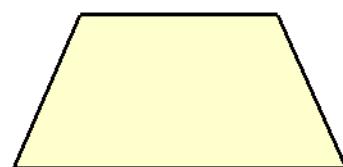
*NOTE: This value of 1.61803 is phi - a crucial number in architecture, art, and nature - including the human body. If you divide this value into 1.0, you get 0.61803.*

## Push/Pull

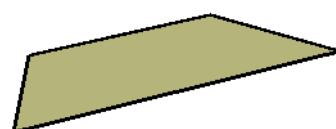
While not exactly a 2D drawing tool, **Push/Pull** it is so crucial to working in SketchUp that it's important to cover it before moving on to other tools.

**Push/Pull** is what makes SketchUp so unique and easy to use. Simply put, it takes a face and makes a 3D assembly of faces. In CAD terms, it's basically an extrude tool but much more flexible and intuitive.

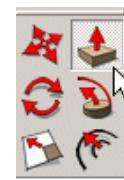
- Start in top view, and use **Line** to make a trapezoid.



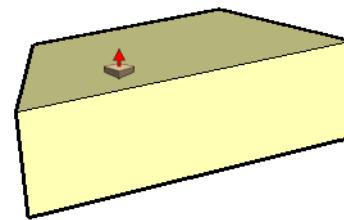
- Orbit to an isometric view.



- Click **Push/Pull** (or select **Tools / Push/Pull**).



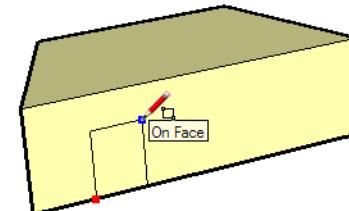
- To use this tool, you can either click on the face and then click the point (above or below the face) to set the height, or you can hold and drag the face up or down. Either way, the face updates dynamically while you move the mouse.



*NOTE: For the **Push/Pull** cursor, the tip of the red arrow is where you select or highlight.*

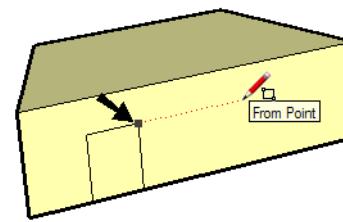
**Push/Pull** always pushes or pulls a face in a direction *perpendicular to the face*. It also creates a prismatic form - the start and end faces are the same size.

- Use **Rectangle** (or **Line**) to draw a rectangle from the bottom edge of the front face.

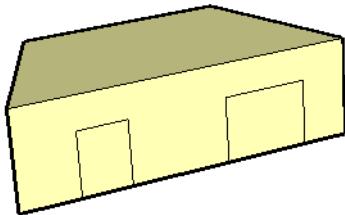


When you use a 2D drawing tool on a face, the object automatically aligns to that face.

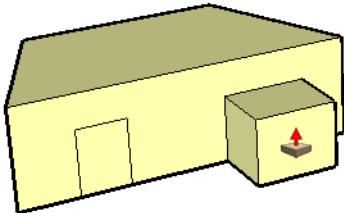
- We want another rectangle on this face that has the same height. Hover over the corner point shown and move the cursor to the right to place the first corner point.



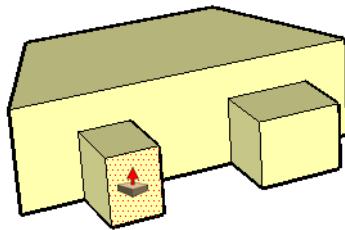
7. Click along the bottom edge to complete this rectangle.



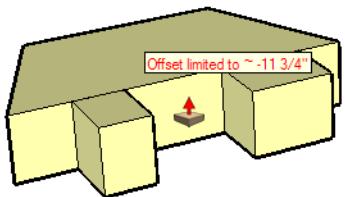
8. Use **Push/Pull** to pull out one of the rectangles.



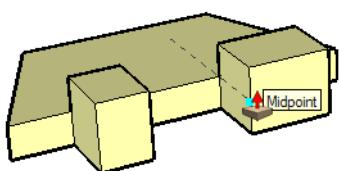
9. Double-click on the other rectangle - this pulls it out by the same distance you just used.



10. Now push the top of the trapezoid down. You can only go as far as the top of the box forms.



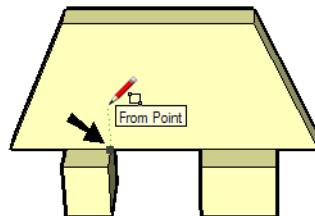
11. Use another **Push/Pull** to continue pushing this face past the boxes. You can use inferences while using **Push/Pull** - stop at the midpoint of the edge shown (or any similar edge).



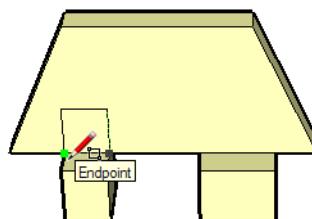

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**TIP:** When using an inference point to set a **Push/Pull** distance, it's easier to use two clicks (face and height point), rather than drag the face.

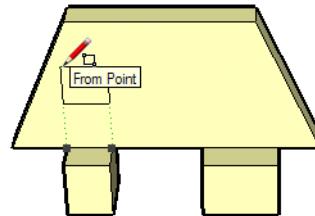
12. We will now draw two rectangles on the top of the trapezoid. Click to place the first corner in the green direction from the corner shown.



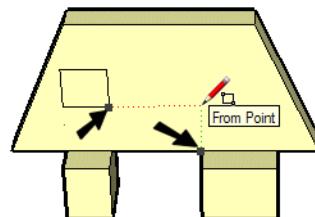
13. Hover over the other corner . . .



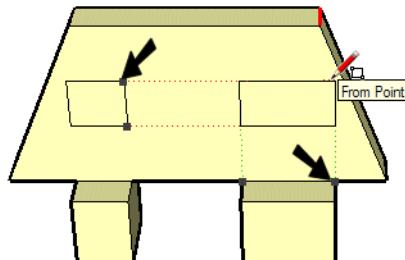
14. . . and place the second corner point.



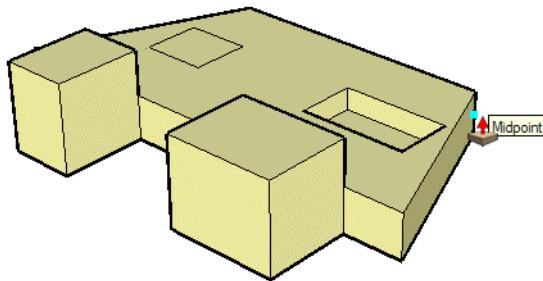
15. The second rectangle will use inferences from two existing lines. Hover over the two points shown, and click at their intersection.



16. Hover over the two points indicated to get inference lines for the second corner point of the rectangle.

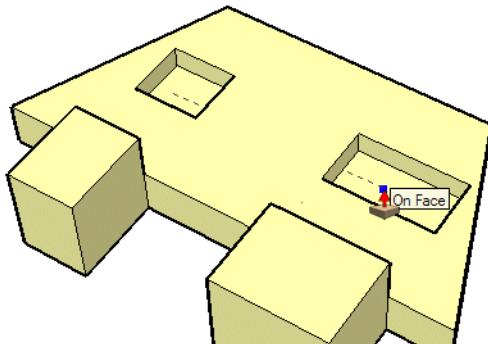


17. Use **Push/Pull** to push in one of the rectangles.



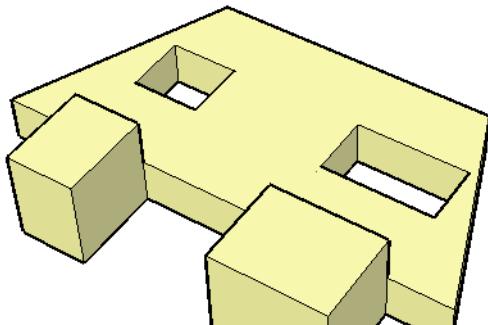
To push the other rectangle in by the same distance, you could double-click it. But this can only be done when you want to use the distance of the last **Push/Pull**. If you used **Push/Pull** somewhere else, then came back to the second rectangle, the distance you want is no longer stored.

18. To get the same **Push/Pull** distance, click the unpushed rectangle, then move the cursor to the one already pushed. When the **On Face** constraint appears, click to use this distance.

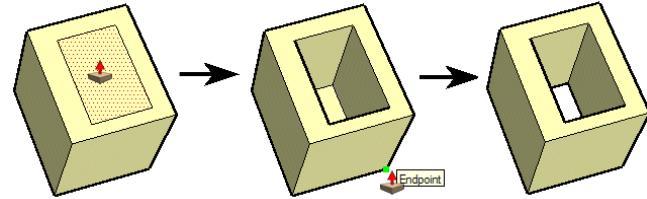


The **Push/Pull** operations have created four vertical faces around each pushed rectangle. You could use **Push/Pull** on any of these faces to resize the cutout, enabling you to quickly easily adjust your designs.

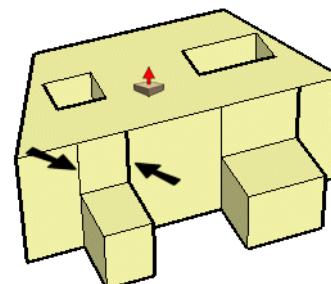
19. You can also use **Push/Pull** to create voids. Push the rectangles all the way through the trapezoidal form - simply end the operation at the bottom face.



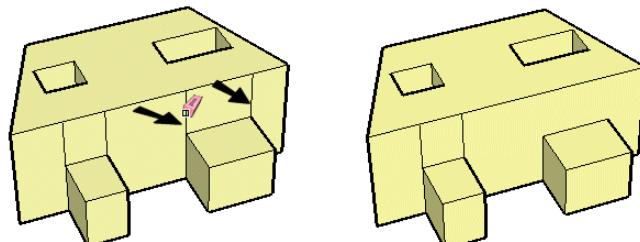
**TIP:** An easy way to push all the way through is to first click the rectangular face you want to push through, then click anywhere on any edge of the bottom face. This prevents you from pushing too far or not far enough, and is very useful in cases where you cannot see all the way to the bottom of the hole.



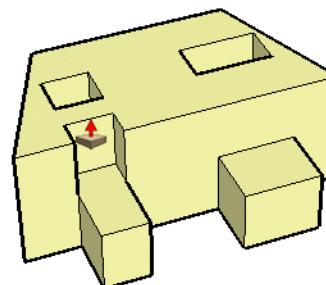
20. Now pull up the top trapezoidal face. Because of the box forms, there are lines above the box corners, dividing the front into five separate faces.



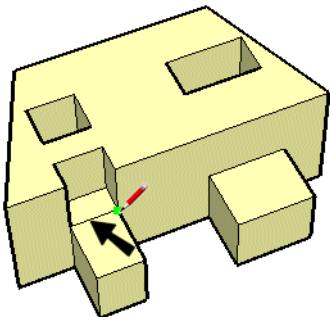
21. Erase two of the lines, healing the face above one of the boxes.



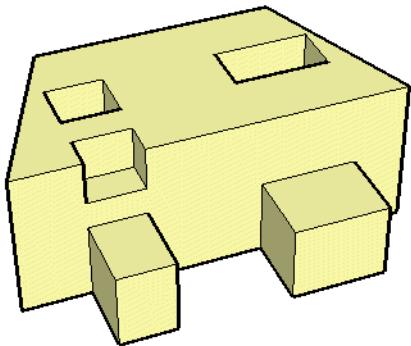
22. Push in the vertical face above the other box.



23. Draw a line to divide the top face of the box.

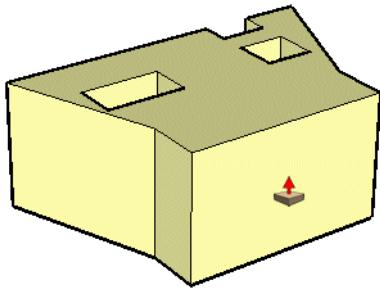


24. Now pull up the inner portion of this face and erase the extra lines to make a little balcony.

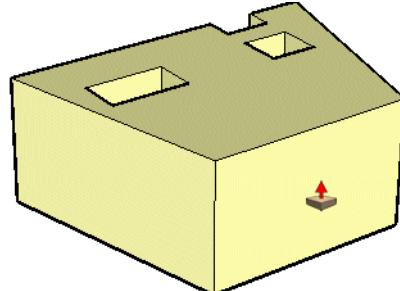


There is an added feature of **Push/Pull** that enables you to control how the adjacent faces act. To demonstrate this, we will work on the back face.

25. Orbit to the back and pull out the face shown. This leaves the neighboring faces in place, and adds vertical faces, between them and the pulled face.



26. Undo this operation (*Ctrl+Z*, *Cmd+Z*), and pull it again, this time holding down the Alt/*Cmd* key. The pulled face remains the same size, but the neighboring faces move with it.

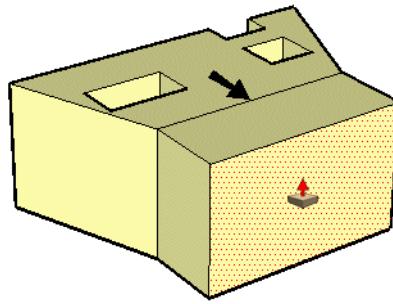



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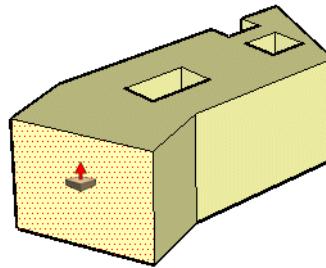
*NOTE: You could get the same results using the **Move** tool, but **Push/Pull** ensures that you are always moving perpendicular to the face.*

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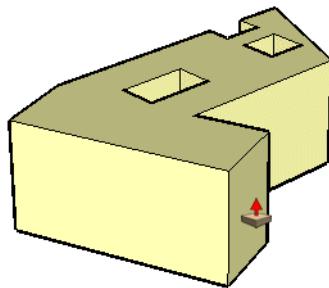
27. Undo and try again, this time keeping *Ctrl/Option* pressed. The difference this time is that dividing lines are created along faces that would otherwise be healed.



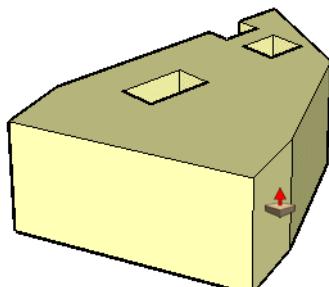
28. For another demonstration of this feature, undo again, and pull out the side of the trapezoid.



29. Now use a normal **Push/Pull** - no extra keys - on the face shown.



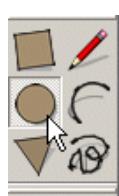
30. Undo, and pull the same face using the Alt/Cmd key. Quite a difference!



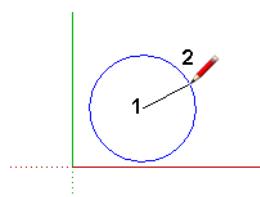
## Circle and Polygon

These two tools are grouped together because they are basically the same. Both create multi-segmented polygons; a higher number of segments is a better approximation to a circle. The difference basically lies in the appearance of the faces that result when you use **Push/Pull**.

1. Start in top view and activate **Circle (Draw / Circle)**.

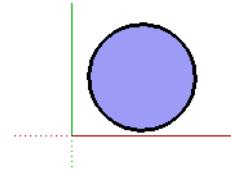


2. Draw a circle in the red-green plane by clicking the center point and then a point on the circumference. You could also click and drag from the center to the circumference.

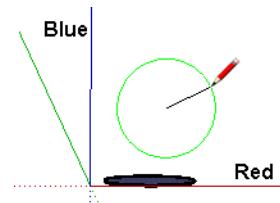


Note that the preview color of the circle tells you what plane you are working in. When you place a circle in the red-green plane, the circle is perpendicular to the blue axis, so its preview color is blue.

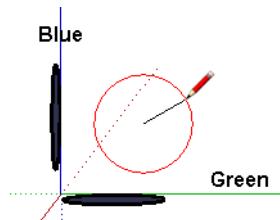
When the circle is defined, it is filled in.



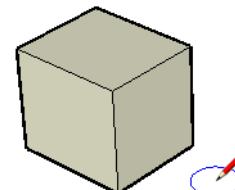
3. Like with all 2D drawing tools, you can draw a circle in any of the three planes. Orbit so that you are facing the red-blue plane and draw another circle. This time the preview color is green.



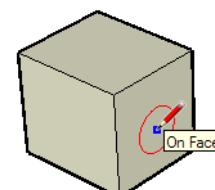
4. Do the same in the green-blue plane. The preview color is red.



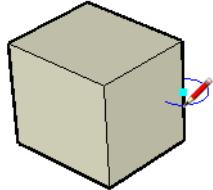
5. You can also create circles on existing faces. Start a new file, and create a rectangle. **Push/Pull** it up to create a box. Activate **Circle**. The circle preview is horizontal anywhere you place the mouse, as long as it is not along a face.



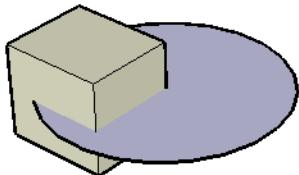
6. Move the cursor to face, and the circle aligns to it.



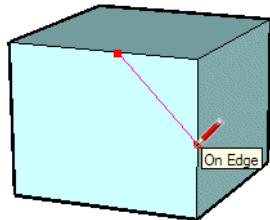
7. You can also draw a circle on a face that is not aligned to it. Move the cursor so that the circle is horizontal again, and press Shift to lock the orientation. Then move along a face or edge - the circle remains flat.



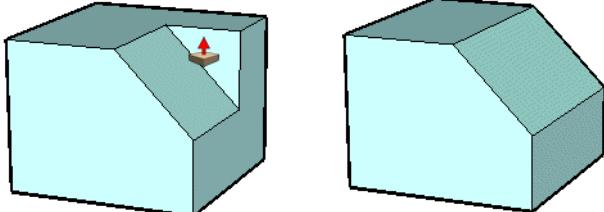
This is how you would draw something like this: a horizontal circle that intersects a vertical face.



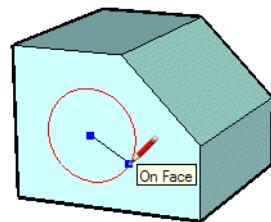
8. Now for more on the inner workings of this tool. Undo the horizontal circle if you created it.
9. Draw a diagonal line on one of the faces - when the line turns magenta that means its endpoints are equidistant from the corner.



10. Push this triangular portion of the face inward until it cuts all the way through. This is a handy way to create sloped faces (though there are many more ways to do this).

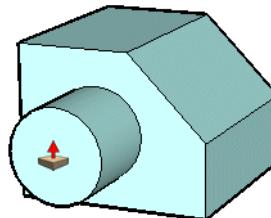


11. Create a circle on the side face.



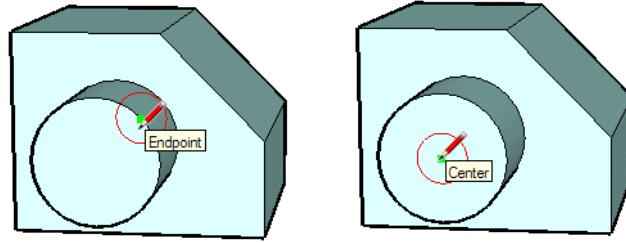
If you look closely at the circle, you'll see that it's not actually round, it's actually comprised of many short segments.

12. Because the circle divided the vertical side into two faces, you can use **Push/Pull** on the circular portion to pull out a cylinder.

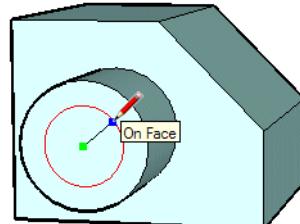


Even though the circle is a series of lines, the cylinder face appears smooth and round. It is actually comprised of a series of flat faces, but looks and acts as one, curved face.

13. The next circle will be concentric with the front face of the cylinder. To pick up the **Center** inference, first hover over one of the endpoints, then move the cursor around the center until the green dot appears.



14. Start to draw a concentric circle on this face, but do not click the second point to complete it.



15. Before the circle is complete, you can choose to specify a radius or a different number of segments. Type “8s” to change the sides to 8. You need the “s” because a number alone will be interpreted as a dimension.



If you change segmentation this way, the segment number stays active for future circles, until the number is changed again. The same applies for **Polygon**.

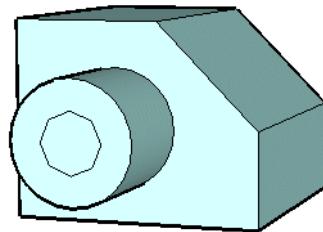
You can also change the number of sides after the circle is completed. However, if the circle is located on an existing face (such as in this example), the circle will sometimes be created on top of (not within) the face.

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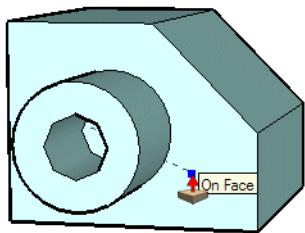
**NOTE:** You can also use the VCB to set the circle radius - simply type in the radius and press Enter. For details on specifying exact measurements, see Chapter 11.

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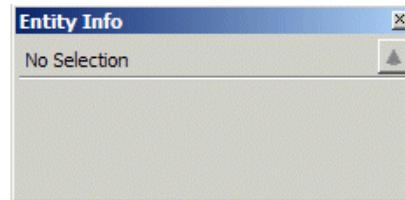
16. Complete the circle, which is actually an octagon.



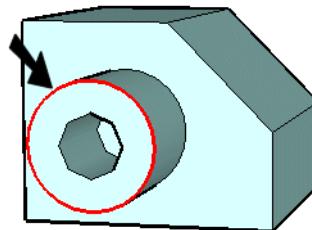
17. **Push/Pull** this inner circle back to the vertical face of the box. This can easily be done with two clicks - the first on the octagonal face, and the second on the vertical face. You now have a hollow cylinder.



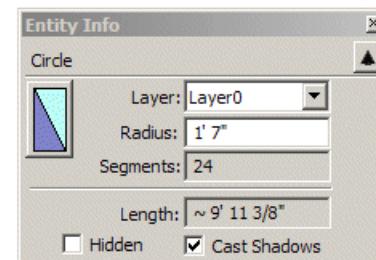
18. If not already displayed, show the **Entity Info** window (**Window / Entity Info**). With nothing selected, and no faces highlighted, the window should be blank.



19. Activate **Select** and select the circle shown.



The **Entity Info** window displays the radius, number of segments, and length of the circle. (If the length does not appear, click the down arrow at the top of the window and select **Show Details**.)



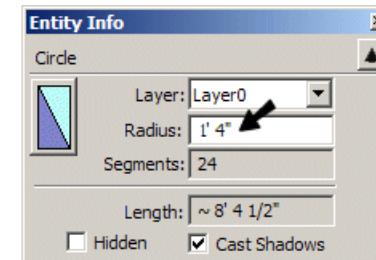
Once a circle has been extruded, you can still change its radius. (Before extruding you can also change its segmentation.)

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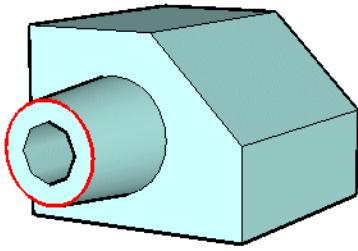
**TIP:** You could also have displayed this by right-clicking on the circle and selecting **Entity Info** from the menu.

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20. Assign a slightly smaller radius - remember to specify your units. (For 1'- 4" you could type 1'4.)

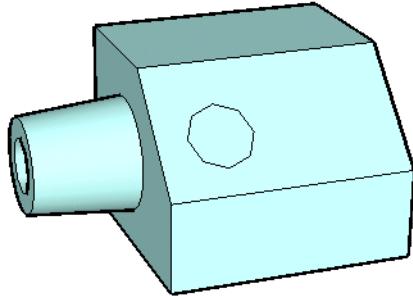


21. The hollow cylinder now has an inward draft angle.

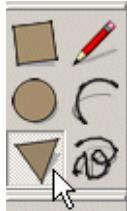


**NOTE:** In addition to using **Entity Info**, the **Move** tool can also be used to resize circles and polygons. **Move** also enables you to resize curved extruded faces. See "Using Move to Resize Curves and Curved Surfaces" on page 54.

22. Now draw a small circle on the sloped face (leave room for another circle next to it). Note that it has eight sides - this is the last segmentation value you used. Also note that the circle automatically aligns itself to this face. Because the circle isn't aligned with any of the three standard planes, it is given the default edge color.

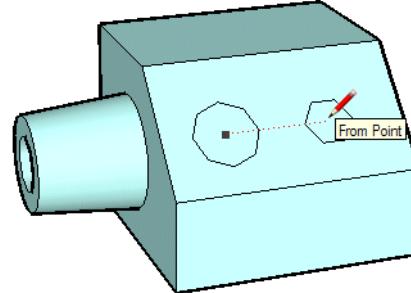


23. Activate **Polygon** (**Draw / Polygon**).

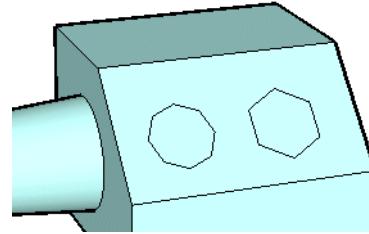


Polygons are drawn just like circles - center then radius.

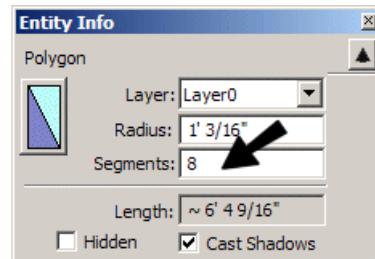
24. Before drawing the polygon, pick up the center point of the last circle you made, and move in the red or green direction along the diagonal face.



25. Align the polygon center to this point. Create a polygon with approximately the same radius as the circle.

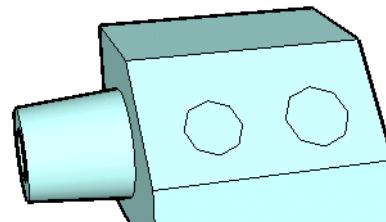


26. By default, the polygon should have six sides, unless this was already changed. Open the polygon's **Entity Info** and change the number of segments to 8, to match the circle. (If you're a perfectionist, you can also use the **Entity Info** to assign the exact same radii to the circle and polygon.)

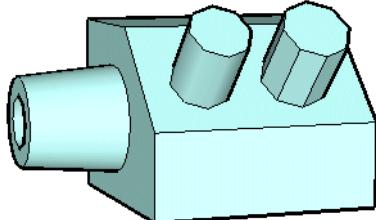


**NOTE:** The "8s" method would also work for polygons. But once you **Push/Pull** a polygon (or circle), you can no longer change its segmentation.

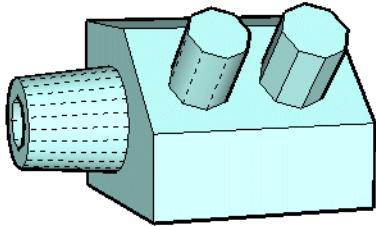
You should now have two adjacent octagons.



27. To see how these are different, **Push/Pull** them both. (Remember, you can **Push/Pull** one face, then double-click the second face to extrude it the same distance.) The circular face appears smooth, while the polygonal face is faceted.

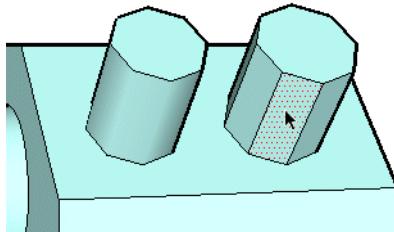


28. In actuality, these objects are the same, only their appearance is different. Circular faces are faceted as well, but their edges are smoothed and hidden. To see the edges of the circular faces, select **View / Hidden Geometry**.

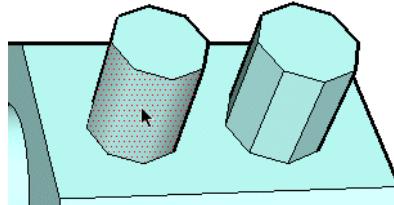


**TIP:** *Faceted objects can be made smooth by smoothing their edges, and vice-versa. See "Displaying and Smoothing Edges" on page 72.*

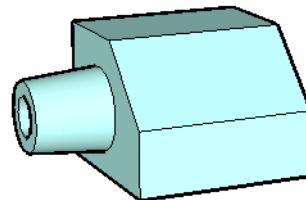
29. Hide the edges again. Another difference in these faces is how they are selected. Activate **Select**, and click one of the polygonal facets. Each of these faces can be selected separately.



30. Select the circular face - it is selected as one face.



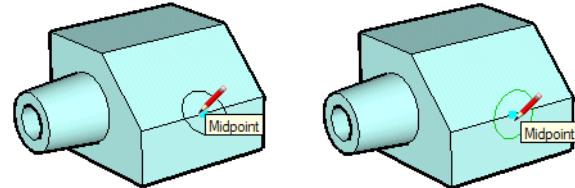
31. Undo as many times as needed to erase the two cylinders on the diagonal face.



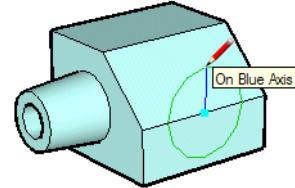
32. Activate **Circle**. You can change the number of segments before placing the first point by simply typing the number (no "s" needed). Enter 12, and the value appears next to **Sides** in the VCB.

Sides 12

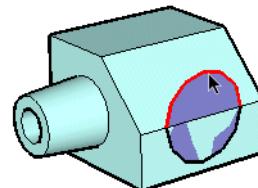
33. Locate the center at the midpoint of the edge shown (do not click yet). Depending on how you move the cursor, you can align the circle with either adjacent face. Click when the circle preview is vertical.



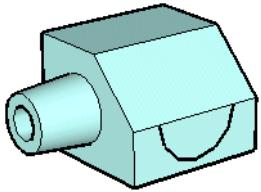
34. Make the circle vertical, and orient the radius straight up (or straight across) so that the box edge contains two segment endpoints.



35. Because two of the segment endpoints lie on the edge, the edge divides the circle in half. Select the top part of the circle . . .

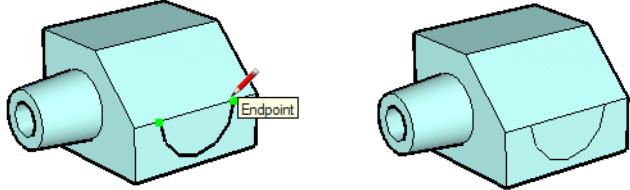


36. . . and delete it (press the Delete key). You are left with an arc that has bold lines, indicating that it is not considered properly aligned with the face.

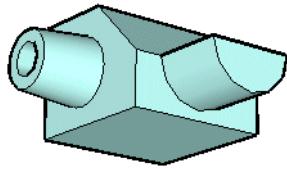


*NOTE: If you had placed the circle so that its segments overlapped the edge, the circle would not have been divided.*

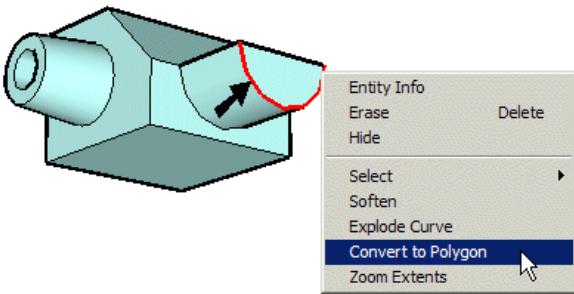
37. To resolve the arc to the face, simply use **Line** to connect its endpoints. (You could also use **Line** to recreate any of the arc's segments.) The arc becomes thin-lined.



38. **Push/Pull** the arc face outward. Because this arc was created from a circle, its extruded face is smooth.

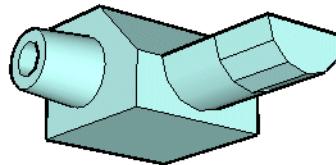


39. Right-click on the arc shown and select **Convert to Polygon**.

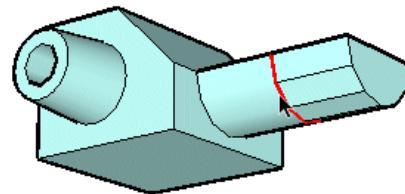


*NOTE: If you get the context menu for one of the faces, try right-clicking again on the arc edge so that the edge is highlighted. Then the menu should look like the one shown above.*

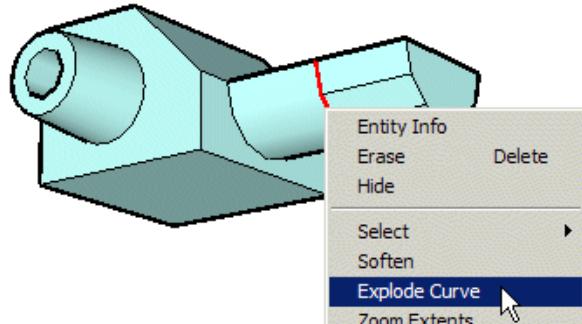
40. **Push/Pull** the arc face out again, pressing **Ctrl/Option** (this is like starting a new extrusion, instead of continuing the old one). This time the extrusion is faceted.



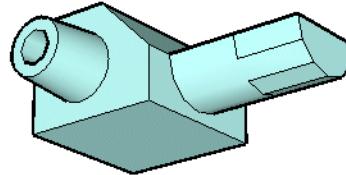
41. Now **Select** the arc shown. It is a half-circle you converted into a polygon, but it is still one object.



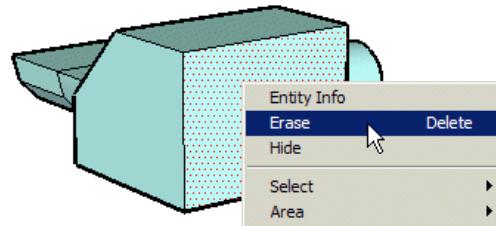
42. Right-click on this arc and select **Explode Curve**. This breaks the curve into its individual segments.



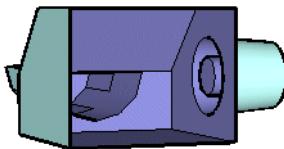
43. You can now select any segment of this curve and delete it.



44. We're finished with the circle and polygon, but here's a neat aside about the **Push/Pull** operation. Orbit around to the back face and hide or erase it.



45. Now you can peek in and see how pulling the circle affected the side and front faces, and how the entire form becomes a shell.

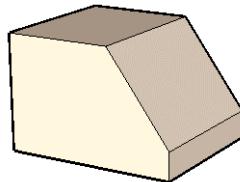


This is an example of how objects in SketchUp are interconnected - connected objects directly affect one another. This is sometimes referred to as “stickiness,” and can be avoided by using groups. See Chapter 6 for details.

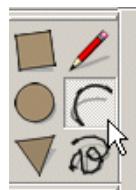
## Arc

Similar to **Circle** and **Polygon**, **Arc** creates multi-segmented representations of arcs. You can draw arcs in any face, or in any of the three main planes.

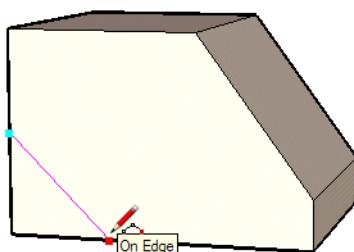
1. Start with the same form you used in the **Circle** exercise (use **Line** and **Push/Pull** to create the sloped face).



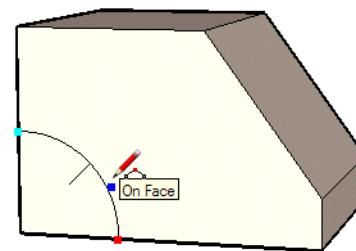
2. Activate **Arc** via the icon, or by selecting **Draw / Arc**.



3. An arc is started by first defining its chord. Select two edge points on the side face. Like when drawing a line, the arc chord appears in magenta when both ends are equidistant from the corner.



4. Move the cursor along the face to set the bulge.

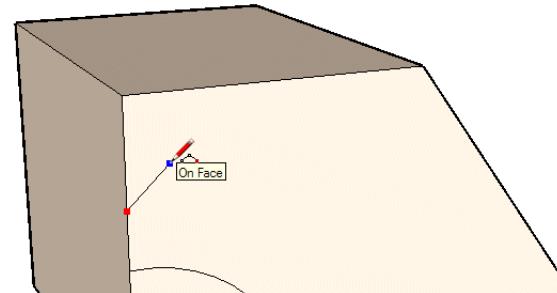



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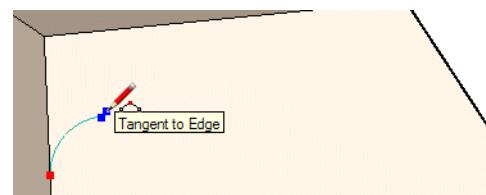
*NOTE: You can also specify exact dimensions for the bulge by entering the value, which then appears in the VCB. See Chapter 11 for a complete exercise using exact dimensions.*

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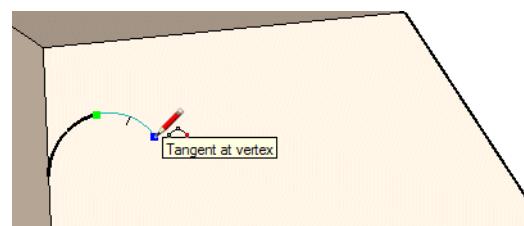
5. Start a second arc in the top corner, locating the first chord point along the vertical edge. Locate the endpoint somewhere on the face, as shown below.



6. To define the bulge, move the cursor until the arc appears in cyan and the **Tangent to Edge** inference appears.

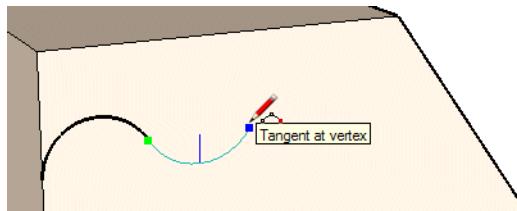


7. When you draw an arc starting from an existing arc, the new arc is tangent to the adjacent one by default, indicated by the **Tangent at Vertex** inference. To set the arc bulge, double-click to keep it tangent.

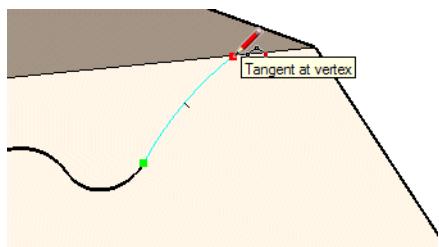


**TIP:** If you are having trouble placing the starting point of the new arc exactly on the endpoint of the previous one, try zooming in closer.

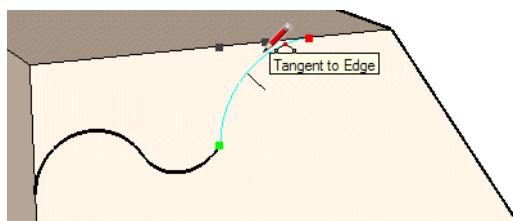
- Do the same for the third arc in the chain.



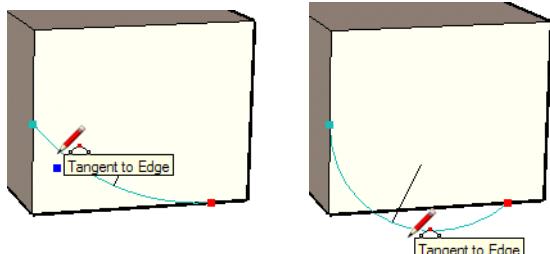
- Arcs in a chain do not necessarily have to be tangent to their adjacent arcs. Start the next arc as before, and locate the second chord point (just one click) on the top edge.



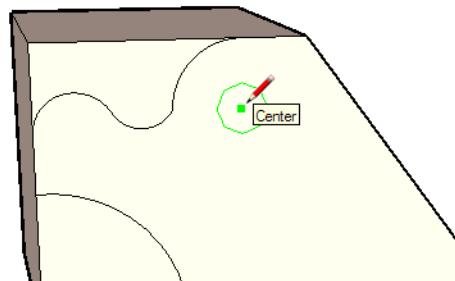
- Move the cursor so that this arc becomes tangent to the top edge, rather than the adjacent arc.



**NOTE:** Be careful when making an arc tangent to an edge, if both chord points are located on edges. Unless the chord points are equidistant from the corner point, there are two tangency possibilities - one for each edge.

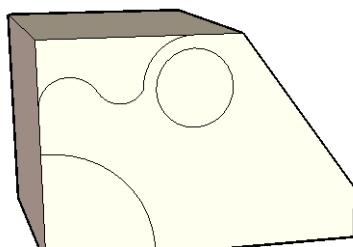


- You can also find the center point of any arc. Activate **Circle**, and move the cursor around the area where the center of the last arc should be. (If you have trouble locating the center, hover over one of the arc endpoints and then try again.) When you find the point, it is highlighted in green and the **Center** inference appears.

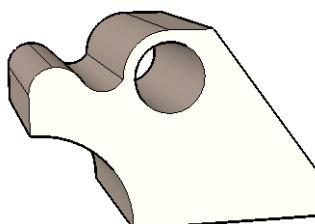


**TIP:** You could also place a construction point at the center by right-clicking on the arc and selecting **Point at Center**. If this option does not appear, open **File / Preferences** to the **Extensions** page and check **Ruby Script Examples**.

Set the number of segments and circle radius high enough so that you can see that the circle and arc are concentric.

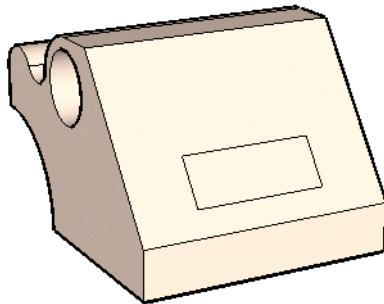


- Use **Push/Pull** on the arc, arc chain, and circle to create voids.

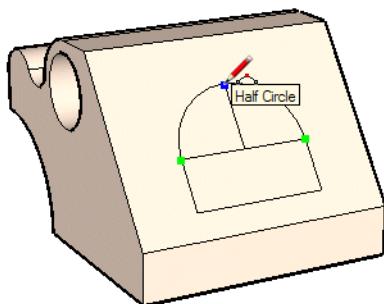


**NOTE:** There are some visible lines created as a result of the **Push/Pull**. If you want, these can be made invisible by right-clicking on them and selecting **Soften**. For more information, see "Displaying and Smoothing Edges" on page 72.

13. As with all 2D tools, you can create geometry on any existing face. Draw a rectangle on the diagonal face.



14. Draw an arc using the top edge of the rectangle. Move the cursor until the **Half Circle** inference appears.

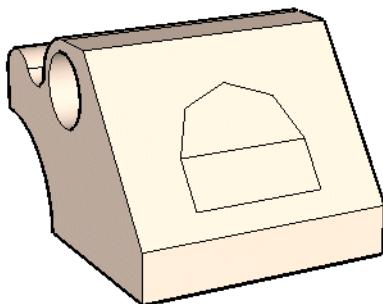


15. When you **Push/Pull** a circle or arc, it looks smooth, but these entities are actually created as a series of segments. One way to change the number of segments is to enter the new number after the arc is created. Type 4s, which appears in the VCB, and press Enter.

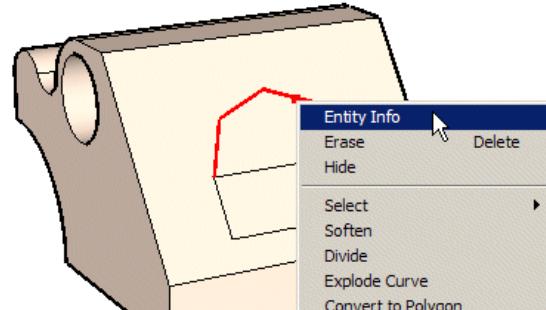
Bulge 4s

**NOTE:** You can also change the number of segments while selecting the chord points, or before you set the bulge. In these cases, you also need to type "4s."

The arc now has four segments.

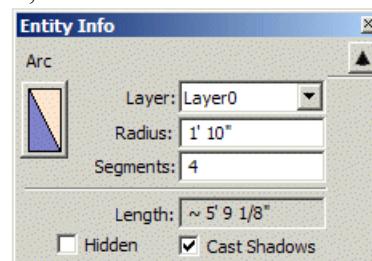


16. Once you create another object or activate another tool, you can no longer change the arc this way (the 4s method). But for another way to change the arc, open its **Entity Info** window.

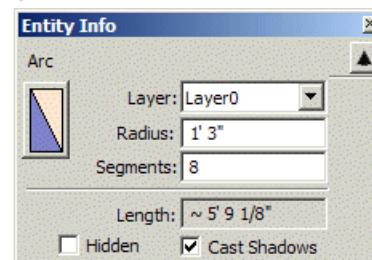


**NOTE:** If the **Entity Info** window is already open, you simply have to select the arc to see its properties.

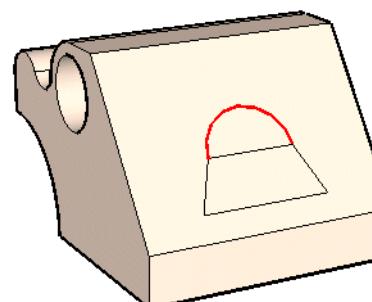
The window shows the radius and number of segments, both of which can be edited.



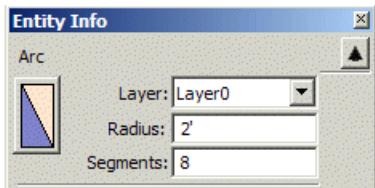
17. Change the segment number to 8, and enter a slightly smaller radius (don't forget the units symbol if necessary).



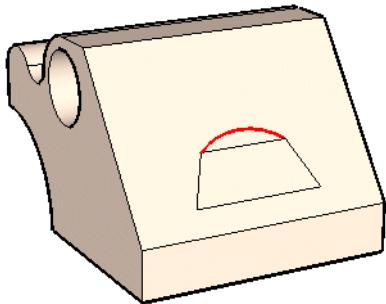
18. The arc shrinks, resizing the rectangle below it as well.



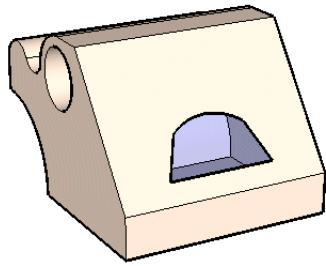
19. Now make the arc radius larger. (Note that even if you are using architectural units, you can still enter a decimal value: 2.5' is the same as 2'-6".)



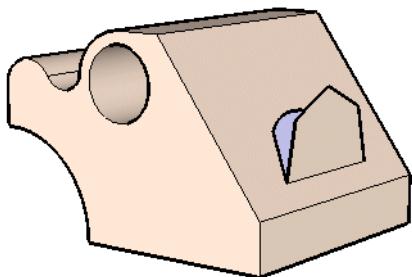
This time the arc updates but does not affect the rectangle (now a trapezoid) below it. This is because an arc can be fit to the current edge below at a size less than a semi-circle. But if the new radius will make an arc greater than a semi-circle, the edge below will update instead.



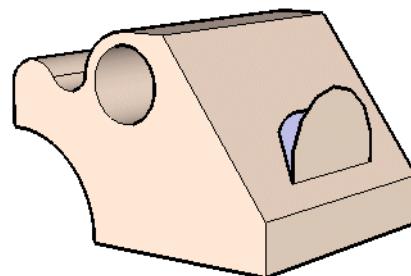
20. Erase the line between arc and rectangle, and erase the face.



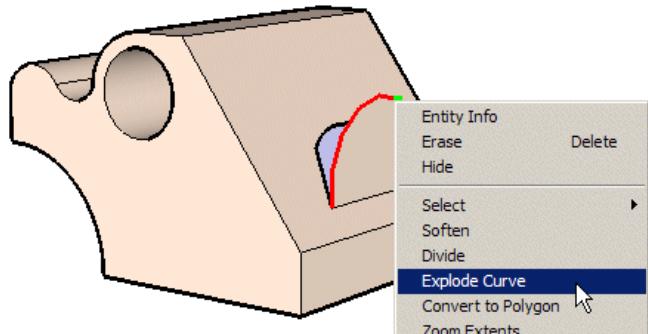
21. For the next arc, use the bottom edge of the cutout as the chord, and set the arc upward (blue direction). Note that it has four segments; this reflects the last arc change you made (and does not take into account the change you made via **Entity Info**).



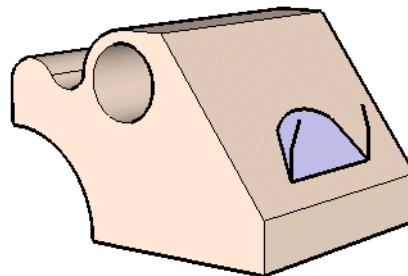
22. Type 8s to make the arc rounder.



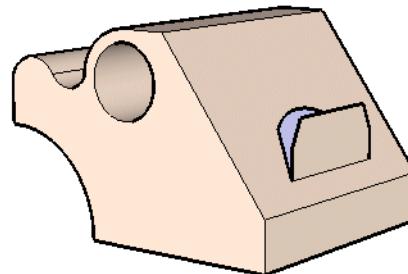
23. Like a circle, an arc can be broken down into individual segments. Right-click the arc and select **Explode Curve**.



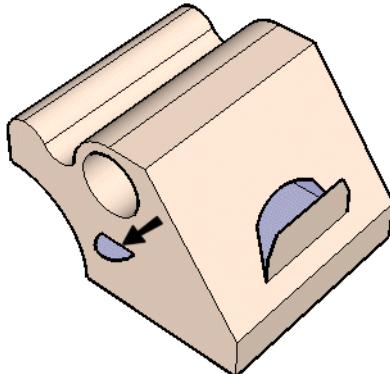
24. Each segment is now a separate entity. Erase the top four segments...



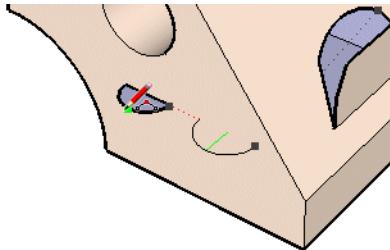
25. ... and draw a line to connect the ends of the remaining segments.



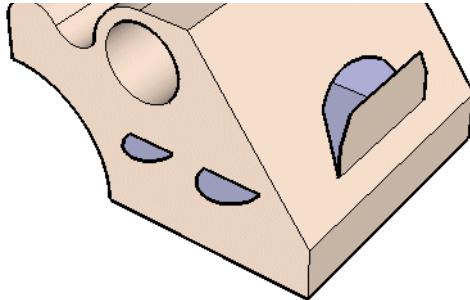
26. Now draw an arc that sticks out of the side face, and close it with a line. Leave room on this face for another, similar arc.



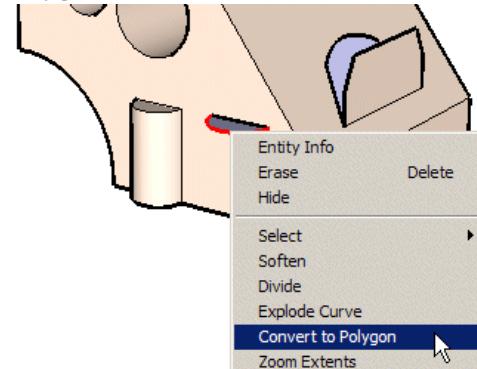
27. Draw the next arc at the same height (by hovering over an endpoint of the first arc and dragging the cursor to the right). To set the bulge, you can pick the bulge point of the first arc.



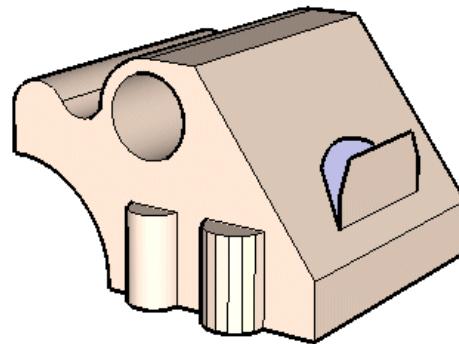
28. Close this second arc with a line.



29. **Push/Pull** the first arc down to the bottom of the box. Then right-click the second arc and select **Convert to Polygon**.



30. **Push/Pull** the second arc the same distance. Because it is actually a polygon, the segmentation is visible.



You could use **Entity Info** to change the radius of the arc faces on either end of the extrusions. But once **Push/Pull** is used, you cannot change the segmentation.

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**NOTE:** In addition to using **Entity Info**, the **Move** tool can also be used to resize circles and polygons. **Move** also enables you to resize curved extruded faces. See "Using Move to Resize Curves and Curved Surfaces" on page 54.

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**TIP:** Faceted objects can be made smooth by smoothing their edges, and vice-versa. See "Displaying and Smoothing Edges" on page 72.

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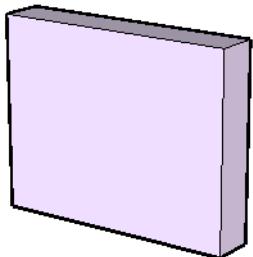
**TIP:** When working with exploded arcs and circles, you may sometime need to locate the arc or circle center point. See "Finding the Center of an Arc" on page 377.

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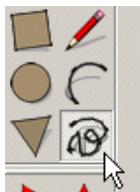
## Freehand

Another self-explanatory tool name, **Freehand** is used to create freehand sketches.

1. Start with a box like this.



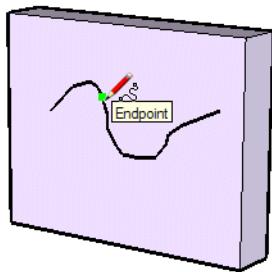
2. Click **Freehand**, or select **Draw / Freehand**.



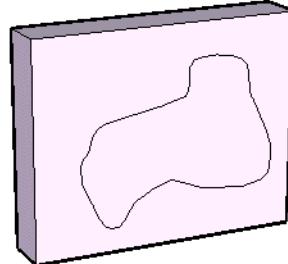
As with all drawing tools, you can draw on any of the three major planes by orbiting your view so that you are facing the plane you want to draw on. To understand this better, see the first few steps of "Circle and Polygon" on page 19.

3. We will draw freehand curves on faces. Move the cursor over the desired face. Draw an open curve by clicking and dragging the mouse. Because the mouse button remains pressed, inferences from other points are not displayed.

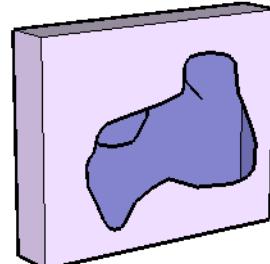
Like circles and arcs, this curve is approximated into segments, though it is selected and manipulated as one object. The lines are thick because they are not edges of a face.



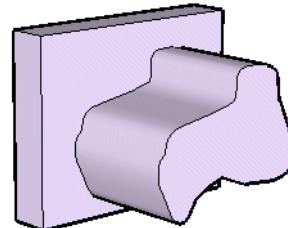
4. Orbit to the other side, and draw a closed freehand curve. To make a curve closed, simply end it at its start point. If you do it right, the lines will be thin, indicating a face has been formed.



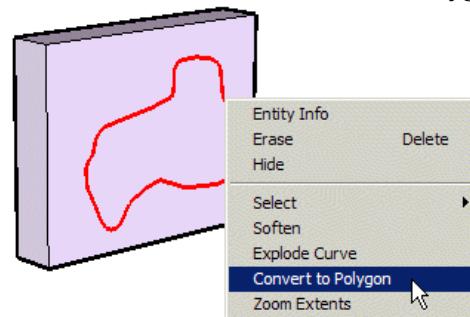
5. Verify that this is a closed face by activating **Select** and clicking it. You can also erase it, but if you do, then use **Undo** to restore it.



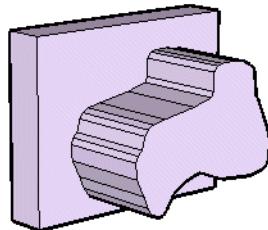
6. **Push/Pull** out the freehand face. Although the curve is segmented, the curved face is smooth.



7. **Undo** to remove the extrusion. Right-click on the freehand curve and select **Convert to Polygon**.



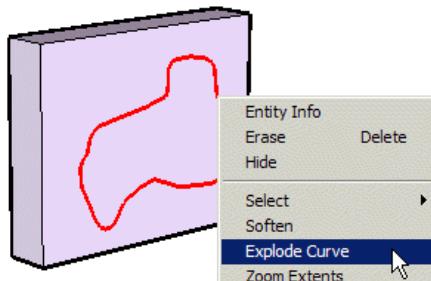
- The curve is still one object, but **Push/Pull**'ing it creates a faceted extrusion.



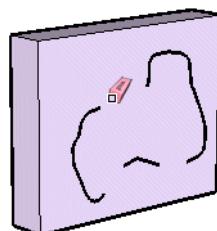
This smooth vs. faceted behavior works the same way as for circles, arcs, and polygons.

**TIP:** *Faceted objects can be made smooth by smoothing their edges, and vice-versa. See "Displaying and Smoothing Edges" on page 72.*

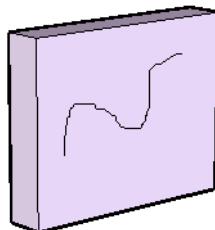
- Undo** the extrusion, and right-click the curve and select **Explode Curve**.



- Now the curve is broken into separate segments. Verify this by erasing individual segments.

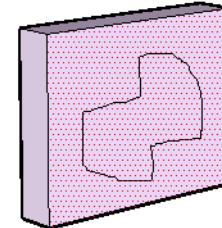


- Erase the rest of the curve to clear the face. Then draw another freehand curve, keeping the Shift key pressed.

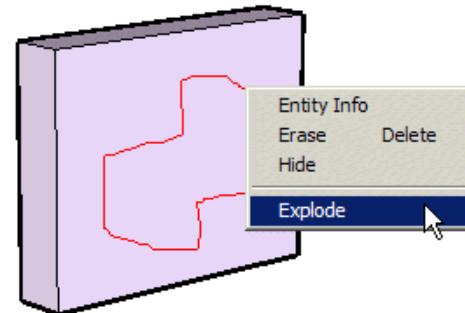


When you use Shift, the resulting curve does not integrate with any other geometry. The curve is thin, but it has not divided the box face.

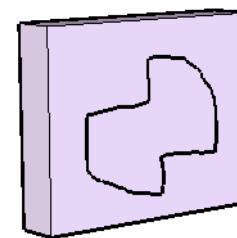
- Do it again, this time creating a closed curve. Even though the curve is thin-lined, the face is not divided.



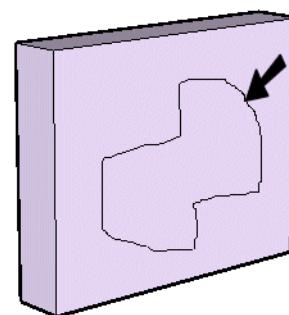
- To change this into a standard object (a curve that will affect neighboring objects), right-click on it and select **Explode**.



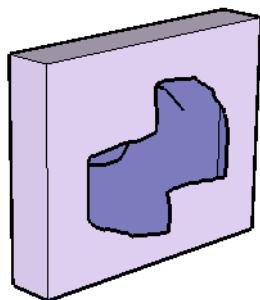
- The lines are now thick, meaning it is not closed. Even though this was created as a closed curve, it does not translate into a closed curve when exploded.



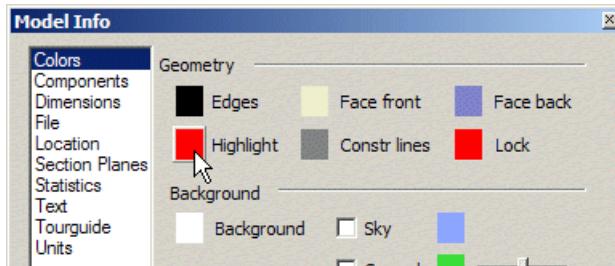
- Use a small line to close the curve. You will probably have to zoom in closely to the start and end points to find the break. Once closed, the lines are thin.



7. You can now erase this face.



The selected edge appears in the color specified for **Highlight**, located on the **Color** page of the **Model Info** window.



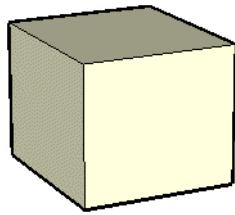
## Manipulation Tools

These are tools you can use once you have some geometry in your model. Among other things, this section includes tools for measuring, erasing, copying, moving, rotating, scaling, and making construction lines.

### Select

You need to understand this tool before getting into the other manipulation tools, because, in many cases, objects need to be selected before you can apply another tool to them. Selecting is very straightforward, but this exercise may show you some features you didn't know about.

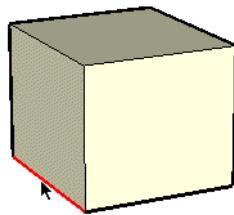
1. Start with a box.



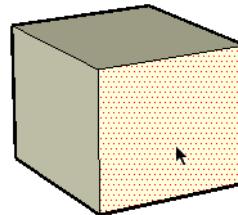
2. Click **Select**, or select **Tools / Select**.



3. When in **Select** mode, the cursor appears as an arrow. Click an edge to select it.

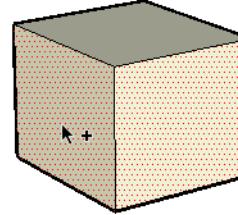


4. Now click a face to select it. The edge now is deselected. Selected faces are covered with a dotted pattern, also in the **Highlight** color.

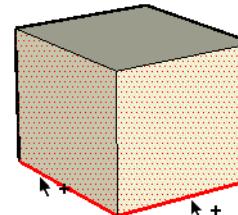


Keep in mind that edges and faces are considered separate objects, so be aware of what you need to select for the tool you want to use!

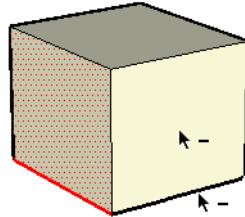
5. Add another face to the set of selected objects, by pressing *Ctrl/Option* while selecting.



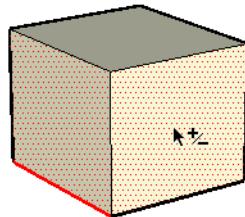
6. Use *Ctrl/Option* to add two edges.



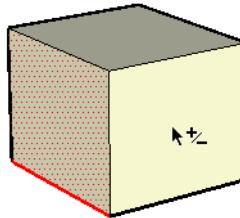
7. Pressing Shift+Ctrl/Option removes objects from the selection set. Remove one face and one edge.



8. Pressing Shift toggles objects between selected and deselected. Press Shift and select a face . . .



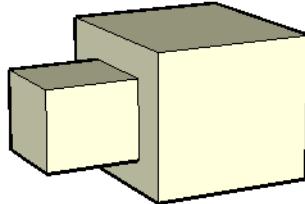
9. . . then click the face again (with Shift) to deselect it.



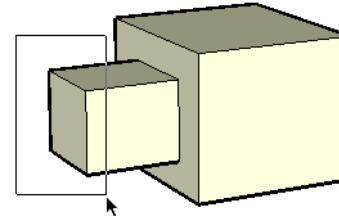
10. To deselect everything, select **Edit / Deselect All**.

**TIP:** You can select everything by selecting **Edit / Select All**, or by pressing **Ctrl+A (Cmd+A)**.

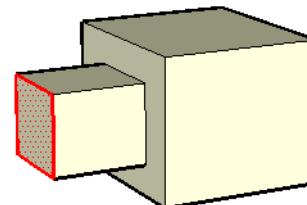
11. Add a rectangle to one of the faces and **Push/Pull** it out.



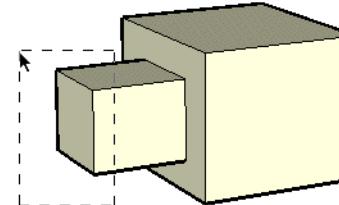
12. We will now use window (marquee) selections. Return to **Select mode** and drag a window from left to right, enclosing the front face of the small box.



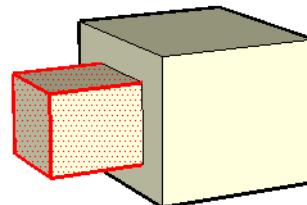
This type of window selects objects that are completely enclosed within it - the face and the four surrounding edges.



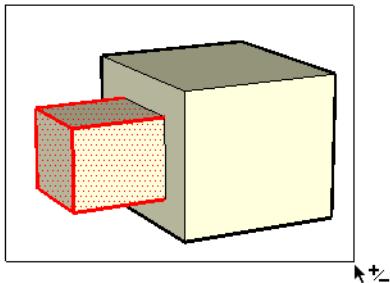
13. Clear the selection (click anywhere in the blank space), and draw the same window selection box, this time from right to left. This time the marquee box is dashed.



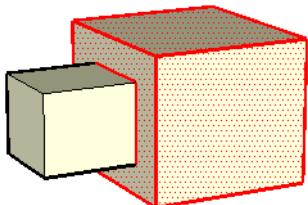
This window selects everything completely or partially inside it - the front face, side and top faces, and surrounding edges.



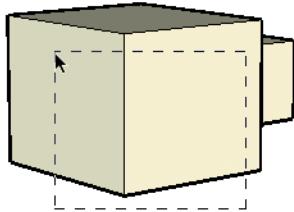
14. Shift and Ctrl/Option keys can be used with window selection. Press Shift to toggle selected objects and drag a window that encloses both boxes.



Objects that were previously selected are deselected, and vice-versa.

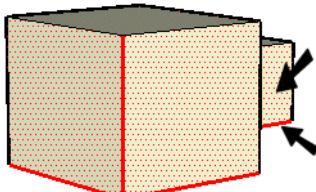


15. Now orbit around so that the small box is behind the larger one. Drag a right-to-left window to select three faces of the large box (the two you can see plus the bottom face), plus the three common edges.



16. The selection window affects all objects inside it, throughout the depth of the model into the screen. Therefore, you need to be careful when using a right-to-left window, because you might select objects that are hidden behind objects.

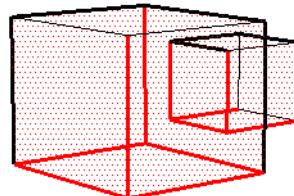
In this case, the window has also selected some edges and faces of the small box.



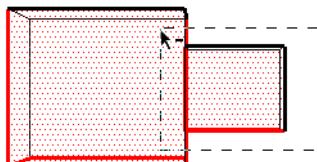
17. Switching to wireframe can show you exactly what's been selected. Click **Wireframe**.



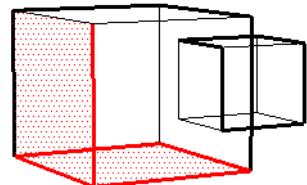
In wireframe view you can see the edges and faces of the small box that are selected.



18. To deselect the small box, orbit the view as shown, press Ctrl/Option + Shift, and drag a right-to-left box around it.



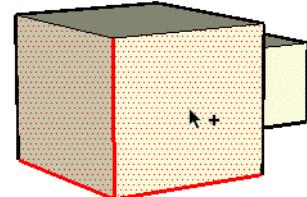
19. The small box is deselected, but the last selection window also deselected the side face of the large box.



20. Switch back to **Shaded** mode.



21. Press Ctrl/Option or use Shift, and re-select the face.

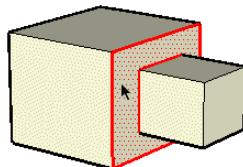
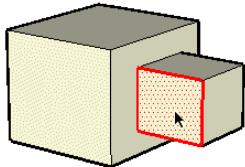



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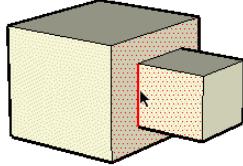
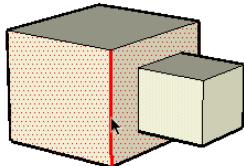
*NOTE: If you are trying to select groups or components, the tool works the same way. The only difference is that the group or component is selected as one object.*

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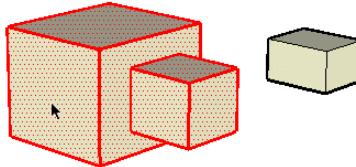
22. Here's a neat feature that allows you to select multiple objects at once. While in **Select**, double-click on any face. This selects not only the face, but also all surrounding edges.



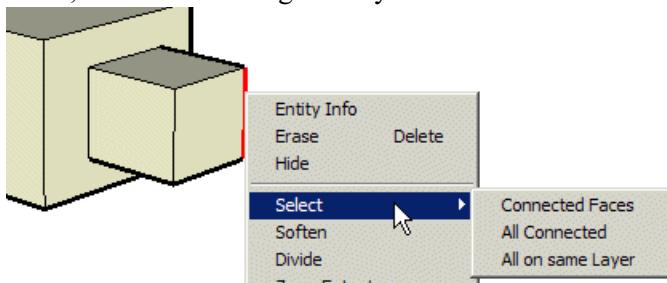
23. Double-click on any edge to select the edge plus all adjacent faces.



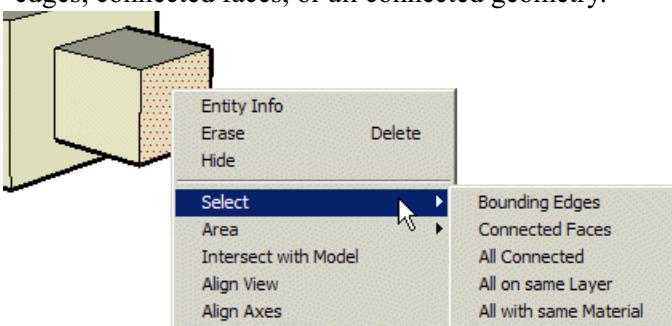
24. Finally, triple-click on any edge or face. This selects all contiguous edges and faces. Unattached objects remain unselected.



The context menu also provides these selection options. If you right-click an edge, you can select all connected faces, or all connected geometry.



If you right-click a face, you can select its bounding edges, connected faces, or all connected geometry.

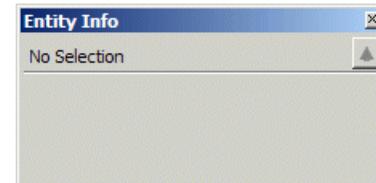


For information on layers, see "Layers" on page 317. For information on materials, see Chapter 7.

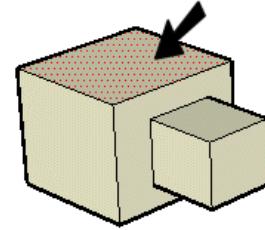
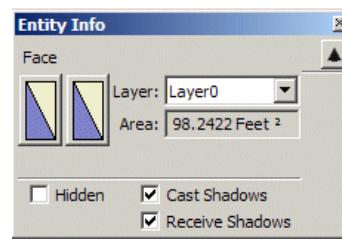
## Taking Off Quantities Using Select and Entity Info

The **Entity Info** window enables you to easily calculate numbers of objects, total lengths of edges, and total area of faces.

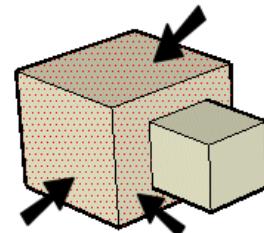
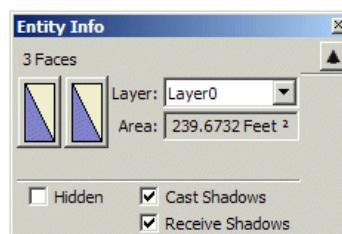
1. If not already displayed, select **Window / Entity Info**. If nothing is selected, the window will be empty.



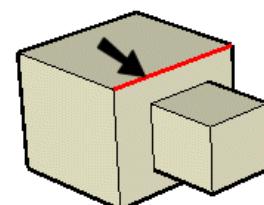
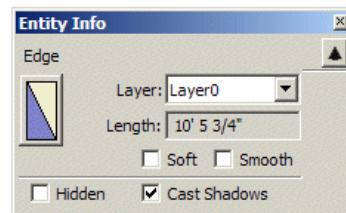
2. Use **Select** to select any face. Its area is listed in the window. You can also check **Hidden** to hide the face.



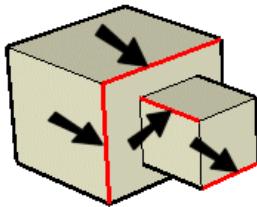
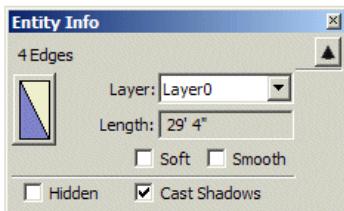
3. Select a few faces, and the total number of faces, as well as total area, are listed.



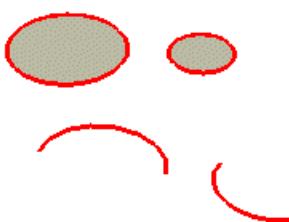
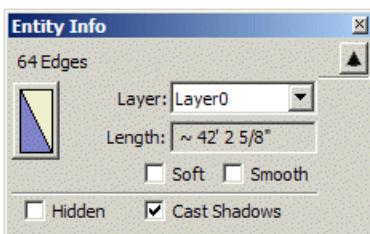
4. Now select one edge; its length is listed. In addition to **Hidden**, for edges you also have the options **Soft** and **Smooth** - these are options that control how the edges are displayed (see "Displaying and Smoothing Edges" on page 72).



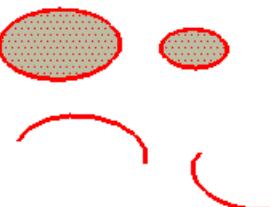
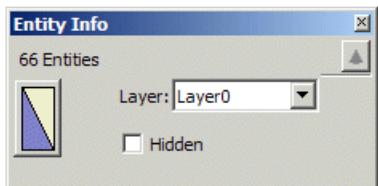
- Select a few edges (they don't have to be contiguous), and their total length is listed.



- Length can be calculated for curves as well, which makes sense since arcs and circles are basically created as a series of small edges. In this case, four objects are selected - two circles with 24 segments each, and two arcs with eight segments each. The faces within the circles are **not** selected. The total number of edges is 64, and the total length is also listed.



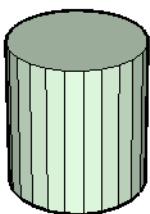
- If your selection set contains different types of entities, such as adding two circular faces to your set of selected edges, the total number of entities will be listed, and nothing else.



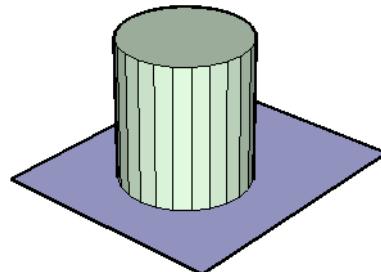
## Erase

After knowing how to select, the next important thing is knowing how to erase.

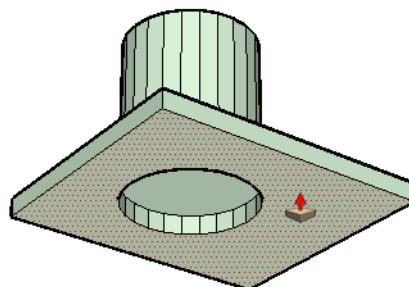
- Start with a polygon, using around 24 sides, pulled into a cylinder.



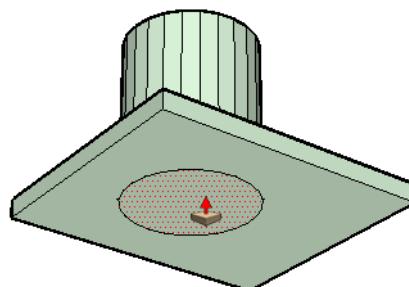
- Draw a rectangle that encloses the bottom of the cylinder.



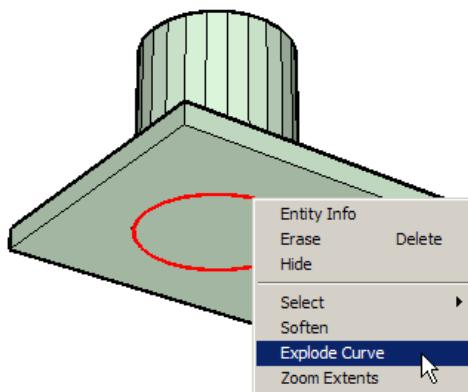
- Push/Pull** the rectangle downward; the circular portion of this face remains in place.



- Push/Pull** the polygon the same distance by double-clicking on it.



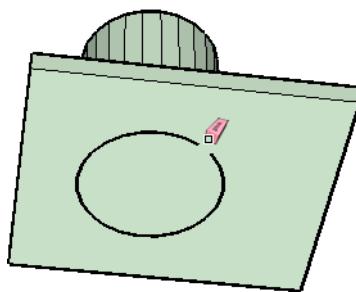
- Right-click on the bottom polygon and select **Explode Curve**. This breaks the polygon into its individual segments.



## 6. Activate Erase (Tools / Erase).



7. The cursor is now an eraser symbol. Click on any of the polygon segments on the bottom face. Because this breaks the circular face, the remaining lines become thick. If you try to select this rectangular face, it has now become a single face.

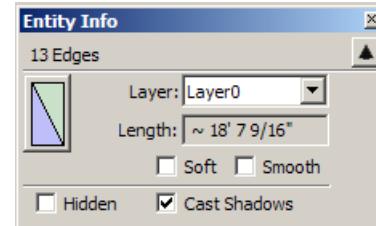



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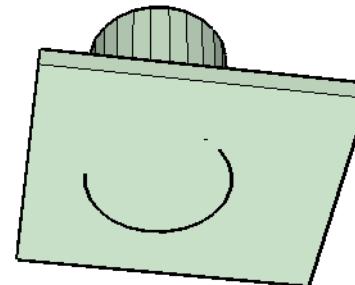
*NOTE: If you hadn't exploded the polygon, the entire polygon would be erased with one click.*

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8. To erase multiple edges in one go, keep the mouse button pressed and pass over the edges you want to delete. They will be highlighted in the "select" color, and will be deleted once you release the button. If the **Entity Info** window is open, you will see the number and total length of the edges to be erased.



If you accidentally pass over an edge you don't want to erase, press Esc to start over. And, of course, you can always use **Undo**.

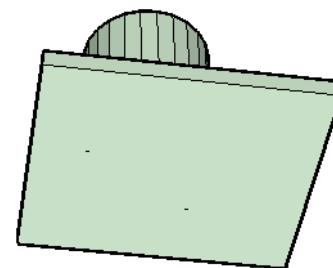



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*TIP: If you pass over edges too quickly, they might be missed. If you're not picking up all the edges you want, move the mouse more slowly.*

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9. Erase the remaining circle segments on this face.



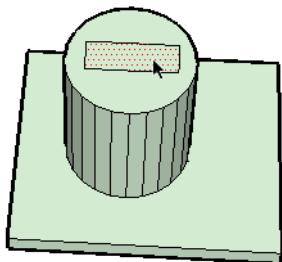
The **Erase** tool does not work on faces, only edges. To remove faces, you need to select them first.

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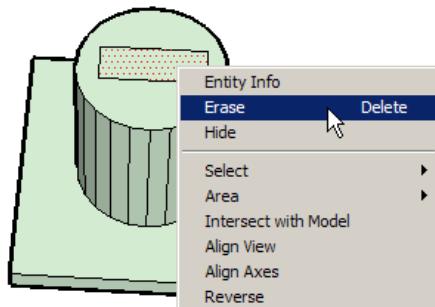
*NOTE: If you erase an edge of a group, the entire group will be deleted. The same is true for components.*

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- Orbit to look down on the top face, draw a rectangle on it, and select it.

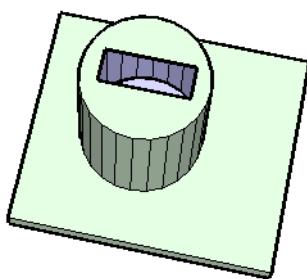


- Right-click and select **Erase**. You could also use **Select** to select the face and press the Delete key.

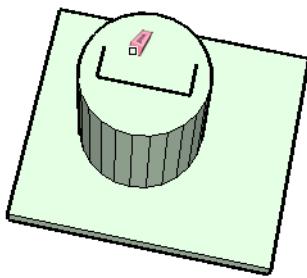


**TIP:** This menu also contains a **Hide** option - useful for blanking faces from the display.

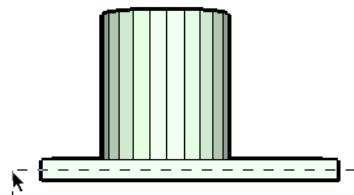
Erasing faces is how cutouts are made.



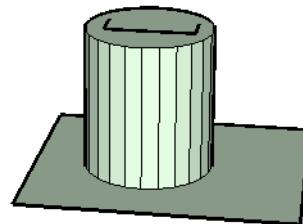
- Erase one of the edges of the cutout. The face is restored, and the remaining three edges are thick-lined.



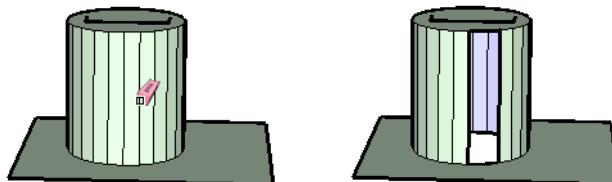
- Another way to erase is to select first, then press Delete. Use a right-to-left selection window to select all edges and faces of the base, except for the top face.



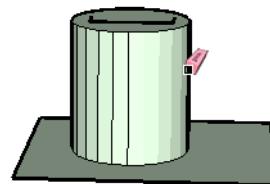
- Press Delete, or right-click and select **Erase**. Only the top face of the base remains.



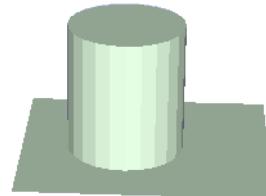
- If you erase an edge of a face, all faces adjacent to it will also disappear. Erase one of the vertical edges of the cylinder, and its two adjacent faces disappear.



- Undo to restore these faces. You could also recreate these faces by manually redrawing the edge you erased.
- The last feature of the **Erase** tool is that it can also hide edges (not faces). Just press Shift and click an edge, or keep Shift pressed while you pass over multiple edges.

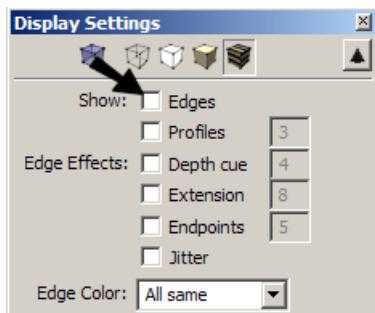


Hiding all, or even just some, edges is a great way to get a smooth look.



**TIP:** You can also hide edges and faces by selecting them first, then pressing **H** (or selecting **Hide** from the popup menu, or selecting **Edit / Hide**).

If you like working without edges, you can uncheck **Edges** in the **Display Settings** window (**Window / Display Settings**).



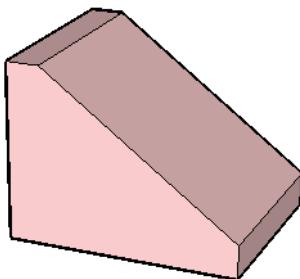
In addition to hiding edges, **Erase** can also be used to soften edges. Hiding and smoothing are two different things. As you saw above, hiding edges leaves surfaces looking faceted, while smoothing creates a smooth look. Hiding also hides profile lines, while smoothed objects still have their profile lines displayed.

For more information, see "Displaying and Smoothing Edges" on page 72.

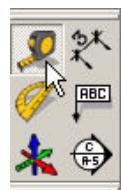
## Measure

This tool has three purposes: to measure distances, to scale an entire model, and to create construction lines.

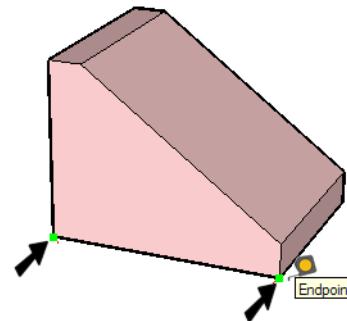
1. Start with this form.



2. Activate **Measure** (**Tools / Measure**, Mac: **Tools / Tape Measure**).



3. Measure the length of the base by clicking the two endpoints.



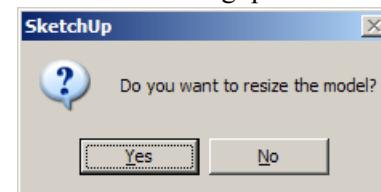
The length is indicated in the VCB.

Length 10' 4 1/2"

4. To change the length of this edge, type the desired length (such as 20') - don't forget the unit.

Length 20'

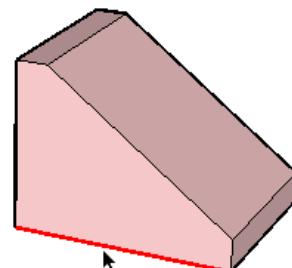
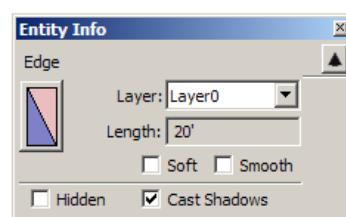
5. Using **Measure** this way enables you to scale your entire model, according to the value you entered. Click Yes to the following question:



The model changes scale. You can verify this by using **Measure** on the same two endpoints, and checking the length in the VCB.

**NOTE:** If your model has components, they will **not** be scaled in this operation. Components have set dimensions which would be lost if they were scaled. This is useful in cases when you want to scale a model around a component. For example, you could insert a door component and scale a face to accommodate it.

6. As you've already seen, you can also use **Entity Info** to measure edges. Select the edge you just resized, and its length appears in the **Entity Info** window. The length is grayed out because it cannot be edited.



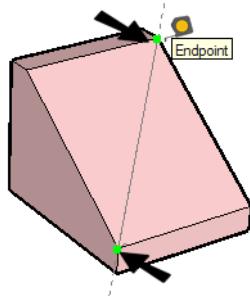
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**NOTE:** You can only use **Entity Info** to edit the length of a line when it has one endpoint free (not connected to another edge).

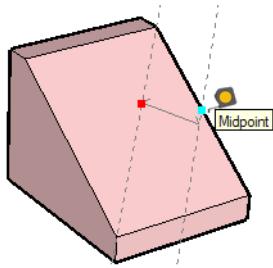
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We now want to create a shape on the sloped face, but we need construction lines to know where to locate points

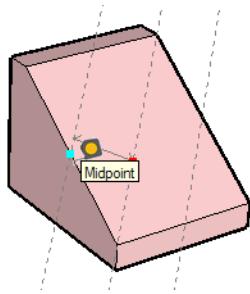
7. Activate **Measure** and click two opposite corners of the diagonal face. An infinite construction line is created here.



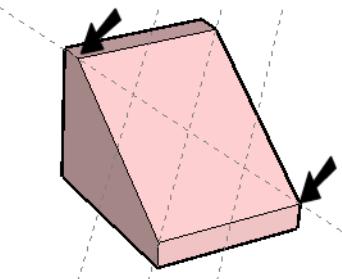
8. **Measure** can also create construction lines offset to edges and other construction lines. Click the construction line you just drew and move the cursor to one side to see the offset line. Place it so that it intersects the midpoint of the edge shown.



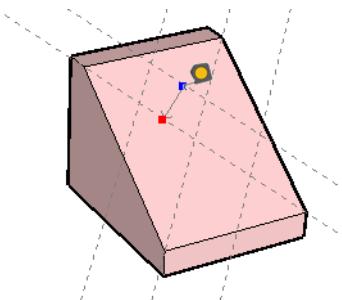
9. Create another offset construction line that intersects the midpoint of the other edge.



10. Now for the construction lines in the other direction  
- create one between the other opposite corners of this face.



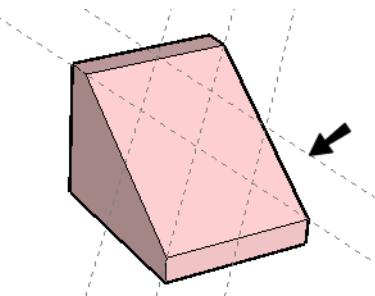
11. Click this construction line and move the cursor to one side, keeping it on the face. Do not pick up any other inferences, and do not click yet.



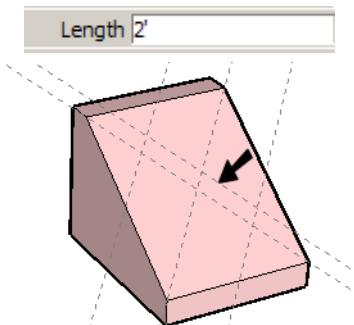
12. You can enter the offset distance manually. Enter a value like 7" (don't forget the foot symbol; otherwise, the value is assumed to be in inches). Press Enter.

Length 7

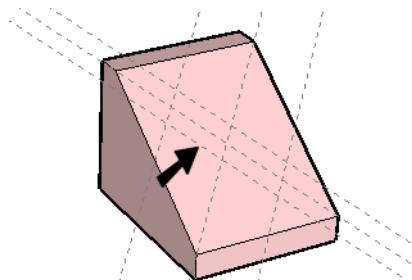
13. The construction line is created at the specified offset.



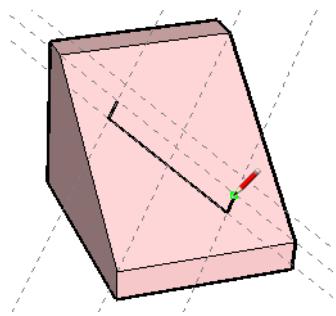
14. This value is a bit too large, but it's not too late to change the offset. Type 2' and press Enter, to move the new construction line closer to the center.



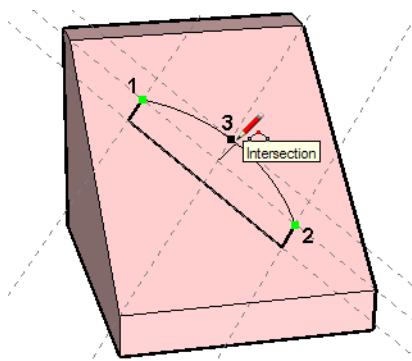
15. Create another construction line at the same offset in the other direction.



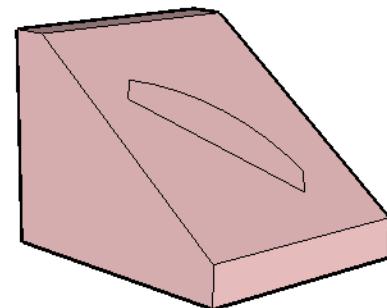
16. Use the intersections of the construction lines to create the three lines shown below.



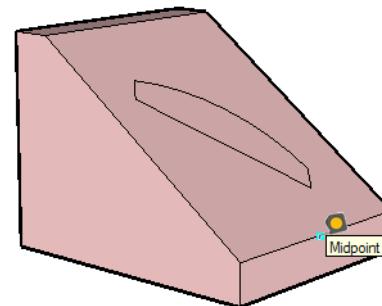
17. Activate **Arc** and close the form using the three points shown below. If drawn correctly, the inner form should be thin-lined (closed and aligned to the sloped face).



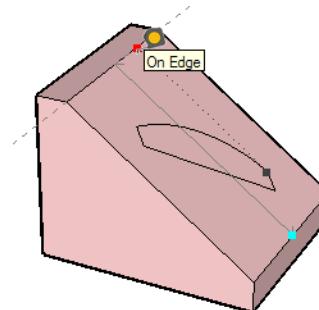
18. Erase all construction lines by selecting **Edit / Construction Geometry / Erase** (or **Hide**).



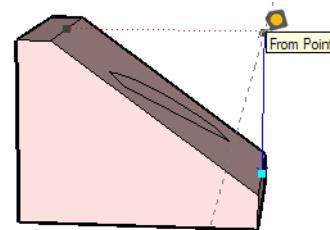
19. The next construction line will use a double constraint. Click the lower edge of the sloped face (not at an endpoint, and without picking up any other inference), so that you can create a construction line parallel to it.



20. Hover on the upper edge to pick up its inference.

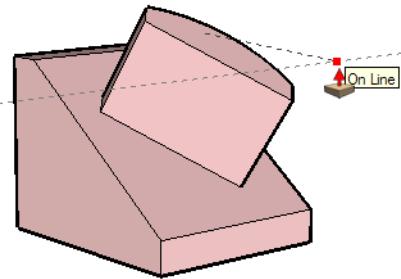


21. Then move out so that the construction line is along the axis (red or green direction) from the upper edge, and directly above (blue direction) the lower edge.

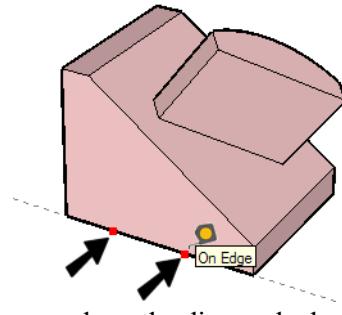


(Here's another way to do the same thing: Click the lower edge and pull up in the blue direction. Press Shift to lock the blue direction, then click any point on the upper edge.)

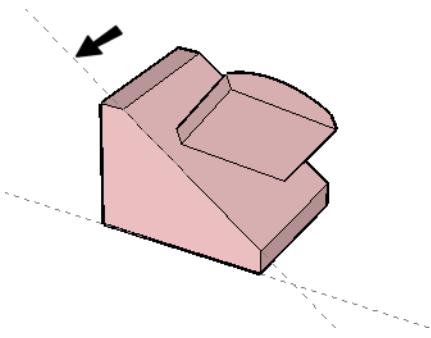
22. Activate **Push/Pull**, click the inner portion of the sloped face, and click the construction line. This extends the face to the level of the construction line.



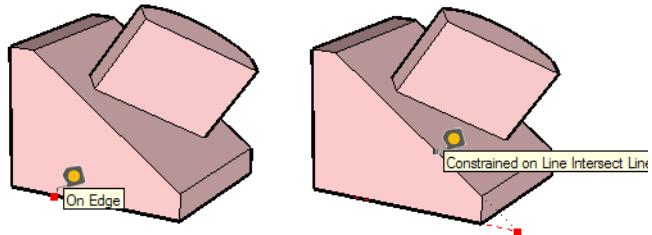
23. Construction lines can also be used to infer points. Create a construction line along the edge shown by clicking any two points along it.



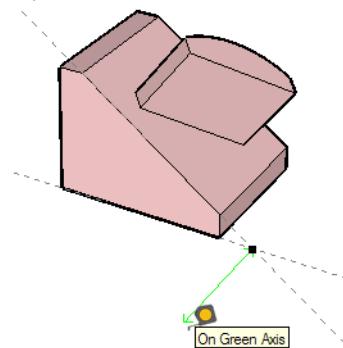
24. Do the same along the diagonal edge. Now you have the intersection of where the two construction lines meet.



**TIP:** There is a quicker way to find this point, by using inference locking. In the **Measure** tool, first hover over one edge and press Shift, then click the other edge. This places the first endpoint of the construction line at the point where the two edges would meet.

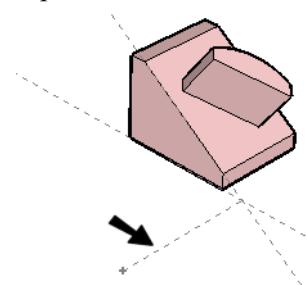


25. From the point where these lines intersect, start another construction line. Move in the red or green direction (depending on where your axes are) but don't click yet.

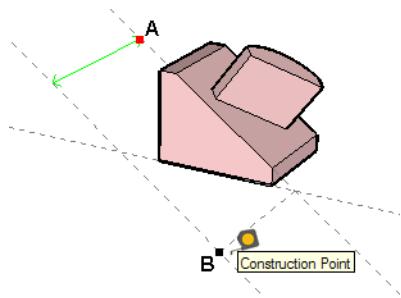


26. Type an offset value, such as 25' and press Enter.

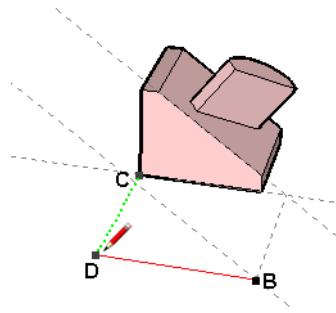
27. This creates a finite construction line, ending at a construction point.



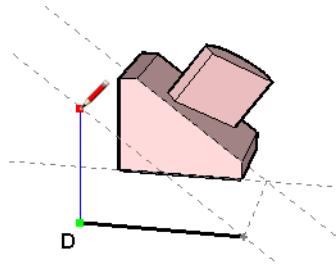
28. Create an offset of the diagonal construction line by clicking on it (Line A), then clicking on the endpoint of the finite construction line (Point B).



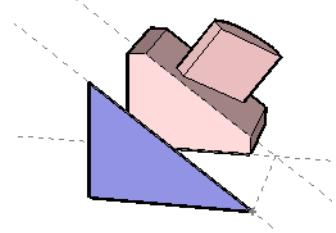
29. We now have the necessary information to locate a second form. Start a line at Point B, hover over Point C, and locate point D when both axis inferences appear.



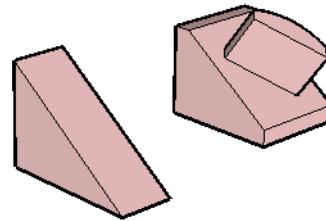
30. Draw the next line straight up from Point D to where it hits the construction line directly above it (blue direction).



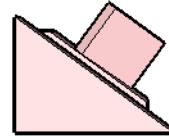
31. Close the triangle.



32. Erase the construction lines, and **Push/Pull** the triangle outward.



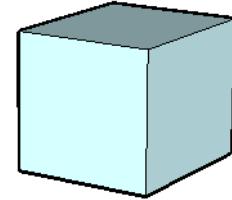
33. If you look from the side, you can see that the sloped faces of both forms lie on the same plane.



## Protractor

This tool has two basic purposes: to create angled construction lines and to measure angles.

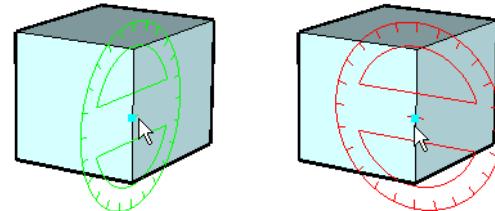
- Start with a box.



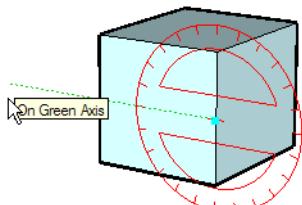
- Activate Protractor (**Tools / Protractor**).



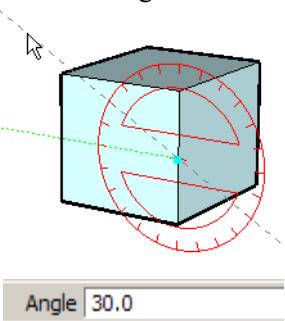
- The protractor appears. Hover over the midpoint shown. If you move slightly to the right and left, you can align the protractor to either adjacent face. The color of the protractor tells you how the protractor is aligned (the protractor is green when aligned in the red-blue plane, etc.).



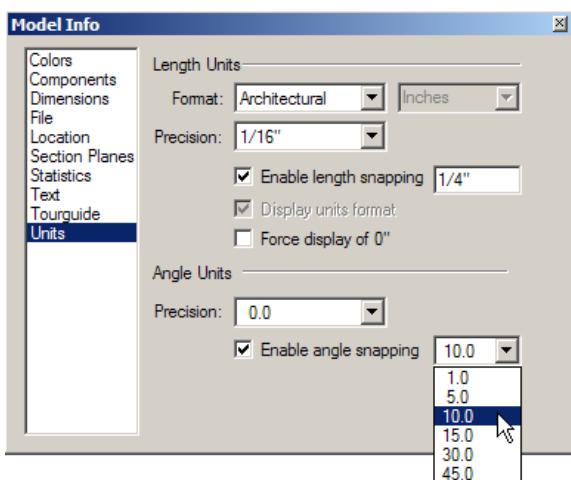
4. Click when the protractor is aligned with the front face (facing you). This sets the protractor's center.
5. The next click sets the orientation of the reference line. Click a point along the axis that will set a horizontal line across the front face. The reference line appears as a dotted line.



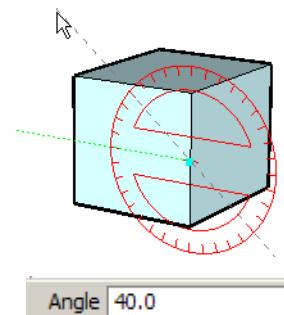
6. The final step is to define the angle, which is measured from the reference line. By default, the protractor has ticks marking angles every 15 degrees. If you move the cursor two ticks above the reference line, you will see 30 degrees listed in the VCB.



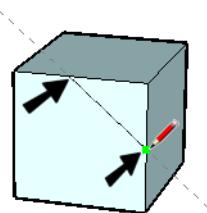
7. To change the default tick spacing, open the **Model Info** window to the **Units** page. **Enable angle snapping** should be checked, which enables you to snap to the tick marks. Change the snap angle from 15 to 10.



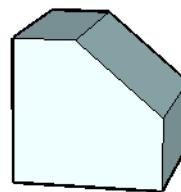
8. Now the protractor has tick marks every 10 degrees. Place the cursor at the 40-degree tick, and click to place the construction line.



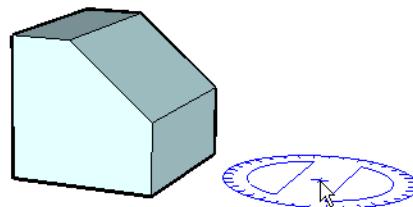
9. Draw a line between the two points where the construction line intersects the edges of the front face.



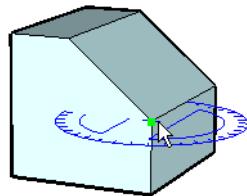
10. Use **Push/Pull** to push the triangular face all the way through. Because the construction line is no longer needed, you can erase it.



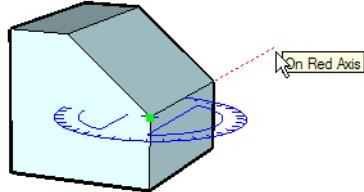
11. Activate **Protractor** again. This time we want to keep the protractor flat (red-green plane) and center it at a specific point. To do this, we need to set the orientation before placing it on the point, since there is no adjacent face we can use.
12. Place the protractor anywhere outside the form and press Shift to lock its orientation. The protractor is blue when sitting in the red-green plane. (You could also use the top horizontal face for orientation.)



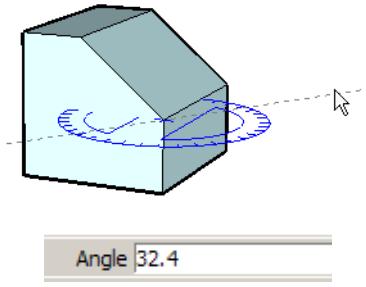
13. With Shift still pressed, click the corner shown to place the protractor center.



14. Define the reference line along the edge or axis as shown.

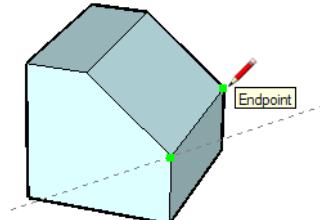


15. You can enter a number manually, if you need an angle that you can't snap to. Place the cursor to indicate the direction of the angle, and type the angle (32.4 in this case) which automatically appears in the VCB. Press Enter to set the construction line.

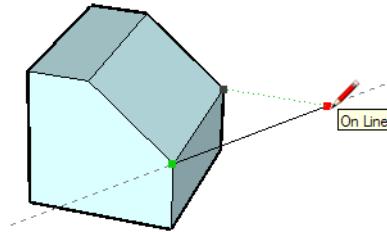


**TIP:** You can enter negative values as well. If the cursor had set the angle direction the other way, you could type -32.4 to get the same result.

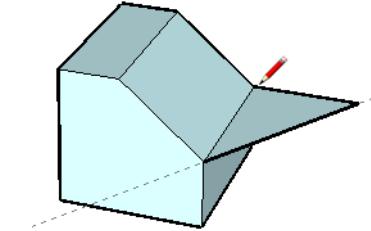
16. For the next line, start at the corner where you placed the protractor and then hover over the endpoint shown to pick up its inferences.



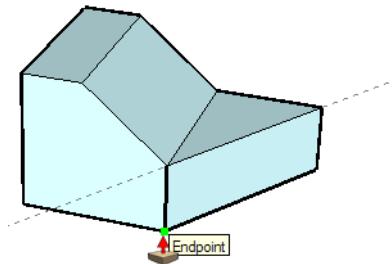
17. Extend the next point in the axis direction until it meets the construction line.



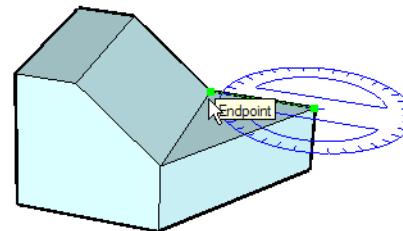
18. Draw one more line to complete the triangle.



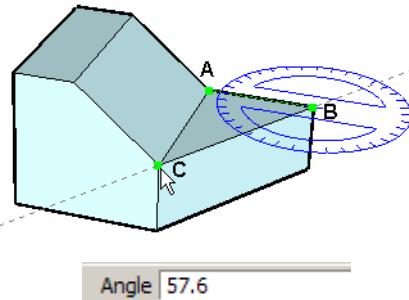
19. **Push/Pull** this triangular face to the bottom of the other form.



20. Erase the construction line. Activate **Protractor** again, which will now be used to measure an angle. Place and orient the protractor on the back edge as shown.

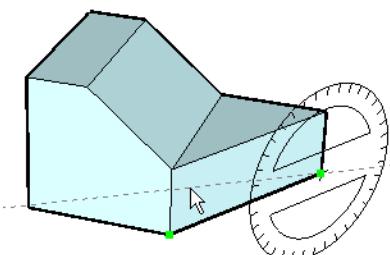


21. Hover (do not click) over the endpoint shown (Point C). In the VCB you will see the measurement of angle A-B-C. The measurement is 57.6, which is the complement of the 32.4-degree angle you created before.



If you had clicked the point, you would have created another construction line, which is not needed.

22. Press Esc to “free” the protractor so it can be placed somewhere else.  
 23. Place it at the corner of the front face, oriented along its bottom edge. This face isn’t aligned with any of the three standard planes, so the protractor is black (or whatever your edge color is). Move the cursor upward (do not click yet) to set the angle direction.



24. You can enter a ratio instead of a degree measurement. Type 8:12 and press Enter.

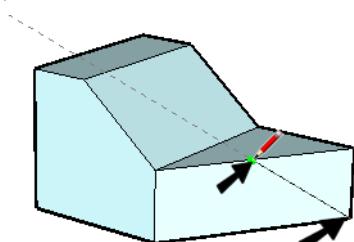
Angle 8:12

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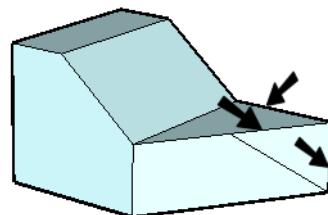
**TIP:** Entering a ratio is a great way to set the rise:run of a roof slope. This is demonstrated in "Resolving Sloping Roofs" on page 158.

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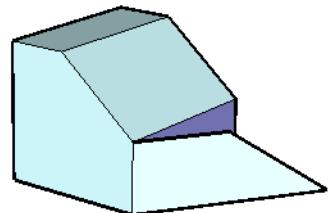
25. Draw a line between the two intersection points on this face.



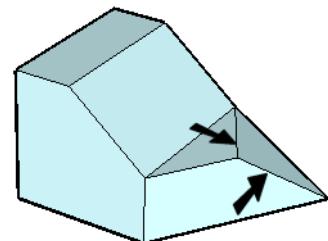
26. Erase the construction line, as well as the three edges shown.



27. This erases a few faces, which will be replaced by sloped faces.



28. Draw the new lines shown, to create a faceted form (any three points defines a plane, and therefore a face).



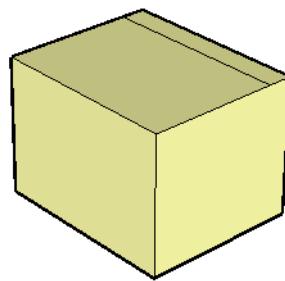
## Move and Copy

The **Move** tool can be used in two ways - to move objects to a different location, or to make one or more copies. Move can also be used to resize curves and curved faces.

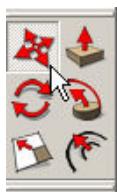
### Move

You can modify your model by moving edges, faces, points, or a combination of selected objects.

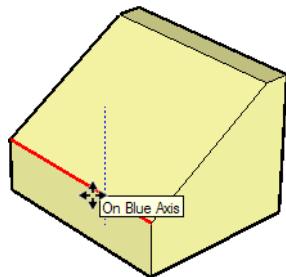
1. Start with a box and add a line parallel to the back edge.



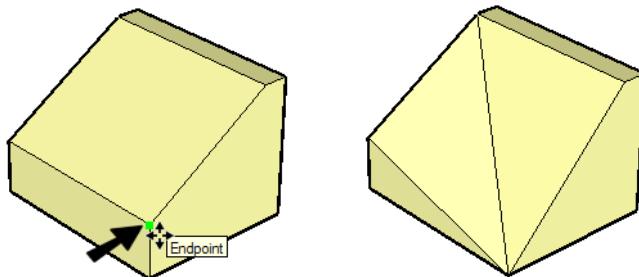
2. Activate **Move** (**Tools / Move**).



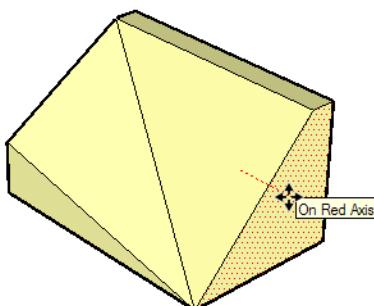
3. Click the edge shown, and drag it downward (blue direction). You can also click the edge and then click its new location.



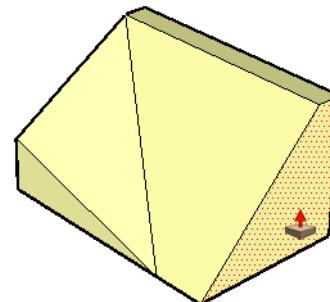
4. **Move** is still active. Move the point shown on the left down till it meets the corner point below it.



5. **Move** also works on faces. Move the face along the red (or green) axis to stretch the entire model.



**NOTE:** If you use **Push/Pull** on the same face, only that face would be extended.

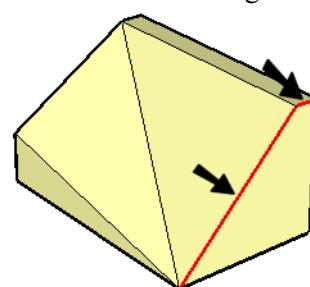


**Move** affects edges and faces adjacent to the selected face, thereby stretching the model.

You could use **Push/Pull** with Alt to get the same effect as **Move**.

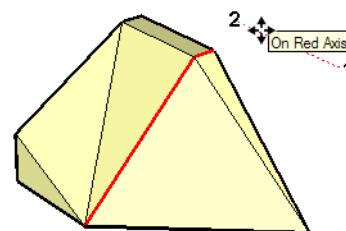
So far we've used **Move** on single objects. Objects can also be selected first, then moved. If you want to move multiple objects, you *must* define the selection set before activating **Move**. (Conversely, if you want to move a point, you must activate **Move** first, then move the point.)

6. Use **Select** to select the two edges shown.

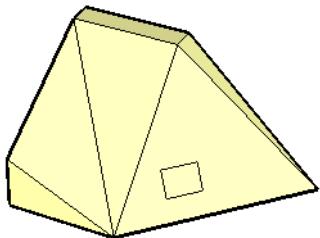


When moving this way, you need to define two points, a reference point and a destination point. The move is applied based on the distance and direction between these two points.

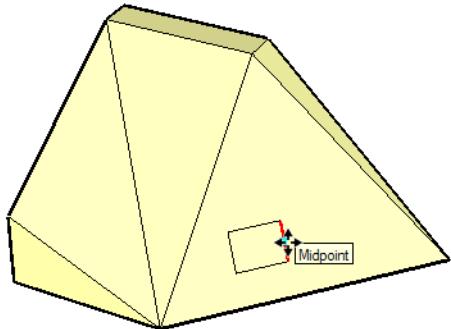
7. Activate **Move** and click any point in space (Point 1) and click or drag to Point 2, following the axis direction (red or green, depending on how you made your model). The two edges move accordingly.



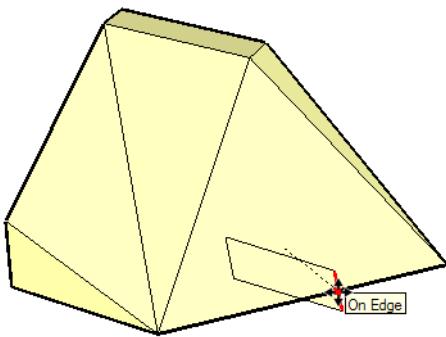
- Draw a rectangle on the large, front face. Make it off-center.



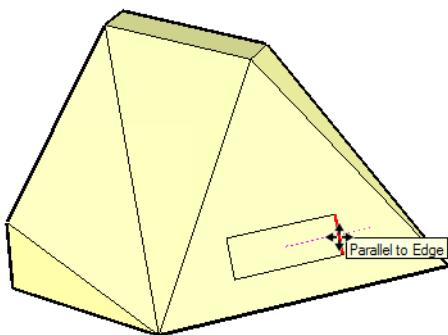
- We can resize the rectangle by moving one of the edges, but these edges are not aligned with any of the standard axes. Use **Move** on an edge, clicking any point along the edge as the start point.



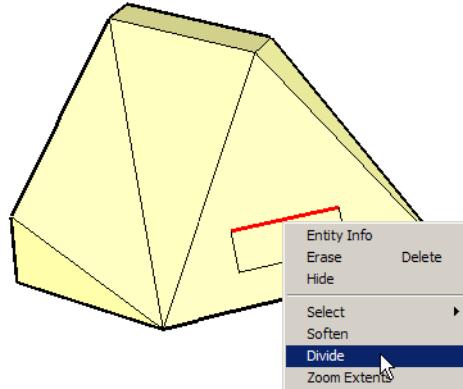
- Then hover over the lower edge (do not click).



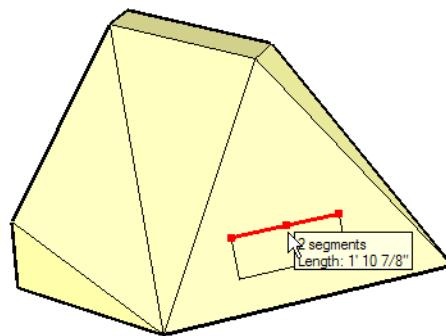
- Now move in the direction you want to go, clicking when the Parallel to Edge constraint is displayed.



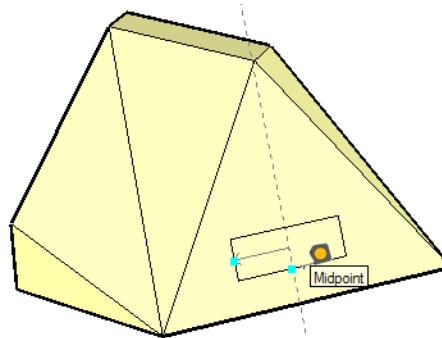
- Now we can create a triangular frame at the top of the rectangle. There is no endpoint on the top edge to use **Move** on, but it's easy to create one. Right-click on the top edge and select **Divide**.



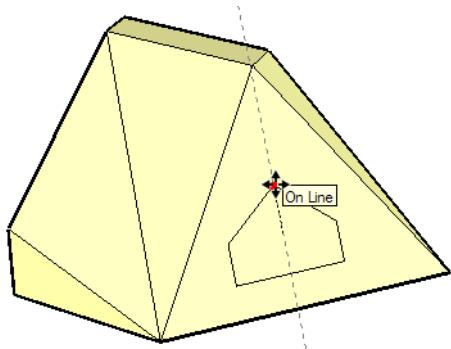
- Move the cursor so that the edge is divided into two segments.



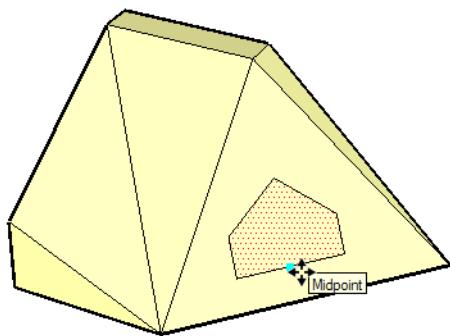
- The midpoint of the top edge can now be moved, but (again) the move direction is not along any of the standard axes. To position it exactly right, use **Measure** to create a construction line. First click either vertical edge, then place the construction line at the midpoint of either horizontal edge.



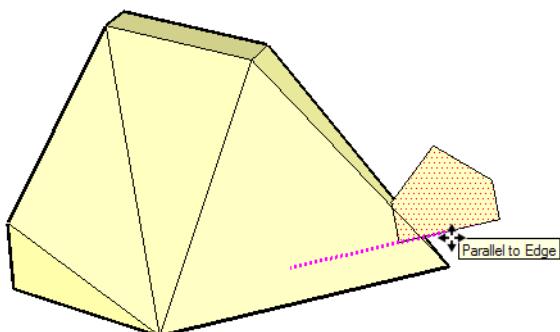
15. Now **Move** the midpoint of the top edge (which is actually an endpoint since the edge was divided) along the construction line.



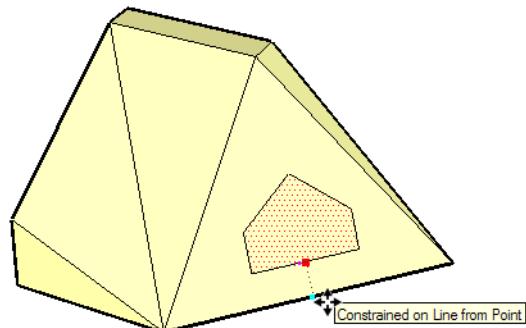
16. Now to center the small face along the lower edge of the large face. Activate **Move** on the small face, and click a point at the center.



17. Hover over the lower edge of the large face to get its Parallel constraint. Press Shift to lock this constraint.



18. With Shift pressed, click the midpoint of the lower edge. Now the small face is centered.

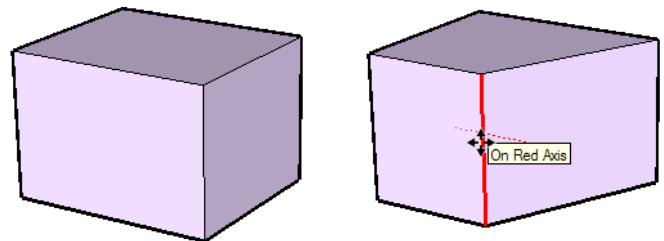


You could erase this face to make it a cutout, like a window.

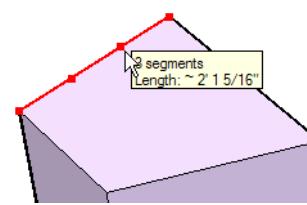
## Copy

When you use the *Ctrl/Option* key within a **Move** operation, you create a copy.

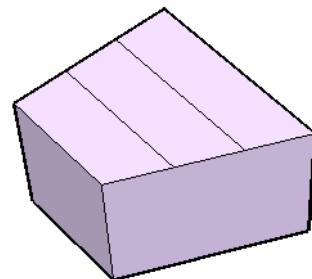
1. Start with a box and use **Move** to move the edge shown.



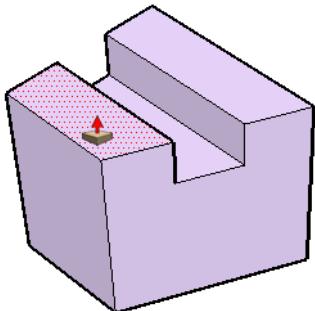
2. Right-click the edge shown and select **Divide**. Move the cursor so that the edge is divided into three segments, and click. Now the edge consists of three lines of equal length.



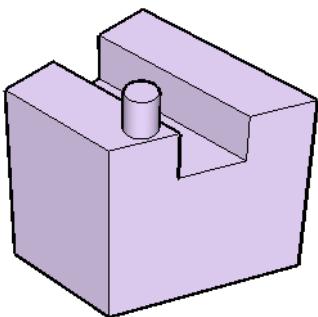
3. Draw two parallel lines from the new endpoints.



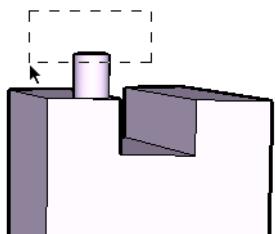
4. Use **Push/Pull** to push up one of the outer top faces. Double-click on the other outer face to extend it the same distance.



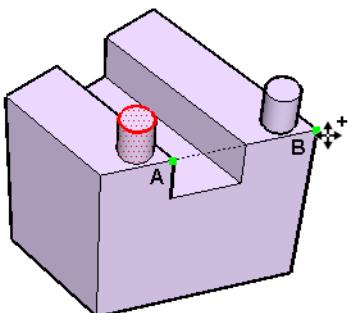
5. Draw a small circle on one of the top faces and **Push/Pull** it up.



6. We now want to select this cylinder to copy it. Use a right-to-left selection window - everything inside or touching the window will be selected. (You can also double-click the top edge to select all the faces that touch it.)

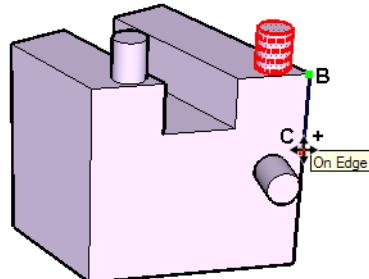


7. With the cylinder selected, activate **Move**. Press **Ctrl/Option**, then click Point A. Release **Ctrl/Option**, then click Point B to make a copy of the cylinder.

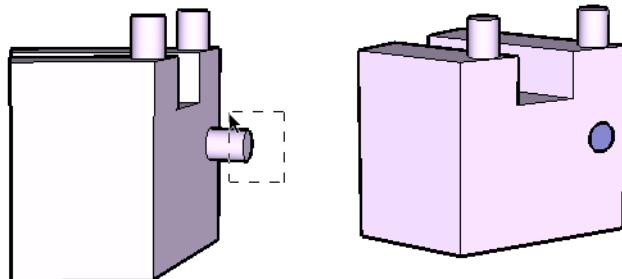


**TIP:** Selecting Point B can place the copy on either the top face or front face. If you're having trouble getting the copy on the top face, try to approach Point B slowly from a point on the top face.

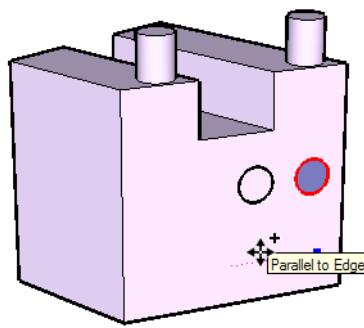
8. The copy should still be selected. Press **Ctrl/Option** again and click Point B. Release **Ctrl/Option** and click a point along the vertical edge (Point C). The copy is automatically aligned with the front face.



9. We want to make a window from this new cylinder. Select the top and sides of the cylinder (leaving the circle along the face) and press **Delete**. This leaves a circular cutout.



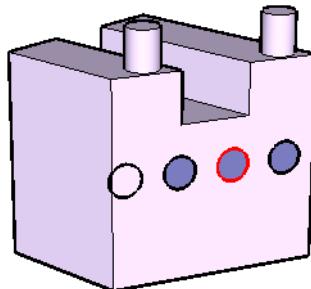
10. Select the cutout circle. Return to **Move** and press **Ctrl/Option**. Click any point on the front face as a reference point. Then hover over the bottom edge. For the second point, make sure the copy is parallel to the bottom edge.



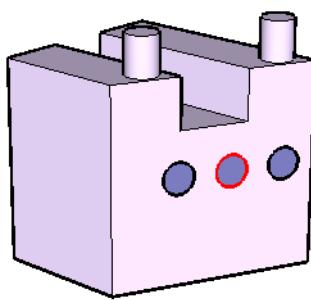
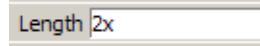
11. One copy is made, but you can make several copies at the same spacing. Type 3x, which appears in the VCB. Press Enter.



Now there are three copies (four total windows).



12. In this case, the last copy extends past the face, so no cutout is made. Enter 2x to remove this copy.

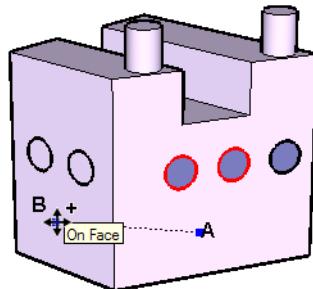



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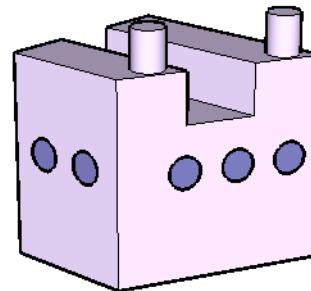
*NOTE: You can also enter a number (no "x") to change the spacing. Multiple copies are explained further in Chapter 4.*

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13. Now select two of these windows, and copy them to the side face. The first reference point should be on the front face, and the second point on the side face.



When the copies are placed, they cut this face as well.




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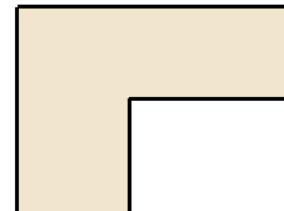
*NOTE: Automatic alignment, which you just saw, works only for copies. Moving objects does not change their alignment.*

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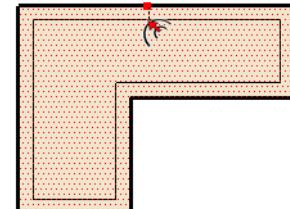
## Autofold

Autofold is a very useful enhancement of the **Move** tool, which enables you to create fold lines where there weren't any before. Normally, **Move** keeps planes as planes, without dividing them into more planes. Autofold will create as many planes as needed to perform the move.

1. Start with this form, with all lines at right angles.



2. Use **Offset** to create an offset face within the original face. (Activate **Offset**, select the face and press Enter, then pick two points to define the offset distance.)

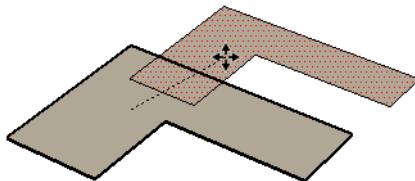



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*NOTE: For an exercise on **Offset**, see "Offset" on page 69.*

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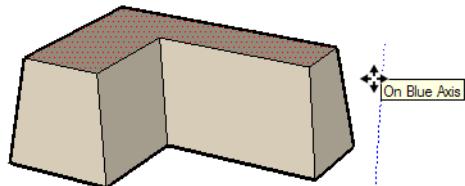
- Select the inner face and try moving it up. You can only move it within its plane.



- Undo.

Here's the first instance when Autofold is useful. There are two ways you can do this:

- Select the inside face first, then activate **Move**. Press Alt/Cmd, and click a reference point anywhere. Then release Alt/Cmd and click a second reference point, directly above the first one. The fold lines between the top and bottom faces are created automatically.



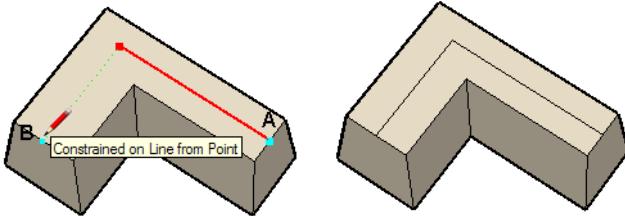
The other way to do this is to start with nothing selected, then activate **Move**. Press Alt/Cmd, click the inner face, release Alt/Cmd, and drag the face upward.

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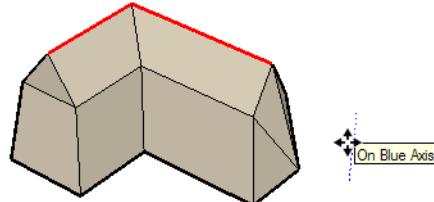
**TIP:** Yet another way to create the same form would be to use **Push/Pull** on the original face (without the offset face), then use **Scale** on the top face. See "Scale" on page 65.

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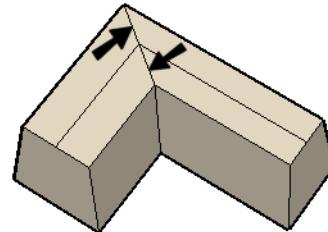
- Now we will create a roof. Start at Point A (midpoint), and start the line in the axis direction. Press Shift to lock the line to the axis and click Point B (also midpoint). Then complete the roof ridge line.



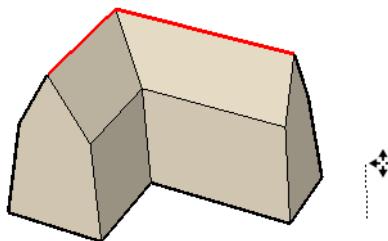
- Select both ridge lines, and activate **Move**, without Autofold. As before, click any two points to raise these lines in the blue direction. This works, though some cleanup would be necessary.



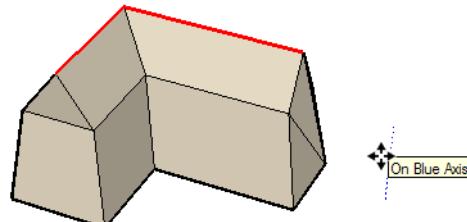
- Undo this move, and add two valley lines.



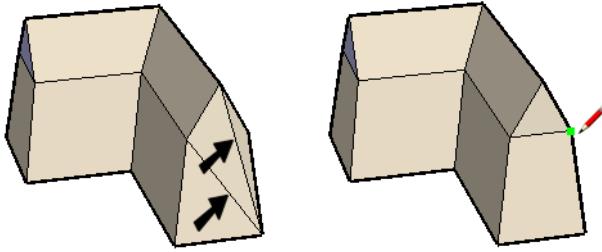
- Now select the two ridge lines as before (not the valley lines), and try to move them up without using Autofold. There is only one direction the edges can be moved; you can't move in the blue direction.



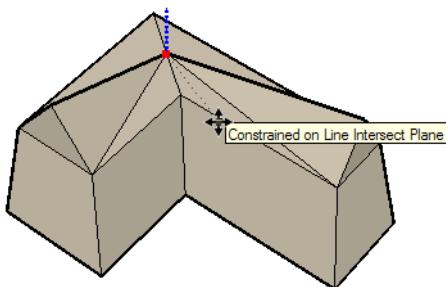
- Try again, this time using Autofold. Now you can move the edges in any direction - use the blue direction.



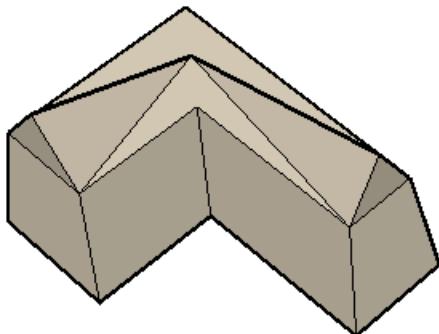
11. The roof wasn't created perfectly, but it can easily be cleaned up. Erase the two lines shown, then correct the roof face by adding one line.



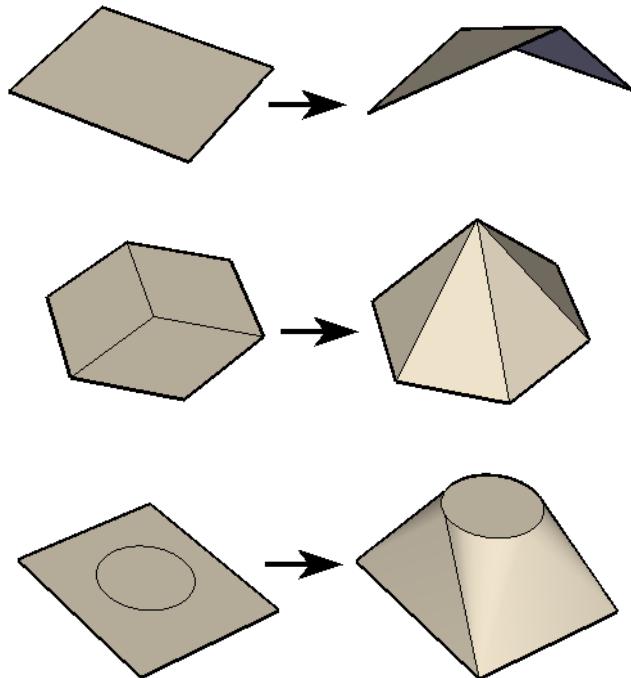
12. Here's a neat way to modify the roof. Activate **Move** and click the ridge line intersection point. Start moving in the blue direction and press Shift to lock this direction. Then click any point on the flat top face.



13. Erase the two unnecessary valley lines.



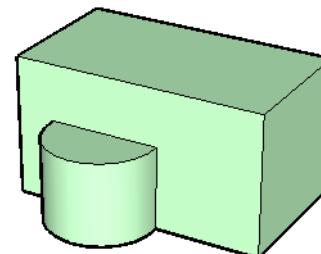
There are so many uses for Autofold, it's impossible to show examples of them all. Here are a few extra examples.



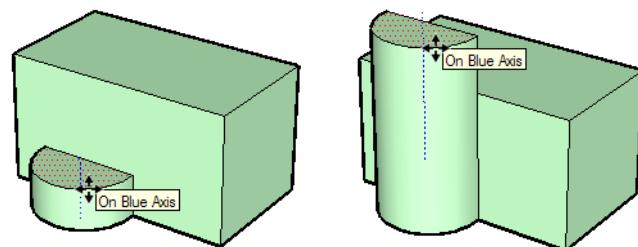
## Autofold with Curved Faces

Autofold can also be handy with faces created as a result of **Push/Pull**'ing arcs, circles, and polygons.

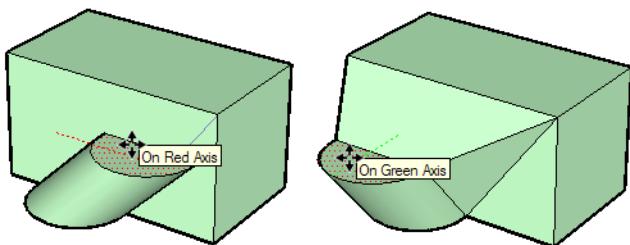
1. Start with a box that has an arc attached to it. Pull the arc up but not all the way to the top of the box.



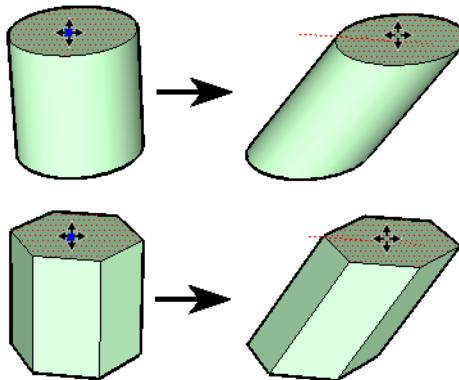
2. Select the top face of the arc form and activate **Move**. The only way you can move this face is up or down.



- Now try to move it again, this time pressing Alt/Cmd for Autofold. You can now move the face in any direction.



Similarly, Autofold is useful when you want to create skewed cylinders and polygonal prisms.

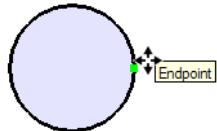


## Using Move to Resize Curves and Curved Surfaces

This section applies to arcs, circles, and polygons, and to the surfaces created when these entities are extruded. Note that the changes you can make in this exercise can only be performed on curves and faces that have not been edited - they must still retain their original shape. For example, once you use **Scale** to change a circle into an oval, the oval cannot be resized.

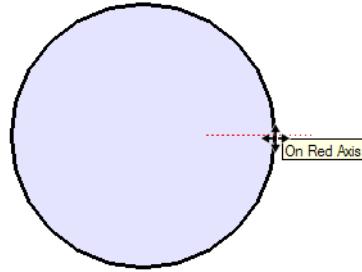
- Create a small circle, and activate **Move**. Make sure nothing else is selected, and move the cursor around the circumference of the circle.

Along most of the circumference, the entire circle is highlighted. But at the four quadrant points, only the point itself is highlighted in green, indicating that it is a point you can drag for resizing.



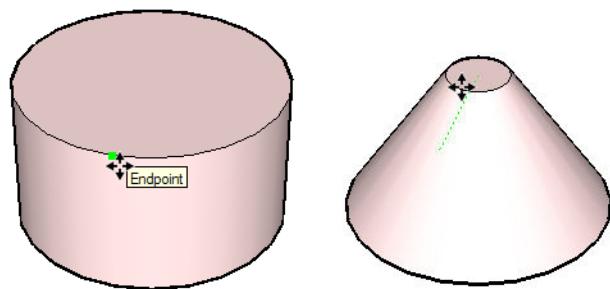
**NOTE:** If you have an even number of segments, these draggable quadrant points will be at segment endpoints or midpoints. For an odd number of segments, play with the mouse to find the four quadrant points.

- Move one of the quadrant points, either by dragging, or by click-move-click. The center of the circle remains in place, but the radius changes. Watch the VCB to see the radius value update.



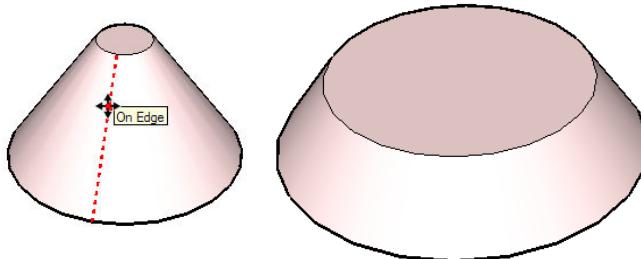
**TIP:** To assign an exact radius value, you can type it and press Enter, or open the circle's **Entity Info**.

- Push/Pull** the circle up. You can now use **Move** to change the radius of the circle at either end of the cylinder.
- Activate **Move**, make sure nothing is selected, and move the mouse along the top edge until only a quadrant point (and not the entire edge) is highlighted. Drag the point inward to make a cone.

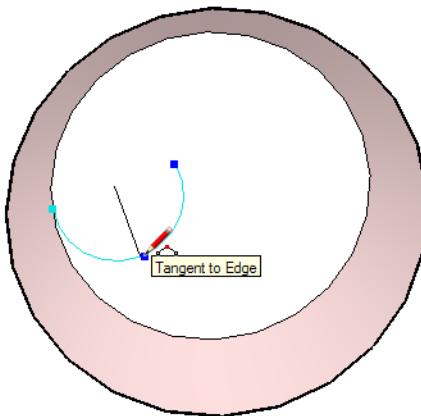


**TIP:** To create drafted extrusions for faces that are not based on circles, arcs, or polygons, you can use the **Scale** tool. See "Scale" on page 65.

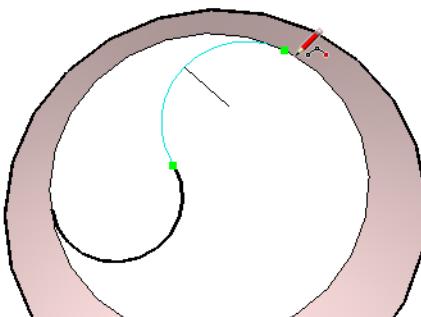
5. You can also resize the curved face itself. While **Move** is still active, move the cursor until a movable edge (and not the entire face) is highlighted as a bold, dotted line. These edges correspond to the locations of the quadrant points. Move the edge outward to create a wide, flat cone.



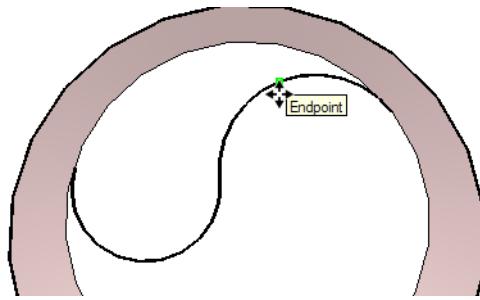
6. Now onto arcs. On the top face, create an arc between an endpoint point on the circumference and a point near the circle center (don't use the exact center). Size the arc so that it is tangent to the circle.



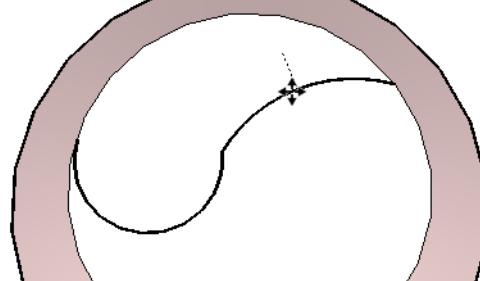
7. Create the next arc from the end of the first one. By default it is tangent to its neighbor. Double-click to place the endpoint somewhere on the other side of the circle.



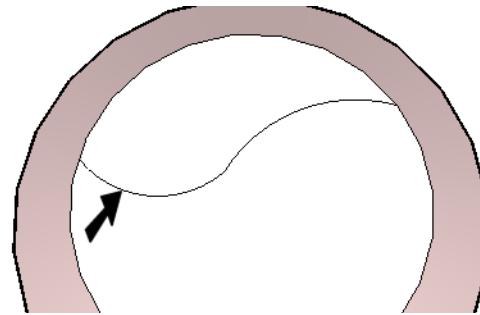
8. Activate **Move** again; now we will resize the arcs. Move the cursor to the midpoint of the second arc - only this point should be highlighted (not the entire arc).



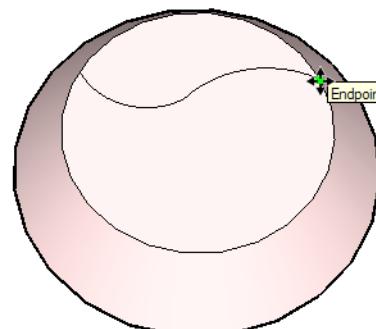
9. Drag this point downward to "flatten" the arc.



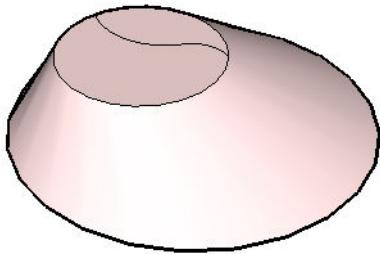
10. Do the same at the midpoint of the first arc.



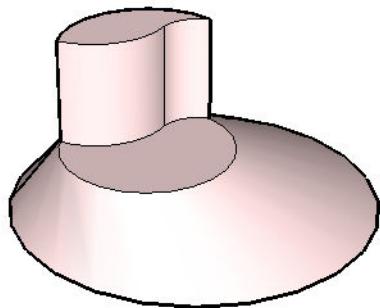
11. Arc endpoints can also be moved. Pick the endpoint shown . . .



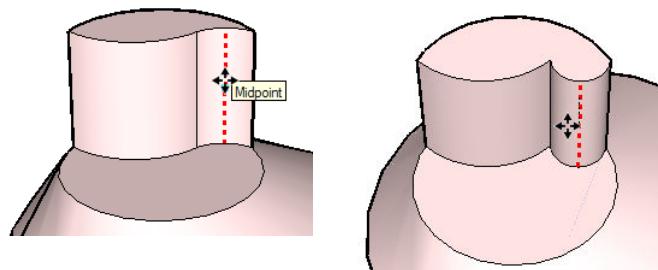
12. . . and drag it toward the center of the circle. This not only changes the arc, but shrinks the circle as well.



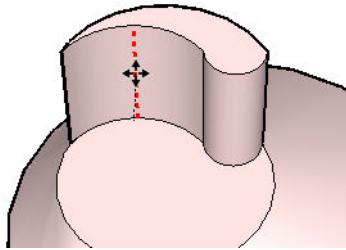
13. **Push/Pull** up the rear face made by the arc chain.



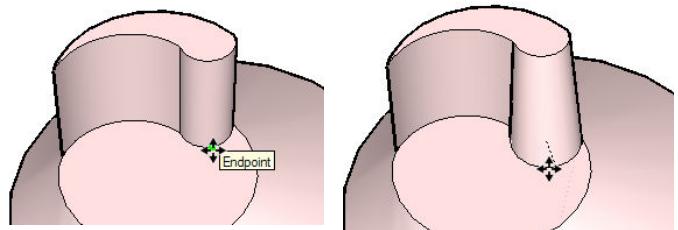
14. Curved arc faces can be resized like we did for the circular face. In **Move**, highlight the moveable edge directly below the arc midpoint. Drag it forward to change the bulge direction.



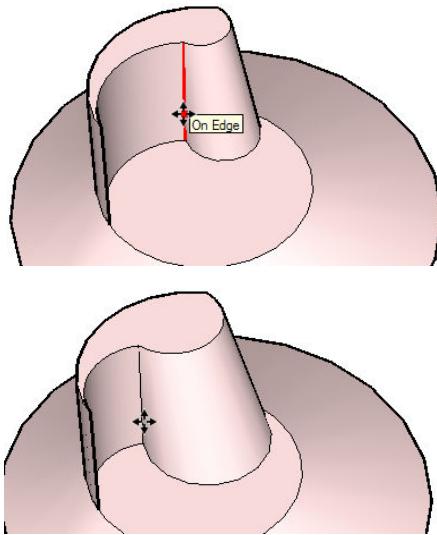
15. Do the same for the other face.



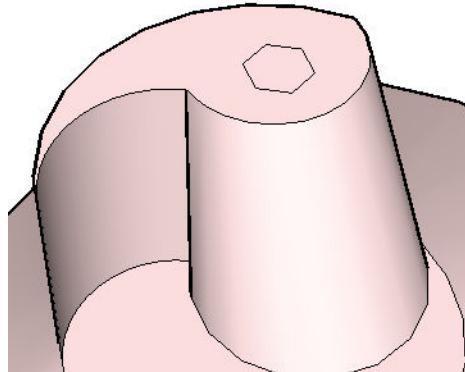
16. Resize the arc at the bottom of the face by dragging its midpoint forward.



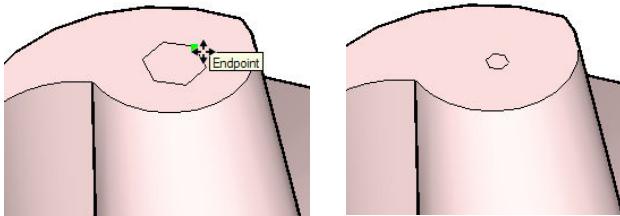
17. Change both arc faces by moving their common edge.



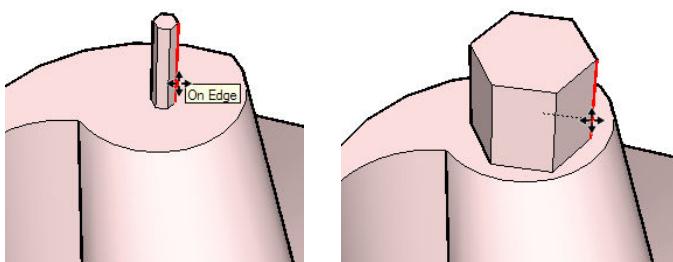
18. Finally, we will use a polygon, which is basically the same as a circle. Draw a hexagon on the top face.



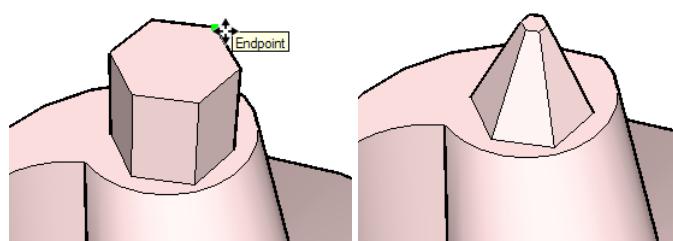
19. Like with a circle, activate **Move** and use one of the moveable quadrant points to shrink the polygon. The location of these points depends on how many segments you have, but there is always at least one at a segment endpoint.



20. Pull up the polygon. To resize the polygonal face, drag one of its moveable edges.



21. And resize the top polygon by dragging a quadrant point inward.

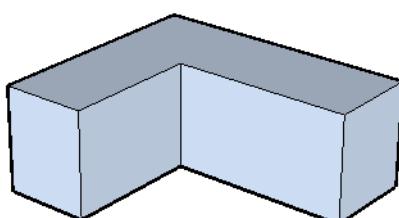


## Rotate and Copy

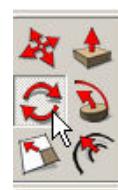
This tool can be used in two ways - to rotate objects to a different position, and to make rotated copies. You can align the rotation axis to a one of the standard planes or to an existing face, or you can define your own rotation axis (see “Defining the Rotation Axis” on page 62).

### Rotate

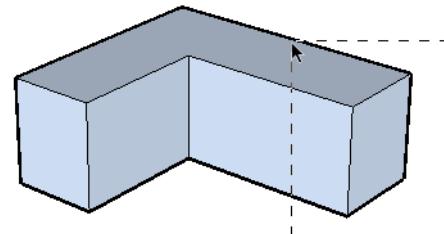
1. For a basic look at **Rotate**, start with a form like this. We want to rotate one of the wings.



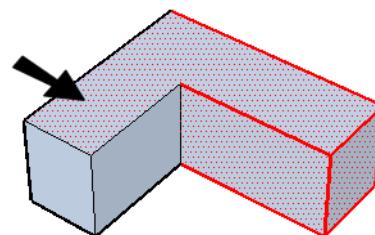
2. Activate **Rotate (Tools / Rotate)**.



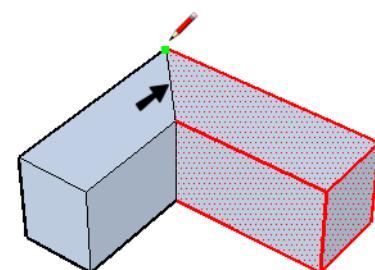
3. Once in **Rotate**, you need to select the objects to rotate. Use a right-to-left selection window to select all faces of the wing.



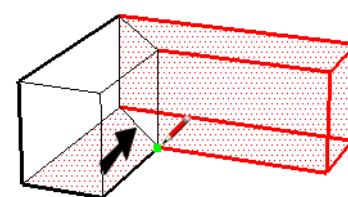
4. The entire top (and bottom) face is selected, so **Rotate** will not work - the entire face will move. The faces must be divided.



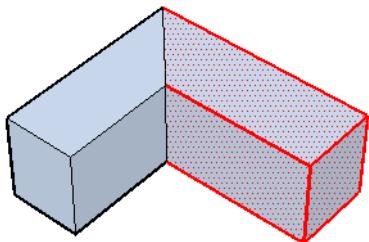
5. Draw a line between the corners.



6. Draw the same line on the bottom face, either by orbiting the model upside-down, or doing it in wireframe view.

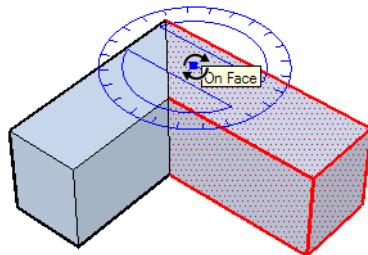


- Deselect everything. Switch back to shaded view, and now activate **Rotate** and select the wing again.

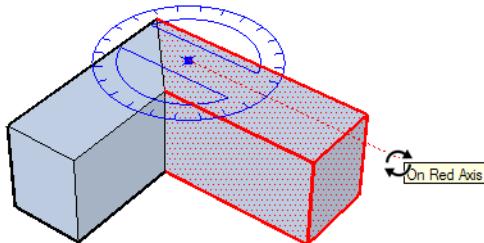


*Mac: **Rotate** only works if objects are selected first. Therefore, select the wing first, and then activate **Rotate**.*

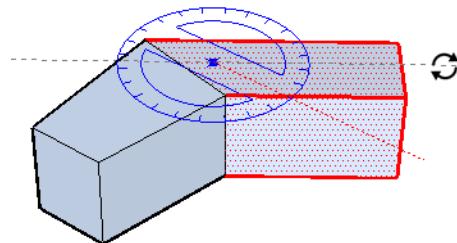
- Press Enter to accept the selected objects and proceed to setting the rotation parameters. The protractor appears, which works the same way as the **Protractor** tool (see "Protractor" on page 43).
- Place the center of the protractor on the top face, close to the intersection with the other wing.



- The next click sets the rotation reference line. In this example the reference line is not important; set it along one of the axes.



- The next step is to rotate. Move the cursor to activate the rotation. You can use the tick marks on the protractor, rotate by eye, or type an angle value.

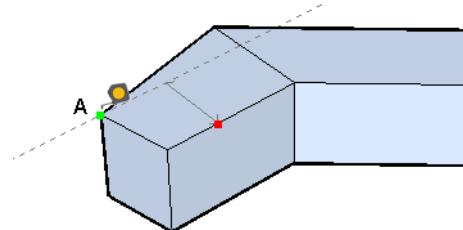


The current rotation angle appears in the VCB.

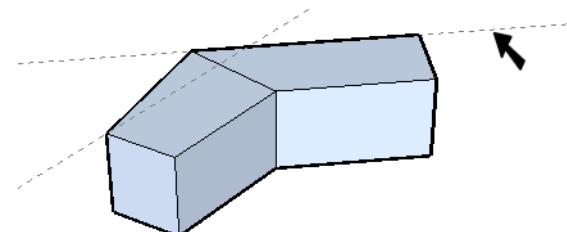
Angle 37.0

Because the rotation has affected adjacent faces, the non-rotated wing no longer consists of right angles. To correct this, some construction lines are needed.

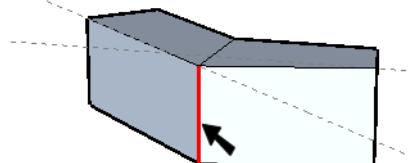
- Activate **Measure** and click the edge that has the correct orientation. Place the construction line so that it intersects Point A.



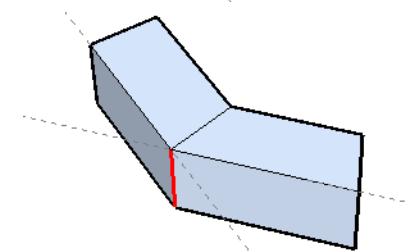
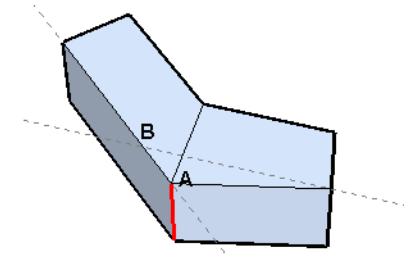
- Create another construction line parallel to the edge shown, by clicking any two points along the edge.



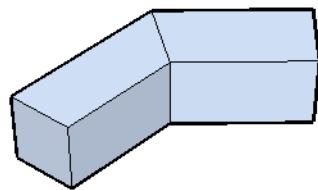
- Select the vertical edge that needs to be moved, and activate **Move**.



- Click Point A as the reference point, and move it to where the two construction lines intersect (Point B).

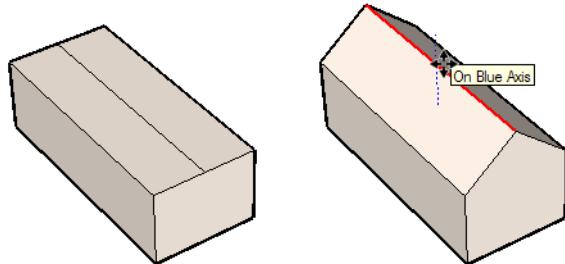


Here is the corrected building with the rotated wing.

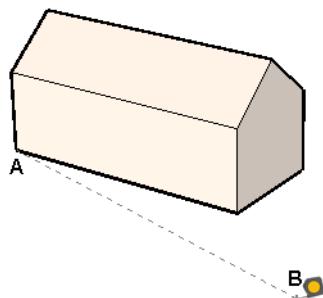


The next exercise explores alignment locking when using **Rotate**.

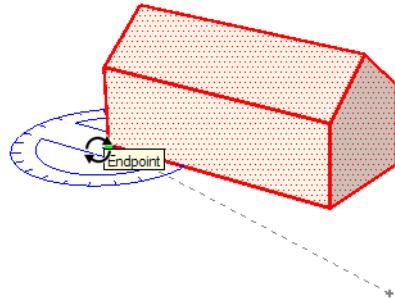
1. Start with a long box with a line across the top. Use **Move** upward on the line to create a ridged roof.



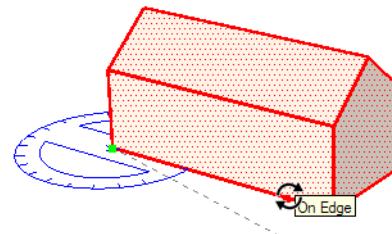
2. The house is aligned with the red-green plane, but we want it aligned in another direction. Activate **Measure** and click Points A and B to create a diagonal construction line in the red-green plane.



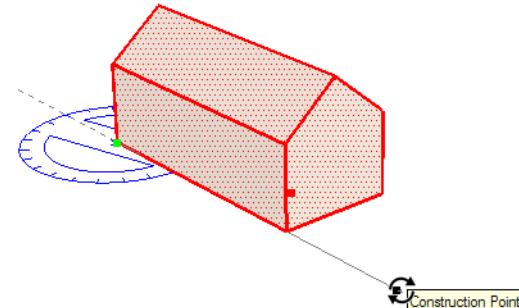
3. Select the entire house and then activate **Rotate**.
4. Place the protractor at the start of the construction line, making sure it is blue (in the red-green plane).



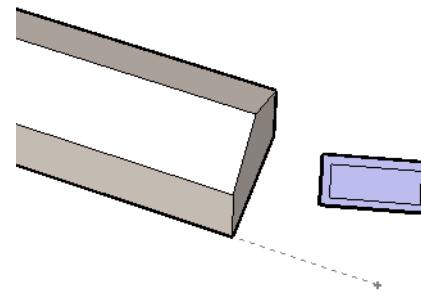
5. Set the reference direction along the long side of the house.



6. Then click along the construction line to rotate the house.

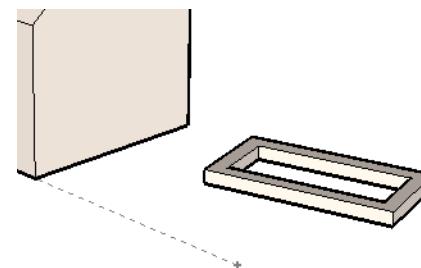


7. We will now create a window that will be placed on the sloping face of the roof. In some blank space, create a long rectangle with a smaller rectangle inside it. Make sure it's sized so that it will fit entirely within the roof face when rotated.

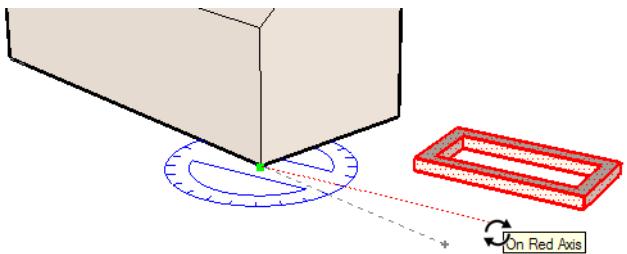


The rectangle is aligned with the red and green axes, and therefore not aligned with the rotated house.

8. Erase the interior face of the window, and **Push/Pull** up the frame.

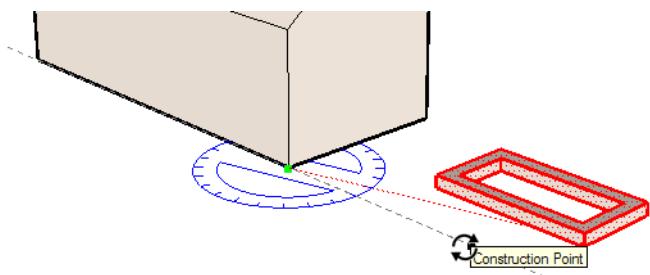


- The window needs to be rotated to the orientation of the house. Select the window, activate **Rotate**, and place the protractor at the front corner of the house. As before, the protractor should be in the red-green plane. Set the rotation reference direction parallel to the window.

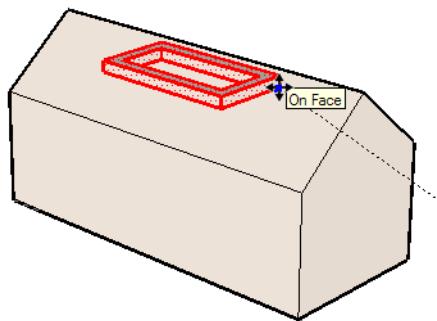


**TIP:** If you have trouble getting the protractor to lie flat, place it outside the house and press Shift to lock its orientation. Then keep Shift pressed and click the corner point.

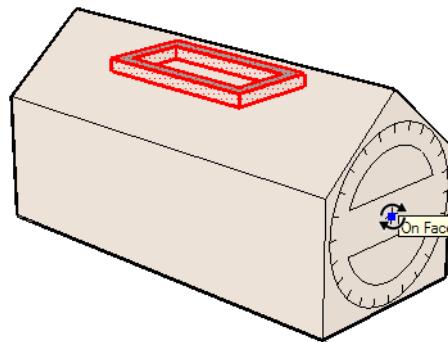
- Rotate it by clicking along the construction line.



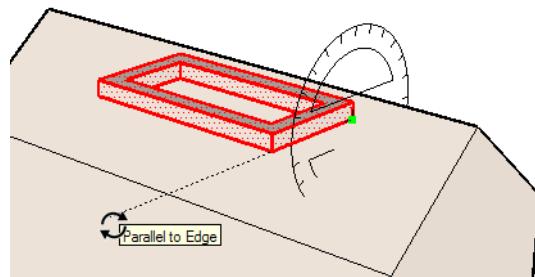
- The window can now be placed on the face, even though it is still not oriented as needed. While the window is still selected, activate **Move**, and drag one of the lower corner points to a point near the top of the roof face.



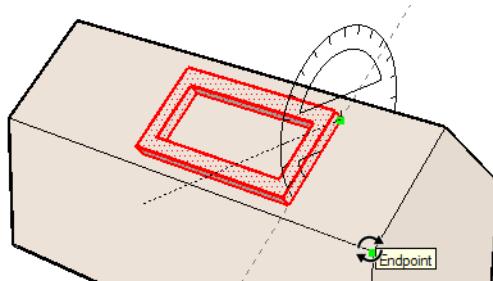
- Activate **Rotate**. This time the protractor needs to be oriented vertically. You could use one of the small vertical faces of the window, but the side of the house is easier to reference. Place the protractor along this face and press Shift to lock its orientation.



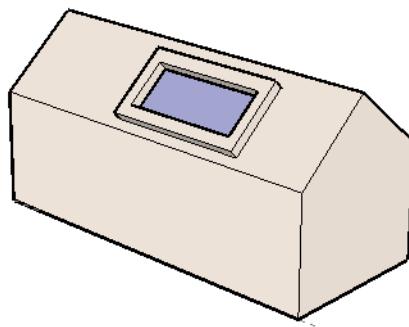
- Keeping Shift pressed, click a point where the window meets the roof. Align the reference line with the window edge shown.



- To rotate, click any point on the roof face.



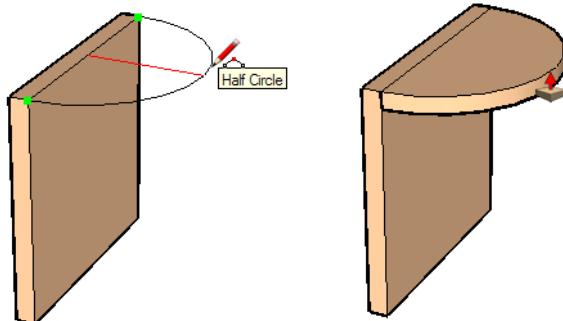
- Press Esc to deselect the window. The window is properly inserted, and cuts the face.



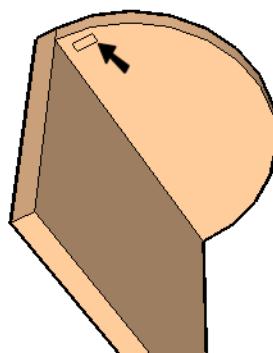
## Rotate - Copy

As with the **Move** tool, you can use **Rotate** to make rotated copies by using the *Ctrl/Option* key.

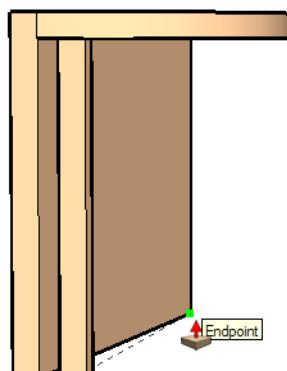
1. Start with a tall box and use **Arc** to create a horizontal half-circle from the top edge. **Push/Pull** the arc down slightly.



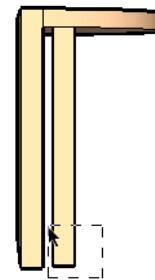
2. The next step is to create a column which will be rotated and copied along the periphery of the arc. Draw a small rectangle on the underside of the arc.



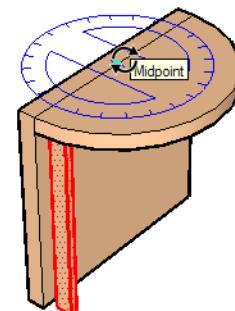
3. **Push/Pull** the rectangle down to the level of the bottom of the box.



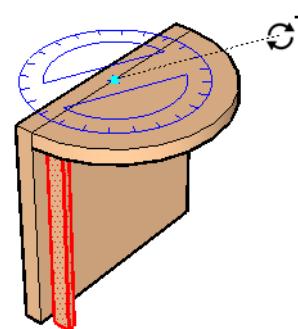
4. Activate **Rotate** on the selected column (use a right-to-left window to select it).



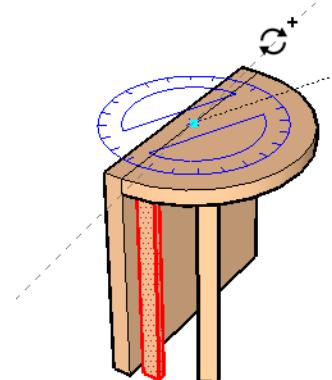
5. Anchor the protractor on the midpoint of the arc diameter line.



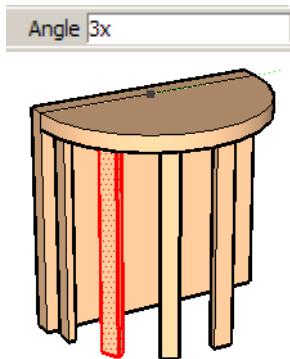
6. Press *Ctrl/Option* and click anywhere to place the reference line. Note that the cursor symbol now has a plus sign, indicating copy mode.



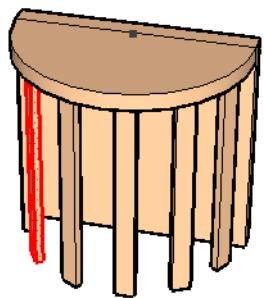
7. Move the cursor to rotate out a copy of the column. Place the copy a reasonable angle from the original.



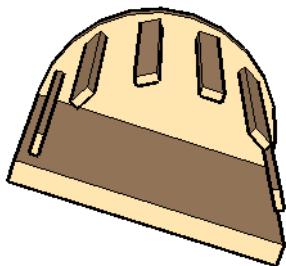
- As with **Move**, you can change the number of copies by entering a value. Type something like **3x**, then press Enter, to create a total of three copies (four total columns).



- If the number of copies is too high or low, type a different value (like **5x**).



That's all there is to it. If you look at the underside of the model, you can see that each column is rotated from the original, and the angular spacing is even.




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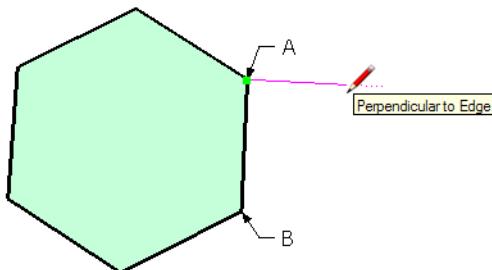
**NOTE:** For a more detailed exercise using **Rotate** with copying, see "Multiple Rotated Copies" on page 145.

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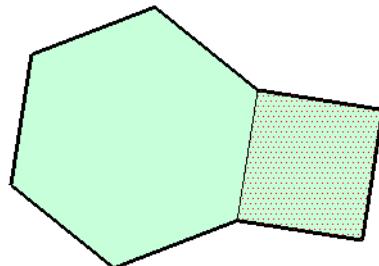
## Defining the Rotation Axis

In the previous exercise, the rotation protractor was set along to a standard plane (like red-green) or along an existing face. This exercise shows how to set your own rotation axis.

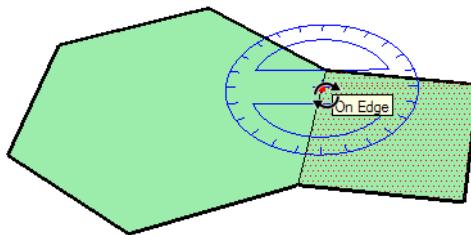
- Start by drawing a hexagon (use the **Polygon** tool, specifying 6 sides). Use **Line** to start a rectangle off one of the sides. For any edge of the hexagon, start the line at Point A, hover over edge A-B, and get the "Perpendicular to Edge" constraint.



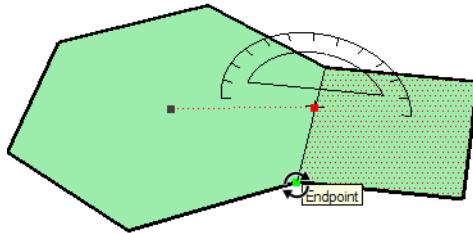
- Complete the rectangle and select it.



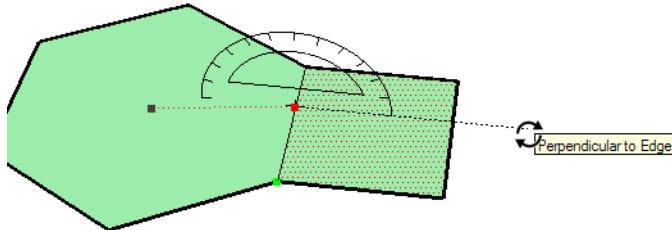
- Activate **Rotate**. If you place the protractor along the common edge, it will only align to the existing faces.



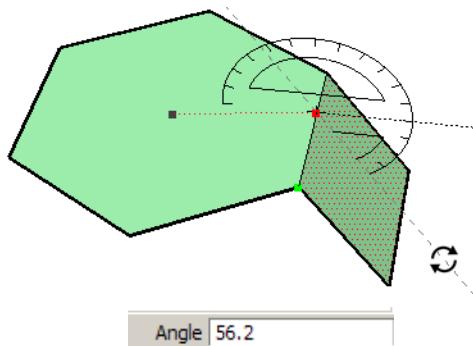
4. Here's how to switch the rotation plane: click the edge and keep the mouse button pressed. The protractor center stays on the edge, and you can move the mouse to pivot it around. To fold the rectangle over, align the protractor by clicking an edge endpoint.



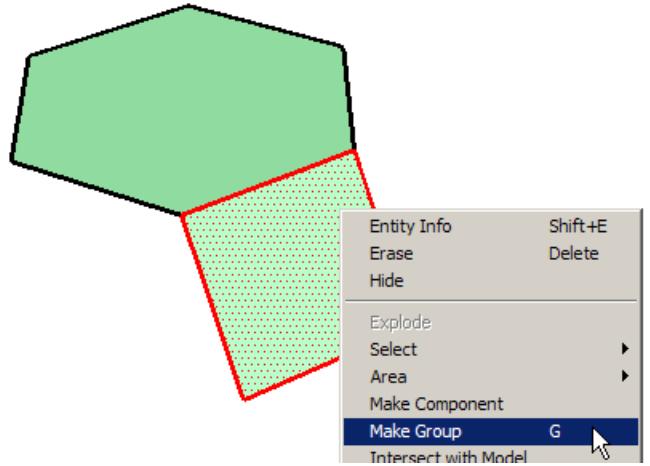
5. This sets the rotation plane perpendicular to the rectangle. Set the orientation along the rectangle...



...and rotate it down. The rotation angle is listed in the VCB; you can change it by entering a different value if you like.

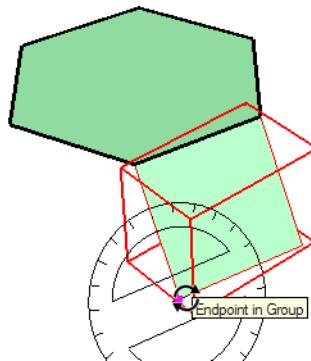


6. You can use this method to define any rotation axis. We will rotate the rectangle again, but first it must be prevented from "sticking" to the hexagon. Select the rectangle (double-click on it to select its face and edges), right-click, and select **Make Group**.

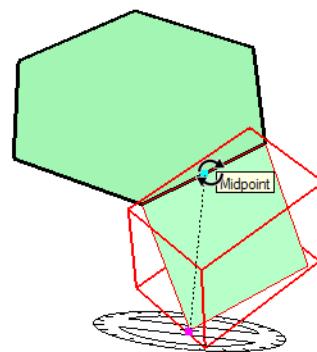


**NOTE:** For details on how grouping prevents objects from sticking, see "Introduction to Groups" on page 179.

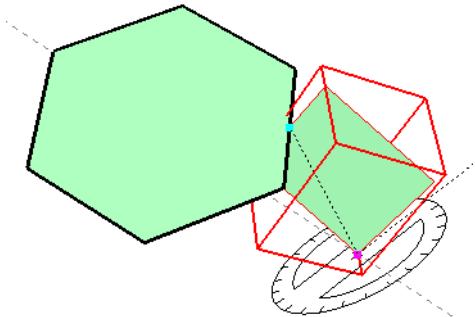
7. Rather than aligning the protractor to an edge, place the cursor at the lower endpoint shown.



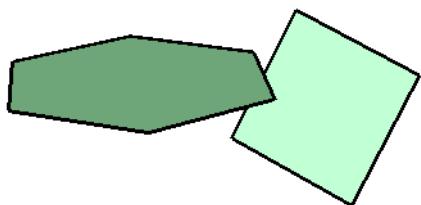
8. Click and hold the mouse button, and click the top midpoint. This defines the rotation axis.



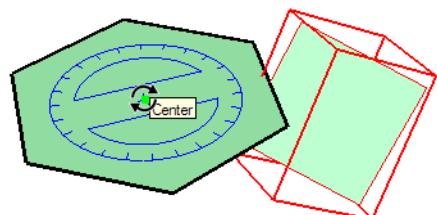
- Click anywhere to set the protractor orientation, and click again to turn the rectangle about the rotation axis.



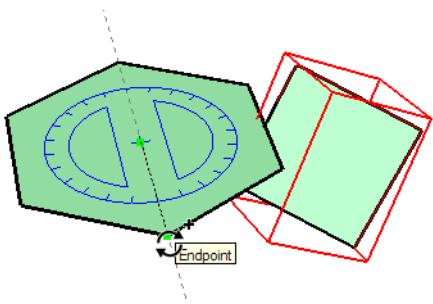
Here is the result: the rectangle is still joined to the hexagon at its midpoint.



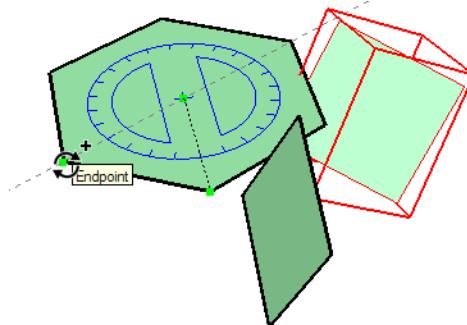
- Now we can copy this rectangle to every side of the hexagon. (If you did the exercise “Rotate - Copy” on page 61, this will be familiar.) Select the rectangle, activate **Rotate**, and place the protractor at the center of the hexagon.



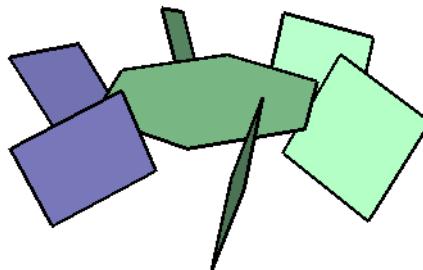
- Press **Ctrl/Option** to make copies, and click any endpoint of the hexagon to orient the protractor.



- Click any adjacent hexagon endpoint to define the rotation angle.

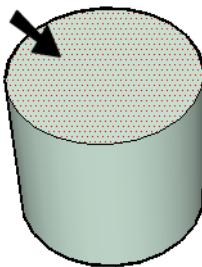


- After creating the first copy, enter **5x** to create a total of six rectangles. The result is a basic turbine form.

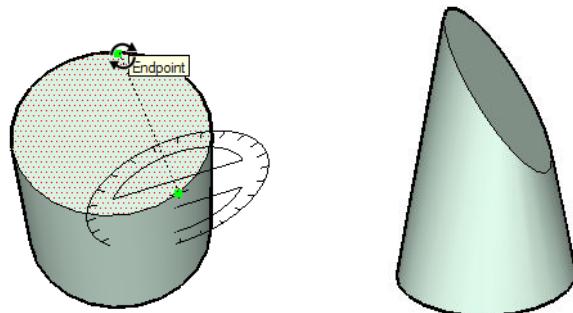


You can also use **Rotate** on one or more faces of a 3D objects.

- For a simple example, create a cylinder and select the top face.



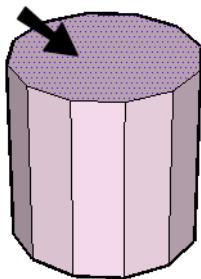
- Activate **Rotate**, and use the click-and-hold method to define the rotation axis between two endpoints of this face. When you rotate the face, you get this result:



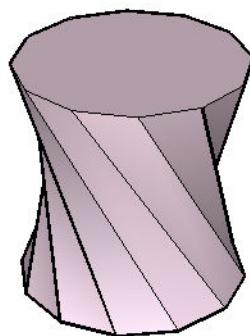
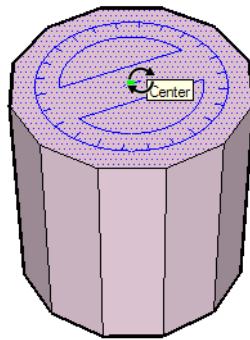
## Using Rotate to Twist

Keeping with the theme of rotation a single face, **Rotate** can also be used to twist a 3D object.

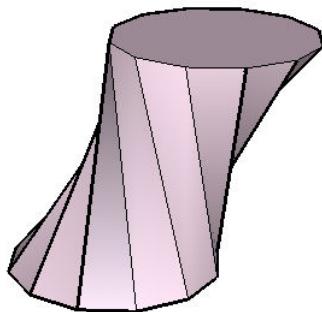
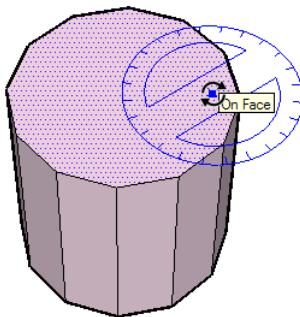
1. Create a polygon (this one has 12 sides) and select the top face.



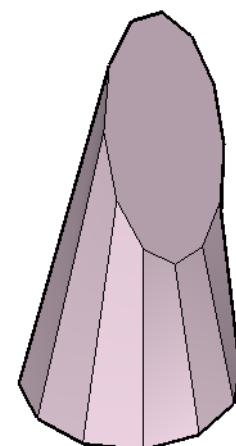
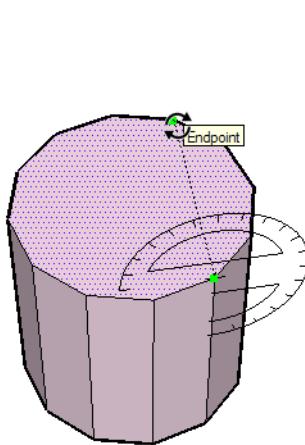
2. Activate **Rotate** and place the protractor at the center of the top face. Rotate it around to twist the cylinder.



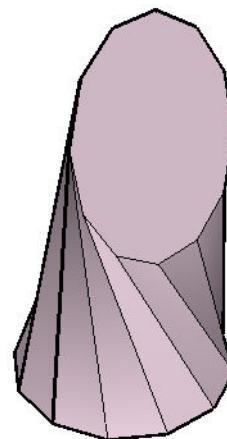
3. Undo, and this time place the protractor off-center. Now the cylinder both twists and skews.



4. Undo and rotate again, defining the rotation axis like this:



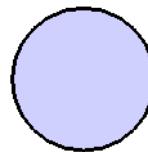
5. Rotate the top face about its center for this effect:



## Scale

Use **Scale** to resize or stretch selected faces, relative to other geometry. You can also use **Scale** to mirror objects, in effect, turning them inside-out.

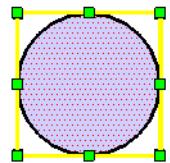
1. Draw a multi-segmented polygon (not a circle) in the red-green plane.



2. Activate **Scale** (**Tools / Scale**).

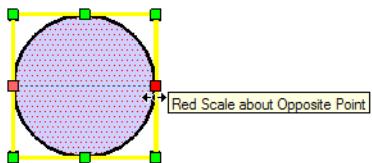


- Select the polygon and press Enter. The circle is surrounded by a bounding box, with eight drag handles.

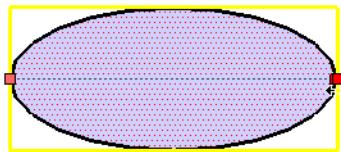


The side handles (as opposed to corner handles) are used to scale the geometry in one direction. A tool tip appears on each handle, telling you what kind of scaling it will do, and from what point.

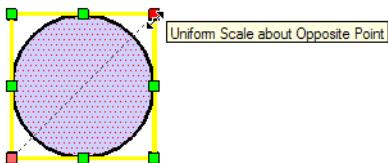
- Hover over a side handle. Moving this handle will scale relative to the opposite side handle.



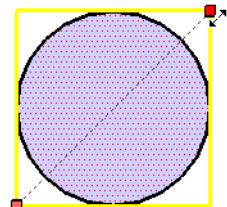
- Drag, or click-move-click, this side handle. By default, moving a side handle causes non-uniform scaling - which means the aspect ratios are not maintained. This is a handy way to create an oval from a circle.



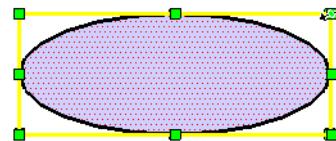
- Undo, and hover on one of the corner handles.



- Move this handle to resize. By default, corner handles cause uniform scaling in two directions - the circle remains a circle.

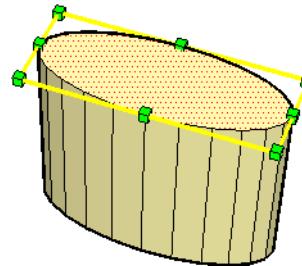


- Undo again. Using Shift toggles between uniform and non-uniform scaling. Drag the same corner handle, while keeping Shift pressed. This way you can create an oval using a corner handle.



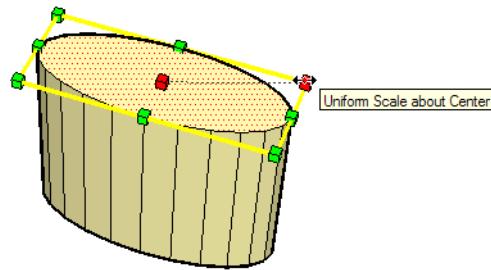
Similarly, if you use Shift on a side handle, the scaling would be uniform.

- Push/Pull** this oval up. Select the top face and then activate **Scale**. (Like the other tools, Windows users can either select the objects and then activate **Scale**, or select the objects from within **Scale**.)

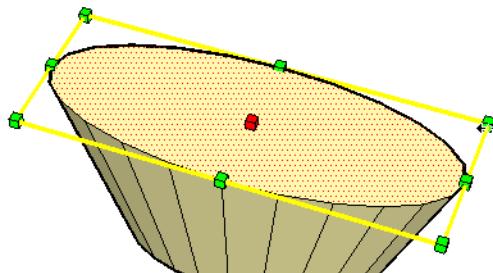


*Mac: Objects must be selected before **Scale** can be activated.*

- Hover on one of the corner handles, and press *Ctrl/Option*. Rather than scaling from the opposite handle, you are now scaling relative to the center of the face.

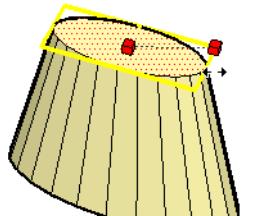


- Drag the corner handle while keeping *Ctrl/Option* pressed, to scale the face outward from the center. This is how to give a form a draft angle.



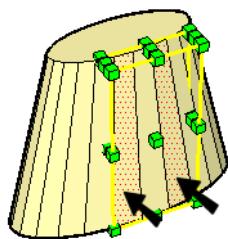
**NOTE:** If you press **Ctrl/Option** and **Shift** together on this face, you can scale non-uniformly about the center.

12. Drag back toward the center using **Ctrl/Option**. Look at the VCB, and note that the scaling snaps to whole values (1.0, 2.0, etc.) and half values. Release the handle when the scale is 0.5.

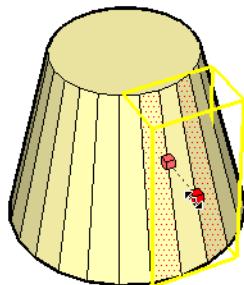


Scale 0.50

13. So far we've scaled only in 2D. Scaling in 3D works the same way. Select two front faces and activate **Scale**. Now there are 26 handles - corners, sides, and bounding box faces.

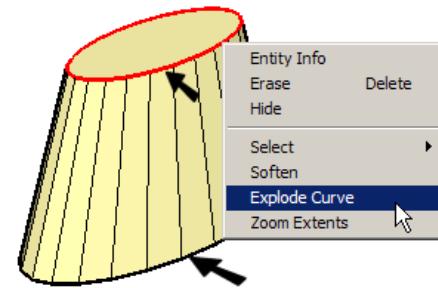


14. Drag the handle at the center of the front of the bounding box outward from the model. The entire model scales with these faces. Try dragging different handles to see how the entire model adjusts.

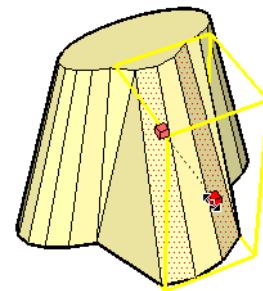


15. **Undo** to return to the model before you did any 3D scaling. The reason the entire model was affected by the scaling of any two faces is that the top and bottom objects are single objects (scaled polygons). When scaling, single objects keep their basic form.

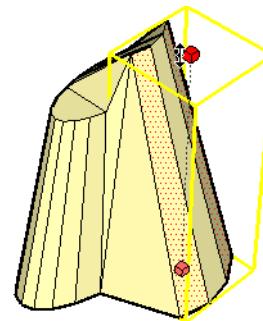
16. To change this behavior, right-click on both the top and bottom edges of this form and select **Explode Curves**.



17. Now when you scale the same faces as before, only these faces change, in addition to the faces immediately adjacent to them.

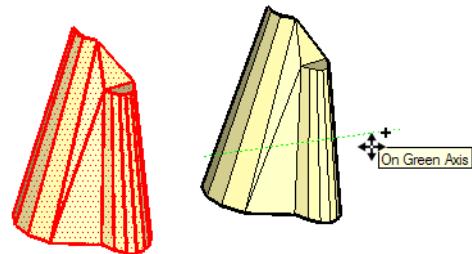


18. Drag the top of the bounding box upward.

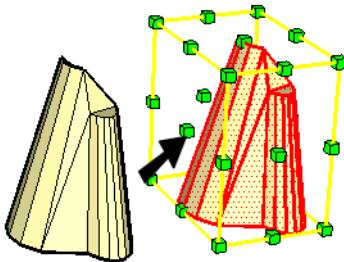


Note that scaling causes faces to fold automatically. Fold lines are added to faces that were previously planar.

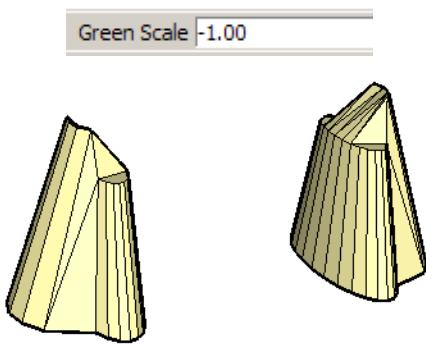
19. Scaling can also be used for mirroring, or turning objects inside out. Start by using **Move** with **Ctrl/Option** to make a copy of the entire form.



20. Activate **Scale**, select the copied form, and press Enter. Start dragging the handle at the center of the front of the bounding box.



21. Drag this handle toward its opposite handle, stopping when the VCB reads -1.0. The form now faces the other direction.

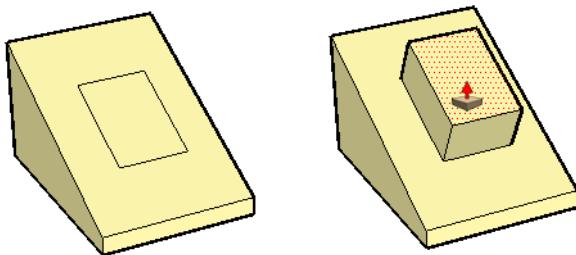


**TIP:** You can make use of components, together with the **Scale** tool, to make mirrored copies of objects. See "Using Components for Mirroring" on page 229.

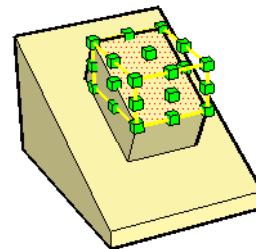
## Scaling with the Axis Tool

By default, the **Scale** bounding box reflects the current red-green-blue directions. But you might need to scale objects according to a different set of axes.

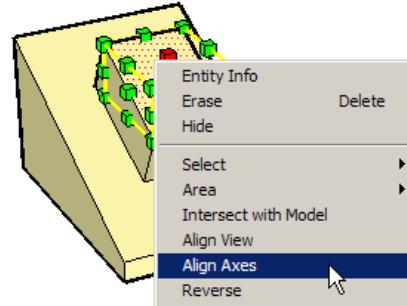
1. Start with a form with a sloped face. Draw a rectangle on the sloped face and **Push/Pull** it outward.



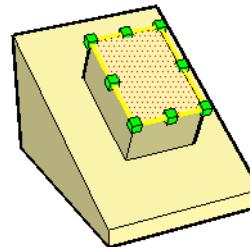
2. Select the top face of this small box and activate **Scale**. You get a 3D bounding box, reflecting the axes in which the original form was created.



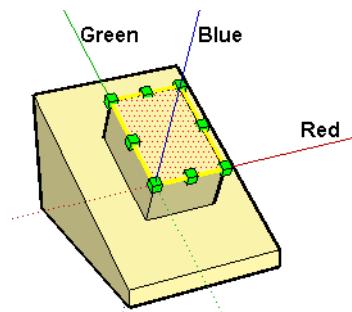
3. To change the axes, you could use the **Axes** tool (see "Axes" on page 70), but in this case there is an easier way. While **Scale** is still active, right-click on the sloped face and select **Align Axes**.



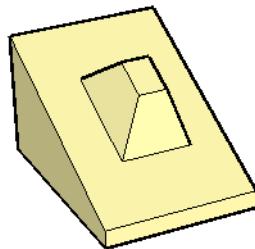
4. Now the scale box is 2D, and aligned to the sloped face.



5. If the axes are not displayed, turn them on by selecting **View / Axes**. Red and green are aligned to the face edges, and blue is normal to it.



6. Use **Ctrl/Option** and a corner handle to give the box a draft angle.

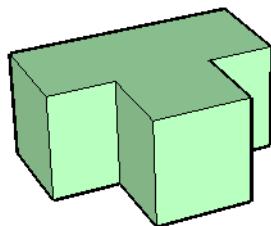


7. If you plan to continue working in this file, the axes should be reset or you will get unexpected results when creating new objects. Move the axes back to their original location by right-clicking on any axis and selecting **Reset**. If you want to start the next exercise in a new file, the axes automatically reset.

## Offset

This tool takes all the edges of a selected face, or a series of connected edges in the same plane, and offsets them.

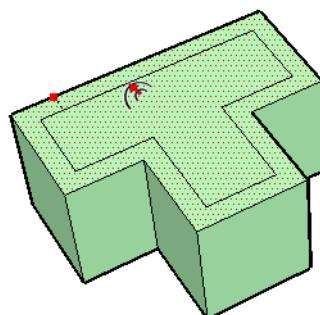
1. Start with a form like this.



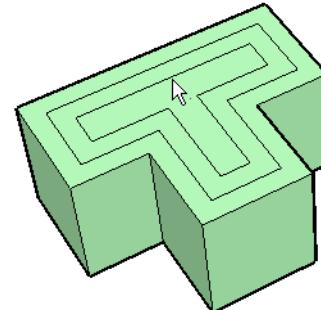
2. Activate **Offset** (**Tools / Offset**).



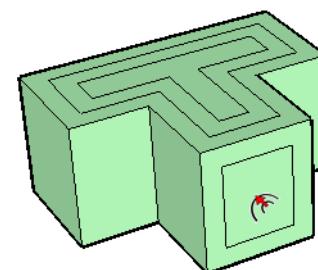
3. Select the top face and press Enter. Move the cursor inward, and the offset distance appears in the VCB. Click to place the offset face inside the original. This creates a new face.



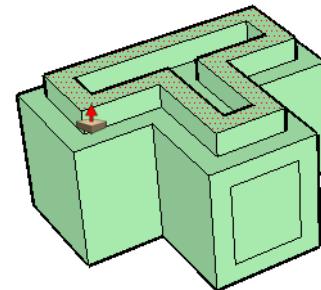
4. Double-click on the inner face to create another offset, using the same offset distance.



5. The repeat offset does not have to be on the same face; double-click one of the vertical faces.



6. **Push/Pull** up the middle face on the top, to create a parapet or railing wall.

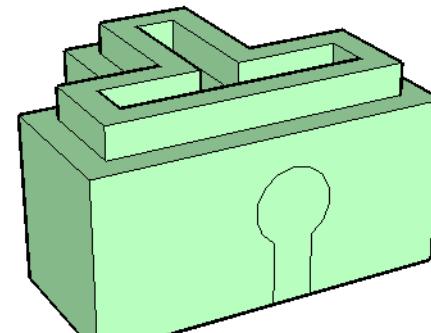



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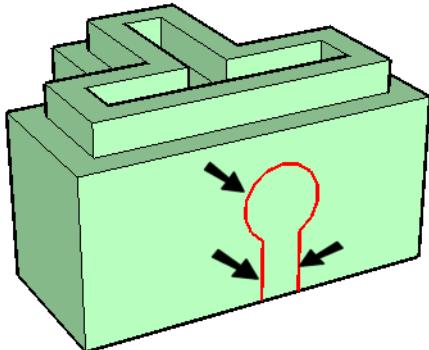
*NOTE: For another example of using **Offset** to create roofs and parapets, see "Using Offset for Roofs" on page 155.*

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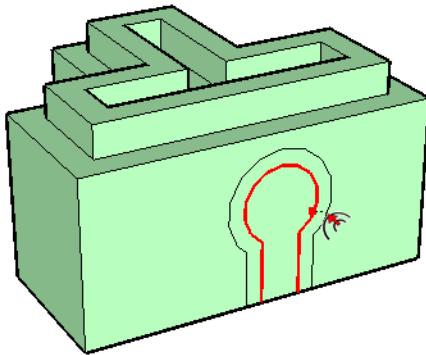
7. Orbit around to the long wall and create an arched doorway (using **Rectangle** and **Arc**, erasing the common edge).



8. Offset can also be used on a series of edges, rather than an entire face. Select all edges of the doorway, not including its bottom edge.



9. Activate **Offset** and create an inner (or outer) doorway shape. Note that the two ends of this edge chain remain connected to the bottom edge.

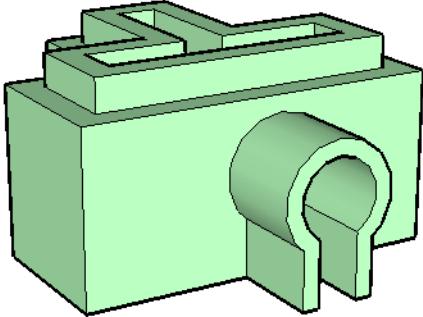



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**NOTE:** As with most tools, in Windows you can activate **Offset**, then select the face or edges, then press *Enter* and set the offset distance. On the Mac, you must select the face / edges first, then activate **Offset**.

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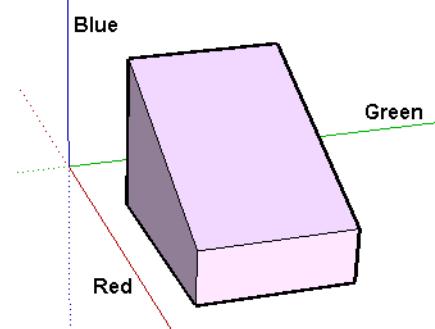
10. Push/Pull the doorway face outward and you have a tunnel or covered entry.



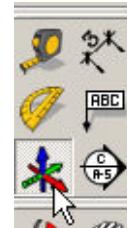
## Axes

This tool can move the origin and/or change the orientation of the axes.

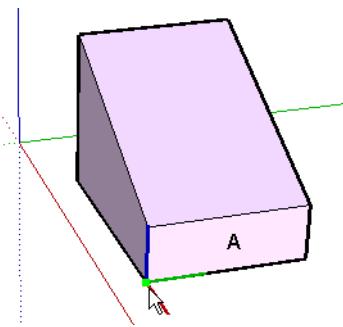
1. If the axes are not displayed, select **View / Axes**.
2. Draw a box with a sloped face, based in the default red-green plane.



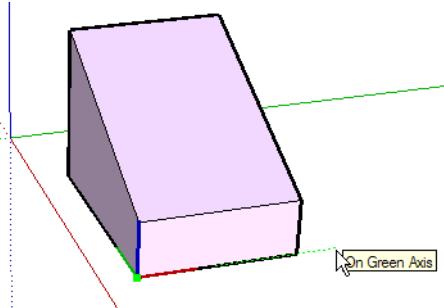
3. Activate Axes (**Tools / Axes**).



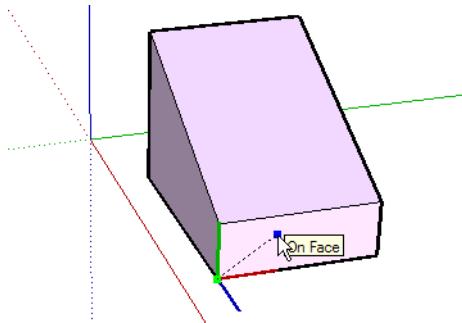
4. We will orient the axes to Face A. Start by locating the origin at the lower left corner.



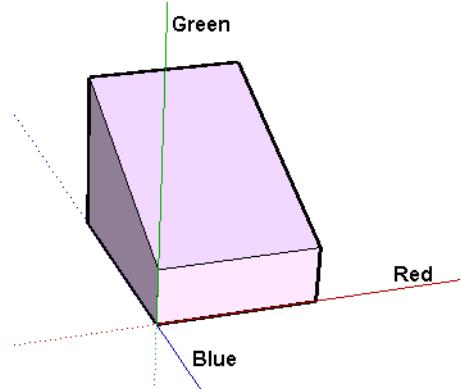
5. The next click defines the red direction. Click anywhere along the lower edge.



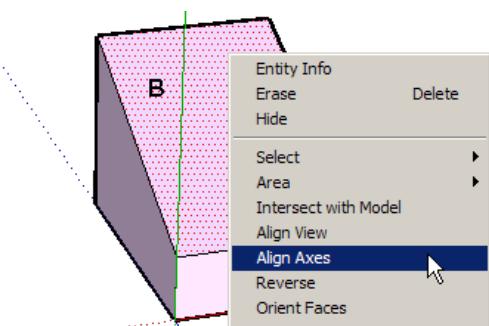
6. The last click defines the green direction. Select any point on Face A.



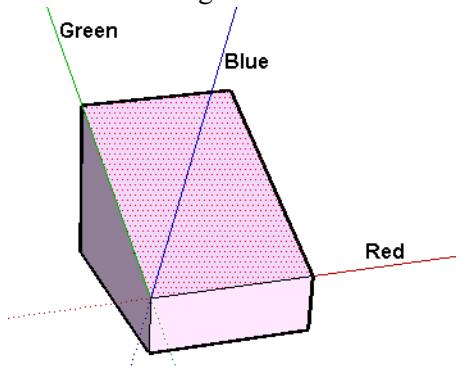
The red and green axes are now aligned with Face A, and the blue axis is normal (perpendicular) to it.



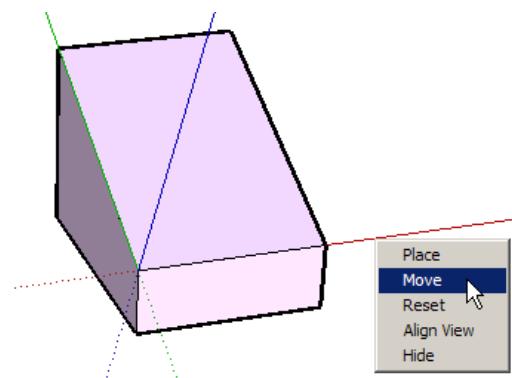
7. To align the axes with Face B, you could use the same method, but an easier way is provided in the popup menu. Right-click on Face B and select **Align Axes**.



8. The axes are now aligned with Face B.

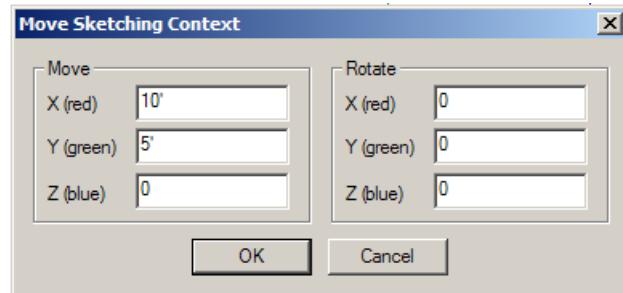


9. You can also move and/or rotate the axes by specified values. Right-click on any axes and select **Move**.

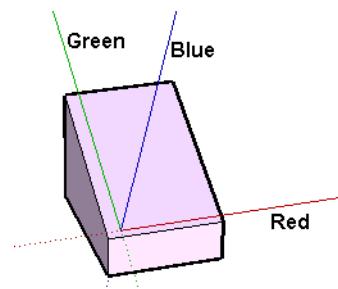


**TIP:** Selecting **Place** from this menu is equivalent to activating **Tools / Axes**.

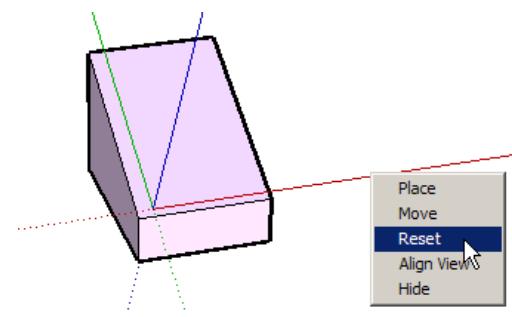
10. Enter **Move** values for the axes you want to move. For Architectural units, if you want feet, be sure to use the foot symbol; otherwise inches are assumed.



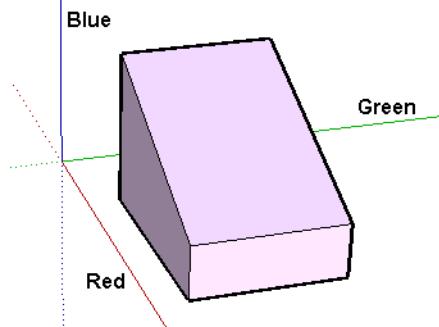
11. Click OK, and the axes move accordingly.



12. To move the axes back to their original location, right-click on any axis and select **Reset**.



We're now back where we started.



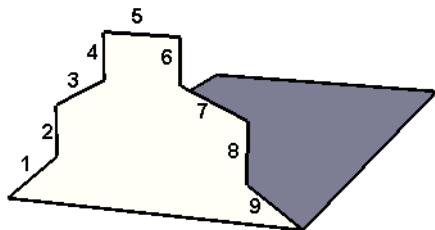
There are many cases in which you might need to move or align axes. One example is while using the **Scale** tool. See "Scaling with the Axis Tool" on page 68.

## Displaying and Smoothing Edges

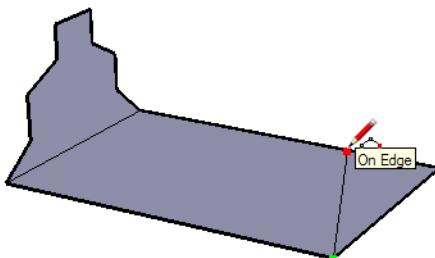
This section covers ways to show, hide, and soften edges of curved objects. For information on ways to display the model itself (shaded, wireframe, transparency, etc.), see "Display Settings" on page 438.

When you are creating curved objects such as spheres, cylinders, etc., SketchUp enables you to display and manipulate these objects either as faceted objects, or as smooth, single objects.

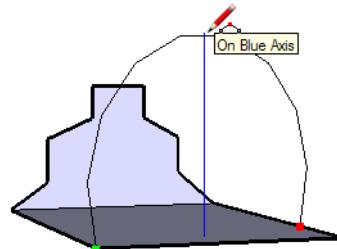
1. First we will construct the object. Start with a horizontal rectangle, and along one edge make a vertical face like this, with nine segments.



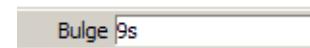
2. At the other end of the rectangle, start an arc with endpoints like this:



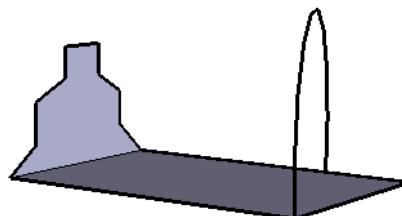
3. Make the bulge vertical (blue direction).



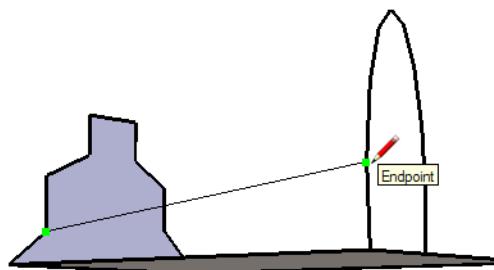
4. After the arc is complete, change the number of sides to 9 (just type "9s" - the number appears in the VCB - and press Enter).



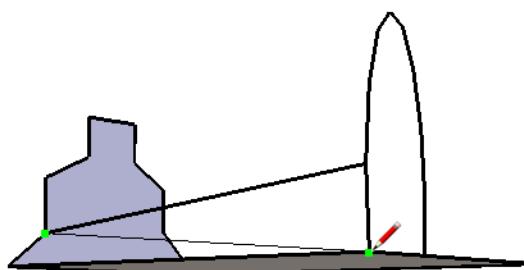
Now the shapes at either end of the rectangle have the same number of segments.



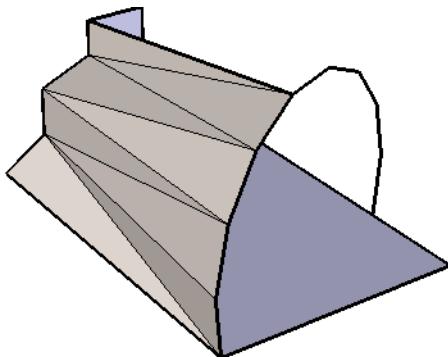
5. We'll fill in the space between the two arcs by drawing lines. Draw a line between the first set of segment endpoints.



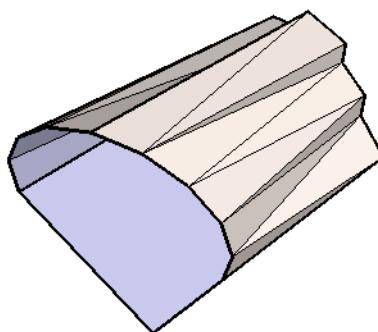
6. Create the first two triangular faces by adding a diagonal line.



7. Continue in this manner along the remaining segments...



... until all 18 faces have been created.



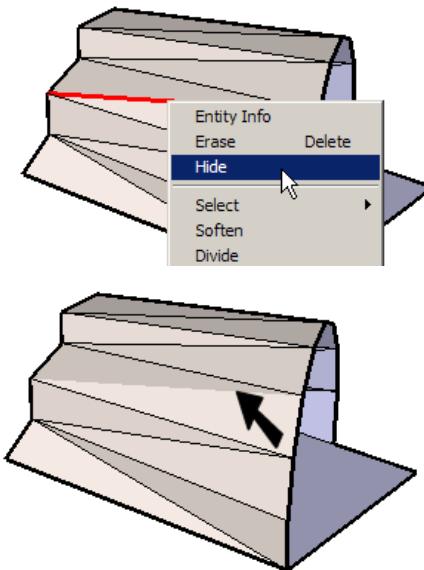

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**NOTE:** If any faces appear in the **Face Back** color, you can change this by selecting them, right-clicking, and selecting **Reverse Faces**.

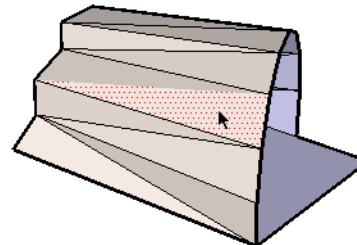
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There are two ways to control edge display: hiding and softening. First we will look at hiding.

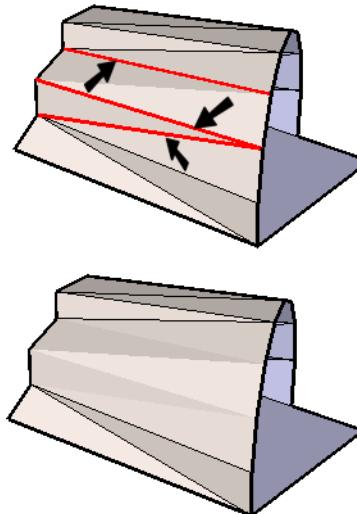
8. Right-click on any interior edge and select **Hide**. The edge disappears.



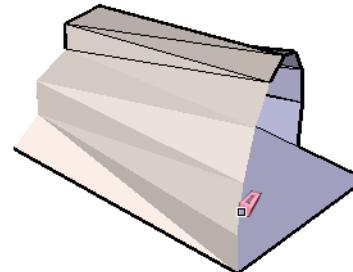
9. Hiding edges does not change the structure of the adjacent faces. Activate **Select** and select either face next to the edge. Each face remains a separate object.



10. Select a few more edges and hide them by selecting **Edit / Hide**. (You could also right-click and select **Hide**.)



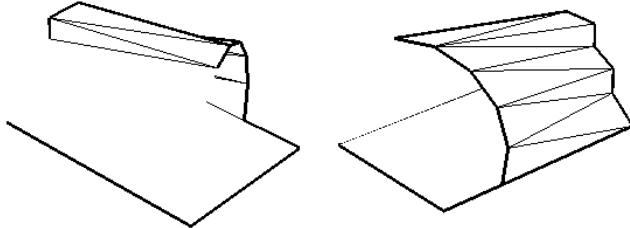
11. For another easy way to hide edges, activate **Erase** and press Shift. You can click individual edges or press and drag over the edges you want to hide. Use this method to hide interior and exterior edges along one side of the arc.



12. Unlike softened edges (as we will see later), hidden edges are always hidden, no matter how you orbit the model. This means that profile lines may be hidden. Turn on **Hidden Line** display.



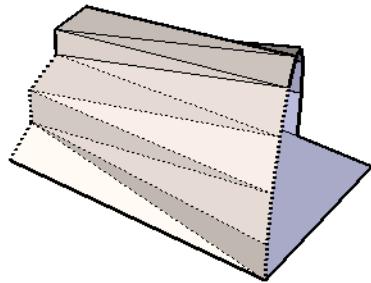
The edges that were hidden are invisible. Even if you orbit the model, you will not see these edges; its profile lines are hidden.



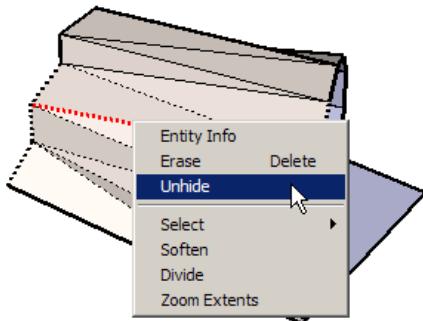
13. Return to **Shaded** mode.



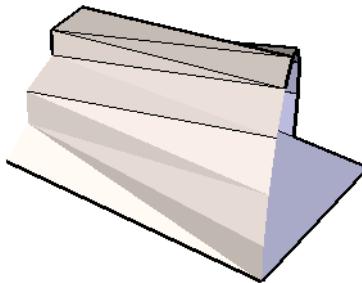
14. To see the edges that were hidden, select **View / Hidden Geometry**. Hidden edges appear as dotted (not dashed) lines.



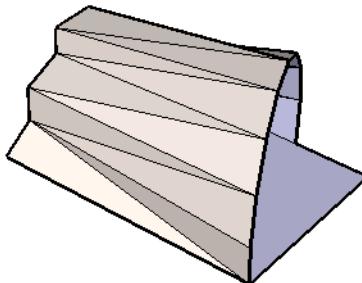
15. To redisplay a hidden edge, right-click it and select **Unhide**.



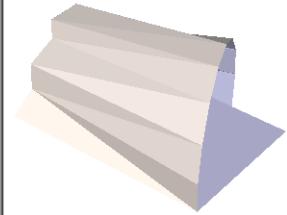
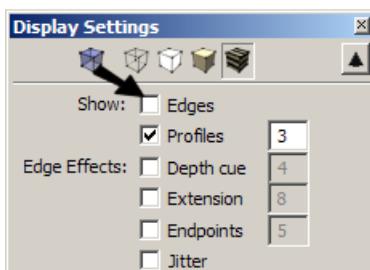
16. Blank the hidden edges again, and you can see the edge you made visible.



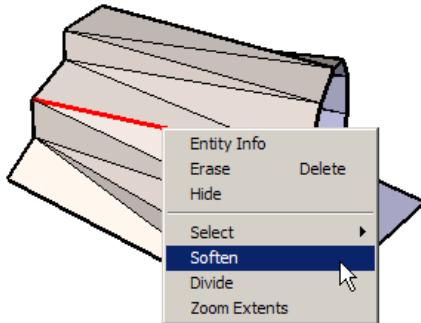
17. To display all hidden edges, select **Edit / Unhide / All**.



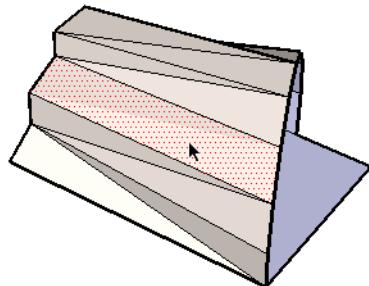
*NOTE: If you always prefer to work without edges, you can set uncheck Edges in the **Display Settings** window (**Window / Display Settings**).*



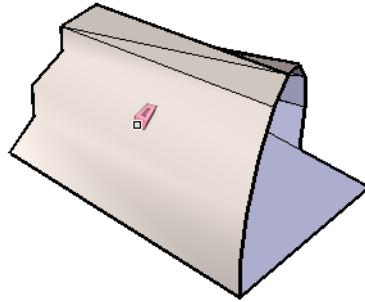
18. Softening edges is similar to hiding them, but can be used for smoothing as well. Right-click an edge and select **Soften**.



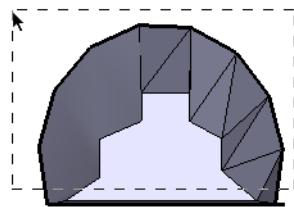
19. The edge is invisible. But in contrast to hiding the edge, a softened edge joins the adjacent faces into one face. Verify this by using **Select**.



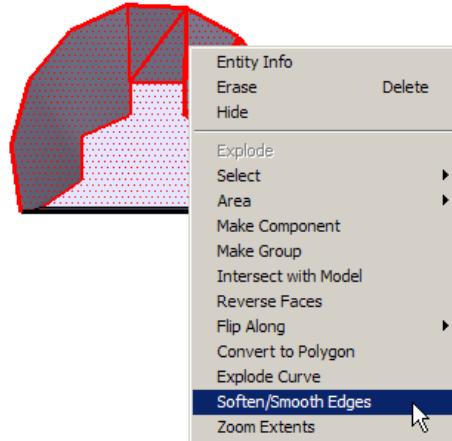
20. To soften several edges, activate **Erase** and press *Ctrl/Option*. Note that in the area where the edges are softened, the face looks smooth.



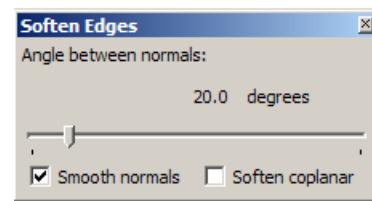
21. You can also soften a group of selected edges. To select all the remaining edges of the arc face, orbit so that you are facing into the arc, activate **Select**, and use a right-to-left selection window.



22. Right-click on one of the selected edges and select **Soft/Smooth Edges**.



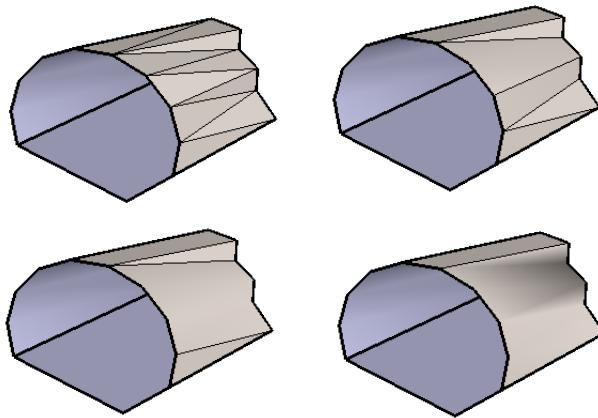
The **Soften Edges** window has a slider that you can use to control which edges are softened. (You can also display this window by selecting **Window / Soften Edges**.)



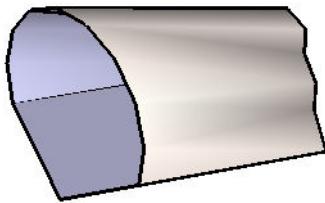
**NOTE:** **Soften Edges** is one of SketchUp's stacking windows. See "Stacking Windows" on page 437.

When **Angle Between Normals** is zero, no edges are softened. When **Smooth normals** is checked, the resulting faces lose their faceted look.

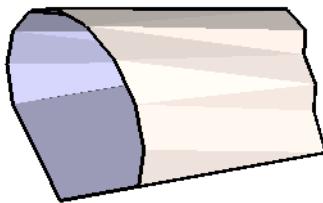
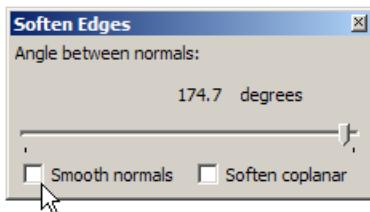
23. Move the slider from 0 degrees to the other end (180 degrees) to see how the edges disappear.



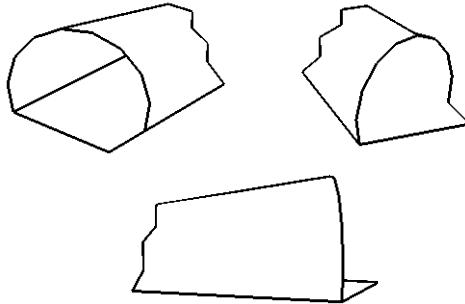
24. At a certain angle, all the edges will be softened, resulting in one, smooth face. Now this face can be selected and manipulated as one face - it is no longer faceted.



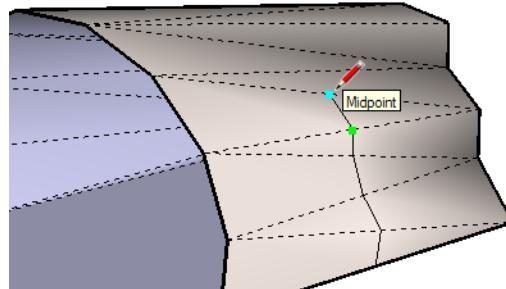
25. Deselect the **Smooth normals** option. The edges are still hidden, but the face now looks faceted. It still acts as one face, however, because this option only controls appearance.



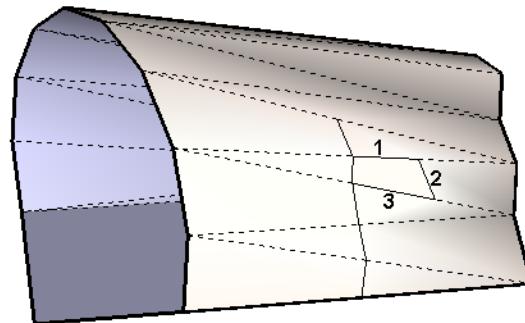
26. Turn on **Hidden Line** display. Unlike hidden edges, softened edges are always visible in profile. You can orbit the model and always see the profile lines.



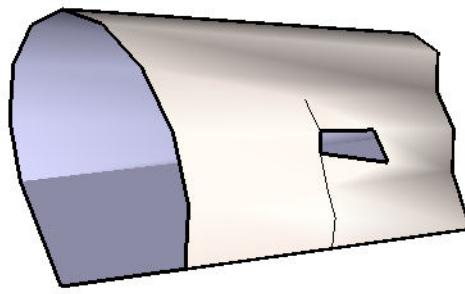
27. Return to **Shaded** display. Display the softened edges by selecting **View / Hidden Geometry**. Softened edges are shown as dashed lines, as opposed to hidden edges which are dotted. Draw a few lines between the midpoints of these edges.



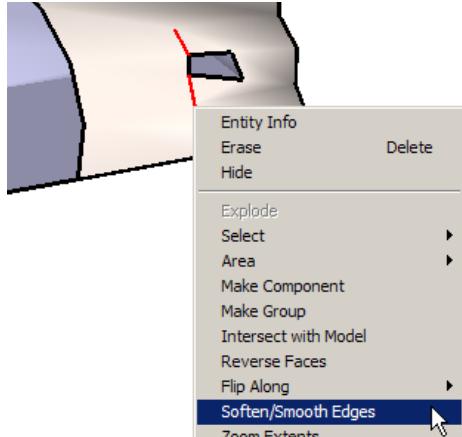
28. Draw three more lines to create a small window in one of the faces. This would not be possible to do if the softened edges weren't displayed.



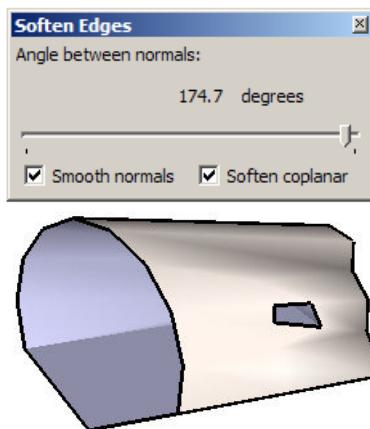
29. Blank the softened edges, and erase the window cutout.



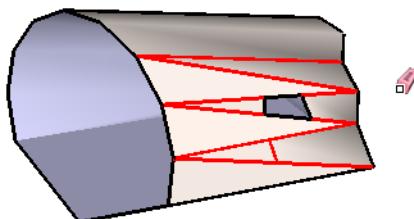
30. The remaining edges lie within existing faces (even though you can't see the faces themselves). You can soften these edges as well - select them all, right-click, and select **Softensmooth Edges**.



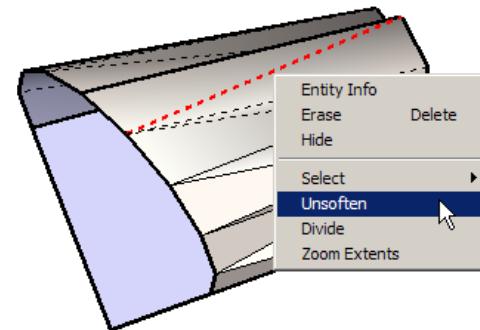
31. Make sure **Softens coplanar** is checked - this softens any interior, coplanar edges



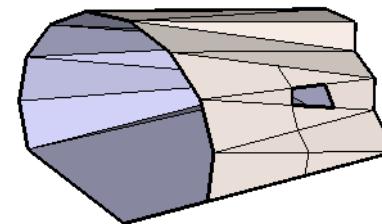
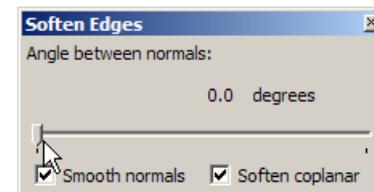
32. You can unsoften edges that you cannot see. Activate **Erase**, and press both Shift and Ctrl/Option. Hold and drag the cursor over a few edges, which become highlighted.



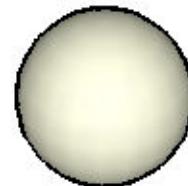
33. To unsoften specific edges, you need to be able to see the edge first. Display hidden edges, then right-click on an edge that is still softened. Select **Unsoften**.



34. To unsoften all edges, select them all using the selection window you used before. Right-click and select **Select/Smooth Edges**, and make sure the slider is set back to zero degrees.



Softening edges is an extremely useful tool for both controlling display and changing the object face structure. For another example of this, look at the preinstalled component **SimpleSphere02** (found in the **Shapes** category).

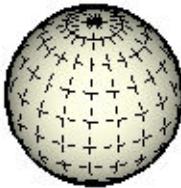



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*NOTE: If you don't know how to do this, see "Inserting and Editing Predefined Components" on page 188.*

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Displaying hidden geometry will show you how this object is actually constructed. You can then unsoften the edges,



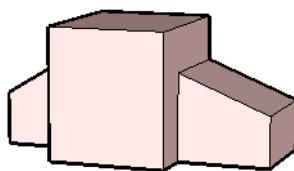
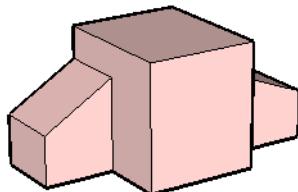
## Annotation Tools

SketchUp provides two ways to add descriptions to your model: text and dimensions.

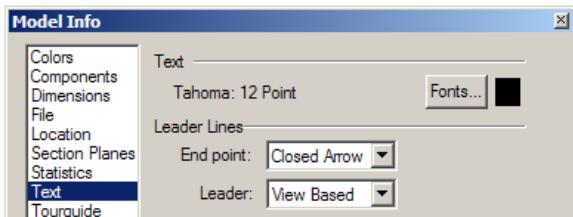
### Text

Text can be placed in your model in two ways: attached to geometry or “floating” in space.

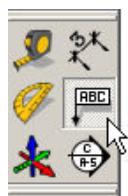
1. Start out a building like this, with one main section and two slope-roofed wings.



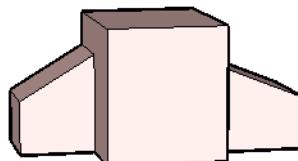
2. Before creating text, we will set the type of text to be used. Open the **Model Info** window to the **Text** page, and make sure **Leader** is set to **View Based**, and **End Point** is set to **Closed Arrow**. For the font and color, use whatever you like.



3. Activate **Text** (**Tools / Text**).

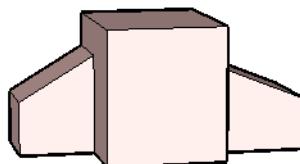


4. For the first text object, click anywhere in the blank space in front of the building.



[Text]

5. Type something like “Proposed Museum” and press Enter twice to complete the text. (Pressing Enter only once starts a new line of text.)

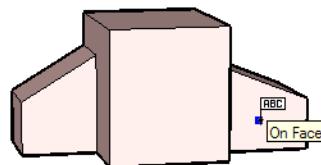


Proposed Museum



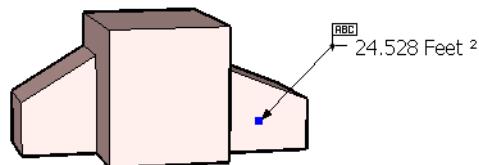
The text now appears as one line, in the selected font and color.

6. For the next object, click the face shown.



Proposed Museum

7. When you first click a surface or edge (as opposed to blank space), you are creating a leader. By default, the area of the face is listed as the text, but this can be changed. Click a second point to determine the location of the start point of the text.



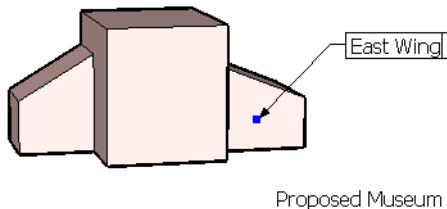
Proposed Museum

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*NOTE: For details on using **Text** to measure length and area, see “Dimensioning Using the Text Tool” on page 92.*

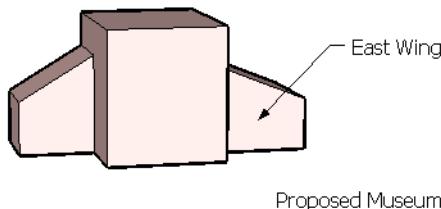
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8. You can now overwrite the area text. Type “East Wing”...



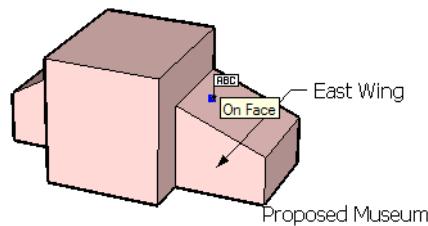
Proposed Museum

9. ... then click outside the text area to complete the text. (Pressing Enter twice also works.)



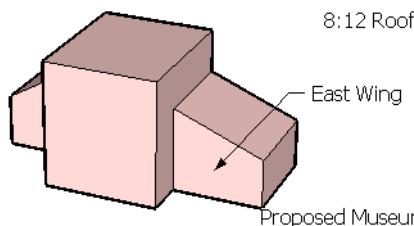
Proposed Museum

10. For the next text object, click on the sloped roof face shown.



Proposed Museum

11. Then *double-click* where you want the text. Overwrite the area with “8:12 Roof” and press Enter twice. This creates text with a hidden leader.

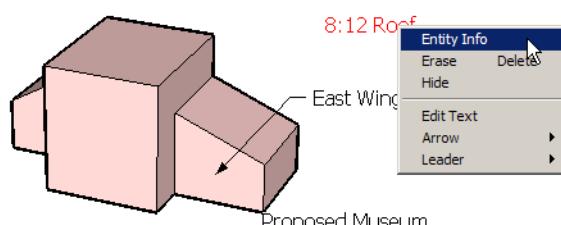


8:12 Roof

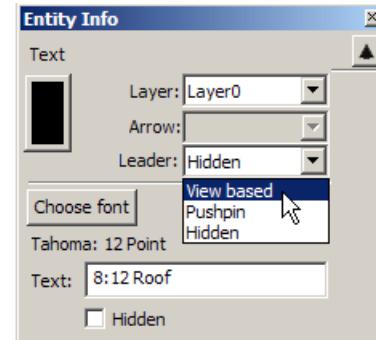
East Wing

Proposed Museum

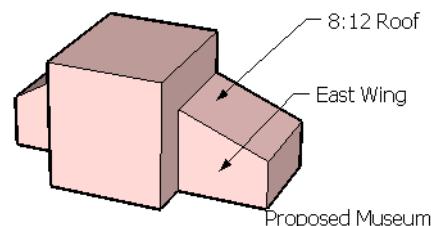
12. To display the leader for this text, right-click on the “8:12” text and select **Entity Info**.



13. In the **Entity Info** window, change **Leader** to **View-based**.

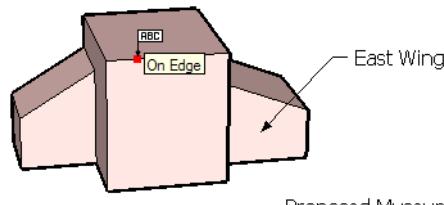


Now the text has a leader.



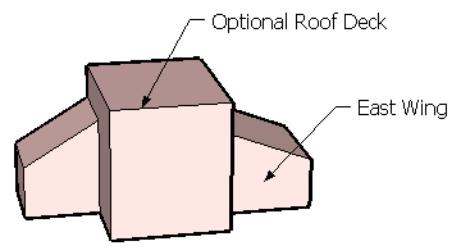
Proposed Museum

14. You can also fix a leader to an edge. Click the top front edge of the rectangular section.



Proposed Museum

15. The default text for edges is the measured length. Click to place the text and overwrite the text with something like “Optional Roof Deck.” (Like with a face, if you double-click the text location, you will get a hidden leader.)



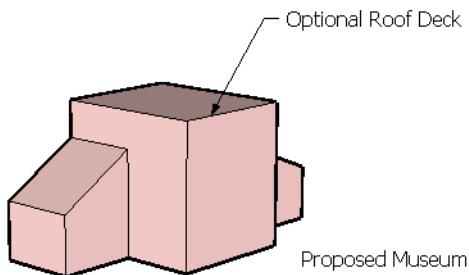
Proposed Museum

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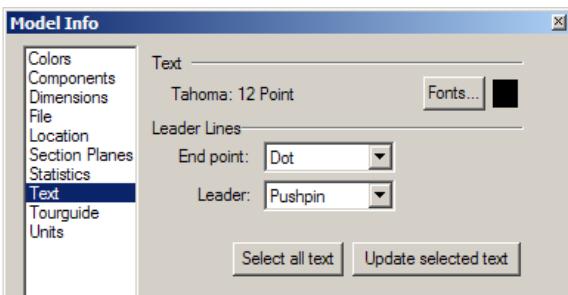
**NOTE:** You've seen what happens when you click an edge or face. When you apply text to a component or group, the default text is the component/group name. You can change names of groups in the Outliner. The Outliner can also be used to assign different names to component instances. See "The Outliner: Manipulating Groups and Components" on page 206.

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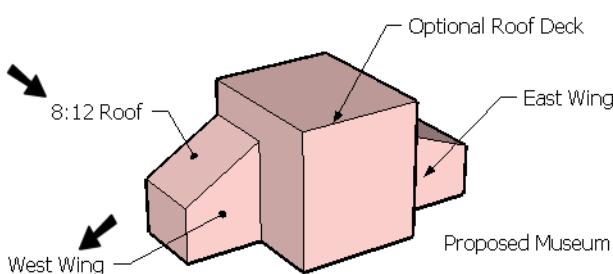
16. The type of text we've been using is view-based, meaning that it always tries to maintain its orientation relative to where it was originally placed. If you orbit so that any leader line is hidden, the entire text object disappears.



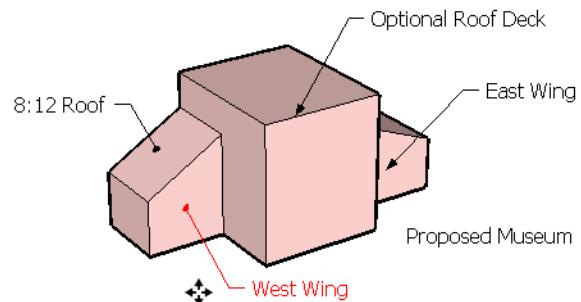
17. Open **Model Info** and change the **Leader** to **Pushpin** and the **End point** to **Dot**. This setting affects text drawn from now on - it doesn't change what's already there. (There are ways to change existing text, as you'll see.)



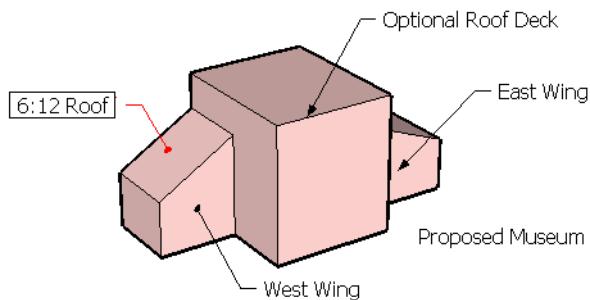
18. Add the two objects shown below to the other wing. Note the different leader end point.



19. While you are in **Text** mode, you can move any text object. Click on "West Wing" once, then click again to relocate it.



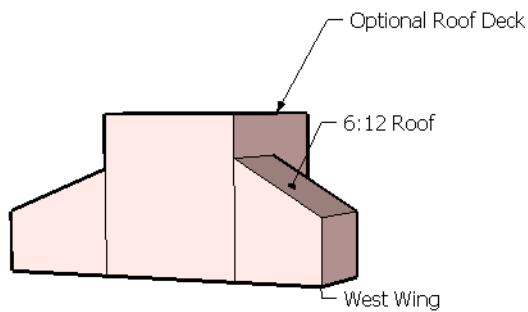
20. You can also edit text. Double-click on "8:12 Roof" and change it to "6:12." Click outside the text area to implement the change.



**TIP:** Another way to change text is to right-click on a text object and select **Edit Text**.

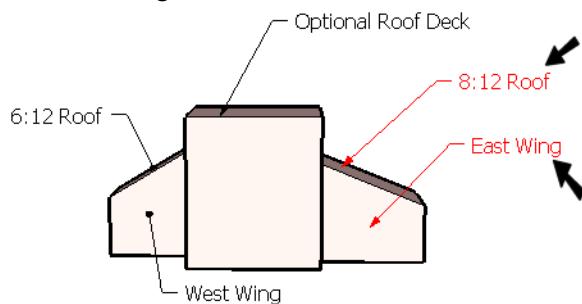
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21. To see the difference between view-based and pushpin text, orbit the model to partially hide the west wing. View-based text disappears when its leader line is hidden, but pushpin text remains visible even when text and/or leaders are partially hidden.

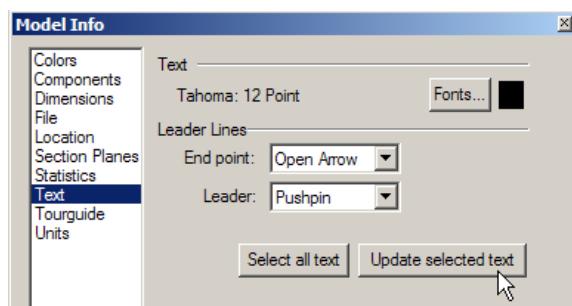


Because of these differences, view-based text is appropriate for presenting still shots from certain angles, in which you don't want irrelevant text cluttering the view. Pushpin text is good for overall studies and plans, in which you want all text available at all times. This type of text should be moved using axis direction inferences, so that you don't inadvertently move it to another plane.

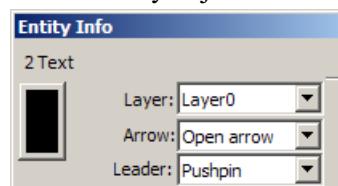
22. In addition to moving and editing existing text, you can also change a text object's type. Activate **Select** and select two of the view-based text objects from the east wing.



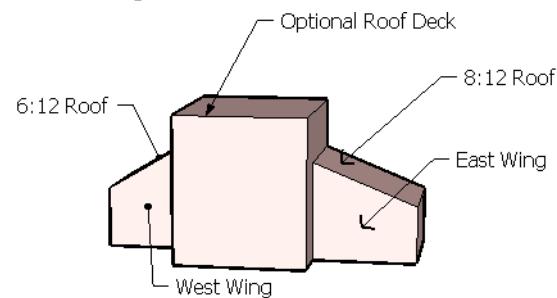
23. There are two ways to change these objects. One is the **Model Info** window: choose **Pushpin** and **Open Arrow**. Then click **Update Selected Text**.



The other way you can change objects is via the **Entity Info** window, as you've seen. This way you can also see how many objects are selected.

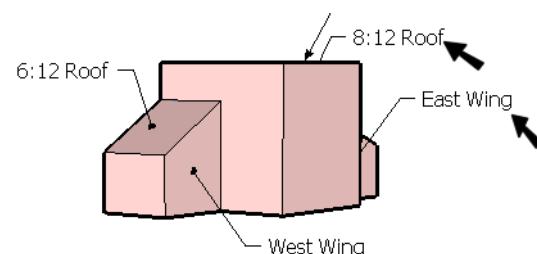


Either way, the selected objects now have open arrow leader end points.



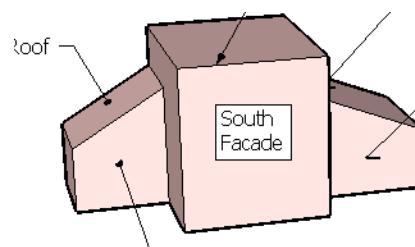
**TIP:** As you probably figured out, you can change all text objects by using the **Select All Text** button in **Model Info**.

24. To verify that these are now pushpin objects, orbit around and note that they do not disappear when their leaders are hidden.



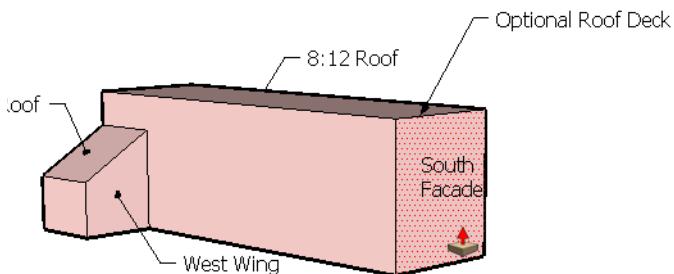
**NOTE:** For a single text object, you can also change its leader type or arrow by right-clicking on it and selecting **Leader** or **Arrow**.

25. You can also create text directly on a face or edge, so that no leader is attached. Activate **Text** again, and double-click on the front center face. Type "South," then press Enter and type "Facade." This creates two separate text lines. Press Enter twice to finish.

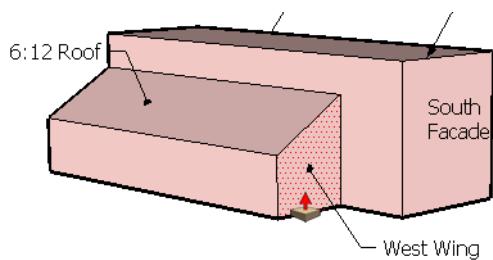


This type of text object has a "hidden" leader line, which can be changed using the methods you've already seen.

26. Text objects that are anchored to faces or edges “stick” to those faces when they are moved. To verify this, **Push/Pull** the south facade forward; both of its text objects (“South Facade” and “Optional Roof Deck”) move with it.



27. Do the same for the “West Wing” face; both the text and leader move.



## Dimensions

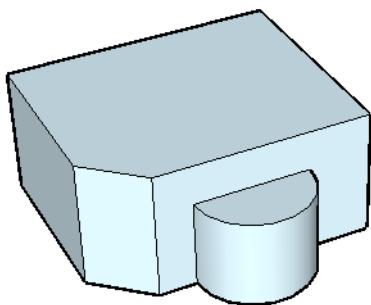
You can add dimensions to your model to show exact measurements.

*NOTE: For an exercise on creating geometry using exact measurements, see Chapter 11.*

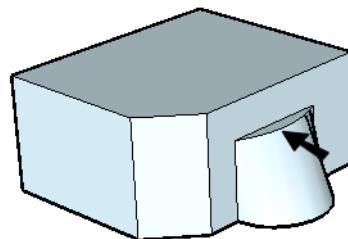
## Creating Dimensions

This section focuses on ways to create and place dimensions. Dimension display and properties will be covered in the next section.

1. Start with a box with a chamfered corner. Draw an arc protruding from the front face and **Push/Pull** it up.

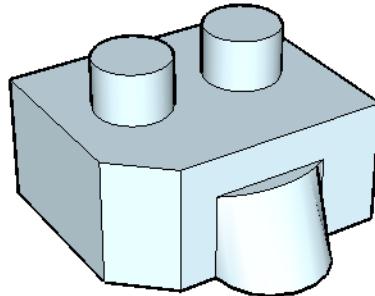


2. Use **Move** to push in the top arc.



*NOTE: If you don't know how to do this, see "Using Move to Resize Curves and Curved Surfaces" on page 54.*

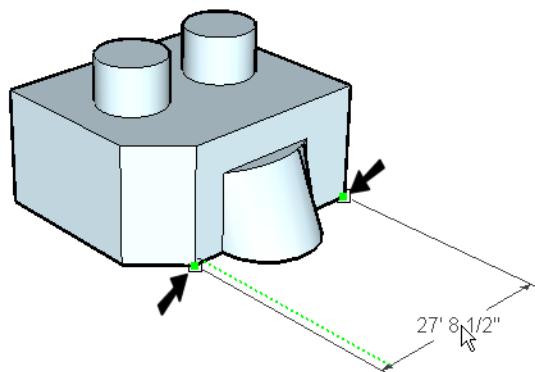
3. Lastly, create two identical cylinders on the top face (create one using **Circle** and **Push/Pull**, and use **Move** with **Ctrl/Option** to make a copy of it).



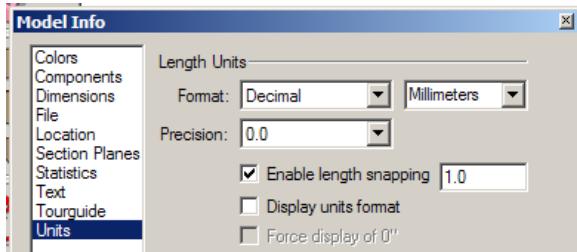
4. Now to add some dimensions to this form. Activate **Dimension (Tools Dimension)**.



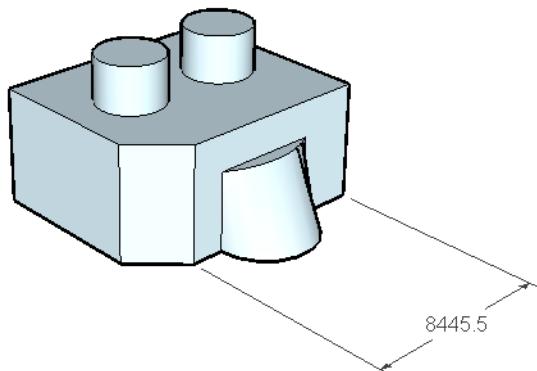
5. The first dimension will be created between two points. Select the points shown below. Then move the mouse in front of the building and click to place the dimension text. Leave enough room for more dimensions closer to the building.



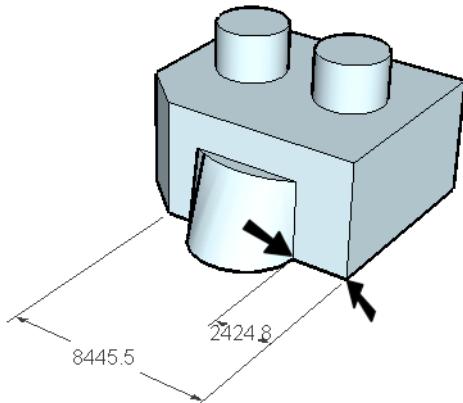
6. The dimension is listed in whatever units are currently set (shown here in **Architectural**). Open **Model Info** to the **Units** page and select **Decimal** dimensions in **Millimeters**. Use a **Precision** of 0.0, so that the dimension will have one decimal point. Deselect **Display units format**, so that the “mm” will not be displayed on every dimension.



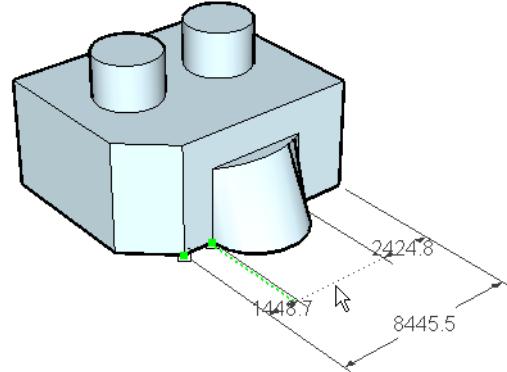
The dimension text should now reflect the new unit settings.



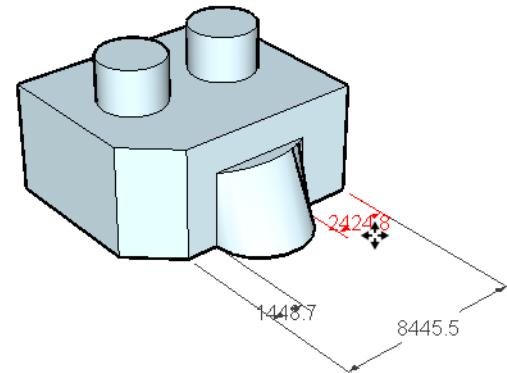
7. Create the next dimension from the right wall to the arc face, by selecting the two points shown.



8. Create a similar dimension on the other side of the arc face. When locating this dimension, use the dotted inference line to align it with the corresponding dimension on the other side.



9. While **Dimension** is still active, you can move existing dimensions. Click one of the shorter dimensions and drag it closer to the building.

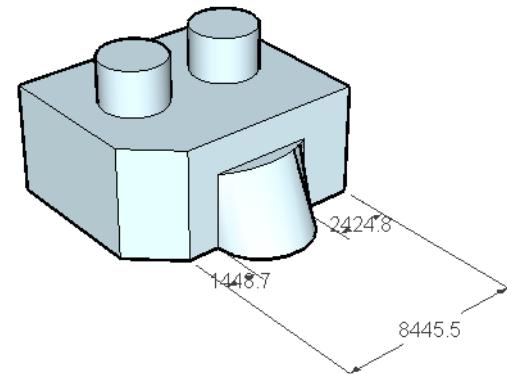



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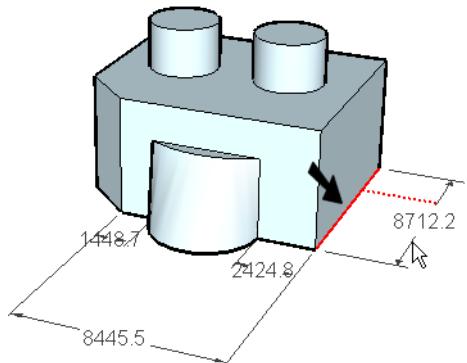
TIP: You could also use the **Move** tool to do this.

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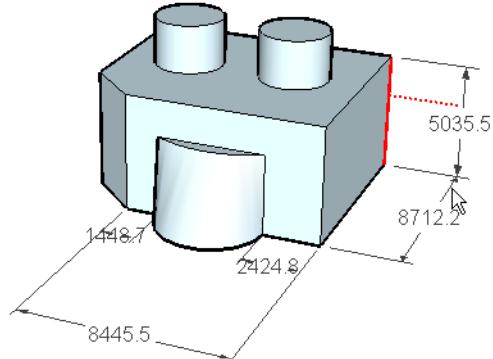
10. Move the other short dimensions as well, keeping it aligned with the first.



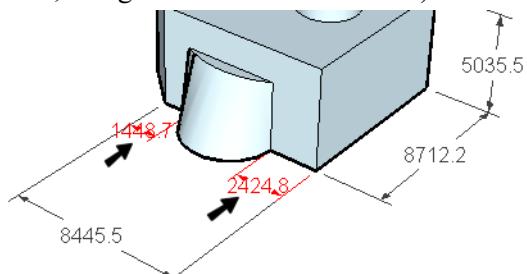
11. You can also dimension an edge with two clicks. Click the edge shown, and pull the dimension to the side of the building.



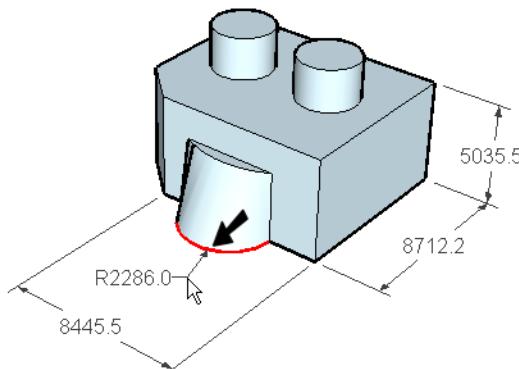
12. Create the vertical dimension the same way, aligning it with the previous dimension.



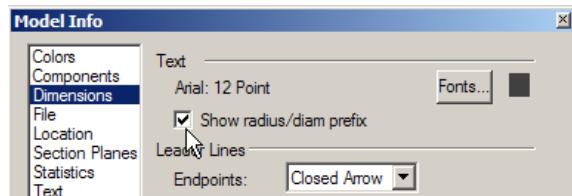
13. Dimensions are objects that can be moved, copied, rotated, and hidden like other objects. Select the two dimensions shown below, and hide them (select **Edit / Hide**, or right-click and select **Hide**.)



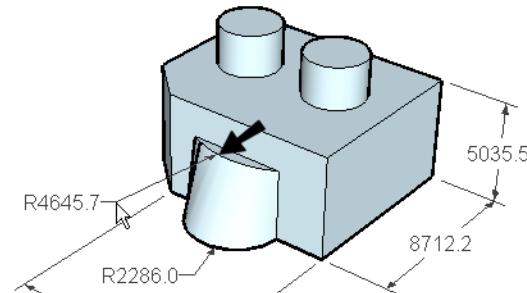
14. To dimension the lower arc, click it and click again to place the dimension.



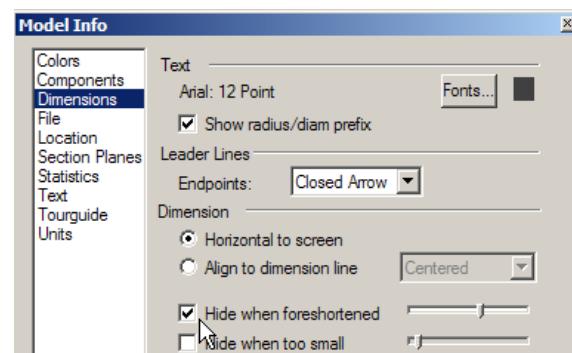
15. If the “R” prefix does not appear with the radius dimension, you can attach it. Open **Model Info** to the **Dimension** page, and check **Show radius/diam prefix**.



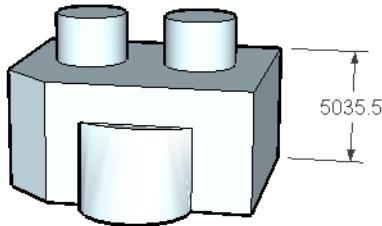
16. Dimension the upper arc the same way.



17. The model is starting to look cluttered, so it's a good idea now to modify the display. Open **Model Info** to the **Dimension** page, and check **Hide when foreshortened**.

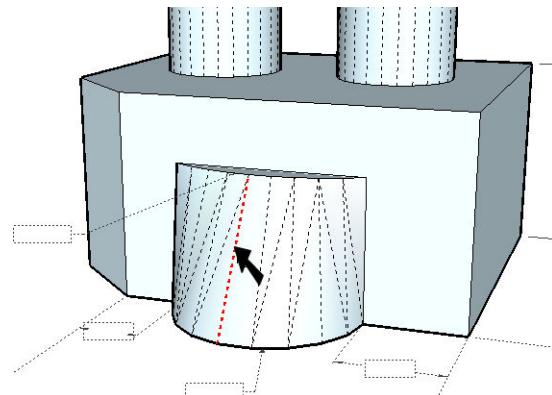


18. With this setting, dimensions oblique to the viewing plane are hidden. Orbit to a more vertical view, and the dimensions on the red-green plane will disappear.

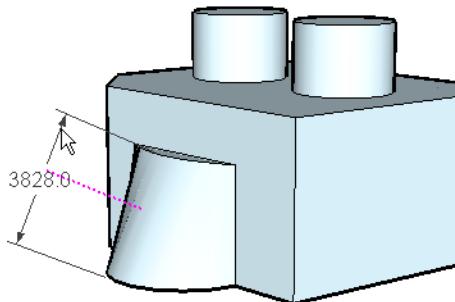


**TIP:** You can use the slider on the **Dimensions** page to control the angle at which dimensions will disappear.

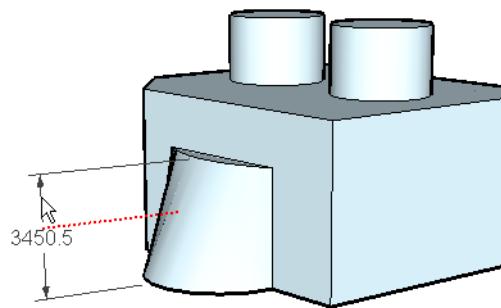
19. To dimension the arc face, first display hidden objects by selecting **View / Hidden Geometry**. All the hidden dimensions are outlined in dashed lines. Click on one of the dashed line at the center of the face.



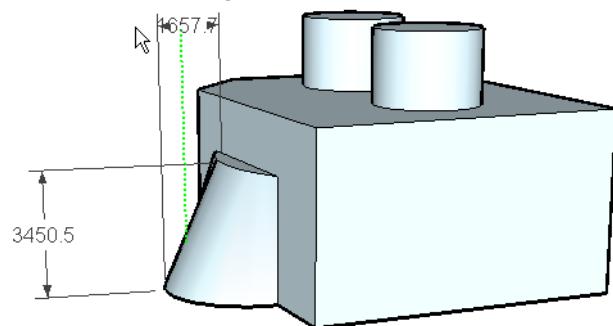
20. Turn off hidden objects.  
21. In addition to dimensioning in the red, green, and blue directions, you can also create parallel dimensions. Move the cursor in a perpendicular direction away from the selected edge; the parallel dimension inference line is magenta. Do not click to create this dimension.



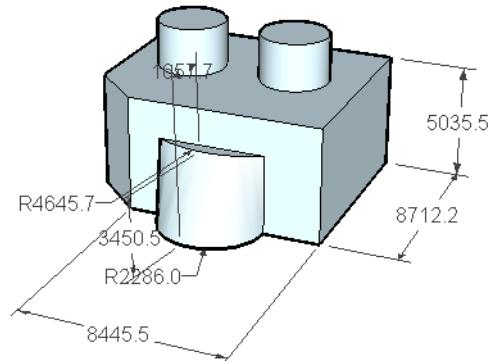
22. Move the cursor down and click to create a vertical dimension.



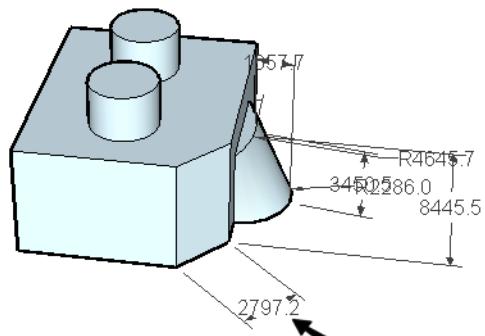
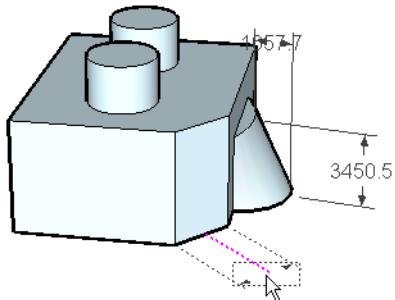
23. Use the same edge to create a horizontal dimension.



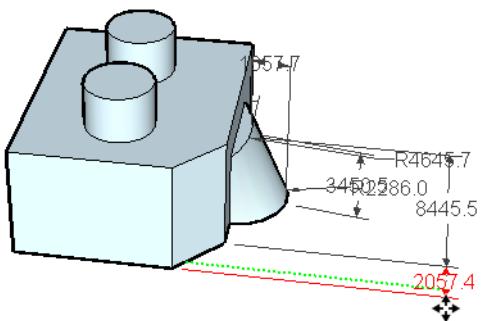
24. Now orbit to a more isometric view. Depending on your foreshortening settings, some dimensions that were previously hidden should now reappear.



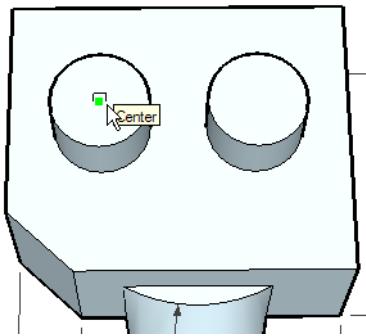
25. Next, create a parallel dimension along the chamfered corner. If the outline is dashed, adjust the viewing angle so that this dimension is visible.



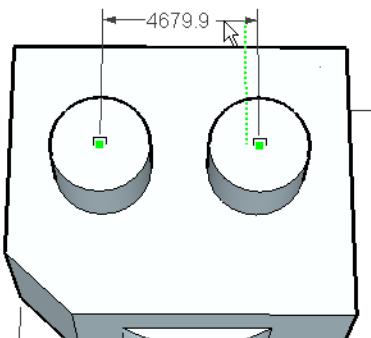
26. Once a dimension is created, you can still change its orientation. Click the dimension for the chamfered corner and move the mouse so that it is aligned with the front edge dimension.



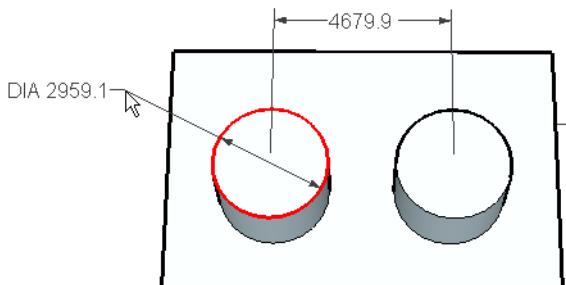
27. For the next dimension, click on the center point on top of one of the circles. If you can't locate this point, hover over the circumference first, then try again.



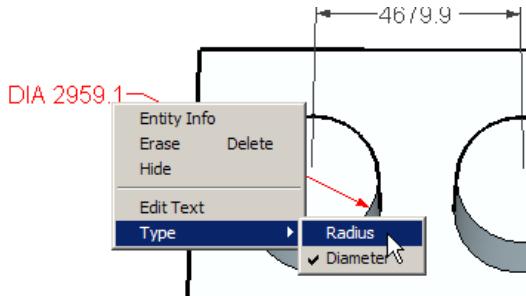
28. Click the other center point, and create the dimension between them.



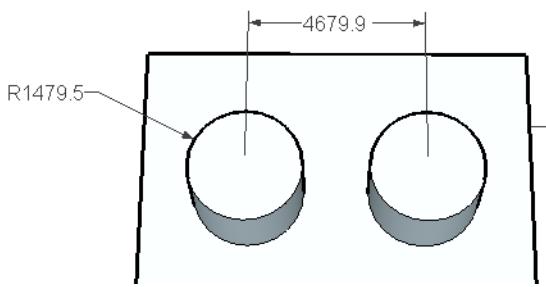
29. To dimension the circle, click the edge, then place the dimension. By default, circles are assigned diameter dimensions, with a "DIA" prefix.



30. Change this diameter to a radial one, by right-clicking on it, selecting **Type**, and selecting **Radius**.

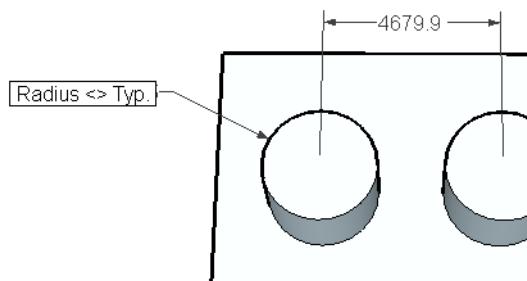


The dimension now has the "R" prefix. This method can be used on both arcs and circles.

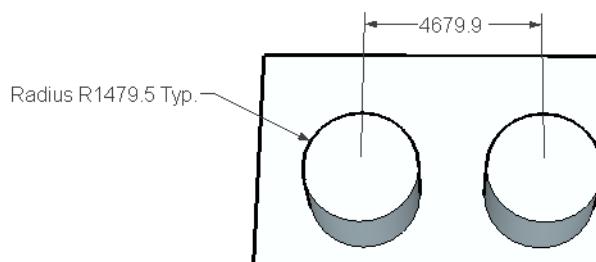


31. You can add prefixes and suffixes to dimensions without changing their numerical value. To edit the dimension, double-click on it, while in **Dimension** or **Select** mode. (You can also right-click on it and select **Edit Text**.)

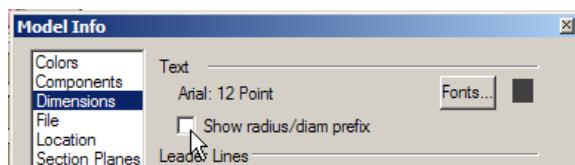
Type “Radius <> Typ.” The angle brackets are placeholders for the dimension value - the number will remain intact, located in between the suffix and prefix.



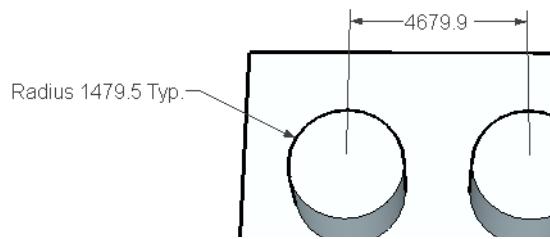
The dimension text now contains the extra text. But the “R” symbol is still there, which is no longer needed.



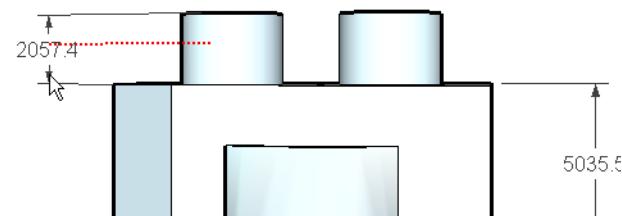
32. Open the **Dimension** page again and deselect **Show Radius/Diam Prefix**.



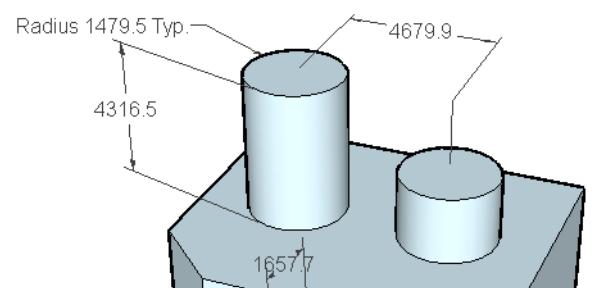
The “R” symbol is now gone. Note, however, that this affects all radial and diameter dimensions, so be careful when changing this option.



33. To dimension the height of the cylinders, select one of its hidden edges and move the cursor to the side to create the dimension.



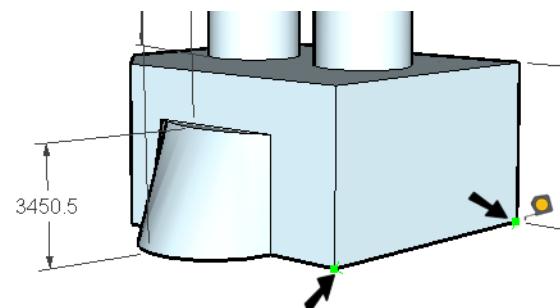
34. As you would expect, changes to the model cause dimensions to update. **Push/Pull** up the cylinder whose height you just dimensioned to see this dimension update. Note also that the dimension between the cylinder center points does not change, but its leader lines update.



35. If you change the size of the model, all the dimensions will update. You can use the **Scale** tool for this, but **Measure** is better if you want to assign a specific measurement. Activate **Measure**.



36. Pick two endpoints of an edge, such as the one shown.



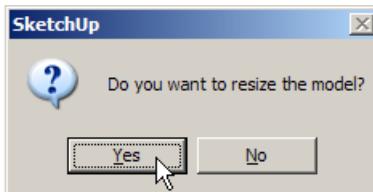
The VCB displays the actual length of this edge.

Length 8712.2

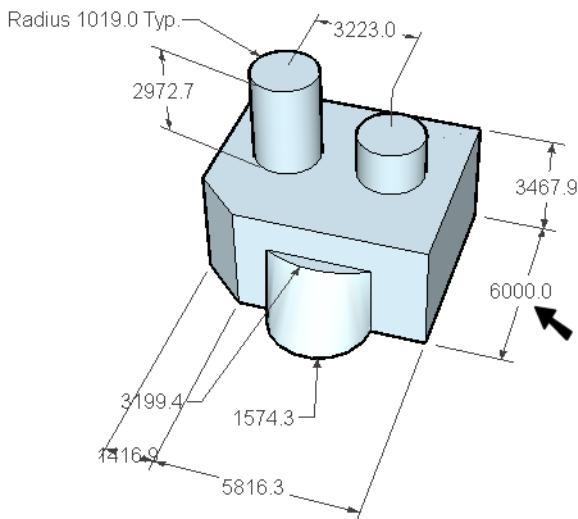
37. To assign a new length, simply type it and press Enter.



38. You will receive the following message - click Yes.



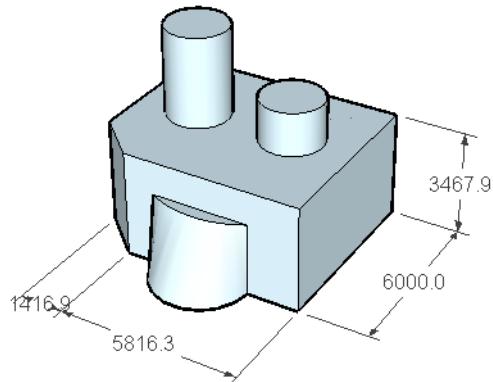
39. The scale of the entire model, and its dimensions, increase to reflect the new measurement.



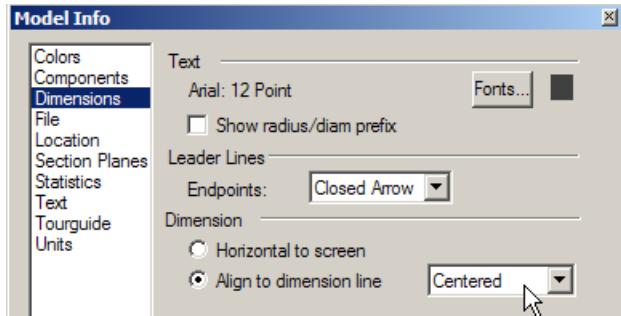
## Dimension Display and Properties

Some display options and dimension properties were covered in the previous section, but this section will cover the rest. We will continue with the same model.

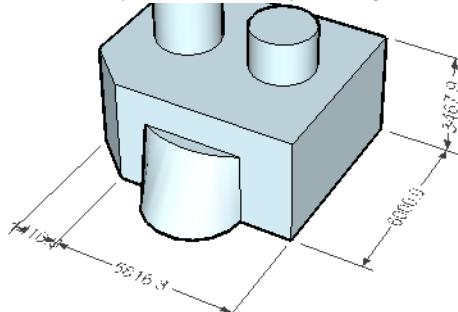
1. Erase or hide all dimensions except those shown.



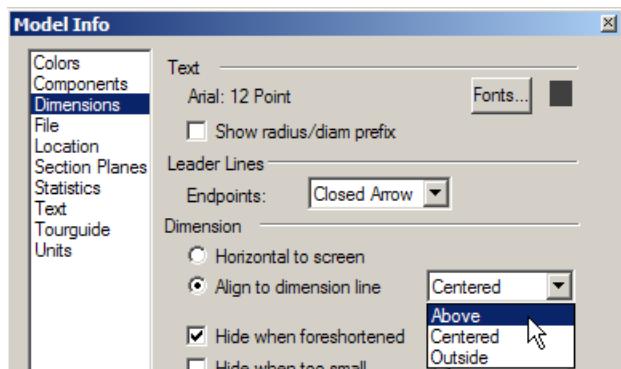
2. By default, so far the dimensions have been aligned so that you can always view them facing you, no matter the orientation of the model. To change this, open the **Dimension** page and check **Align to Dimension Line**, and set alignment to **Centered**.



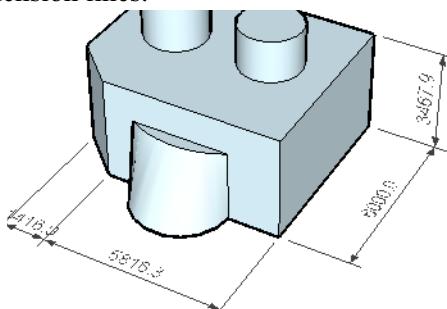
Each dimension is now aligned to its plane. This is typical of most CAD programs, but can be a bit hard to read unless you are directly facing the dimension.



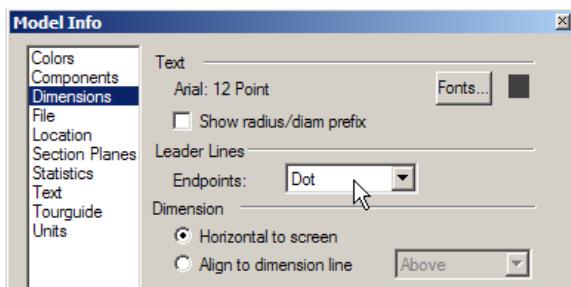
3. Change the alignment to **Above**.



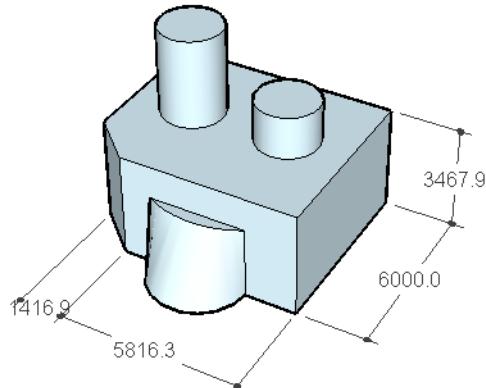
The dimensions are now located above the dimension lines.



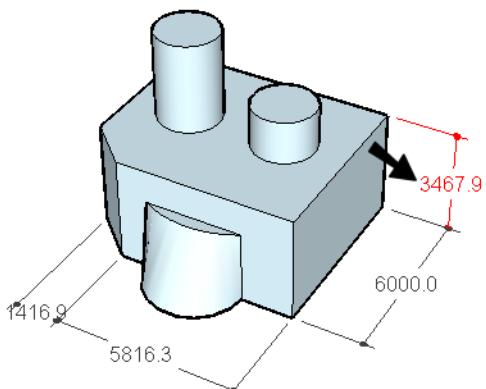
4. Change back to **Horizontal on Screen**, and change the **Arrow Heads** to **Dot**.



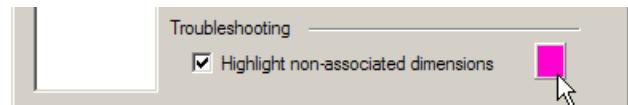
The dimensions are all aligned to the viewing plane, and end in dots at the witness lines.



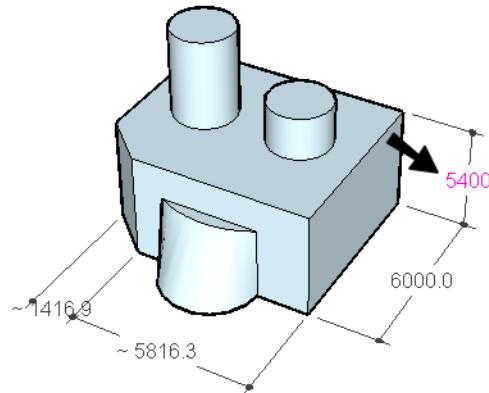
5. We will now look at dimension overrides. Double-click the dimension shown and type in a different number. This dimension is no longer numerically accurate.



6. With the current settings, we cannot tell if there are any problems with dimensions, such as overridden numbers. To change this, open the **Dimension** page again and check **Highlight non-associated dimensions**. Set a color that is easily visible.

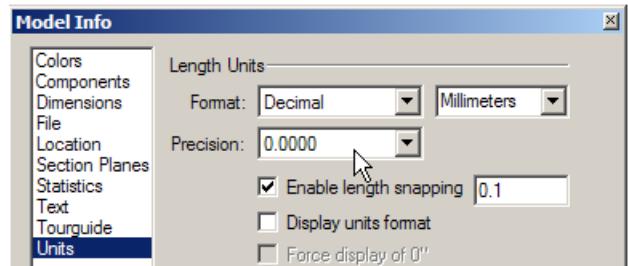


Now the dimension you edited will appear in the “problem” color. In addition, any dimensions that are not accurate to the specified precision will now have a tilda (~) symbol.

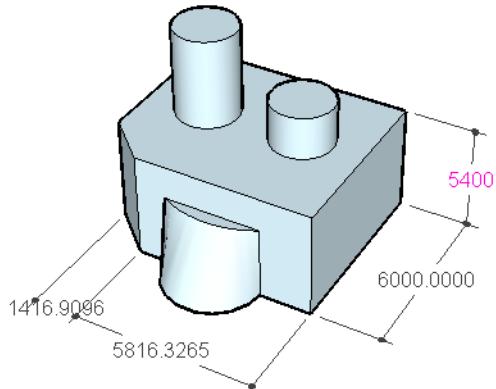


Note that only the edited dimension text itself, and not the witness lines, appear in the “problem” color. This indicates that the dimension itself is still valid, only the number is wrong. You would also see the “problem” color if you changed the dimension to text, or added a prefix or suffix without using the “<>” format described in the previous section.

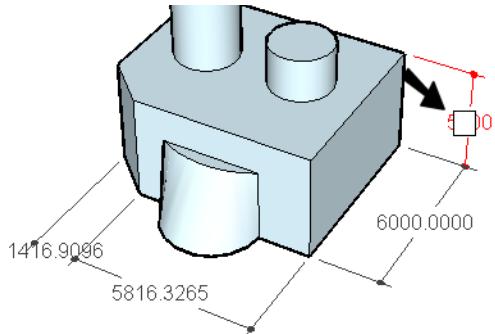
7. To remove the tilda symbols, you can always increase the precision. Open the **Units** page and increase the **Precision** to several decimal places.



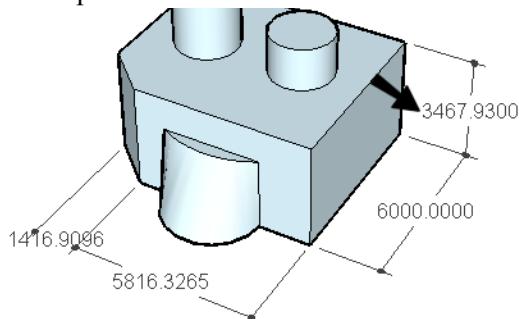
The dimensions are now more accurate. The edited dimension does not change, however, it remains how it was edited.



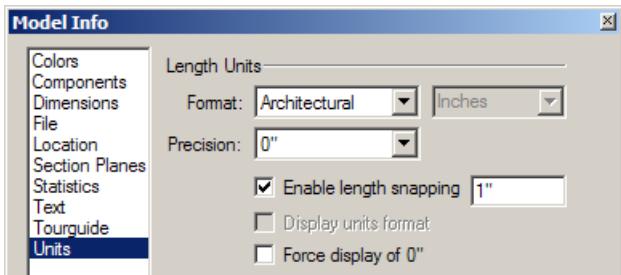
- To remove a dimension override, simply delete its text. Double-click it, and press Delete to remove the text.



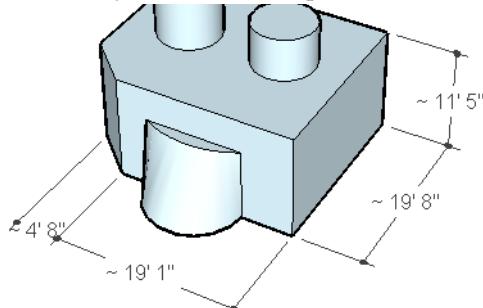
The dimension now reflects the actual number, to the correct precision.



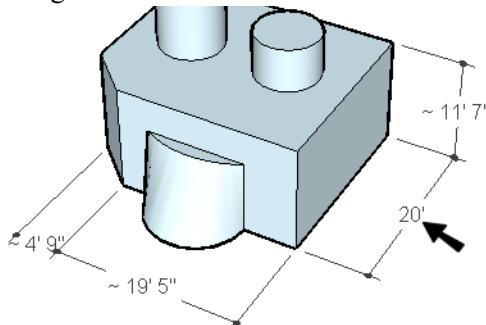
- Now change the units to **Architectural, Precision = 0"**, and do not check **Force Display of 0"**.



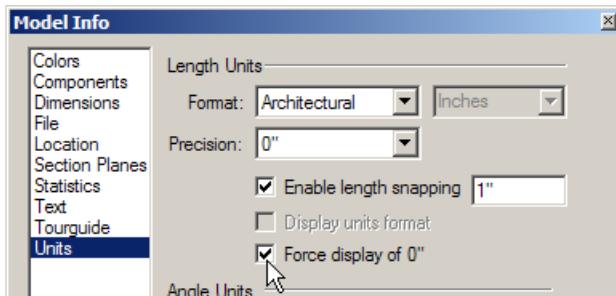
The dimensions are now in foot-inch, rounded to the nearest inch. Most or all of these dimensions will have a tilda symbol since the precision is low.



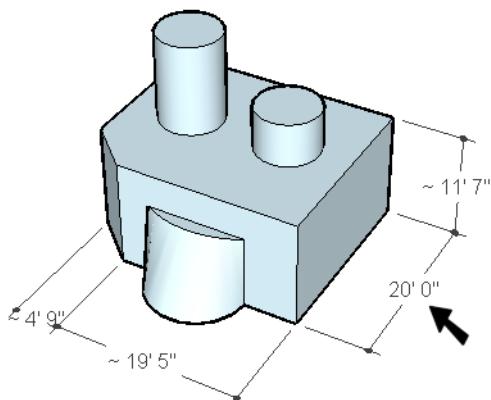
- Use the **Measure** tool to change the dimension shown to a whole foot value, and to scale the entire model accordingly. This dimension does not include "zero inches," which you would want on final drawings.



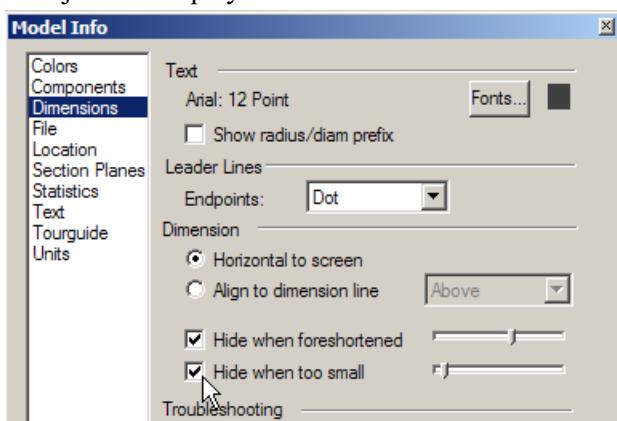
- Back in the **Units** page, check **Force Display of 0"**.



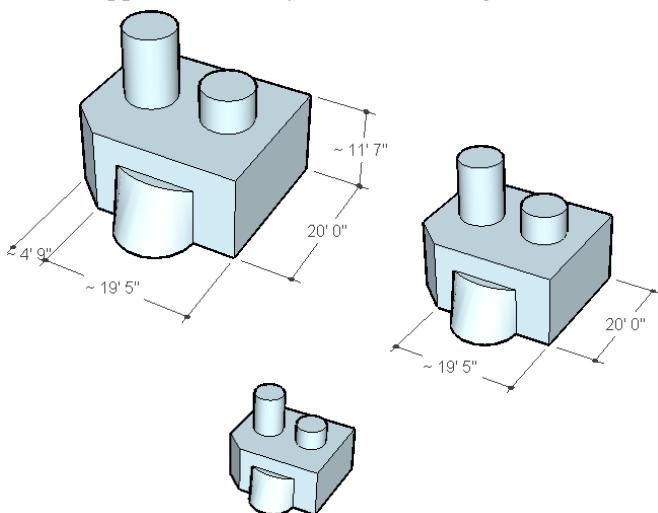
The zero is now displayed.



12. Another way to avoid clutter is to hide dimensions when they get too small to display. In the **Dimension** page check **Hide when too small**. Use the slider to adjust the display tolerance.



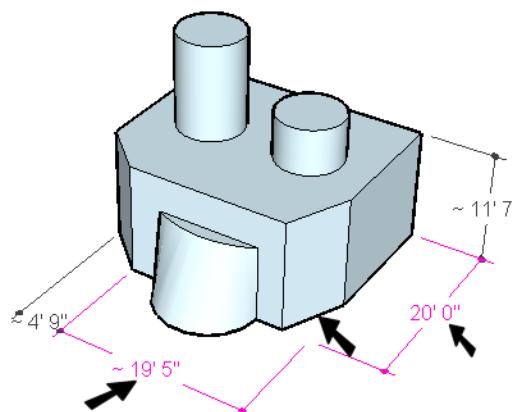
13. Zoom out on the model, and note how dimensions disappear when they are small enough.



**WARNING:** Be careful when using this option, because you might then create dimensions that immediately disappear!

Lastly, we have already seen how dimensions are associative to the model, and update with changes to geometry. But what happens when the geometry used to create them disappears?

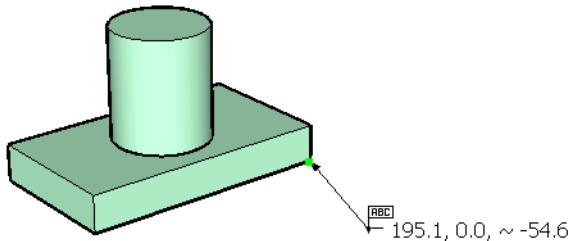
14. Cut a chamfer on the other front corner. The two dimensions that are affected are those that referred to the corner that was eliminated. These dimensions appear in the “problem” color, and not just the text itself. The witness lines are problematic as well, since it is no longer clear what they reference.



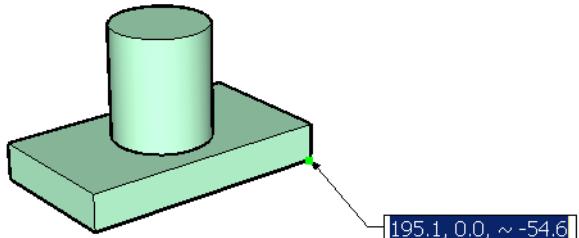
## Dimensioning Using the Text Tool

If you worked through the exercise "Text" on page 78, you have seen how **Text** can be used to label dimensions. Depending on what start point is selected, you can label coordinates, edge lengths, and areas.

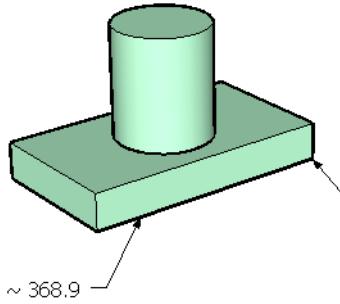
1. Start with a form like this and activate **Text**. This example uses Decimal cm units.
2. For the first point, select one of the corner points. Drag out the text, and by default it is a label of the X, Y, Z coordinates of the point.



3. Click the second point, and the text is highlighted. At this point you can overwrite the text, but we want to keep the coordinate values.

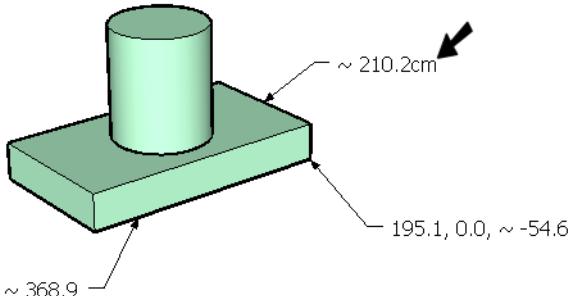


4. To place the text as is, click anywhere outside the text.
5. For the next text label, click anywhere along an edge. Place the second point - this time the text shows the edge length.

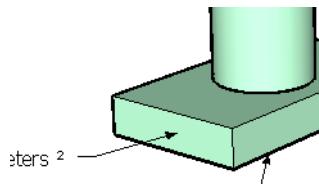


Unlike dimensions, the **Text** tool creates labels, which are not associative to the model. If you make geometric changes, or change units, the text does not update.

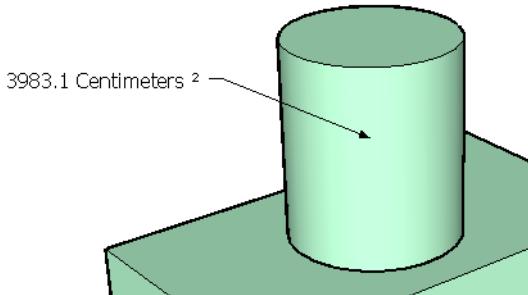
6. To demonstrate this, change the units to display the unit format (i.e. cm). Create another edge label, and it includes the format. The previous labels do not change.



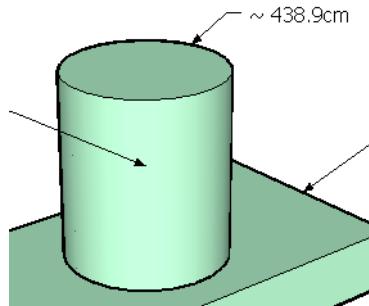
7. **Text** can also label areas. Click a point within a face, and the label contains the area.



8. If you click within a curved face to get its area, you will get the area between hidden edges - not the entire face. (You may have to zoom in closely to get the **On Face** constraint, since there are hidden edges and endpoints within this face.)



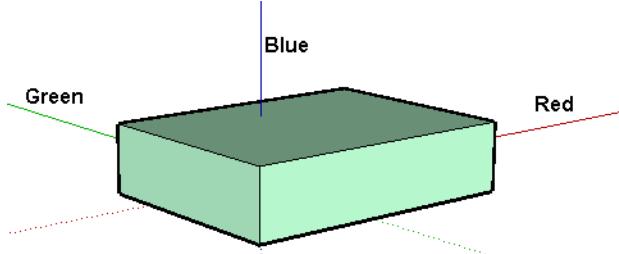
9. However, labeling a circular edge will give you the entire length. Be sure to click within one of the circle segments, and not on one of the segment endpoints.



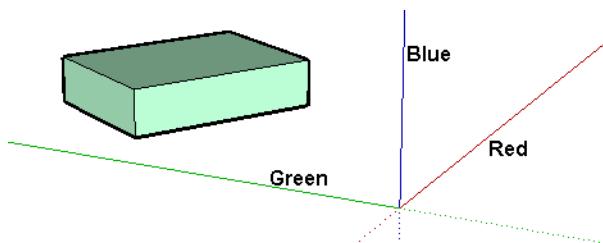
## Using the Axis Tool with Dimensions

Dimensions are always relative to the current axes. If you need to create dimensions relative to a different set of axes, you can use the **Axes** tool.

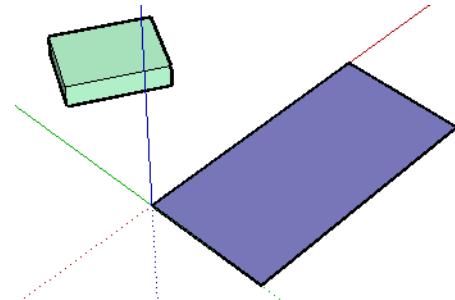
1. Turn on the axes display and create a box.



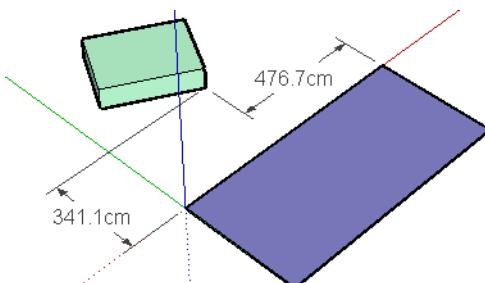
2. Activate **Axes** and create a new set of axes, not perpendicular to the original axes. (For information on this tool, see "Axes" on page 70.)



3. In the new axes system, create a rectangle.



4. Create dimensions between the rectangle and box. Dimensions are always in the current axes system.



5. To reset the axes, you can right-click any axis (they must be displayed), and select **Reset**. The dimensions remain in place.



# 3 Intersect and Follow Me

These tools are combined in this chapter because they are often used together. For other exercises in this book that use them see:

- "Roofing with Follow Me" on page 169
- "Using Section Planes with Model Intersection" on page 312
- "Creating a Log Cabin" on page 427

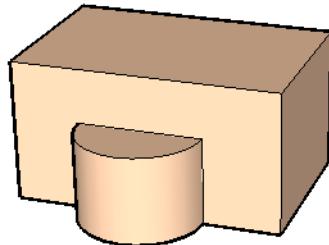
## Follow Me

This tool basically takes a flat face of any shape, and drives it along a path. In other CAD applications, this is called extruding or driving.

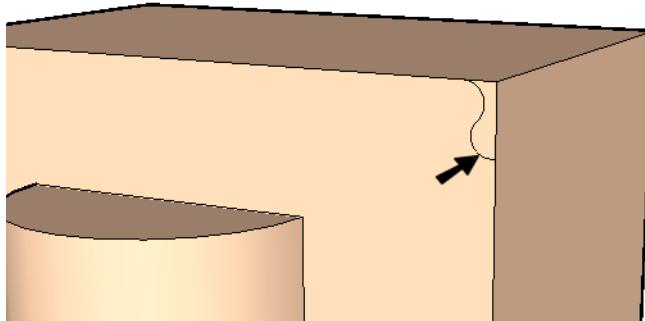
### Basic Follow Me

This exercise will show you the several ways you can use **Follow Me**.

1. Start with a form like this - a box with an arc form pulled up part-way.



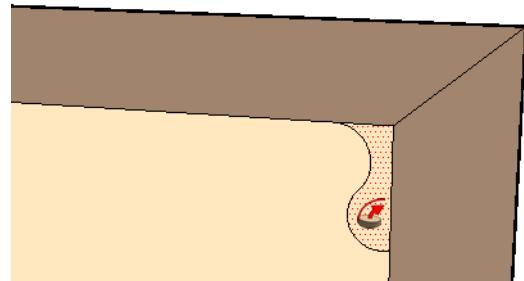
2. Use two arcs to create a cutout section in one corner of the box. This is the section that will be used in **Follow Me**, in a few different ways.



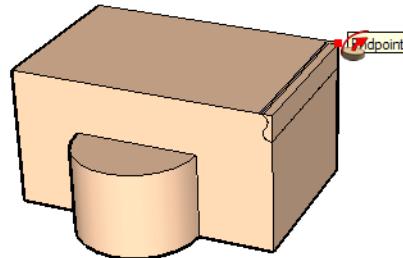
3. The first way to use this tool is the "real-time" way. First, activate **Follow Me (Tools / Follow Me)**.



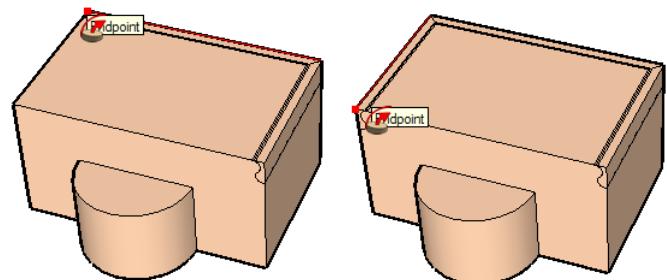
4. Then select (click and release) the cutout face as the face to drive along the path.



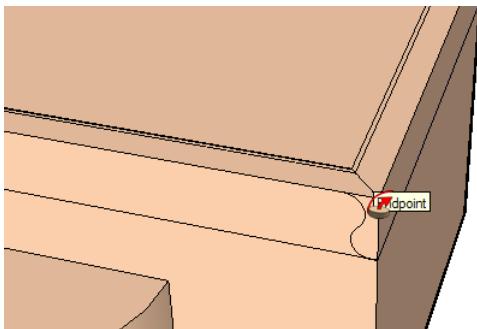
5. Move the cursor to the back endpoint shown. . .



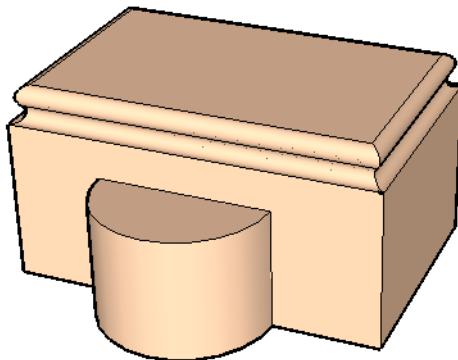
6. . . then move it along the back of the box and the opposite edge . . .



7. . . and back to the point from which you started. It might be a little tough to get this point since the cutout shape starts before this point. If you miss it, try zooming in and approaching more slowly, or try approaching from a different angle.



8. Click at this point, and the section is removed.

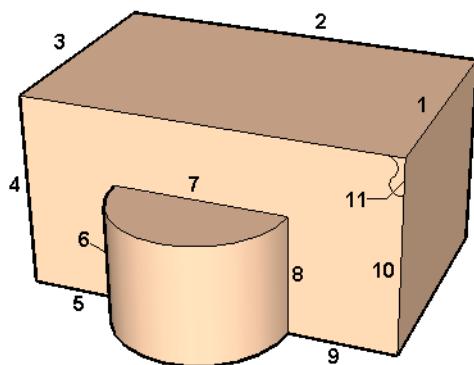



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**TIP:** You can also hold and drag the section all the way around. Activate **Follow Me** and click on the section, without releasing the mouse button. Keep the button pressed and move along the path. When you release the mouse, the cutout is made.

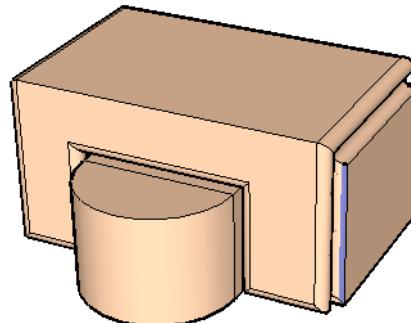
---

9. **Undo** (hotkey: Ctrl/Cmd + Z) to restore the top edge of the box. Try the real-time **Follow Me** again, using the edges shown. Don't leave out Edge 11, which takes you back to the start point.



This may be tough to do - you may end up with incorrect edges selected. If you have trouble, try approaching endpoints slowly, zooming in, or changing the view.

Here is the result - the cutout is made along the entire path.



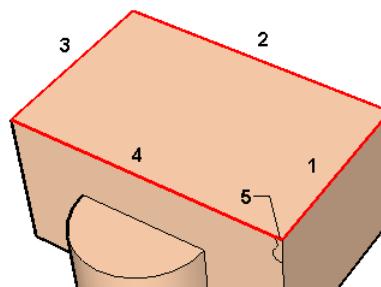

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**NOTE:** You don't always have to select a closed path; just stop wherever you need.

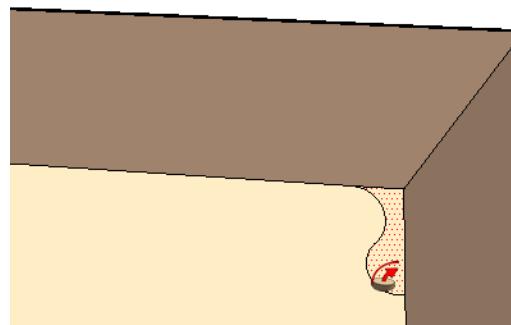
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The real-time, dragging method is great in some cases, but as you've seen, it's not always so easy to pick the path. Also, the driven section must be connected to the path and must meet it at the path endpoint.

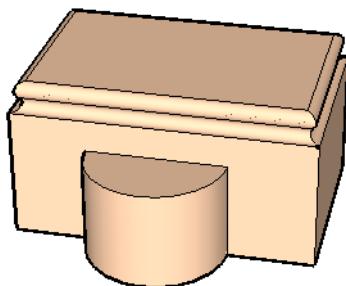
10. **Undo** again. The next method shows how to set the path ahead of time. Activate **Select** and select all edges along the top (five edges total).



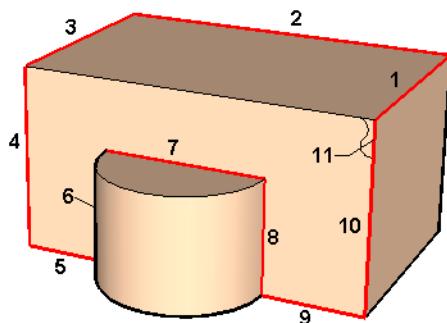
11. With the edges selected, activate **Follow Me**. Then select the cutout section.



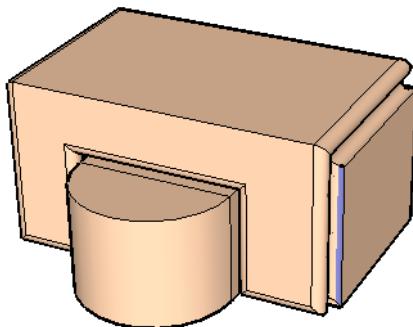
This drives the section around in one step.



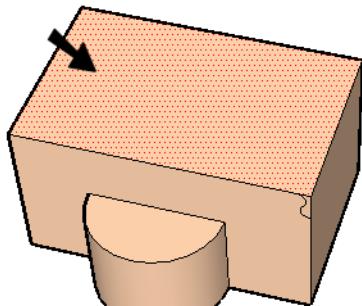
12. **Undo**, and pre-select the edges you used before.



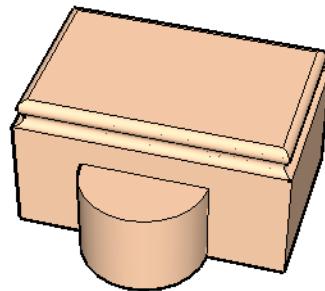
13. Activate **Follow Me** and use the same cutout section - the same results as before. But with an unusual path like this, it's an easier way to make sure you get a clean, closed result.



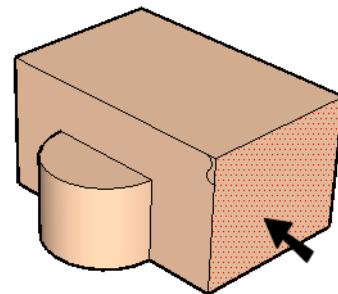
14. **Undo**. If you plan to drive a section around a face, you don't have to select each edge in advance. Use **Select** to select just the top face.



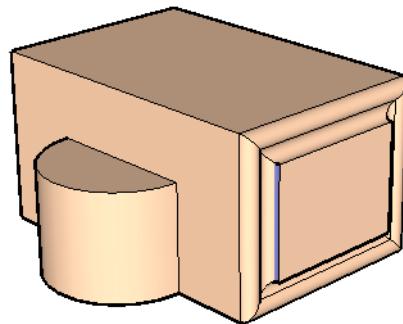
15. Then activate **Follow Me** and select the section - the cutout goes all along the face.



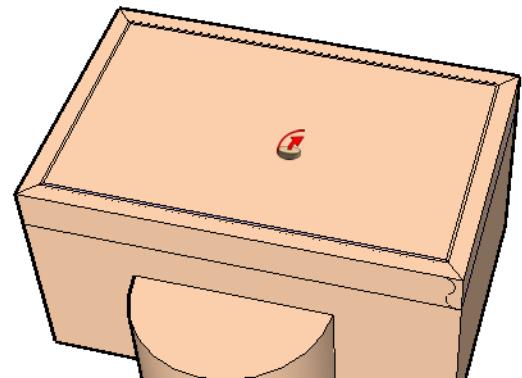
16. **Undo** and use the face-select method with a side face . . .



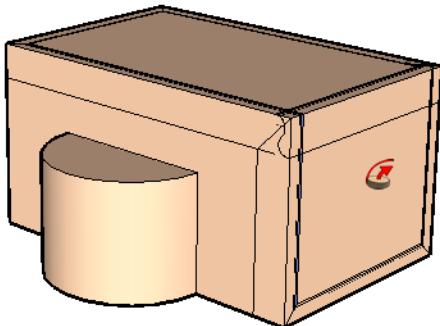
. . . with this result.



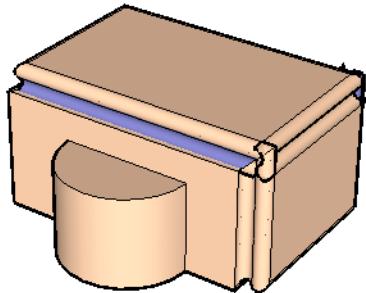
17. **Undo** again. If you want to drive around a face, you don't have to pre-select it. With nothing selected, activate **Follow Me**. Select the section, press Alt/Cmd, and select the top face. Do not click yet.



18. With Alt/Cmd still pressed, move the mouse to the side face and click.

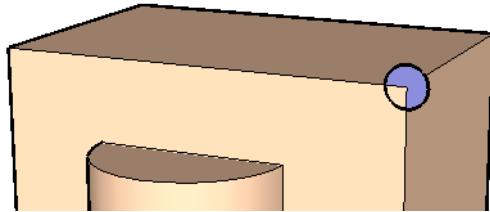


This is the result - the section is removed from both faces (with a little cleanup needed).

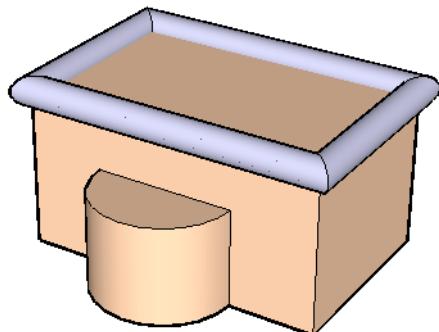


The Alt/Cmd-face method is convenient, but only works on sections immediately adjacent to the driven section.

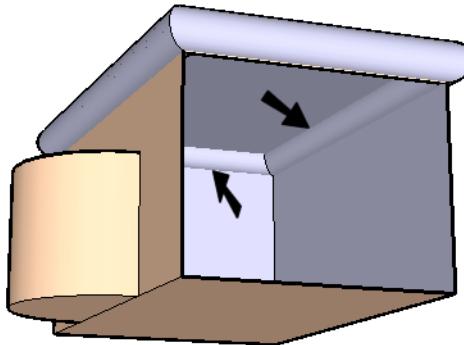
19. Now we will see how driven sections affect the forms on which they are created. **Undo** to erase the arc section and draw a small circle at the corner shown.



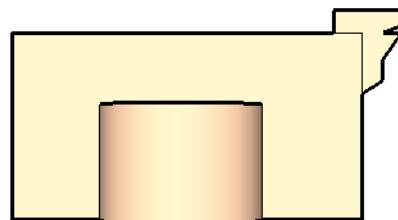
20. Use **Follow Me** to drive it around the top.



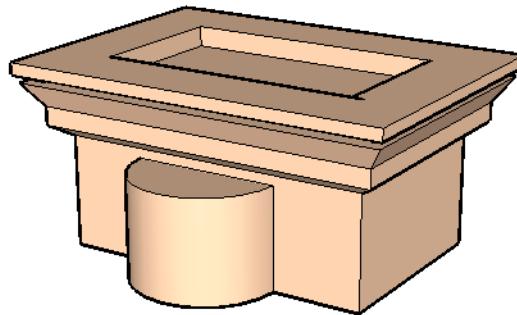
21. Now erase or hide one of the side faces. Because the circle section was partially inside the building, you can see the quarter-circle section sticking into the room.



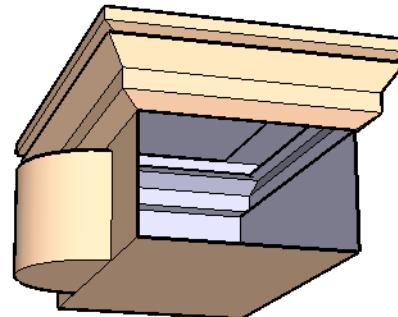
22. Undo and create a section like this, all outside the building.



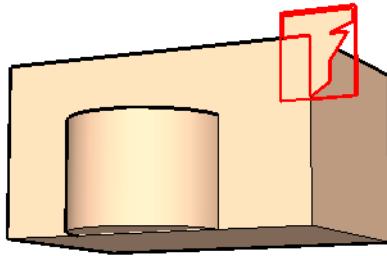
23. Drive this section along the top.



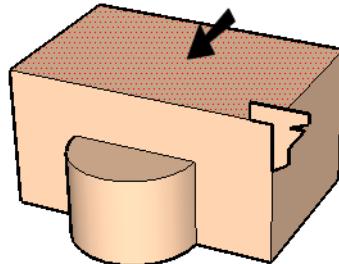
Now the section has dragged the walls out with it.



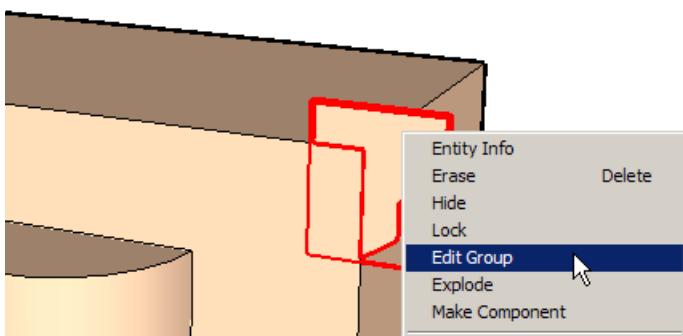
24. One way to use **Follow Me** so that the driven section does not affect the form on which it sits is to use groups. **Undo** the last action and select the section face. Make it a group by selecting **Edit / Make Group**.



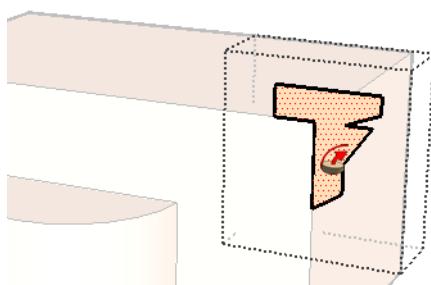
25. When using **Follow Me** on a group, you need to pre-select the path. So, select the top face or select its edges.



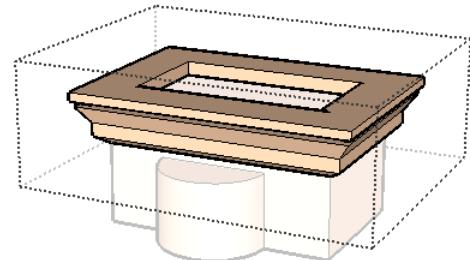
26. Activate **Follow Me**. The section to drive is within the group, so right-click the section and select **Edit Group**.



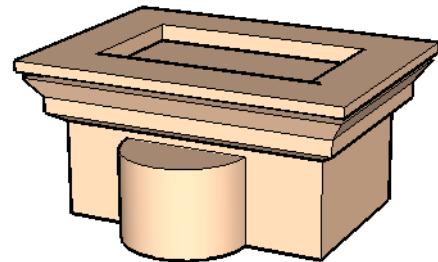
27. Select the face.



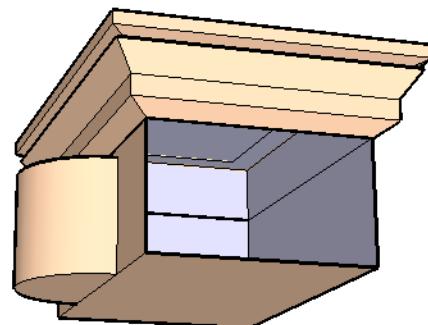
Within the group, the section is driven around the top.



28. Right-click outside the group and select **Close Group**. The top looks like it did before . . .



. . . but if you look inside, you'll see that the vertical walls of the room remain unchanged, though you can see the outline of the group.

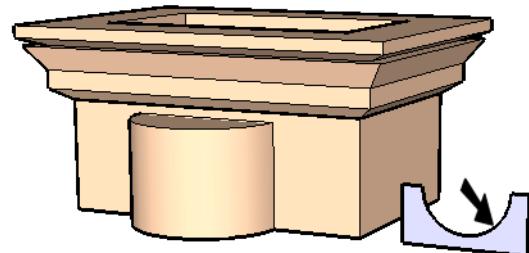



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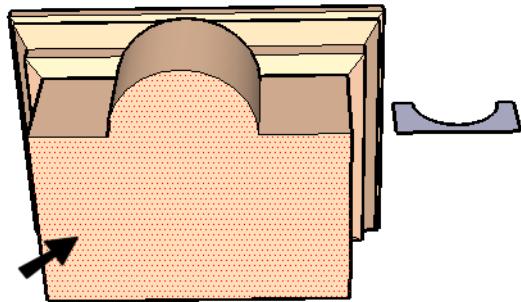
*NOTE: Groups are explained further in Chapter 6.*

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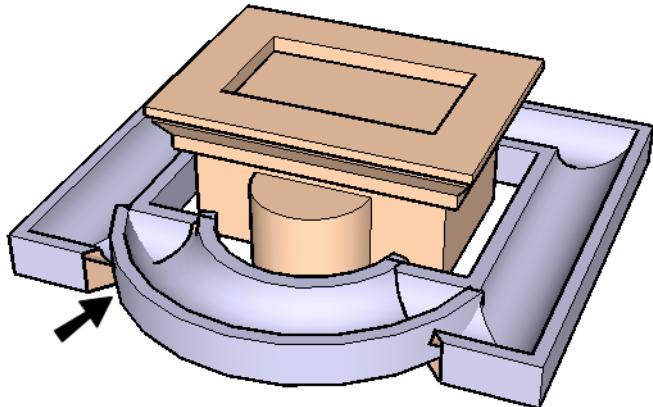
29. If you pre-select the path, the path does not have to touch the section. As an example, we'll create a moat around the building (a very useful thing no doubt). Create a rectangular section with an arc cutout.



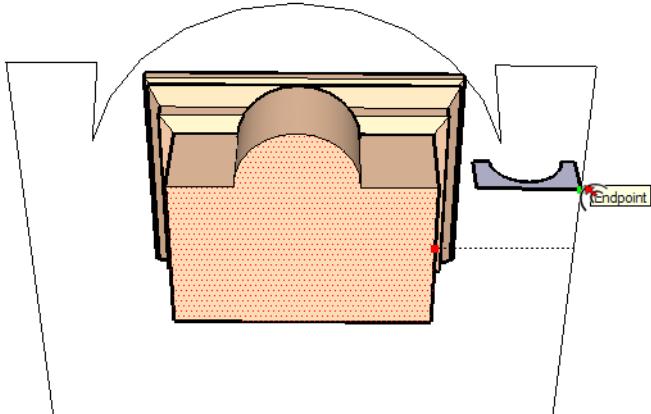
30. Use the bottom face for the path. If you select this face (as opposed to the edges), be sure to first heal it into one face.



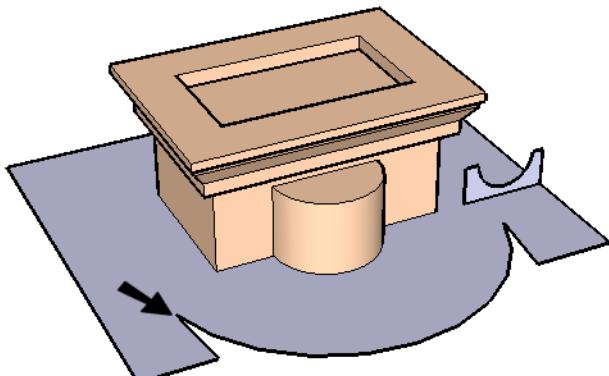
31. Select the moat section. It remains the same distance from the path, all the way around. However, the intersections between the straight and curved portions are not clean.



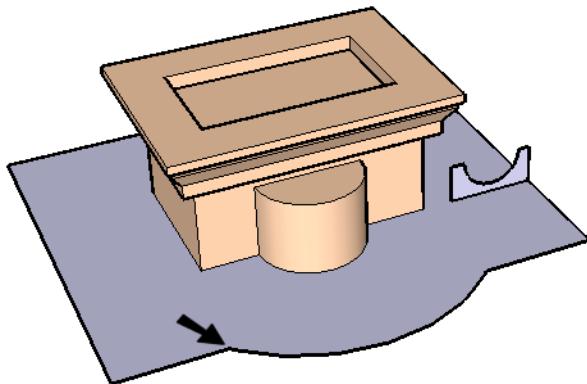
32. To find out why, undo the last action. Use **Offset** on the bottom face to create the surrounding edges. Stop at the moat section's far endpoint.



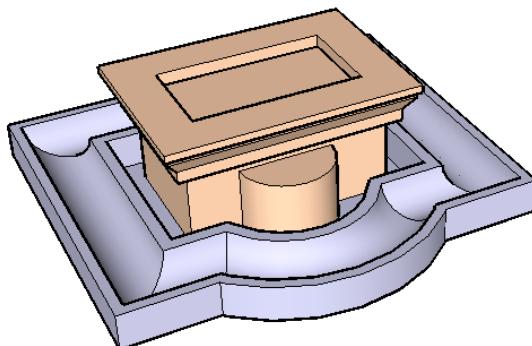
Here's the problem - the intersections here are not clean either.



33. Extend the lines to meet the arc segments, and heal the face.



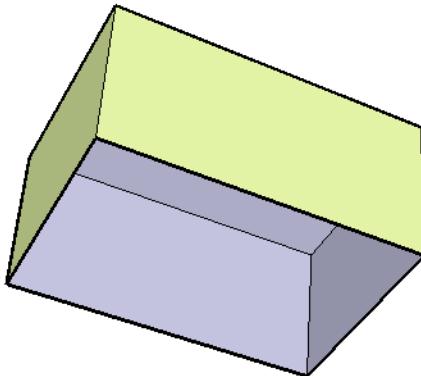
34. Now use the edges of this face for the moat section. Much better.



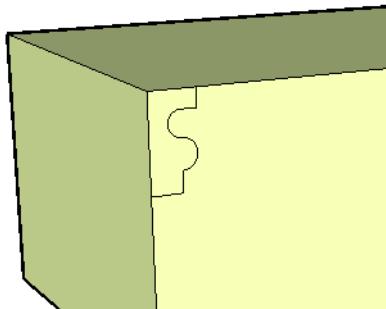
## Follow Me with Components

The previous exercise showed how you can avoid “stickiness” with **Follow Me** by using groups. You can also use components for the same effect, with the advantage that you can reuse sections repeatedly. A good example is the use of moldings.

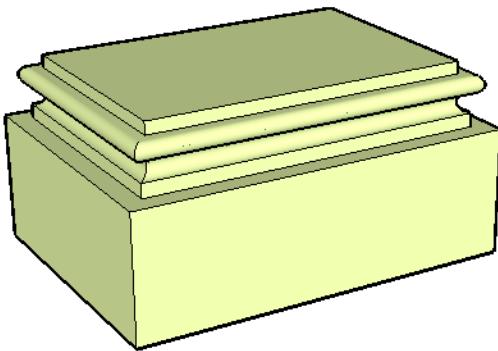
1. Start with a box and remove the floor, so that you can see the moldings.



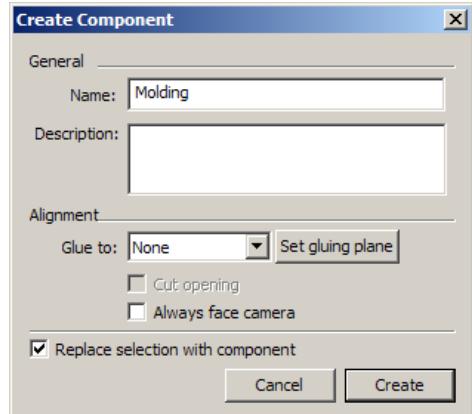
2. Draw a molding section on the outside of the box.



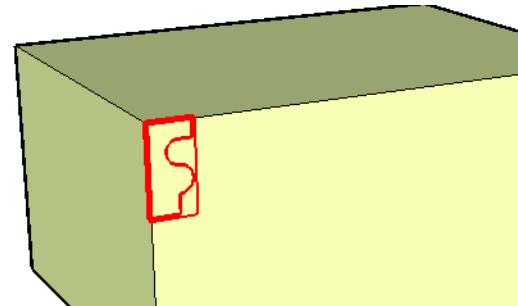
3. Use **Follow Me** on this section along the top of the box. This cuts material from the top of the box, but doesn't create a molding inside the box.



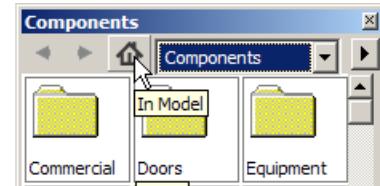
4. Undo, and select the molding face. Make it a component by using the icon or selecting **Edit / Make Component**. (Or right-click on the section and select **Make Component**.) Assign a name and be sure that **Replaced selected** is checked.



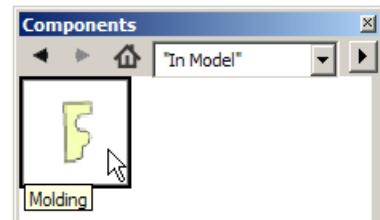
The section now has a bounding box, like it would as a group.



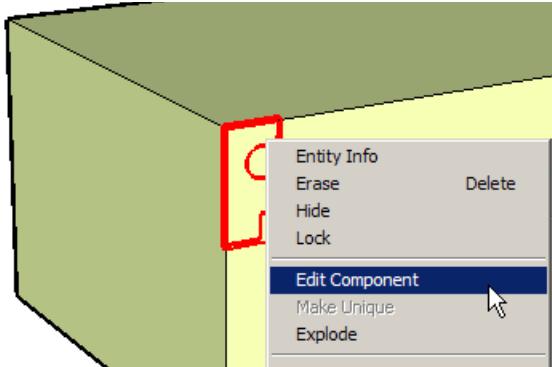
5. If the Component Browser is not open, select **Window / Components**. Click the **In Model** icon.



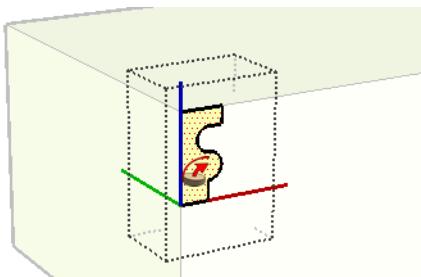
**In Model** contains the molding section you just created.



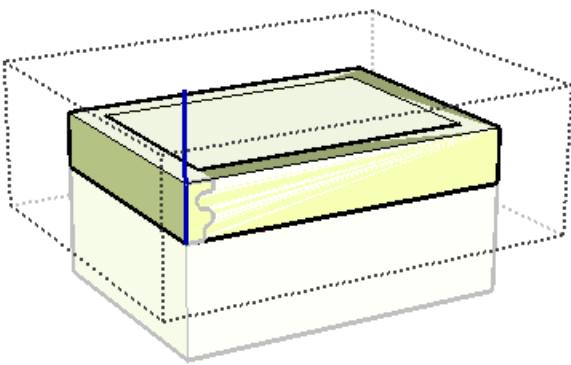
- To drive this component around the top of the box, first select the top face or the four top edges. Then activate **Follow Me**. Right-click on the component and select **Edit Component**.



- Select the molding face . . .

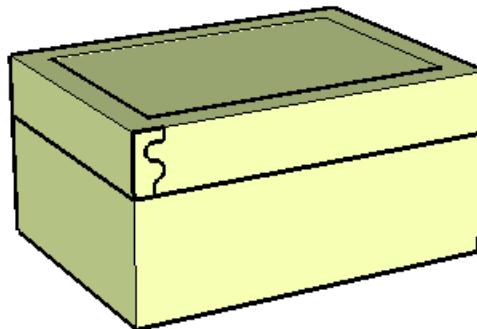


. . . and it proceeds along the top face.

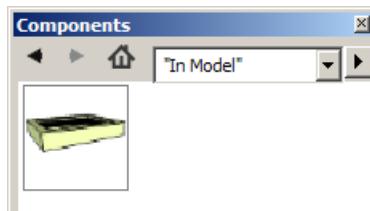


- Right-click outside the molding and select **Close Component**. (You can also go to **Select** mode and click outside the component bounding box.)

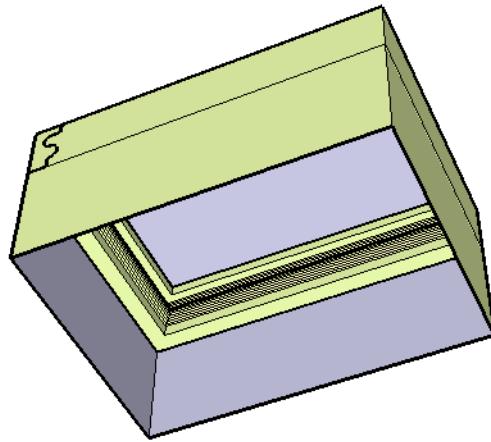
Here is the result from the outside - the box remains closed on top.



- In the browser, you can see that the component has changed - it used to be a 2D section, now it is the entire molding.



- Look up from the bottom - the molding appears on top of the box walls and ceiling.

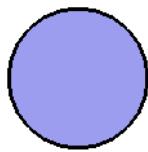


If you have standard moldings (or other sections) that you use frequently, they should be placed in a component library for easy importing. The edited (3D) molding would still appear in the **In Model** tab, but the original molding section would be preserved in the library. See "Creating and Saving Components in the Library" on page 193.

## Round Objects

By extruding a face along a circle, you can create rounded, or lathed, objects.

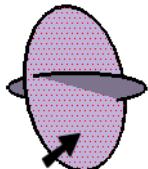
- We'll start with the most basic round shape - a sphere. Start with a circle.



- Orbit so that you can create a new circle perpendicular to the first one. Start the new circle at the center point of the first one, and make it larger.



- Select the new, larger circle.



- Activate **Follow Me**, and select the smaller circle. The smaller circle is driven around the larger one.



- Erase the larger circle to get the sphere.



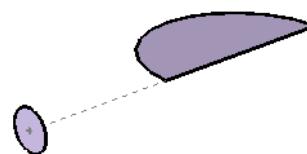
You also could have driven the larger circle around the smaller one, but then you would have to erase a circle inside the sphere.

**NOTE:** If you prefer not to go through all of these steps each time you need a sphere, open the Component Browser to the "Shapes" category to find some spheres and domes already created for you.

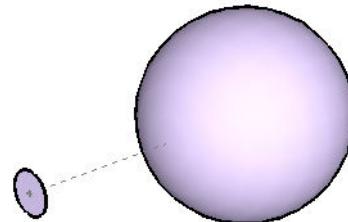
- For another way to create a sphere, start with a half-circle arc closed by a line.



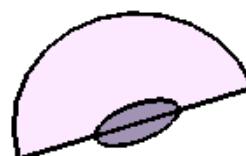
- Draw a circle perpendicular to the arc shape. The center point must be aligned with the line, but does not have to touch it. (It might help to use **Measure** to draw a construction line. You can center the circle at the endpoint of the construction line.) The circle can be any size, as long as its center point is located correctly.



- Select the circle, activate **Follow Me**, then select the arc shape. The sphere is created.



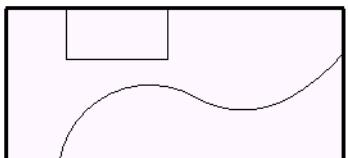
- To create a hemisphere, start with the same arc shape as before. Draw a perpendicular circle of any size at the midpoint of the arc shape line.



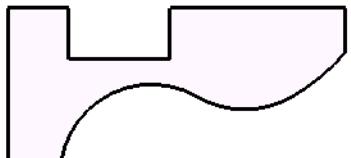
- Select the circle and activate **Follow Me** on the arc shape, to create the hemisphere.



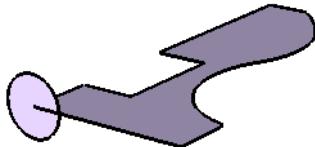
11. Where you place the circle affects the outcome of the extrude. Draw a rectangle with some lines and arcs inside it.



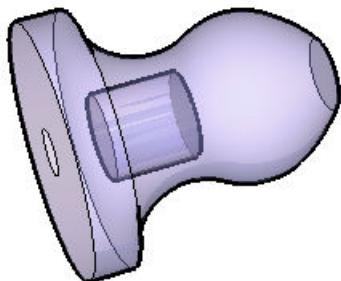
12. Erase as needed to make a face like this.



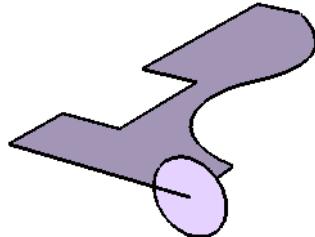
13. Place a perpendicular circle at the corner point shown.



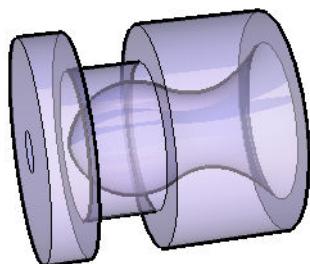
14. Use this circle to extrude the shape, and this is the result, shown in **X-Ray** mode. The rectangular cutout is in the center of the object.



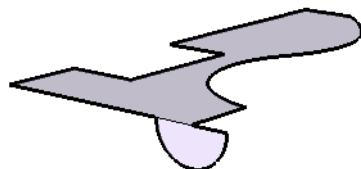
15. **Undo**, and move the circle to this corner point.



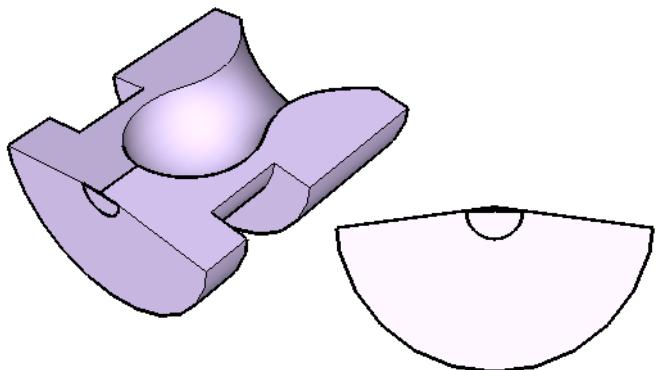
16. The extrusion this time has the rectangular cutout on the outside and the curved portion on the inside.



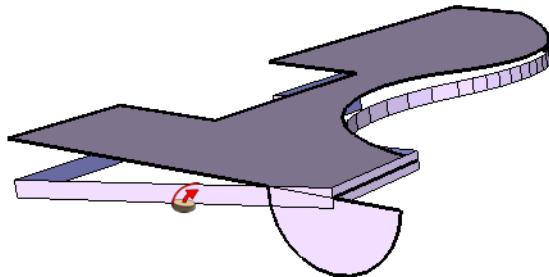
17. Here's a funny aspect of **Follow Me**. Change the circle so that it is a half-circle. (This is easily done if the circle has segment endpoints along the face edge. Then you can use a line to divide the circle, and erase the top half.)



18. Use **Follow Me** along the 180-degree arc (not the half-circle face). If you look closely, you can see that the start and end faces are not flush.



19. **Undo**, and make sure nothing is selected. Activate **Follow Me** and select the face, then extrude it manually along the arc. Now you can see the problem - the face is **Push/Pull**'d along the first arc segment, and after that the extrusion is curved. So, arcs don't always give you the results you'd expect.



To remedy this, you can try an arc with many more segments. You'll still get an extrusion that's not exactly 180 degrees, but it'll be closer. The disadvantage is that more segments make for a more complex, and therefore slower, model.

Another way is to use the “slice and copy” method. This will give you the exact shape you want, but takes a bit more work. See "Domed Apse" on page 378.

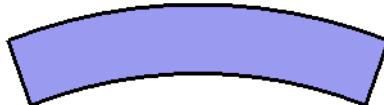
## Intersect with Model

These easy exercises are a good introduction to **Intersect with Model**. This tool basically enables you to perform solid Boolean functions - combining, intersecting, and/or subtracting one solid from another.

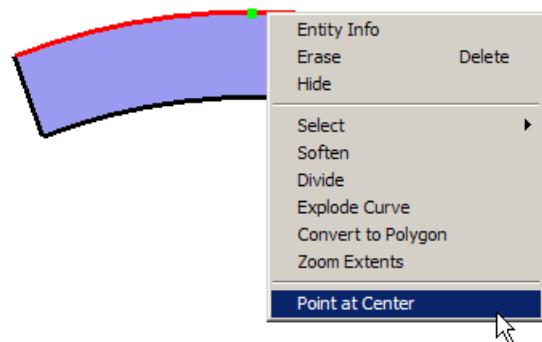
### Cutting and Embossing

This exercise shows how you can use **Intersect with Model** to create the edges needed to make cutouts.

1. Start with an arc and use **Offset** to create an outer arc. Connect the arcs with lines to complete the face.



2. For future reference, right-click on the original arc and select **Point at Center**.



**NOTE:** If this option does not appear, open **File / Preferences** to the **Extensions** page and check **Ruby Script Examples**.

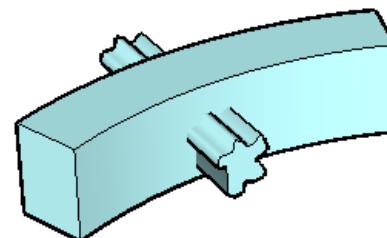
This creates a construction point at the center of the arc.



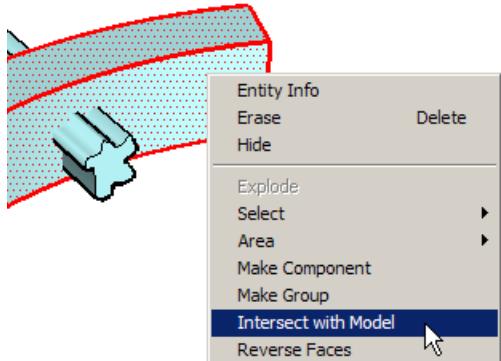
3. Orbit to face the front of the arc face, and use **Freeform** to create a shape like this.



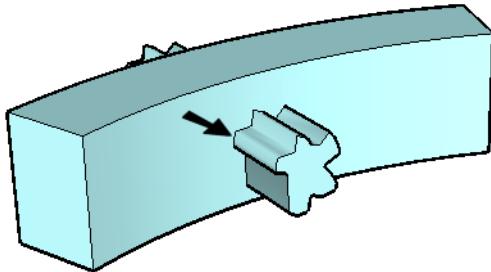
4. Use **Push/Pull** on both the freeform face and the arc face so that they intersect like this:



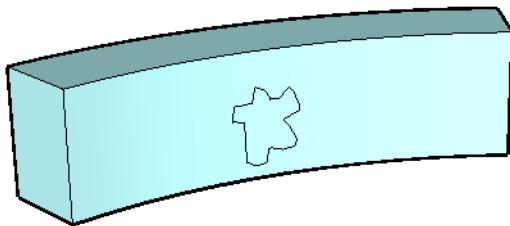
- To find the intersection edges, select the arc wall (or at least the front and back faces of it), right-click and select **Intersect with Model**. (You can also find this on the **Edit** menu.)



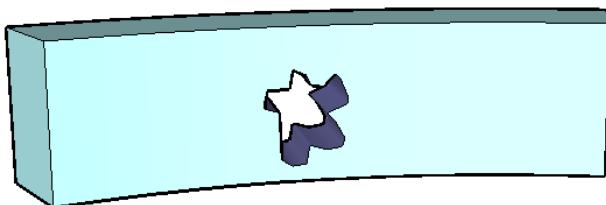
There are now edges where the freeform face meets the wall.



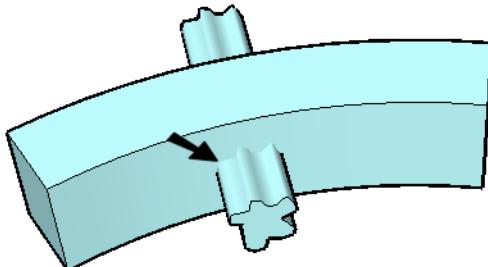
- To see these edges better, delete the portions of the freeform body that extend past the arc wall on either side.



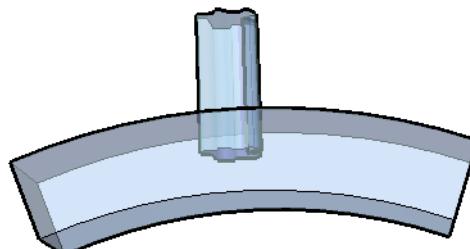
- Now erase the faces inside these edges, on both sides of the arc wall. The result is a solid arc wall with a solid cutout.



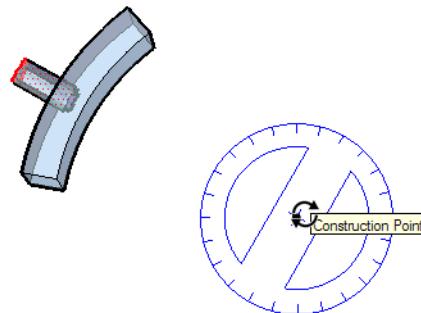
- Embossing is similar. Use **Undo** to return to the step before the intersection edges were created.



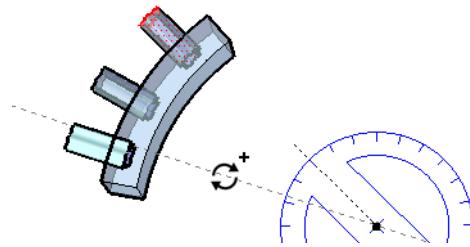
- Switch to **X-Ray** mode and **Push/Pull** the freeform body so that it stops inside the wall.



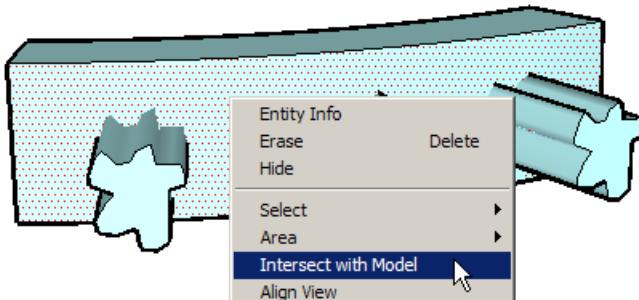
- Select the freeform body and activate **Rotate** (**Tools / Rotate**). Place the protractor at the construction point.



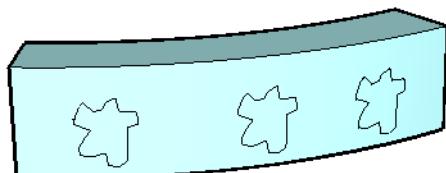
- Press **Ctrl/Option** to make copies, and set the reference axis anywhere. Rotate-copy the original form on either side.



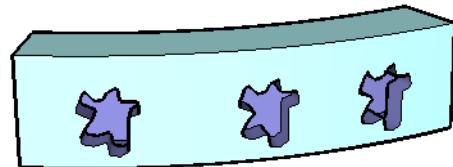
12. The intersection edges are only needed on the outer face of the arc wall. Right-click on this face and select **Intersect with Model**.



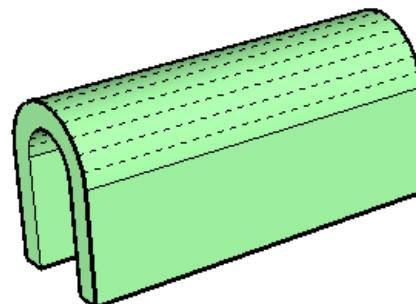
13. Erase the overhanging portions to see the three sets of intersection edges.



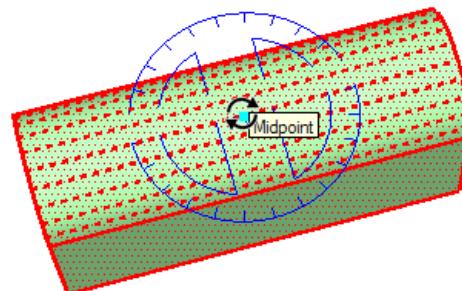
14. Erase the freeform faces, and you see partial cutouts - similar to poking the bodies slightly into the wall.



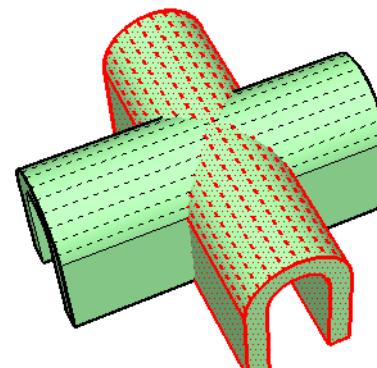
3. **Push/Pull** it out and display the hidden edges (**View / Hidden Geometry**). This is so that we will have a reference for copying and rotating.



4. Select the arch and activate **Rotate**. Shift-lock the protractor to the red-green plane and place it at the midpoint of the top (hidden) edge of the arch.



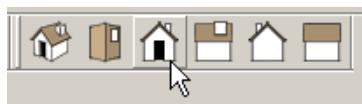
5. Press *Ctrl/Option* for copying, and set the rotation axis anywhere. Enter, or snap to, a 90-degree rotation angle.



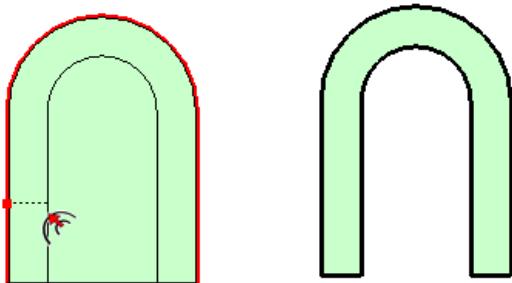
## Intersecting Arches

This exercise is pretty straightforward - intersecting two arches that meet at a 90-degree angle.

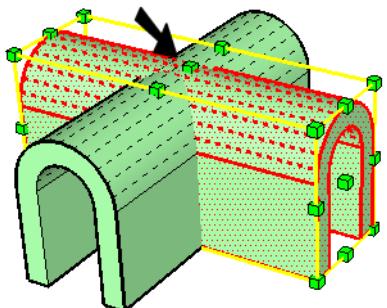
1. Start in a new file in **Front** view.



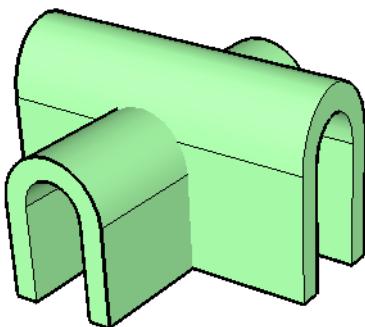
2. Use **Rectangle** and **Arc** to draw an arch. Select all edges except for the bottom one, and use **Offset** to create an inner arc. Then erase the bottom edge.



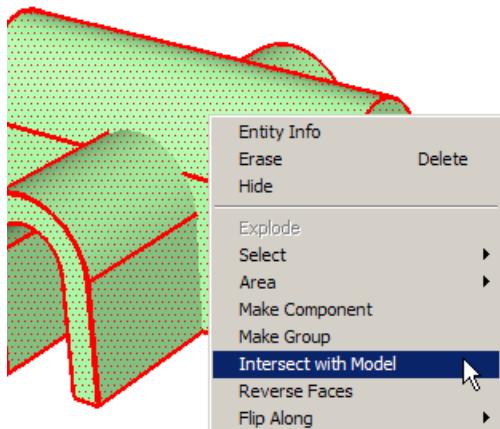
- With the copied arch still selected, activate **Scale**. Drag the top center handle upward to create a higher arch.



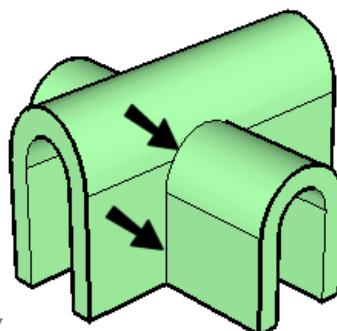
- Deselect everything and hide the hidden edges. We want to cut the arch openings, but first we need the intersection edges.



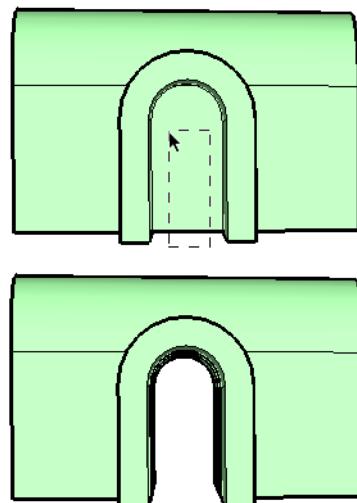
- Select both arches, and right-click and select **Intersect with Model**.



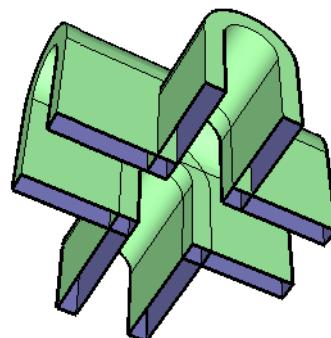
This creates edges where one object intersects with another.



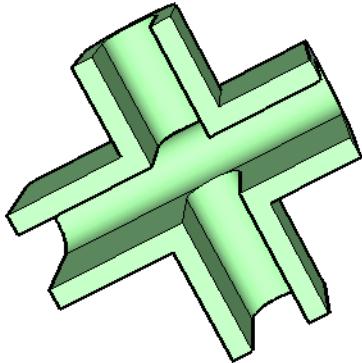
- To cut the openings, switch to a front or side view and use a right-to-left window to select and delete everything inside the shorter arch.



- Do the same for the higher arch. This is how the model should look from the bottom (this one was **Push/Pull'd** to shorten the arch lengths).



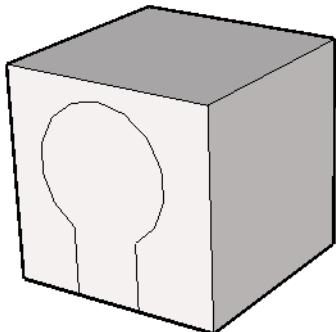
11. Recreate and erase edges as needed to clean up the ceiling and floor. This is sometimes easier to do in **X-Ray** or **Wireframe** mode.



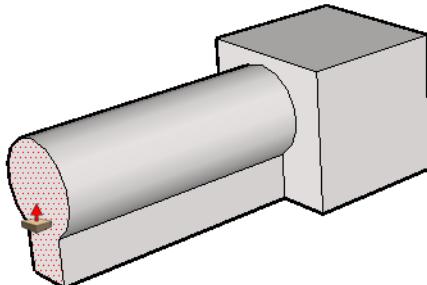
## Arch Cutouts Using Groups

This exercise is similar to the previous one, but uses an arch form to create intersecting cutouts. The result is a vaulted ceiling.

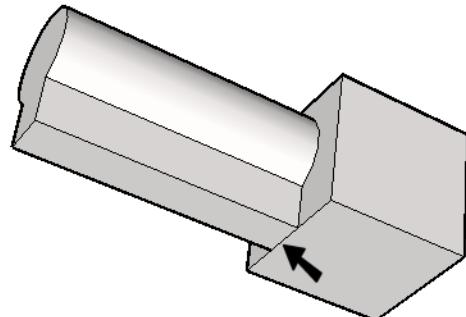
1. Start with a square (sides must be equal) in the red-green plane and **Push/Pull** it up to a box. Draw an archway on one side.



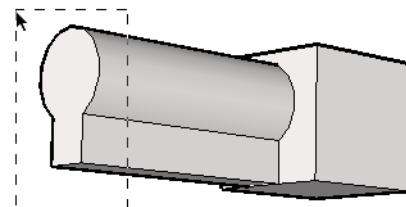
2. **Push/Pull** this arch out.



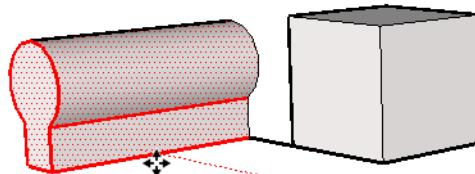
3. To separate this arch from the box, add a dividing line. (If you used the **Ctrl/Option** key when you pulled out the arch, this step wouldn't be necessary.)



4. Now we need to move the cutout all the way through the box. Select the arch form . . .



5. . . and try to move it into the box. It can only move side-to-side.

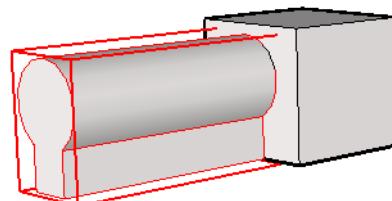



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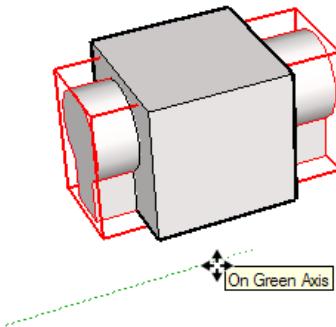
*NOTE: You could move it into the box using **Autofold**, but this would push in the side of the box as well!*

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6. Undo the move, and with the arch still selected, make it into a group (**Edit / Make Group**).



7. Grouping the arch has eliminated the “stickiness” to the box. Now you can move it into the box.

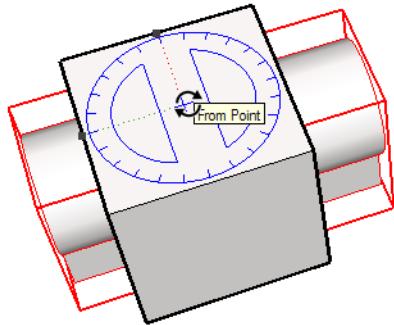



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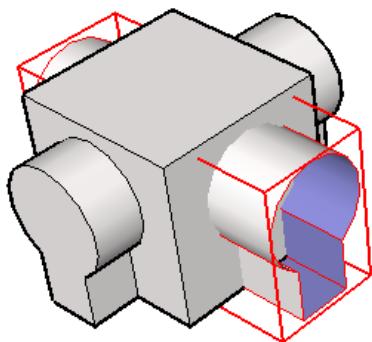
NOTE: For more details on groups, see Chapter 6.

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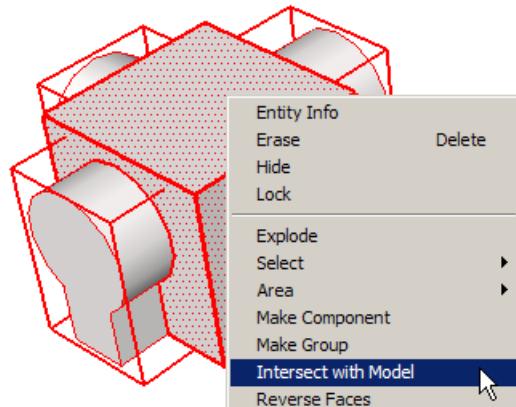
8. With the group still selected, activate **Rotate**. Place the protractor at the center of the box top. You can do this by hovering over two adjacent midpoints and finding their intersection.



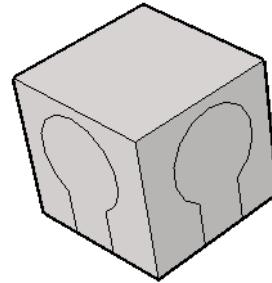
9. Use **Ctrl/Option** to create a copy 90-degrees from the original.



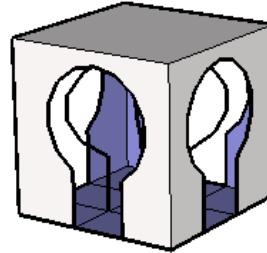
10. Select everything, right-click and select **Intersect with Model**.



11. Now erase the arch groups, and the intersecting edges remain on the box.



12. Erase the arch faces, and this is the result. Because the cutouts were grouped, no part of them remains inside the box when they are deleted. To solve this, groups must be *exploded* before creating intersections.

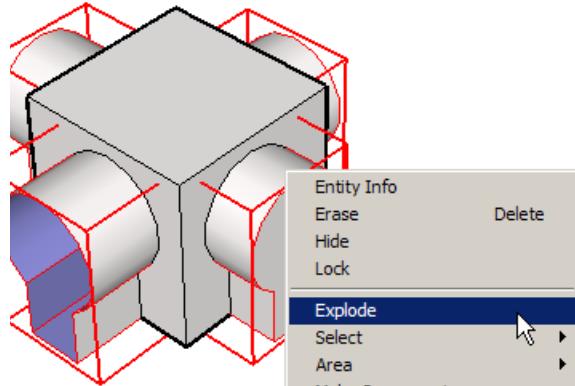



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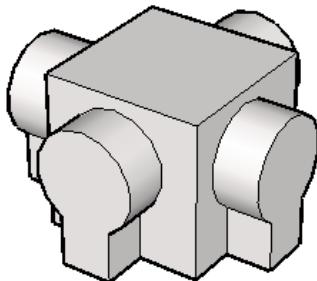
NOTE: This is also true for components, as you will see in "Creating a Faucet" on page 126.

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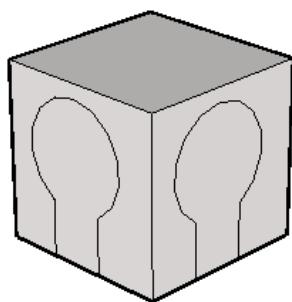
13. Undo until you return to the step in which you had two arch groups. Select both groups, right-click and select **Explode**.



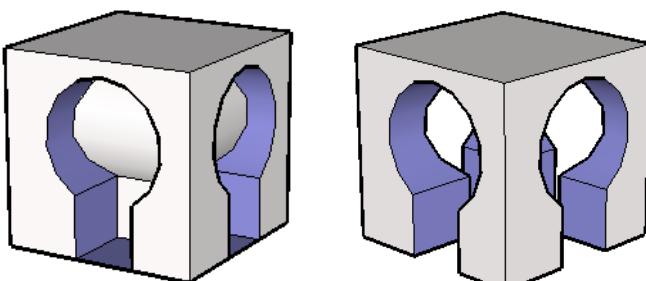
14. Now select everything again and intersect the model.



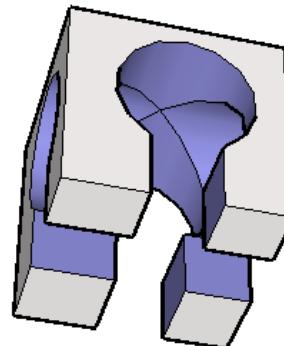
15. Delete the portions of the arches that extend past the box. This is easy to do in **Top** view.



16. Erase the arch faces, and you are left with some interior faces. Erase these interior faces as well to create an arcade.

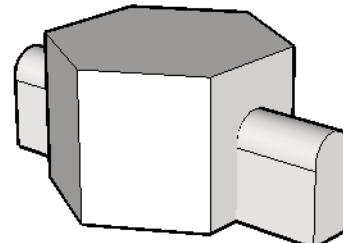


This is how the arcade should look from below - a nice vaulted ceiling.

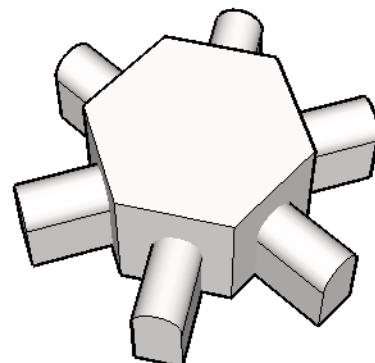


This method works great for simple forms like arches and cubes. When you attempt something more complex, it still works, but you may have a bit more cleanup to do.

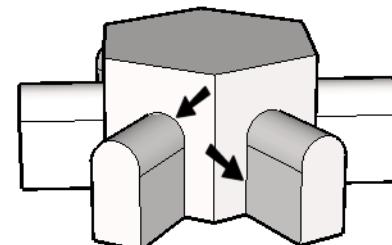
1. As an example, create a hexagon (use the **Polygon** tool) and create a similar arch cutout group.



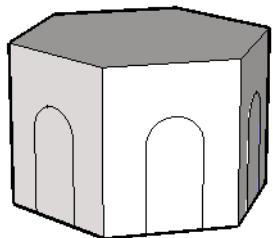
2. Rotate-copy the cutout group 60 degrees, making two copies.



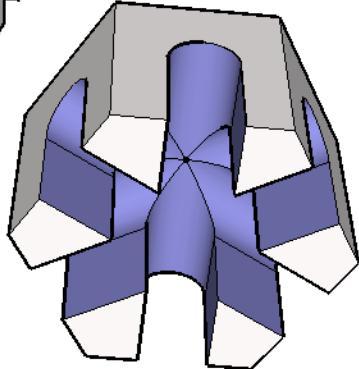
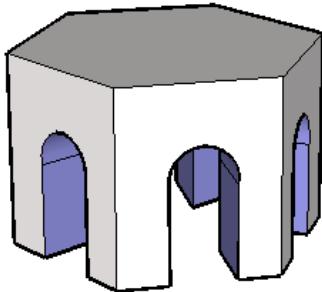
3. Explode the three groups and intersect the entire model.



4. Trim the portions of the arches that extend past the hexagon form.



5. Erase the arc faces. Now when you get inside, you will find a number of faces to delete, as before. But you will also have more extra edges and small faces to erase.

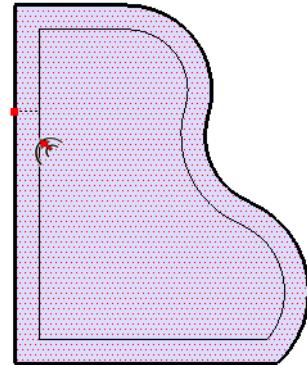


## Cutting Using Components

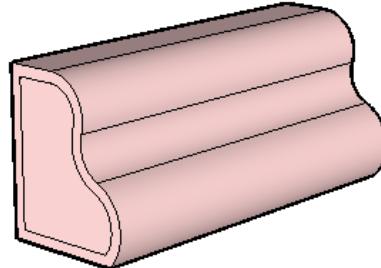
This exercise shows how components can be used in conjunction with **Intersect with Model**.

**NOTE:** For an in-depth exercise on using **Intersect with Model** and components, see "Creating a Log Cabin" on page 427

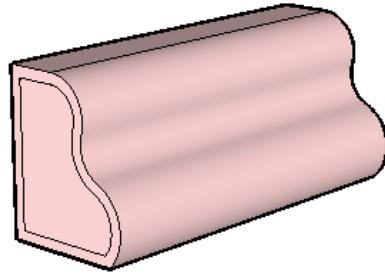
1. Start with a form like this (using lines and tangent arcs) and use **Offset** to create an inner set of edges.



2. **Push/Pull** the form out and close the end faces. This will be the grill form that will have several cutouts made.



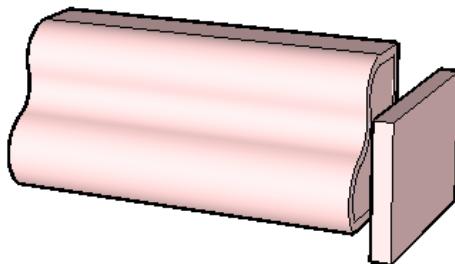
3. Smooth the long, lateral edges on the front face, by using **Ctrl/Option + Erase**.



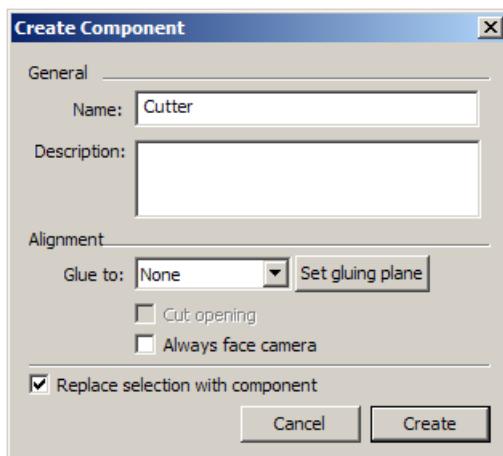
4. To make the cutter, face the front of the grill and create a vertical rectangle next to it.



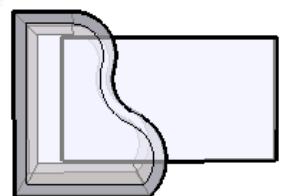
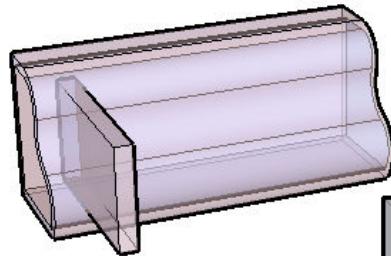
5. This rectangle will be the cutter; so make a box out of it.



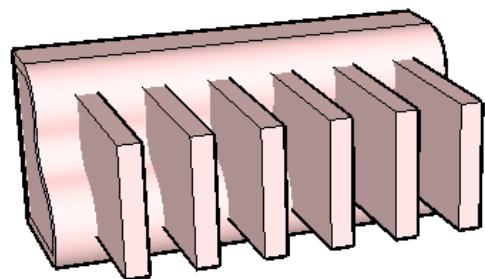
6. Select the box and make it a component (**Edit / Make Component**). Assign any name, and be sure that **Replace selection** is checked.



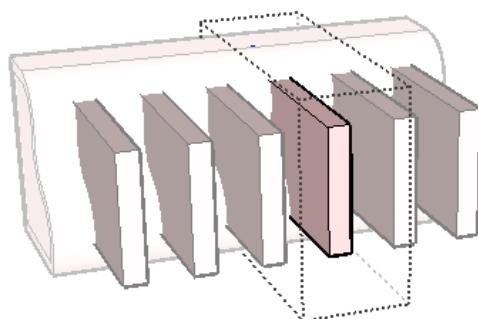
7. Position the cutter component within the grill, so that it stops in the hollow space. It may be easiest to do this in **X-Ray mode**. You'll probably need to move a few times, in a few axis directions.



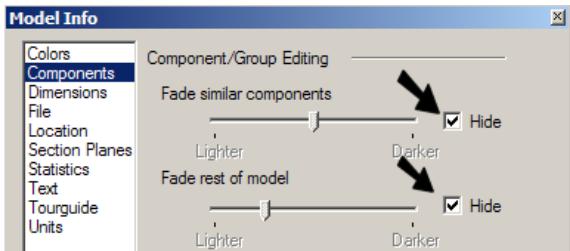
8. With the cutter selected, activate **Move** and use **Ctrl/Option** to make several copies of it. (To make multiple copies, place the first copy and then type **4x** - or whatever works for you.)



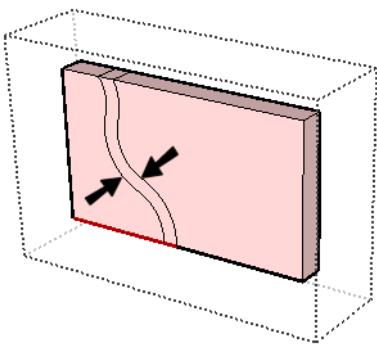
9. Double-click on any cutter to open it for editing. The rest of the model, including other components, are faded.



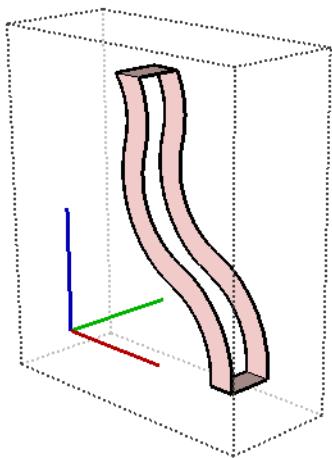
10. The easiest way to edit this component is to blank everything else. On the **Components** page of the **Model Info** window, check **Hide** for both components and the rest of the model.



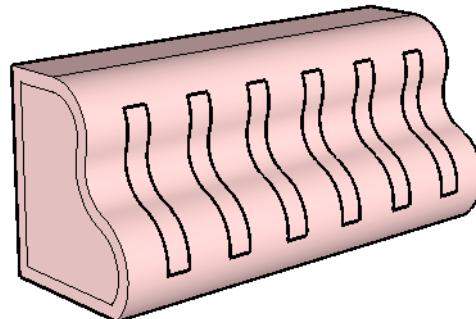
11. Select the entire component (select everything - only the edited component is selectable) and perform an intersection. The edges where it meets the grill are created.



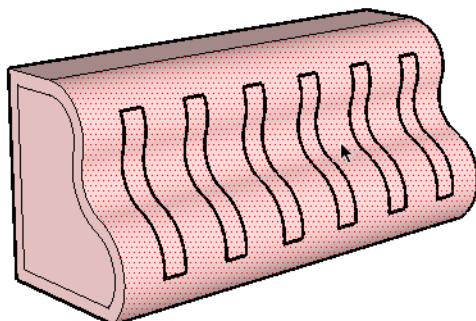
12. Trim the cutter on either side of these edges. You should have four faces, representing where the cutter meets the front of the hollow grill “shell.”



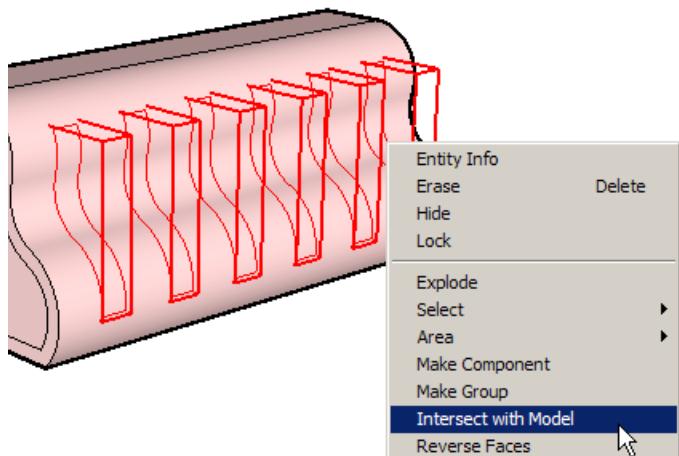
13. Close the component by double-clicking outside it, or right-click and select **Close Component**.



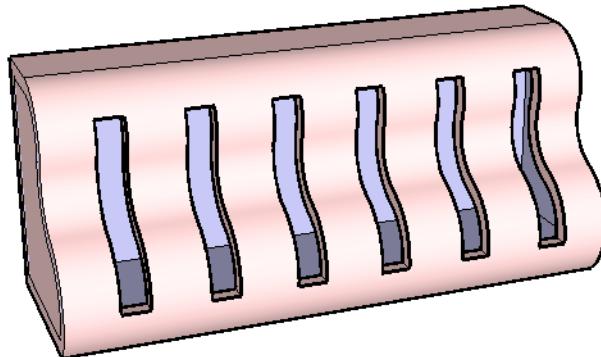
14. If you try selecting and deleting the interior faces, you can't do it yet - the grill face is not yet broken.



15. To break the face, you need to use the components as cutters. Select all of the components and run **Intersect with Model** again.



16. Now you can delete the cutout faces, and the interior faces of the front face.

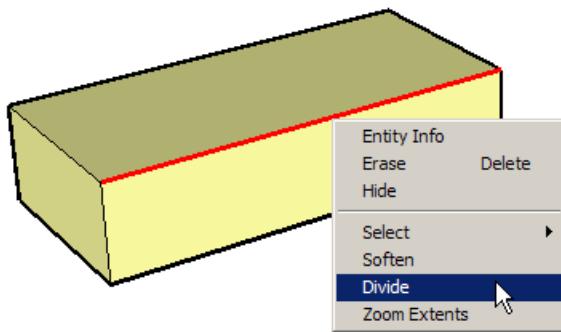


This works because the grill is a hollow shell, and not a full solid. To do the same thing with a solid, you would have to explode each component. Or, see the next exercise for a work-around.

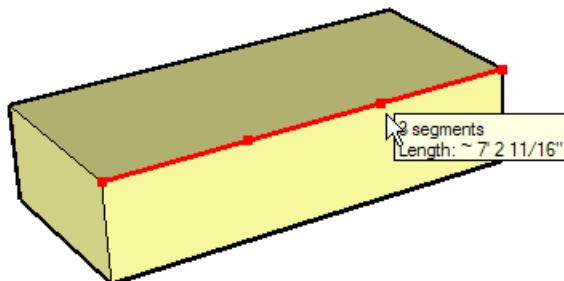
## Hiding Intersection Edges with Components

This exercise is a neat work-around to the problem of model intersection, in which you cannot find edges on a component when its intersecting face has already been cut.

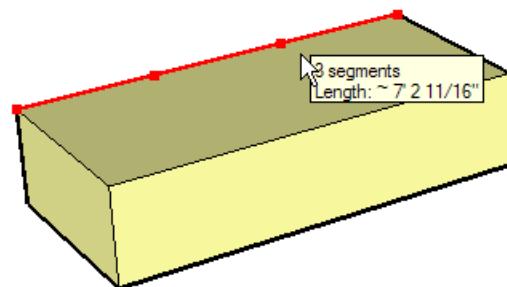
1. Start with a short rectangular box. Right-click one of the long top edges and select **Divide**.



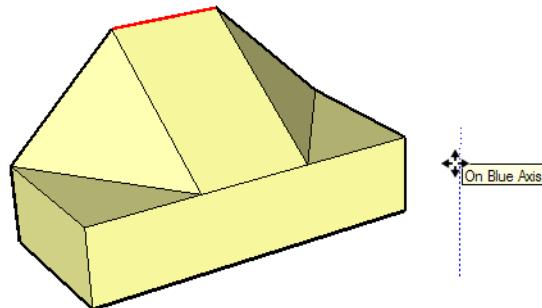
2. Move the cursor until the edge is divided into three segments. If you hover over the division point, the tool tip will tell you the number of segments and the segment length.



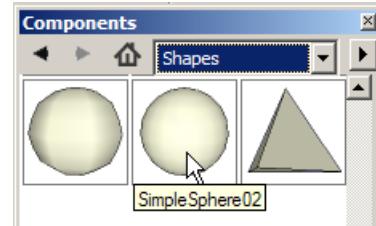
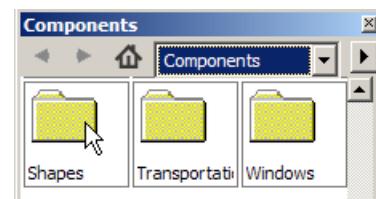
3. Do the same for the other long top edge.



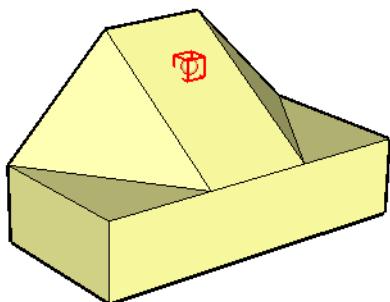
4. Select the middle back edge and activate **Move**. Press Alt/Cmd for Autofold and move this edge up. (Without Autofold, the edge cannot move up.) If your model does not look like this, you can erase and recreate the needed edges.



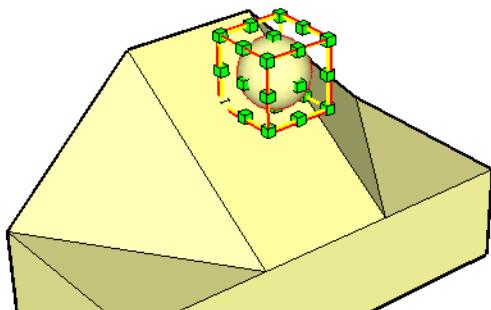
5. We will add skylights to this sloped roof. Display the Component Browser (**Window / Components**). Open the Shapes category and click one of the spheres.



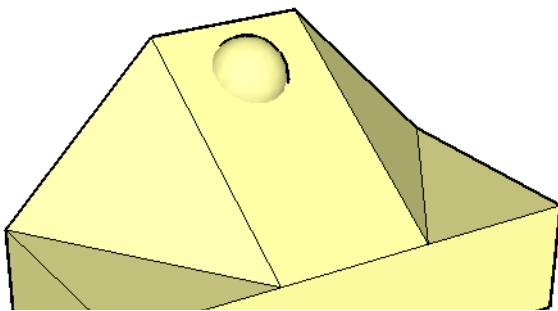
6. Drag the sphere to the sloped face.



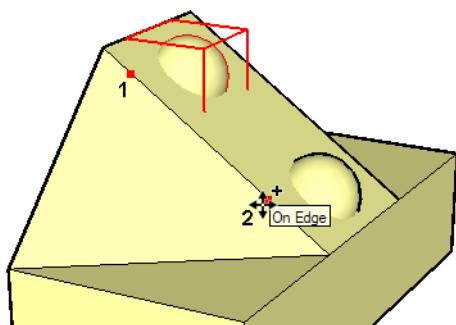
7. Unless the size of your model is perfect, you will have to resize the sphere. With the component still selected, activate **Scale** and drag one of the corner handles outward.



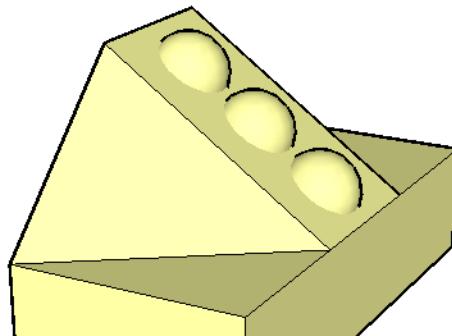
8. Move the sphere as needed in the red, green, and blue directions so that it sticks out of the roof, approximating a skylight. It helps to do this in the **Top** and **Left / Right** views.



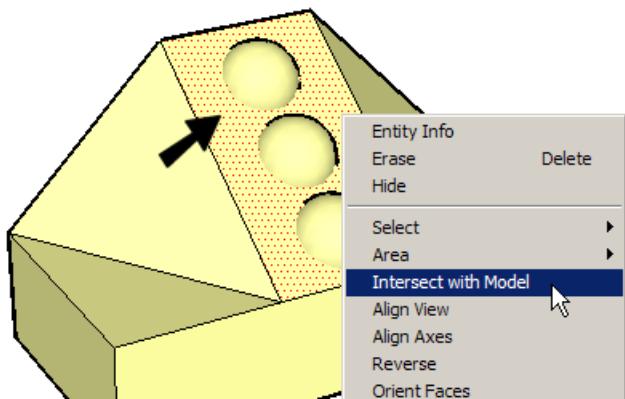
9. Activate **Move** and press **Ctrl/Option** to make a copy. Select two points along the sloped edge to place a copy on the other end of the face.



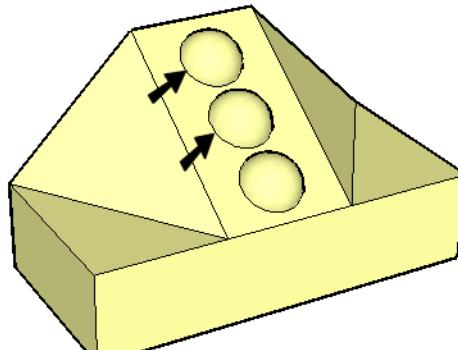
10. Type “2/” (or whatever number you want) to create some more skylights between the first and last ones.



11. In order to see through the skylights, the roof face must be cut. Right-click on this face and select **Intersect with Model**.



This creates edges around each skylight.



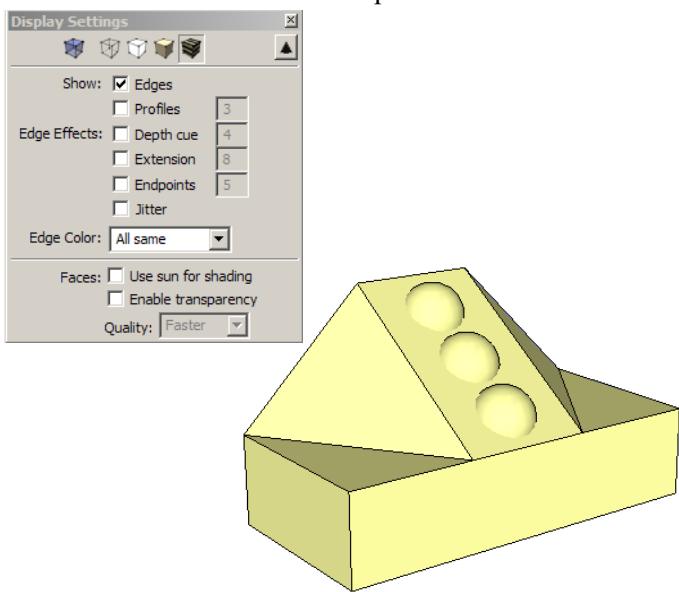
12. Now edit one of the sphere components, select it, and perform an intersection. Unless your spheres overlap, no intersection will be created. The roof face has already been cut, so no edges are created where the sphere meets it.



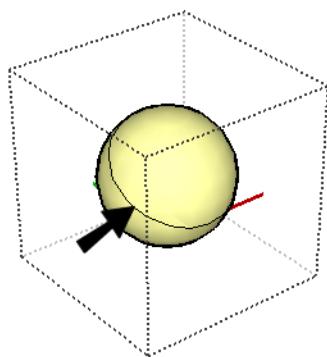
13. If intersection edges *are* created, it is where the sphere overlaps with other spheres. **Undo** any intersection edges, and close the component.
14. Here is the crucial step: select and **Hide** (do not erase) all the intersection edges. Do not hide the cutout faces, however! The roof face has to appear whole.

The easiest way to do this is to keep *Ctrl/Option* pressed and use several left-to-right selection windows. Be sure not to create any selection window that would enclose an entire cutout face, or an entire component. With all edges selected, press H or right-click and select **Hide**.

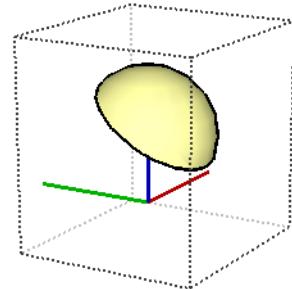
. This should be the result: no intersection edges visible and the components are still in place. Profiles are turned off in this example.



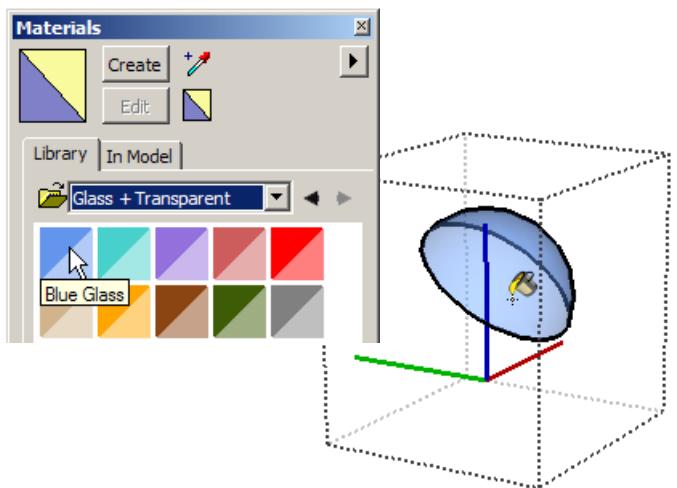
15. Now edit one of the spheres and do an intersection. The intersection edge with the “whole” roof face is created this time.



16. Erase everything but the face that represents the skylight.



17. To make this realistic, open the Material Browser (**Window / Material Browser**). In the Library, open the “Glass + Transparent” category and click one of the glass thumbnails. Click the skylight face to apply the glass material.

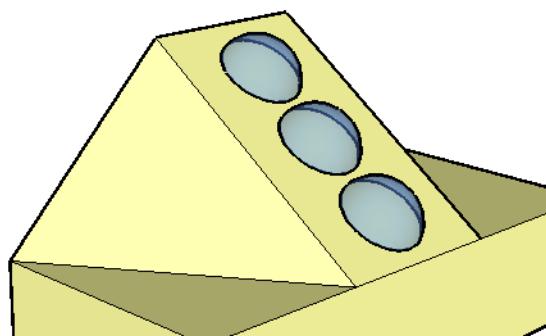



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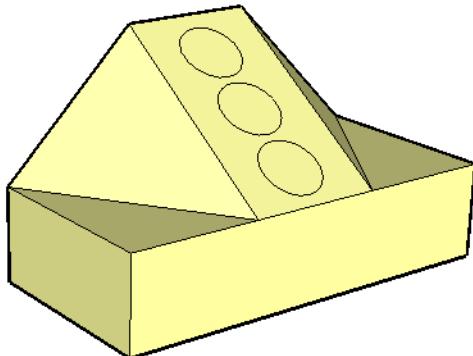
*NOTE: Materials are covered in Chapter 7. For details on transparency, see "Material Transparency" on page 249.*

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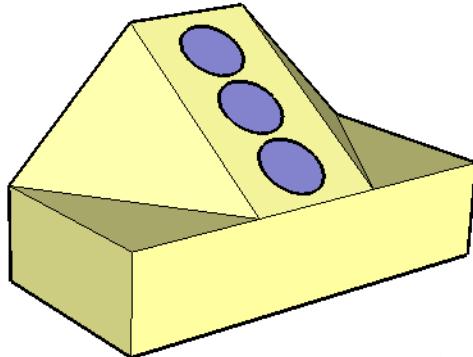
18. Close the component. The skylights appear on the roof, but you cannot see through them because the roof face is still whole.



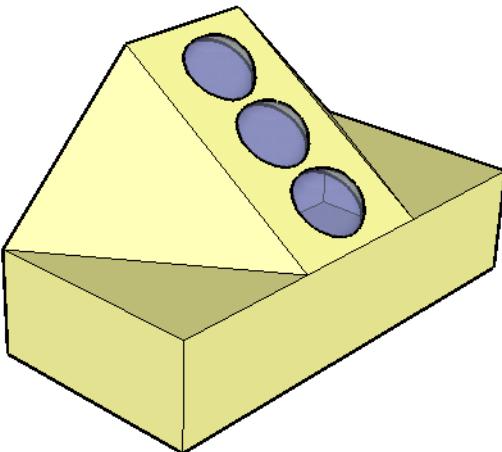
19. Display the intersection edges you hid before (**Edit Unhide / All**).
20. Now select all of the skylights and hide them. Here is what remains - those edges you hid before.



21. Erase the cutout faces . . .



22. . . and unhide the skylights. Now you can see through the glass into the model.



## Combining Follow Me and Intersect with Model

These exercises use both tools, which you'll find are very often used in conjunction with each other.

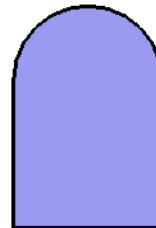
### Creating a Wall Niche

This simple exercise shows you how to use **Follow Me** to create a rotated form to use as a cutout, and how to use **Intersect with Model** to make the cutout.

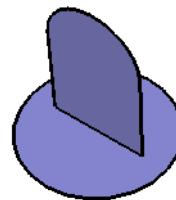
1. Start in **Front** view.



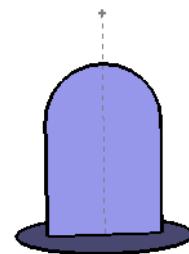
2. Draw a shape like this.



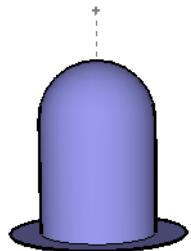
3. Draw a circle of any size in the red-green plane (press Shift to lock the plane), using the midpoint of the bottom line as the circle center.



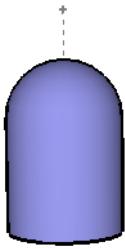
4. To make things easier later, use **Measure** to create a vertical construction line along the center.



5. Use **Follow Me** to rotate the arch shape. You can select the circle first, then activate **Follow Me**, and then select the arch. Or you can activate **Follow Me**, select the arch, press Alt/Cmd, then select the circle.



6. Erase the circle. To replace the bottom face, you can redraw one of its segments. Another way is to select all edges of the bottom circle and then select **Tools / Utilities / Create Face**.

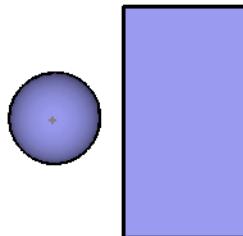



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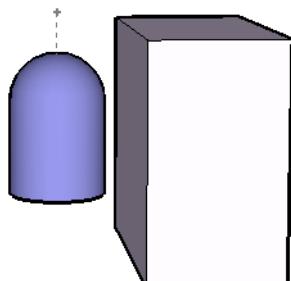
**NOTE:** For **Create Face** to be available, open **File / Preferences** to the **Extensions** page. Make sure **Utilities Tools** is checked.

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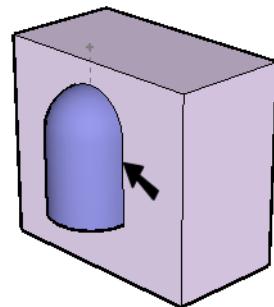
7. In **Top** view, draw a rectangle for the base of the box that will be cut.



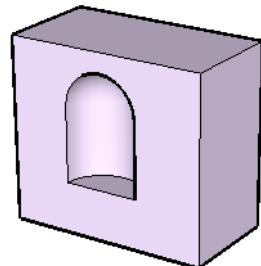
8. **Push/Pull** the rectangle up and down so that it will encompass the niche shape.



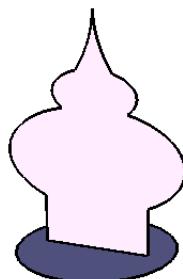
9. Move the niche and construction line, dragging it by the construction line, into the box. Stop when the construction line aligns to the front face. With the niche still selected, right-click and select **Intersect with Model**. The edges along the box are now created.



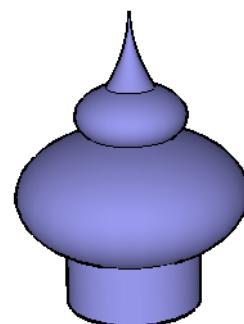
10. Trim all the extra faces and edges, and here is the wall niche.



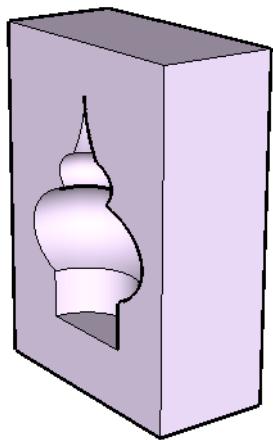
With **Follow Me**, you're not limited to a simple arch-shaped niche. If you have a section like this . . .



. . . you can easily rotate it into this.

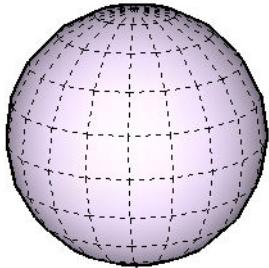


This would be the resulting niche.

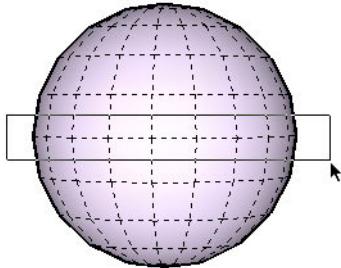


As an unrelated aside, here's another way to create the arched niche.

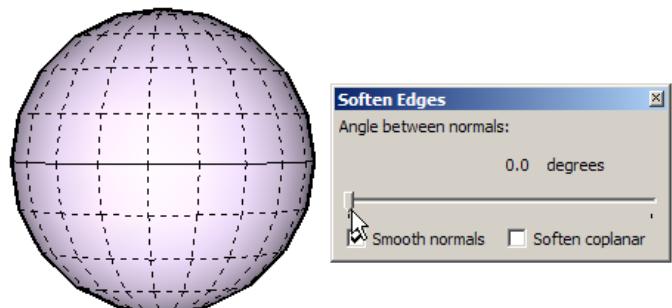
1. Start by bringing in a sphere component (located in the Shapes folder of the Component browser).
2. Explode the sphere (right-click and select **Explode**), and select **View / Hidden Geometry** to display hidden edges.



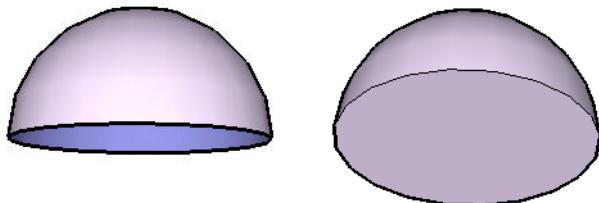
3. Select all edges separated the top and bottom halves of the sphere. Right-click and select **Soften/Smooth Edges**.



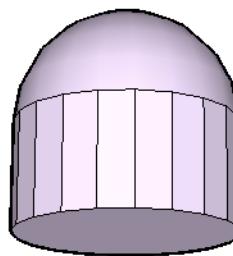
4. Move the slider to zero to unhide these edges.



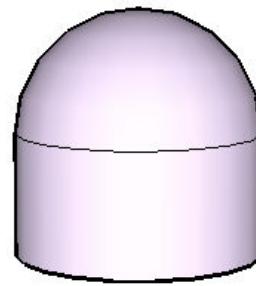
5. Turn off the hidden edge display, and erase the lower half of the sphere. Create the bottom face.



6. **Push/Pull** the base out.



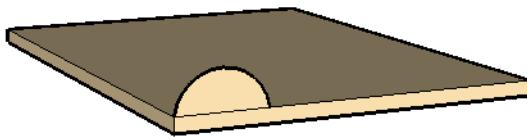
7. To soften these edges, use the **Soften/Smooth Edges** option once again. (You could also use **Erase** with *Ctrl/Option* to smooth the edges.)



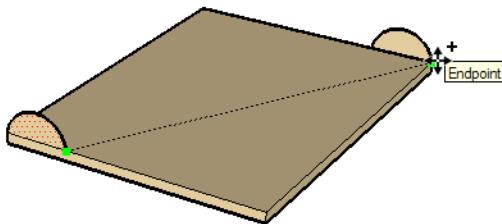
## Intersecting Moldings

This exercise may not represent a typical or practical design (a funky picture frame), but it's useful to know how to handle objects that intersect. It demonstrates how to use **Follow Me** to easily create interesting edges, and uses **Intersect with Model** to trim them to one another.

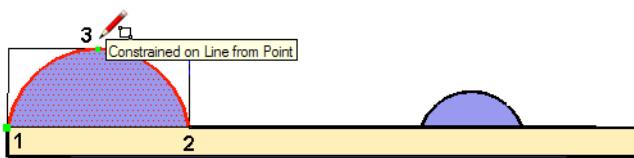
- Start with a flat box for the frame itself, then draw a vertical arc starting from the endpoint of one edge. This arc will be driven along two of the frame's edges.



- Another section will be driven along the other two edges. Its dimensions should be consistent with the arc, so copy the arc to the opposite corner.



- Zoom in on the copied arc, and draw a rectangle that encloses it. In **Rectangle**, click Points 1 and 2, and press Shift to lock the width. Then click Point 3 (the top of the arc) to define the height.



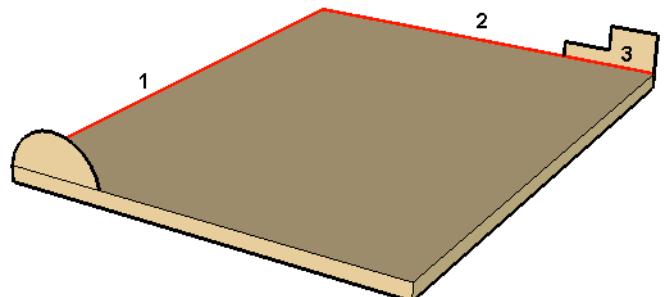
This should be the result:



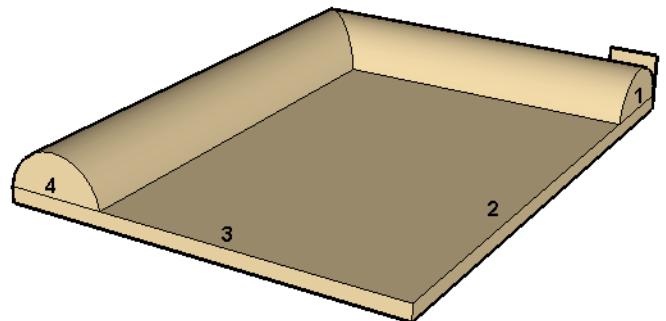
- Erase the arc, and change the section to something like this:



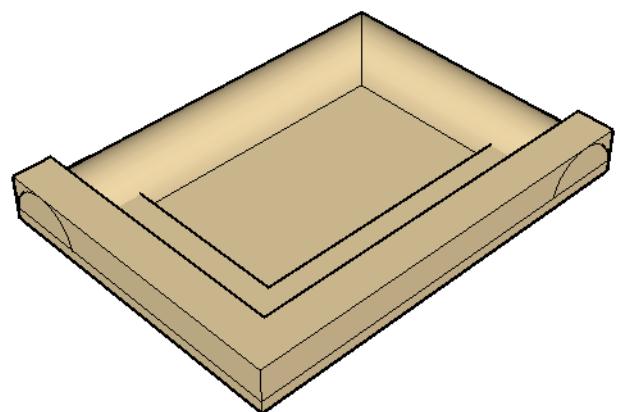
- Now to drive the sections. It's easier to pre-select the edges, so select the two frame sides shown (three edges total).



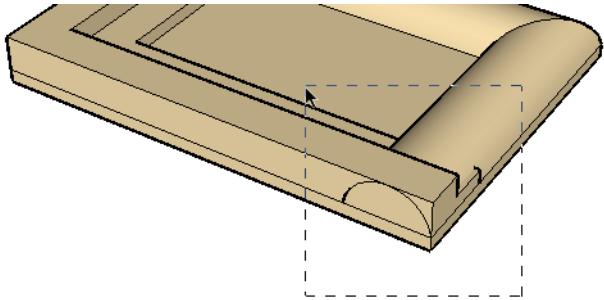
- Activate **Follow Me** and select the arc section. Then select the other two frame sides (four edges total).



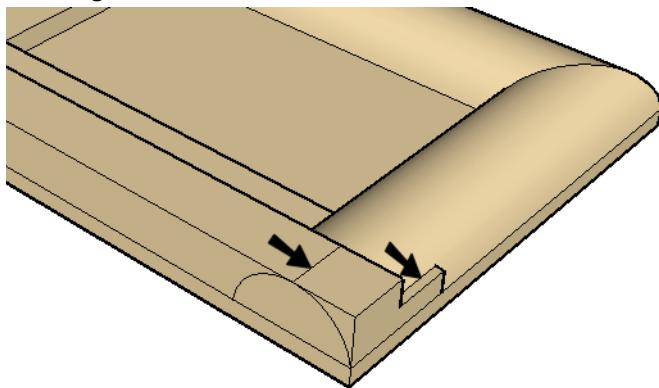
- Activate **Follow Me** again, and select the segmented section. All edges are created, but they need to be trimmed.



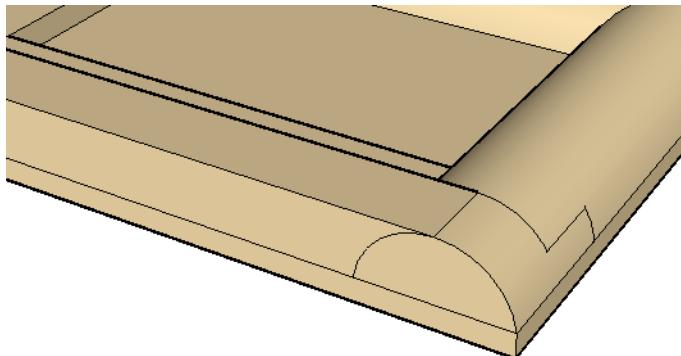
8. Select all faces and edges at one intersection corner, and run **Intersect with Model**. (You could also run it on the entire model.)



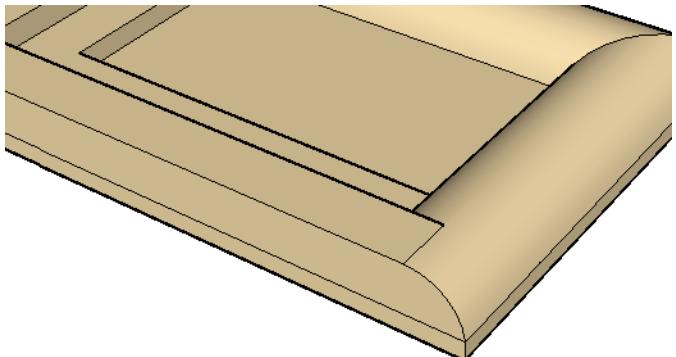
Intersection edges are now created where the two edges meet.



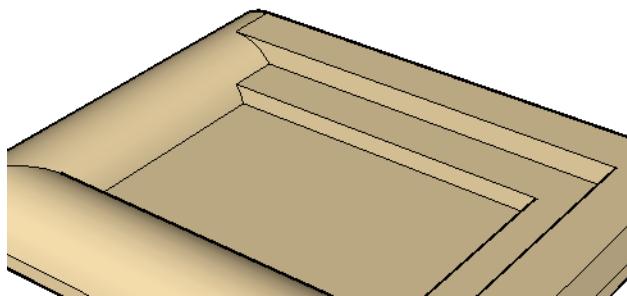
9. Start cleaning up by trimming away the parts of the edges that stick out. You should be left with some edges aligned with the faces.



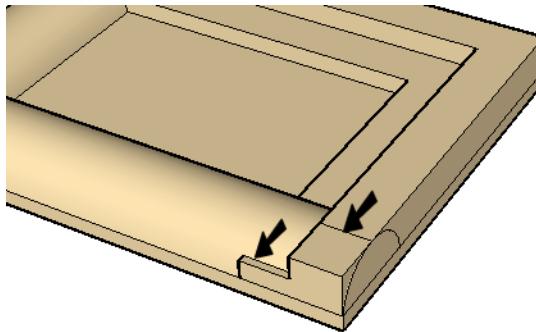
10. Erase these unnecessary edges as well. You'll probably need to recreate one or more faces as a result - this is easily done by using **Line** to connect two adjacent endpoints you know to be on the same face.



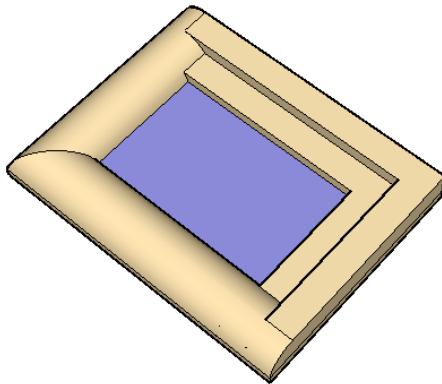
This is how the interior side of the corner should look:



11. Now do the same on the other corner. First run the intersection (unless you ran it on the entire model before).



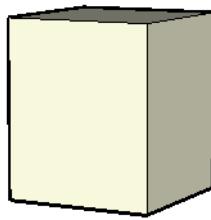
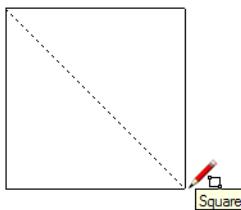
12. After cleaning up this corner, here's the result. In this example, the frame face itself was switched to its "Face Back" color (right-click on the face and select **Reverse**).



## **Creating a Table Leg**

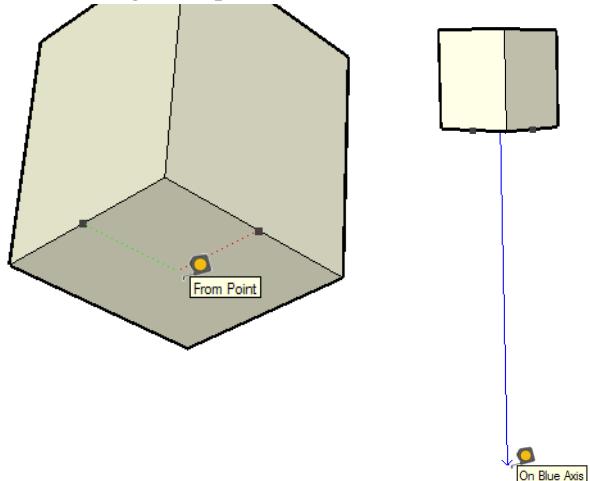
This exercise will show how to create a lathed form - a table leg. Its dimensions are a bit exaggerated, but it shows clearly how to use **Intersect** with **Follow Me** to create everyday shapes.

1. Start with a square in **Top** view, and **Push/Pull** it into a box.

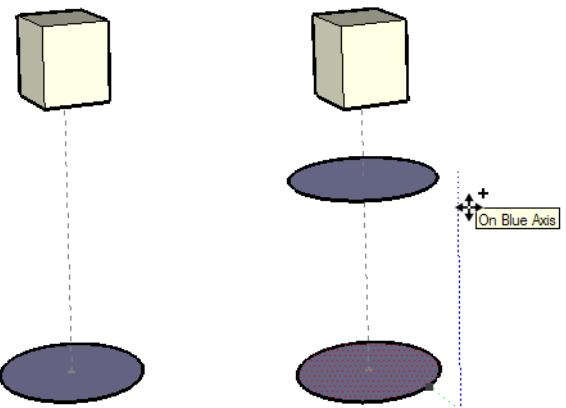


2. We will mark the center of the table leg with a construction line from the bottom of the cube. Activate **Measure**, hover over two adjacent

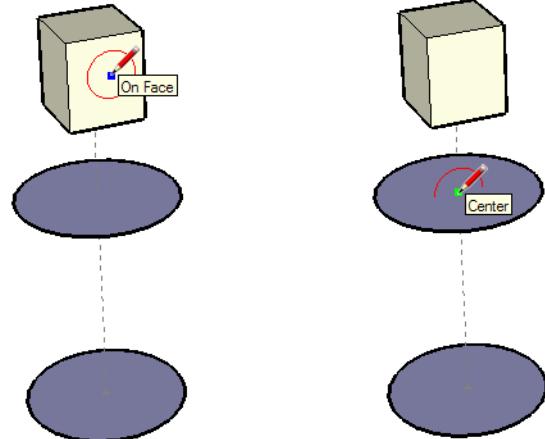
midpoints, and start the line at their intersection. Draw straight down and stop where you want the table leg to stop.



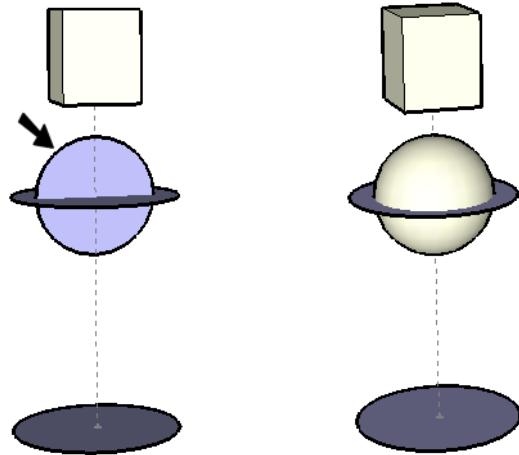
3. Draw a large, flat circle at the bottom of the construction line, and copy this circle up close to the cube.



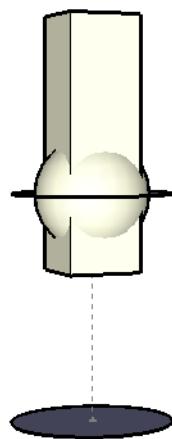
4. Align the next circle to a vertical face of the cube, and press Shift to lock the alignment. Place its center at the center of the large flat face.



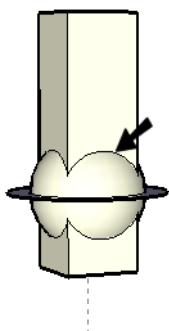
5. Make the vertical circle approximately this size, relative to the cube. Then select the larger circle, activate **Follow Me**, and select the smaller circle. This creates a sphere.



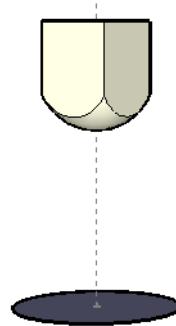
6. **Push/Pull** the box through the sphere.



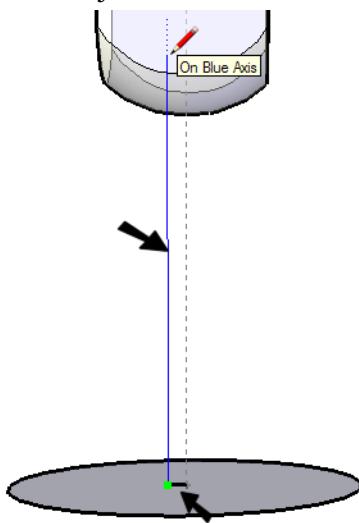
7. Select the sphere and run **Intersect with Model**.



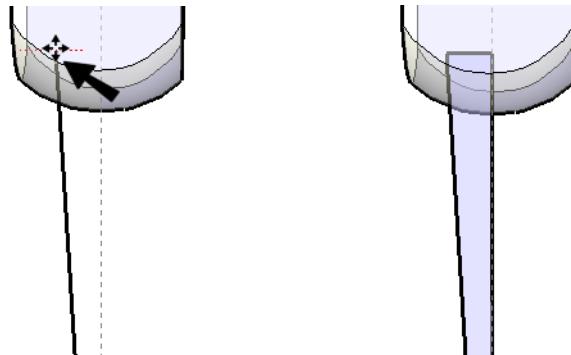
8. You can now trim the box past the sphere, and the portions of the sphere outside the box. You can also **Push/Pull** the box back down to a reasonable height.



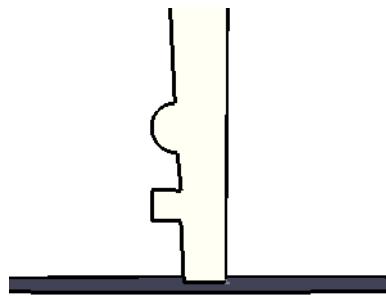
9. Now for the table leg. We will create half the leg cross-section, then drive it around the remaining circle. Start by drawing two lines - one from the bottom of the construction line, and the next straight up. End the line just inside the box.



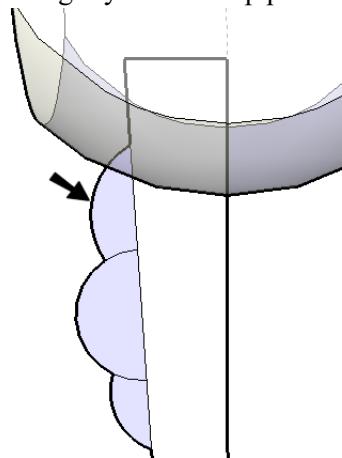
10. Move the top of this line slightly outward to give the leg a draft angle, and complete the face of the cross-section. It is easiest to do this in **X-Ray** or **Wireframe** mode.



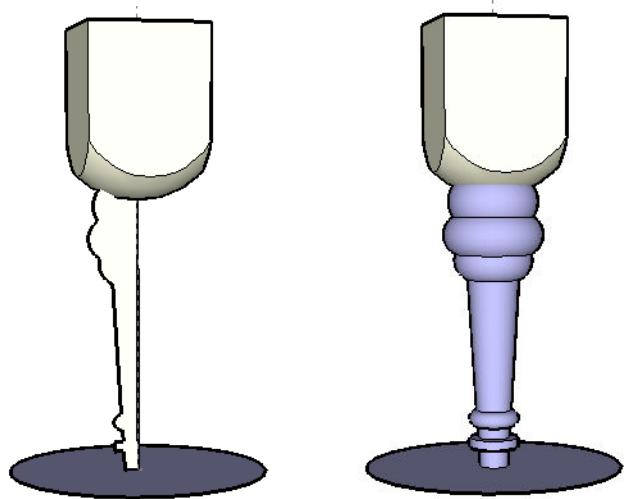
11. Add some detail at the bottom of the cross section like this:



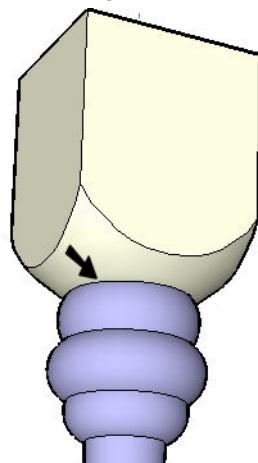
12. At the top of the leg, make a few arcs. The top arc should protrude slightly into the top part of the leg.



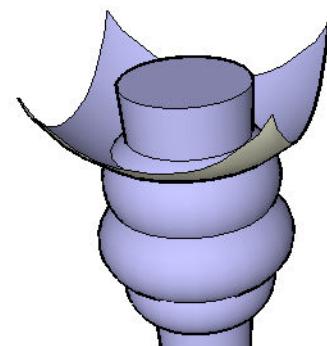
13. The final cross-section should look something like this. Use the circle at the bottom with **Follow Me** to complete the leg.



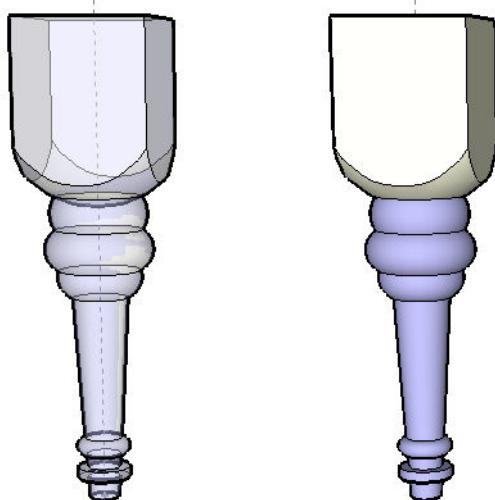
14. Use **Intersect** to get the intersection edges between the two parts of the leg.



15. To trim the leg, you can **Hide** the top section, or do it in **X-Ray** mode.



Here is the final, trimmed table leg.



## ***Creating a Faucet***

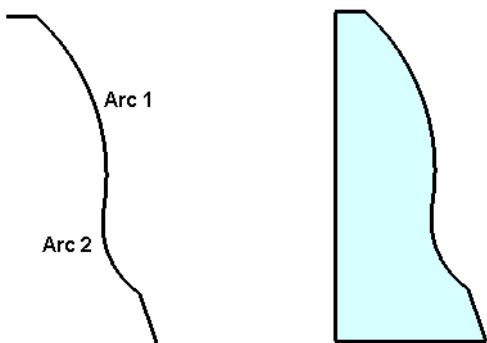
Like the previous exercise, this exercise shows how to create revolves, and shows what happens when **Intersect** is used with components.

(If you want to skip the actual creation of this model and go straight to the intersection part, go to [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm) and download the file “faucet.skp.” You can then skip to Step 27.)

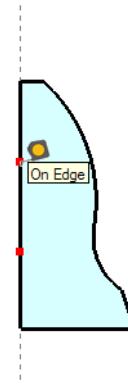
1. Start in a new file in **Front** view, so that you are working in the red-blue plane.



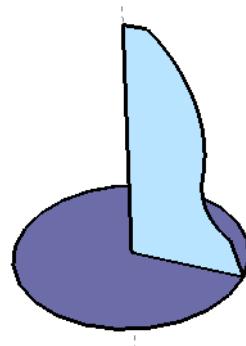
2. Use lines and tangent arcs to draw something like this: the outline of the faucet cross-section. Complete the face with a vertical and horizontal line. This is half of the faucet cross-section.



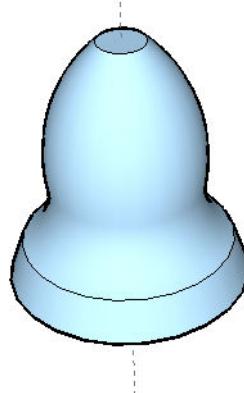
3. Activate **Measure** and click any two points along the vertical edge to create a construction line. This line will be used later when placing the faucet handles.



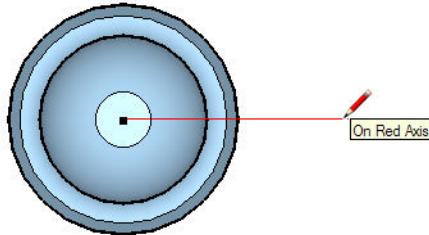
4. Draw a circle to represent the faucet base.



5. Select either the circular face of the base, or the circle itself. Then activate **Follow Me**. For the face to drive around the circle, select the faucet section. This creates the round faucet.



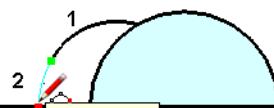
6. Now for the faucet handles, which will involve the use of components. Start with a line that starts from the center of the faucet and extends as far as you want the handle to stick out. To make things easier later, keep this line in either the red or green direction.



7. Select and move this line somewhere in the blank space.  
8. Draw a semi-circle at one end of this line.



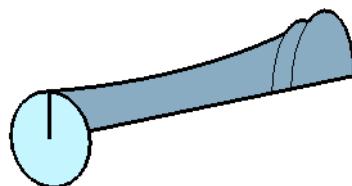
9. Use two arcs to create the next section. The second arc should be tangent to the first.



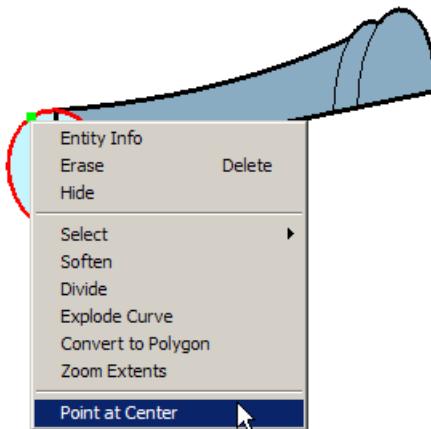
10. Complete the form with one more arc, then a short vertical line. This is half the cross-section of the handle.



11. Just like you did with the faucet base, draw a circle perpendicular to the handle section. This is why you drew the base line along one of the axes. If the line were not parallel to red or green, it would be tougher to find the perpendicular plane.



12. For reference later, right-click the circle you just created and place a construction point at its center.



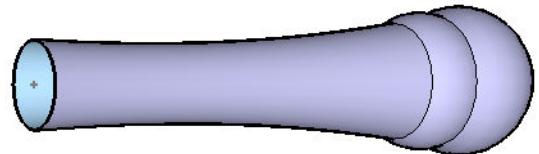
13. Like before, use **Follow Me** to create the handle. First select the circle, then activate **Follow Me**, then select the semi-circle to revolve.



This creates the ball at the end of the handle.

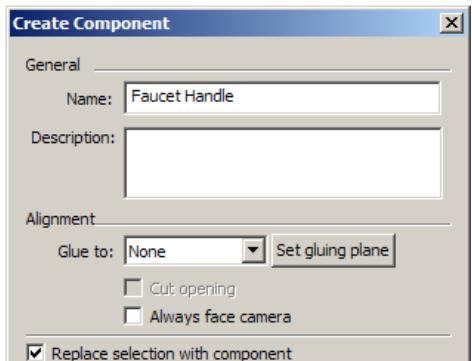


14. Do the same for the other two sections of the handle.



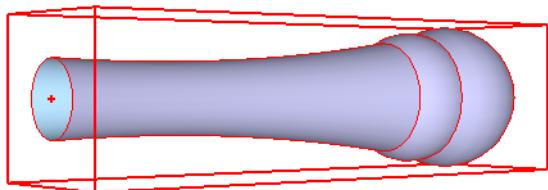
*NOTE: You would get the same results if you had healed the original handle section into one face. This would require erasing some segments and possibly recreating edges, so both methods require a bit of work.*

15. Select the entire handle and make it into a component (**Edit / Make Component** or right-click and select **Make Component**). Assign a name like “Faucet Handle” and set the other options as shown:

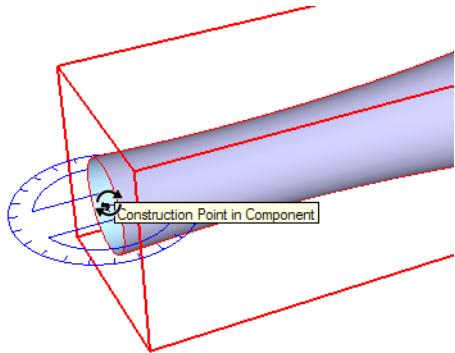


NOTE: Components are detailed further in Chapter 6.

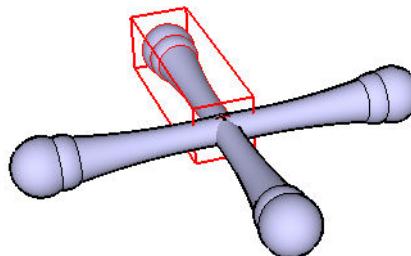
The handle appears in a bounding box, indicating that it is now a single object.



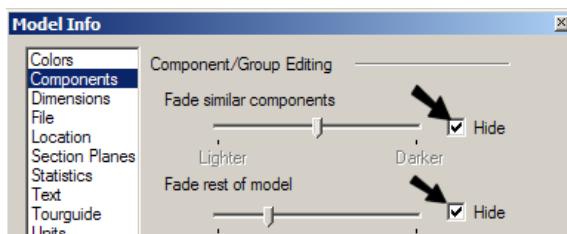
16. With the handle component still selected, activate **Rotate**. Position the protractor in the red-green plane (protractor turns blue) and press Shift to lock it. Then place the protractor on the construction center point.



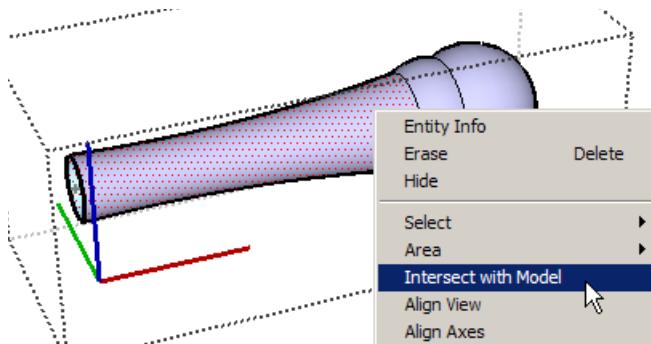
17. Press Ctrl/Option to make copies, and click anywhere to set the rotation axis. Type 90 for the rotation angle, and then type 3x to make three copies. This is the complete set of handles, but you can see that the handles overlap at the center.



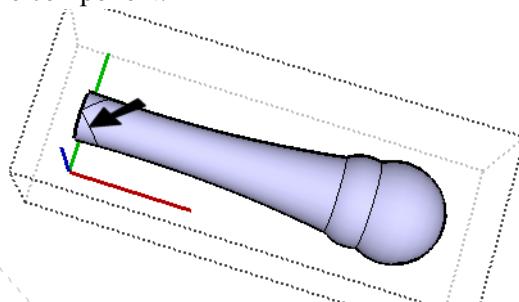
18. When editing the handle, it will be helpful to blank the other components, as well as the rest of the model. On the **Components** page of the **Model Info** window, check **Hide**.



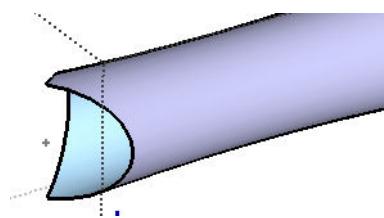
19. Double-click on any handle component to edit it. Right-click on the long, narrow segment and select **Intersect with Model**.



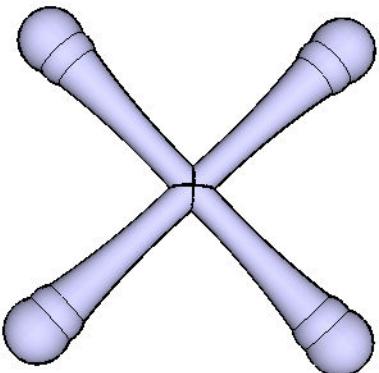
20. This creates the two sets of edges shown. Even though the other components are hidden, SketchUp still knows where they are and where they intersect the component.



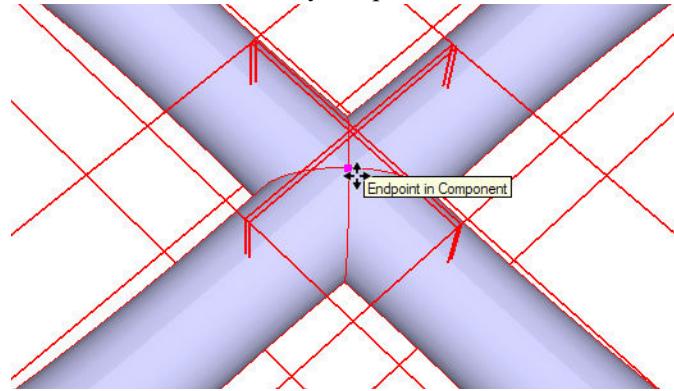
21. Erase the faces on the short side of these new edges.



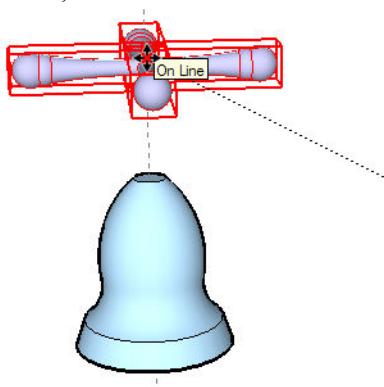
22. Right-click outside the component area and select **Close Component**. Here are all four components, all trimmed where they previously overlapped.



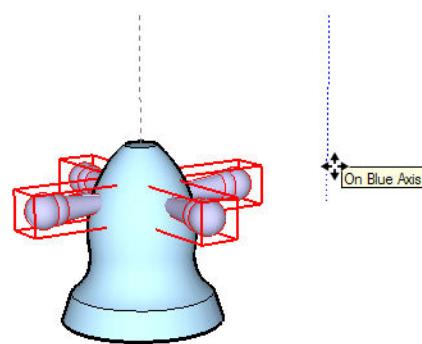
23. Select all four handle components and activate **Move**. Move them by the point at their center . . .



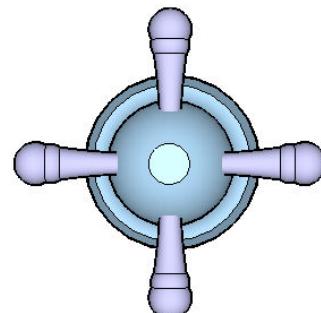
24. . . and place them anywhere along the vertical construction line. (This is why the construction line was created.)



25. **Move** should still be active; move the handles down (blue direction) to their correct location.



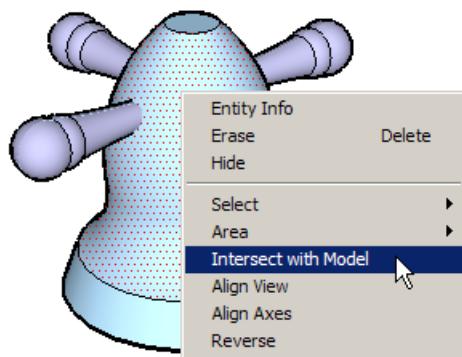
This is how the faucet should look from above - the handles are perfectly centered.



26. Save the file, naming it something like **faucet.skp**. We will look at a few ways to create intersection edges, and will need to jump back a few times to the faucet as it is now.

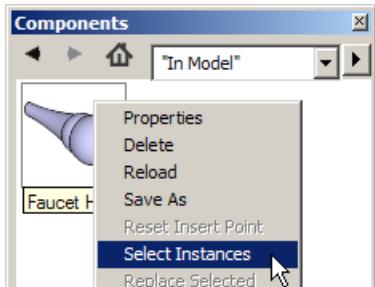
(If you want to download this faucet file, go to [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm) and download the file "faucet.skp.")

27. Right-click on the main face of the faucet and select **Intersect with Model**.

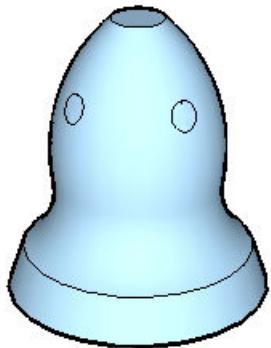


28. This creates edges on the faucet body at all four handles. To see this, hide all handles. The easiest way to select them all is via the Components browser

(Window / Components, open In Model). Right-click on the handle and select Select Instances.

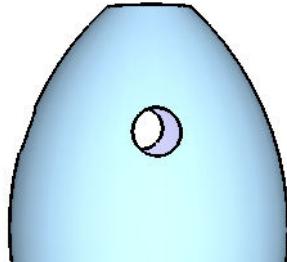


29. Right-click on one of the selected handles and select Hide. Now you can see the intersection edges.

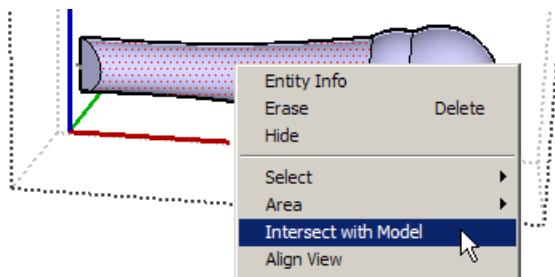


*NOTE: If you had hidden any of the handles before intersecting, the intersection edges would not be created.*

30. Erase the circular cutout faces.



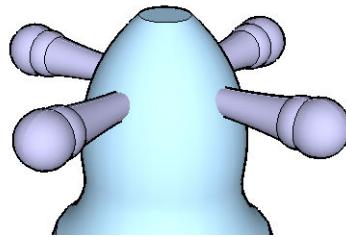
31. Unhide everything (Edit / Unhide / All) and double-click one of the handles to edit it. Perform an Intersect on the handle.



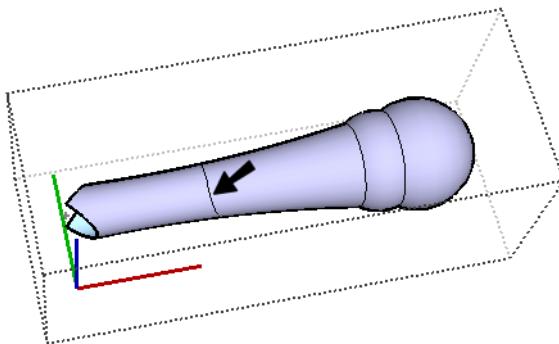
The result - nothing happens. The faucet body has already been cut at the intersection, so there is no actual intersection anymore.

*NOTE: If you did the exercise "Hiding Intersection Edges with Components" on page 115, you know there is a workaround to this - hiding intersection edges first. Then you could get intersection edges on the handle.*

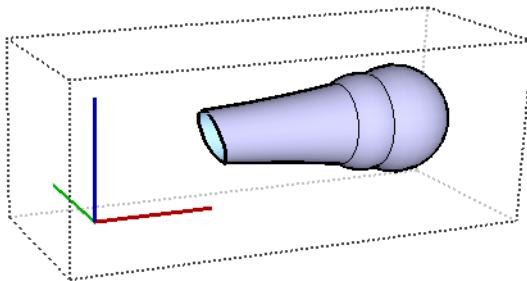
32. Go back to the saved version of the file - there should be no intersection edges.



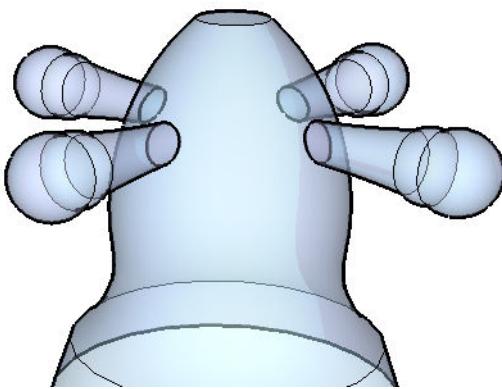
33. Rather than intersect the faucet body, we will intersect the handles this time. Edit one of the handles and perform Intersect with Model. This creates edges where the handle meets the body.



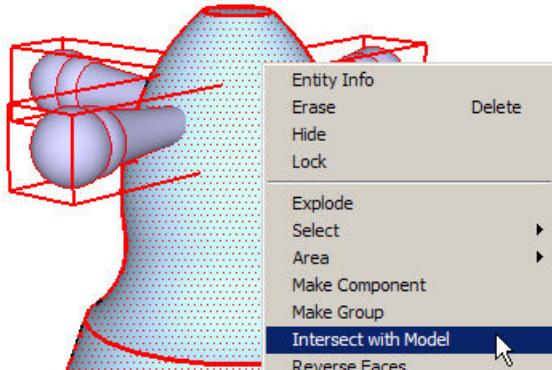
34. Erase everything on the other side of these edges.



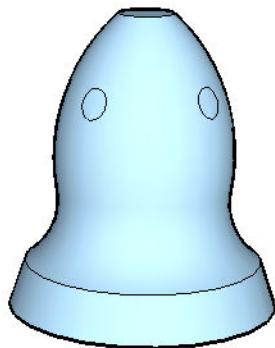
35. Close the component. If you switch to **X-Ray** mode, you can see that the handles do not protrude into the base.



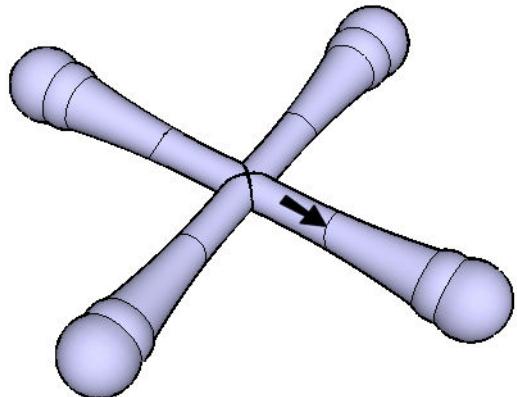
36. Revert to the saved file once again. Now select everything - body plus four handles and intersect everything.



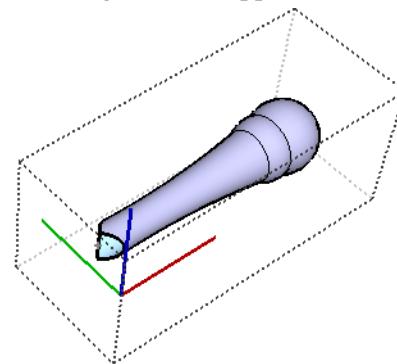
37. Hide the handles to see the intersection edges.



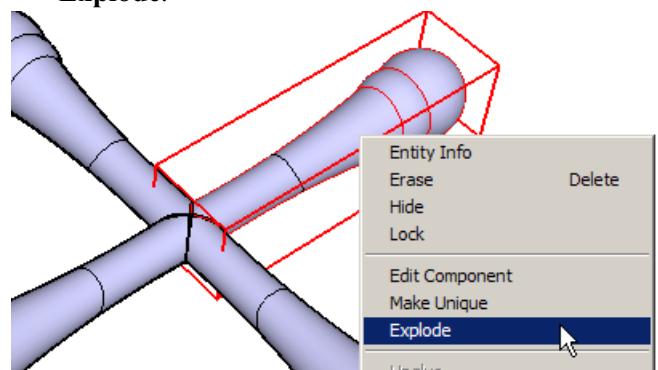
38. Unhide, and now hide the body. The intersection edges are created on the handles as well. However, these edges are not part of the handle components themselves; they are separate entities.



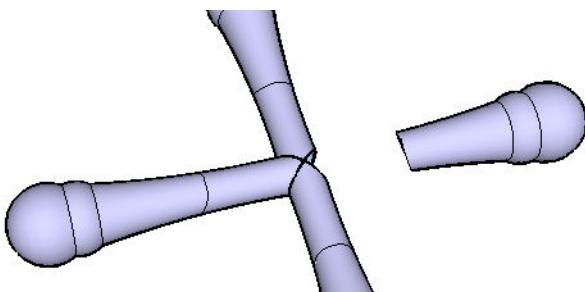
39. Verify this by editing one of the handles - the intersection edges do not appear.



40. If you want to trim the handle by these edges, you need to right-click the component and select **Explode**.

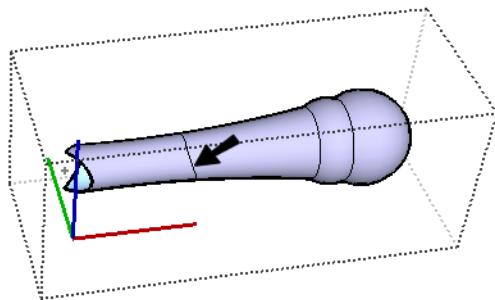


41. Now the component can be trimmed.

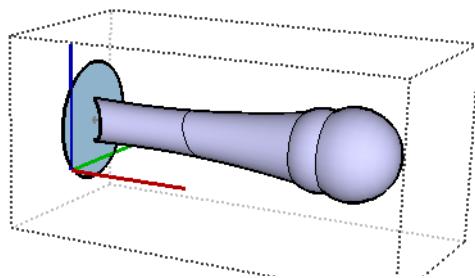


42. Return one last time to the saved file. Now we will see how to create the faucet body as a solid (not a shell), with solid cutouts for the handles.

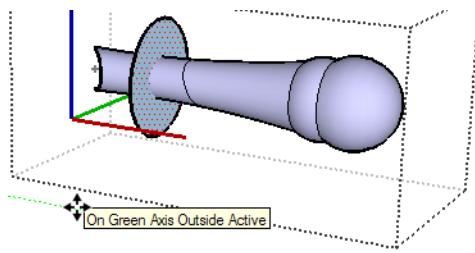
43. Edit one of the handles and intersect it with the model to get the edges along the faucet body.



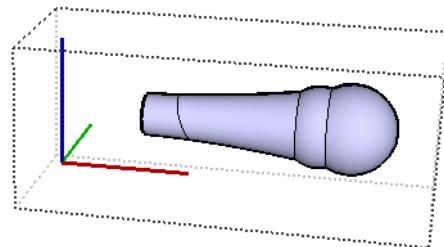
44. We will now shorten the handle so that it just barely sticks into the faucet body. Use the construction point to draw a circle in the blue direction.



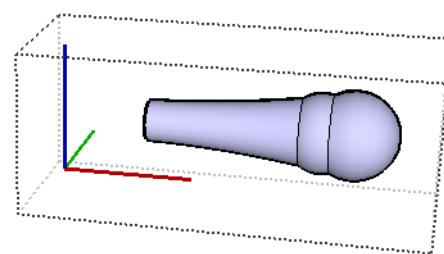
45. Move this circle so that it intersects the handle somewhere between the end and the intersection edges.



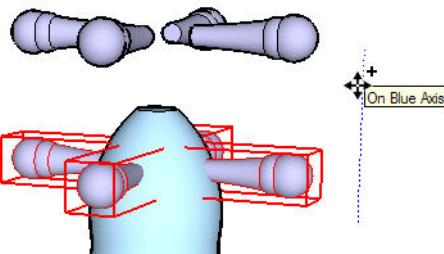
46. Select the circle and handle and perform an intersection. Then trim the handle on the other side of the circle (and erase the circle itself).



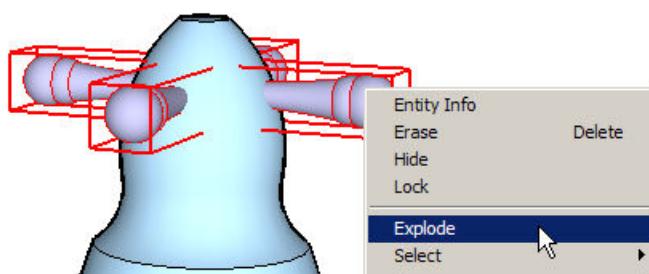
47. Finally, erase the intersection edges you created when you first edited the handle.



48. Close the handle. Now select all four handles and copy them straight up at a known distance (i.e. type in 3') Remember the distance, since you will move them back down later.



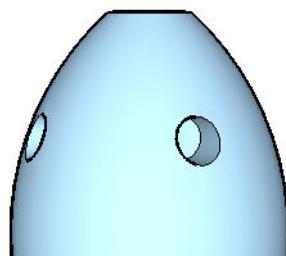
49. Now explode each of the original handles. We want to keep a portion of each handle, which will not work if the handles remain as components.



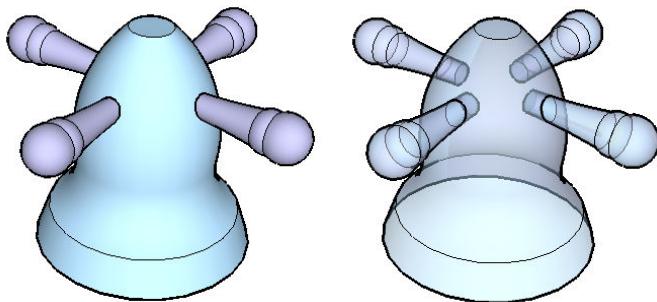
50. Select the faucet and all four exploded handles, and intersect them. Trim away the parts of the handles that protrude from the body.



51. Then erase the circular faces on the base. What remains are solid cutouts you could use to insert the handles. The faucet body itself is still a solid, making it more realistic than the shell we've seen until now.



52. Now you can move the copied handle components back down, and you have five solid pieces. In **X-Ray** mode, you can see how the handles protrude partially into the base.



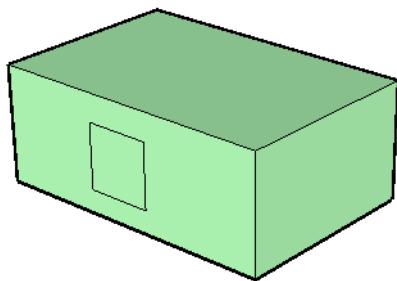


# 4 Making Multiple Copies

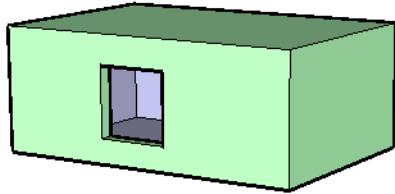
## Basic Move and Copy

Exercises in previous chapters have already used both moving and copying. This short exercise shows a few more ways you can move and copy objects - to specific locations.

1. Draw a rectangle and **Push/Pull** it into a box. Draw a rectangle on the front face for the window.

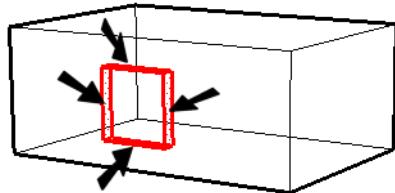


2. **Push/Pull** this window in to give it a little depth, and erase the window face.



**HINT:** Forgot how to erase a face? Use **Select** to select the face and press **Delete**. Or right-click the face and select **Erase**.

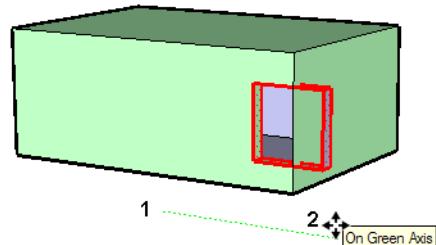
3. Select the window, making sure all twelve edges and four faces are selected. If you use a selection window, it's usually a good idea to check in wireframe to make sure no extra objects are selected.



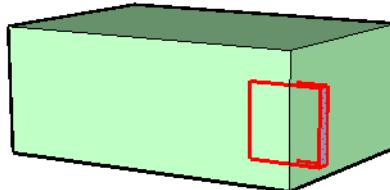
4. Return to shaded view, and active **Move**.

**NOTE:** For basic **Move** exercises, see "Move and Copy" on page 46.

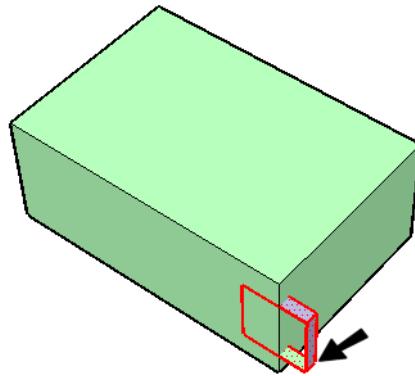
5. Moving is always done relative to a selected reference point, so select a known endpoint, or any point in space. Using an edge or axis direction, move the window outside the boundary of the front face.



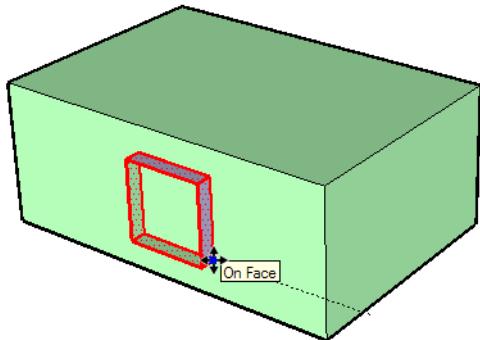
When placed, it no longer makes a cutout.



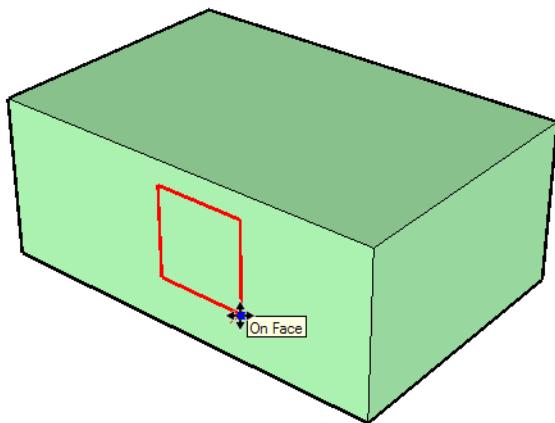
6. Now move the window by clicking one of the inside endpoints. . .



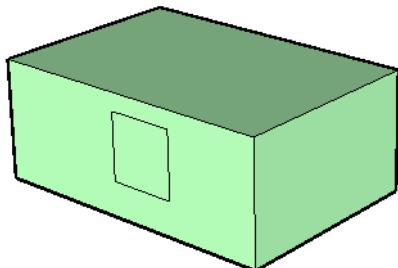
7. . . and placing it on the front face. The window now sticks out of the building.



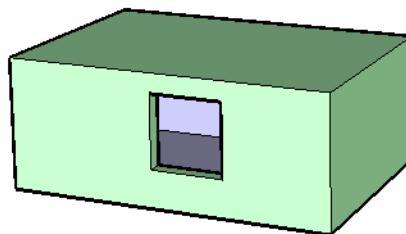
8. Move the window back to the front face by dragging one of the outer endpoints (or any point on the front of the window) to the front face.



9. The cutout is not made because the face alignment of this window has already been broken. You can see this because the rectangle has thick lines. Resolve the rectangle by redrawing any of its lines - the rectangle becomes thin-lined. (If the window is still selected, deselect it to see that it has thin lines.)

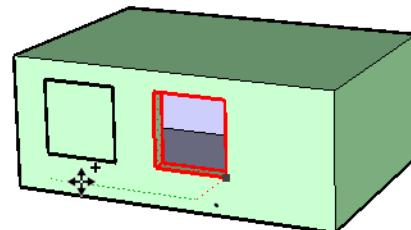


10. Now you can erase the window face.



Copying is done in the **Move** tool by pressing *Ctrl/Option*. Once *Ctrl/Option* is pressed you can release it; copy mode has already been established.

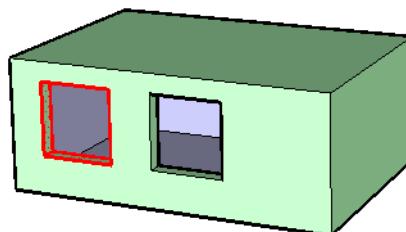
11. Select the window again and activate **Move**. Press *Ctrl/Option*, click any point, and release *Ctrl/Option*. Place a copy of the window next to the original.



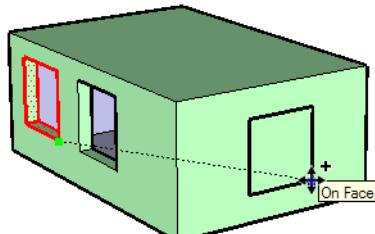
Any time you use **Move** (or copy), the delta distance appears in the VCB. You can enter a different value and press Enter, which will be seen more in the next exercise.

Length 6' 5 1/2"

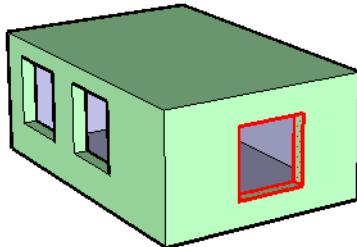
The copy is made, which also cuts out the window.



12. With **Move** still active, press *Ctrl/Option* and copy the window to the side face. It aligns itself with this face.



Once the copy is located, it cuts out the face here as well.

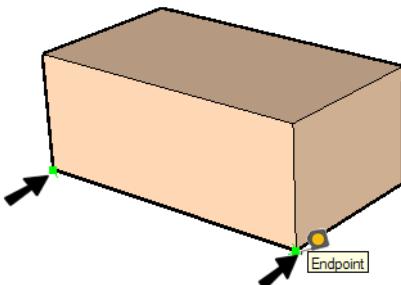


Alignment to faces works only when copying, not moving. If you had moved a window to the side face, it would not have aligned to or cut the face. To do that, you would need to rotate, then move, the window.

## Multiple Linear Copies

If you want to make repeated (array) copies, you can easily do this using the **Move** tool.

- Start out with a new box. We will assume that we know some basic dimensions about this building, and that we need to figure out a layout for its windows. To set the first dimension, we will use the **Measure** tool. Click the endpoints that define the width.



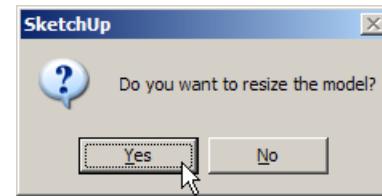
- The distance between these points is listed in the VCB.

Length 18' 11 1/2"

- To set the exact distance, type 20' and press Enter. Depending on your system of units, you may need to include the foot symbol - typing 20 in Architectural units will create a 20-inch wide building.

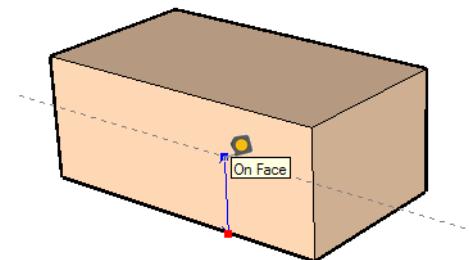
Length 20'

- When the **Measure** tool is used this way, you can rescale the entire model. Click Yes.



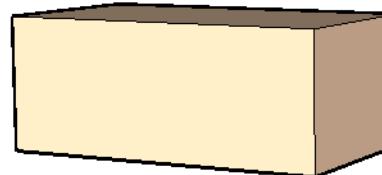
*NOTE: The reason for using exact dimensions, aside from demonstrating how it can be done, is so that the numbers you enter for moving and copying will be similar to those presented here. It's not crucial that your building be at any exact scale, but your dimensions later in the exercise may be quite different.*

- Next we will set the height. **Measure** can also be used to create construction lines for this purpose. **Measure** should still be active; click any point on the lower edge and move up in the blue direction. This creates construction lines parallel to the selected edge.

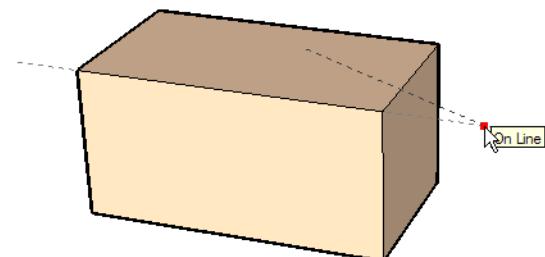


- Type 10' to offset this edge 10' vertically.

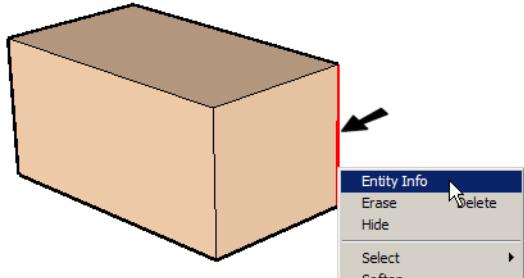
Length 10'



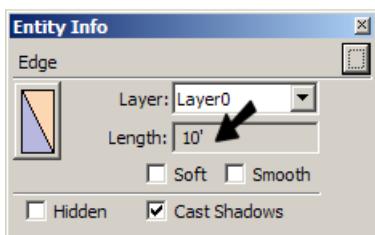
- To change the building height, activate **Push/Pull** and click the top face. Then click any point on the construction line. Now the box is 20' x 10' (the depth is not important).



8. Erase the construction lines (**Edit / Construction Geometry / Erase**).
9. To make sure the height is correct, right-click on any vertical edge and select **Entity Info**. (If **Entity Info** is already open, you can activate **Select** and click any vertical edge.)



The **Length** should be listed as 10'.

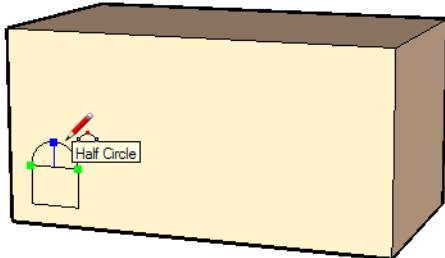



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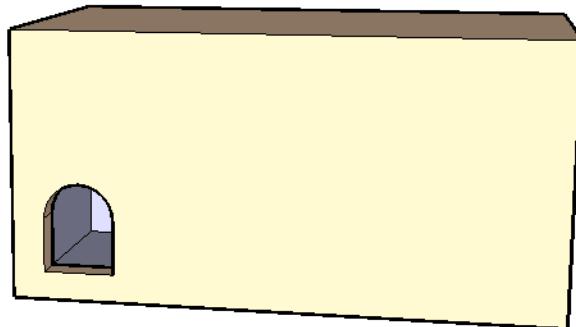
**TIP:** Another way to create this box: Create a rectangle and use **Measure** to resize the long edge to 20'. Then activate **Push/Pull**, start to pull up the rectangle, and type 10'. You can also create the first rectangle using exact dimensions. In SketchUp, there are usually several ways to create anything.

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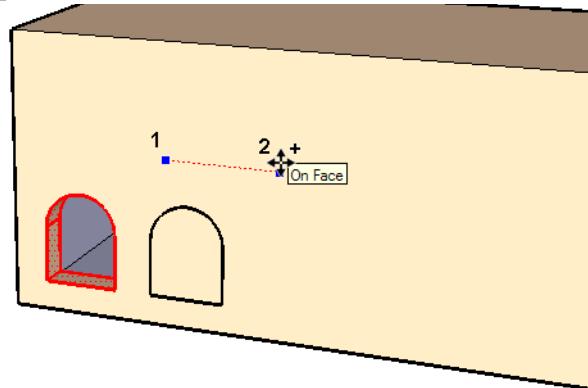
10. We are now ready to create some windows. On the front face (use **Front** view if you want), use **Rectangle** and **Arc** to draw the outline for an arched window. Make it small enough so that several copies can be made in the red direction, and one copy in the blue direction.



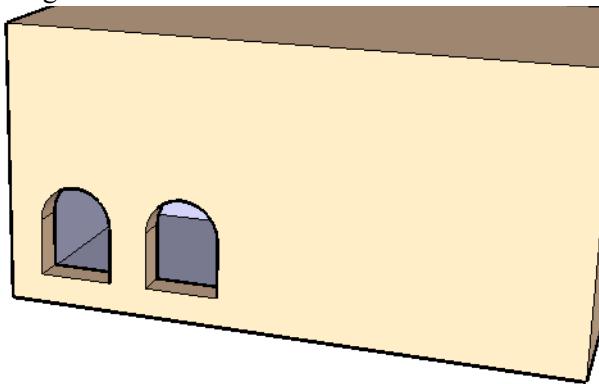
11. Heal the window by erasing the top rectangle line. **Push/Pull** the window in slightly, and erase the window face.



12. Select the window (be careful not to select any extra edges), activate **Move**, press **Ctrl/Option**, and click any point as the reference point. Release **Ctrl/Option** and drag the copy along the axis from the reference point.



13. Click to place the window. It makes a cutout like the original.



14. As long as **Move** is still active, you can play with the spacing and number of copies. Look at the VCB to see the delta distance you just used. (Of course, what appears here depends on your model.)

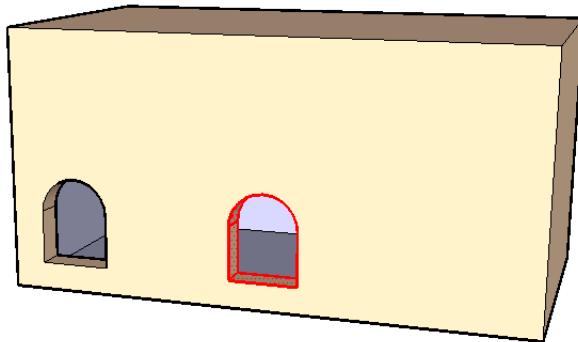
Length 3' 9 1/4"

**NOTE:** This spacing may not be what you would want for a real building, but use whatever makes sense for the current scale. The entire model can be scaled later using the **Measure** tool, as you've already seen.

- Type a larger spacing and press Enter. If you are using feet and inches, you do not need a space or dash - just type something like 7'6. (7'6" would also work, as would 7.5').

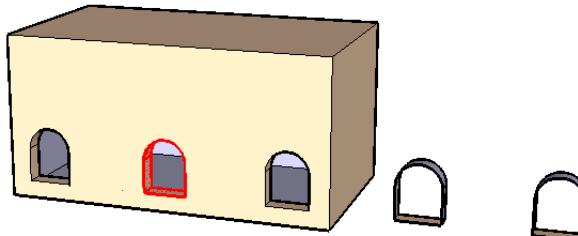
Length 7'6

The copied window moves a bit farther from the original.



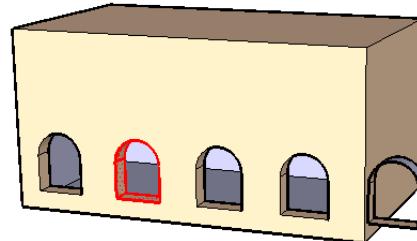
- To make more copies, type 4x and press Enter. This creates four copies at the same spacing, for a total of five windows.

Length 4x



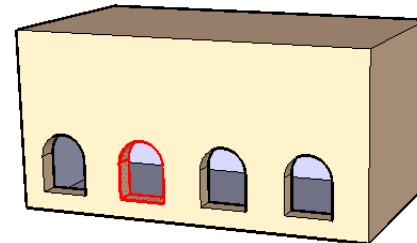
- The spacing is too far apart, so type a spacing that will bring the windows closer together. Rather than type in feet and inches, you can also type in decimal feet, like 4.75'.

Length 4.75

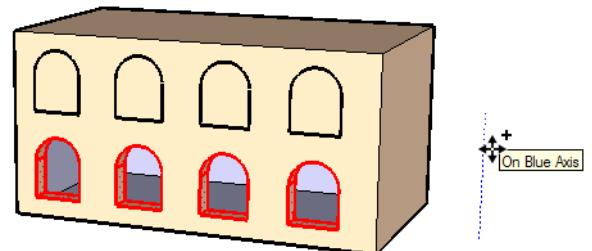


- There are still too many windows, so type 3\* (you can use \* or x) to make four windows.

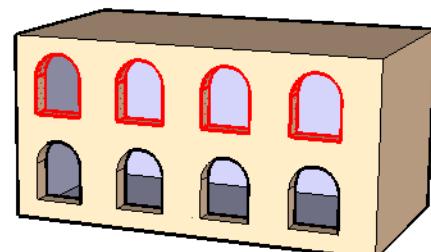
Length 3\*



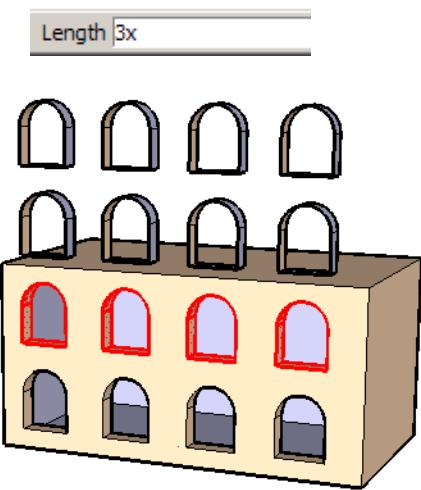
- Select the four windows and use **Move** to copy them upward (blue direction).



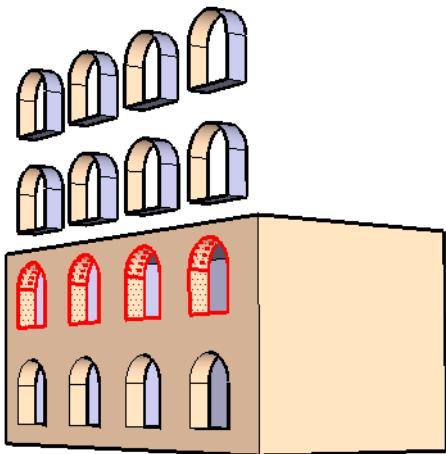
The cutouts are made once again.



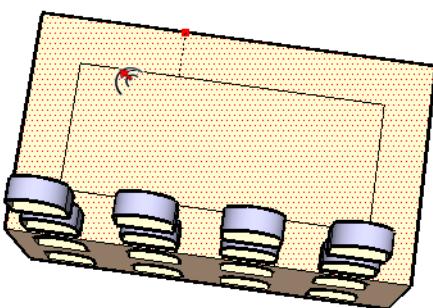
20. Type 3x to create three copies of the row of windows.



21. If you need to, adjust the vertical spacing by entering a distance. The second row from the top should be located slightly above the top of the box. The bottom two rows should both be within the face of the box.

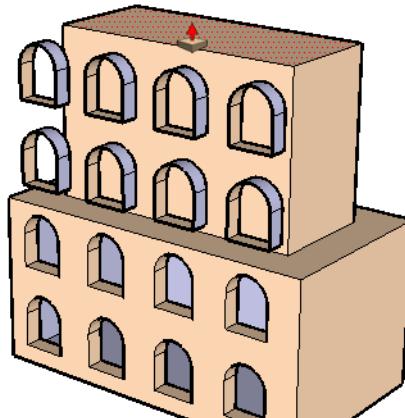


22. We will now create another two-story section. Use **Offset** to create a rectangle offset from the edges of the top face.

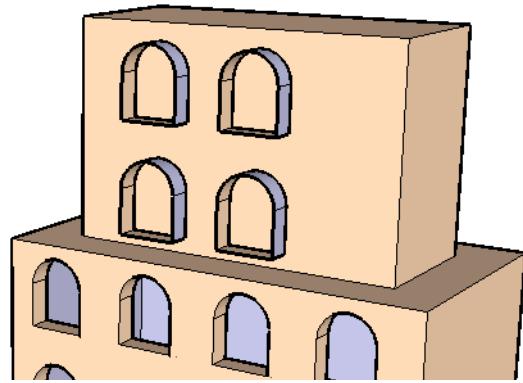


**HINT:** To offset a face, activate **Offset**, select the top face, pick a point and drag the offset inward.

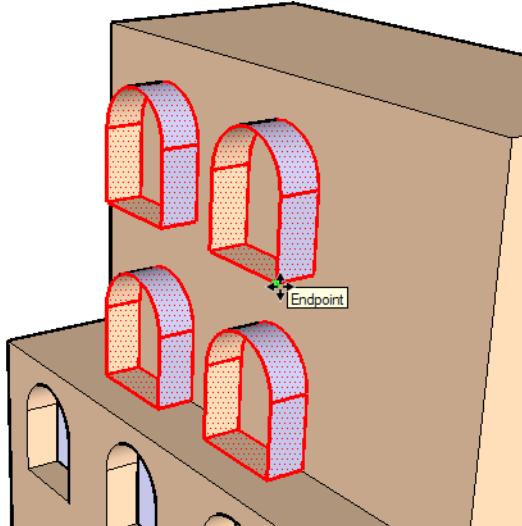
23. **Push/Pull** this rectangle upward so that it will contain the upper windows.



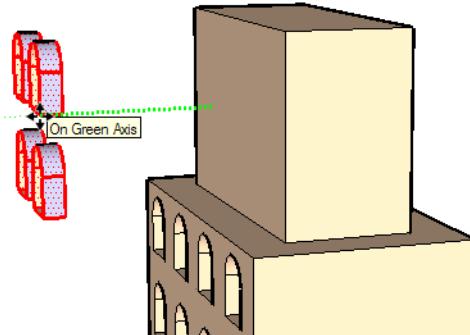
24. Erase the outer windows in the top two rows.



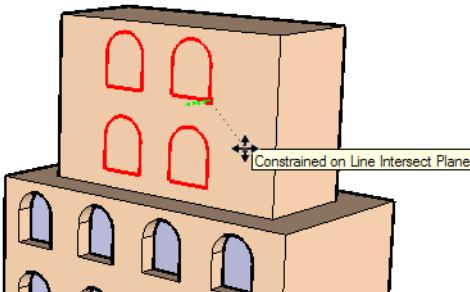
25. The upper windows are not flush with the vertical face. Select these four windows, and activate **Move**. Here we will use a double constraint. Click any point on the front of any window...



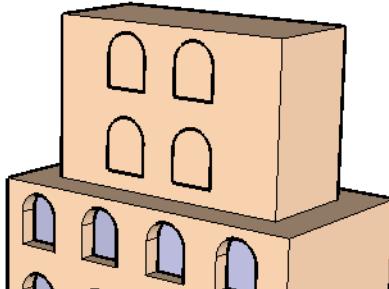
26. . . and move the windows along the axis perpendicular to the vertical face. Press Shift to lock this orientation (the axis constraint line becomes thick).



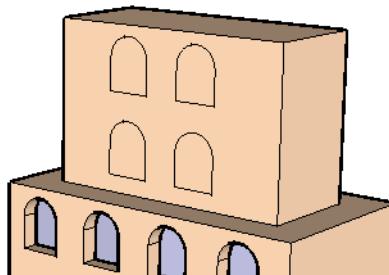
27. With Shift pressed, move back to the vertical face, and click when the double constraint is indicated.



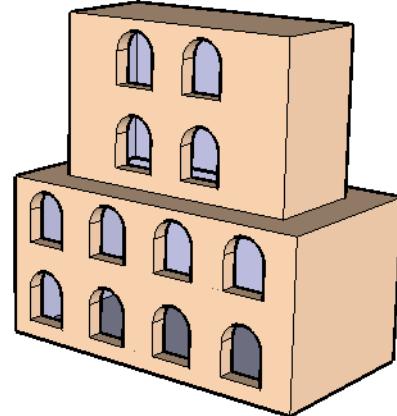
28. Press Ctrl/Option+T to deselect the windows. They appear as thick lines, which means they are not aligned to the face. This is because they were moved to this face, not created on it.



29. Resolve the window alignment by redrawing any line on each window.



30. Then erase the front face of each window. The easiest way to do this is to activate **Select**, and press Shift to select all four faces. Then press the Delete key.



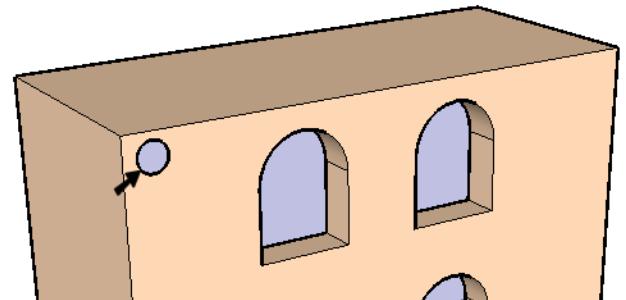

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*NOTE: Copied objects such as these and components can only cut one face. For more information on cutting faces, see "Cutting Openings" on page 214.*

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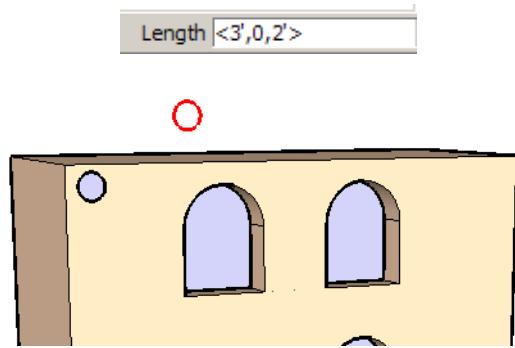
Linear array copies are not limited to orthogonal (horizontal or vertical) directions. The remainder of this exercise will focus on sloped copies.

31. Draw a small circle on the top left corner of the front face. Erase the face to create a window.



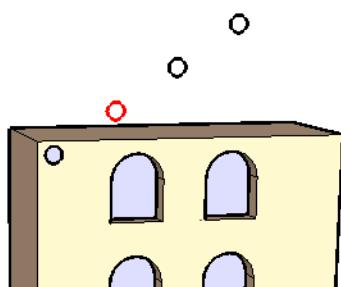
32. Select the circular window, activate **Move**, press Ctrl/Option, select any reference point, and release Ctrl/Option.

33. As long as **Move** is active, you can enter values in the VCB to play with spacing, number of copies, and angles. You can specify a relative distance by using angle brackets. Type  $<3',0,2'>$  to make a copy at a 3:2 slope.

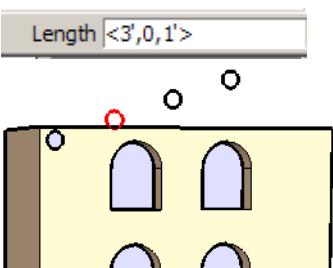


*NOTE: Distances are entered in order of red, green, and blue directions (analogous to x, y, z). If your face was in the green-blue plane, you would type <0,3',2'>.*

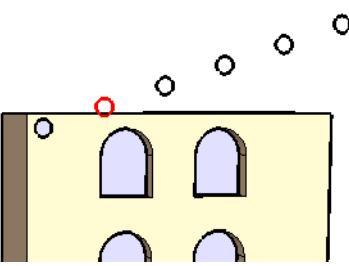
34. Type 3x to create three copies.



35. The slope of the window line is too steep. Enter  $<3',0,1'>$ .

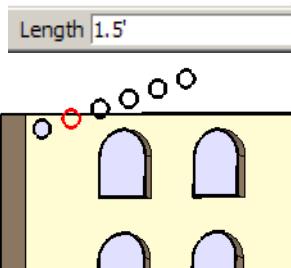


36. Add more windows along this line by typing 5\*.

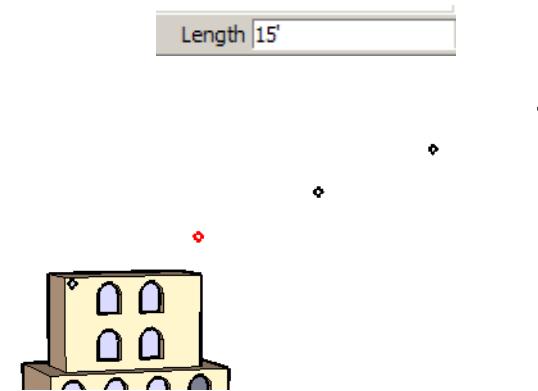


In case you hadn't already noticed, there is always one copy in the highlighted color. When manipulating numbers of copies and spacing, the highlighted copy is the first copy in the row.

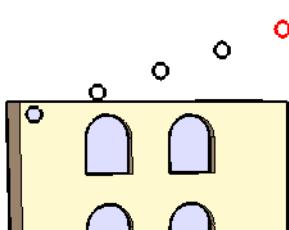
37. When changing the spacing between copies on a slant, the distance is the absolute distance (along the slant) between copies. Try something small like 1.5'.



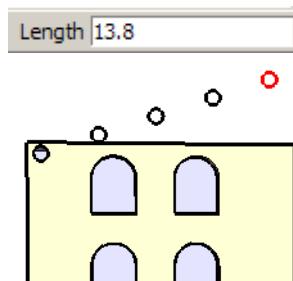
38. In this case, the most useful copy method is probably to set the distance to the last copy and adjust the number of copies in between. Change the spacing to something large like 15'. (There are still five copies, but each one is spaced at 15' so they might not all fit on your screen.)



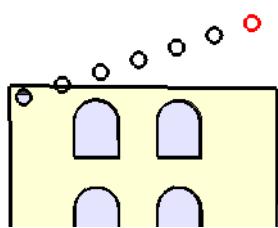
39. Enter 4/ to create four equal divisions between copies (five total windows).



40. Now adjust the first-to-last spacing so that all windows fit within the vertical projection of the face. It's easiest to do this in **Front** view.

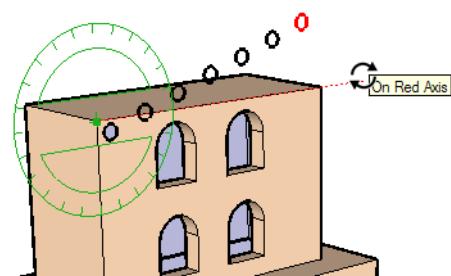


41. Enter 6/ to create seven seven windows.

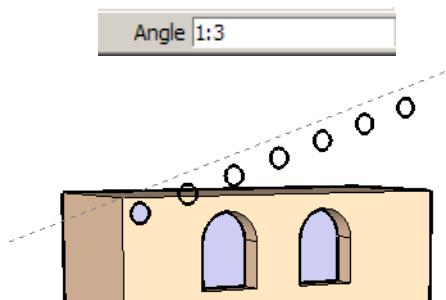


The window line looks good, and now the roof needs to be adjusted to accommodate it. This is one of the things that makes SketchUp unique - you can draw windows and then adjust the walls to accommodate them!

42. The slope of the window line is known (1:3), so we can draw a construction line with this slope. Activate **Protractor**. Locate the origin at the corner above the first circle, and set the orientation along the horizontal roof line.

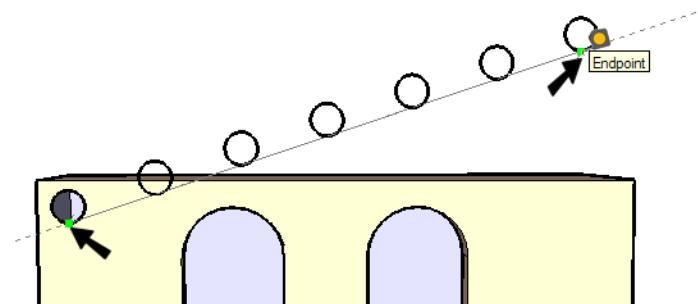


43. Type 1:3 and press Enter. You now have a construction line by which you can adjust the roof slope.

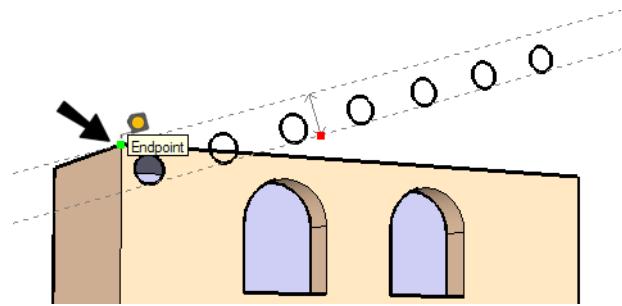


44. This method is fine for cases in which the slope is known, but let's assume the slope is not known. Erase the construction line, or undo it with **Ctrl/Cmd + Z**.

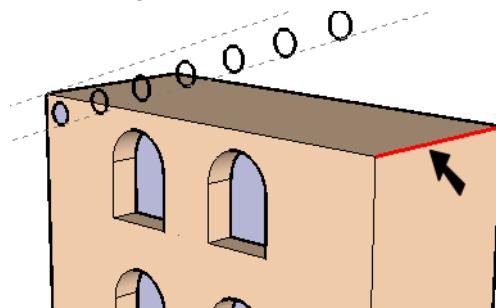
45. This time use **Measure** and draw a construction line between the lowest endpoints of the two outer circles.



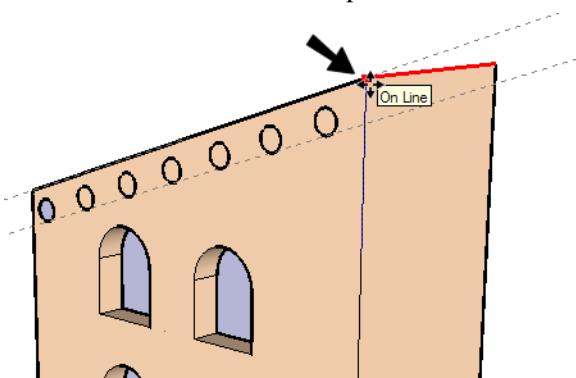
46. While still in **Measure**, click the line you just drew. This enables you to offset-copy the construction line. Click the corner point shown to place the second, parallel construction line.



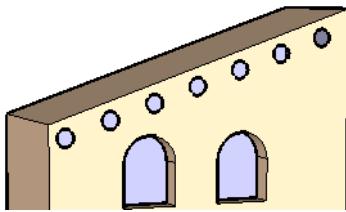
47. Select the edge shown and activate **Move**.



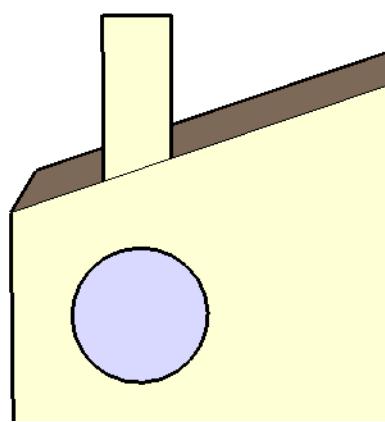
48. Click the front endpoint and move it up in the blue direction until it meets the top construction line.



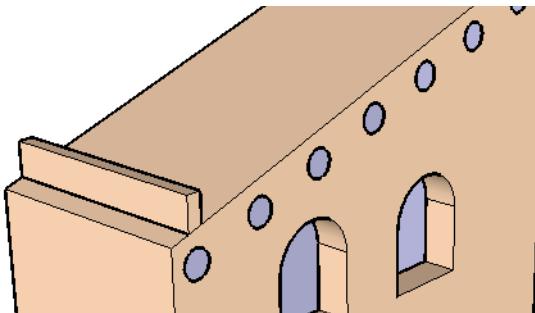
49. To create the remaining window cutouts, you have to merge each circle to the face by redrawing one of its segments (you may have to zoom in very close to do this). Use the green Endpoint inferences to help you recreate the segments. Then erase all six window faces.



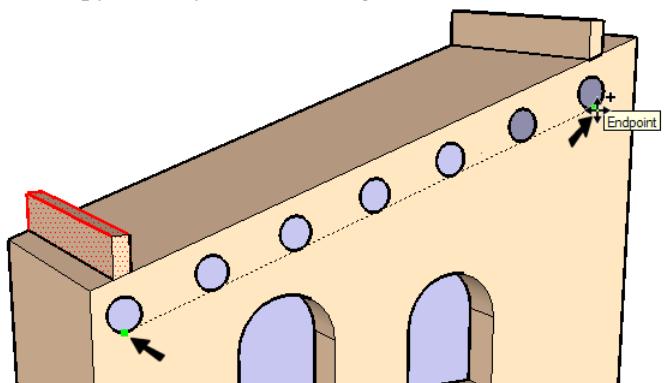
50. We will now make the roof a little more interesting. Use **Line** to create the beam shape shown, centered above the first circle.



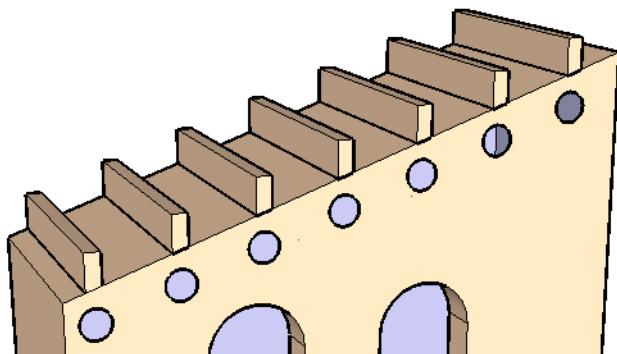
51. **Push/Pull** the beam to the back of the roof.



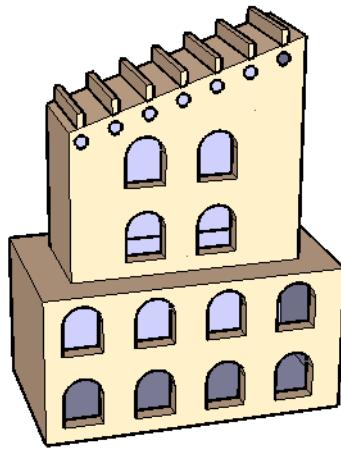
52. Select all objects associated with this beam (easiest in **Front** view). Use **Move** with **Ctrl/Option**, and click reference points on the outer circles to make a copy directly above the higher outer circle.



53. Enter 6/ for the spacing. This creates one beam over each circular window.



54. Here is the final building, with all its copied objects.



**TIP:** If you are working with multiple copies of the same object, you might want to use components. See Chapter 6.

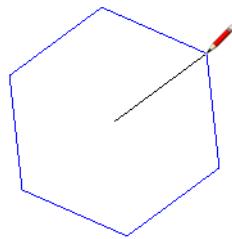
## Multiple Rotated Copies

There are several ways to make rotated copies of objects. To demonstrate this, we will build a gazebo. Start a new file.

1. Start with the roof - use the **Polygon** tool (**Draw / Polygon**) to draw a hexagon.

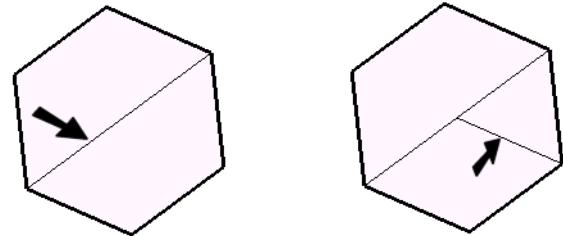
The default number of sides for a polygon is six, but if you used the tool before with a different number, you will have to change it back to six. Before drawing, simply enter 6 in the VCB.

Draw the hexagon in the red-green plane, not necessarily aligned to either axis.

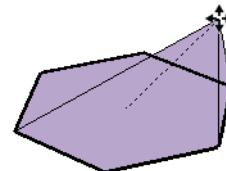


**TIP:** You could also draw a polygon with a different number of sides, and, before selecting another tool, enter 6s in the VCB to change it to a hexagon.

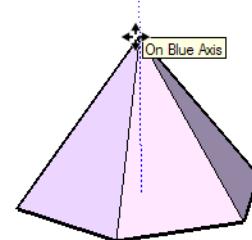
2. Draw a line connecting two opposite corners. Then draw a line from the midpoint of this bisecting line to any corner.



3. This is a good place to demonstrate **Autofold**. Activate **Move** and try moving the center point up (in the blue direction). You will find that you are limited to the red-green plane.

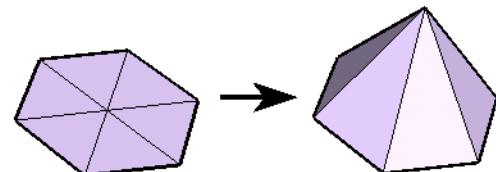


4. Undo this move. Now try move again, but this time press Alt/Cmd (for Autofold) before selecting the center point. Now you can move it up in the blue direction, forming the roof shape.



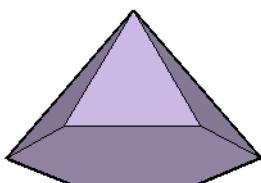
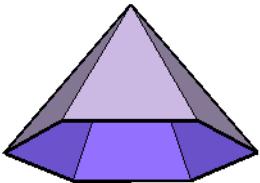
Autofold is a great feature - as you can see, it can be used to create fold lines automatically.

**TIP:** You can create this shape without using Autofold, if you create all six faces before moving the center point.



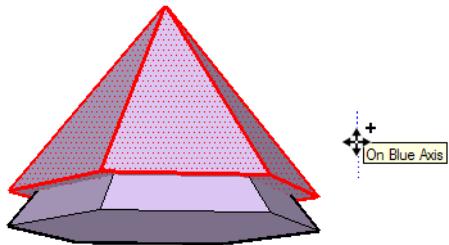
In this case, Autofold saves you from the lengthy task of creating three extra lines!

- Orbit so that you can see the bottom of the roof. It does not have a bottom. Redraw any line on this plane to create the face.

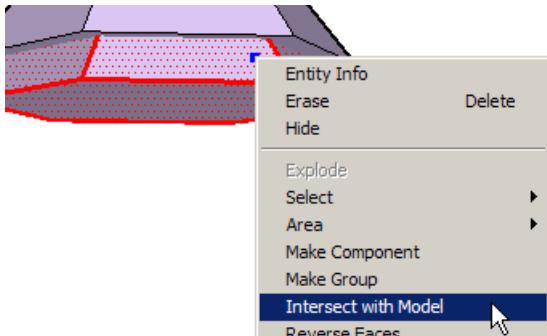


Now we'll use a Boolean subtract function - using one shape to cut volume from another. The cutting shape will be a copy of the original one.

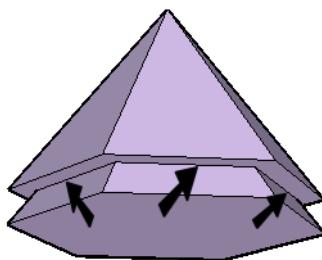
- Select all faces of the roof: you can use a selection window, or press **Ctrl+A (Cmd+A)** to select everything.
- Activate **Move**, press **Ctrl/Option**, and create a copy slightly below the original (use the blue axis constraint).



- Edges are not automatically created at face intersections. With the copied form still selected, right-click on any face of it and select **Intersect with Model**.

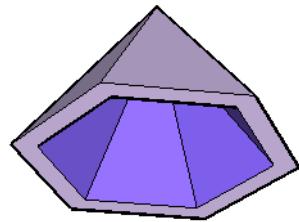
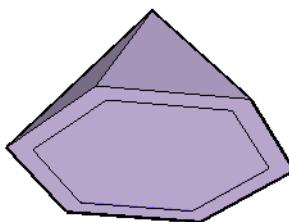


This creates the six intersection lines we need.

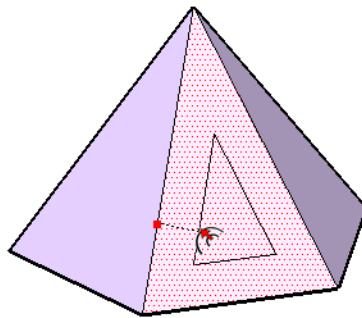


*NOTE: Of course, you could also draw these six lines manually.*

- Now use **Erase** to delete everything that extends past the bottom of the roof. Erase the center of the bottom face as well, and you now have a roof with some thickness.

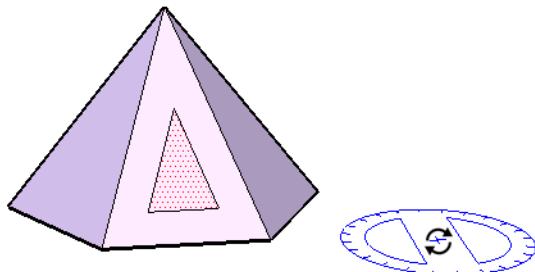


- The first object to be copied is a window shape in the roof. Use **Offset** to create a small triangle in one of the roof faces.

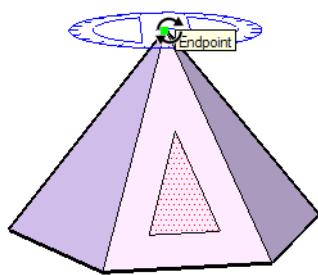


You could use **Push/Pull** at this point to make a cutout of the triangle. However, to save time, leave the triangle as is. Cutouts will be made quickly after the triangle is copied to the other faces.

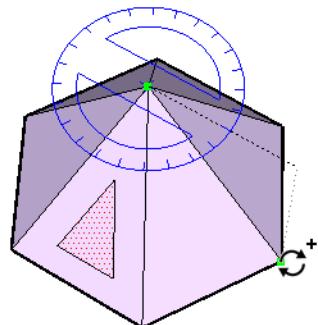
11. Select the triangle and activate **Rotate (Tools / Rotate)**. The protractor appears, which is used to set the rotation center and orientation. To keep the protractor flat (aligned to the red-green plane), place it somewhere outside the model and press Shift to lock the alignment.



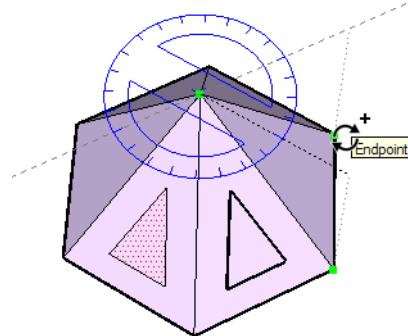
12. With Shift pressed, click to place the protractor at the center.



13. Press Ctrl/Option for copying, and click any corner point as the reference point.



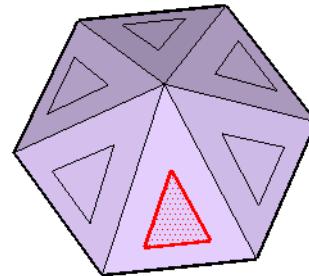
14. Click an adjacent corner point to set the rotation angle. One copy appears on an adjacent face.



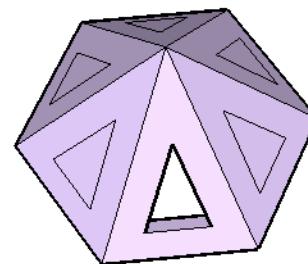
In this example, the rotation angle was known, and appears in the VCB. The angle is 60 degrees, which is 360 divided by six faces. You could have entered this value manually, but the reference point method is useful for cases when you do not know the exact angle.

Angle 60.0

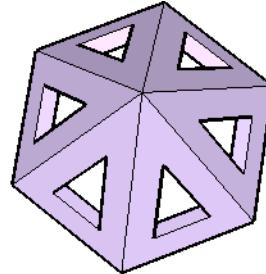
15. Because five total copies are needed, type 5x (or 5\*). Five copies are made, each separated by 60 degrees.



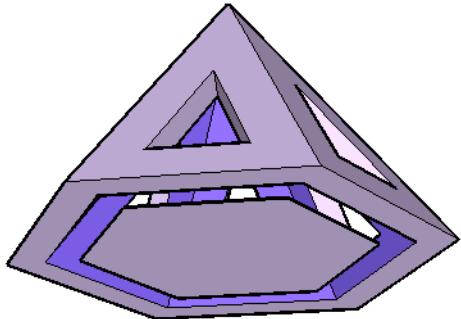
16. Openings can now be cut. Use **Push/Pull** to push one of the triangles inward. The back face will be cut if you push back through the roof thickness.



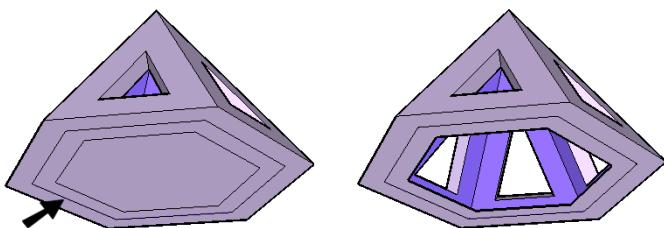
17. Because the roof has a uniform thickness, while **Push/Pull** is still active you can simply double-click on the five other faces to make the remaining cutouts.



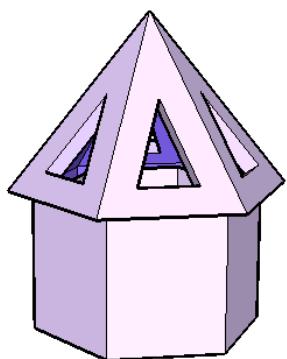
18. Now onto the base of the gazebo, which will be a set of hexagonal walls. Use **Offset** on the bottom face of the roof, pulling inward to create an inner hexagon. A face is automatically created, but this is not the face we want.



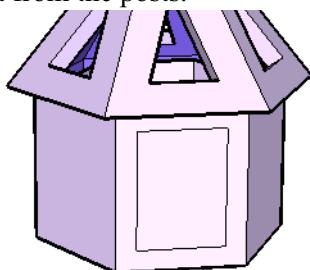
19. Fill in the missing face by redrawing any of its lines. Then erase the inner face.



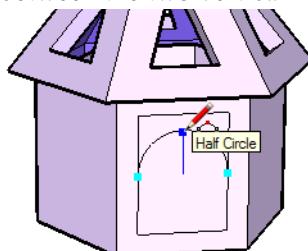
20. Now **Push/Pull** the walls downward an appropriate distance.



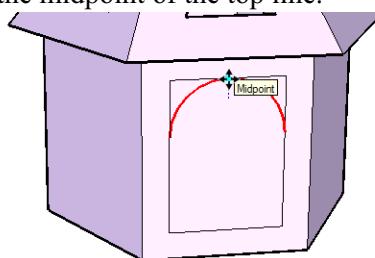
21. We now need to cut arches for the openings between the gazebo posts. For the first cutout, use **Offset** on one of the faces to create an inner rectangle. This ensures that the sides of the opening will be equidistant from the posts.



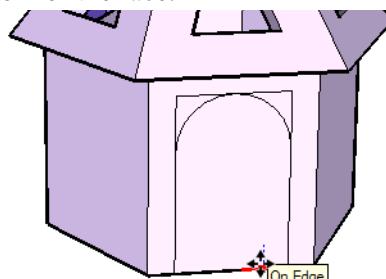
22. Use **Arc (Tools / Arc)** to create a half-circle anywhere between the two vertical lines.



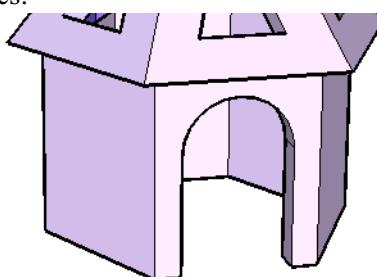
23. Select the arc and move it up so that its top point meets the midpoint of the top line.



24. Use **Move** to move the lower line of the rectangle to the bottom of the face.

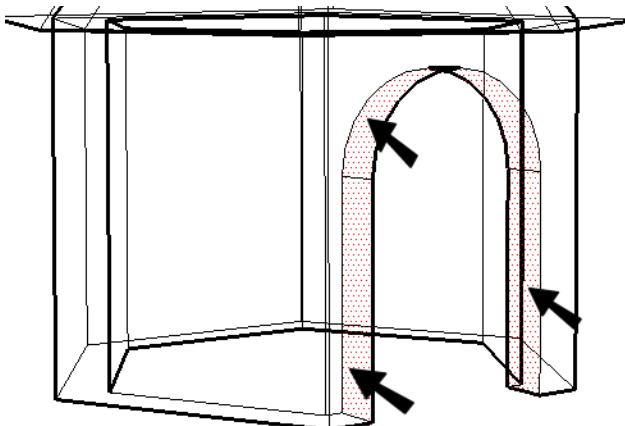


25. **Push/Pull** to cut out the arched opening. Erase the extra lines.

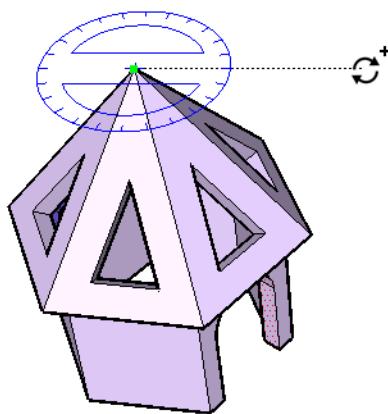


26. This arched cutout is the next object to rotate. Select all objects comprising the cutout. One easy way to do this is to Shift-select each of the faces of the arch - there should be three.

As always, it's a good idea to check out the model in wireframe to make sure no unwanted objects are selected.



27. Activate the **Rotate** tool. Set the protractor as before, on top of the roof, lying in the red-green plane. Press *Ctrl/Option* to copy, and click anywhere for the first reference point.



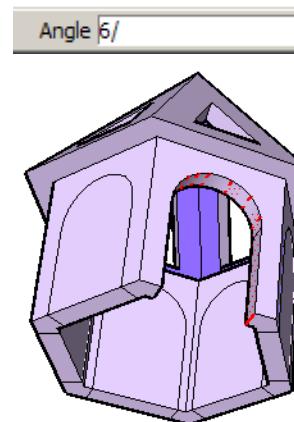
**TIP:** Windows users can activate **Rotate** first, then select the objects to rotate and press *Enter* to set the rotation parameters.

You could pick two corner points as before to set the rotation angle, but let's do it another way. This method is handy when you don't know the angle between each copy, but you know how many copies you want.

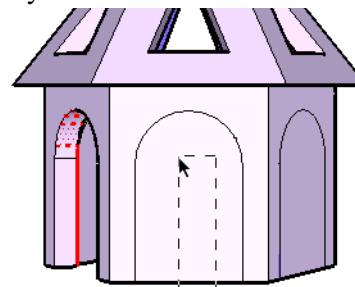
28. Type 360 for a full-circle rotation, and press *Enter*.

Angle 360

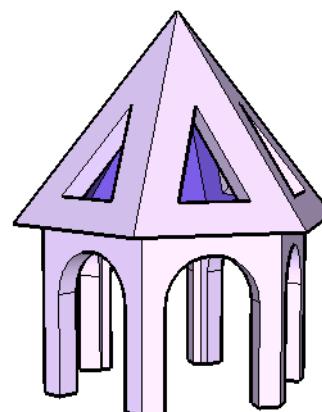
29. Now type 6/ to specify six divisions between copies. For a 360-degree rotation, this also means six copies. Press *Enter*, and the arch appears (uncut) on each face.



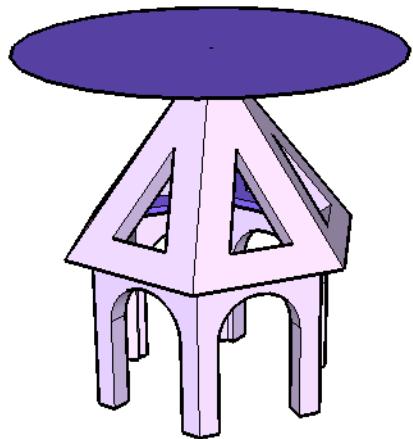
30. You could use **Push/Pull** as before to cut the openings, but here's also a good place to use a right-to-left selection window. This type of selection includes everything inside or touching the window. If you draw your window like this, facing one arch head-on, you should be able to select both it and the one directly behind it.



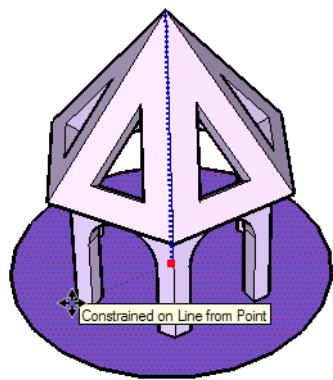
31. Press *Delete* to remove these objects. Repeat for each pair of openings, and here's what you should have:



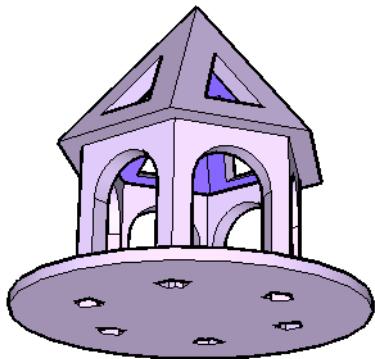
32. The last step is to add a circular base. Create a circle in the red-green plane (press Shift to lock the orientation), starting at the center of the roof.



33. Move the circle in the blue direction, pressing Shift to lock the direction. Then click any point at the bottom of the gazebo.



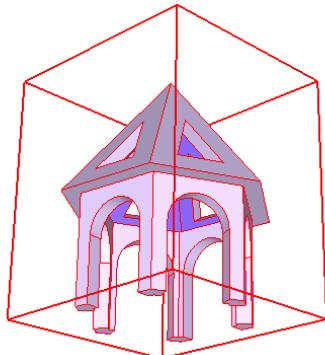
34. Give the base a little depth. Holes are created at the support locations.



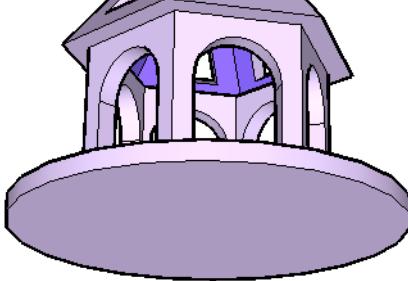
You could simply erase the lines of these holes on the underside of the base, but this is a good place to introduce groups.

The holes are made at the posts because all coplanar geometry is “sticky” - objects are linked to adjacent geometry. The best way to eliminate this stickiness and separate geometry so that it does not affect its neighbors is to use groups.

35. Undo to erase the circular base, but keep the construction lines. Select all the geometry and group it (**Edit / Make Group**, select **Make Group** from the **Edit** menu). A bounding box appears enclosing all selected objects.



36. Now create the circle again, and when you **Push/Pull** it this time, no holes appear. The gazebo objects are prevented from sticking to the base.

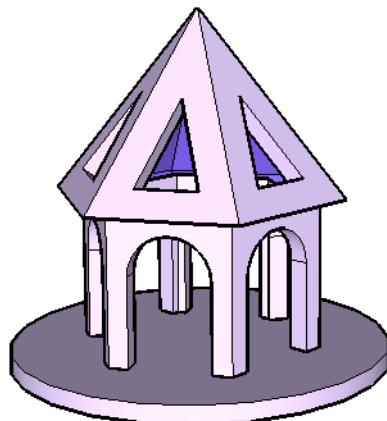



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*NOTE: See Chapter 6 for more on groups.*

---

Here is the final result.

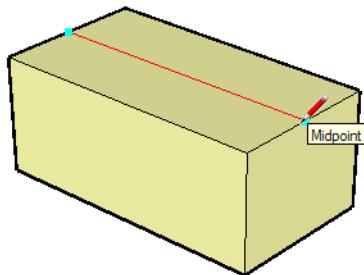


# 5 Working with Roofs

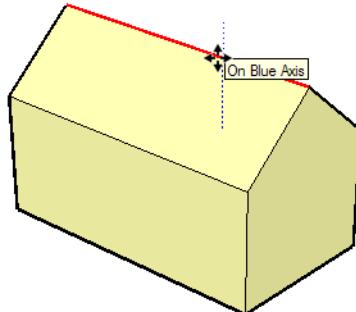
Sometimes the most difficult aspect of building design can be roofs. This chapter contains a few simple exercises to show you how simple roof design can be once you're familiar with the SketchUp interface.

## Simple Roof and Dormers

1. Start with a box like this, and make the roof ridge line by drawing a line across the top, from midpoint to midpoint.

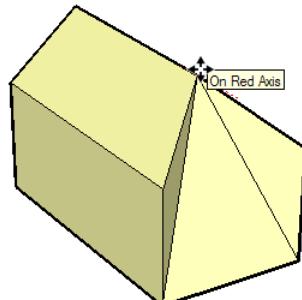


2. Activate the **Move** tool and drag the ridge line upward (blue direction).

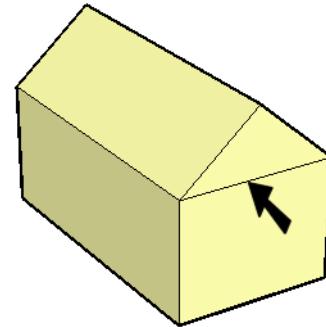


*NOTE: As you've probably already seen, you can also select the line first and then move it.*

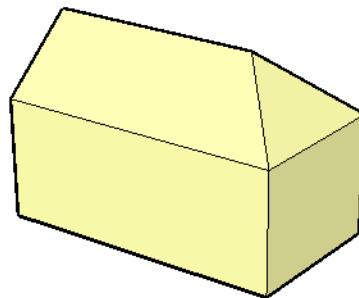
3. Try creating a gable by moving the ridge endpoint shown. This breaks the vertical face - not the result we want!



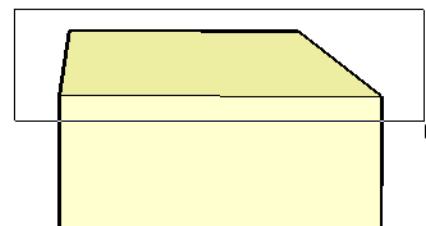
4. Press **Ctrl+Z (Cmd+Z)** to undo the move, or **Esc** if you haven't finished the move yet.
5. At this point you should know the solution - draw a line to break the face.



6. Now move the ridge endpoint back, constraining it to the red axis (or green axis, depending on how you drew your original rectangle).



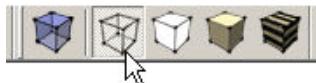
7. Because we will be adding dormers, let's adjust the proportion of the house to be more appropriate for two stories. Orbit or to face the front of the house. Activate **Select** and drag a window from left to right to select the roof. This type of window selects only those objects completely enclosed within it.



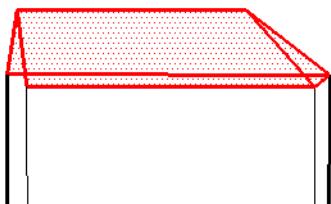
Whenever you select by dragging a window, it's a good idea to switch to wireframe to make sure you didn't select anything you don't want. In this case it's pretty clear there isn't anything else to select, but for

complex models you can sometimes include things that lie behind the window but aren't visible from your viewpoint.

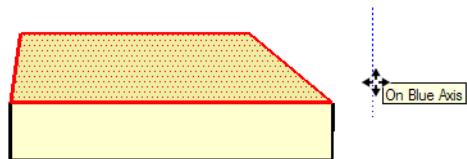
8. Switch to **Wireframe** display.



All roof edges and faces are highlighted.



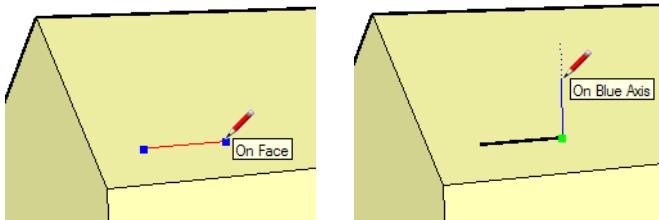
9. Switch back to **Shaded**, and activate **Move**. The objects are already selected, and you can pick any point as a reference point for moving. From the reference point, move down (blue direction) to position the roof as shown.



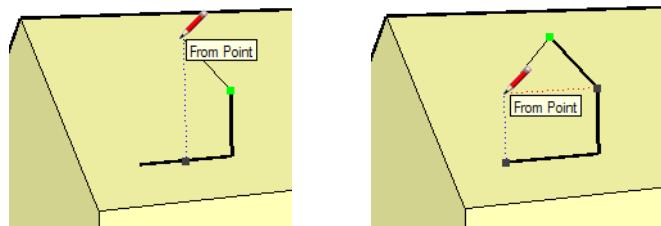
10. Press Esc to exit the **Move** tool. Deselect everything by pressing **Ctrl/Option+T**

The next step is to create a simple dormer. It should be small enough so that you can fit three of them along the long side of the roof.

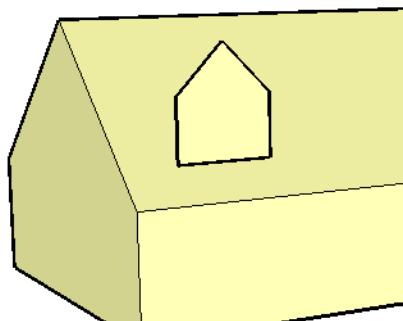
11. Use axis inferences to create a horizontal (red or green), then vertical (blue) line.



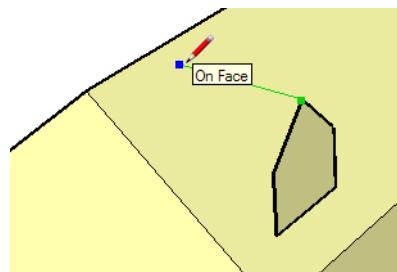
12. Make the top point of the dormer gable directly vertical from the midpoint of the first line. The next point should form a rectangle relative to the first two lines.



13. Close the dormer outline, and it will become a shaded face.

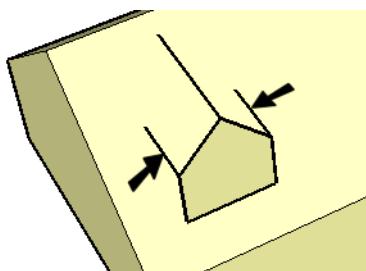


14. Drag a line from the top point in the green direction, back toward the roof. Because you won't be attaching another line at the end of this one, it's best to drag the line from one endpoint to the next. Release the mouse when you hit the roof face. This is a double constraint.

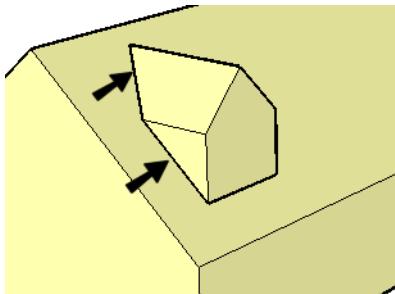


*NOTE: It's not needed in this step, but you can also press Shift to lock an inference. This can be helpful when the point you want isn't obvious or easy to find. Shift-locking will be used quite a bit later in this chapter.*

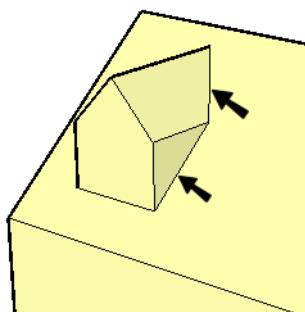
15. Draw the two lower horizontal lines the same way.



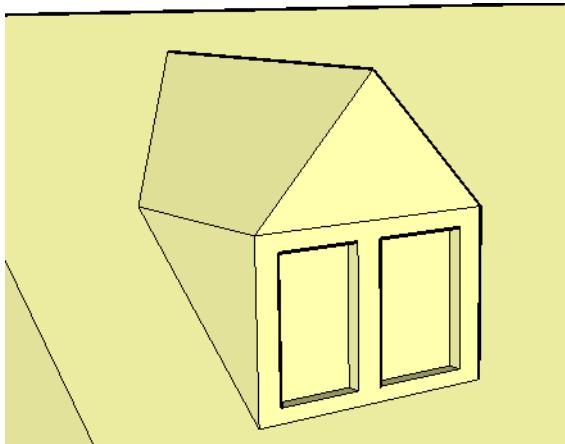
16. Complete the dormer form by connecting the endpoints on one side . . .



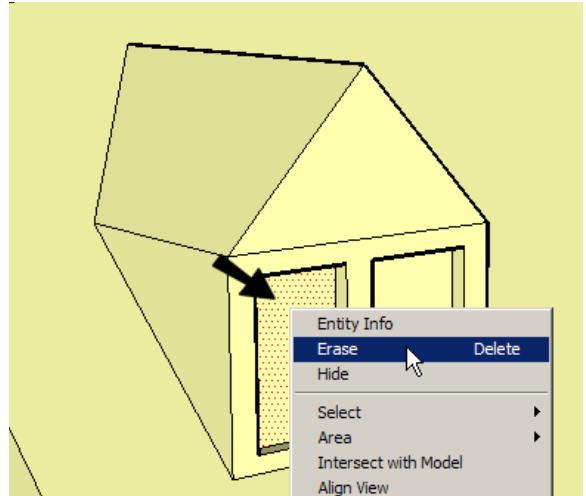
17. . . and the other side.



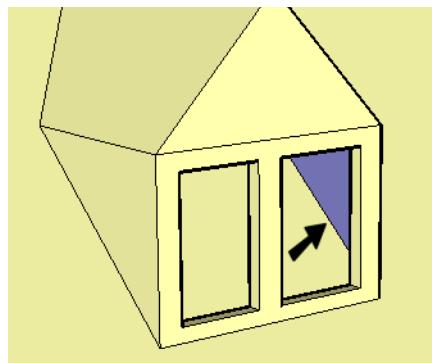
18. Add a line to subdivide the front face of the dormer, and add two rectangles for window cutouts. Use **Push/Pull** to push one rectangle in slightly, and double-click on the other window to push it in the same distance.



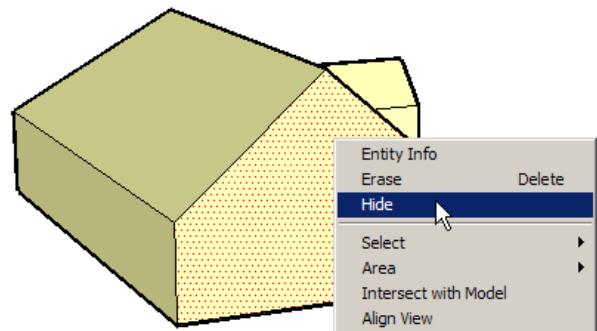
19. To cut out the window holes, right-click on the window faces and select **Erase** from the popup menu. (You could also use **Select** both faces, and press **Delete**.)



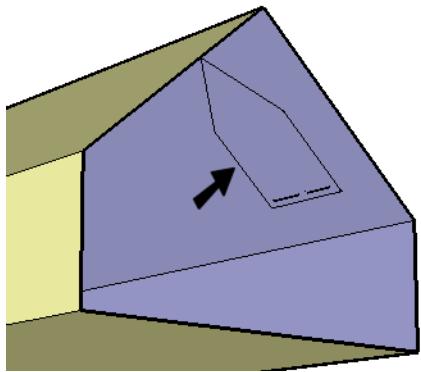
The dormer base lines (those that lie on the sloped roof face) have subdivided the roof itself into two faces.



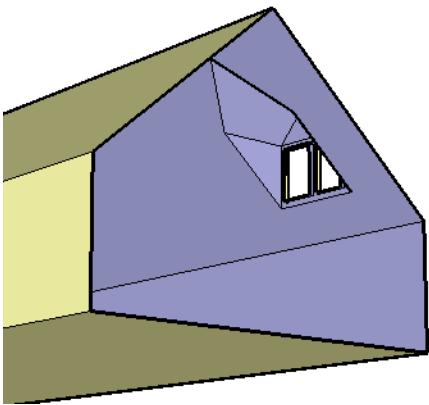
20. To see the face cut into the roof by the dormer, right-click on the side of the house and select **Hide**.



21. This view shows how the dormer appears from the inside. Erase this face.

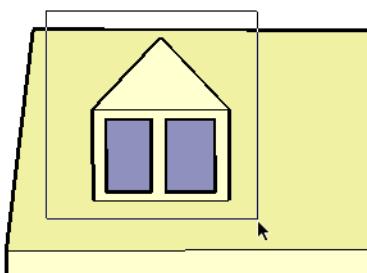


Now you can see the dormer from the inside.

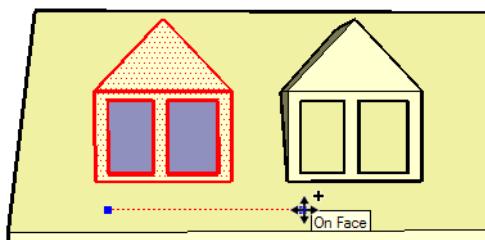


Now we'll look at a few ways to copy the dormer. For basic information on copying, see "Copy" on page 49.

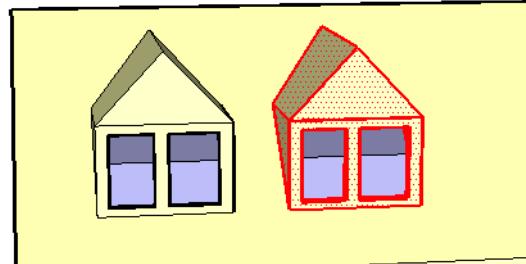
22. Activate **Select** and use a window (left to right) to select the entire dormer.



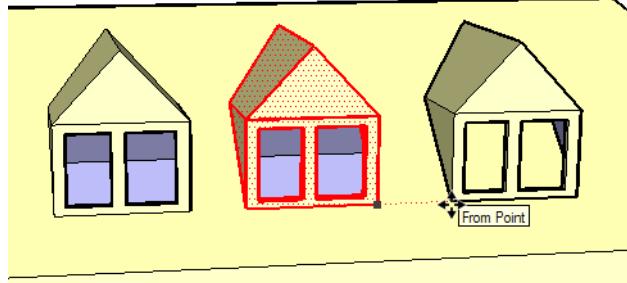
23. Activate **Move**, press **Ctrl/Option** to copy, and use any reference points to slide the copy to the right.



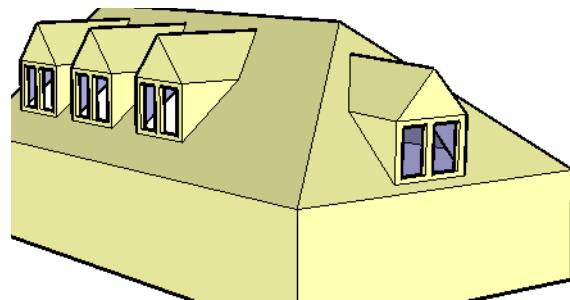
When you click to place the copy, note that the window and roof cutouts are made.



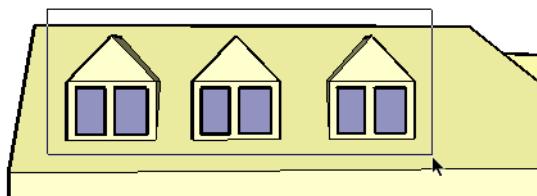
24. Another way is to use the clipboard, similar to most Windows and Mac applications. With the copied dormer still selected, press **Ctrl+C** (**Cmd+C**). Then press **Ctrl+V** (**Cmd+V**) to paste. Hover over a reference point and place the copy to the right of it.



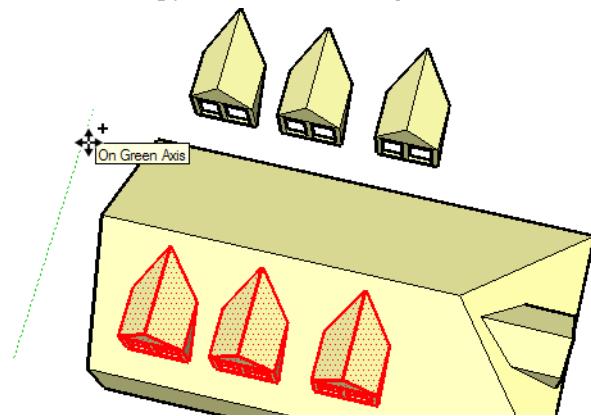
25. Copies are automatically aligned to their destination face. Place another copy on the sloped gable. This dormer might not be exactly vertical, depending on the slope you used. But you get the idea - the cutout is still made, and the dormer is still perpendicular to the face.



26. Now to copy the three longitudinal dormers to the other side. Select the three dormers.

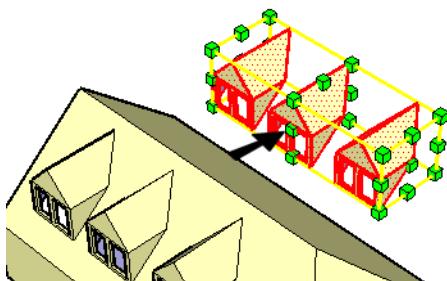


27. Orbit so that you see the back side of the roof. Use **Move** to copy the dormers straight back.

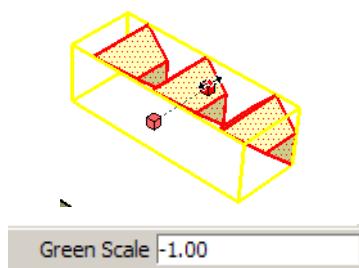


Here's a great place to briefly demonstrate the **Scale** tool. Aside from changing an object's scale, you can use this tool to mirror objects, or turn them inside out.

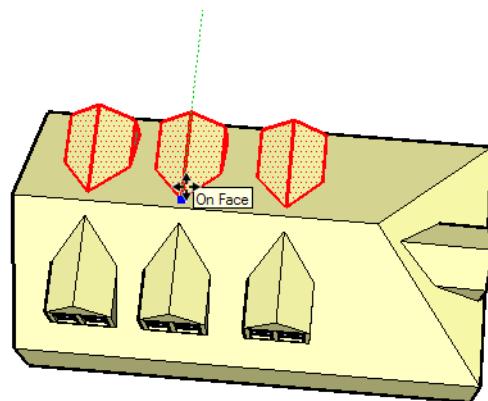
28. With the three copied dormers still selected, activate **Scale (Tools / Scale)**. A bounding box and several drag handles appear. Click the handle shown . . .



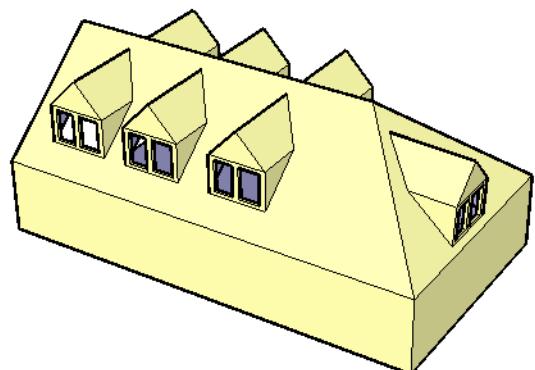
29. . . and drag it toward the opposite side, turning the dormers inside out. Stop when -1.0 is indicated in the VCB, or you can enter this value yourself.



30. Activate **Move**, and move the dormers straight back toward the roof (along the axis again), stopping when you get to the face.



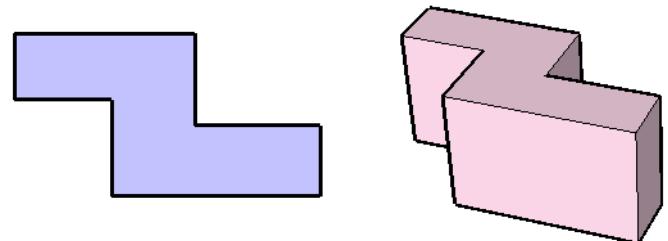
31. The final result - a simple house with seven dormers.



## Using Offset for Roofs

This simple exercise will demonstrate how to use the **Offset** tool. This is useful for creating parapets and overhanging roofs. For general information on this tool, see "Offset" on page 69.

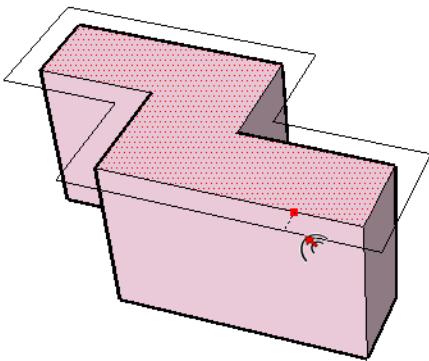
1. Start a new file and create a stepped form. **Push/Pull** it up to create the basic building.



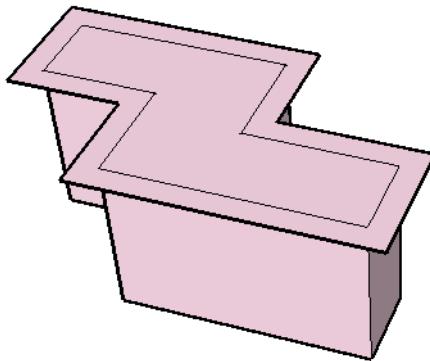
2. Activate **Offset (Tools / Offset)**.



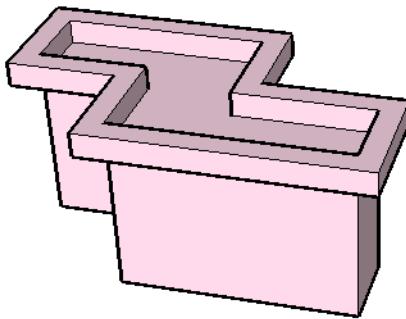
3. If you click a face, **Offset** will create new lines from all face edges. Select the top face and drag the offset outward. (You can also click instead of dragging.)



Now there are two top faces - the original and the offset face.



4. **Push/Pull** the offset face to create a parapet.

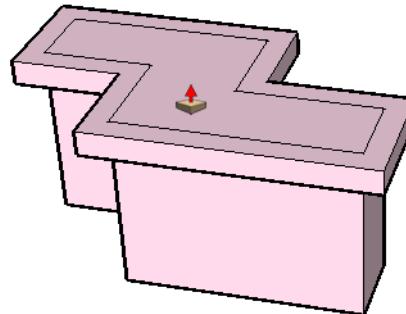



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**NOTE:** For a more ornate parapet, you can use the **Follow Me** tool. See "Basic Follow Me" on page 95.

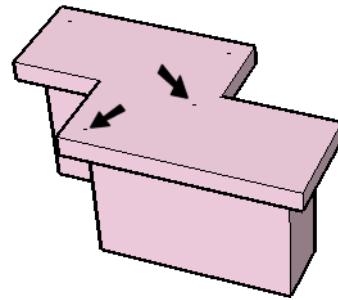
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5. While still in **Push/Pull**, double-click on the original top face to push it up the same distance.

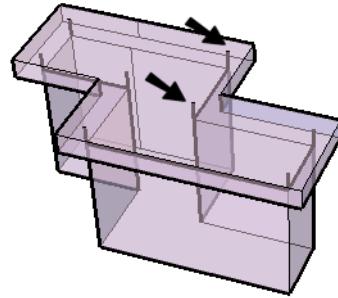


6. Heal the top face by erasing the extra lines. While in **Erase**, you don't have to click each line; you can keep the mouse button pressed and pass the eraser cursor over all the lines you want to delete. Then release the mouse to delete the selected lines.

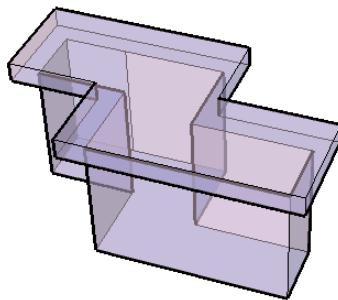
Note that you can still see a few dots on the top face - these are the ends of vertical lines at interior corners of the roof.



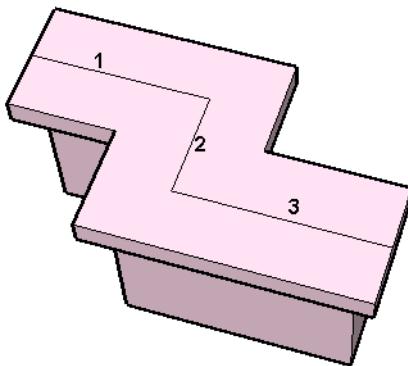
7. Switch to **X-Ray** mode, and you can see the vertical lines that formed the inner corners of the parapet.



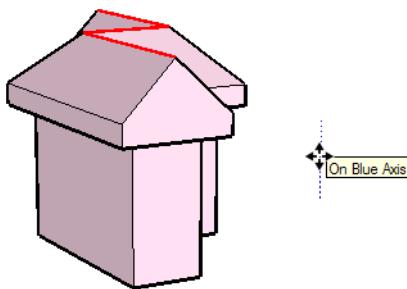
8. Erase these lines to create a nice, clean form.



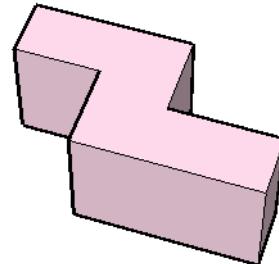
9. Back in shaded view, add three approximate ridge lines for a sloped roof.



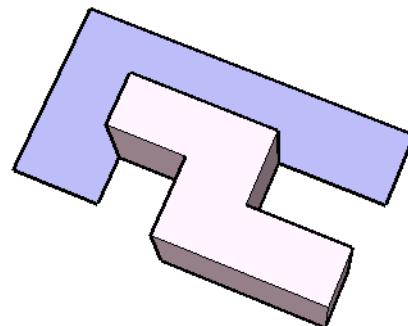
10. Activate **Select** and select all three ridge lines. Activate **Move**, and press Alt/Cmd for Autofold. This creates fold lines for you - there is no need to draw the valley lines manually. (**Move** without Autofold won't work in this case.)
11. Click any reference point, and then you can release the Alt/Cmd key (Autofold has already been activated). Move the ridge lines upward slightly. This is a very simple way to create a basic roof that consists of multiple angles.



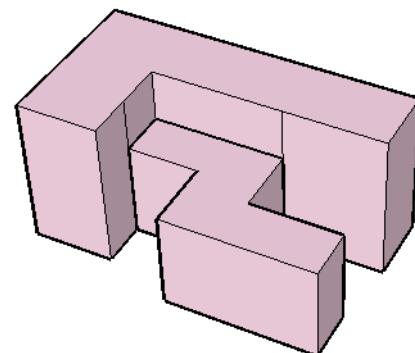
12. **Undo** (Ctrl+Z, Cmd+Z) what you've done so far, until you're back at the simple building form with no offsets.



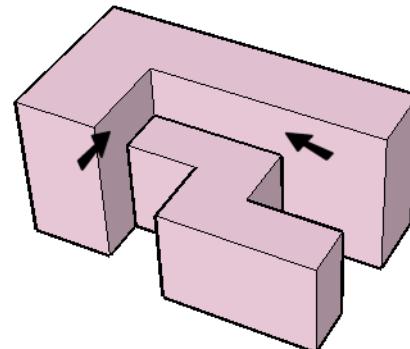
13. Create a form for an L-shaped adjacent building.



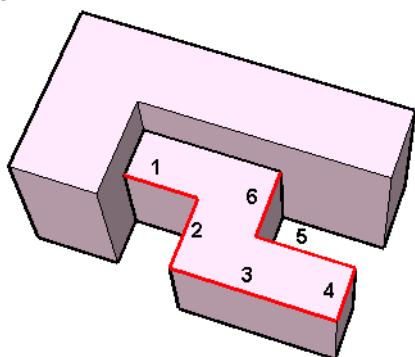
14. **Push/Pull** this form up so that it is higher than the original building.



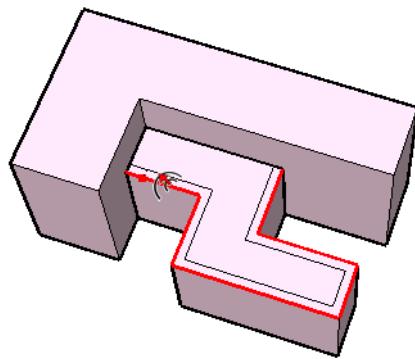
15. Heal the interior face by erasing the two extra lines.



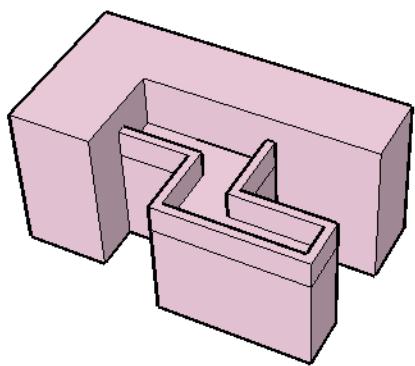
16. Now we will use **Offset** in a different way. Select the six edges shown, then activate **Offset**.



17. Offset the edges inward. The offset lines still touch the adjacent building - **Offset** correctly constrains all endpoints.



18. **Push/Pull** the offset face upward to create a parapet wall. If you press *Ctrl/Option* while pulling, the parapet walls will be separate from the walls below.

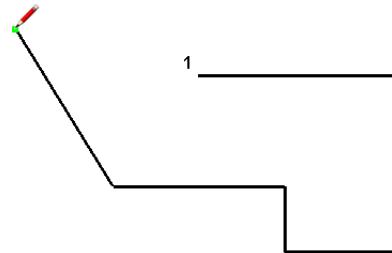


## Resolving Sloping Roofs

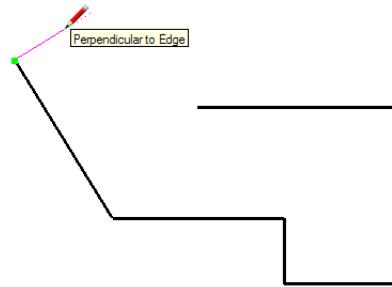
This exercise will show you how to create one roof for the entire house, keeping all roof slopes at the same pitch.

(If you want to download the house used in this exercise, go to [www.flhelp.biz/cep51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/cep51/cgi-bin/SU5Files.htm) and download the file “RoofHouse.skp.” You can then skip to “Set Slope and Double Constraints” on page 160.)

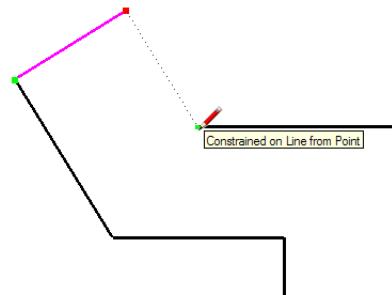
1. In **Top** view, start by drawing the basic form as shown below, starting at Point 1.



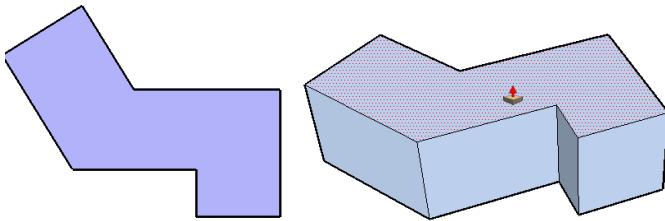
2. For the next line, you will use a double constraint. Move the cursor so that the **Perpendicular** inference is shown. Press Shift to lock this constraint, and the magenta constraint line becomes thicker.



3. While still pressing Shift, click the start point (Point 1). This makes the line the exact length needed to create a wing with 90-degree corners.

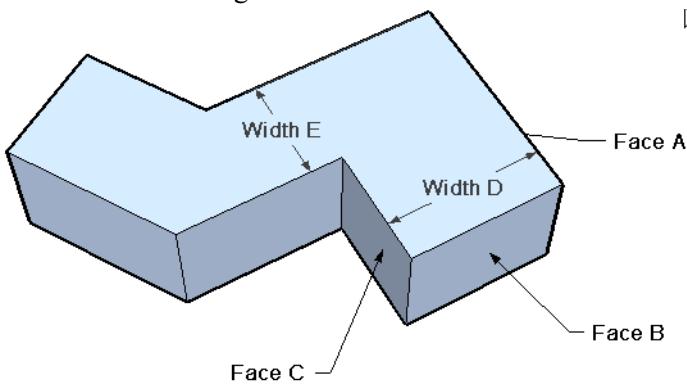


4. Close the form to create the footprint of the house. Use **Push/Pull** to give it some height.



For the purposes of this exercise, the initial slopes of the roofs need to be different. In order for the roof slopes to be different, the width of each wing needs to be different.

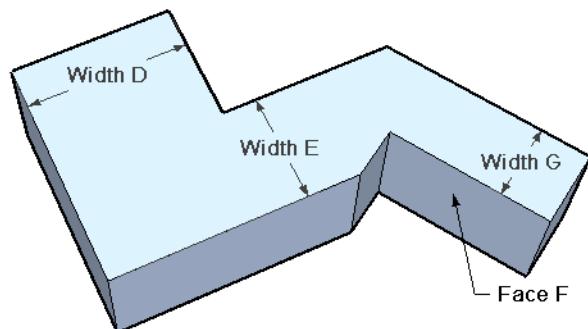
5. **Push/Pull** Faces A, B, and C as needed, so that Width D is larger than Width E.



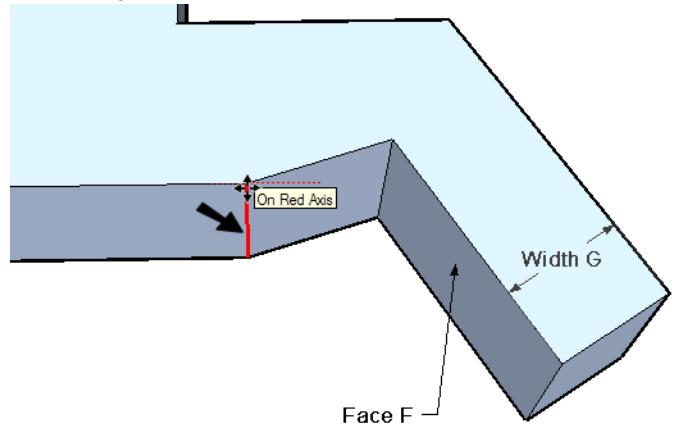
**TIP:** The "Width" labels in these pictures were created using the **Dimension** tool, by overwriting the actual dimension with text. See "Dimensions" on page 82. Face and point labels are created using Text. See "Text" on page 78.

You can create layers for text and dimensions, so that they can easily be hidden. See "Layers" on page 317.

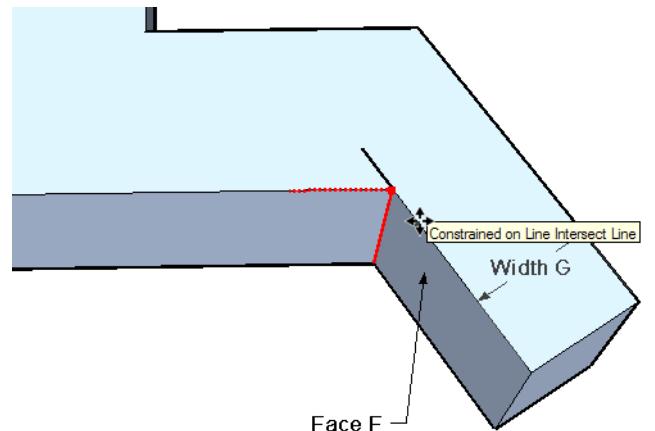
6. To make the diagonal wing narrower than the main section, push Face F inward so that Width G is smaller than Width E.



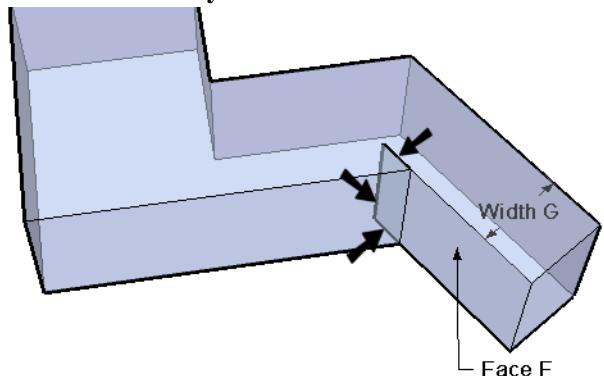
7. There are a few ways to fix this corner, but this one is probably the easiest. Use **Move** on the edge shown, using Shift to lock its movement to the red direction.



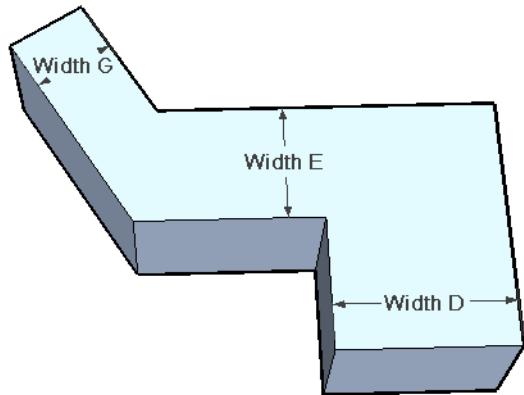
8. Click the top edge of Face F to constrain the moved edge to it.



9. There are three edges that now must be erased. Switch to **X-Ray** mode and erase these lines.



10. Switch back to shaded view. The basic form should look something like this:



11. Save this model as **RoofHouse.skp**.

(You can also download the model for this house. Go to [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm) and download the file "RoofHouse.skp".)

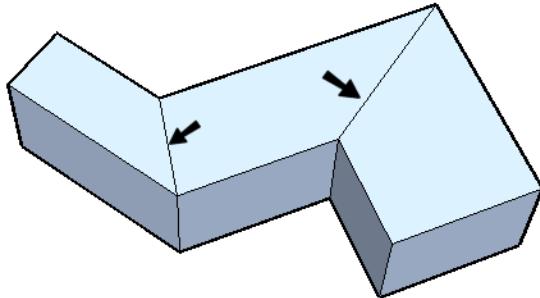
This form will be used to explore three ways to make a uniformly sloped roof:

- The first method is the most lengthy: you use the **Protractor** tool to set the slope, then use several sets of double constraints to resolve the ridge lines. It's complex, but it's also an excellent way to become an expert in SketchUp constraints.
- The second method ("Delete and Recreate" on page 166) starts with a single raised ridge line. Then certain edges are deleted and recreated in the correct locations, requiring some edges to be trimmed or extended.
- The last method ("Roofing with Follow Me" on page 169) is the easiest method. You draw one roof section and extrude it along the entire roof edge, then clean up the extra edges.

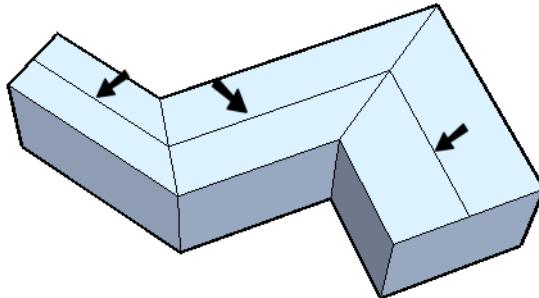
## **Set Slope and Double Constraints**

This method is probably not what you'd use to actually solve this problem, since it's complex and there is an easier tool to use (**Follow Me**). But if you need practice using double constraints, this will get you up to speed.

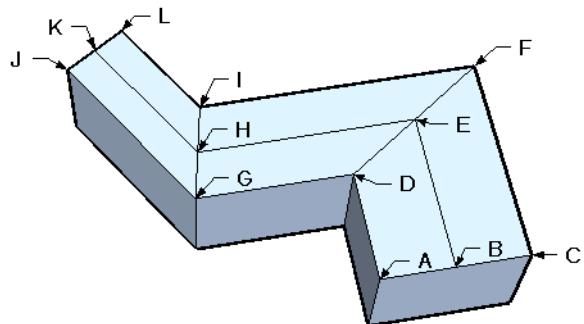
1. On the house form, draw the two valley lines between wings.



2. Then use **Midpoint** snaps to draw the three ridge lines.



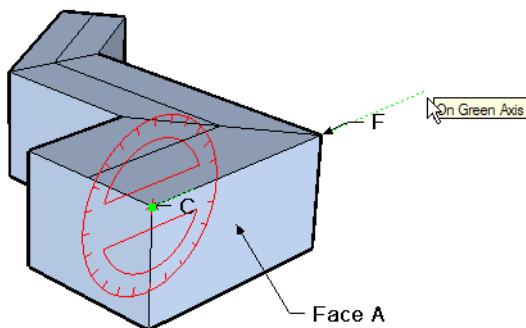
For the remainder of this exercise, it will be helpful to refer to certain points. The following reference points will be used:



The slope we want to use for all roofs is a standard 8:12 slope. The roof of the main section (between H and E) will be established at this slope first, and the other two roofs will be adjusted to it.

To begin, we will want to raise all ridge lines together to the level of an 8:12 slope for the main roof (H-E). To raise line H-E to the proper height for an 8:12 slope, we need to first create an 8:12 construction line along a face that is perpendicular to H-E. Since Face A is perpendicular to H-E, it will be used to create the construction line. The construction line will then be moved to an appropriate location for raising the roof ridge into place.

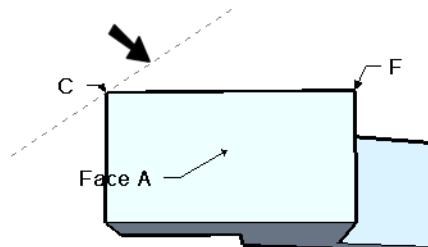
3. Activate **Protractor**. Place the protractor center at Point C, aligning it with Face A. Click to locate the reference line along C-F (which is in the green direction).



4. Use the cursor to indicate the direction of the roof angle (above, not below, line C-F), and type 8:12; this ratio is automatically entered in the VCB. Press Enter to create the construction line.

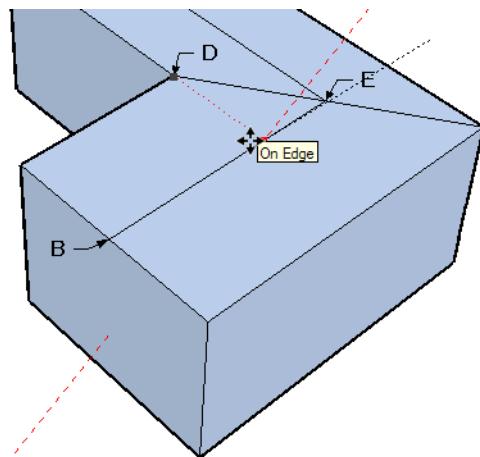
Angle 8:12

This is how the construction line should look from the side:

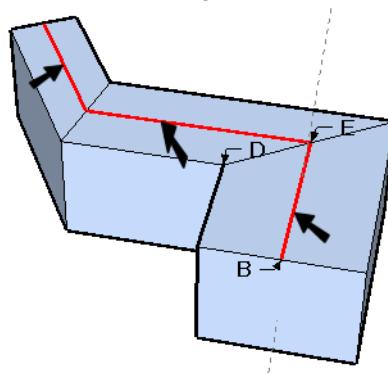


Because the ridge lines will be moved upward using Point E, the construction line needs to be positioned accordingly.

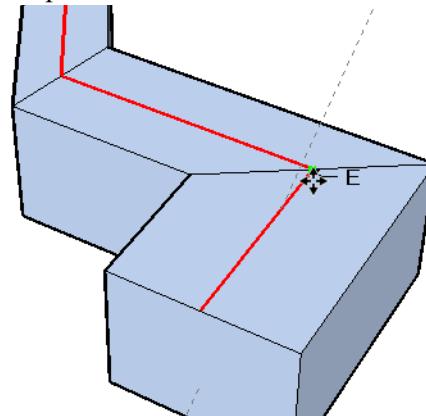
5. Activate **Move** and pick any point on the construction line. Drag the line to Point D (do not click yet), then move it in the red direction from Point D. Stop at the point where it intersects Line B-E. This is so the slope of the roof will be aligned properly with the center section of the house.



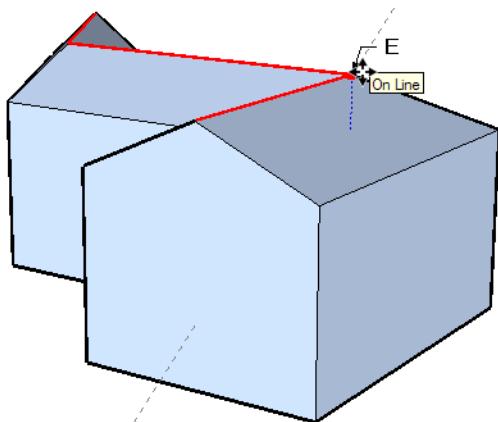
6. Now **Select** all three ridge lines.



7. Activate **Move**, and pick Point E as the move reference point.



- Move the ridge lines straight up (in the blue direction) until Point E meets the construction line.



- Because the construction line is no longer needed, right-click it and select **Erase**.

**TIP:** You can delete all construction lines by selecting **Edit / Erase Construction Geometry**. For cases when you'll need the lines again (not this case), use **Hide Construction Geometry**.

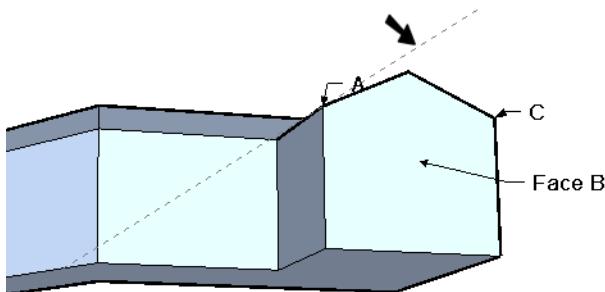
- Since we'll want to refer back to this state of the model later, save the file as **RoofIntersections\_before.skp**.

(If you want to download this model, go to [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm) and download the file “RoofIntersections\_before.skp.”)

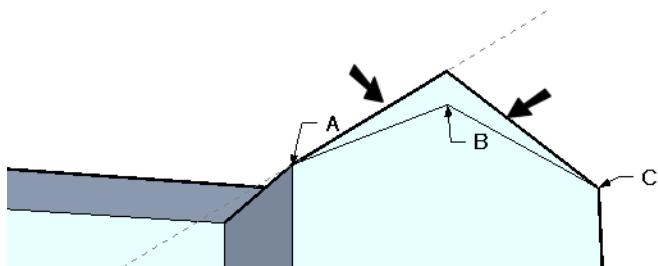
- Because it's a good rule of thumb to save your model after every few steps, make another copy of this file, which you will continue working in, called **RoofIntersections.skp**.

Now the main section's roof has an 8:12 pitch. The other two roofs, however, have different slopes. We'll start fixing this by focusing first on the wider, perpendicular wing.

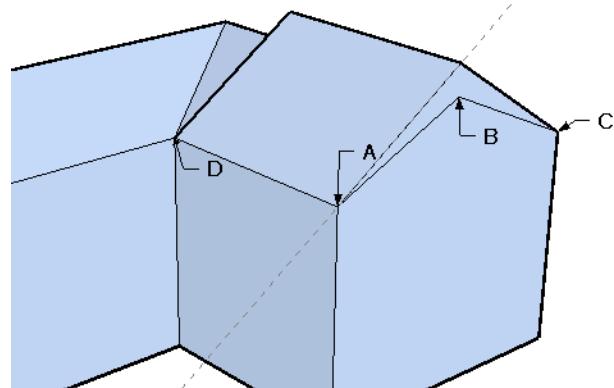
- Use **Protractor** to draw an 8:12 construction line on Face B, from either Point A or Point C.



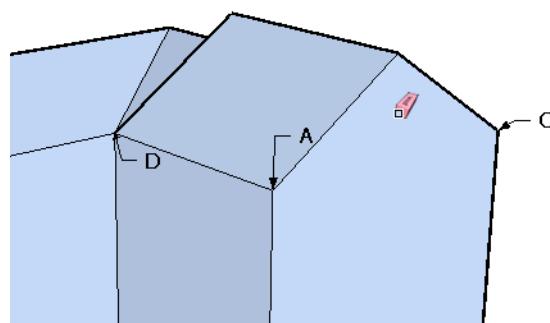
- The current pitch is too flat, so material must be added. Draw a line from Point A to a point directly above Point B, that lies on the 8:12 construction line. Close the chevron shape by drawing another line to Point C.



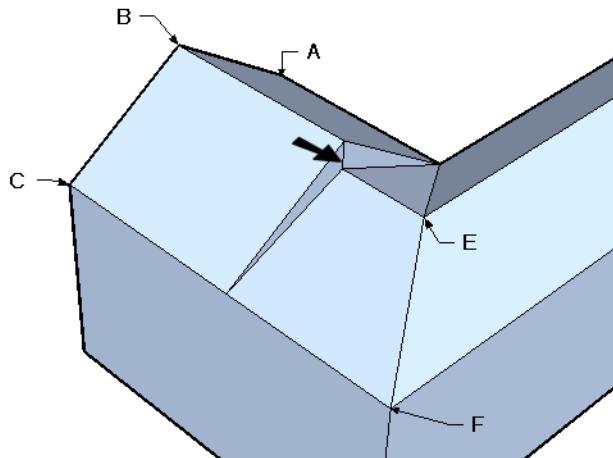
- Push/Pull this chevron face back to the valley intersection with the main roof (Point D).



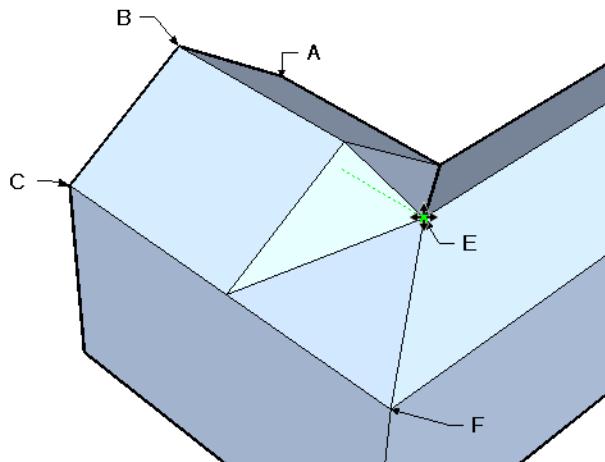
- Clean up the front face by erasing the two original roof lines. You can also delete the construction line.



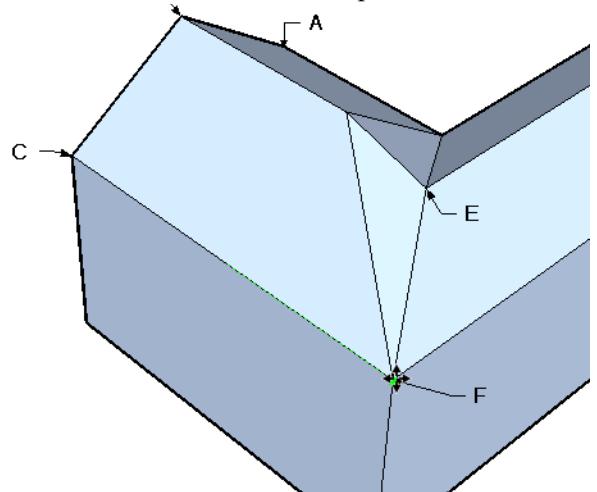
16. Now spin the house around so that you can see the intersection area that needs to be resolved. The lower point on the chevron apex needs to be moved, but you can't move it as long as the chevron is a single face. Therefore, divide the chevron by drawing a vertical line at the apex.



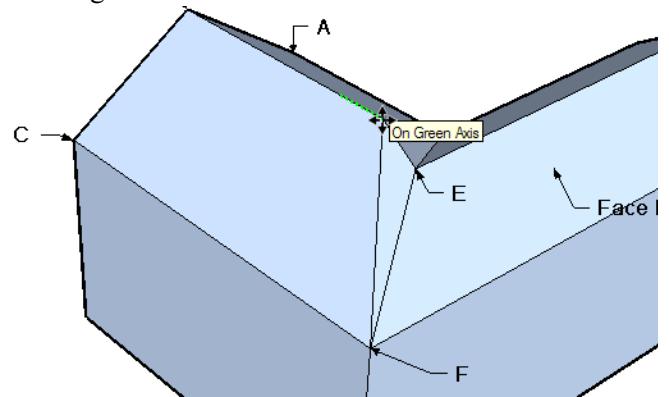
17. Use **Move** to drag the lower middle chevron point to Point E. (You can't select points using **Select**, so activate **Move** and then drag the point.)



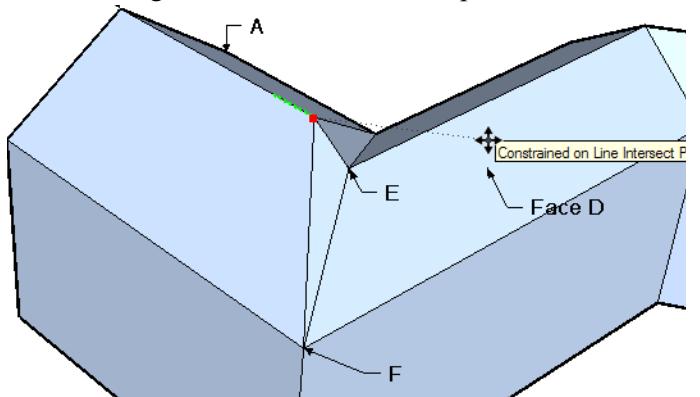
18. Now move the outer chevron point to Point F.



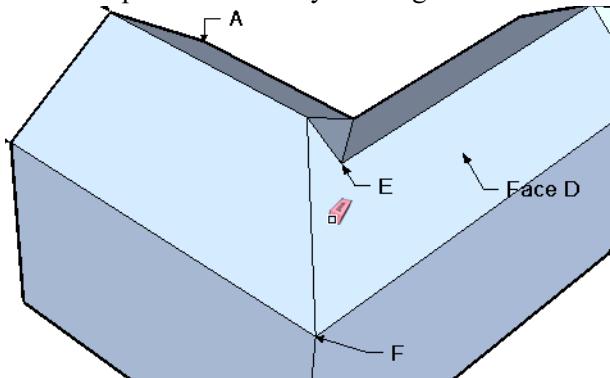
19. The last (upper) chevron point needs a double constraint to move into the proper position. Start dragging this point along its ridge line, which is in the green direction. Press Shift to lock this direction.



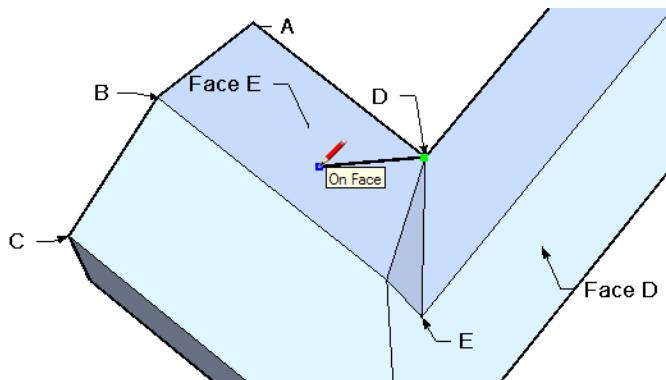
20. Keep pressing Shift. Because it is the rear face of the center roof (Face D) that will be extended to connect with the modified (higher) roof, place your cursor anywhere on this face. When the line-face constraint appears, click to relocate the chevron point. This will place the point at the correct location along the ridge line to generate the same 8:12 slope as Face D.



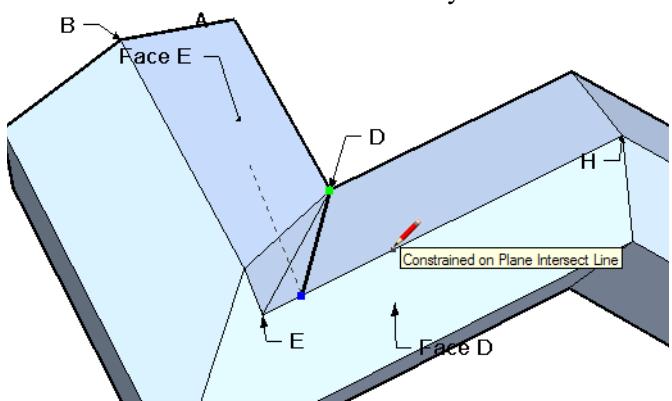
21. Clean up the rear face by deleting the extra line.



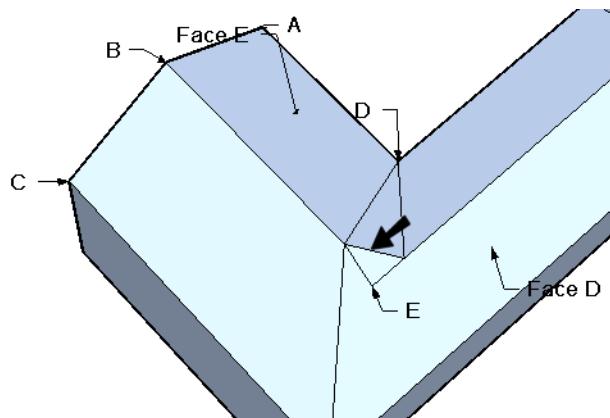
22. Now the slope on the interior corner needs to be readjusted. To do this, you need to create a valley line from Point D that lies at the correct angle on the center roof. So draw a line from Point D that is constrained to Face E. Press Shift to lock this constraint.



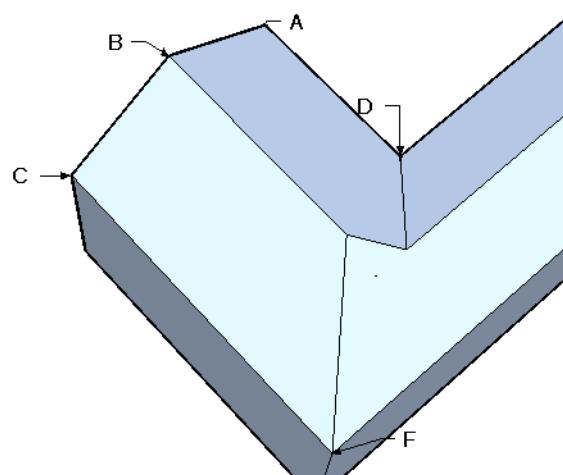
23. Keep Shift pressed, and place the cursor anywhere along the center ridge line (H-E). Use this double constraint to create the new valley line.



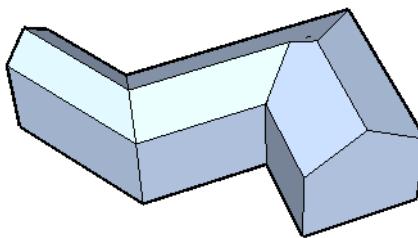
24. To complete this corner, draw the line shown.



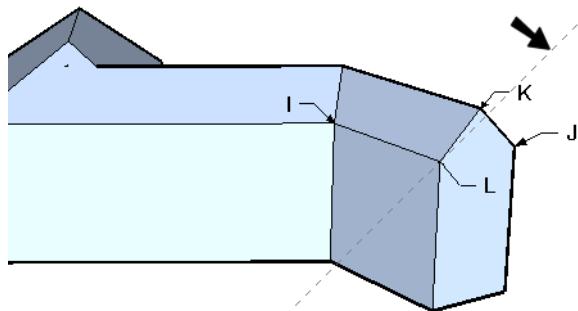
25. Now erase all extra lines. This roof is now resolved.



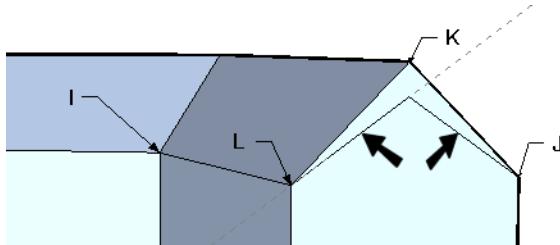
This is how the house should look from the front.



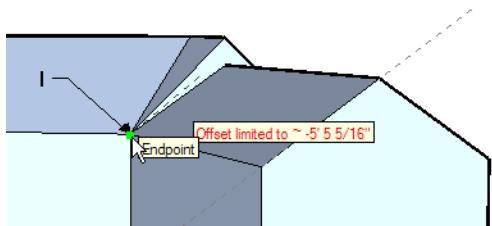
26. Now swing around to face the front of the diagonal wing. Use **Protractor** to create another 8:12 construction line on this face.



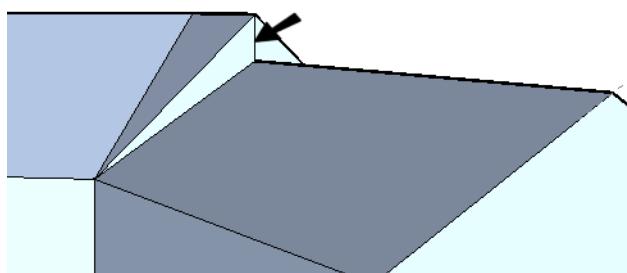
27. This time the roof is too steep. Draw another chevron shape as before, which will be used to remove material from the roof.



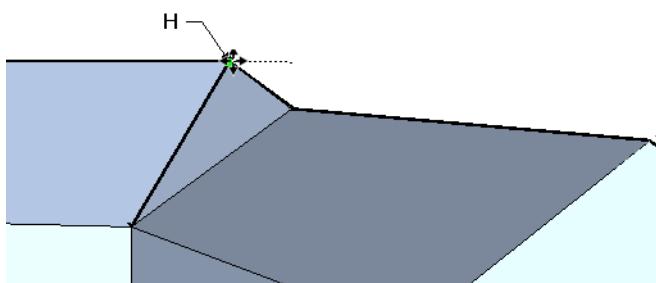
28. **Push/Pull** the chevron face back to the valley line of the center roof (Point I). You can't go any further than this point.



29. As before, draw a vertical line at the chevron apex.

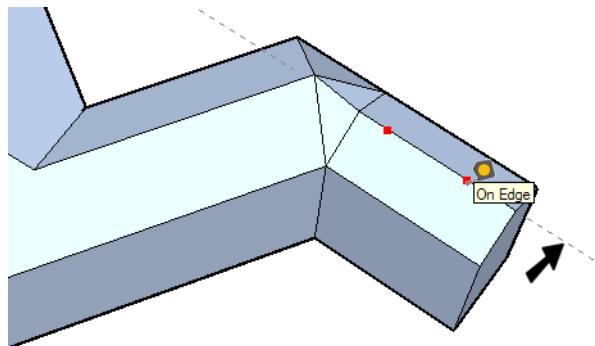


30. Move the top point of the chevron apex to Point H.



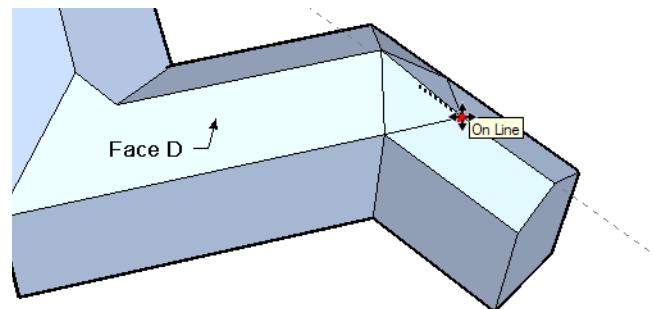
The lower apex point also needs to be moved, and needs to be constrained along the diagonal roof ridge line. This point can be moved freely along the ridge line, but the ridge line can't be used for a double constraint because it is not parallel to any axis. Therefore, a construction line is needed along this ridge.

31. Activate **Measure** and click any two points (except endpoints) on this ridge line to create the construction line.



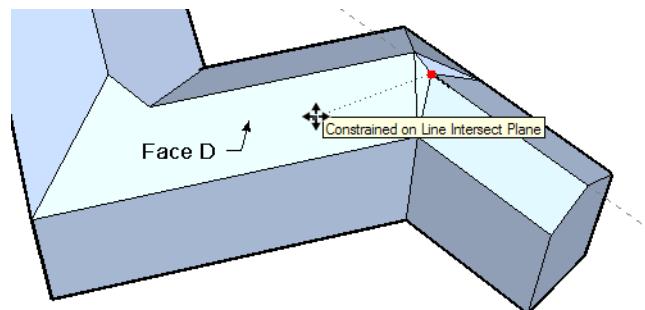
**NOTE:** If you click endpoints of an edge, **Measure** will measure the line. Clicking non-endpoints along an edge, or endpoints of different edges, creates a construction line.

32. Now use **Move** to drag the chevron point along the ridge line, pressing Shift to lock it to the construction line.

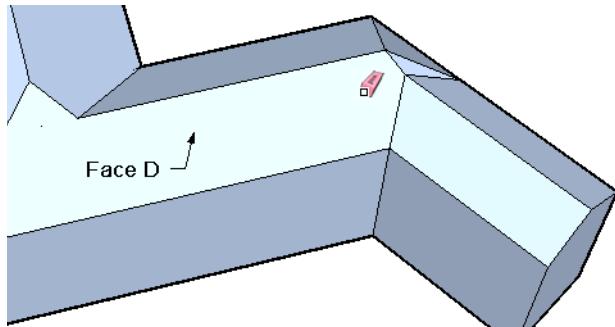


You've probably already noticed that, when using double constraints, it doesn't matter which direction you move the cursor when picking up a linear constraint. The second constraint controls where the target point is located.

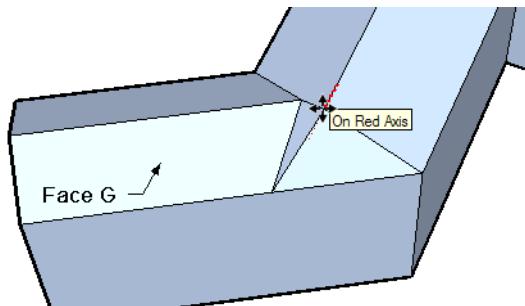
33. Constrain this point to the inside face of the center roof (Face D), because this face has the slope you want to match.



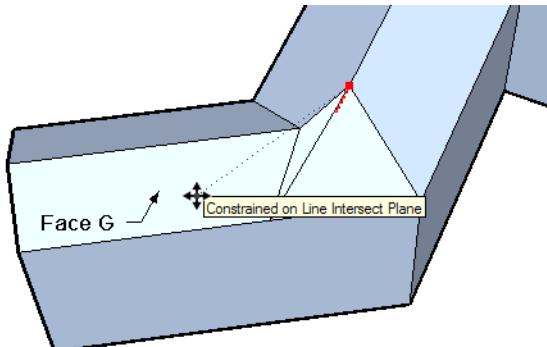
34. Erase the extra line on Face D, as well as the construction line. Now the triangular face at the exterior corner is the only one whose slope is not 8:12.



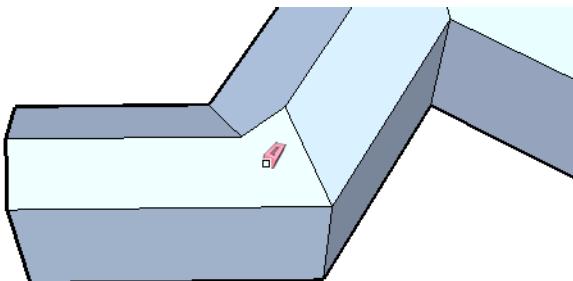
35. Orbit to face this area. Move the top triangle point so that it is constrained to the center roof ridge line (in the red direction), press Shift . . .



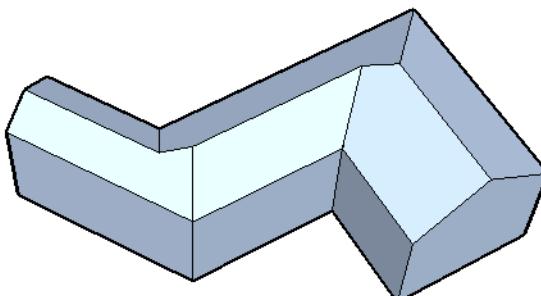
36. . . and constrain to Face G as well., to match its slope.



37. Erase all extra lines at this corner.



Now all three roofs have the same slope. Be sure to save the file (**RoofIntersections.skp**), because you will use it later.

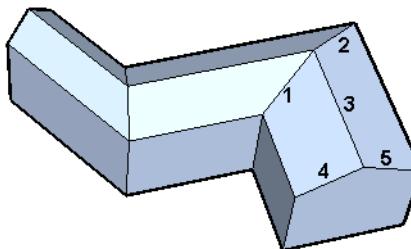


(If you want to download this model go to [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm) and download the file “RoofIntersections.skp.”)

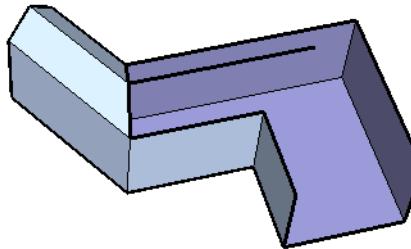
## Delete and Recreate

This method is a slightly faster way to achieve the same results. It will give you some more practice with the double constraints.

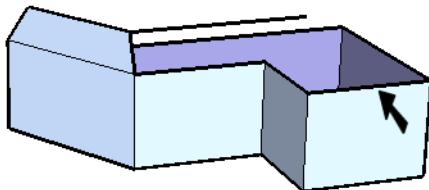
1. Go back to the preliminary file you saved - **RoofIntersections\_before.skp**. (Or download it from [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm).)
2. First we'll resolve the wider, 90-degree wing. Erase all the lines you know will change (five total).



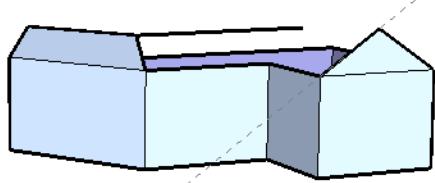
This deletes all the faces that will change as well.



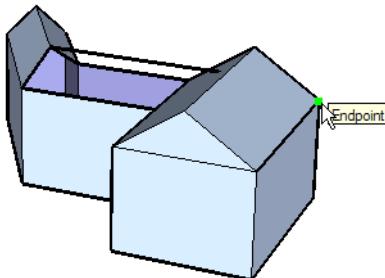
3. Replace the front face by drawing a line across the top.



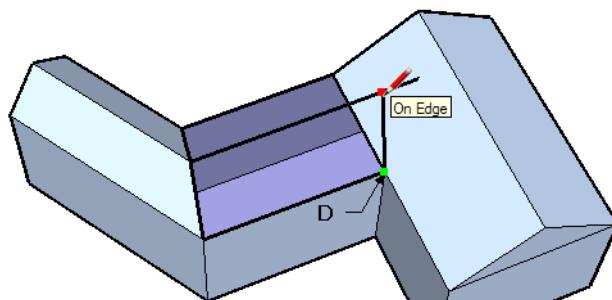
4. Create an 8:12 construction line on this face, and draw a triangular face using the 8:12 slope.



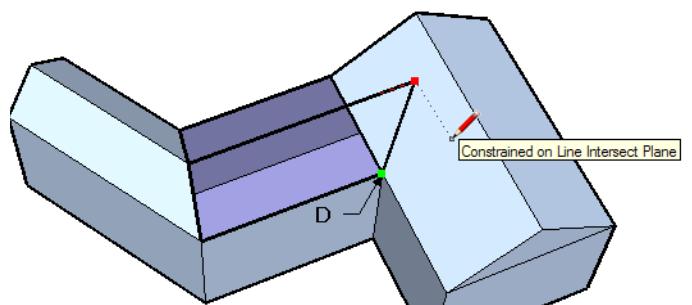
5. **Push/Pull** the triangular face to the end of the house.



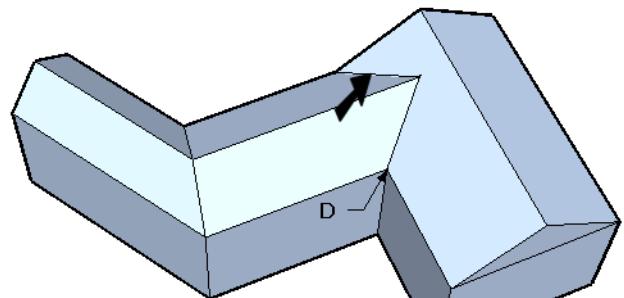
6. To replace the edges of the center roof, we will use double constraints as before. From Point D, draw a line whose endpoint is constrained to the center ridge line . . .



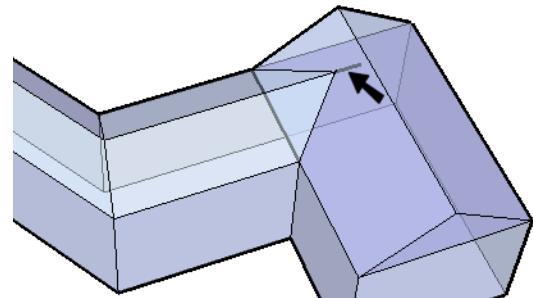
7. . . and the adjacent face of the new roof.



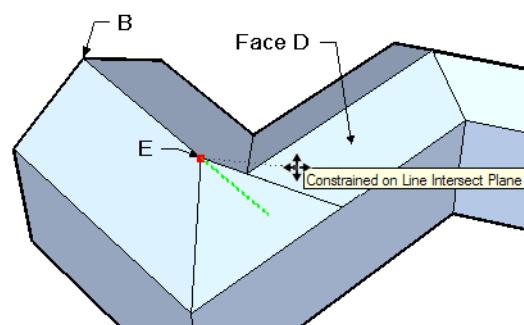
8. Now you can easily replace the back roof face.



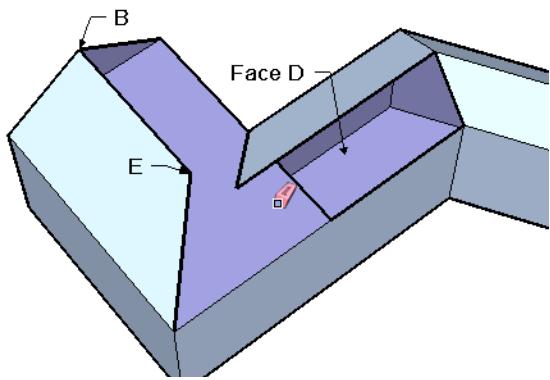
9. The original center roof ridge line is now too long, as you can see in X-Ray view. Erase the extra portion of this line.



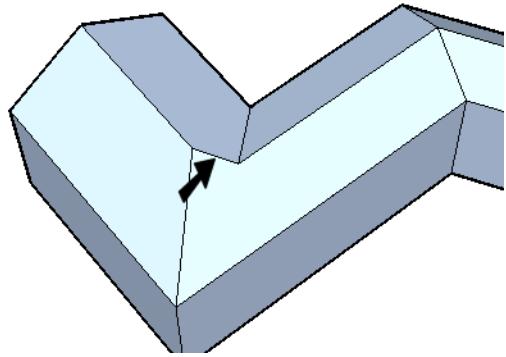
10. Go back to shaded view. Orbit to the other side, where the back of the roof needs to be fixed. Move the roof apex point so that it is along line B-E, constrained to Face D.



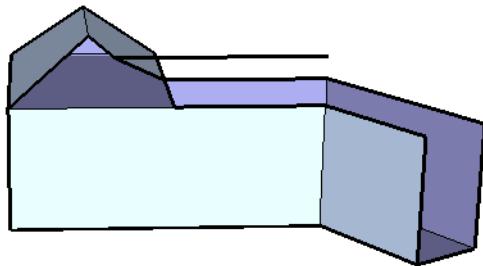
11. Erase the extra line on Face D, which causes the adjacent faces to disappear.



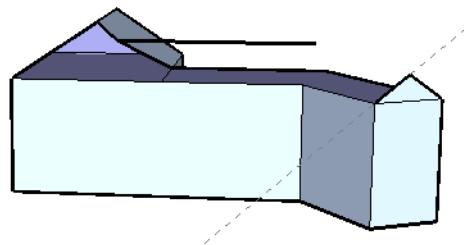
12. Replace both faces by redrawing the edge shown.



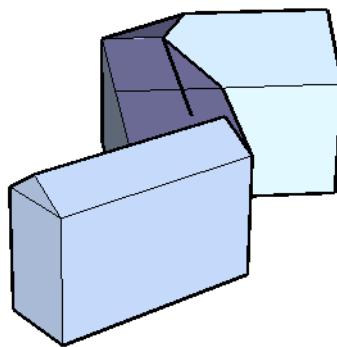
13. That takes care of the perpendicular wing, but the diagonal wing is a bit trickier. Swing around to that side and erase the five edges you know will change.



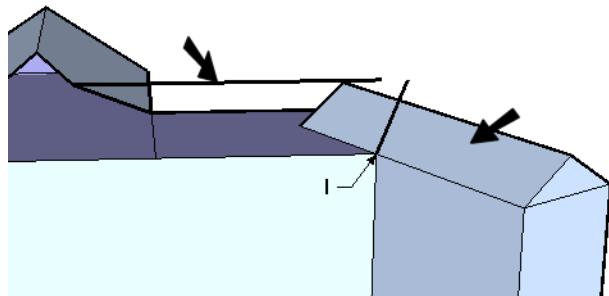
14. Replace the front face and place an 8:12 triangle on top of it.



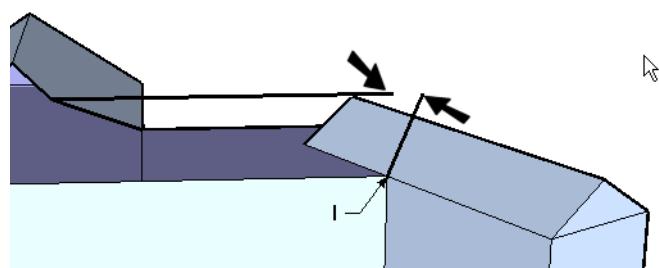
15. **Push/Pull** the roof triangle to the other side.



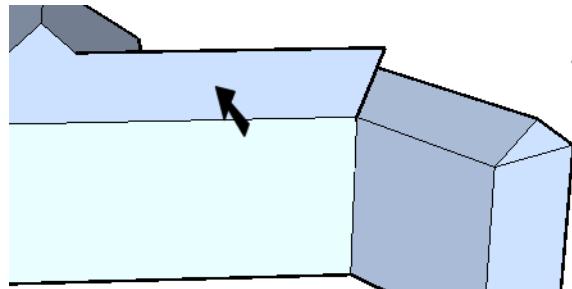
16. From Point I, draw a line constrained to the center ridge line and adjacent diagonal roof face.



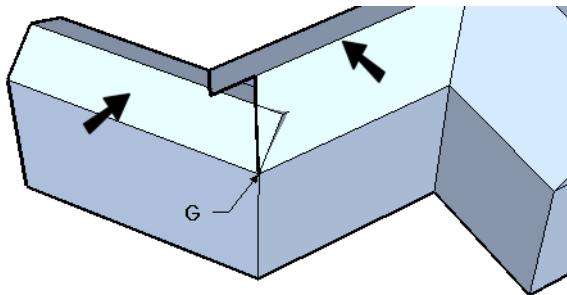
17. On the other side, the center ridge line was too long and needed to be trimmed. This time it's too short. Draw a line between the two points shown to extend the ridge line.



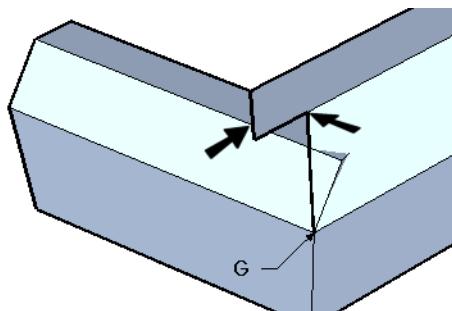
This replaces one face of the center roof.



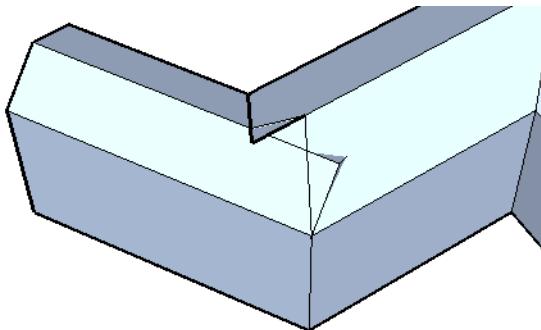
18. From Point G, draw a line constrained to the center ridge line and the adjacent diagonal face. This replaces the other face of the center roof, but there's some trimming to do.



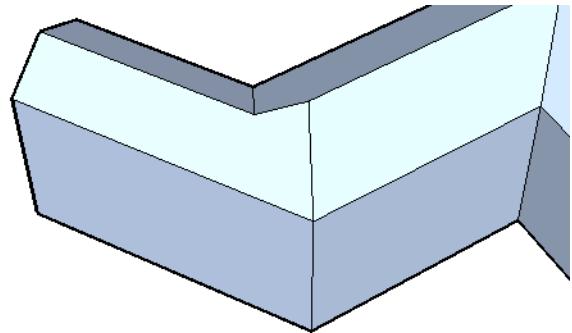
19. First, draw a line from where the diagonal ridge line first meets the center roof face to the endpoint of the line you just drew from Point G.



It looks like a mess, but trimming should be easy.



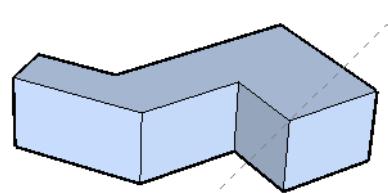
20. Start erasing the edges you can tell are overhanging. It then becomes clearer which of the remaining edges can then be erased. As before, if any erased edges cause a face to disappear, just recreate it with a simple line.



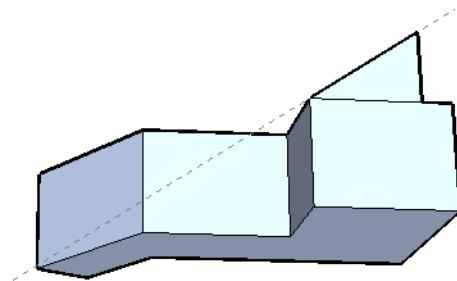
## Roofing with Follow Me

This is the easiest method; you use the tools **Follow Me** and **Intersect with Model**.

1. Start with the initial house form - **RoofHouse.skp**. (Or download it from [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm).)
2. Use **Protractor** to set an 8:12 slope line at the front of the 90-degree wing.



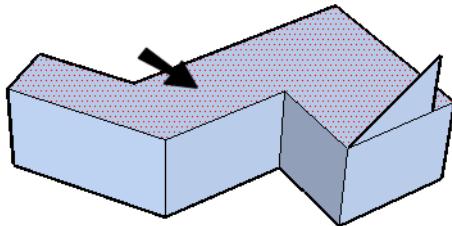
3. Use **Line** to create a triangular section of the roof. Make sure it extends past the halfway point of the wing.



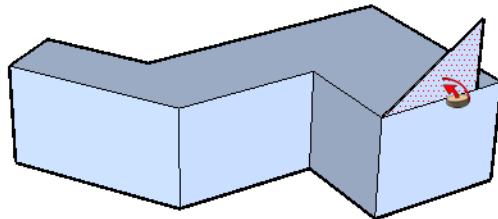
Now for the magic of **Follow Me**. With this tool you can either select a shape and then the path along which to extrude it, or select the path first. We'll use the latter method.

**NOTE:** See Chapter 3 for more on **Follow Me** and **Intersect with Model**.

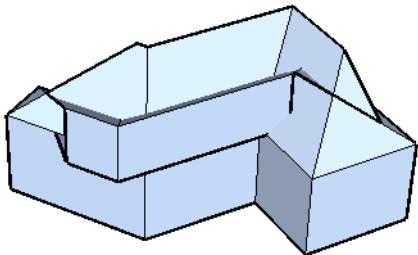
4. Select the top face of the house.



5. Activate **Follow Me (Tools / Follow Me)**. For the face to extrude, select the triangular roof section.

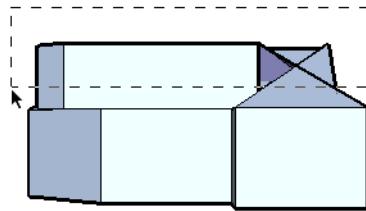


Here is the result - the roof section is driven all along the top of the house. Clearly a good bit of cleanup is needed.

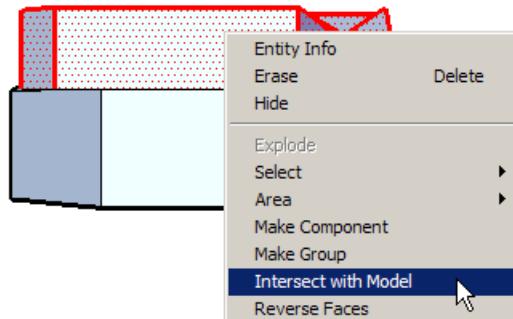


**TIP:** Another way to do the same thing: activate **Follow Me**, and select the triangular roof section. Then press Alt/Cmd and select the top face of the house.

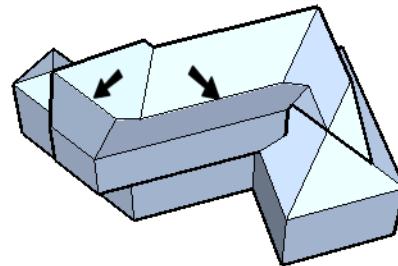
6. In Front view, activate **Select** and use a right-to-left window to select all faces of the roof.



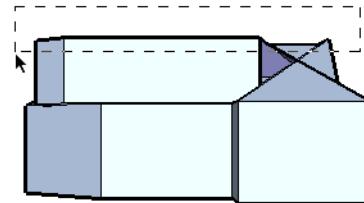
7. Right-click on one of these selected faces and select **Intersect with Model**.



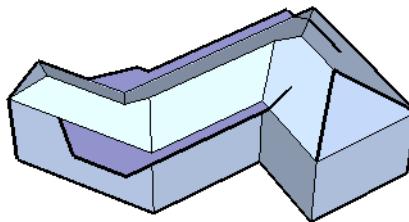
The results - all the intersections between the selected faces are now marked by edges.



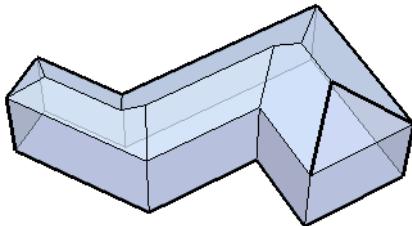
8. To continue with the cleanup, select all faces above the ridge line and delete them (press the Delete key).



This looks better, and now it's easy to see the remaining entities that need to be deleted.

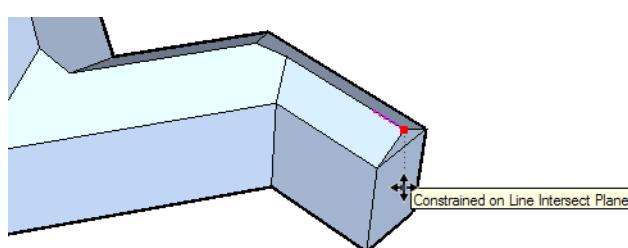
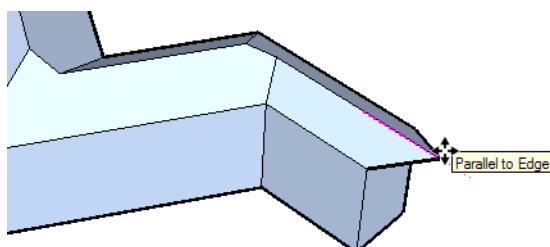
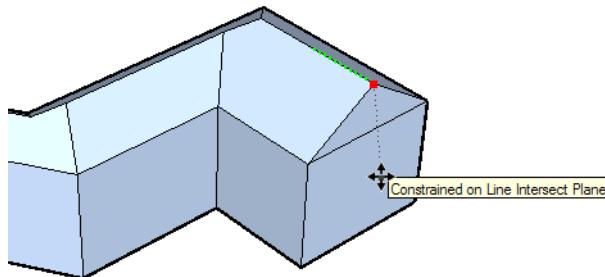


- Erase all the extra lines, and recreate any missing faces. Check in Wireframe or X-Ray mode to catch any hidden extra edges.

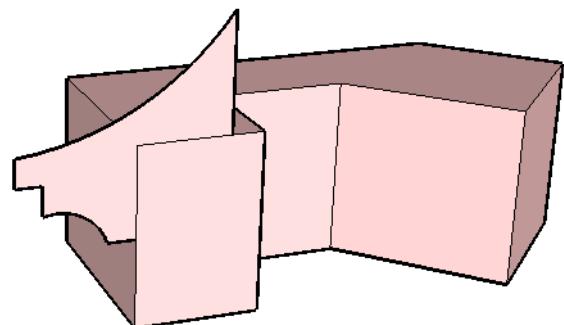


In these few steps, you have created (almost) the same roof as in the previous two exercises, but without all the tedious constraint work.

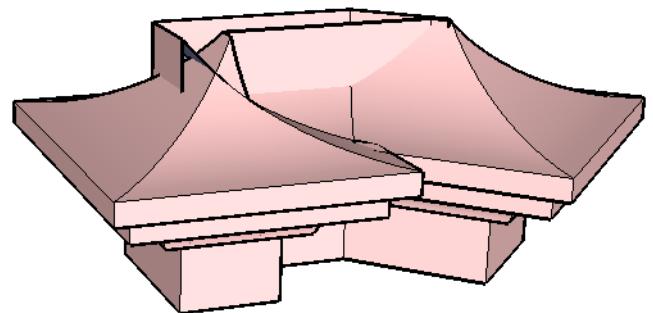
- The only difference between this roof and the double-constraint method roof is that the front roof faces are also sloped, not vertical. To straighten these faces, use **Move** on the top points with double constraints.



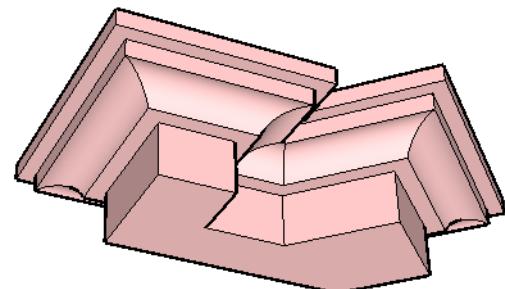
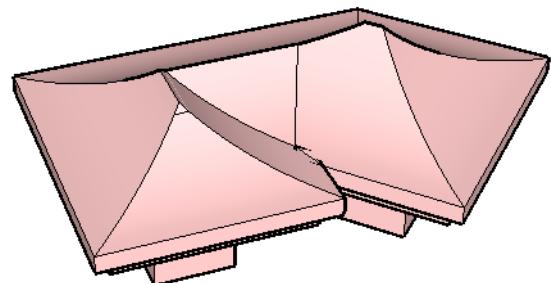
This was a simple example, but you can use it for any type of building and any type of roof. Here's another example, using a complex roof section:



Use **Follow Me** along the top of the building.



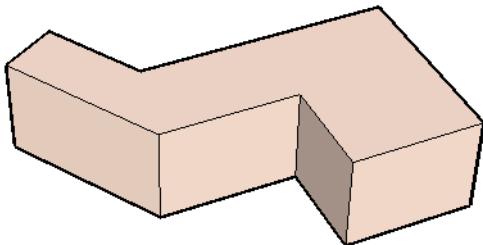
Intersect and clean up. In some cases you may get lots of pesky edges to delete, but it's still pretty easy to create complex roofs.



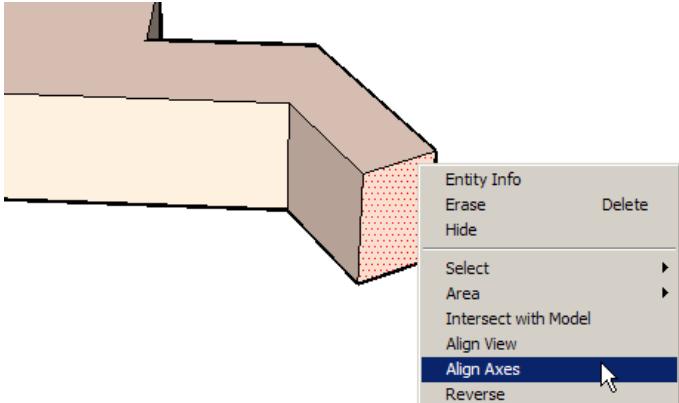
## Overhangs

Because the model you just created has uniform roof slopes, it is a convenient place to start for creating overhangs.

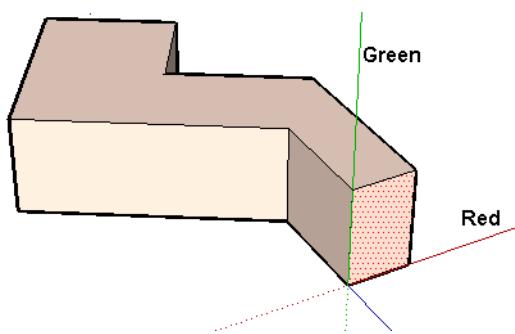
1. Open the original form **RoofHouse.skp**. (Or download it from [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm).)



2. It would be easy to create an overhang roof on the large, 90-degree wing, since it is already parallel to the red and green axes. But to show another feature of SketchUp, we will use the narrow, diagonal wing. It is always a good idea to set the axes to match the geometry, so right-click on the front face of this wing and select **Align Axes**.



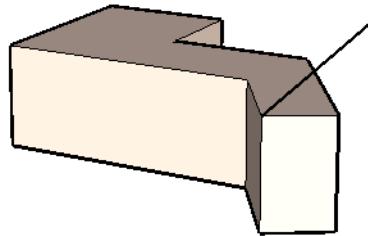
3. If the axes are not displayed, turn them on (**View / Axes**). Your axes should look like this:



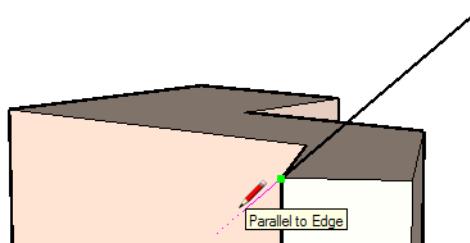
4. Turn off the axes if you want.

Now we will create the section for the overhang roof. It will be a simple rectangle that touches the front face at its top left corner. There are infinite ways you can create this section, but this way seems the fastest.

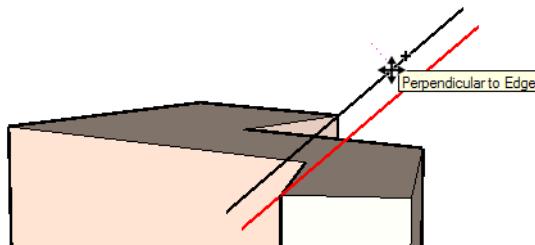
5. Use **Line** to create the interior roof line. Make it pretty long - this section will be driven along both sides of the house, and will need to overlap the other side of the roof.



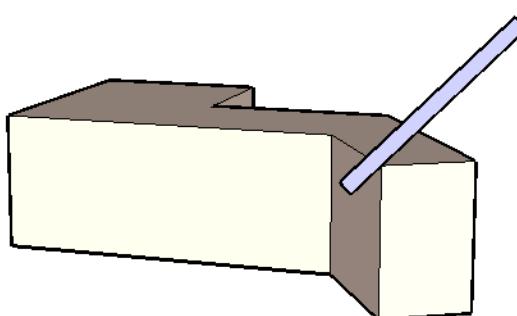
6. Draw a short line for the overhang, making it parallel to the previous line.



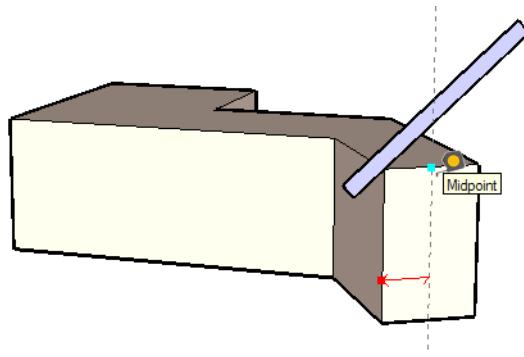
7. Select both these lines and use **Move** with *Ctrl/Option* to copy them. Press Shift to lock the Perpendicular constraint, and make the section a reasonable thickness.



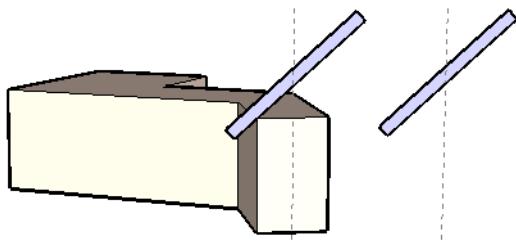
8. Complete the rectangle. For contrast, you can keep the section in the "Face Back" color.



9. This section will have to be used for the other side as well, so it will need to be copied and mirrored. To make this easier, create a construction line via the **Measure** tool. Click on any vertical edge, and place the construction line at the midpoint of the diagonal wing.

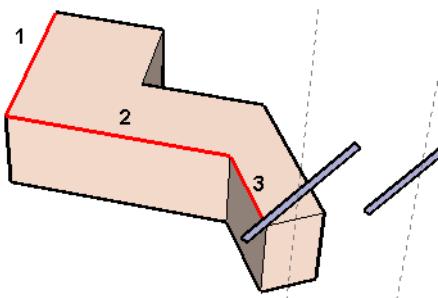


10. Select both the roof section and the construction line and use **Move** to copy it anywhere in the blank space.

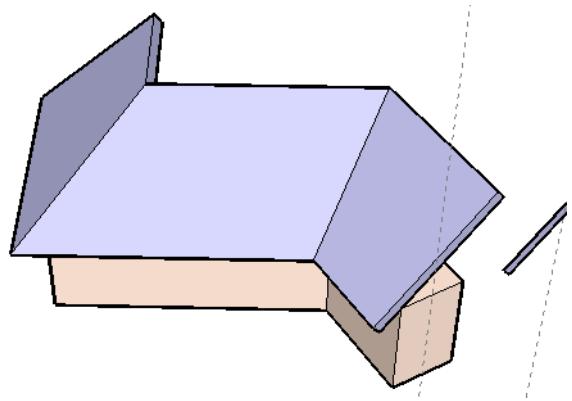


**NOTE:** For details on copying, see "Basic Move and Copy" on page 135.

11. If you did the previous exercise, "Roofing with Follow Me" on page 169, you'll know what to do next. To create the first half of the roof, start by selecting the three roof edges shown.

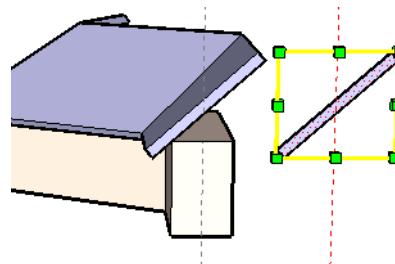


12. Activate **Follow Me (Tools / Follow Me)**, and select the roof section. It is now extruded along the three edges.

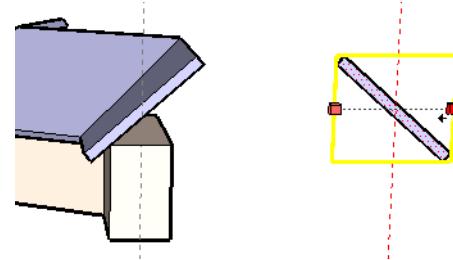


13. Now set the section for the other half of the roof. Select the copied roof section and construction line and activate **Scale (Tools / Scale)**.

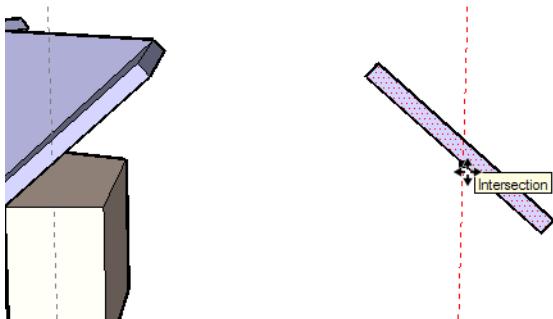
The drag handles are based on the current set of axes. If you hadn't set the axes to this wing, you would be seeing a 3D set of scaling handles, and flipping the section would have been much harder.



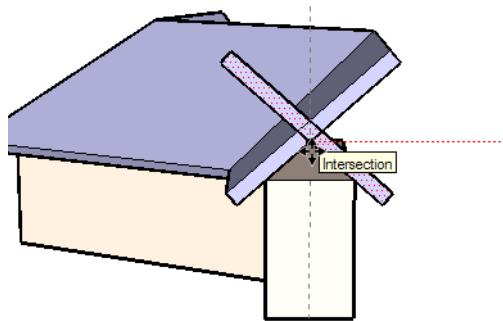
14. Drag one of the side handles toward the opposite side. Stop when the scale factor is -1.0 (or you can enter -1 manually). This flips the section.



15. With the section and construction line still selected, activate **Move**. Drag the objects by the intersection point shown . . .

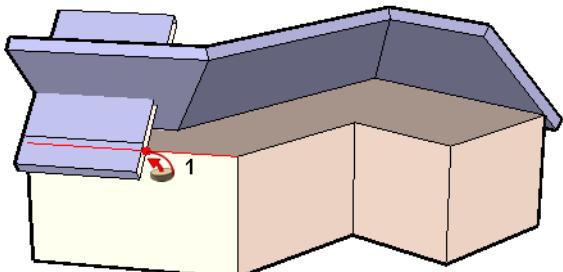


16. . . and place them at the similar intersection point on the original roof section.

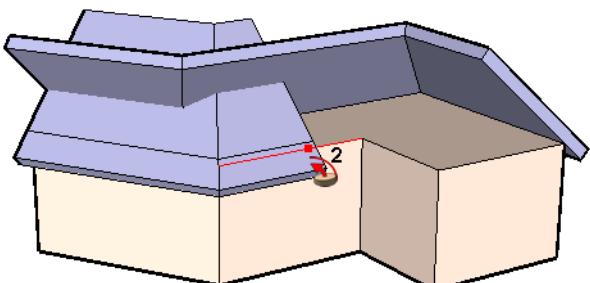


17. Make sure nothing is selected.

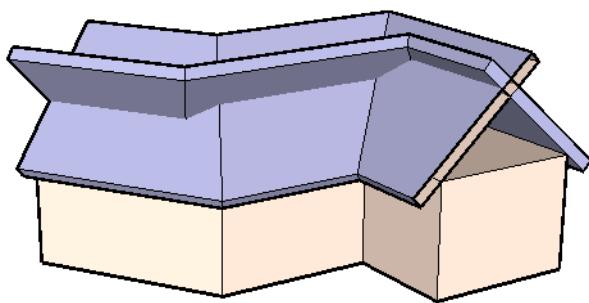
18. Previously we used **Follow Me** by selecting the edges first; this time we will use the tool another way. First, activate **Follow Me** and then select the roof section you just moved. Drag the cursor along Edge 1 - the section follows along.



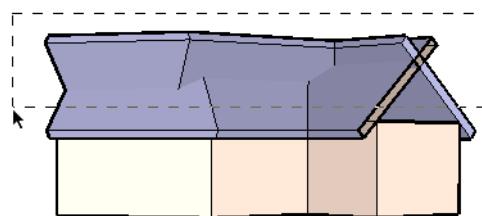
19. Continue along Edge 2 . . .



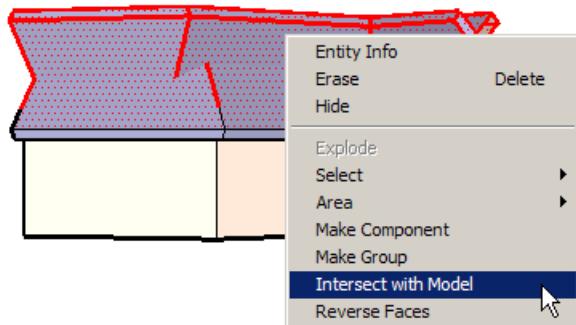
20. . . and along Edge 3.



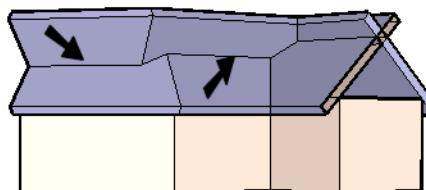
21. The rest should be familiar. Activate **Select**. Use **Front** view and a right-to-left selection window to select all roof faces.



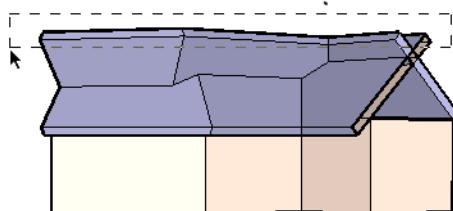
22. Right-click and select **Intersect with Model**.



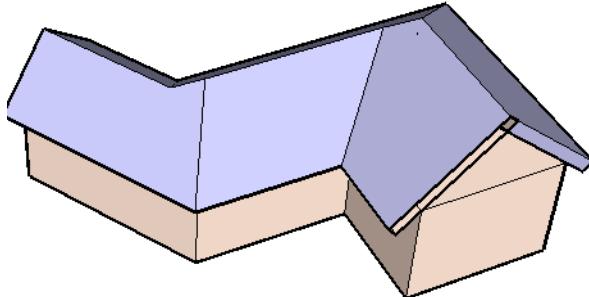
This creates intersection lines where faces meet other faces.



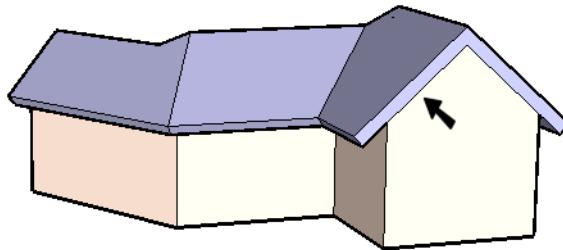
23. To clean up, select all faces above the top ridge line.



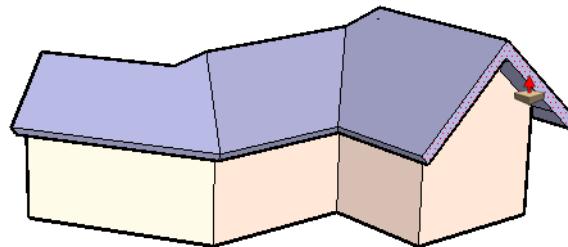
24. Erase everything that's selected, and use **Erase** to do some more cleanup. Check in Wireframe or X-Ray for short, stray edges.



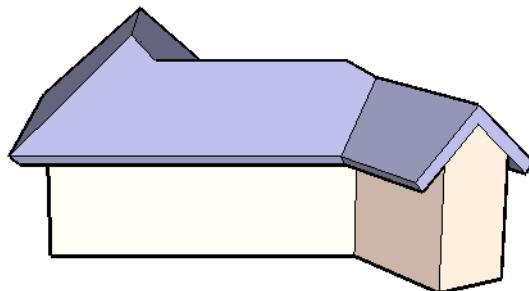
25. The fronts of both wings also need to be cleaned up. Complete both faces using **Line** and **Erase** as needed.



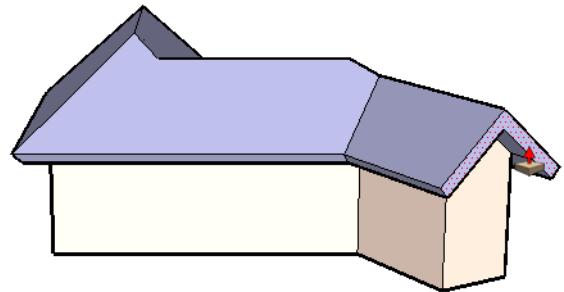
26. Use **Push/Pull** to extend the overhanging roof.



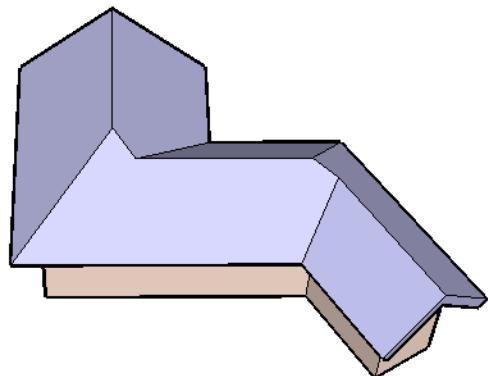
27. Clean up the other face the same way.



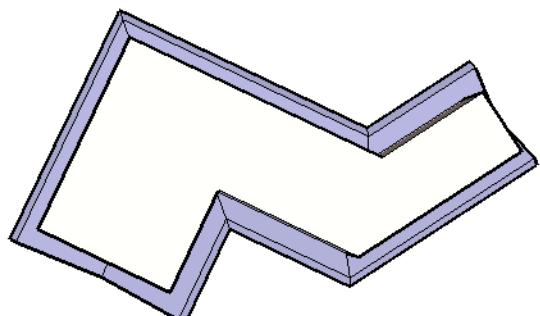
28. Use **Push/Pull** and double-click on the roof face to extend it the same distance as you used for the other face.



The results - all edges on the top are neatly resolved. . .



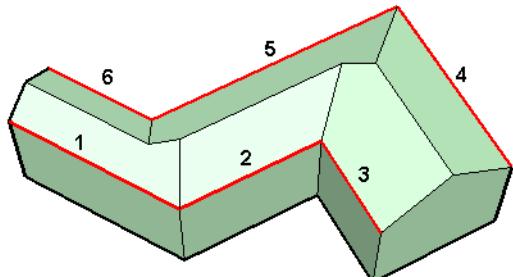
. . . as are the intersections on the underside of the house.



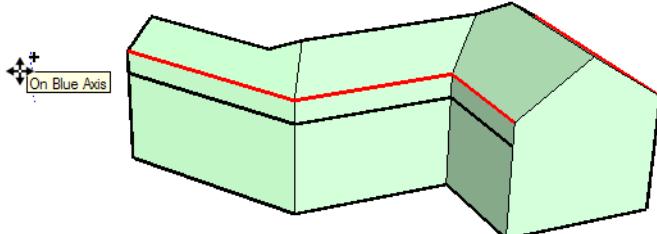
## Overhangs by Moving Faces

Here's an easier and faster way to achieve similar results. This method works when all slopes are uniform.

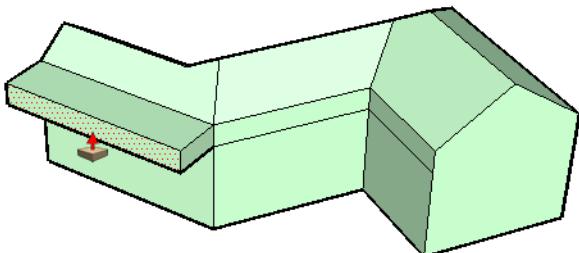
1. Open the saved file **RoofIntersections.skp**. (Or download it from [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm).) Select all six roof edges.



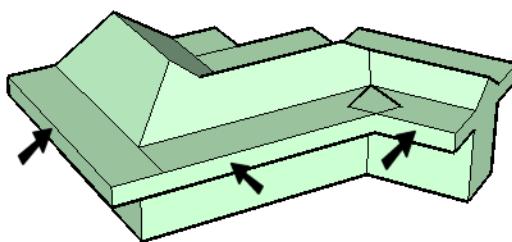
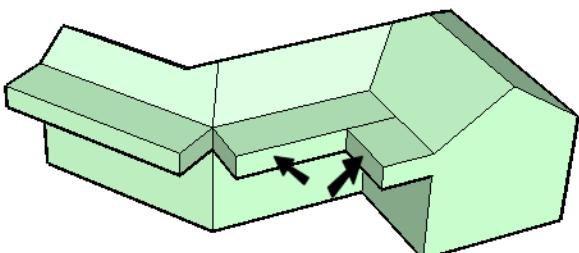
2. Copy the six lines down slightly.



3. Push/Pull one of the new faces outward.

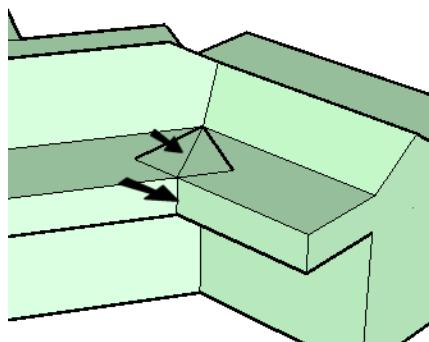


4. In Push/Pull, double-click the other five faces to pull them out the same distance.

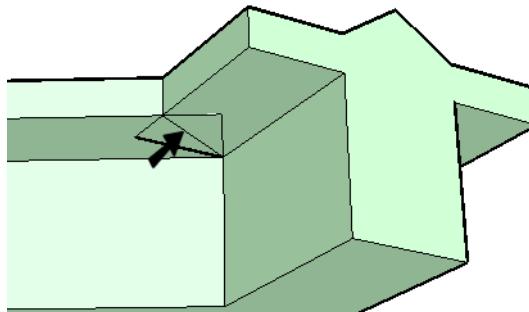


The 90-degree corners don't need to be fixed, but the diagonal ones do. We can either fix the corners now or later, so let's fix one now. Look at the inside corner - the one that overlaps.

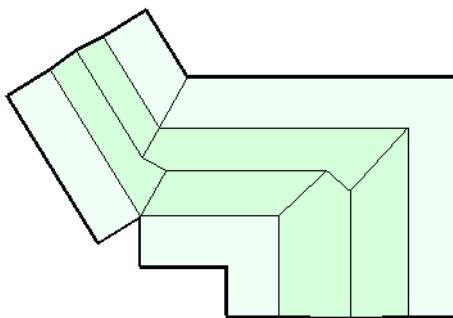
5. Draw two intersection lines on the top . . .



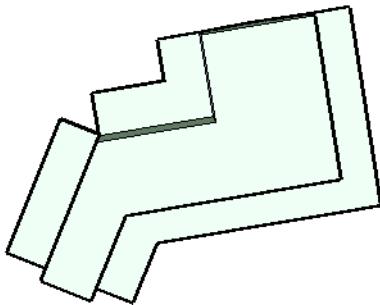
6. . . and one on the underside.



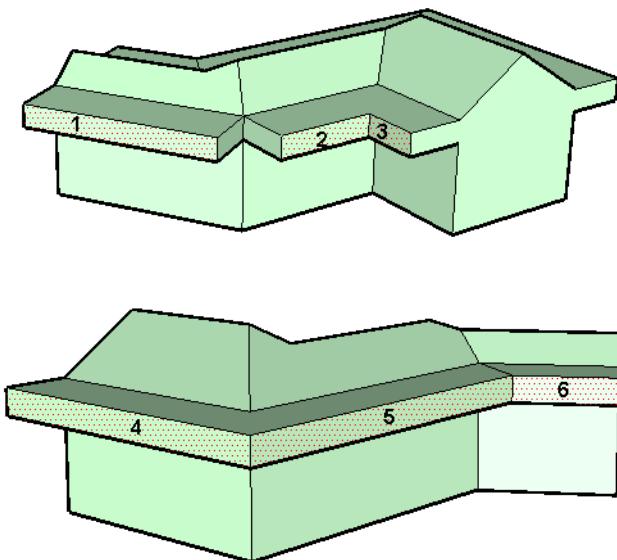
7. Switch to Top view and erase all extra lines. If a face is deleted, redraw one of its edges to recreate it.



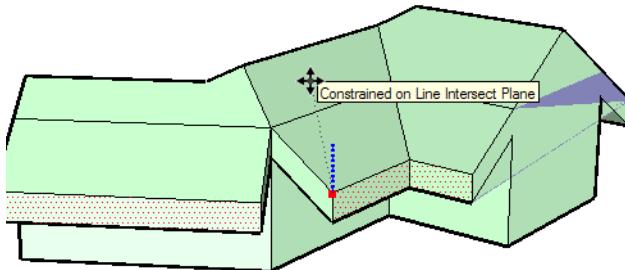
8. Erase extra lines on the underside as well. (Or switch to **X-Ray** mode so that you can see all extra lines without switching views.)



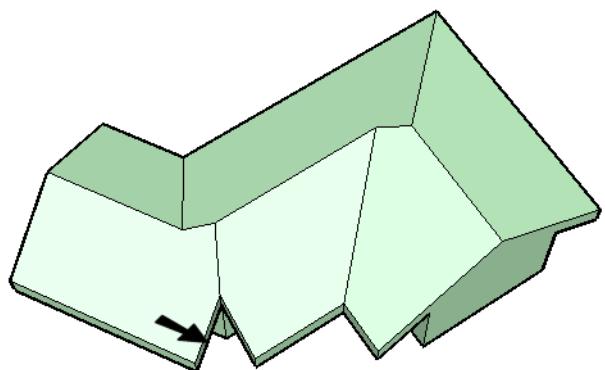
9. Now select the six vertical fascias.



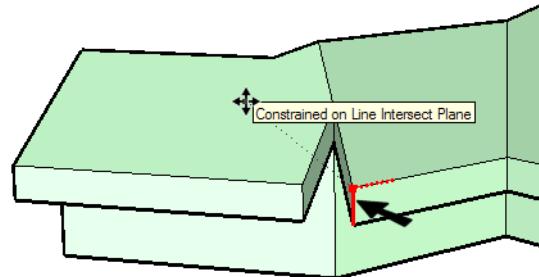
10. Activate **Move**, and click any point along the top edge of one of the fascias. Move the fascias in the blue direction, press Shift to lock them, and constrain them to the slope of the adjacent roof face.



11. Erase the extra lines on the now-continuous roof. There is only one corner left to be fixed

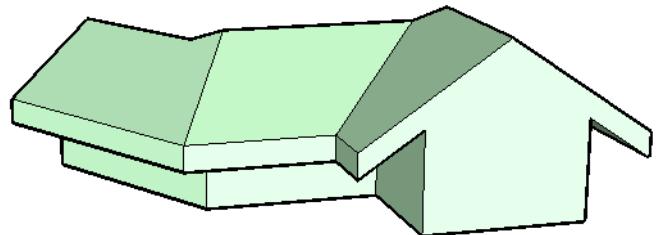


12. Select the edge shown and activate **Move**. Drag any point of this edge along the axis, and press Shift. Then constraint the point to the adjacent roof face.



13. Move the other edge of this corner to meet the corrected edge.

Here's the whole house - fixed corner and all.



You have now created a continuous overhanging roof using a pretty small number of steps. The difference with the result here is that the fascias are all vertical; in the previous exercise the fascias are at right angles to the roof planes.



# 6 Groups and Components

You may have noticed the “stickiness” of SketchUp - faces stick to one another, and objects become embedded in one another. The way to make objects independent from one another is to use groups or components.

## Components Versus Groups

Groups and Components are similar, but it's important to understand the differences between the two.

**Simplicity:** Groups are fast and straightforward to make and use. They don't require you to define a name, insertion point, or adjust special behaviors. (You can use the Outliner to assign a name to a group, but it is not necessary.)

**Instancing:** When you place a component in your model, it creates a definition within the file. All instances of the same component refer to this definition, so editing one component edits all simultaneously. Groups are simply a collection of geometry that acts as one object; multiple copies of groups do not refer to any other source.

**File Size:** Using a component multiple times will not increase your file size, because its reference information is only stored once. Multiple groups, on the other hand, are all unique, so each one adds to the file size.

**NOTE:** Having many **complex** components can slow down performance. See "Replacing Components" on page 231 and "Tips for Efficiency with Components" on page 235.

**Alignment and Hole Cutting:** Both groups and components have options that allow you to align them and 'stick' them to faces. They also have the ability to cut holes in faces (see "Cutting Openings" on page 214). With components, you can control this behavior (see "Alignment and Insertion Point" on page 202), whereas groups work more automatically. Both groups and components store their own set of drawing axes, but components visually display those axes.

**Naming / Referencing:** Components can be named so that you can reference them again from the Component Browser. You can also save a component individually as a standalone SketchUp file. Groups do not appear in the Component Browser, but they are listed in the Outliner.

**Materials:** When you explode either a group or components, any elements inside that object that were assigned the default material take on the material of the group or component. See "Materials of Groups and Components" on page 257.

To sum up:

- Often-used and referenced parts such as windows, doors, trees, etc. are usually best inserted and/or saved as components.
- You can combine groups and components. For example, you can make a window component, make copies of it, then group different arrays of copies together. This is a good way to build efficiency into your model.

## Introduction to Groups

Grouping is easy: select the objects you want to group and do one of the following:

- Select **Edit / Make Group**
- Right-click and select **Make Group**.

To ungroup objects, select the group and then:

- Select **Edit / Group / Explode**
- Right-click and select **Explode**.

Aside from those in this chapter, there are some other exercises scattered throughout this book that use groups. See:

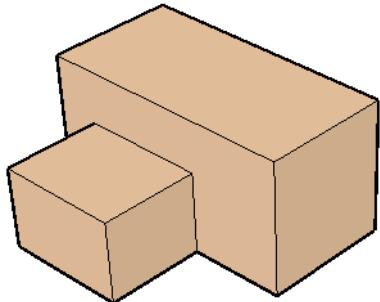
- "Materials of Groups and Components" on page 257
- "Simultaneous Section Cuts" on page 315
- "Using Groups to Separate Materials" on page 259
- "Arch Cutouts Using Groups" on page 109

The following short exercises will get you familiar with the concept of groups, and why they are useful.

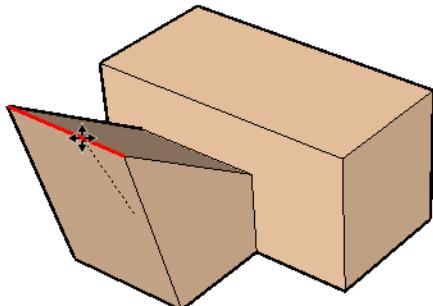
## **Breaking Connected Faces**

When two objects have a common face, that face acts as one face - the objects are both stuck to it. Grouping one or both of the objects breaks this link.

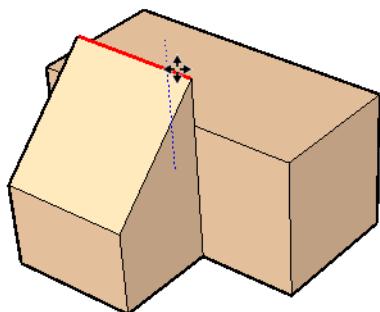
1. Start with two joined forms.



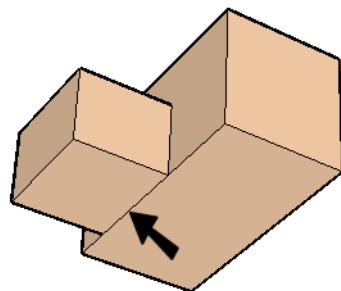
2. A free edge can be moved up or down. (It can only move left or right if you use Autofold.)



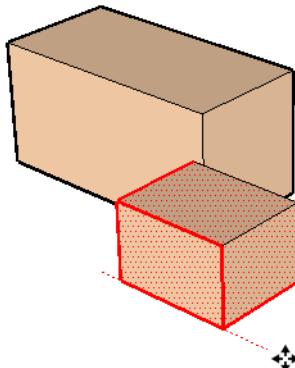
3. An edge along the shared face, however, can only be moved within that face.



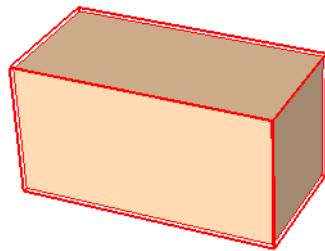
4. To separate the forms, draw the line shown on the bottom face (if it's not already there).



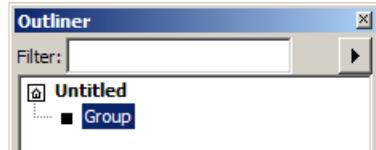
5. If you try moving the smaller form, you are restricted to the common face. You cannot disconnect it from the larger form.



6. Erase the small form, select the large form and group it (select **Edit / Make Group**, right-click and select **Make Group**). A bounding box appears around all selected objects.

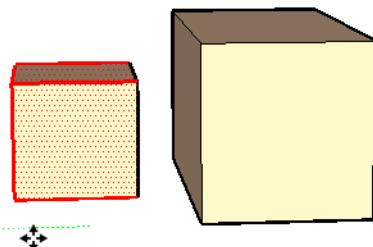
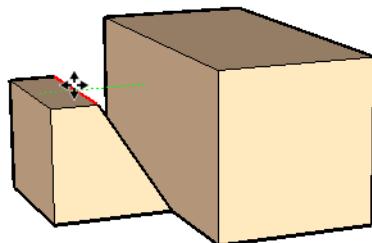


7. Open the Outliner (**Window / Outliner**). The group appears in the list, with the title “Group.” You can right-click on this to **Rename** it. Groups are indicated by a single-square symbol (as opposed to component symbols, which contain four small squares).

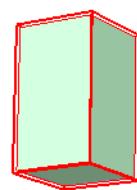


**NOTE:** For more information on the Outliner, see “The Outliner: Manipulating Groups and Components” on page 206.

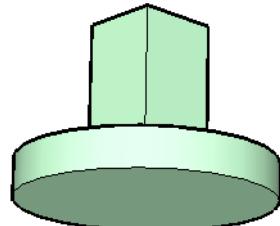
- Now if you create the smaller form along the same common wall, you can move its edges, and the form itself, wherever you want.



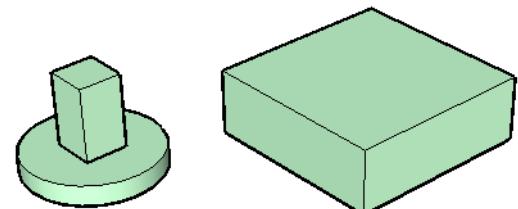
- Erase the base, and group the column.



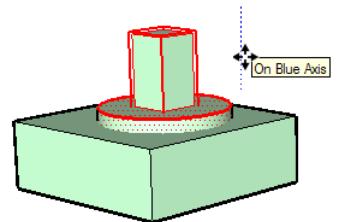
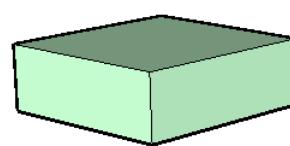
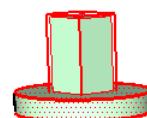
- Now you can create a circular base with one **Push/Pull**. The base does not stick to the column,



- Groups are also useful for embedded objects. Create a rectangular form.

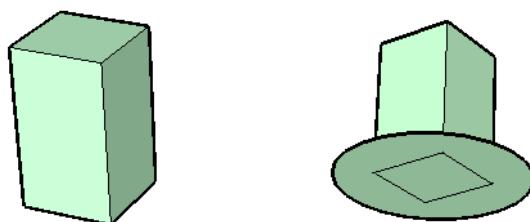


- Move the column and base so that it is slightly embedded into the rectangular form. Because of stickiness between faces, move the column/base up first, then position it over the rectangular box, then move it down into the box. (If you move the base onto the box first, the faces will stick and you won’t be able to move it vertically.)

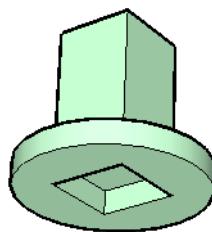


## Disconnecting from Other Objects

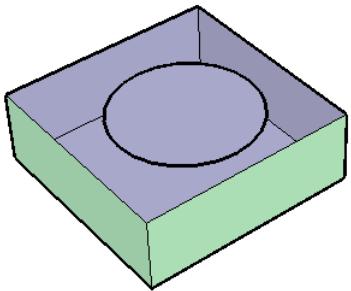
- Start with a rectangular column and draw a circle along the bottom face for a base.



- Push/Pull** the base down. The original circle was automatically divided into two faces by the square, and the square face was not included in the **Push/Pull** operation.



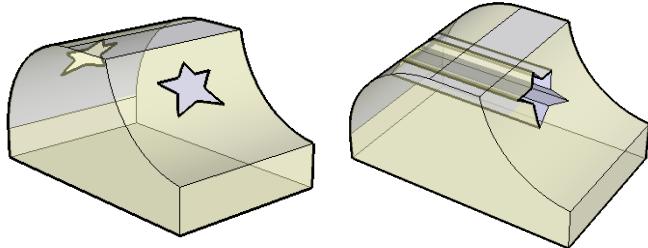
- To erase or move the column and base, select all visible portions and perform the operation. However, if you erase or hide the top rectangular face, you will see that a portion of the base still remains inside.



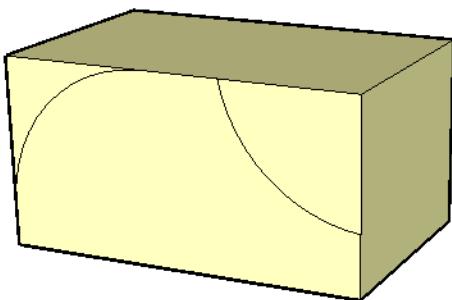
If you had grouped the column and base before embedding it, the whole thing could be selected and manipulated, ensuring that no portions are left out.

## Using Groups for Cutting

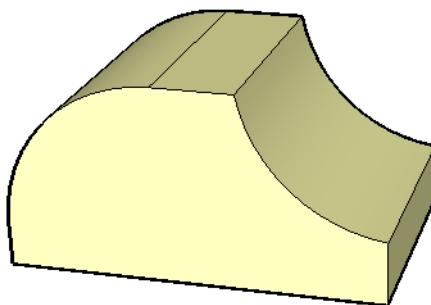
Groups (and components) can be very useful as cutting tools. This is because of their “unsticky” nature - they remain separate from other objects surrounding them.



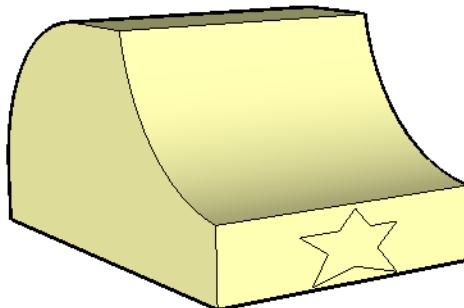
- Start with a box and draw two arcs (one concave and one convex) on one side.



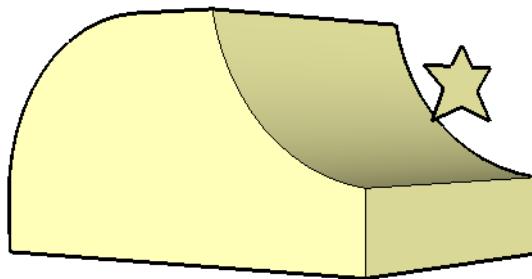
- Push/Pull** the arc faces all the way through.



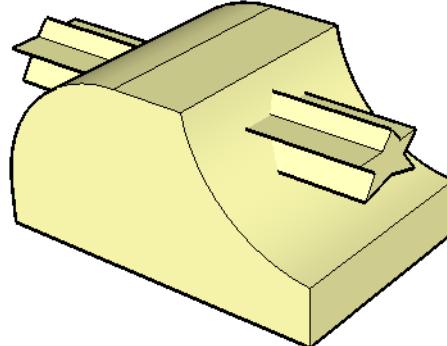
- The cutout will be based on a vertical shape, so draw a closed shape (use lines or arcs as you like) on a vertical face.



- Move the shape straight up so that its projection will be enclosed within the arc faces.

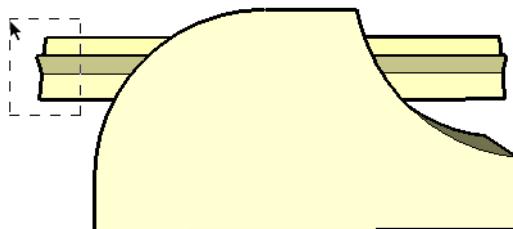


- Push/Pull** the shape so that it goes through the back.

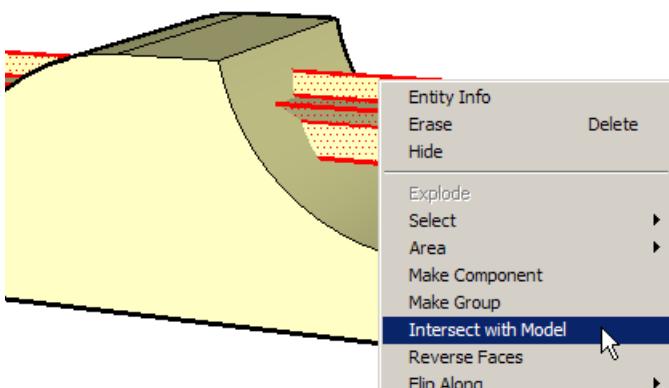


We will do this cutout in two ways: first without grouping, then using a group.

6. Select the cutout shape. The easiest way is to triple-click on one of the cutout faces. Or you can use a right-to-left selection window at one end.

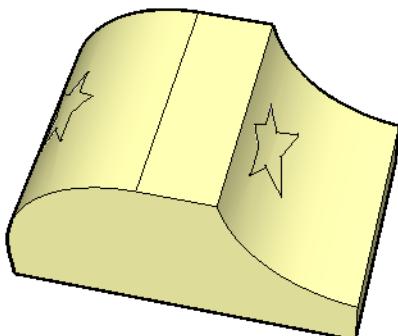


7. Right-click on a selected face and select **Intersect with Model**.

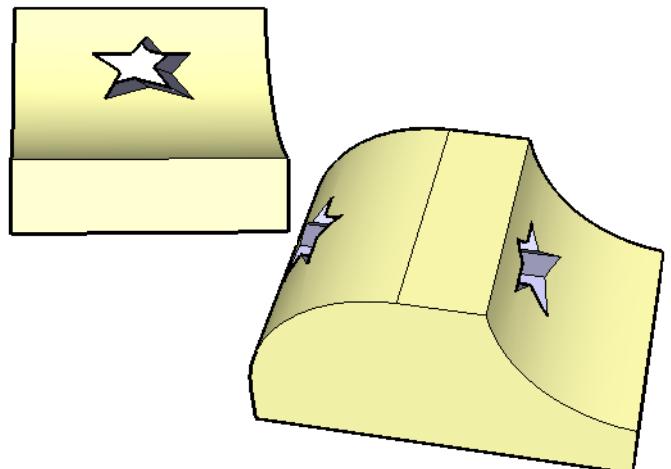


*NOTE: You could also do the intersection on the two faces of the box that intersect the cutout shape.*

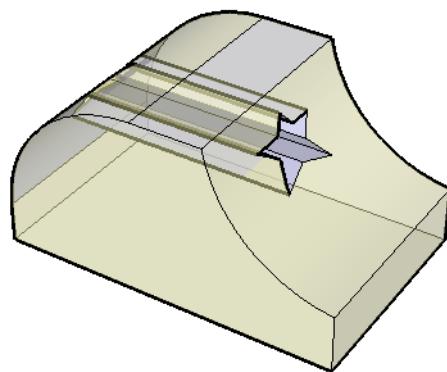
8. Erase the ends of the cutout shape.



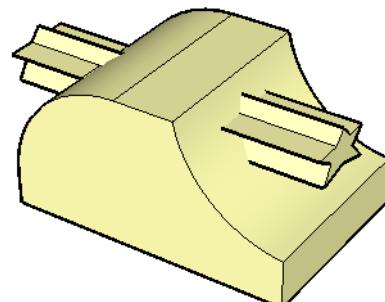
9. Erase the faces that remain on the box. The cutout goes all the way through, and the interior portion of the cutout shape remains in the box, which explains the walls surrounding the hole.



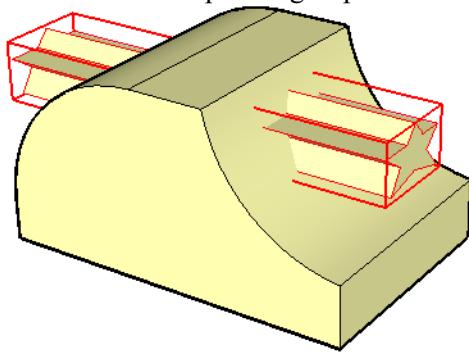
10. Check the results in **X-Ray** mode to easily see these walls.



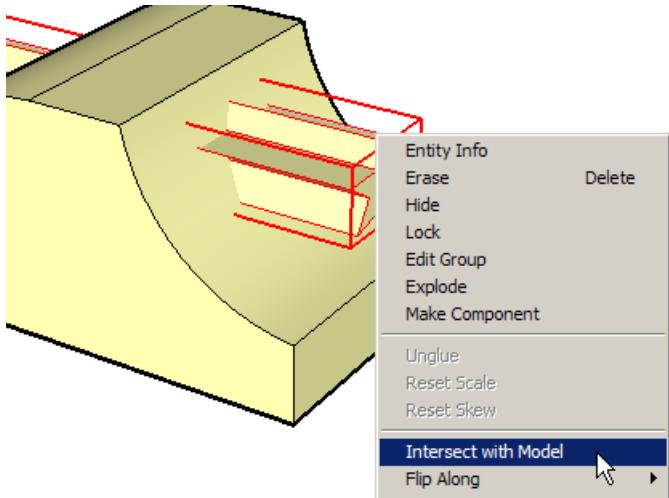
11. **Undo** to return to this point: the cutout shape with no intersecting edges.



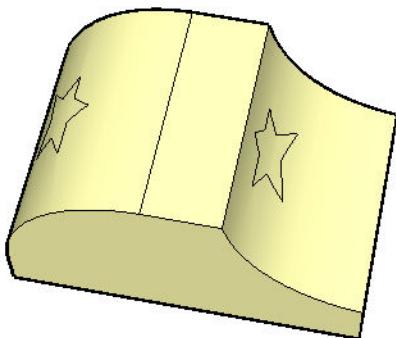
12. Select the cutout shape and group it.



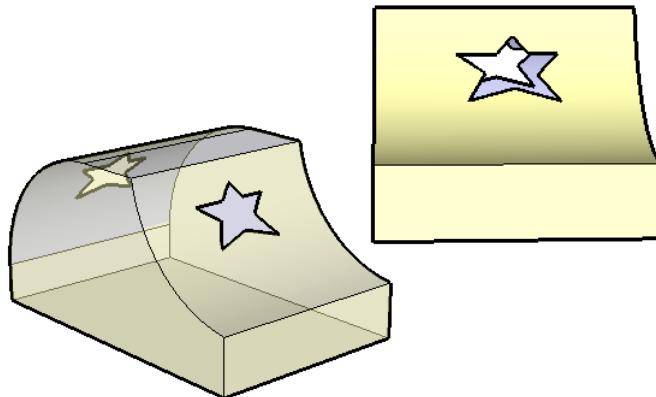
13. Right-click on the group and select **Intersect with Model**.



14. Erase the group, and the intersection edges remain. This looks the same as before.



15. Erase the intersection faces, and you can see that the box faces were cut, but no walls surround the cutout. Because the entire cutout group was erased, no part of it remains.



The lesson: groups are useful as cutting tools because they do not stick to surrounded objects. But if you want a portion of a group to remain inside whatever you are cutting, be sure to explode it before finding its intersecting edges.

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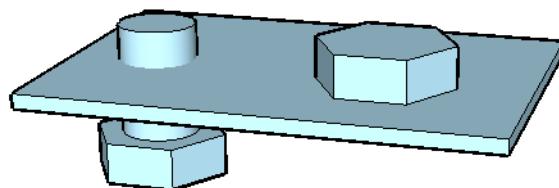
**NOTE:** If you want to use the cutout form again, be sure to make a copy, since the exploded one will no longer exist.

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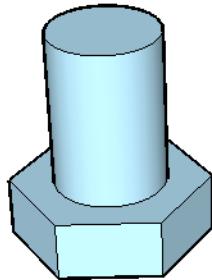
For a similar exercise using groups for cutting, see "Arch Cutouts Using Groups" on page 109.

## Unsticking Objects from a Group

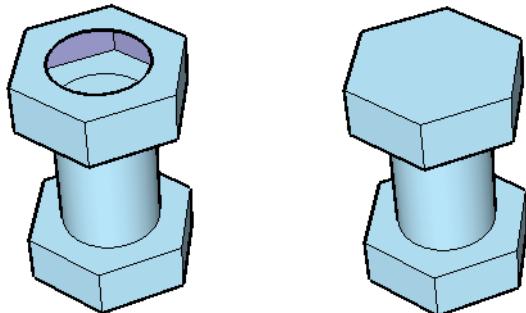
Sometimes you may create a group that you might later want to break. An example of this could be a group of objects from which you want to remove some objects and place them elsewhere, outside the group. Editing a group is straightforward; you know how to delete objects from a group. And a simple cut-and-paste operation enables you to preserve the removed objects and insert them elsewhere.



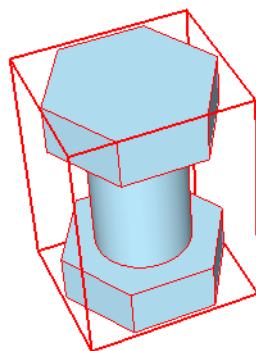
- Start with the following objects: a hexagon pulled to create a nut, and a circle pulled to create a bolt.



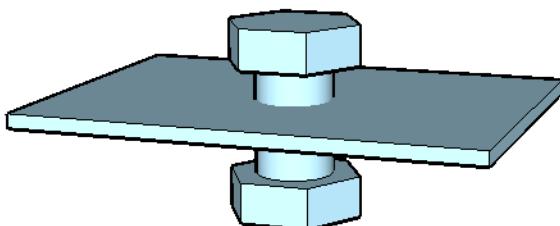
- Copy the nut straight up to the top of the bolt. There will be a cutout on the top face. Erase this cutout to heal the top face.



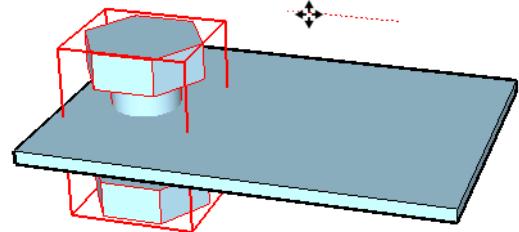
- Select the bolt and nuts and group them.



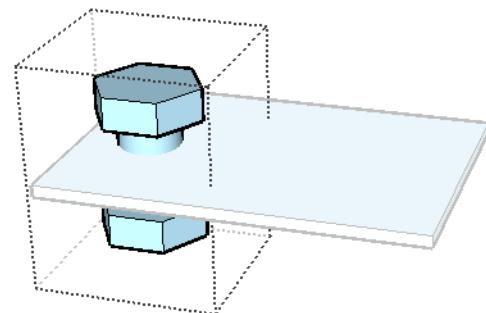
- Now create a thin box that passes through the bolt.



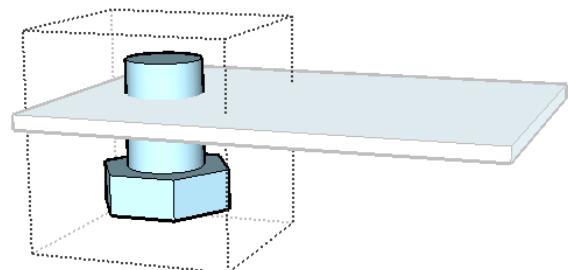
- Move the bolt to one end of the box. Because this is a group, all objects move as one object.



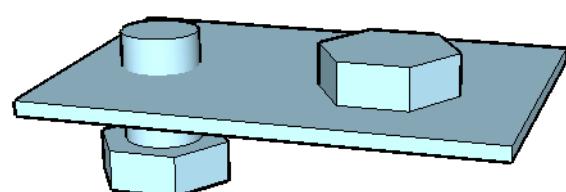
- Say you want to remove one of the nuts from the group and place it somewhere else. Start by editing the group (double-click on it).



- Select all edges of the top nut (be sure not to select the top edge of the bolt) and cut them (*Ctrl/Option+X* or **Edit / Cut**).



- Close the group, and paste (*Ctrl/Option+V* or **Edit / Paste**) the removed nut somewhere else, like to the top of the box.



This is a simplified example, but the method is easy and clear. You can also use this method to copy (not cut) objects from a group, then paste them elsewhere.

The Outliner enables you to easily move objects in and out of groups, as well as components. See “The Outliner: Manipulating Groups and Components” on page 206.

## Introduction to Components

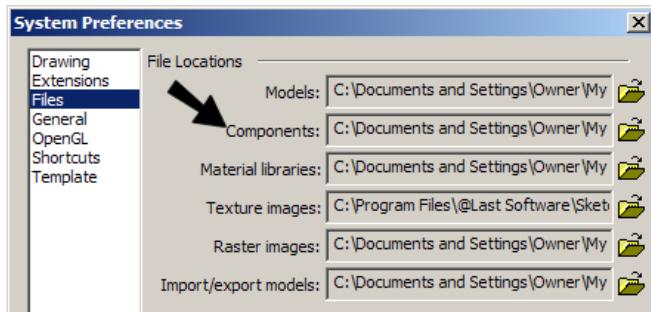
Like a group, a component is a collection of objects that works as one unit. But components can be reused in a file, as well as in other files.

Many components are provided for you (see "Where to Find More Components" on page 193), and you can create your own. Components can either exist only within the file in which they were created (internal), or can be exported for use in other files (external).

### Component Files

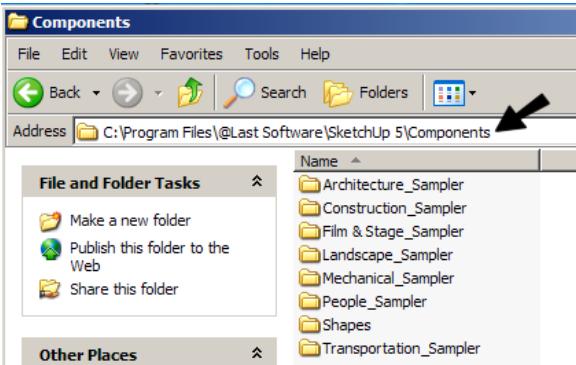
SketchUp comes with many components defined for you. These are simply groups of \*.skp files, grouped into categories. You can also create components and save them into your own folder.

1. In Windows, open the **Preferences (Window / Preferences, Mac: SketchUp / Preferences)** to the **Files** page. The folder you set for **Components** is where component files will be created when you save them.

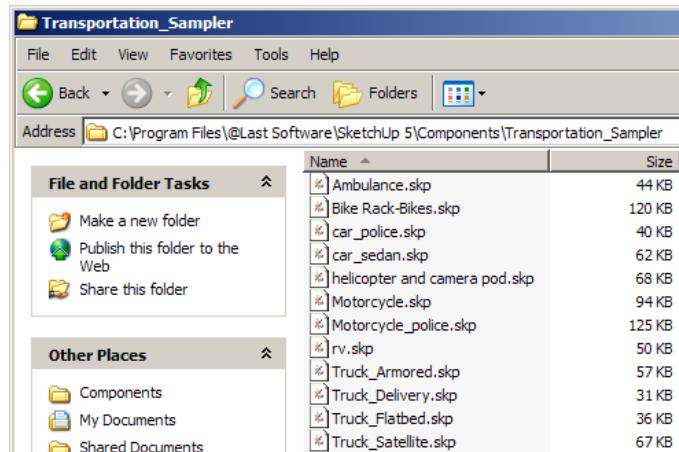


*Mac: To find component files, start in the root directory and go to Library\Application Support\SketchUp\Components. Components are added automatically to this library; or you can add them manually here.*

2. In Windows, for predefined components, use your browser to open the SketchUp5 / Components folder.

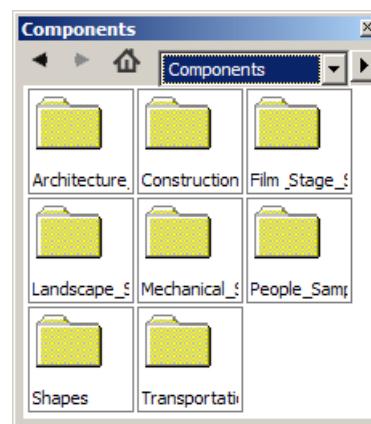


3. Open one of the folders, such as **Transportation\_Sampler**, to see the \*.skp files it contains. Each of these files is a file that can be opened itself within SketchUp, and can be inserted into another file as a component.

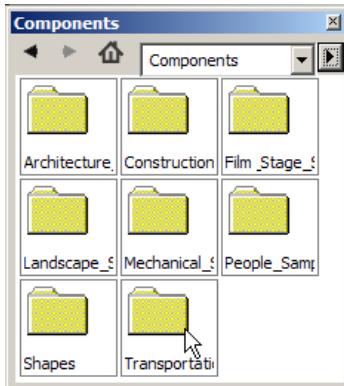


### Component Browser

Open the Component browser (**Window / Components**). The categories reflect the folders in the default Components folder.

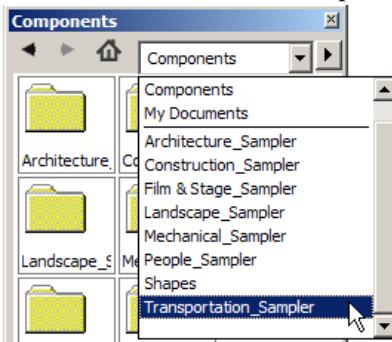


There are a few ways to insert a component. In the Browser, you can access a folder like in any browser - opened by double-clicking.

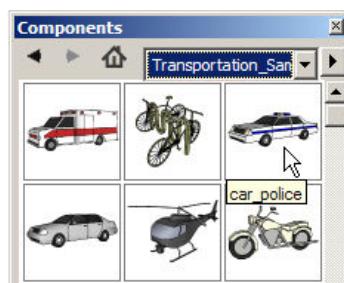


*Mac: This folder structure is only visible if you have clicked the **Component** option in the drop-down menu while in **Icon** view.*

You can also access folders from the drop-down menu.

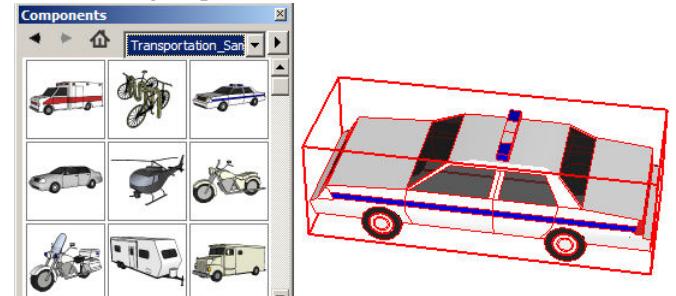


Open a folder to see the components (\*.skp files) it contains. If you hover over a thumbnail you will see the component name.



To insert a component, simply click a thumbnail, then click in the graphic area where you want to place the component. You can also drag a component out of the browser and into the graphic area.

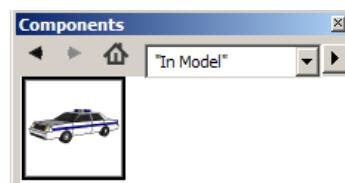
The inserted component has a bounding box around it, similar to a group.



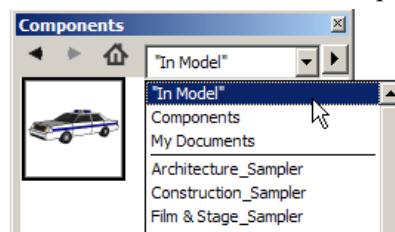
When a component has been placed in your model, it appears in the **In Model** area of the browser. Click the house icon to open this category.



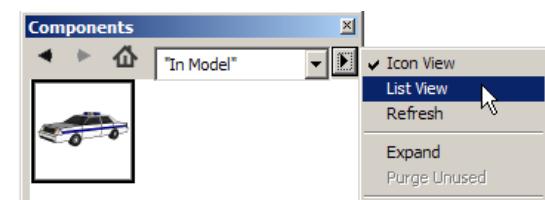
All components currently defined in the file are listed here.



You can also access **In Model** from the dropdown list.



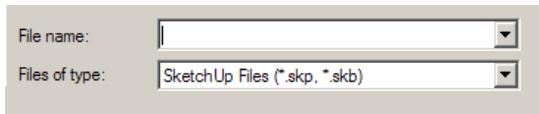
To change the view from thumbnails to a text list, click the arrow to the right of the dropdown menu. Select **List View**.



If you have many components that look similar, the text list may make components easier to locate and insert.



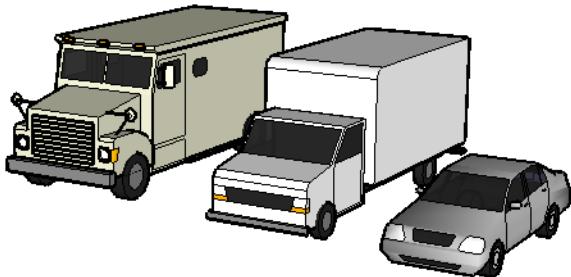
Aside from the predefined components, you can insert a separate file as a component. Use **File / Import / 3D Model**. In the **Open** window, choose the **Files of type** to search for.



## Inserting and Editing Predefined Components

Editing components is a simple procedure. We'll start with predefined components, to save you the trouble of creating your own (for now).

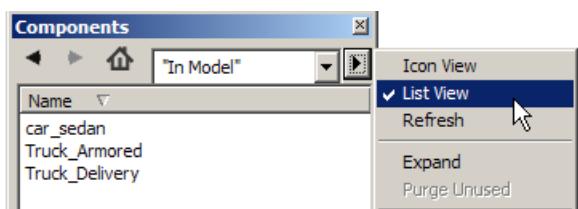
1. Open the Transportation\_Sampler category and insert an armored truck, a delivery truck, and a sedan.



2. Open **In Model**. The three components you inserted will appear here.

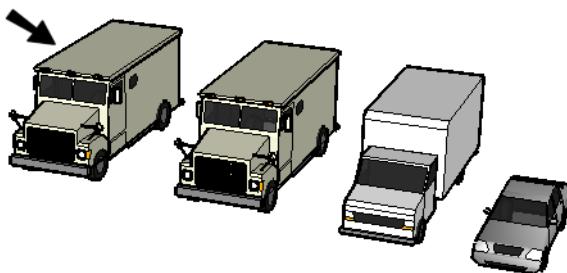


3. Switch to **List View** to see the components listed by name.

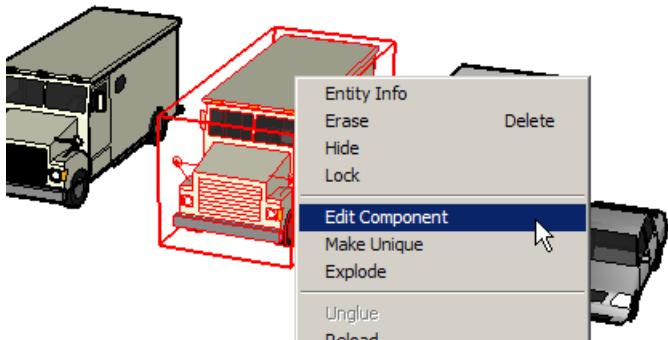


**NOTE:** While Transportation components do not have this property, certain types of components (such as windows and doors) can cut holes in the walls into which they are inserted. For an example of this, see "Alignment and Insertion Point" on page 202.

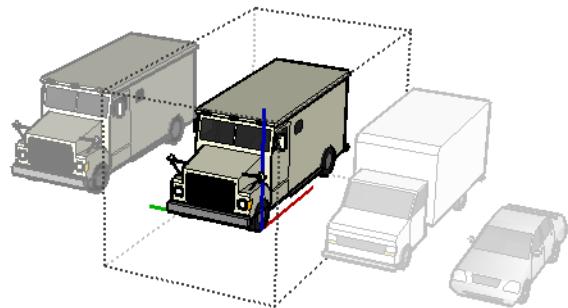
4. Insert another armored truck.



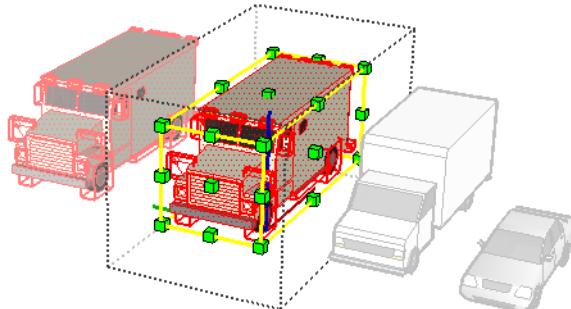
5. Right-click on either truck and select **Edit Component**. You can also activate **Select** and double-click a truck to open it for editing.



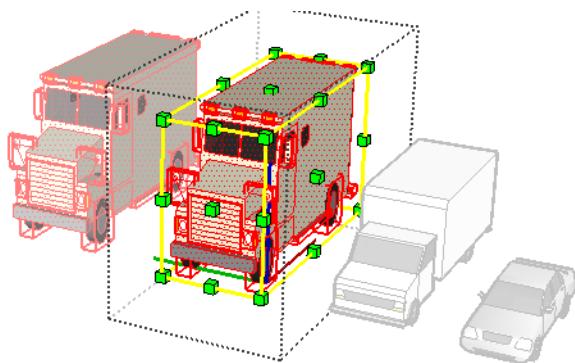
The opened component appears in a bounding box, and the other objects in the model appear faded. This fading can be changed, as we will see in later exercises.



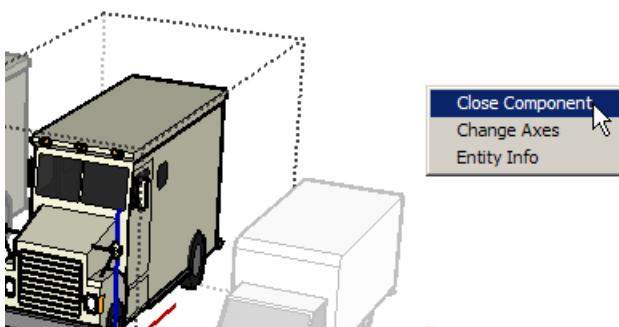
6. One thing we can easily change about this truck is its size. Select the entire truck (you can only select objects within the component, so select everything). Note that the other truck component is also selected. Then activate **Scale**.



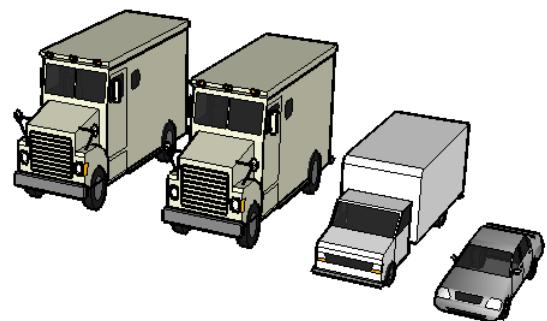
7. Drag the center top scale handle to make the truck taller. Note that the other truck updates the same way - this is the essence of components: change one and you change them all.



8. Right-click outside the component and select **Close Component**. You can also click anywhere outside the component (while in **Select** mode) to close it.

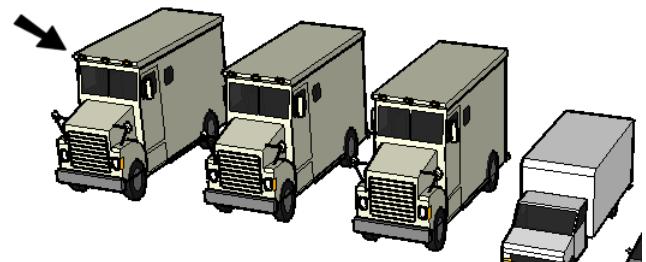


Now both trucks are taller.

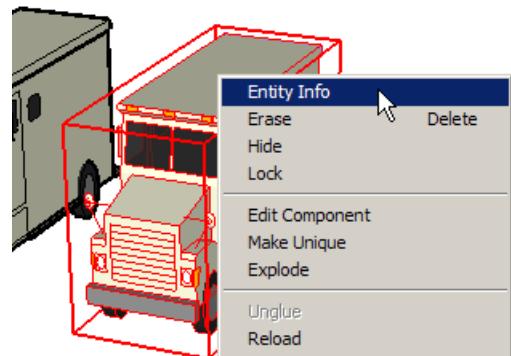


This is an important point: you did **not** change the original component you took from the **Transportation\_Sampler** category. You only changed the definition of the component in your model.

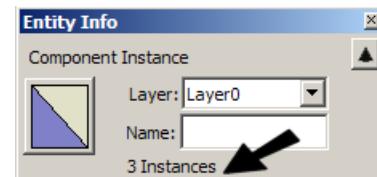
9. Insert another armored truck from **In Model** (not **Transportation\_Sampler**). It should be the same size as the existing ones.



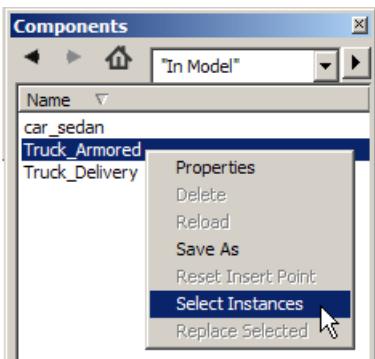
10. Right-click on any truck and select **Entity Info**.



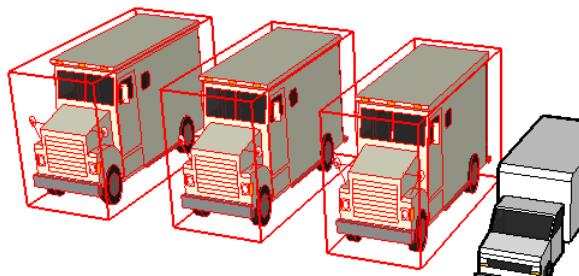
This tells you that there are three instances.



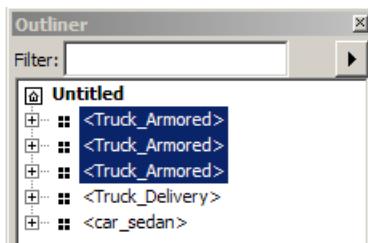
11. In the Component Browser, right-click on Truck\_Armored and select **Select Instances**.



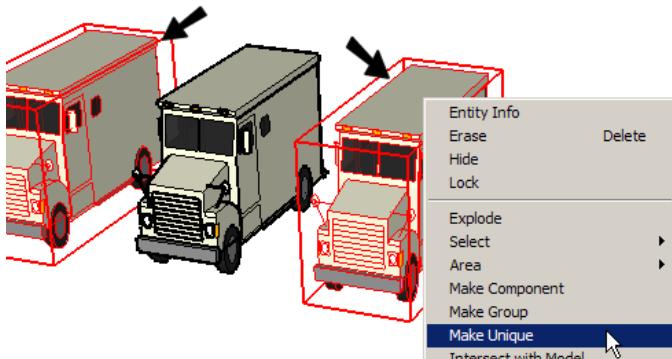
Now all three armored trucks are selected.



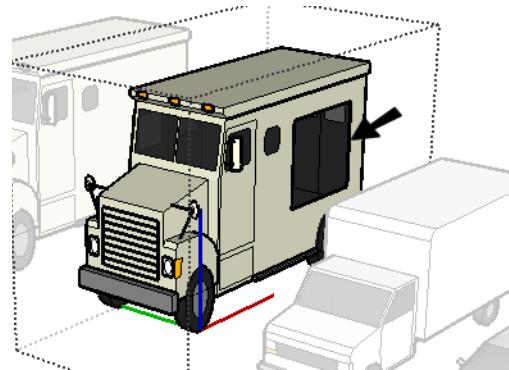
12. Open the Outliner (**Window / Outliner**). This outline shows all components and groups defined in the file, including sub-components (also called nested components). Collapse the list if necessary, and the three trucks are highlighted as selected. The other two vehicles are listed here as well



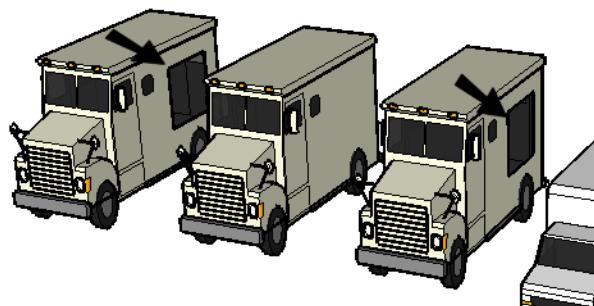
13. You can also change one or more component into a new component. Select two of the components, right-click and select **Make Unique**.



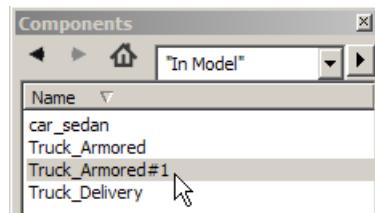
14. Edit one of these trucks and perform some change like adding a window on the back.



15. Close the component. Only the edited trucks were changed.

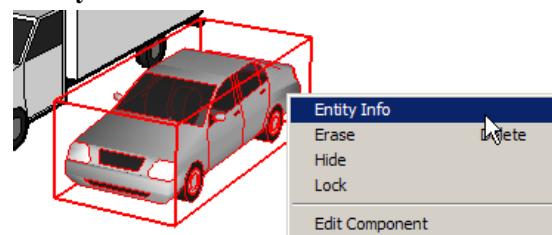


16. Under **In Model** you can see that a new component was added. Truck\_Armored#1 is the one you just modified.

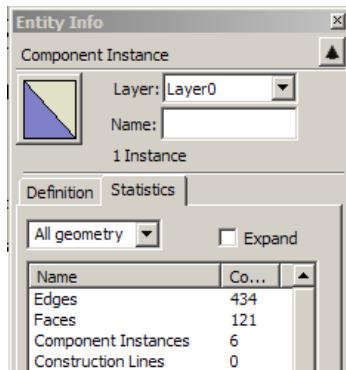


You can change this name by right-clicking on the component in the browser and select **Properties** (Windows only), or via the component's **Entity Info**.

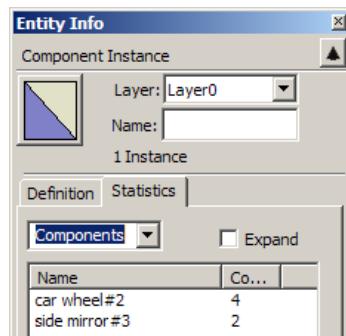
17. Now for the sedan. Right-click on it and select **Entity Info**.



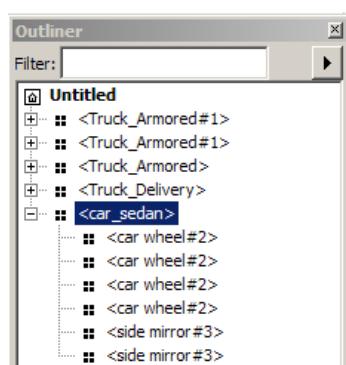
18. Open the **Statistics** tab. (If needed, use the arrow icon at the top of the window to expand the window.) When set to **All geometry**, you can see a compilation of the edges, face, and other objects included in the sedan.



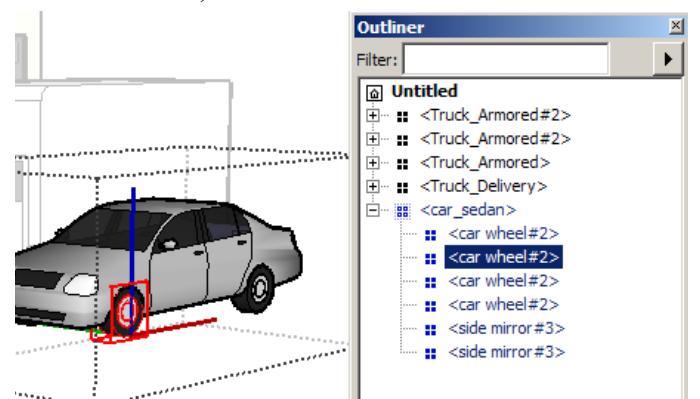
19. Switch to **Components** in the drop-down menu to see all nested components. These include four car wheels and two side mirrors.



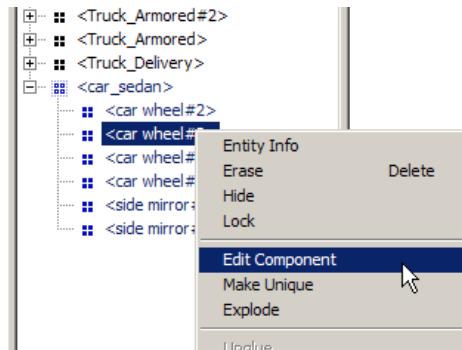
20. Open the Outliner (Window / Outliner). Open the sedan to expand it, and you can see the same nested components listed.



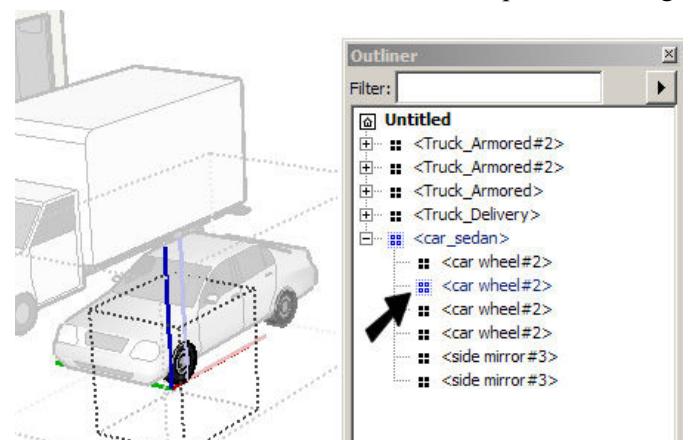
21. In the Outliner, highlight the wheel sub-components one at a time. You can see each one appear as selected on the sedan, and the sedan itself is in **Edit** mode - the sedan must be edited for the wheels to be accessible. (You can Shift-select or Ctrl/Option-select in the Outliner to select more than one wheel.)



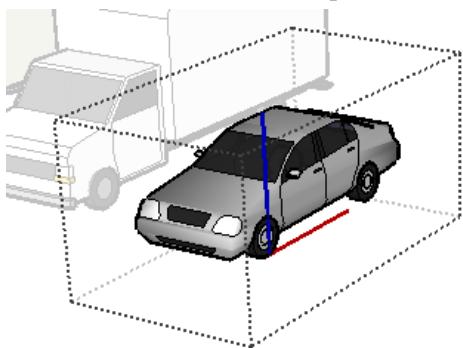
22. In the Outliner, right-click one of the wheels to edit it - this is the same as double-clicking on the wheel itself.



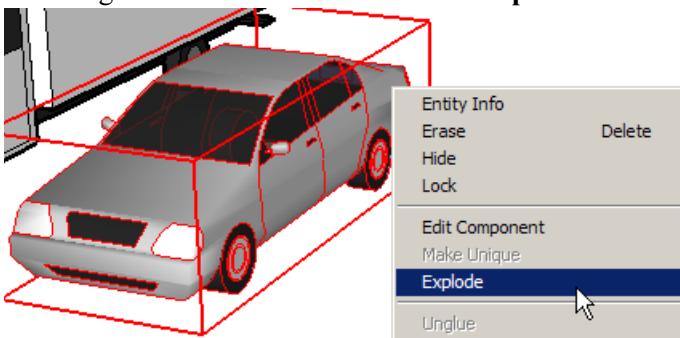
The wheel is open for editing, and you can still see a faint bounding box around the sedan as well. This is how you can tell that the wheel is nested within the sedan component. Also, the wheel's icon in the Outliner indicates that the wheel is open for editing.



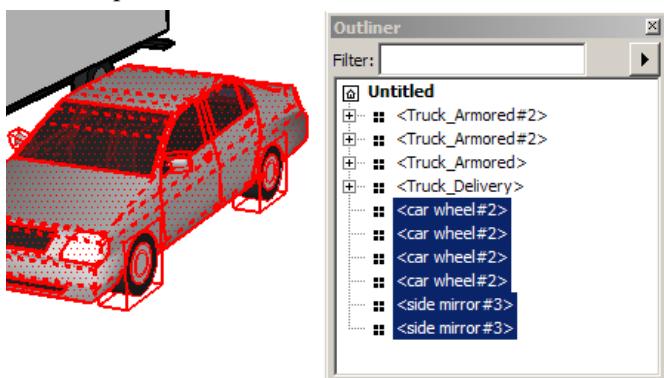
23. In **Select** mode, click once outside the wheel. You are now back inside the sedan component.



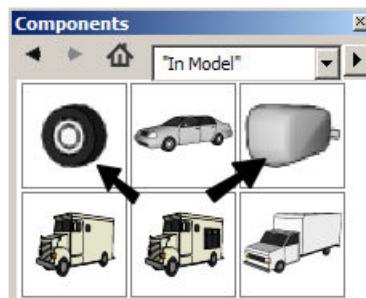
24. Click outside once more to close the sedan for editing.  
25. Another way to edit a component is to explode it. Right-click on the sedan and click **Explode**.



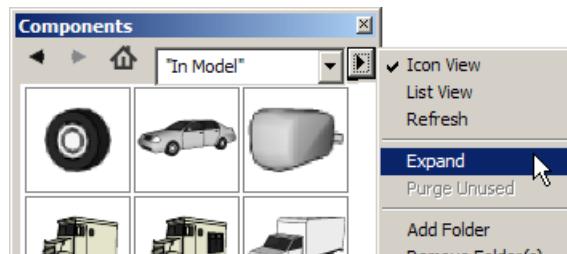
26. Now this vehicle is no longer grouped, and does not act as one individual object. Its sub-components are still intact, but now they appear as first-level components in the Outliner.



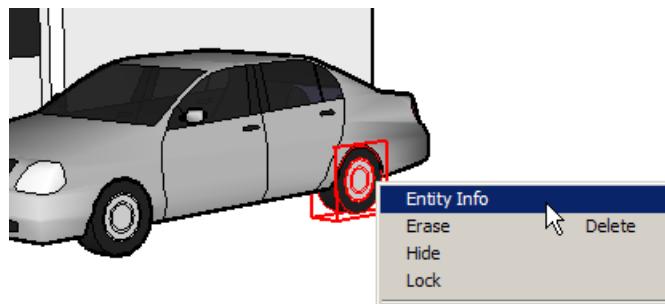
27. Now that the sedan was exploded, its wheel and side mirror components now appear on the list of components in your model.



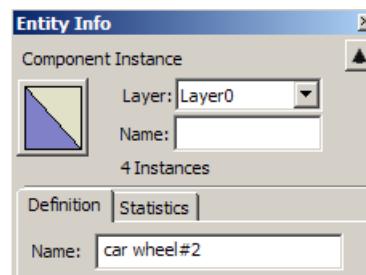
**TIP:** You can display nested components in the browser, without exploding their parent component first, by clicking on the right-facing arrow and selecting **Expand**.



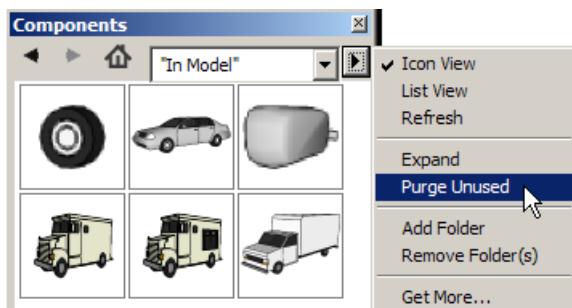
28. Right-click on one of the wheels and select **Entity Info**.



As before, you can see the component name and number of its instances.

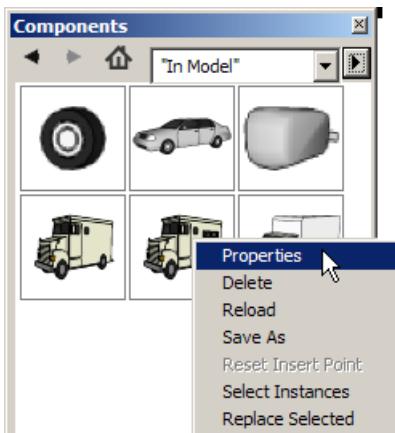


29. Even though the sedan was exploded and no longer exists in the model as a component, it still appears in **In Model**. To delete it, click on the arrow at the top of the browser and select **Purge Unused**.

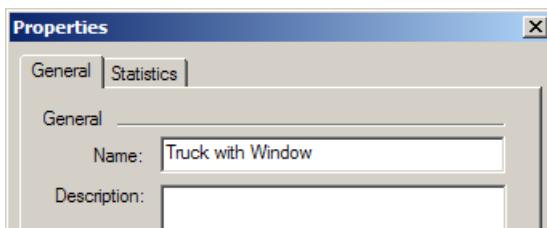


**NOTE:** To purge all unused components, materials, and layers, open **Model Info** to the **Statistics** page and click **Purge unused**.

30. Lastly, we can rename the component of the armored truck with the window. In Windows, right-click on it and select **Properties**.



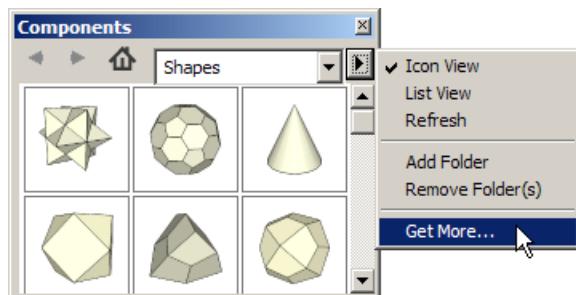
31. Use this window to assign a new name.



*Mac: The **Properties** option does not work as of this writing, but you can change a component's name using the **Entity Info** window.*

## Where to Find More Components

For a wealth of components, click on the arrow at the top of the Component Browser and select **More**.



This opens SketchUp's component download page. These are free, and download / installation instructions are listed here. This page can also be accessed from the main page ([www.sketchup.com](http://www.sketchup.com)) under "Downloads."

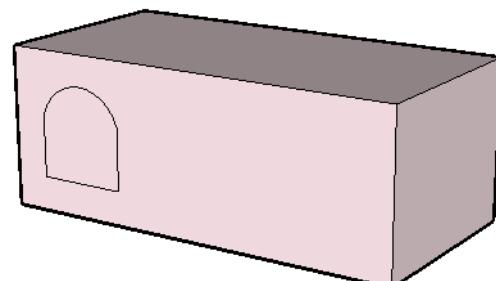
SketchUp's "Partners" page also has a list of sites where components can be found. On the main company page ([www.sketchup.com](http://www.sketchup.com)), click "Company" at the top. Then click "Partners" just below the main bar at the top. Try the links listed under "Product Resources." Some of these components are free, some are by subscription, some are a la carte.

You can also try [www.sketchup.com/forum](http://www.sketchup.com/forum) (located in the **Support** section of the main website) and click **Materials/Components**. These are objects created by SketchUp users who have generously posted them for public use. You can search for something specific or post a request to see if someone might have what you're looking for.

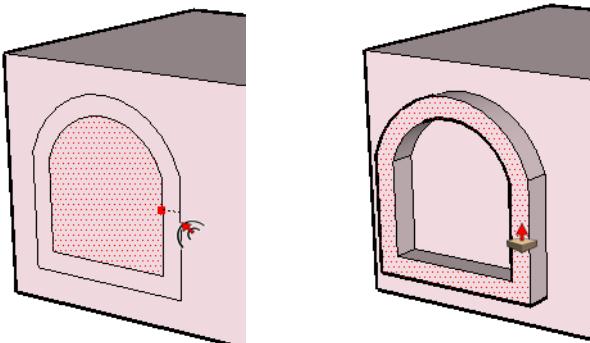
## Creating and Saving Components in the Library

This exercise creates a window component. After it is created, it can then be saved as its own file to be used in the future as a component.

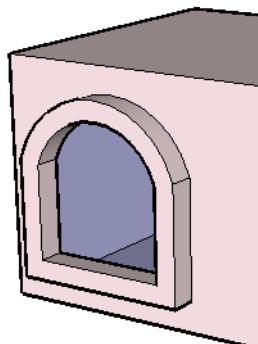
1. Start with a long box. On the front face use **Line** (or **Rectangle**) and **Arc** to draw the outline of an arched window.



2. Use **Offset** to create the window frame. Then **Push/Pull** the frame outward slightly.



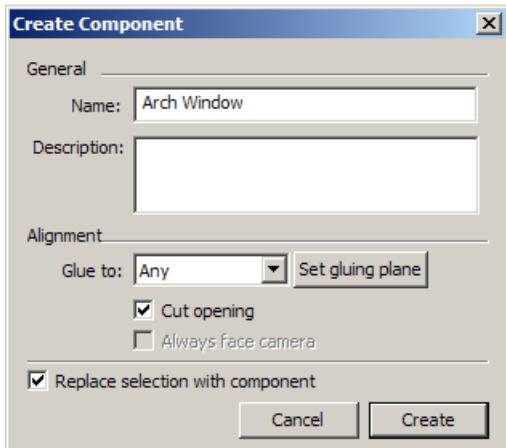
3. Finally, erase the window face. The window cuts out an opening on the front face.



4. Select all elements of the window, and select **Edit / Make Component**. (You can also right-click on selected objects and select **Make Component**. Or you can click the **Make Component** icon. Mac: This icon is available when you customize your UI. See "Toolbars / Tool Palettes" on page 454.)



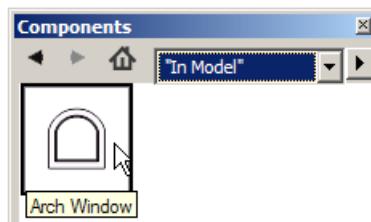
5. Assign a name like **Arch Window**, and make sure **Cut Opening** is checked so that future instances of the component will also make cutouts.



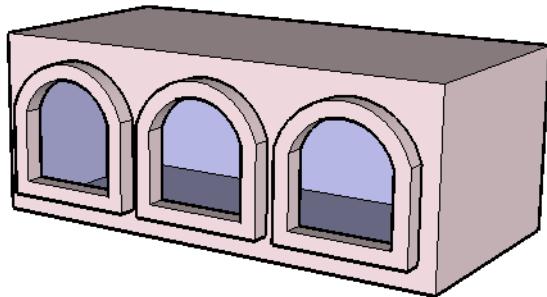
**NOTE:** If you right-click a group and select **Make Component**, this assigns an automatic name (Group#1) to the component. You can then change the name in the component's **Properties** (Windows only) or **Entity Info**.

**NOTE:** If the component is capable of cutting a hole in the face, then **Cut Opening** will automatically be checked. If the component cannot cut a hole, as in the case of a double-faced wall, this box will be grayed out. See "Cutting Openings" on page 214.

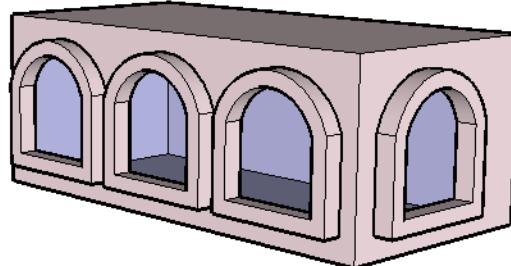
The component should now appear in **In Model**.



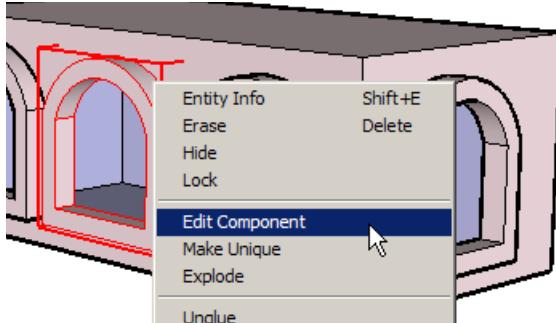
6. To use this component to create more windows, click (or drag) the component from **In Model** and place another window onto the front face of the box. You can also use **Move + Ctrl/Option** to copy the existing window.



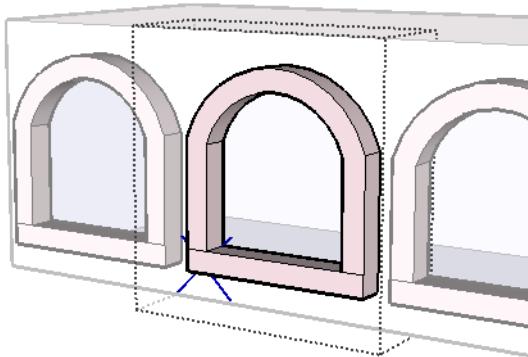
7. Drag another window component to the side face, which automatically aligns to this face and cuts an opening.



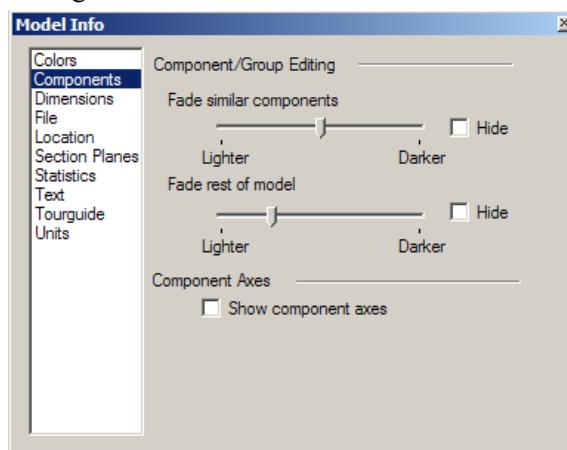
8. To change the component, right-click on any of the windows and select **Edit Component**. (Or double-click the component while in **Select** mode).



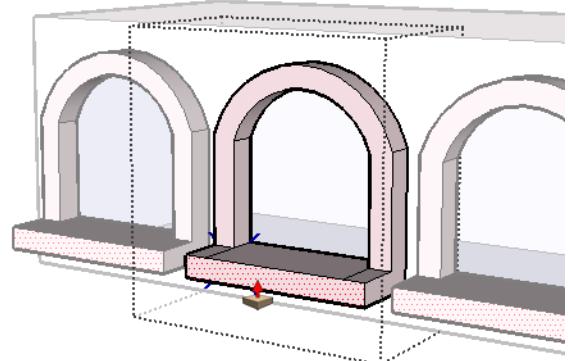
The selected window appears in a dotted box, and everything else appears faded.



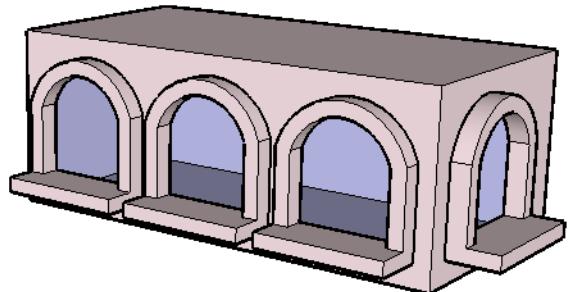
You can control the fading of the rest of the model, as well as similar components, in the **Components** page of **Model Info**. You can check **Hide** to eliminate other objects from the display during editing, or use the **Fade** slider to control the degree of fading.



9. Create a window sill by first adding lines to create the bottom face, then **Push/Pull**'ing it out. All windows have the same change.

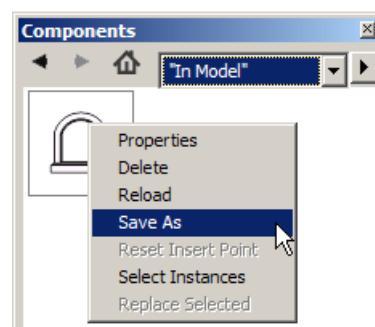


10. Right-click and select **Close Component**, or in **Select** mode click anywhere outside the component.

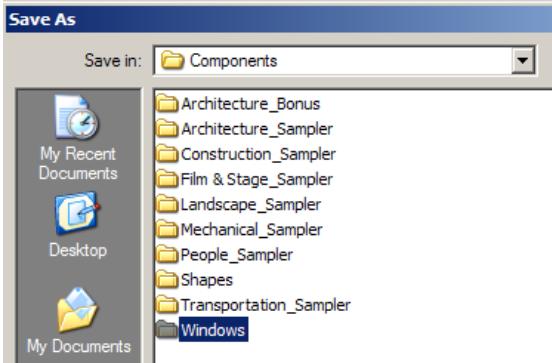


The component is defined only for this file; at this point you cannot use it in other files. To do this, the component must be saved as its own \*.skp file.

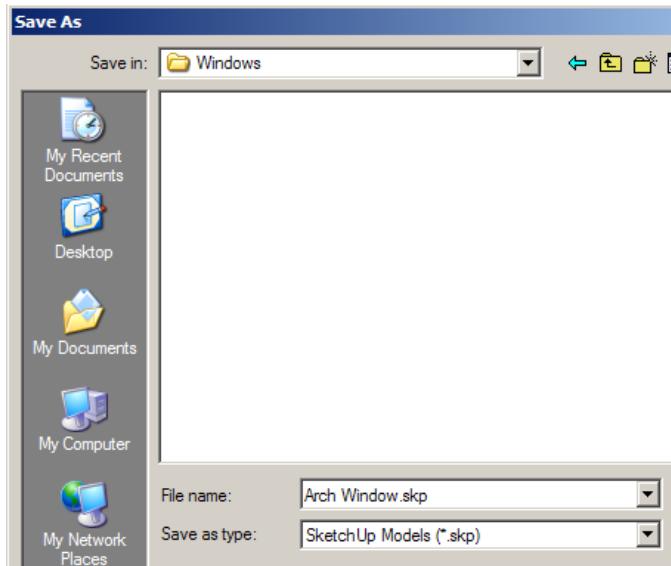
11. Right-click on any of the windows, or on the component in **In Model**. Select **Save As**.



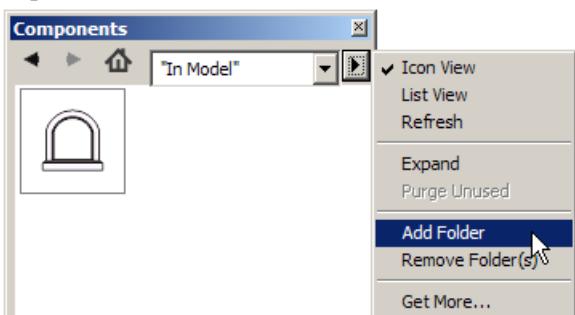
12. Browse to where the predefined components are kept (Program Files\@Last Software\SketchUp5\Components (Mac: Library\Application Support\SketchUp\Components)). Create a new folder here called “Windows.”



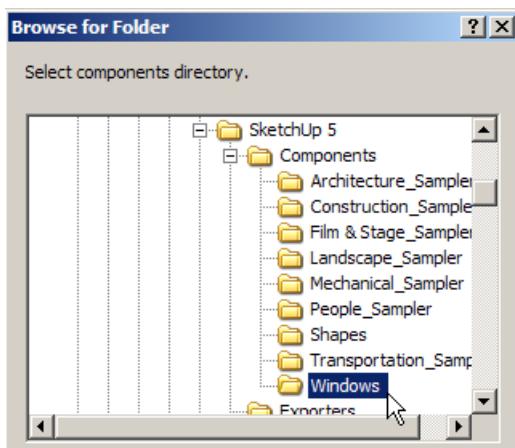
13. Place the Arch Window file in this new folder.



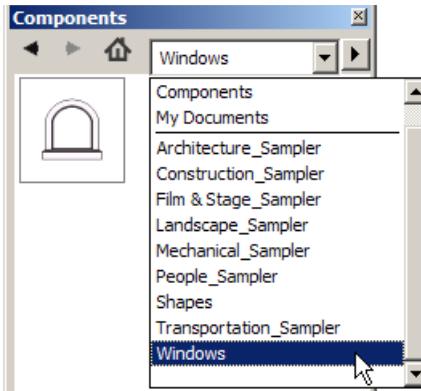
14. For this new folder to appear in the drop-down list of component folders, click on the small arrow at the top of the browser and select **Add Folder**.



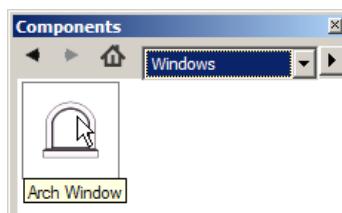
15. Locate the new “Windows” folder.



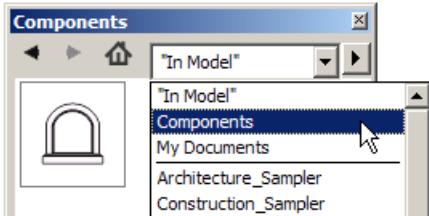
16. Back in the Component Browser, “Windows” now appears in the drop-down list. Select the folder to open it.



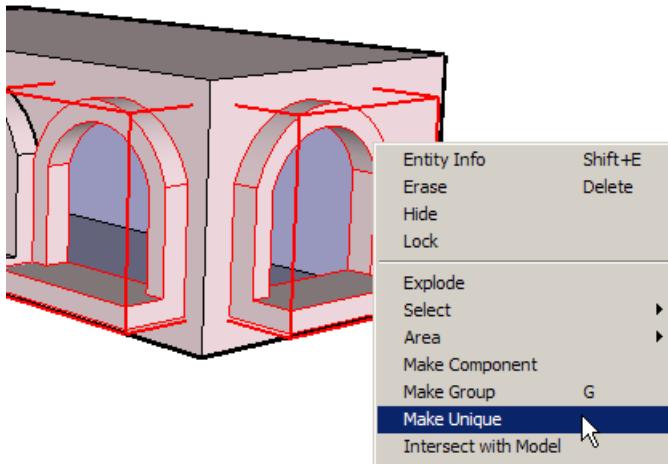
The new component appears here, and can be accessed in future files.



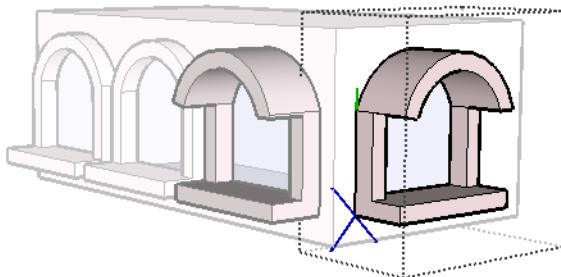
**NOTE:** If you did not want to use **Add Folder**, you could simply select **Components** from the drop-down list. Then “Windows” would appear as a sub-folder of Components, along with all other folders defined within Components.



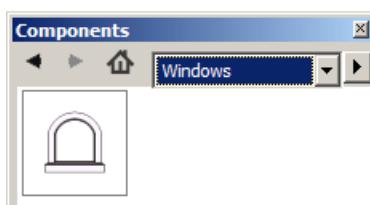
17. Now select two of the windows, right-click on one of them, and select **Make Unique**.



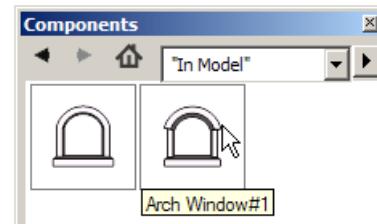
18. Edit either one of these, and make a new change.



19. This new component does not appear in the “Windows” folder, since you didn’t save it into that folder.



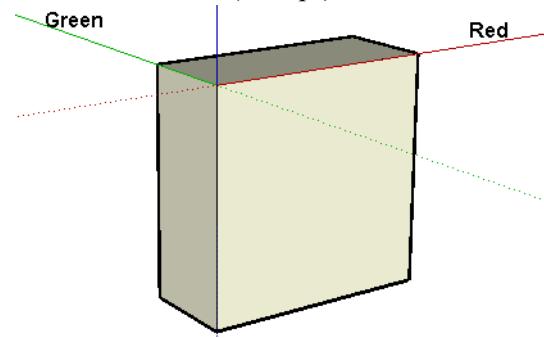
20. Open **In Model**. The new component does appear here, with a new name. To save it into “Windows” you would have to go through the same **Save As** procedure you used before.



## Component Source Files and Reloading

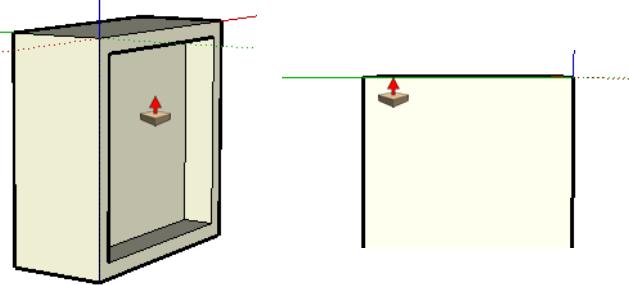
This exercise will show you how to create a component in its own file, insert it and manipulate it in another file, and make changes to the component in its original file.

- We will first make a bookcase component. In a new file, draw a rectangle starting at the origin, and **Push/Pull** it down (not up!).

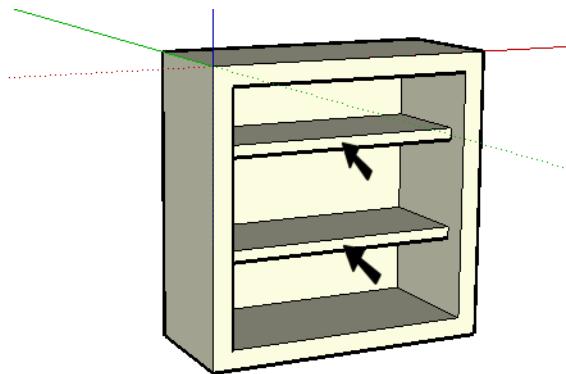


**NOTE:** The reason for starting at the origin is this: when you save objects as a component, the default component insertion point is based on the origin of the sketch axes. The insertion point can be changed, however, as you will see.

- Offset the front face inward and **Push/Pull** it almost to the back (not all the way through). To stop before hitting the back, you can view the bookcase from the side and move along the top edge, stopping close to the endpoint.



- Make two narrow rectangles on the back face and pull them forward to create the shelves.



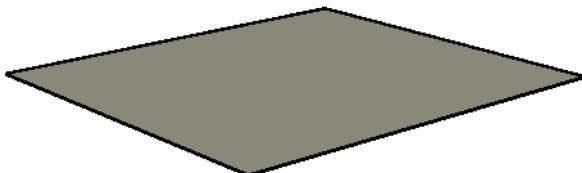
- Save this file as **bookcase.skp** in whatever folder you choose.

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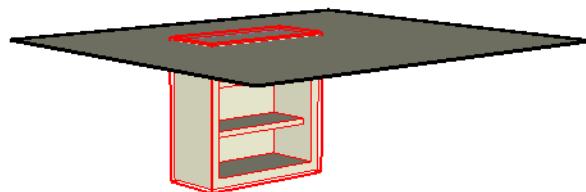
**NOTE:** Open **Window / Preferences** to the **Files** page to see the default components where components are placed.

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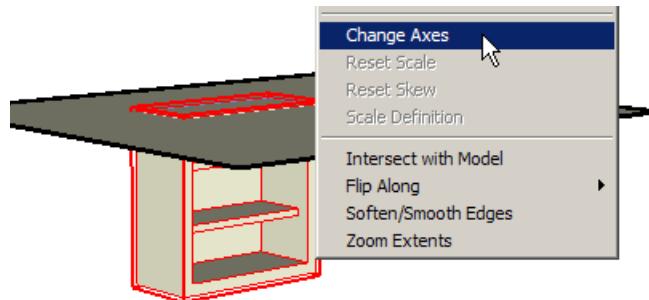
- Start a new file (you can have more than one instance of SketchUp open at once) and draw a rectangle in the red-green plane to serve as a reference.



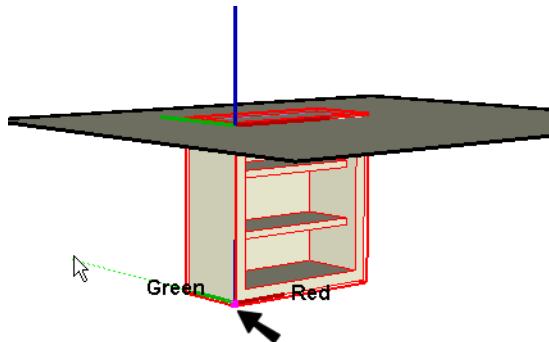
- To insert this component into the model, select **File / Import / 3D Model**, and find the component you just saved. Make sure you have **Files of type** set to **skp**.) You can also drag a \*.skp file straight in from your browser. The insertion point is based on where the origin was in the bookcase's original file.



- To change the insertion point, right-click the bookcase (or the thumbnail in the Component Browser) and select **Change Axes**.

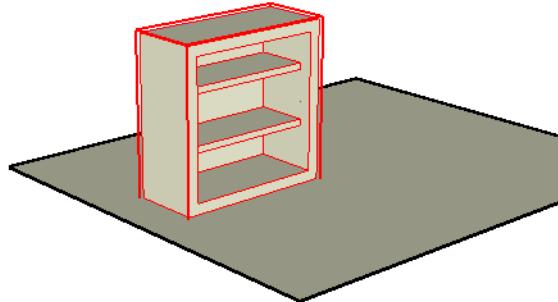


- Keeping the red and green directions the same, locate the new origin at the lower corner of the bookcase.

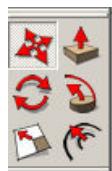


As we will see later, this change only affects the component in the current file. The original bookcase file is not changed.

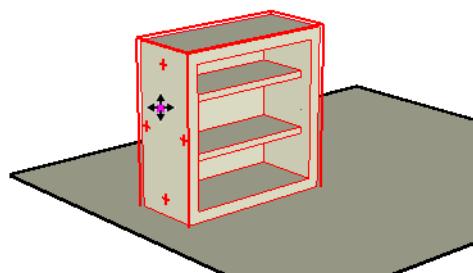
9. Erase the previous component, and insert another one from **In Model**. This time you insert it by its lower corner.



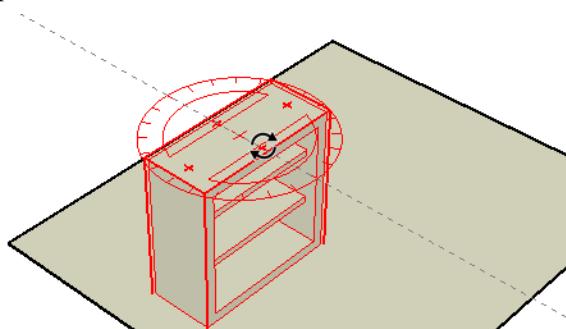
Immediately after inserting a component, you are in **Move** mode (note that the **Move** icon is pressed).



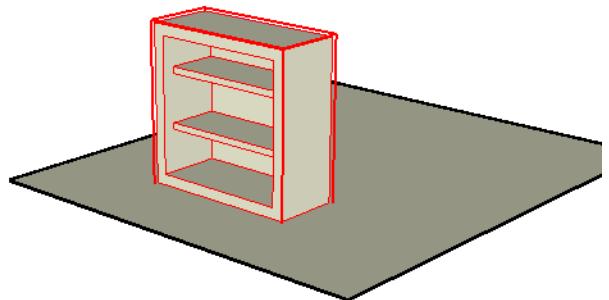
10. In addition to being able to move the component, you can also rotate it. Move the cursor over any face of the component's bounding box, and four crosses appear. These are rotation handles.



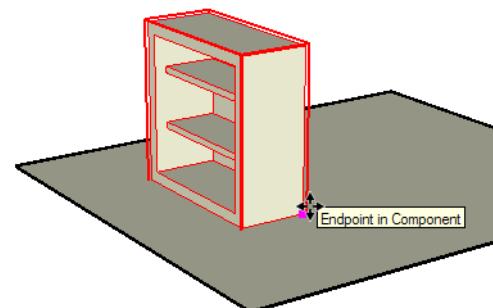
11. Click one of the crosses on the top face to set the protractor.



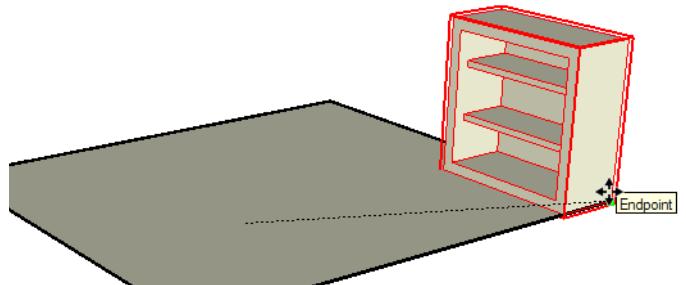
12. Rotate the bookcase 90 degrees.



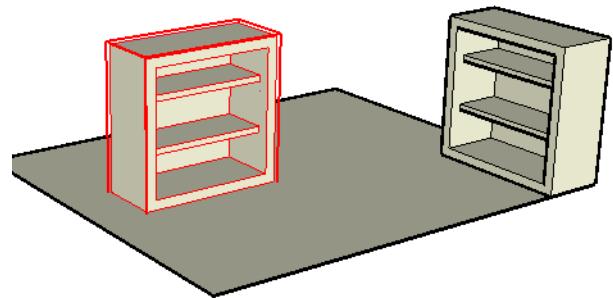
13. Since you are still in **Move** mode, click the endpoint shown ...



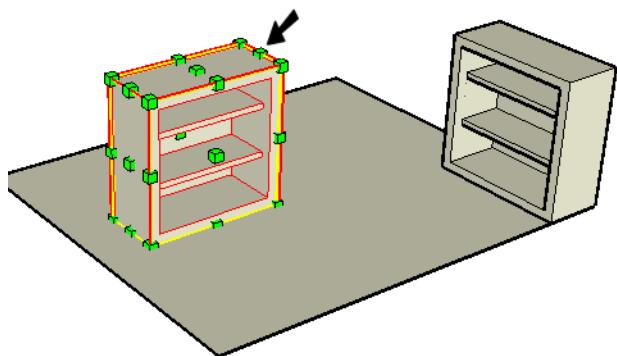
14. ... and drag it to the corner of the rectangular face.



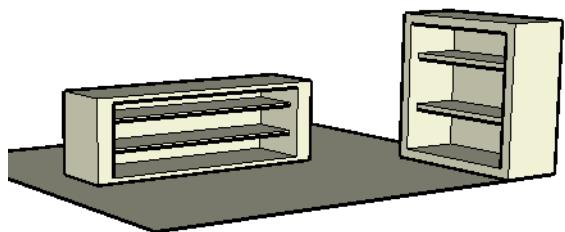
15. Insert another bookcase from **In Model**.



16. While still in **Move** mode, activate **Scale**. Click and drag the handle shown . . .

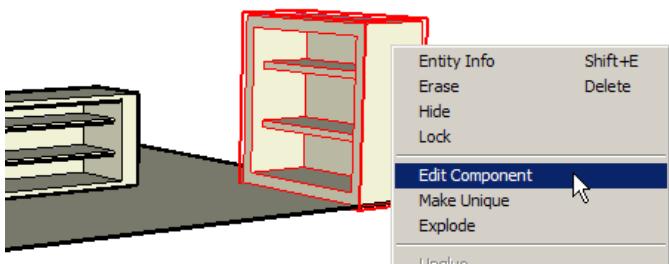


17. . . to make the bookcase wide and short.

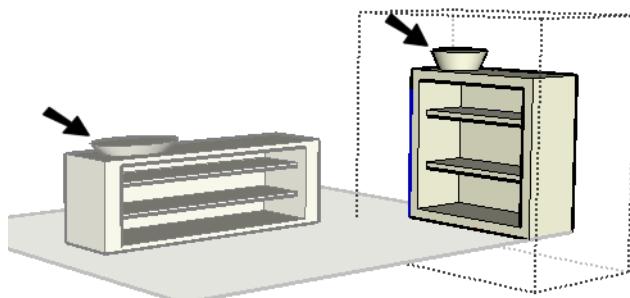


You can have multiple instances of the same component that have different orientations and scales. This does not affect the definition of the component itself.

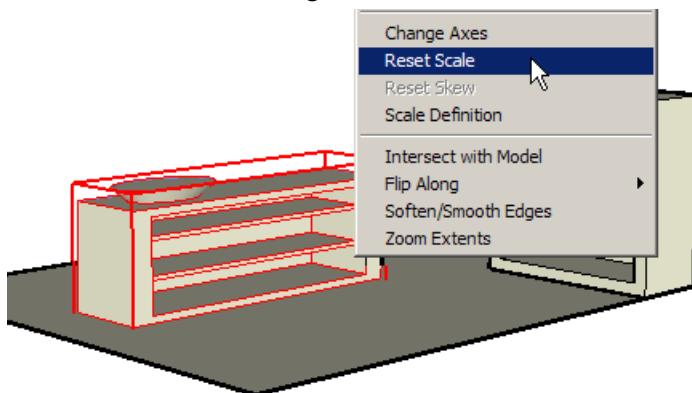
18. To demonstrate multiple scales, right-click the unscaled bookcase and select **Edit Component**. (You can also double-click on a component in **Select** mode to edit it.)



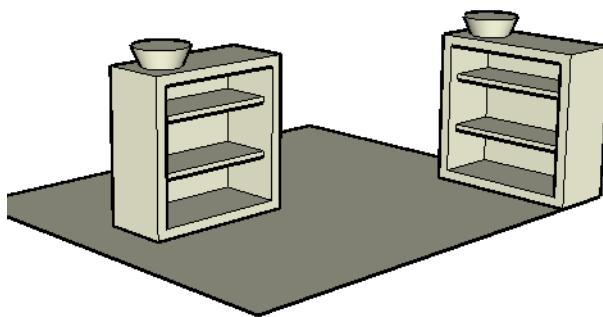
19. Whatever changes you perform affect all other instances of the same component. Make a circular cylinder on the top (you can **Scale** or **Move** the top of it outward). A scaled version of the cylinder appears on the lower bookcase.



20. Close the component. To return the scaled bookcase to its default size, right-click and select **Reset Scale**.



Both bookcases now have the same scale.



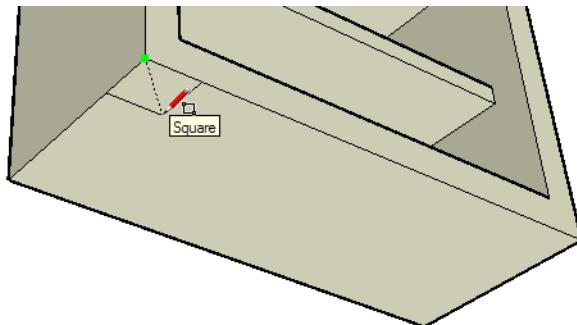

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**NOTE:** If you had selected **Scale Definition**, that would have reset the default scale to that of the selected bookcase. Any future instances of the component would then be scaled.

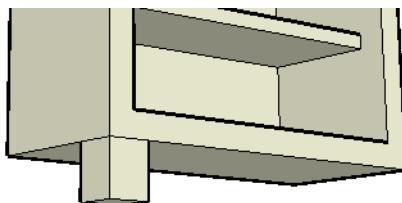
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21. Now we will go back and edit the bookcase in its original file. Save the current file and return to **bookcase.skp**.

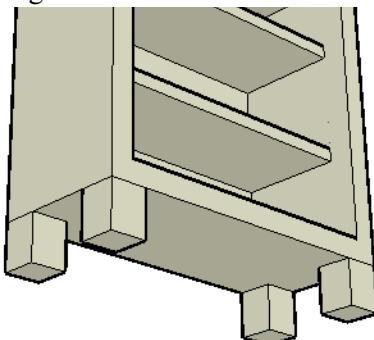
22. To add legs to the bookcase, start by adding a square in the corner of the bottom face.



23. Use **Push/Pull** with **Ctrl/Option** to pull out the leg.

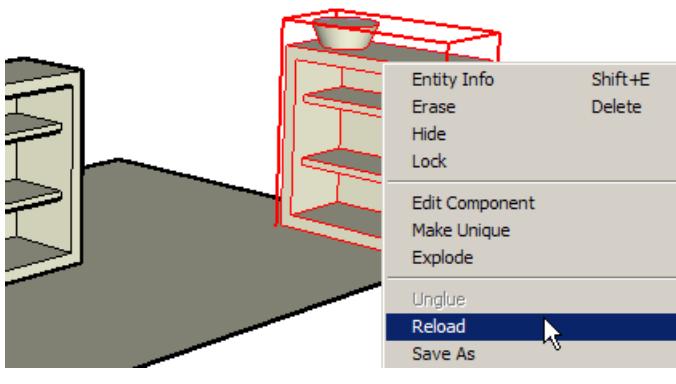


24. Copy the leg to each corner.



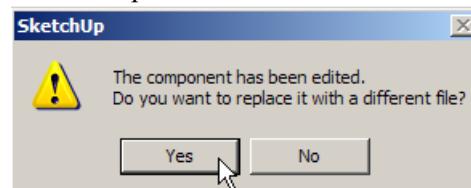
25. Save the bookcase file again.

26. Returning to the other file, right-click on one of the bookcases and select **Reload**.

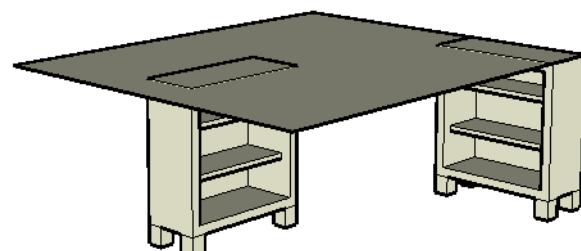


**TIP:** You can also access **Reload** from the component's thumbnail in the Component Browser, or from a component's **Entity Info** window.

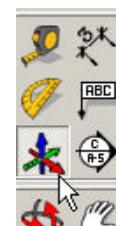
27. You are notified that the component was edited, and click **Yes** to replace the file.



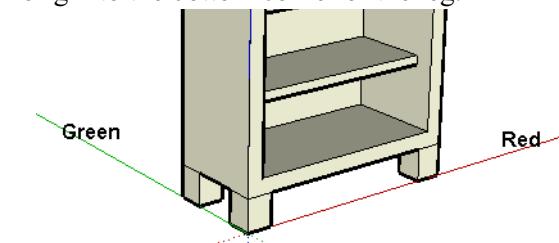
28. You won't be replacing it with a different file, but you still have to reselect the file. The bookcase legs appear, but the insertion point has reverted back to the component's origin.



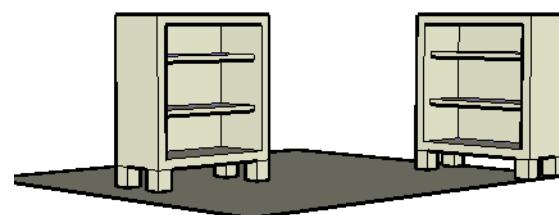
29. Go back once again to the bookcase file, where you can reset the origin. Select **Tools / Axes**.



30. Maintaining the red and green directions, move the origin to the bottom corner of the leg.



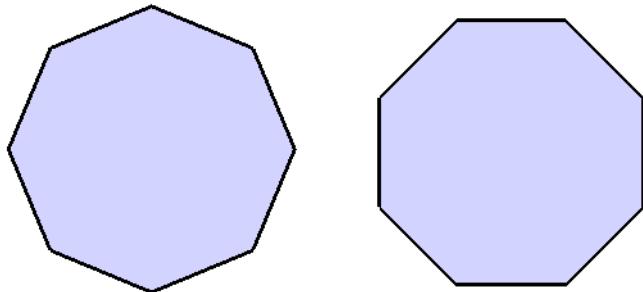
31. Back in the other file, reload again. Now the bookcases are inserted correctly.



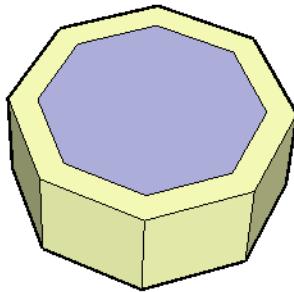
## Alignment and Insertion Point

Components can be set to automatically align to faces in your model, and you can adjust the point at which they are inserted, relative to the alignment face.

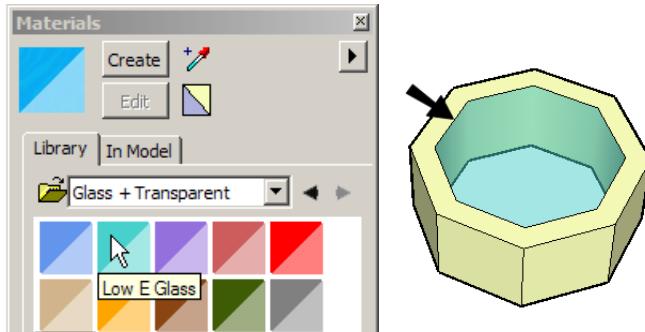
- We will create an octagonal window for this, so start with an 8-sided polygon. In **Top** view activate **Polygon**, and before starting to draw, enter 8 to set the number of sides. To get it aligned with the red-green axis, rotate it 22.5 degrees.



- Offset the octagon and Push/Pull the frame downward.

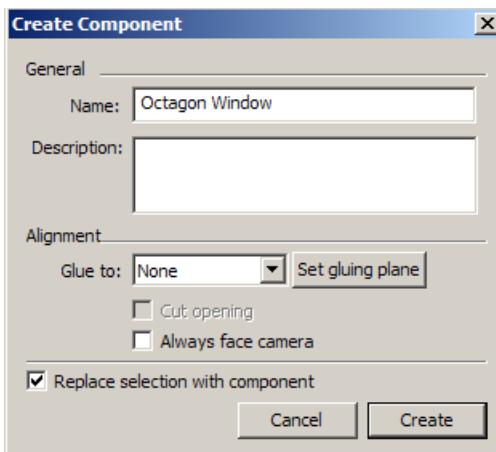


- To make it more realistic, open the Material Browser to the “Glass + Transparent” category, and apply a glass material to the window face.

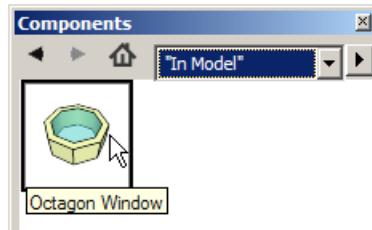


NOTE: Materials are covered in Chapter 7.

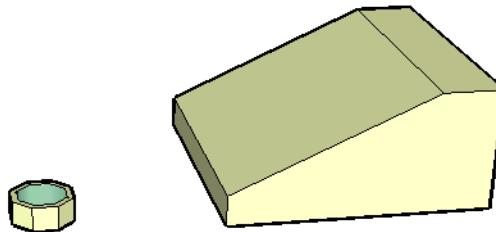
- Select the entire window and make it a component.



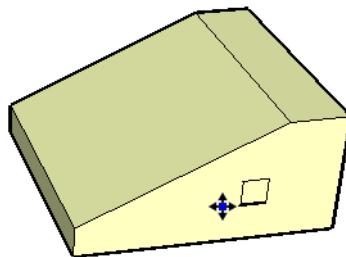
The window now appears in **In Model**.



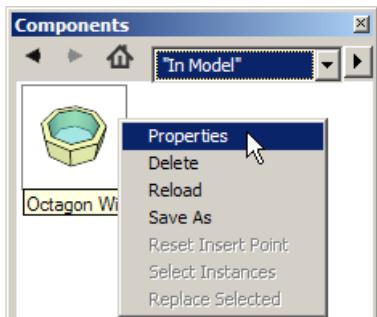
- Draw a form like this, with a sloped top. Size it so that two octagonal windows can fit on each of the side and top faces.



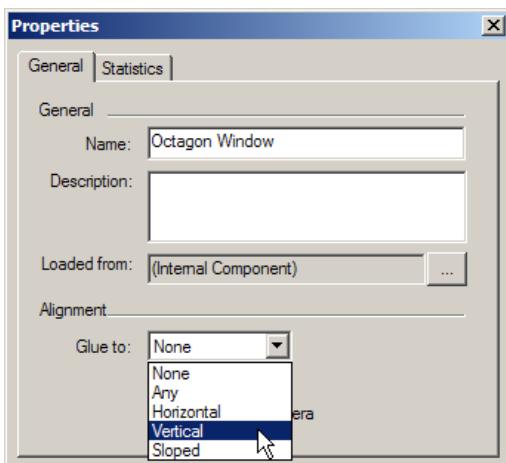
- Try inserting the window into the side face. It will not align to it.



7. Press Esc, or Undo if you placed the window. In the browser, right-click on the window and open its **Properties**.

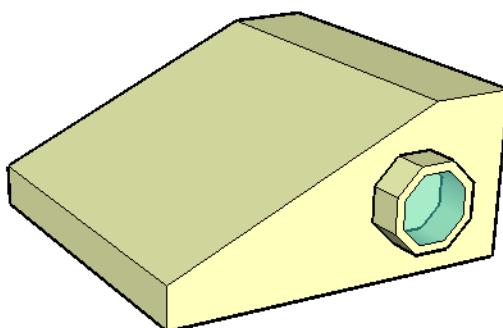


8. Under **Alignment**, choose to glue the window to **Vertical** faces. This is how window components are typically created - lying flat in the red-green plane, and set to stick to vertical walls.

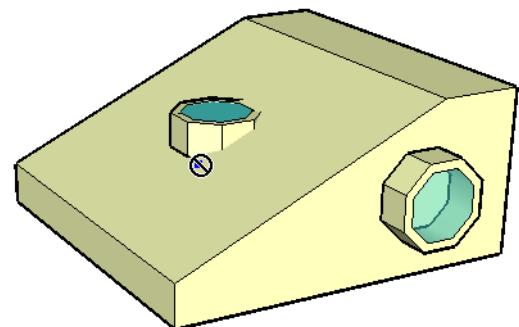


*Mac: The **Properties** option does not work as of this writing. Alignment must be defined when creating the component. To modify an existing component, you must first explode it and then redefine it as a component with the desired alignment.*

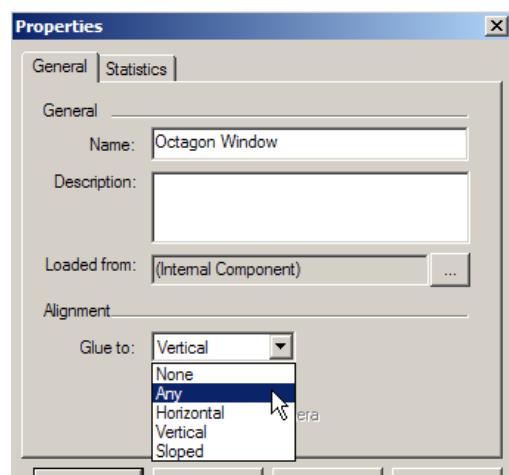
9. Now insert a window into the same face. It now aligns properly. However, it does not cut the face. (This will be corrected in a few steps.)



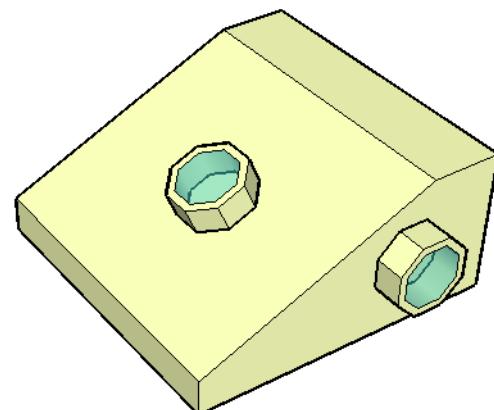
10. Try inserting another window on the sloped face. The window does not align itself to this face.



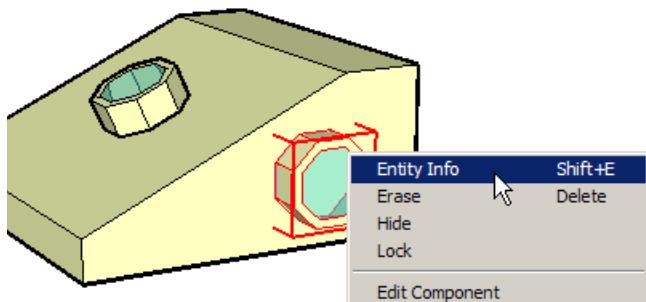
11. Open the **Properties** again, and change **Vertical** to **Any**.



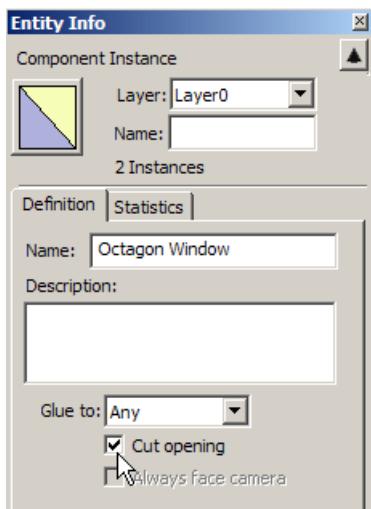
12. Now you can insert a window into the sloped face. They align correctly, but they do not cut the faces.



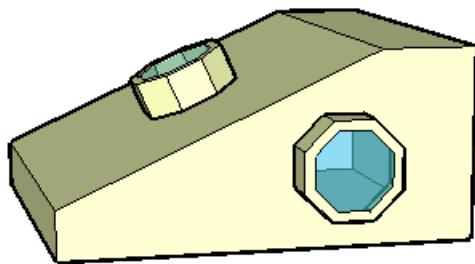
13. Re-open the window **Properties**, or right-click either window and select **Entity Info**.



14. In **Entity Info** or **Properties**, check **Cut opening**.

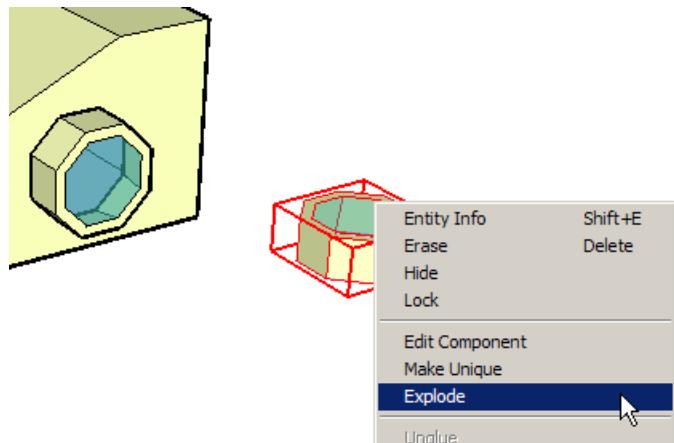


Now the windows cut the face, and you can see into the box.

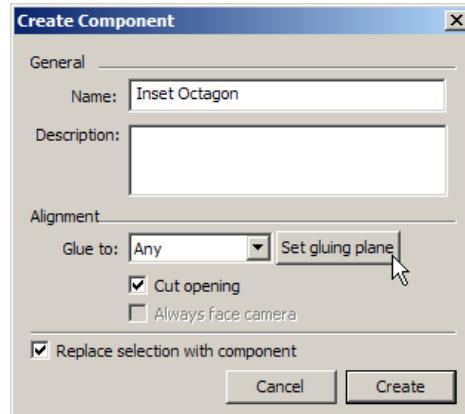


These windows are inserted so that their frames stick out. We would like to change this so that the window frame is flush with the wall (i.e. the window itself is set into the wall).

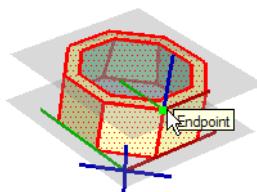
15. Insert another window into the blank space and **Explode** it. We will now see how to change the insertion point and gluing plane of a component while creating the component.



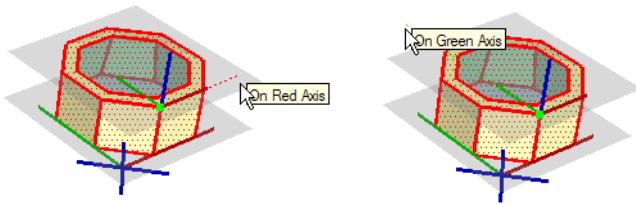
16. With the exploded window selected, make it a new component. Assign a new name, set it to glue to **Any** plane and to **Cut openings**, then click **Set gluing plane**.



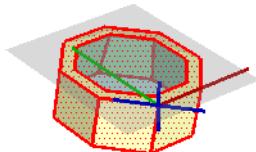
17. These steps are similar to those in the **Axes** tool (see "Axes" on page 70). Place the new insertion point at the top of the window.



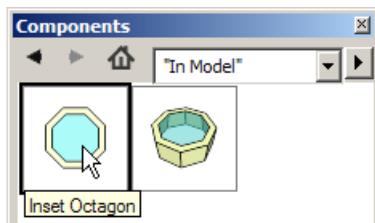
18. Define the red and green axes of the new gluing plane.



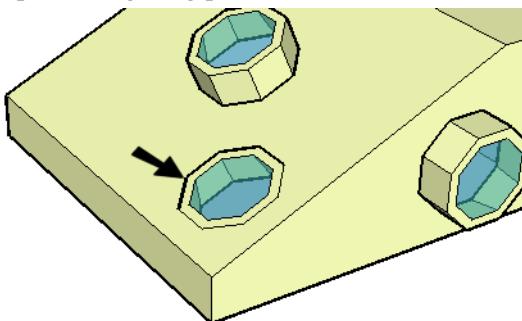
The gluing plane should look like this:



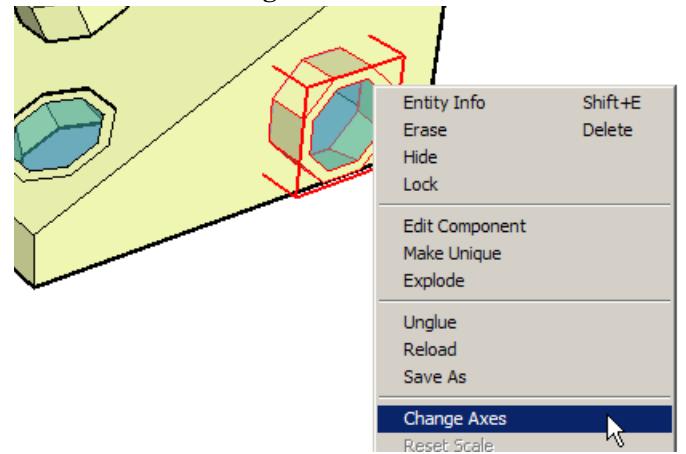
19. Create the component, which then appears in **In Model**.



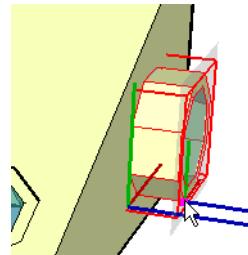
20. Insert this new window onto a face. It is inset, and the face is still cut. A face is always cut along a component's gluing plane.



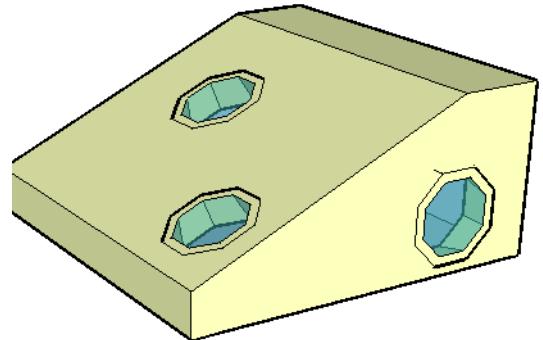
21. Here's an easier way to do the same thing. Right-click on either of the two original components, and select **Change Axes**.



22. Use the same steps to change the window's inserting point and gluing plane.



When finished, the components automatically align according to the new gluing plane.




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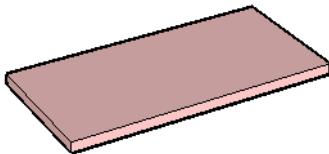
**NOTE:** For details on setting the origin of a component within its source file, see “Component Source Files and Reloading” on page 197

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## The Outliner: Manipulating Groups and Components

This exercise will show you how to move groups and components around, and how to combine them.

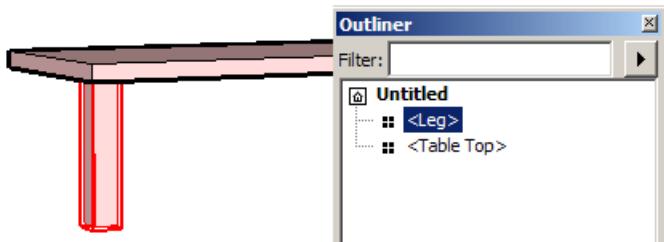
- We will start with a table that has nested components (also called sub-components). In the red-green plane draw a rectangle approximately 5' x 2'-6" (look at the VCB to see the dimensions of the rectangle). **Push/Pull** it a bit.



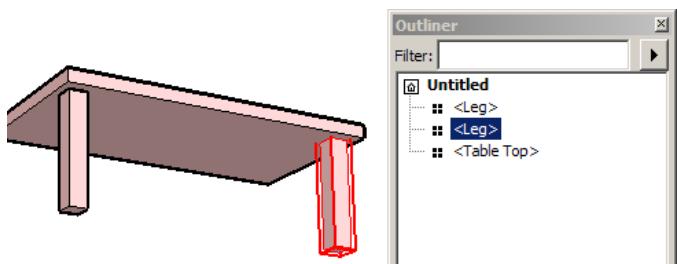
- Make this box a component called Table Top. Open the Outliner (**Window / Outliner**), and the component is listed. The four-square symbol next to the component name indicates that it is a component. (The Outliner can also contain groups, which we will see later.)



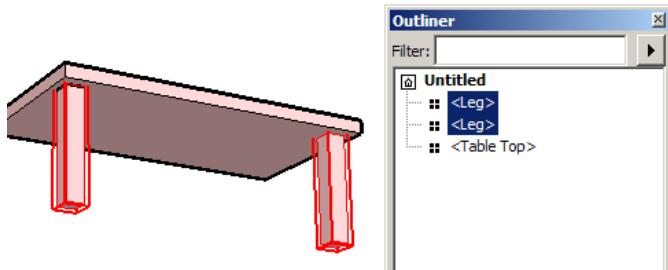
- Add a rectangular table leg and make this a component as well. The Outliner now shows two components. If the leg is selected, the component name is highlighted in the Outliner.



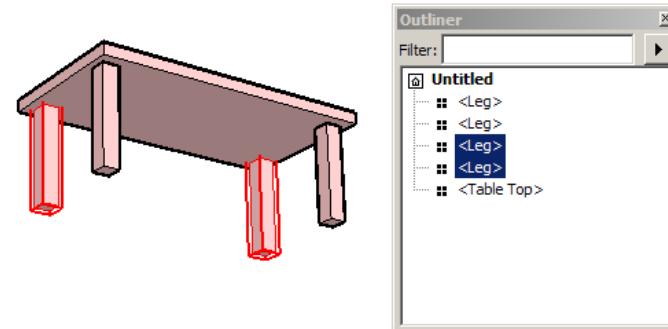
- Use **Move** with **Ctrl/Option** to copy the leg once.



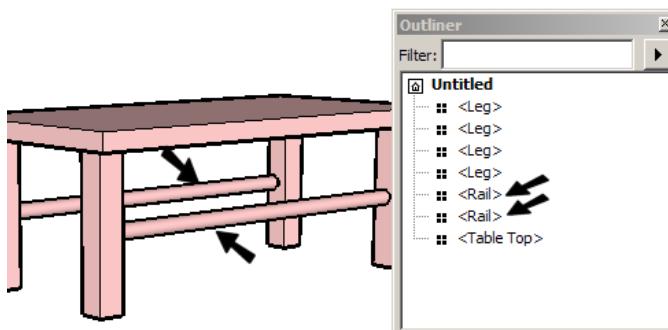
- In the Outliner, select both leg components. (You can use Shift or Ctrl/Cmd to select multiple items.) This selects both components in the model.



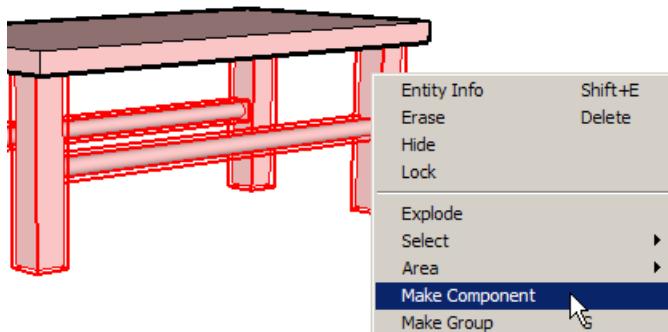
- Copy both legs to the other side of the table.



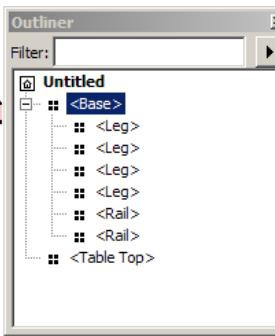
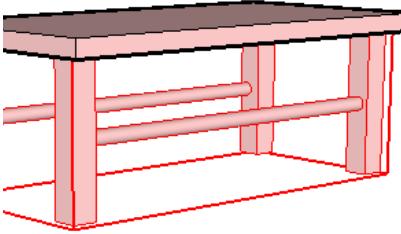
- Add a rail between two legs, make it a component, and copy it.



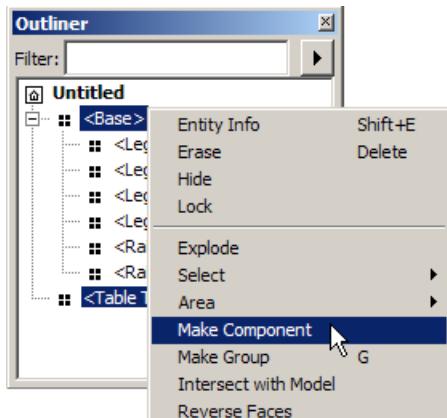
- Now some components can be nested into larger components. Select all components of the base: four legs and two rails. Right-click and select **Make Component**, and call the new component "Base."



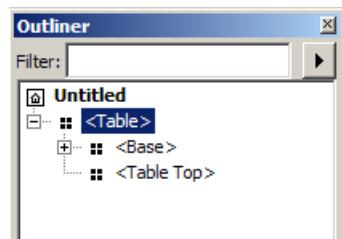
Now the legs and rails are listed under Base.



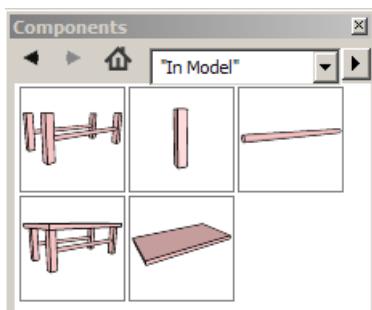
9. You can make groups and components directly in the Outliner as well. Select Base and Table Top and make it a new component called Table.



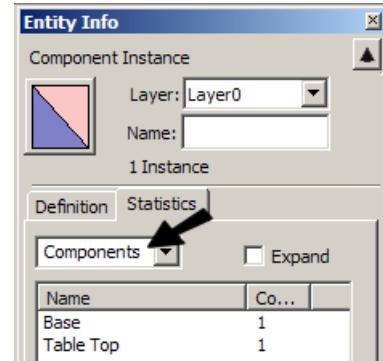
Now the table consists of two nested components.



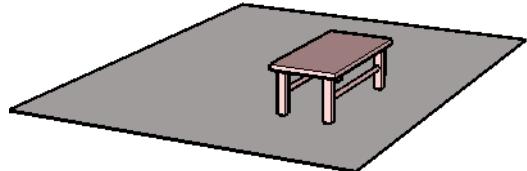
In the Component Browser under **In Model**, all components are there, whether they are nested or alone.



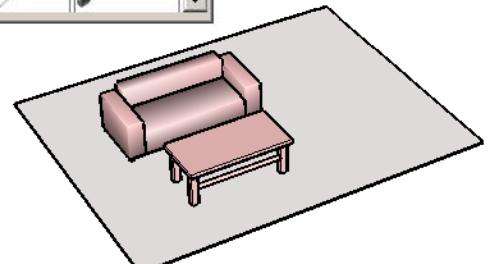
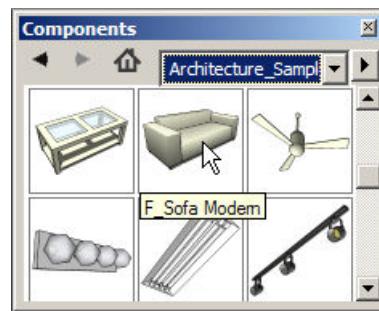
10. Open the **Entity Info** window for the table. (This can be accessed via the Outliner as well). Set the **Statistics** page to **Components** to see the sub-components of the table.



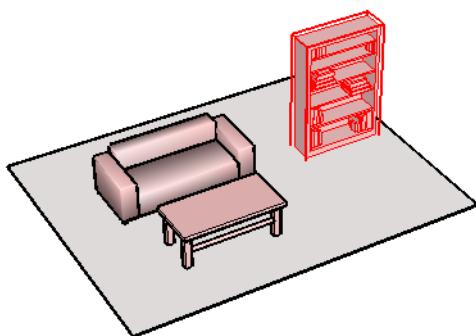
11. Now to add some more components. Start by adding a floor under the table - this provides a reference plane for adding more objects.



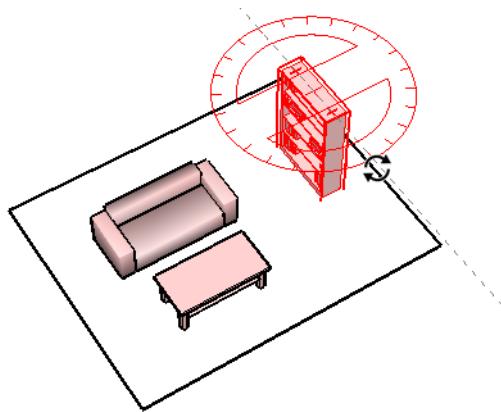
12. In the Component Browser, open the **Architecture\_Sampler** folder. Locate the sofa and bring it in. Exact placement is easily done in **Top** view.



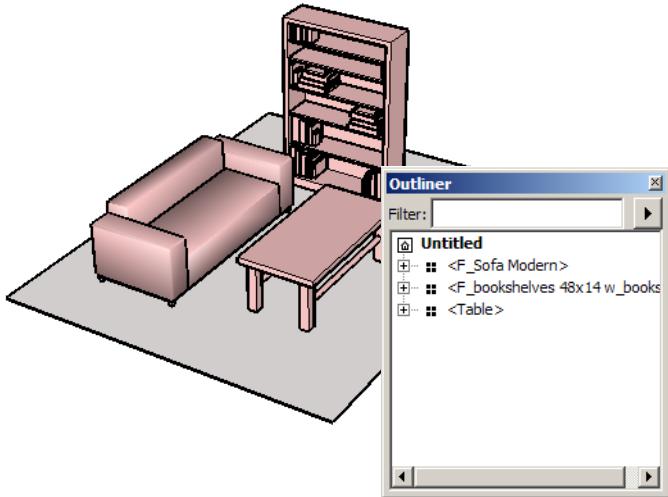
13. Add a bookcase as well.



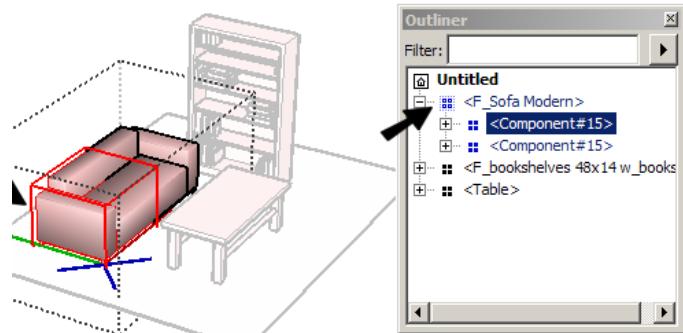
14. While still in **Move** mode, place the cursor on one of the crosses on the top face; this invokes the Protractor. Rotate the bookcase so that it is facing the room.



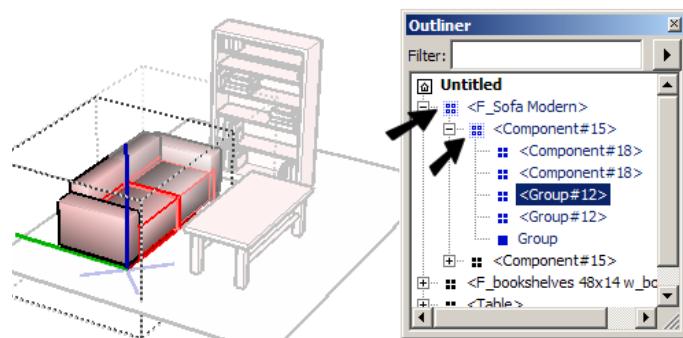
There are now three components in the model.



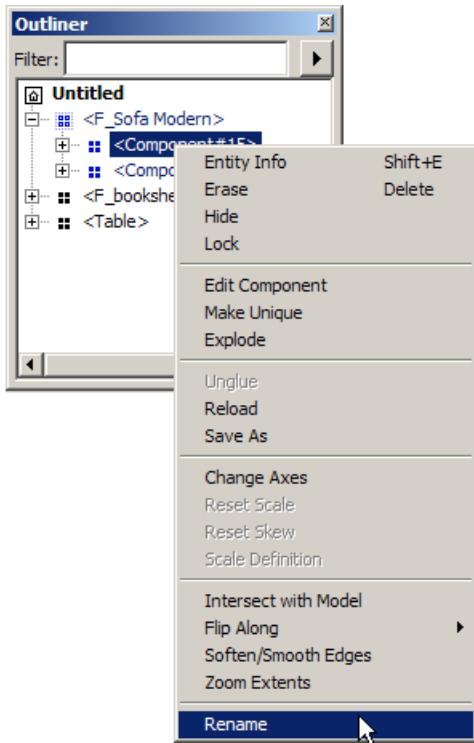
15. Expand the sofa component in the Outliner and highlight one of its sub-components. The sofa has to be open for editing in order for its sub-component to be highlighted, so the sofa has an “open” symbol in the Outliner - four blue square surrounded by a box.



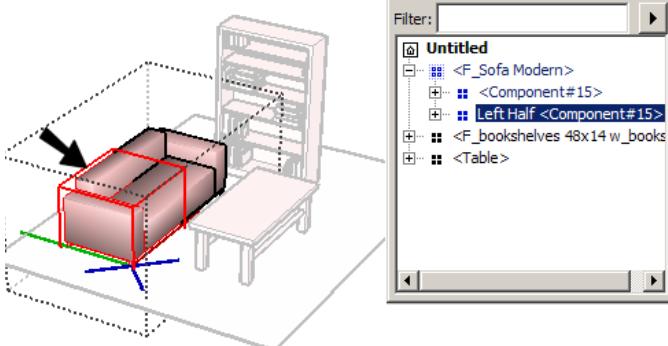
16. Now highlight a sub-component of the sub-component (such as Group#12). Both the sofa and its first-level nested component (Component#15) are now open for editing. There are dashed lines surrounding all components and sub-components, so you can tell where you are in the hierarchy.



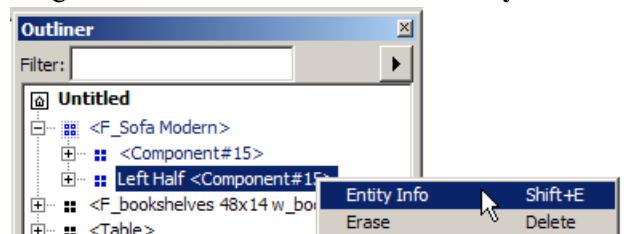
17. The name “Component#15” is not very helpful if you are looking for a particular object. Right-click on this item and select **Rename**.



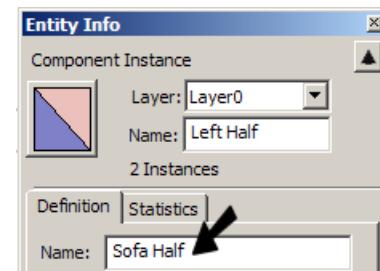
18. Assign a name like “Left Half.” The original component name (“Component#15”) is still listed after the new name. This is because you can assign different names to different component instances in the Outliner, but the actual component name in its definition remains constant.



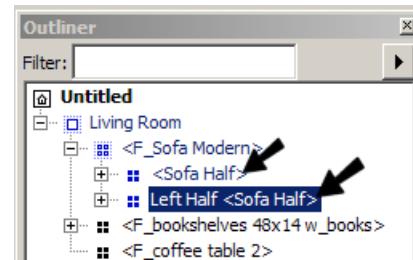
19. To change the component name in its definition, right-click on Left Half and select **Entity Info**.



20. The instance name is displayed above. Enter a new component definition name, such as “Sofa Half,” under **Definition**.

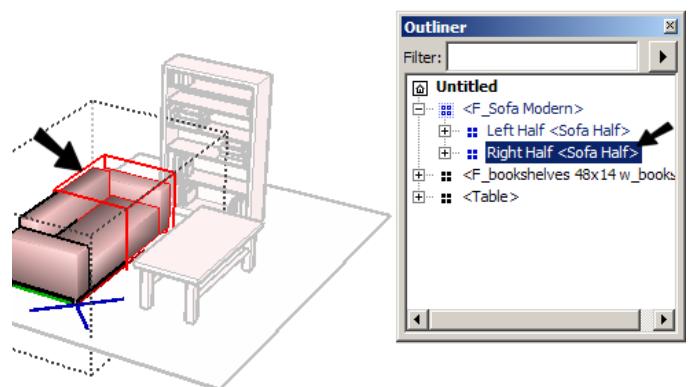


Now both sofa halves have the same component definition name.

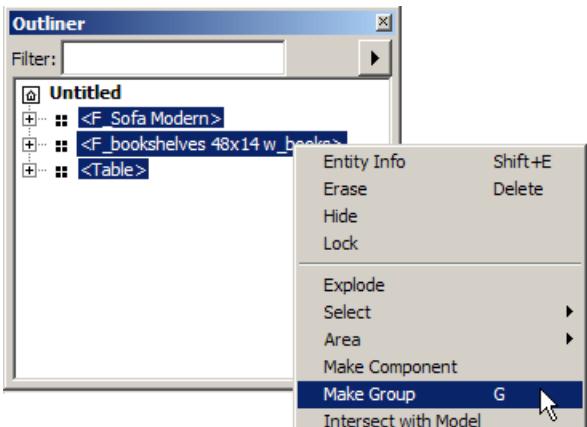


*NOTE: You could also have changed the definition name via the Component Browser. You would have to **Expand** the browser to show sub-components, find the sofa half, and open its **Properties**.*

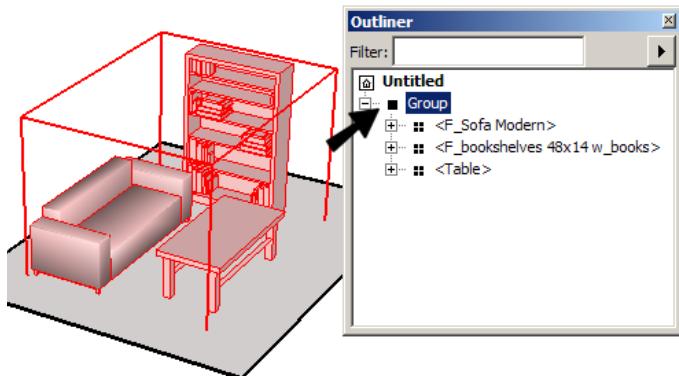
21. Now rename the other instance separately.



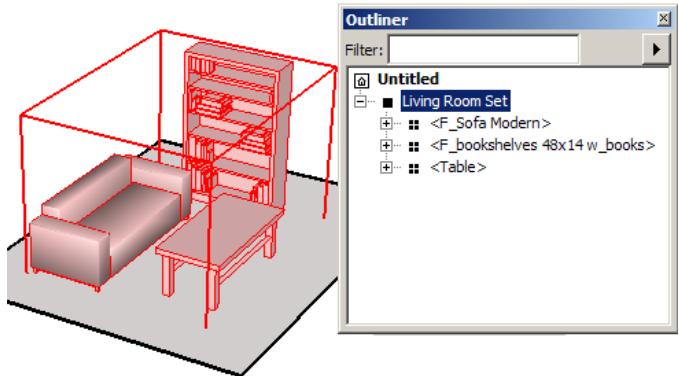
22. Now select all three components in the Outliner and make them a group.



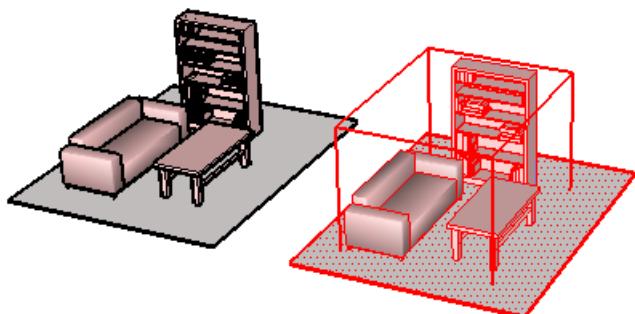
23. Now the furniture is placed under the “Group” heading. Groups are indicated by a single-square symbol.



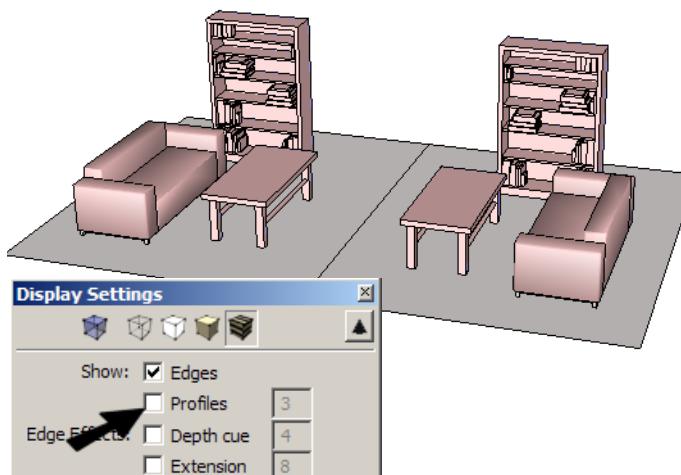
24. Use **Rename** to change the name to something more meaningful.



25. Create another group by copying the existing room into the blank space.

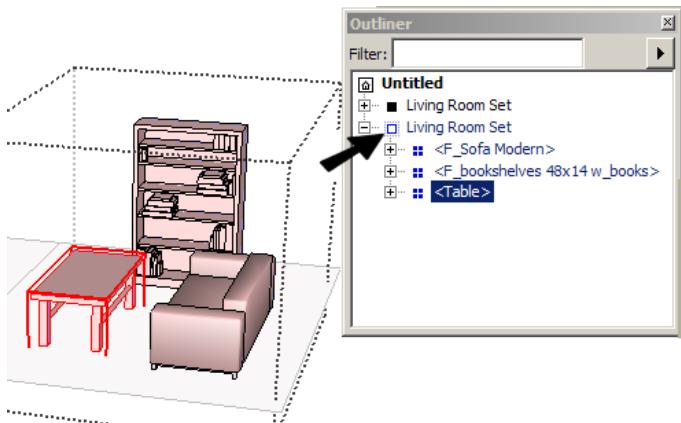


26. Use **Scale** to turn the new group inside-out (use a drag handle in the red or green direction, with a scale value of -1.0), and move it so that the rooms are adjacent. In this example, **Profiles** are not displayed.

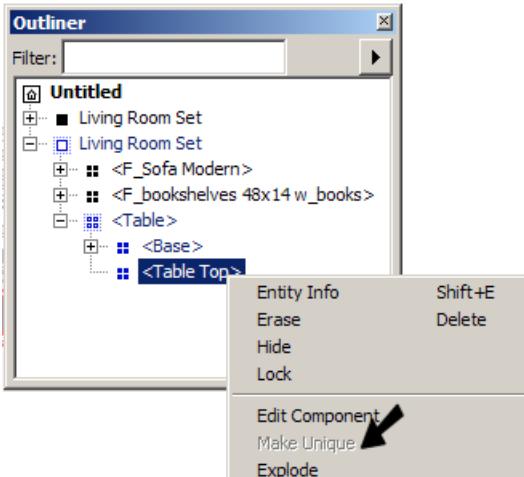


*NOTE: For an example that uses **Scale** for mirroring, see “Using Components for Mirroring” on page 229*

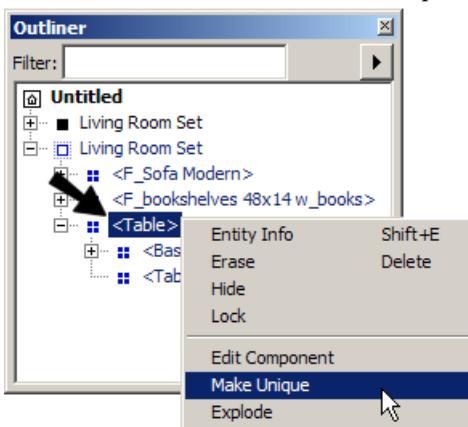
27. Highlight the table in the copied group. This opens the group, indicated by a single, open square surrounded by a box.



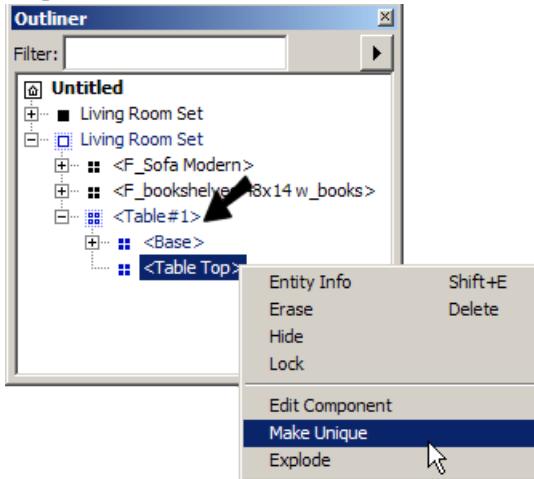
The next step is to change the table top. This component must be made unique, but **Make Unique** is not available for this sub-component.



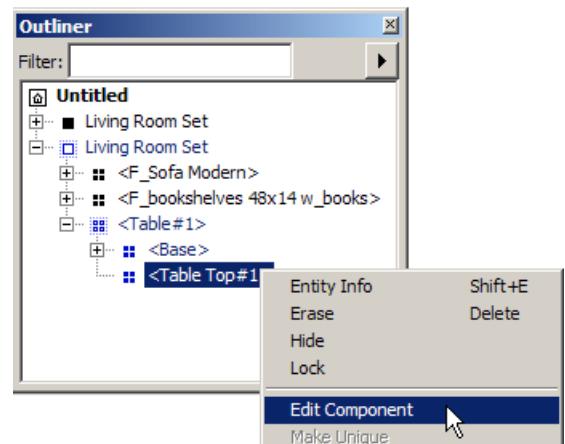
28. In order for a sub-component to be unique, its first-level component must be made unique first. So right-click on the table and make it unique.



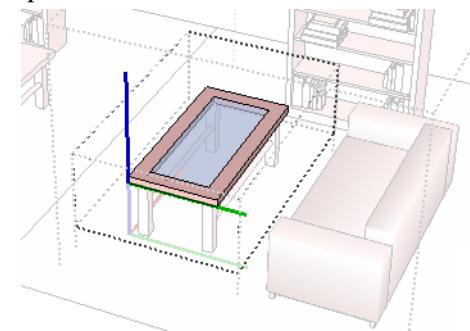
29. The table is assigned a new name (Table#1, but you can change it). Now you can make the Table Top unique.



30. Right-click on this new table top component and select **Edit Component**.

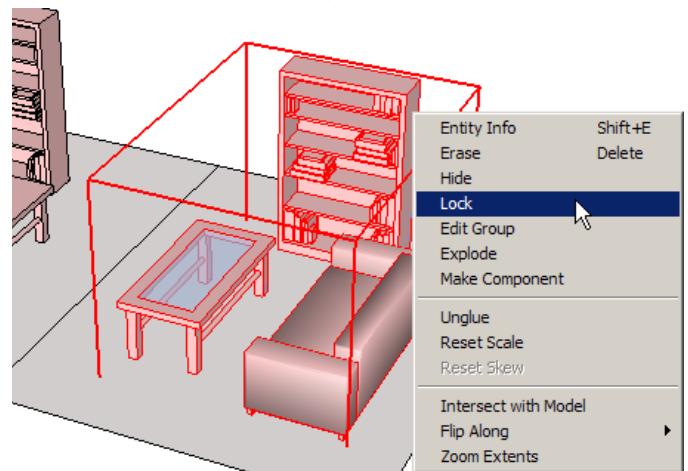


31. Make some changes to the table top. In this example, the top face was offsetted and pushed through. The table face was then replaced and assigned a transparent material.

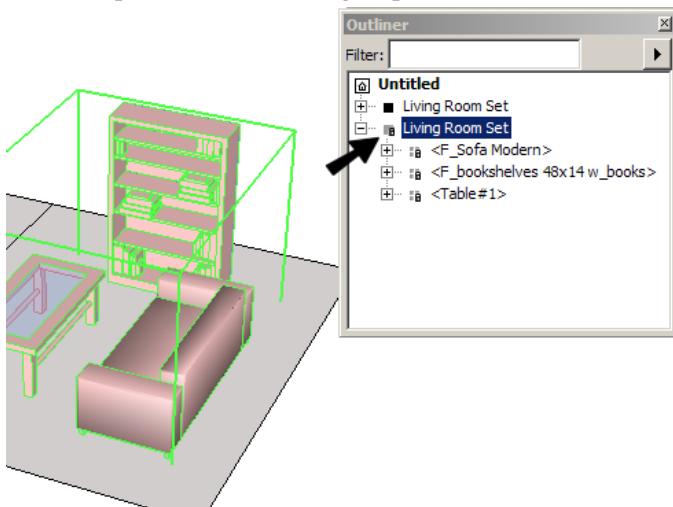


To exit editing mode, you need to close sub-components, then main components.

32. Now right-click on this edited group (or right-click its line in the Outliner) and select **Lock**.

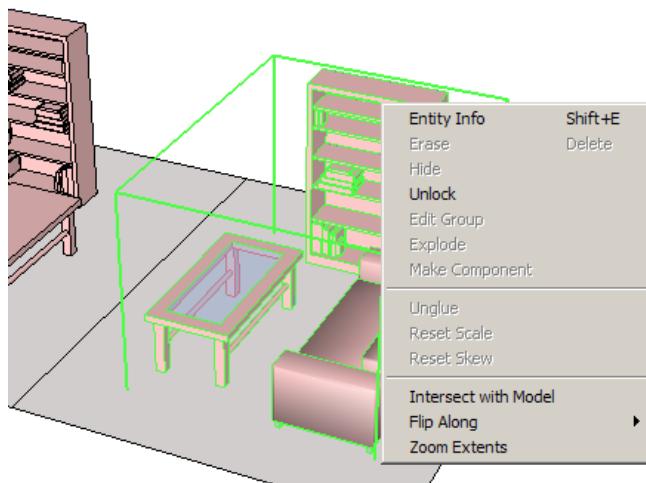


The group now has a lock symbol, as do all the components within the group.

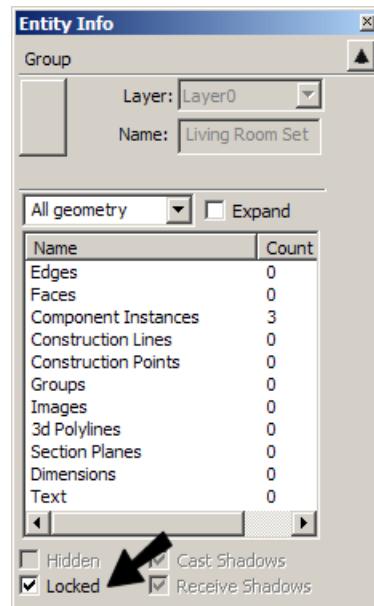


The color of the bounding box and object outlines for locked groups and components can be set in **Model Info**. Open the **Colors** page and set the color for **Lock**.

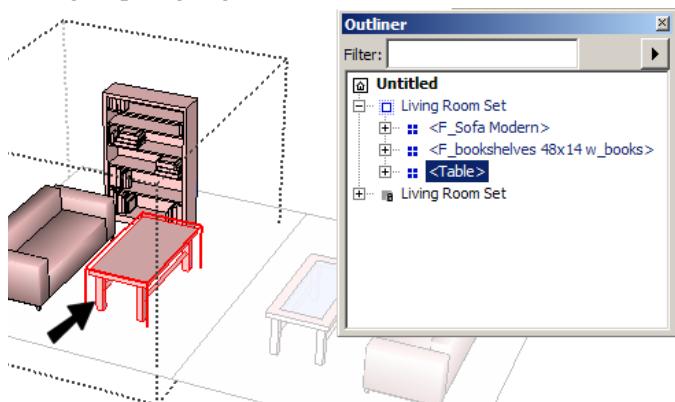
33. Right-click the group, and all editing options, including **Erase**, are grayed out. You cannot touch this group or anything inside it, unless you **Unlock** it.



34. Look at the group's **Entity Info** window - the **Locked** box is checked. You can uncheck the box to unlock the group.



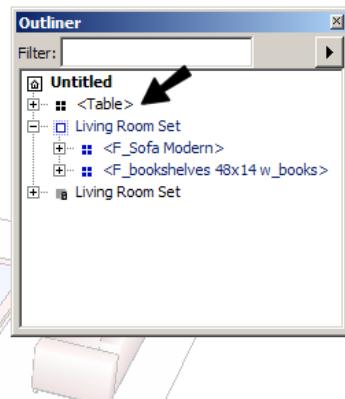
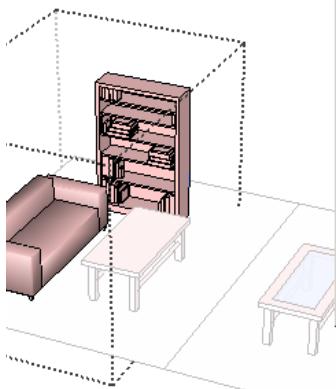
35. You can also use the Outliner to change group or component hierachal structure. In the unlocked group, highlight the table.



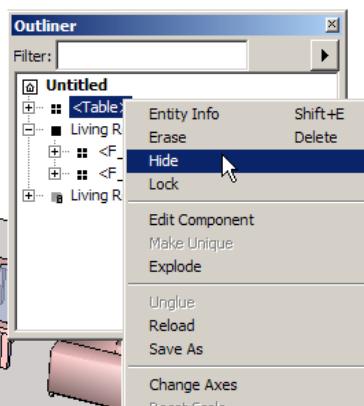
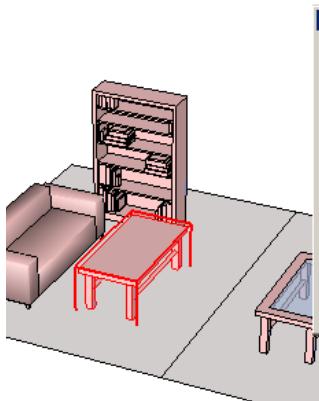
36. Drag the table just below the title of the file.



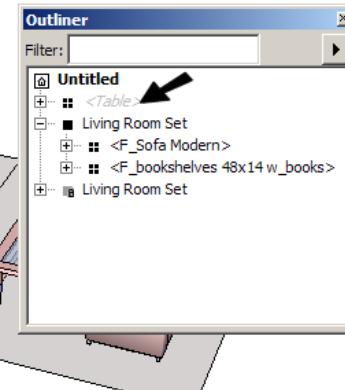
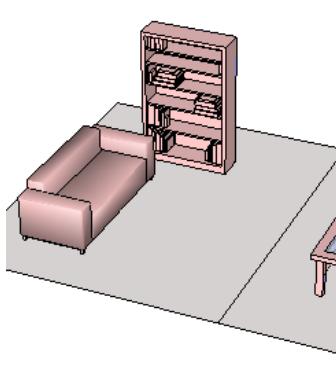
This makes the table a first-level component - it is no longer part of any other component or group. The furniture group now contains only the sofa and bookcase.



37. Right-click on this table and select **Hide**.



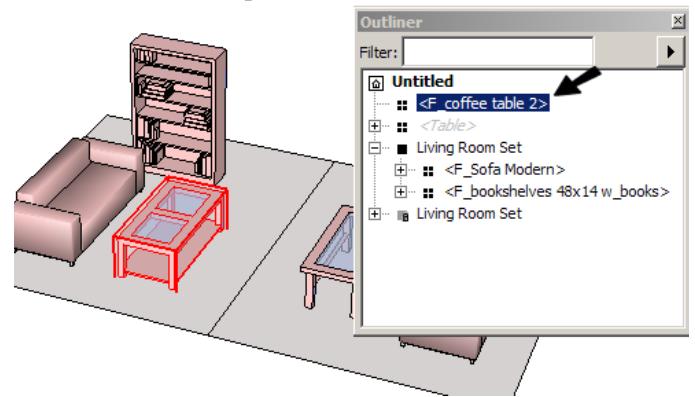
The table disappears from the display, but it still appears in the Outliner, in italics.



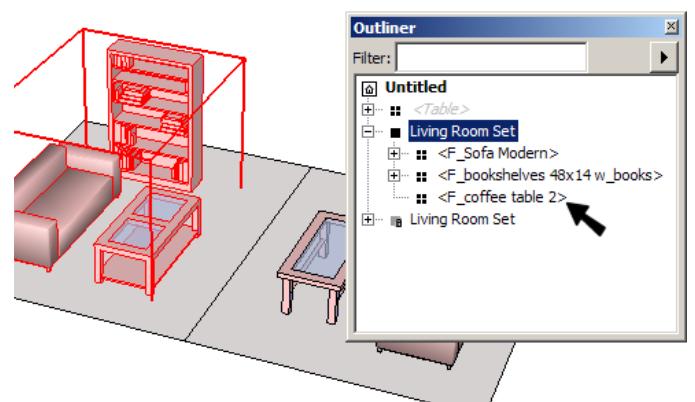
38. In the Architecture\_Sampler folder of the Component Browser, find the coffee table.



39. Insert it next to the sofa and bookcase where the previous table was hidden. The coffee table is a first-level component.



40. Use the Outliner to drag this table into the unlocked furniture group.



This is an easy way to change a group - otherwise you would have to cut or copy the object you want to add to a group, then open the group for editing, then paste it in.

**TIP:** You can also use the Outliner to move one component below another component, creating a nested component. If there is more than one instance of the first-level component, the nested component will go in each instance. This is shown in the exercise, "Creating a Spiral Staircase" on page 388.

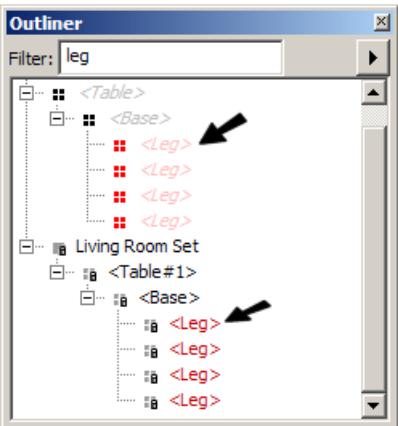
41. The last feature of the Outliner is the Filter. Type "leg" into the **Filter** field (Mac: **Search** field). This will highlight all items in the Outliner that contain this string. If the Outliner is collapsed, the highlighted objects will not be displayed.



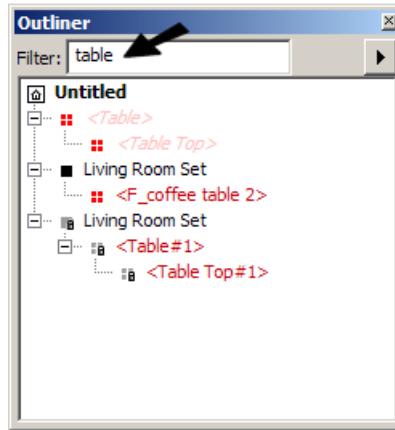
42. Right-click on blank space in the Outliner and select **Expand All**.



43. Now you can see all the legs, in red font.



44. Do the same for the string "table." This highlights hidden tables, table tops, and the coffee table.



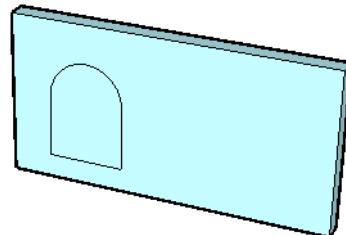
## Cutting Openings

In the exercise "Creating and Saving Components in the Library" on page 193, the window component created an opening on the face of the box. Components can cut an opening on one face only, so if you are working with double-faced (or double-sided) walls, the back face will not be cut.

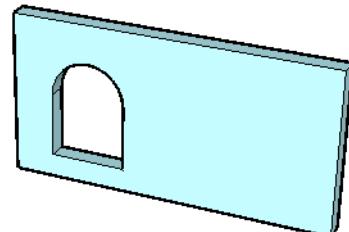
To create openings on both faces, you need a few extra steps.

### Cutting Method 1

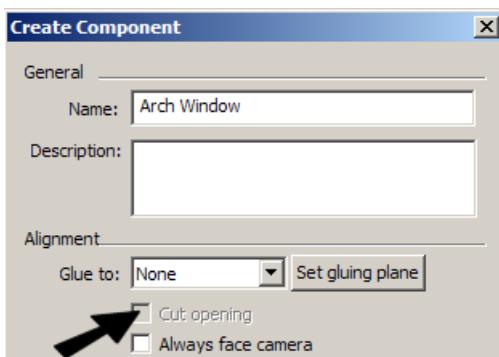
1. Draw a thin, long rectangle and **Push/Pull** it upward to create a wall. Draw lines and an arc to create the window outline.



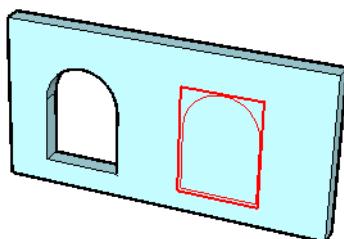
2. **Push/Pull** the window to the back face to create the hole.



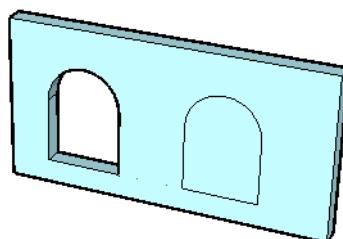
3. Select the window objects, and create a component. Because this component contains more than one cutting face, it cannot align automatically to a face - the component would not know which face to align to or cut. Therefore, **None** is selected for **Glue to**, and **Cut Opening** is grayed out as well.



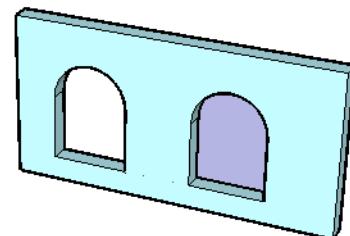
4. Insert another one of these from **In Model**; the wall is not cut.



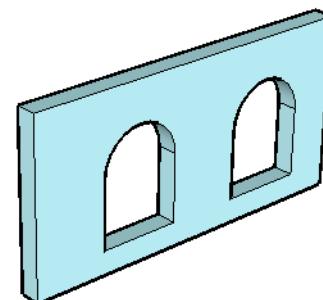
5. To fix this, you need to explode the window. In **Select mode**, right-click on the window and select **Explode**. The lines of the window become thick, indicating that they are not aligned with the front face. Fix this by simply redrawing any of the lines or segments of the window - notice how the lines become thin.



6. Now you can erase the window face. The cut is not made on the back face, however.



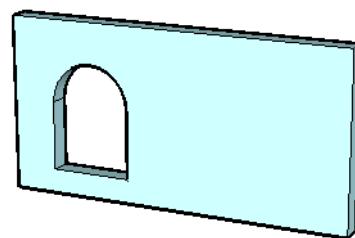
7. On the back face, do the same thing - redraw one of the window segments and erase the window face.



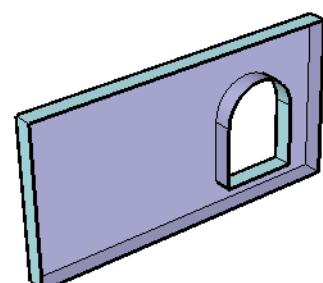
**TIP:** Another way to create the cutout would be to explode the window component, redraw a segment of the window on the front face, and **Push/Pull** to the back face.

## Cutting Method 2

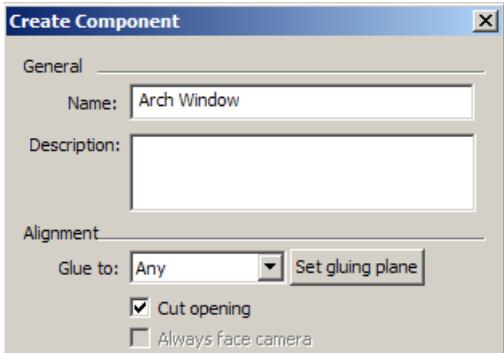
1. Starting with an empty wall, create the arched outline as before, and use **Push/Pull** to make the hole.



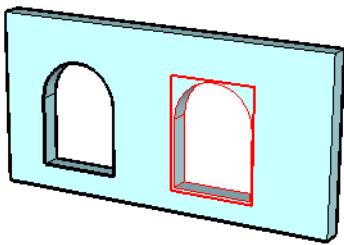
2. Because components can only cut through one face, we can eliminate one of the cut faces. Erase the back face of the wall.



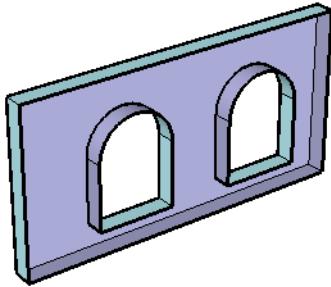
- Now when you make a component out of the window objects, **Cut Opening** is available (and checked), and the component will glue to **Any** face.



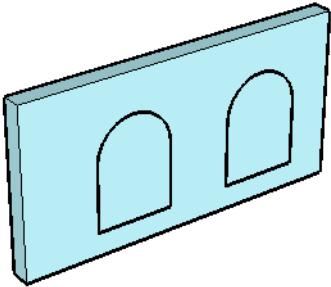
- Create the component, and drag this component to create another window on the front face. This time, the window cuts the front face.



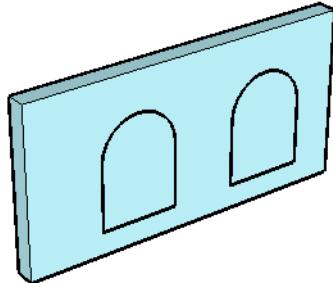
The back face of the wall, however, is still missing.



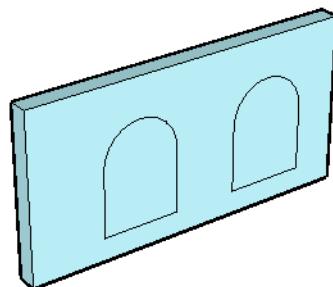
- Recreate the back face by redrawing any of its edges.



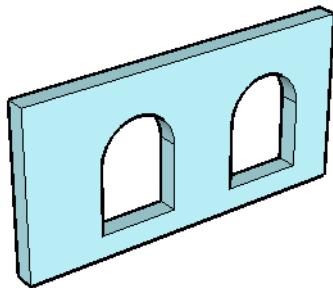
- Explode both of the windows. The window lines are heavy, meaning they need to be resolved into the face, as before.



- Redraw one segment in each window. The lines are now thin.



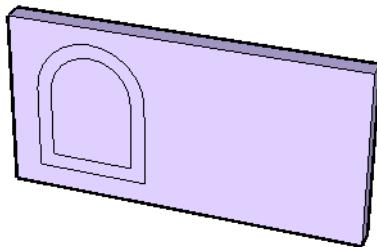
- Erase the window cutouts on the back face.



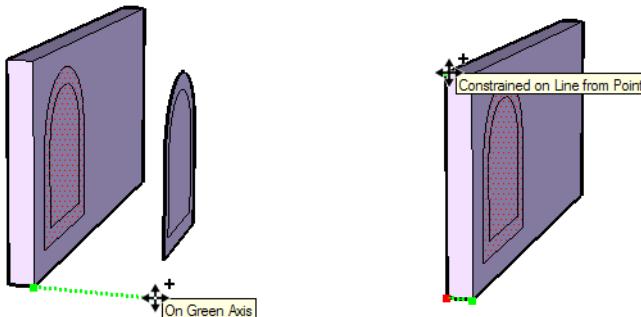
## Creating a Window Component Plus a Cutout Component

Here's a convenient way to handle cutouts for components that have a non-rectangular shape. Basically you create two components to be used each time you insert the cutout - one is the component itself and the other is used as the cutout.

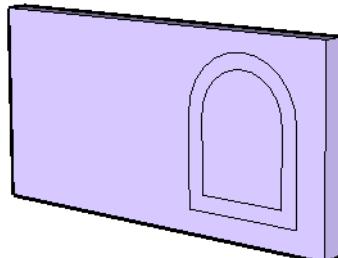
1. Make a vertical wall and create an arch shape (rectangle + arc) for the window. Offset the shape to create the frame.



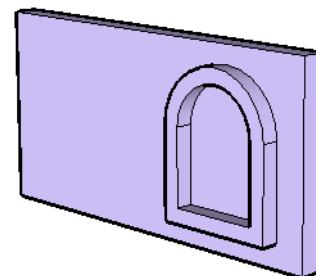
2. Use **Move + Ctrl/Option** to copy the two arch shapes to the other side of the wall. Use Shift to lock the copy direction normal to the wall and click any point on the back wall to create the copy.



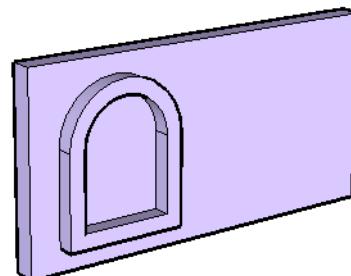
The arch shapes are now on the back wall. If necessary, reverse faces (right-click on a face and select **Reverse**) so that all faces are uniform.



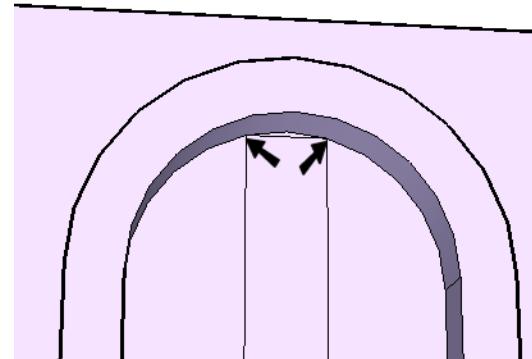
3. **Push/Pull** the frame slightly outward.



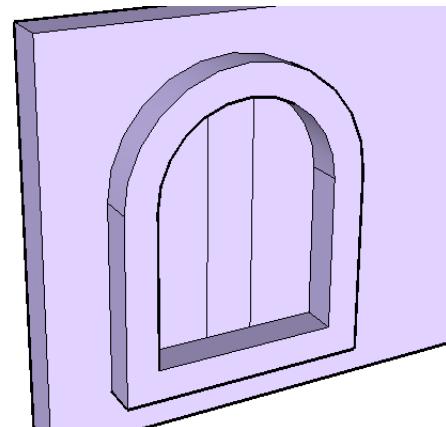
4. Double-click on the frame on the other side of the wall to **Push/Pull** it outward the same distance.



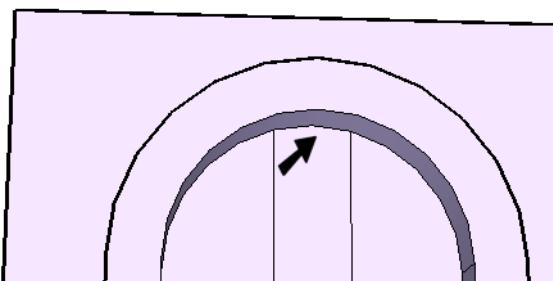
5. To create the center post, draw a rectangle on the wall face, using two arc segment endpoints.



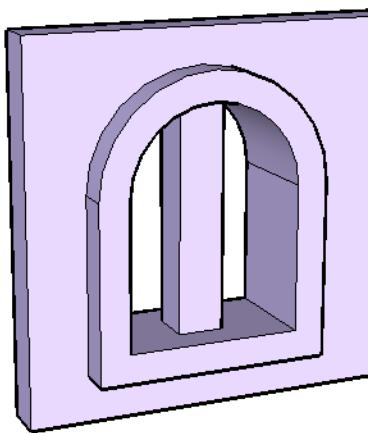
The rectangle should extend to the bottom of the window.



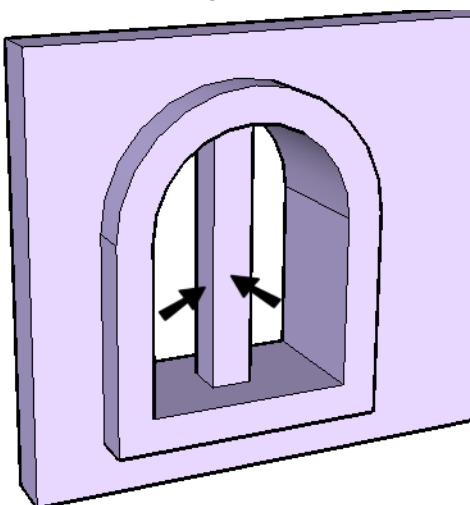
- Erase the horizontal line at the top of the post.



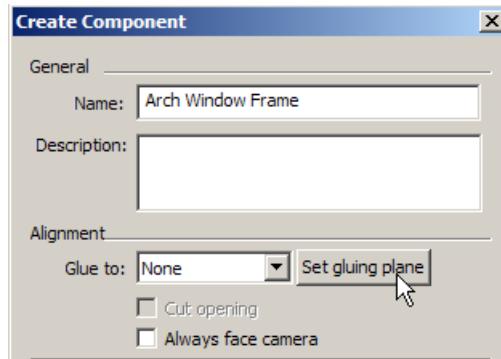
- Now use **Push/Pull** to cut out the window on both sides of the post. The easiest way to do this is with two clicks - first on the face, then on any point on the back wall.



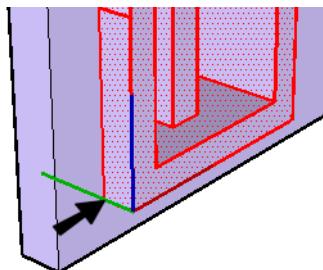
- Use **Push/Pull** to move each of the four walls of the post slightly inward. Use a double-click to ensure that the offsets are all the same. (This ensures that the post is contained within the wall, so that you won't see this post when you first insert the window.) Erase any unneeded lines. (If you're ambitious, you can resolve the extra material at the top of the post. This involves drawing some new lines and erasing some old lines, then recreating faces.)



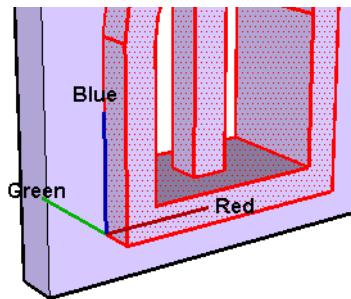
- Select the entire window and make it a component called Arch Window Frame. **Glue it to None**. Because we want to set the location of the insertion point, click **Set gluing plane**.



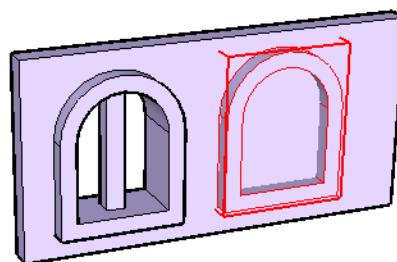
Place the origin at the point where the frame meets the wall.



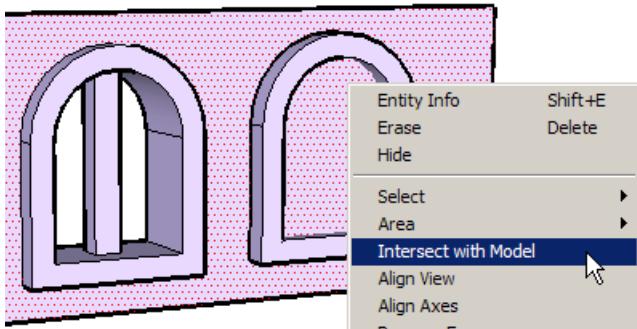
- Keep the same orientation as the previous axes. Red and green directions depend on how you drew your wall.



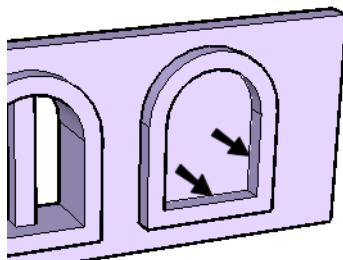
- Click **Create** to create the window component. Now insert another copy of the component. It is inserted at the correct depth, but there is no cutout. You cannot see the post, and the wall face hasn't been divided by the window.



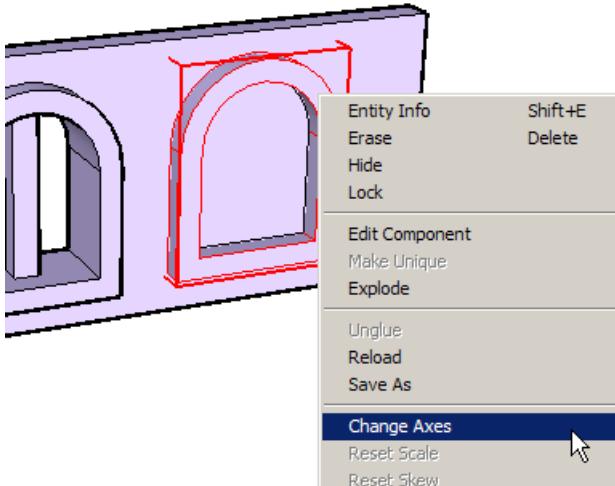
12. Now we create the cutout component. Right-click on the front face of the wall (the cutout is only needed on one face) and select **Intersect with Model**.



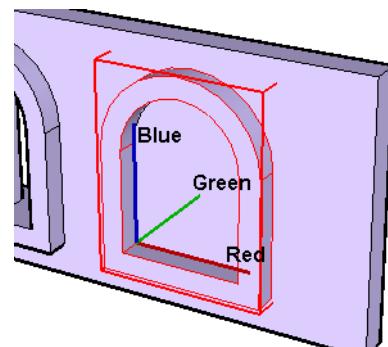
This creates edges along the wall where it meets the arch window.



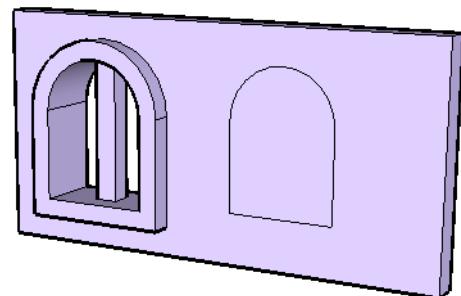
13. The component axes will be changed one more time, so that it will be inserted at the lower corner of the cutout shape. Right-click on the window and select **Change Axes**.



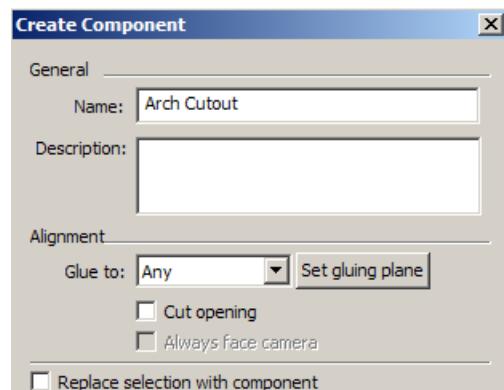
14. Place the origin and axes at this corner point.



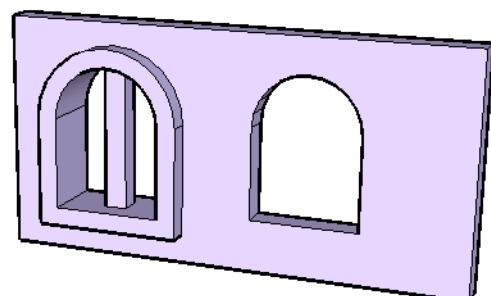
15. Erase the window component, and only the arch cutout shape remains.



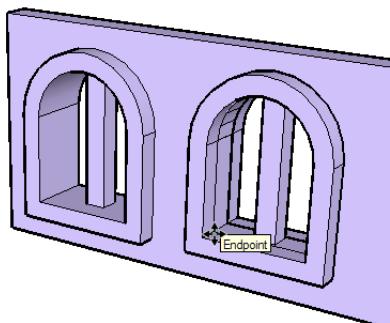
16. Select the arch cutout face (double-click the face to select it plus its edges) and make it a component. Leave both **Cut opening** and **Replace selection** blank.



17. Because this original cutout was not replaced with a component, you can still manipulate it. **Push/Pull** it back to create the opening.

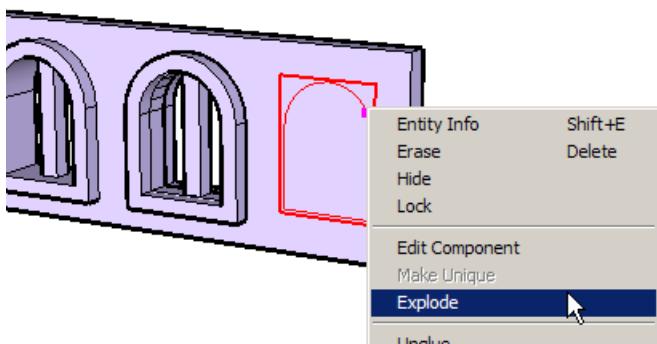


18. Now insert a window component at the lower corner of the cutout.

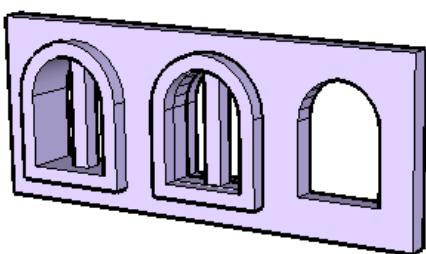


Future insertions of the cutout plus the window will now involve the following three steps:

19. Insert an arch cutout component and **Explode** it. . .



20. . . . **Push/Pull** to create the opening. . .

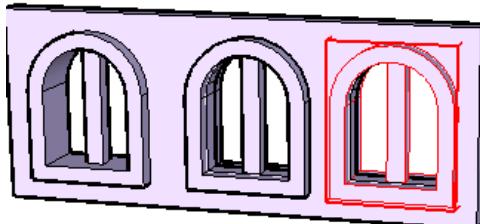



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*NOTE: This is where you can see the advantage of using just the 2D arch shape for the cutout component. If the component consisted of the entire cutout, you would have to explode and resolve lines on both front and back wall faces. Also, with just a 2D shape, you can use it on walls of any thickness.*

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21. Finally, insert a window component at the corner of the hole.



The advantage of this method is that you can have a cutout shape accompanying each window, so that you don't have to create intersection edges each time. The disadvantage is that inserting each window now involves three steps.

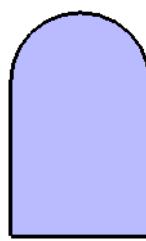
For another way to do the same thing, which involves nesting and exploding components, see "Nested Cutting Components - Any Wall Thickness" on page 223. That method is similar to this one; you create a window component and the cutout shape, which you then combine into one component.

## **Nested Cutting Components - Specific Wall Thickness**

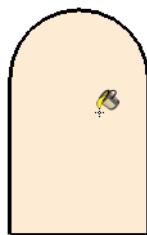
This method presents a very neat way to use one component to cut both faces of a wall simultaneously. You create the front and back components that are set to cut, then combine them into the total window component. When exploded, the subcomponents are "released" to do their cutting.

This exercise also gives an introduction to the use of materials.

1. Start out in **Top** view (drawing in the red-green plane). When components are set to cut, they need to be aligned according to the red-green plane of the component, so it's easiest to create them in this plane.
2. Create the basic shape - an arch once again.

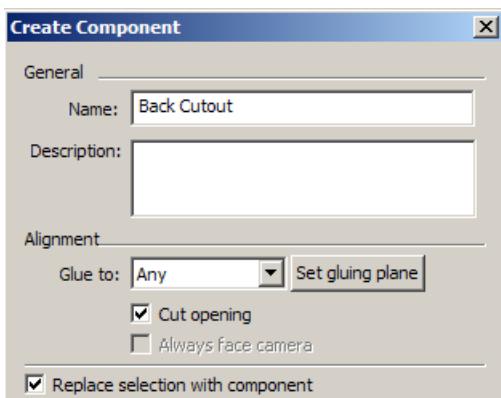


3. Display materials by selecting **Window / Material Browser**. Open the Glass + Transparent category and click one of the glass materials. Click the arch face to apply the glass material to it.

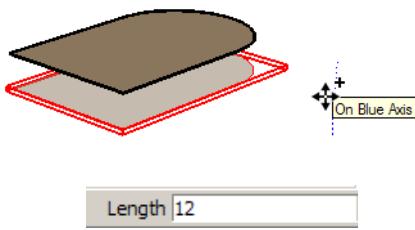


*NOTE: Materials are covered in Chapter 7.*

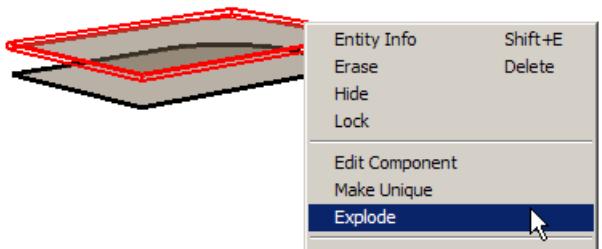
4. Select this arch and make it a component, called Back Cutout. Make sure it can glue to **Any** face, with **Cut openings**, and with **Replace selection**.



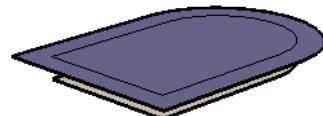
5. Copy this component 12" upward (or use any known distance). Start copying the blue direction, type 12 and press Enter.



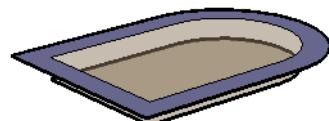
6. **Explode** this top component.



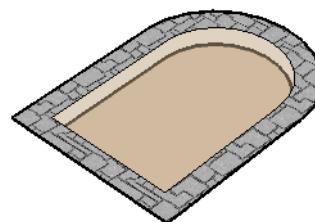
7. Use **Offset** to create an outer arch.



8. Assign the same glass material to the center face of this arch.



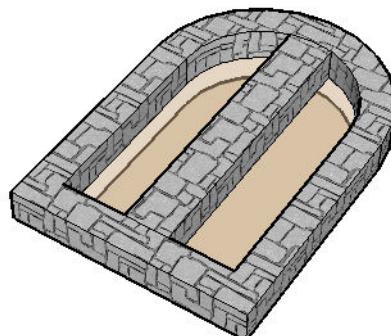
9. Assign a different material to the outer face. This example uses Ashlar Stone, found in the Sketchy Materials category.



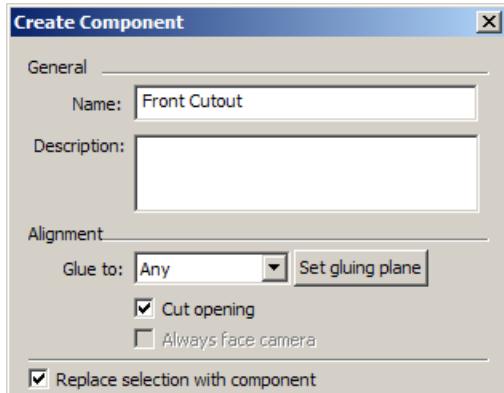
10. **Push/Pull** this outer face; all vertical faces created by this have the same material.



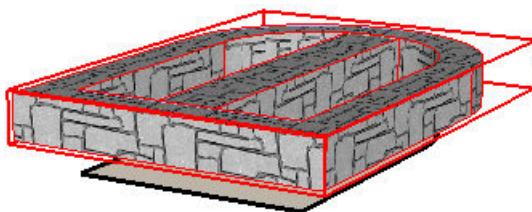
11. Add a post in the center, make it stone, and **Push/Pull** it to the same thickness as the outer arch.



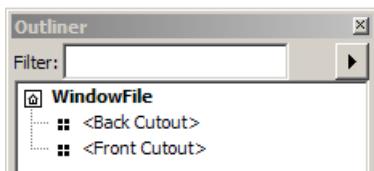
12. Select the top window objects (be sure not to select the bottom arch component) and make it a component called Front Cutout. Make the parameters the same as the back cutout.



The top cutout is now a component.

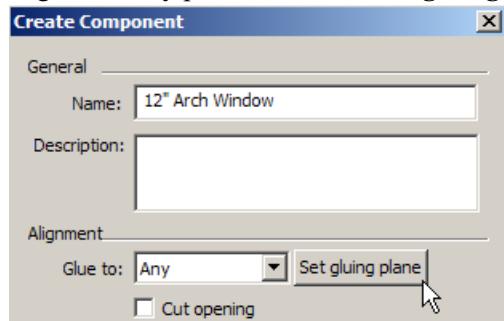


13. Open the Outliner (**Window / Outliner**) to see both front and back components in the list.

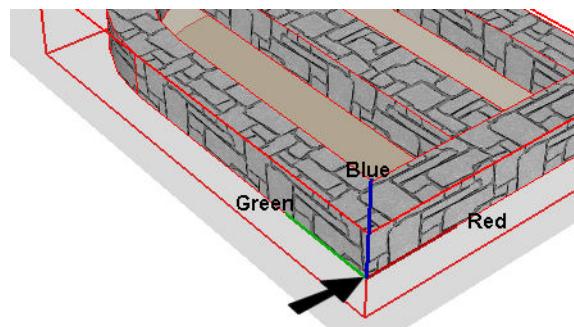


The front and back cutouts are both set to cut openings, but you don't want to insert them separately each time. So, you can create a component comprised of these two components. This is called a nested component (components within a component).

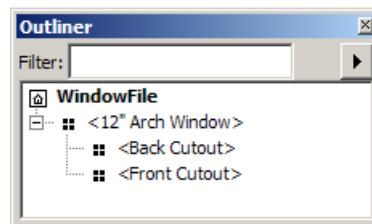
14. Select both components, and create a new component from them called 12" Arch Window. Set it to glue to **Any** plane, and click **Set gluing plane**.



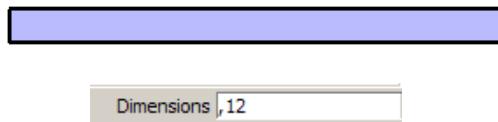
15. Locate the origin at the back of the front frame, keeping the red and green axes in the same direction as before.



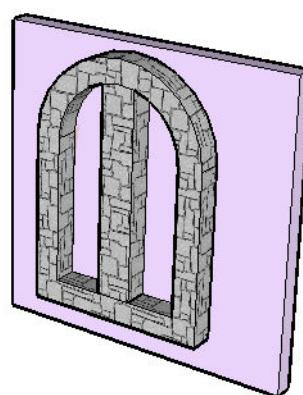
16. The Outliner now shows one component with two nested subcomponents.



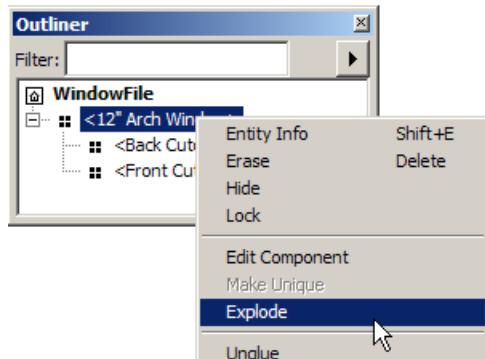
17. Now draw a 12" thick rectangle in the red-green plane. The easiest way is to draw a long rectangle, and then type ",12" to change the second dimension.



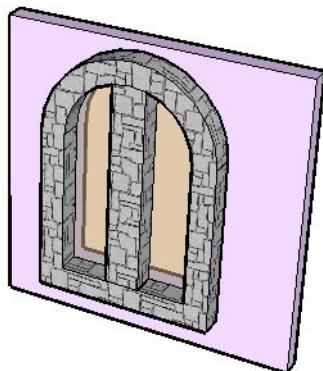
18. **Push/Pull** it up to create the vertical wall and insert a 12" Arch Window component into the wall.



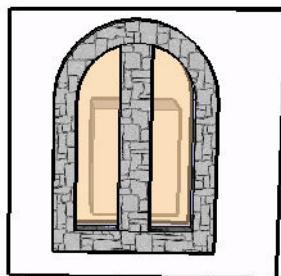
19. **Explode** the component. To get this option, you can right-click on either the component itself, or the item in the Outliner.



This activates the front and back cutout components, which are now free to cut the front and back walls.



20. Because the cutting faces are transparent glass, you can see whatever is behind the wall. Add a small box behind the wall to verify this.

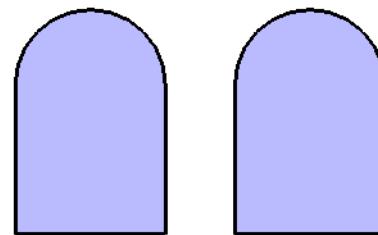


This type of component is a bit heavier to prepare than simple windows, but once it's done you can cut your walls with one click. But the disadvantage is that the component is dependent on the wall thickness. The next method solves this problem.

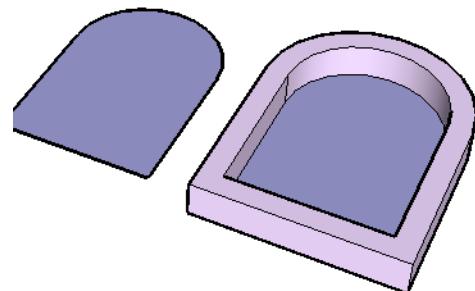
## Nested Cutting Components - Any Wall Thickness

This method uses nested components that can be used to cut walls of any thickness. It is similar to "Creating a Window Component Plus a Cutout Component" on page 217, which uses two separate components - the window plus the cutout shape. This method uses a single component, but does not allow for window frames on both sides of the wall - only the front. (To use a component with details on both sides of a wall means you need to have a set wall thickness.)

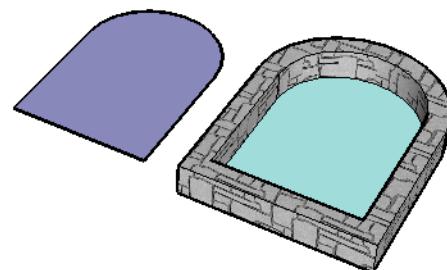
1. Start in **Top** view like before. (If you want, you can start with a wall and create all the components vertically - that also works here.) Draw one arch shape, and copy it.



2. Offset the copy outward and **Push/Pull** to create a frame.



3. Assign a transparent material to the inner face and another material to the frame.

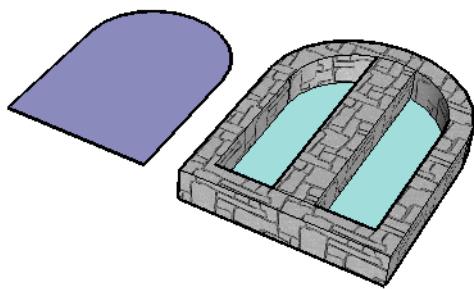



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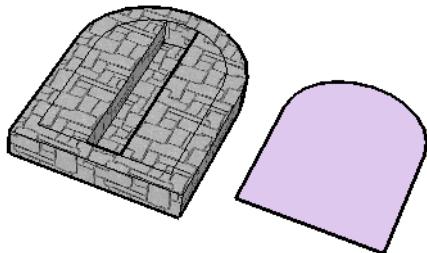
**TIP:** Press **Ctrl** while applying a material to paint all connected faces.

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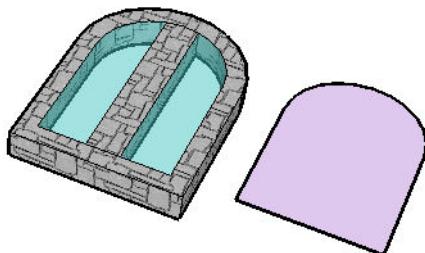
- Add a post using the same material as the frame.



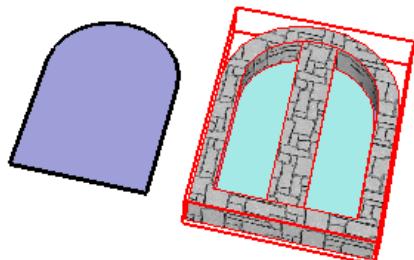
- The window looks great from the front, but look at it from behind. A face can have different materials on its front and back. Also, the post needs a back face.



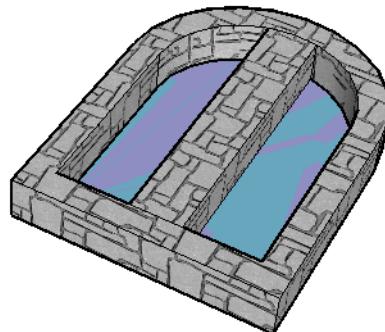
- Fix the post, and assign the glass material to the window faces.



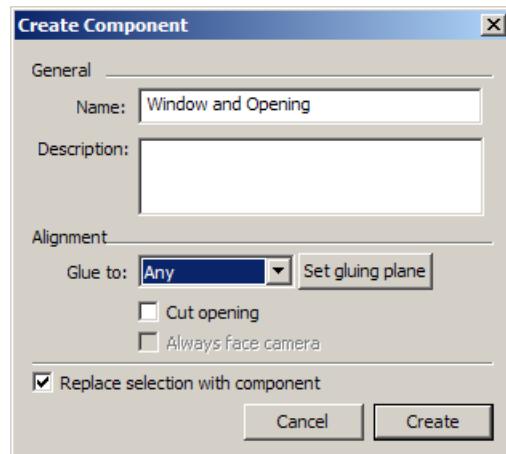
- Make a Window Front component from this framed shape (not including the original arch shape). It should be glued to **None**, and it does not cut openings.



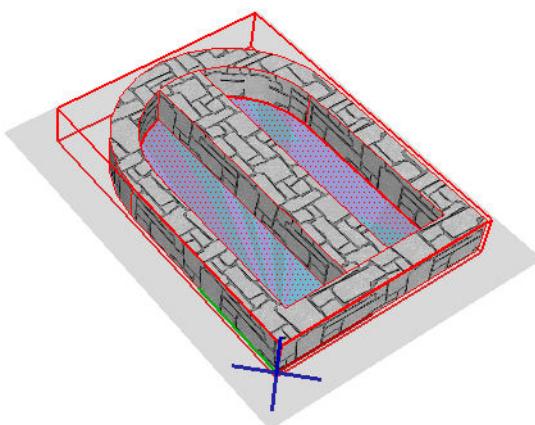
- Move the original arch into this new component, fitting it into the cutout area. (It might be easiest to do this in **X-Ray** mode.)



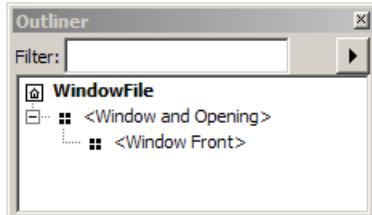
- Create a new component consisting of the window component plus the arch shape, called "Window and Opening." The insertion point should be along the back of the frame, and it should be glued to **Any** plane.



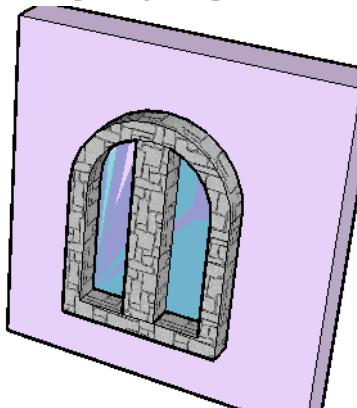
The gluing plane should be along the back of the arch frame.



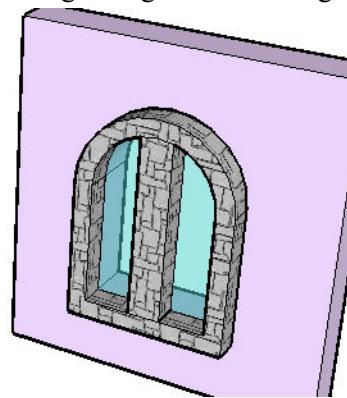
The new component appears in the Outliner, consisting of one nested component. (The arch face is also part of this component, but it does not appear in the Outliner because it is not a group or component.)



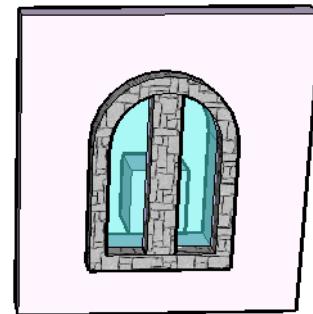
10. Make a vertical wall of any thickness and insert the Window and Opening component.



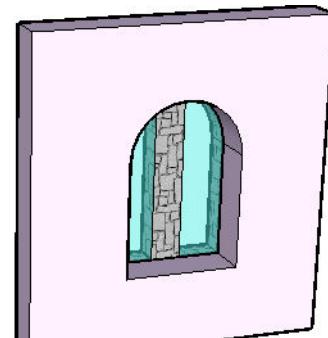
11. **Explode** this component so that it breaks down into the window component and arch cutout shape.
12. **Push/Pull** the arch face through the wall. You can now see through the glass and through the wall



13. Verify the transparency again by drawing a small box behind the wall.



14. Check the window from behind. The wall has a neat cutout, and there is a face of glass where the window starts.



## Cutting Holes in a Curved Wall

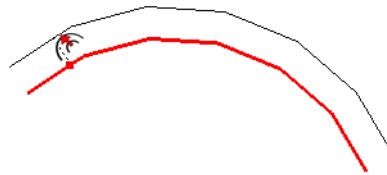
In order for a component to cut, its cutting face must be entirely contained within the plane it is cutting. But what if the wall is curved? A curved wall is actually a series of connected flat planes, and if a component is placed over a joint between walls, the component will not be able to cut both walls.

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*NOTE: For complex shapes, you can also use model intersection to make cutouts. See "Cutting and Embossing" on page 105.*

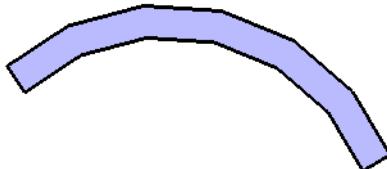
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1. First we need to create the curved wall. Start with an arc. Use a small number of segments, such as 6 or 8. Use **Offset** to create a second arc.

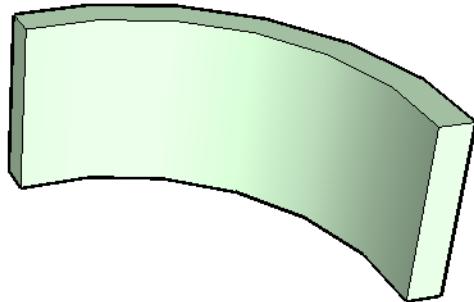


**TIP:** To change the number of arc segments, type 8s (for example) while you are creating it. You can also type the number of segments immediately after creating it, but once you activate another tool you can no longer go back and change the arc.

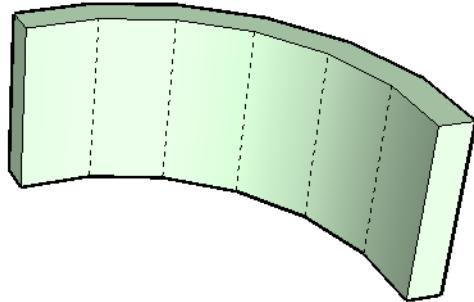
2. Use **Line** to connect the two sets of endpoints. This is the base for the curved wall.



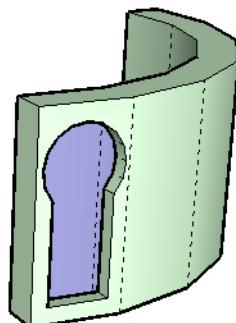
3. **Push/Pull** the wall up.



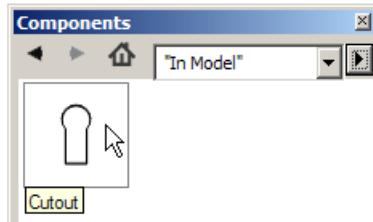
4. The wall looks smooth, but it is actually comprised of several segments. To see the hidden edges, select **View / Hidden Geometry**.



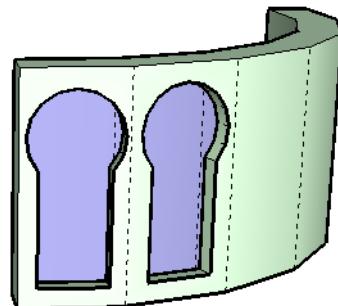
5. Within the first flat segment, draw a cutout shape, **Push/Pull** it inward (not all the way through), and erase its interior face.



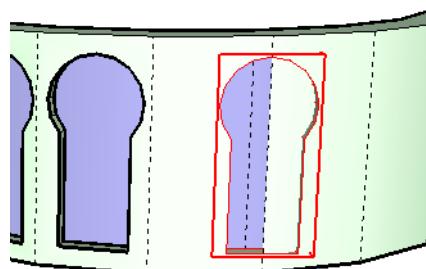
6. Make a component from this window called "Cutout." Set it to cut openings. It appears in **In Model**.



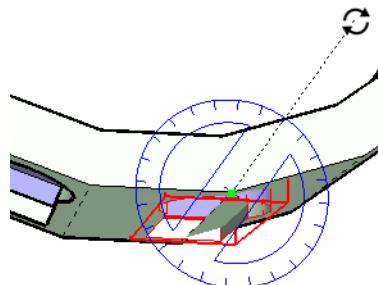
7. Insert one of these components along another face. It properly aligns to the face, cutting an opening in it.



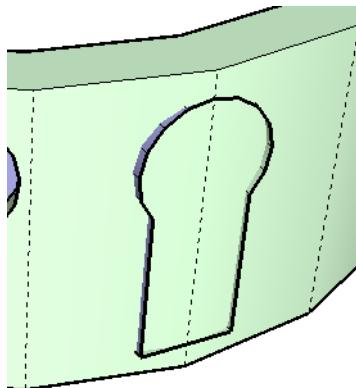
8. Now insert a component over a joint between two of the wall segments. It cuts only one of the faces.



9. The first step is to rotate the component so that it is approximately the same angle from both faces. The component should already be selected, so activate the **Rotate** tool.
10. Locate the protractor at the intersection point between the faces, and align it anywhere.

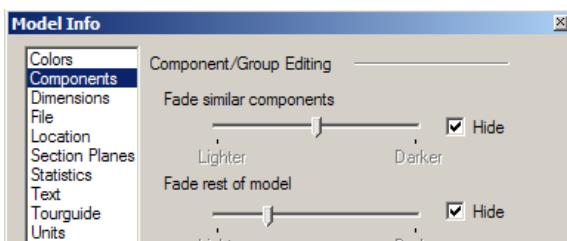


11. Rotate so that the window extends evenly from both sides. There are ways to obtain the exact rotation angle, but doing it by eye is good enough for this exercise. This is how the window should look after rotation.

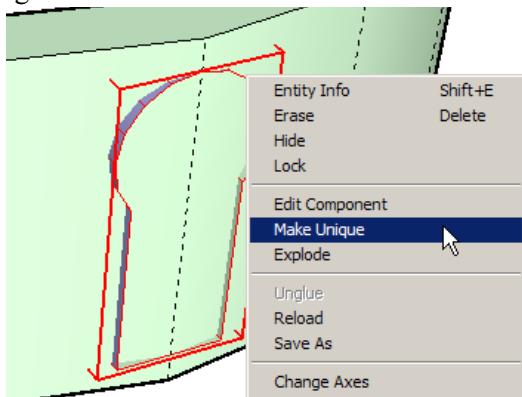


At this point you could finish up by creating the intersection between the window and the walls, exploding the component, and trimming. But we'll do another few things first in order to demonstrate the **Scale** tool, which makes it a bit easier to visualize the intersection edges later.

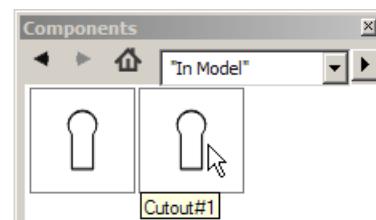
12. Because we will be scaling this component, it will be easier to work with it if everything else is hidden while editing. Open **Model Info** to the **Components** page, and click **Hide** for **Fade rest of Model** and **similar components**.



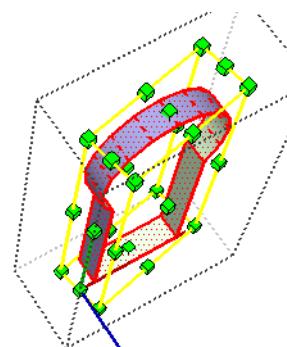
13. Right-click on the window and select **Make Unique**.



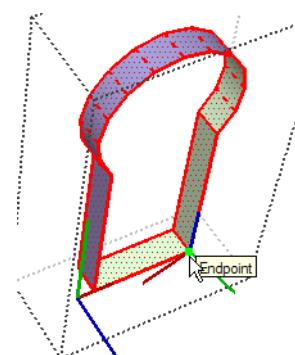
In the Component Browser, a second component was added to **In Model**.



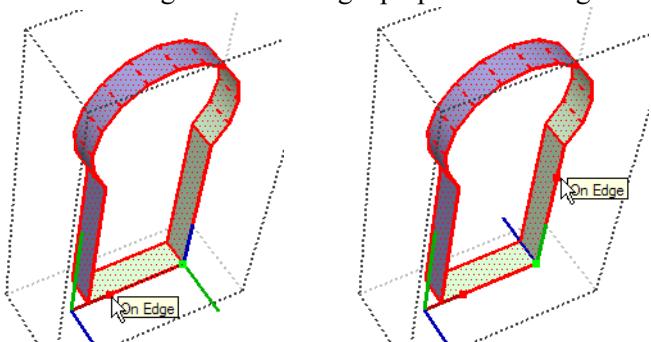
14. Open this component for editing. Select the entire window and activate **Scale**. A set of drag handles appear. However, the bounding box doesn't correspond to the orientation of the window - the box dimensions are relative to the axes of the overall model.



15. We need to change the axes to be relative to the component. Without leaving **Scale**, select **Tools / Axes**. Locate the origin at a corner point of the component.

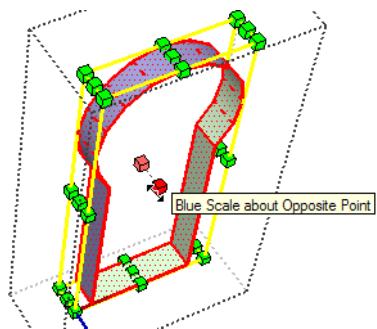


16. Orient the red axis along a component edge and orient the green axis along a perpendicular edge.

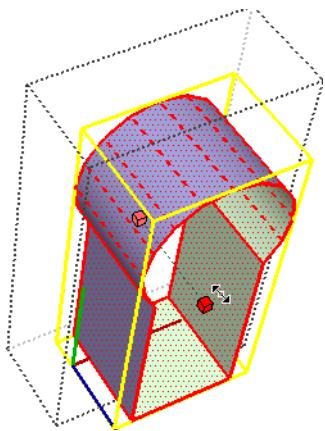


**TIP:** You could also have done this by leaving **Scale** and right-clicking on a horizontal or vertical face of the cutout, then selecting **Align Axes**.

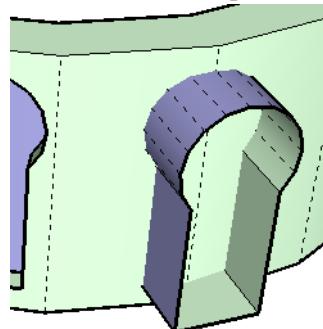
17. You return to **Scale**, and now the drag handles make more sense. We want to pull the window outward, so click and hold the center front handle . . .



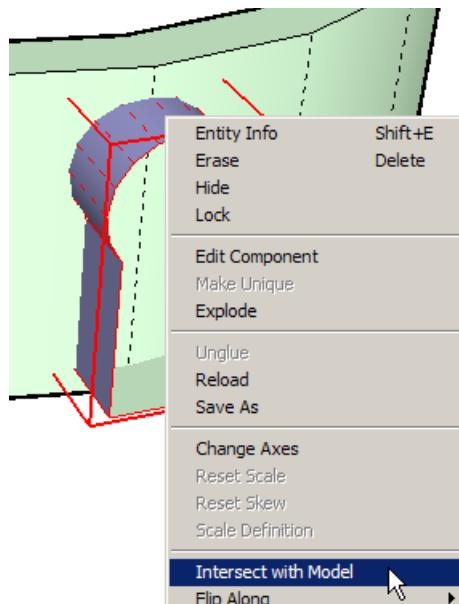
. . . and pull it outward.



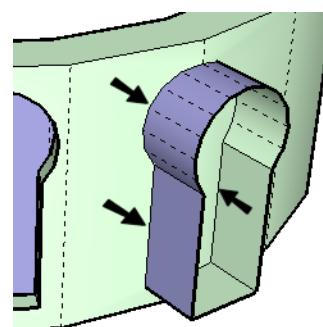
18. Right-click and select **Close Component**. The wall reappears, and the cutout shape sticks out of it.



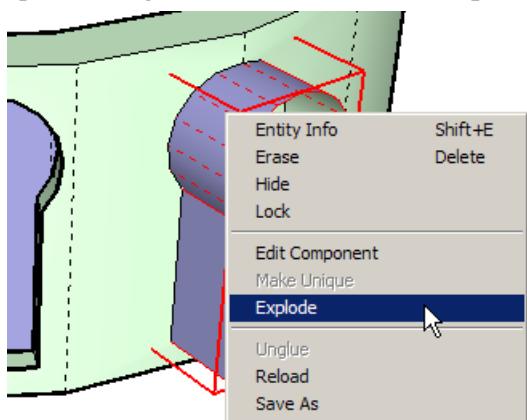
19. Right-click on the changed component and select **Intersection with Model**.



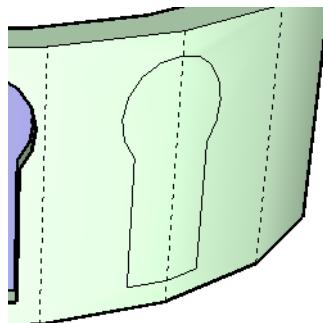
This creates all the edges where the arch shape meets the wall.



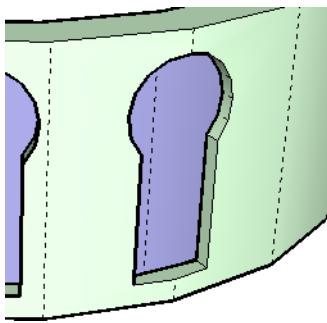
20. Before the window can be trimmed, it must be exploded. Right-click on it and select **Explode**.



21. Erase the extra lines.



22. Erase the faces of the window - the cutout is made.



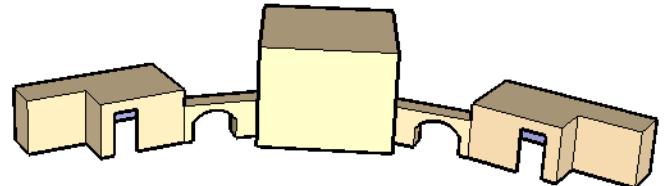

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*NOTE: You also could have exploded this cutout before making it into its own separate component. The advantage to keeping it a component is the ability to hide the rest of the model while editing it.*

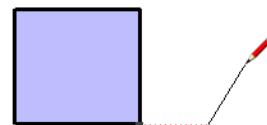
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## Using Components for Mirroring

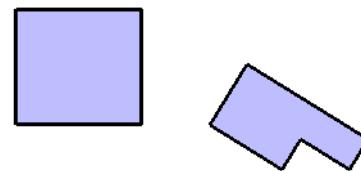
While SketchUp does not have a mirroring function, you can make use of the **Scale** tool on components to achieve the same effect.



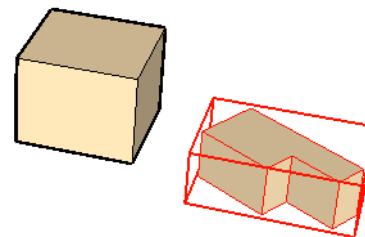
1. Start in **Top** view to create the footprints of the main building and one out-building. Start the diagonal out-building along the red axis from the nearest corner of the main building.



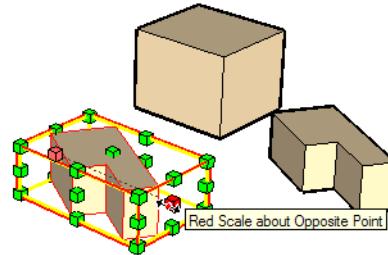
2. Complete the plan of the out-building, keeping all the edges perpendicular.



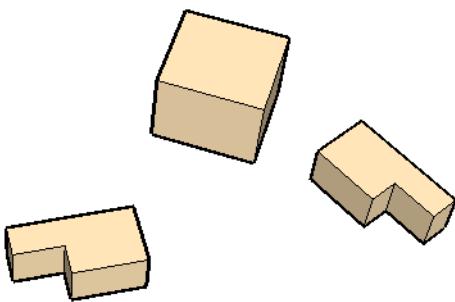
3. **Push/Pull** the two buildings up so that the main building is taller. Make a component of the out-building.



4. Make a copy of the component anywhere, and activate **Scale**. Drag one of the center handles toward the opposite handle . . .

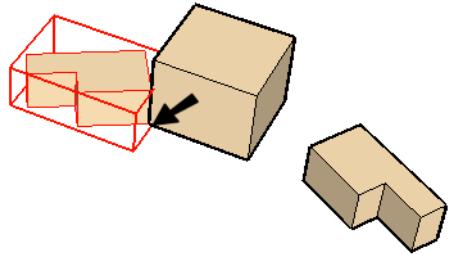


5. . . to turn the component inside-out. Stop when the VCB reads -1.0.

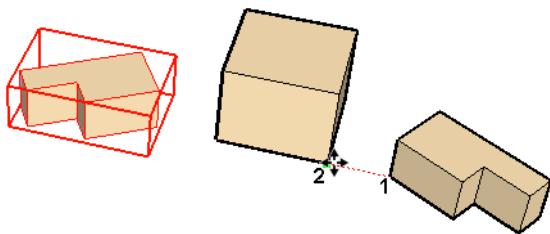


**TIP:** You could do the same thing by right-clicking on the copied component and selecting **Flip Along**, selecting the relevant mirror axis.

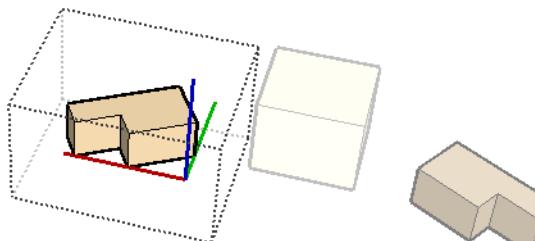
6. To move the copied building into the correct location requires two steps (unless you use construction lines, which isn't necessary here). Start by joining the front corners.



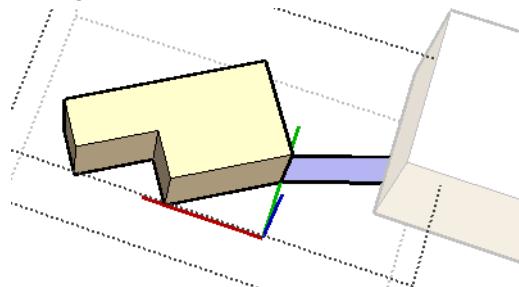
7. Then use Points 1 and 2 as reference points to move the copied building by the same distance.



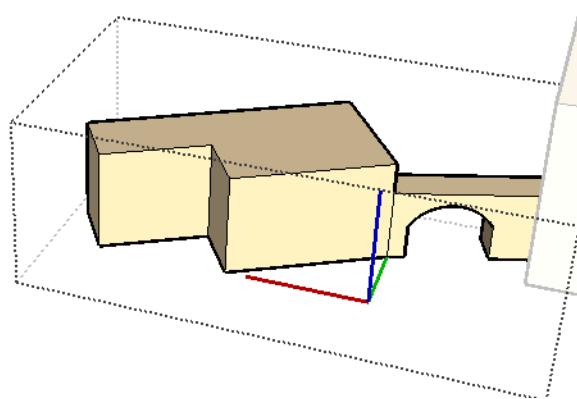
8. Edit one of the components. Any change you make to either component will be reflected in the other, as a mirror image.



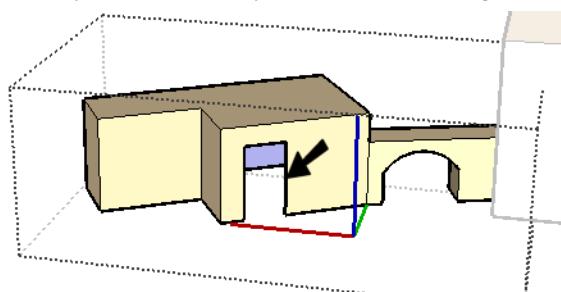
9. Start by adding a thin strip between the two buildings.



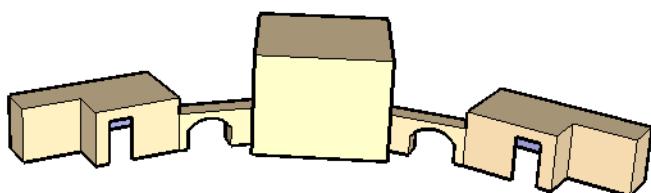
10. **Push/Pull** it up to connect the buildings. Cut an arch in this connecting wall.



11. Finally add a doorway in the out-building.



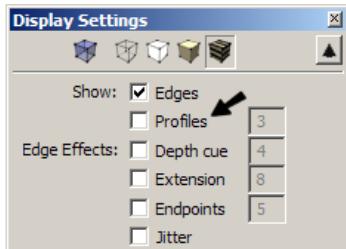
12. Close the component. You should have two mirrored out-buildings, connected to the main building.



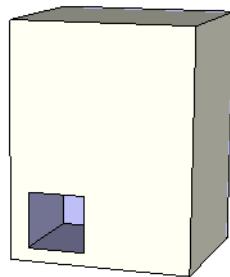
## Replacing Components

In SketchUp it is easy to replace any or all components with another component. A good example for this is a building with many windows.

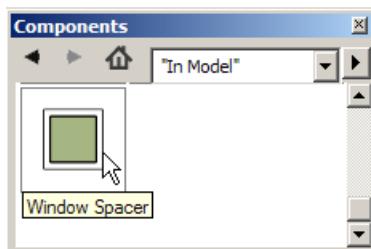
In this example, profiles are turned off so that all edges are thin. This is handy when you have a busy model that can look cluttered with thick lines.



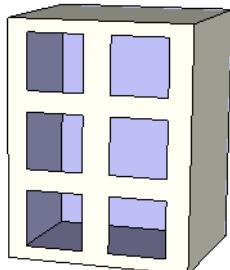
1. Create a tall box with one window cutout.



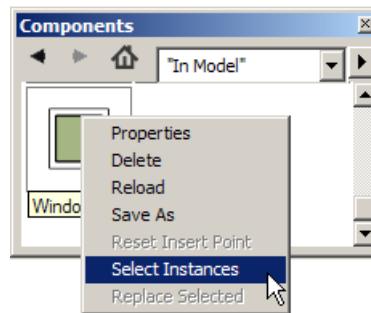
2. Make a component from the cutout rectangle.



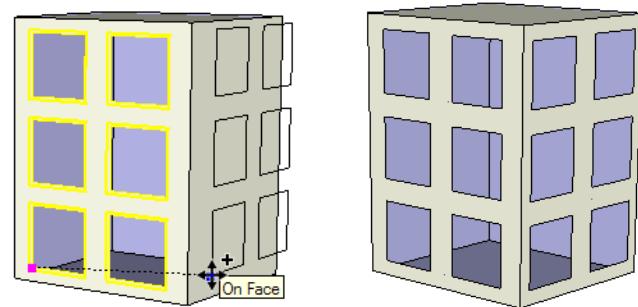
3. Make several copies of the cutout.



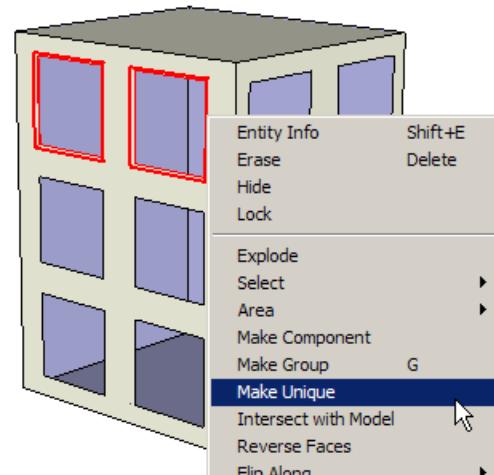
4. To copy these cutouts to the other face, you need to select them all. The easiest way is to right-click the cutout in the Component Browser and select **Select Instances**.



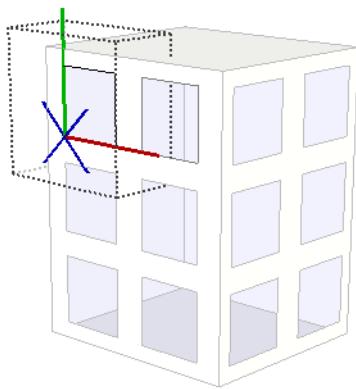
5. Use **Move** with *Ctrl/Option* to copy all cutouts to the adjacent face. You can do this in two steps: Copy loosely to get the cutouts aligned to the face, then move **Move** to place them relative to the neighboring cutouts.



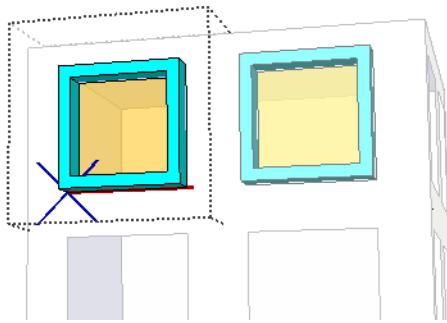
6. Select two of the cutouts, right-click and select **Make Unique**.



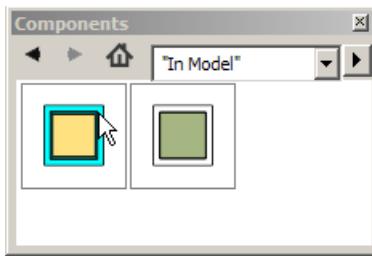
7. Then open one of the new components for editing.



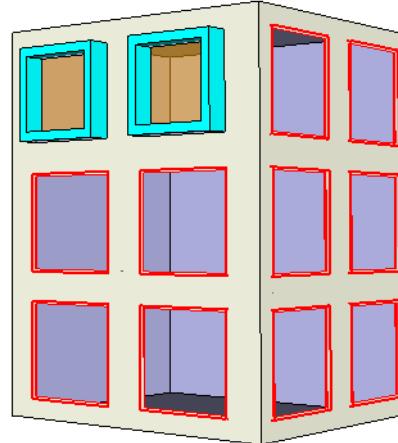
8. Perform a change like this: **Offset** the rectangle, **Push/Pull** out a frame, give the window face a transparent material, and give the frame itself a color.



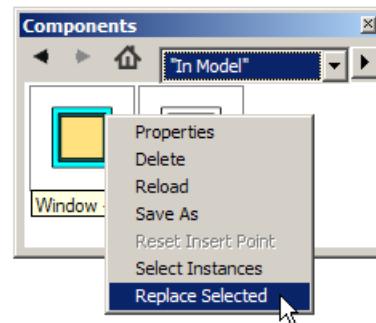
9. Close the new component. You should now have a cutout component and a window component in **In Model**.



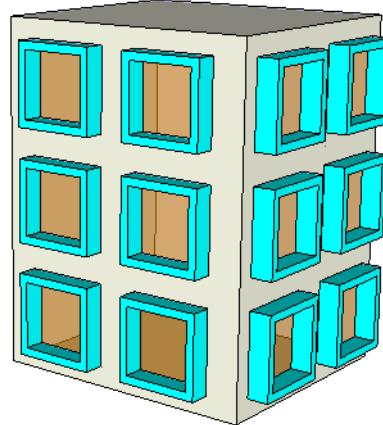
10. Use **Select Instances** again to select all of the original cutout components.



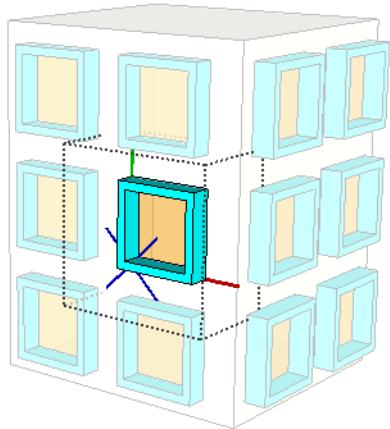
11. Right-click on the new window component in the browser and select **Replace Selected**.



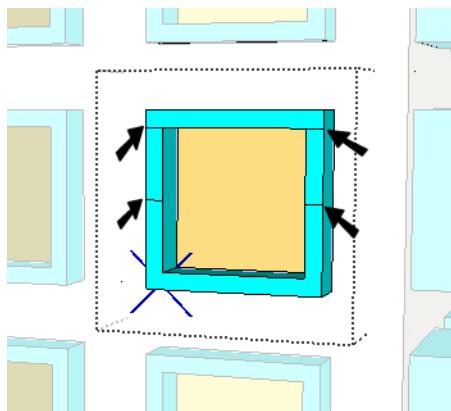
This replaces all the selected components with the one that you right-clicked in the browser.



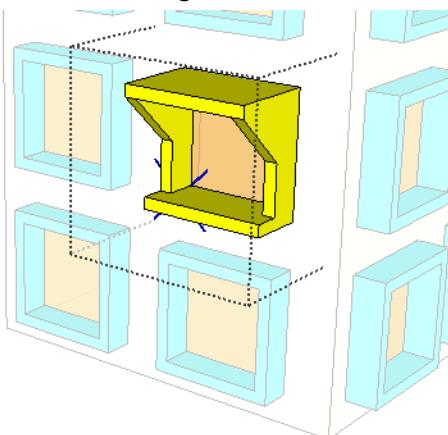
12. Make another window unique and open it for editing.



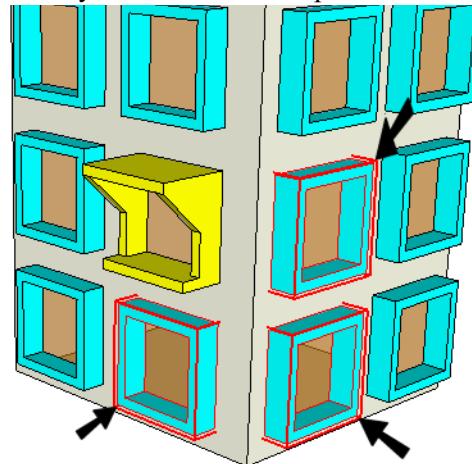
13. To make this window different, add four small horizontal lines where shown.



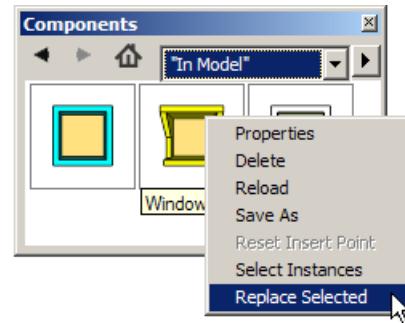
14. With the front face divided, you can **Move** the top face outward to create a canopy. Create a sill at the bottom as well, and give it a new color.



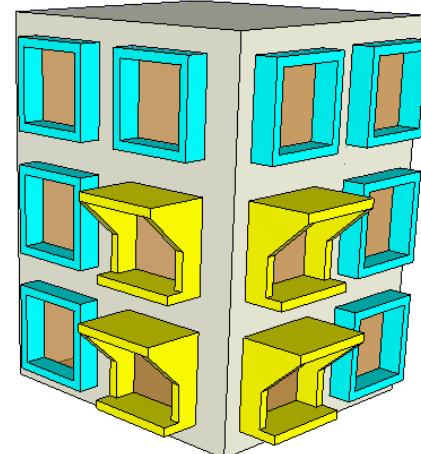
15. After closing the component, select a few of the windows you would like to replace.



16. Right-click on the canopied window in the browser and select **Replace Selected**.

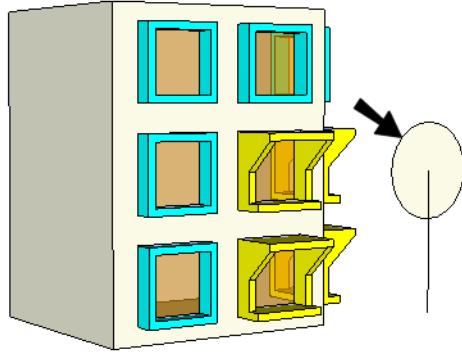


The selected windows are replaced with the canopied window.

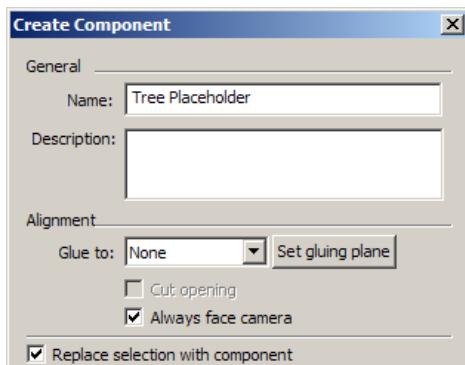


If your file has a large number of complex components, the speed can get bogged down. A good way to prevent a file from getting too heavy is to use simplified components as temporary placeholders.

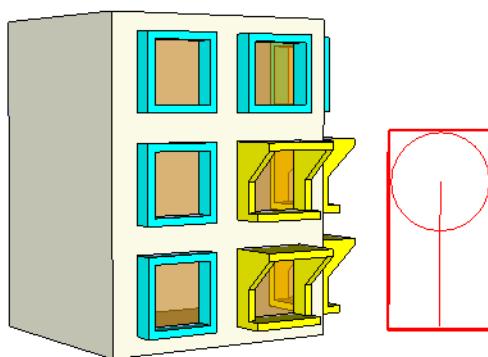
17. Start by drawing a line and a circle to represent a tree. Make it a reasonable height, like 20 or 30 feet. (If the building size needs to be adjusted, use **Scale** - the components will scale with the building.)



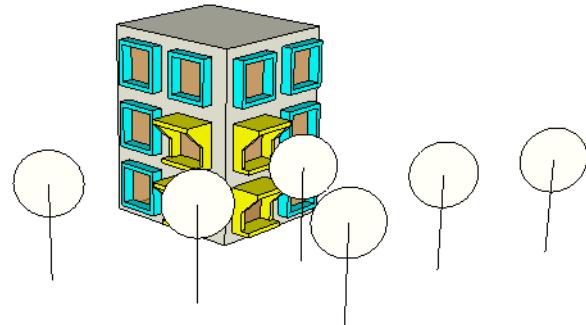
18. Make the line and circle into a component, and check **Always face camera**. This means that 2D components will always be parallel to the screen, and will not look like cardboard cutouts.



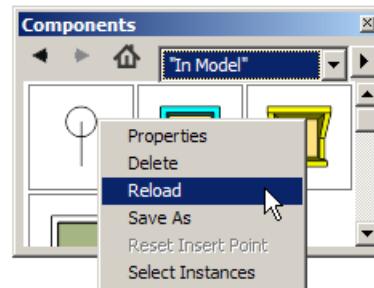
The tree placeholder component should always look the same no matter how you orbit around.



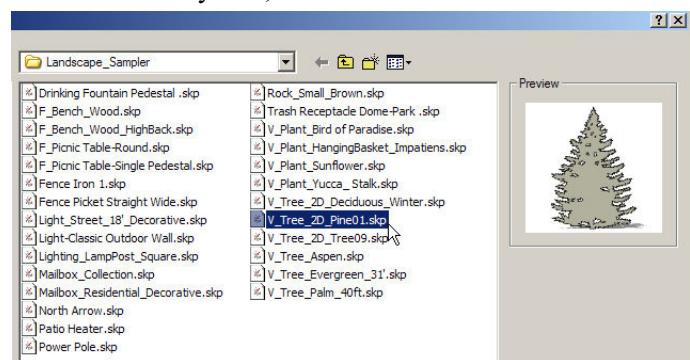
19. Place several of these tree placeholders around the building. It may be easiest to do this in **Top** view.



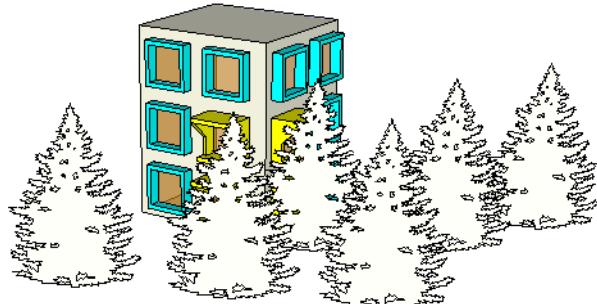
20. To replace all placeholders (not just selected ones) with a component, use **Reload**. You can access **Reload** by right-clicking any placeholder component, or by right-clicking the item in the Component Browser.



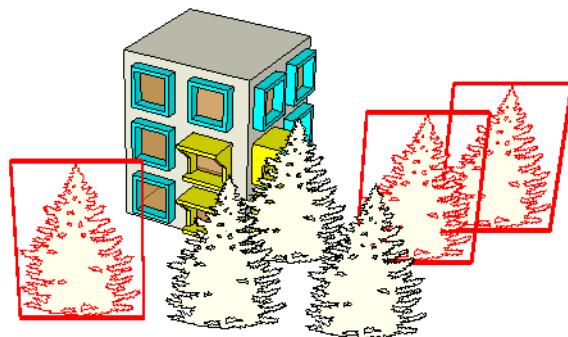
21. To find a predefined tree, browse to where the predefined components are installed (...SketchUp5\Components\Landscape\_Sampler). Choose any tree; in this case a 2D tree was selected.



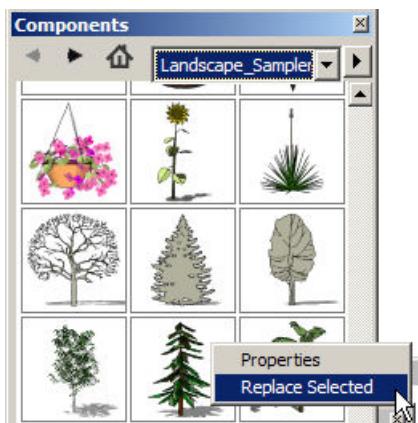
All tree placeholders are replaced with **Face camera** trees.



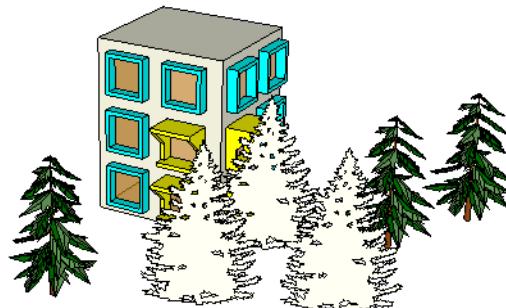
22. As you've seen, you can replace just selected components. Select a few trees.



23. In the Component Browser, open the **Landscape\_Sampler** folder and right-click a different tree (in this case, a 3D tree). Select **Replace Selected**.



The selected trees are replaced.



As components go, 2D trees and people are “light” components, and will not bog down your file too much. If you have numerous 3D components, however, using placeholders is a great way to keep up speed while working on the file. At the last minute you can switch out the placeholders for the real thing.

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*NOTE: For an example that uses an image to create a “Face camera” component, see “Creating a Painted 2D Tree” on page 275. If you have alpha-channel transparency in your component image, see “Alpha Transparency” on page 296.*

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## Tips for Efficiency with Components

- If you want to make a component of a symmetrical object, it's handy to make a component of one half, make a copy, then mirror the copy. Any changes to first half are reflected in the other. For complex components, this can cut down the file size.

- As you may have noticed, when you delete all instances of a component from your file, it still appears listed in **In Model**. These components are still attached to your file, and having a large number of them can slow down performance. Therefore, it's a good idea to purge the ones you're not using.

You can purge an individual component by right-clicking it and selecting **Purge**. (Components that are in use have this option grayed out - this can't be used as a way to mass-delete components.) In **In Model** you can click on the right-facing arrow and select **Purge Unused**. To get rid of all unused components, materials, and layers, open **Model Info** to the **Statistics** page and click **Purge unused**.

- The number of instances of any component does not affect performance (since they are all copies of the original). But if you use numerous and complex

components, this can get cumbersome. To solve this, you can use substitute components - simple objects like lines or boxes - as placeholders for the real thing. Then when the model is ready, you can replace the placeholders. See "Replacing Components" on page 231.

# 7 Painting, Materials, and Textures

## Overview of Materials

One of the things that makes SketchUp such a great visualization tool is its texture, or material, feature. You can use this to apply colors, pictures, and textures to any face or edge.

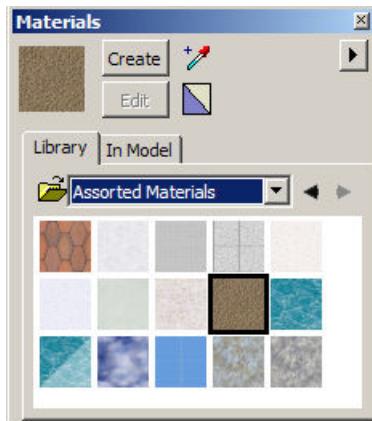
To open the Material Browser, click the **Paint** icon, or select **Window / Material Browser** (*Mac: Window / Colors*).



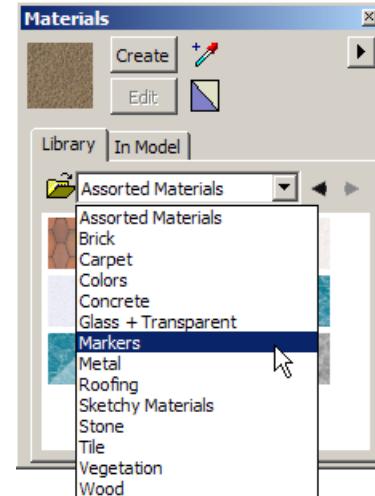
## Windows Material Browser

(*Mac users: see "Mac Materials Browser" on page 239.*)

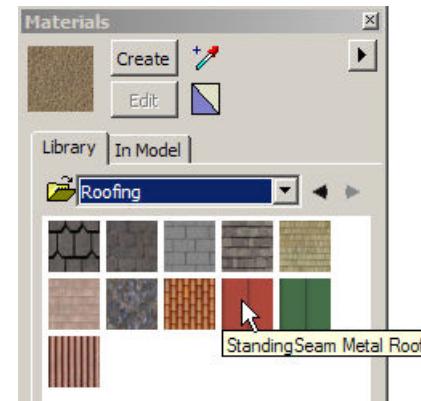
The Material Browser looks like this. It is one of SketchUp's stacking windows - see "Stacking Windows" on page 437.



1. To see the various categories of materials provided, click the drop-down arrow.



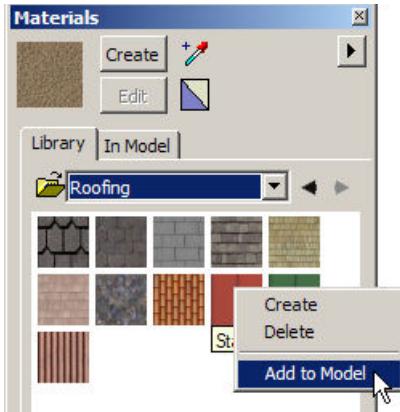
2. Click **Roofing** to see the materials in that category. Hovering over a thumbnail will open a tool tip telling you the name of the material.



All materials are either a solid color or a graphic. The graphics provided are jpg's, and are located by default in the folder ...@\Last Software\SketchUp5\Materials. You can use the browser icon to locate graphic files in any folder, including those you make yourself.

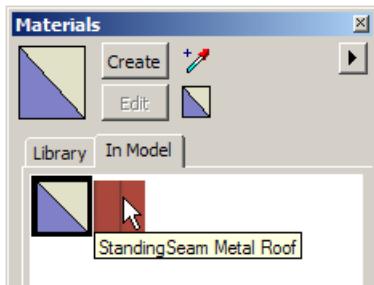
**TIP:** In Windows, you can change this default folder on the **Files** page of the **Preferences**, by modifying the path for **Texture Images**.

- Note that the default tab you're in is called **Library**. The library contains all the material included with your installation, plus any you add to it. But there are no materials yet defined in your model. Right-click on any material and select **Add to Model**.

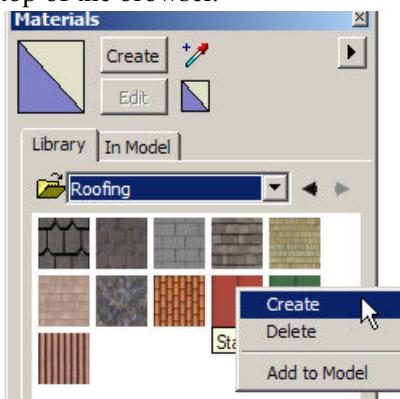


**NOTE:** As you'll see, you don't have to use **Add to Model** for every material you plan to use. You can just start painting with a material, and that material gets added automatically.

- Now click the **In Model** tab, and the thumbnail is now listed.

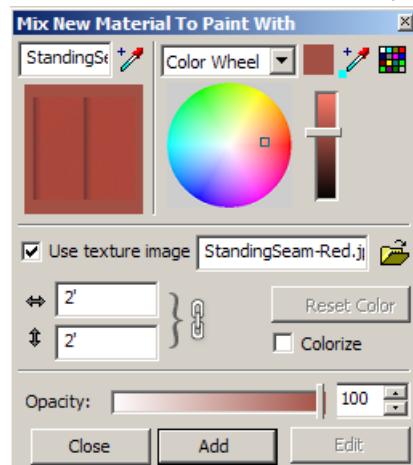


- Returning to the library, right-click on a material and select **Create**. You can also click the **Create** button at the top of the browser.



**NOTE:** In Windows, you cannot click **Edit** because materials in the library cannot be changed from within the browser. You can, however, edit materials in the **In Model** tab, as we'll see later.

- Clicking **Create** opens a window in which you can create a new material based on the one you selected.



There are four color selection methods:

- **Color Wheel:** Select a color from the circular spectrum.

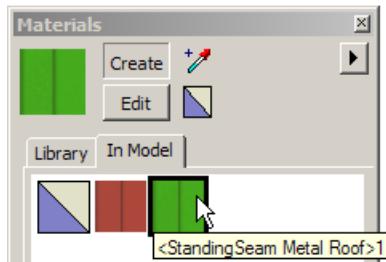


- **HSL:** Hue, Saturation, Luminance values.
- **HSB:** Hue, Saturation, Brightness values.
- **RGB:** Red, Green, Blue values.

- Change the material name (or use the name provided by default), and then modify the color.



8. Click **Add** to add the new material to the library. The material with its new color, and new name, are listed in **In Model**.



There is also a **Delete** option. Be careful not to delete materials you might want! The deletion is not final however; you will be asked if you want to save changes to the library.

## Mac Materials Browser

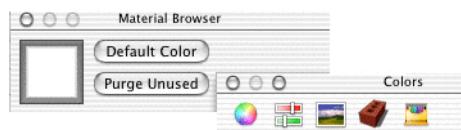
On the Mac, the browser is actually called **Colors**, but is sometimes also referred to as Materials browser.

To show the Materials / Colors browser, click the **Paint** icon, or select **Window / Colors**.

The browser appears, by default, on the right side of the screen, but you can move it anywhere.

## Colors

The default color is initially blank, meaning that your faces are unpainted when created. There are several ways to select colors and textures to assign to faces.



When you want to apply color, SketchUp uses the Mac OSX internal Color Picker (Color Wheel) or any color chosen from Color Sliders (Grey Scale, RGB, CMYK, or HSB sliders), Image Palettes, Texture Palettes, or Crayons.

You can activate the Color Picker by clicking on any color well in the SketchUp interface, such as in the Material browser pane.

Below the toolbar is the Active Color Well, which shows the current selection. You can drag and drop colors from this well into your model or into any other visible color well.

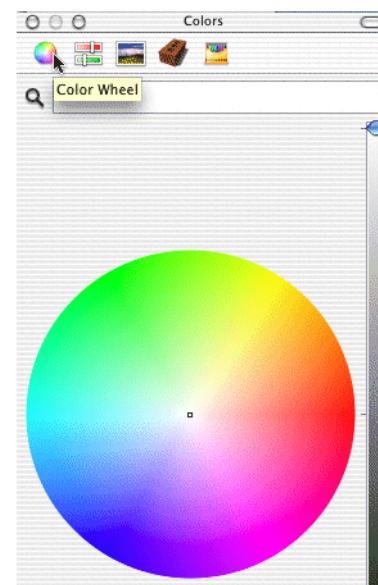
---

**NOTE:** You cannot drag textures from this well into your model. If you do, you will simply get the solid color associated with the texture.

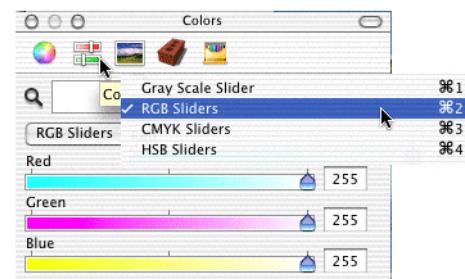
---

The magnifying glass to the left of the Active Color Well activates the Screen Sampler. This enables you to select a color from anything current visible, anywhere on the screen.

Another way to select a color is to click **Color Wheel** - you can click anywhere on the wheel to select the color at that point.

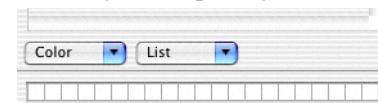


Click **Color Sliders** to specify a color numerically by RGB, CMYK, or HSB values.



You can also click **Image Palettes** and select the preinstalled **Spectrum** image, then use the magnifying glass to pick out a color. Or click **Crayons** for an easy way to view and pick colors.

Below the Color Picker Panel is the User Palette - an expandable palette of small color wells into which you can drag colors that you frequently use.

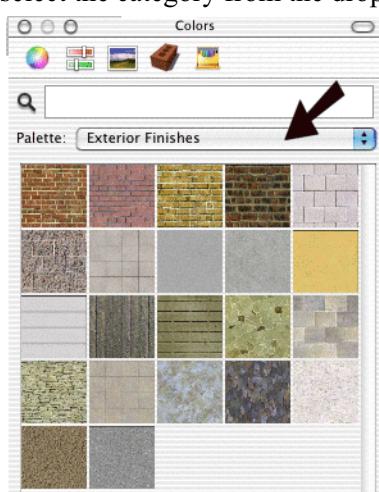


To add a color to the User Palette, drag a color swatch from any visible color well into one of the small wells. Dragging a color over an existing one will replace it. You can delete a swatch by dragging an empty square over it.

The User Palette remains constant between files, so it's a good place to store materials and colors you want to transfer between models.

## Textures and Materials

By default, the browser opens to a category called Base Materials. Texture categories include preinstalled textures provided for you as \*.jpg images, which tile seamlessly when repeated. These images are stored in Root directory\Library\Application Support\SketchUp\Materials. To switch between categories, such as Exterior Finishes, Roofing, Markers, etc., simply select the category from the dropdown menu.



If you want to be able to edit a material or image, you need to create a “personal” palette. (Colors and textures used in your model are automatically added to **Colors in Model**, which is the only place they can be edited.) Open the **List** dropdown menu at the bottom of any pane and click **New**.



(You can also add a new texture by right-clicking within this pane of **Colors in Model**, or the personal palette.) By default, this new personal palette is called **My Textures** but you can rename it. Once loaded into **My Textures**, an image or material can be edited, just like from within **Colors in Model**.

You can delete a material from your personal palette by right-clicking on its swatch and selecting **Remove**. You can also select **Remove** from the **Colors** dropdown menu in **Colors in Model** or **My Textures**. Be careful when using this, because you cannot undo the action! If the material still exists in the User Palette, you can still drag it back into your personal palette.

Once a color, texture, or image has been used in your model, it appears in the **Colors in Model** palette, available in the dropdown menu.

To remove unused materials, go to **Colors in Model** and select **Purge Unused** from the **List** dropdown menu.

## Importing Images

You can also import your own custom textures. Select **Colors in Model** or **My Textures** (if you want to edit the image) from the palette dropdown menu. At the bottom of the pane is a **Color** button; click this to get a dropdown menu including the option **New Texture**. (This option is also available when you right-click inside the pane.) **New Texture** enables you to load an external image file to be used as a texture.

You can also import an image to use for picking colors. Click **Image Palette**, where the image **Spectrum** is already preinstalled. Select **New from file** to browse to the image you want to import.



You can also drop an image file directly into the Image Well of the Image Palette. Like the User Palette, images imported this way remain available from model to model.

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**TIP:** If the image is only to be used as a texture, you may want to import it directly into **Colors in Model** or **My Textures** (if you want to edit it). The main reason to import an image into the Image Palette is to use it for picking colors.

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## Where to Find More Materials

If you need materials that aren't included in the installation, and don't feel like creating your own, there are a few places you can try.

Go go [www.sketchup.com](http://www.sketchup.com) and open the **Downloads** page. Under the top bar on this page, click **Materials** (you will also find components and plug-ins here.) Installation instructions are provided for Windows and Mac.

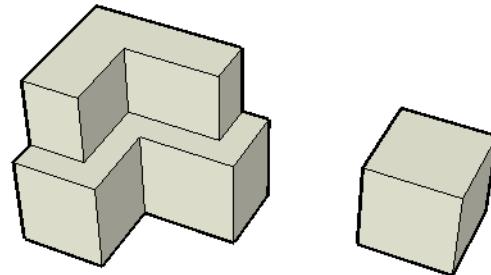
You can also try [www.sketchup.com/forum](http://www.sketchup.com/forum) (located in the **Support** section of the main website) and click **Materials/Components**. These are objects and materials created by SketchUp users who have generously posted them for public use. You can search for something specific or post a request to see if someone might have what you're looking for.

SketchUp's "Partners" page also has a list of sites where materials can be found. On the main company page ([www.sketchup.com](http://www.sketchup.com)), click "Company" at the top. Then click "Partners" just below the main bar at the top. Try the links listed under "Product Resources." The sites listed mostly carry components, but you can find some materials as well (try [objectivenetworks.net](http://objectivenetworks.net) and [formfonts.com](http://formfonts.com)).

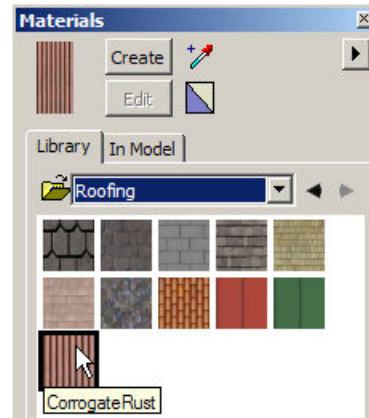
## Applying Materials

Now that you can navigate your way through the browser in Windows or Mac, let's apply some materials to faces.

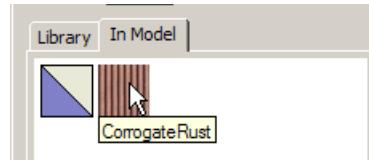
1. Start a new file and draw two forms like these:



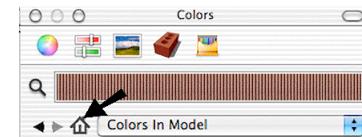
2. Open the Material Browser to the Roofing category and add CorrugateRust to the model.



3. Click the **In Model** tab to see that the material has been added.

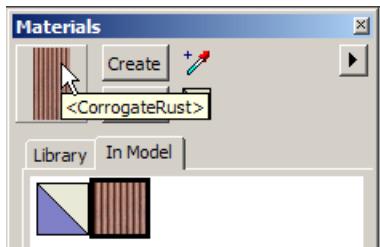


*Mac: select **Colors in Model** from the dropdown menu or click the house icon to take you directly to **Colors in Model**.*



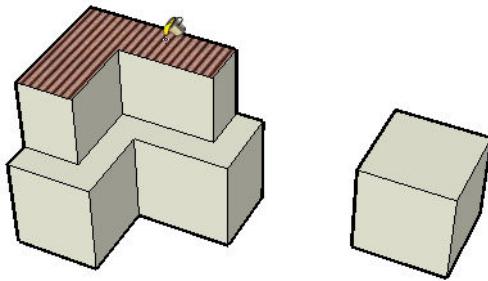
*The arrows next to the house icon can be used to scroll between the last palettes you used.*

- Click the thumbnail to activate the material. It appears at the top of the browser, (*Mac: In the Active Color Well*) instead of Default which was there before.



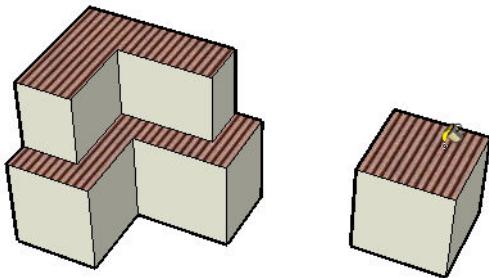
**TIP:** "Default" is always available. If you want to return any face to its non-painted state, just apply Default as you would any material.

- Click one of the roof faces to paint it with CorrugateRust.



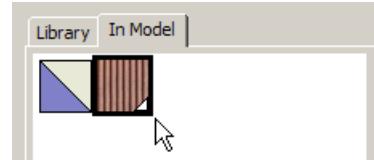
**NOTE:** Faces in SketchUp are double-sided, and when you apply a material it generally paints one side only. The exception is when you use transparent materials. For more information, see "Double-Sided Faces" on page 254.

- Click the other two roof faces to paint them the same way. Any face you click while CorrugateRust is active will take on that material.



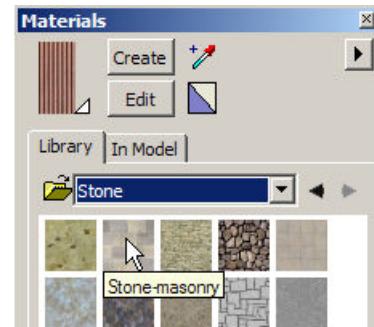
**TIP:** You can get the total area of all faces that use the same material. Right-click on any face and select **Area / Material**. (In Windows you can also right-click on the thumbnail in the browser and select **Area**.) For details, see "Measuring Length and Area" on page 373.

- In Windows, look at the thumbnail in the **In Model** browser. It now has a small white triangle at the lower right corner, to indicate that it is in use.

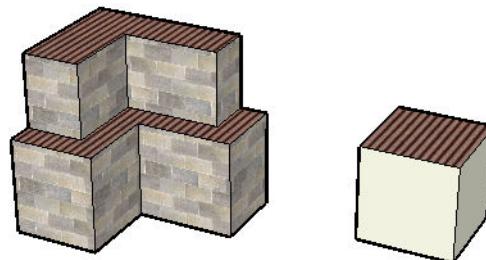


*Mac: There is no indication for materials in use.*

- For the next material, go to the Stone category, and click Stone-masonry. Now this material is active.



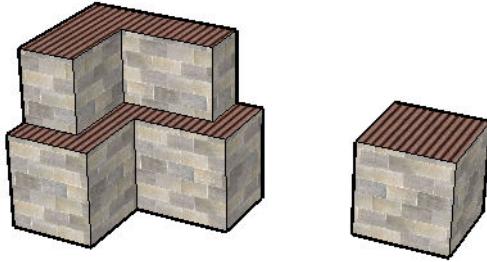
- You can apply this material to each face separately, but there are easier ways. Press **Ctrl/Option** and click any vertical face of the large building. This applies the material to the selected face and all faces connected to it - directly or indirectly - that have the same material as the clicked face (Default, in this case).



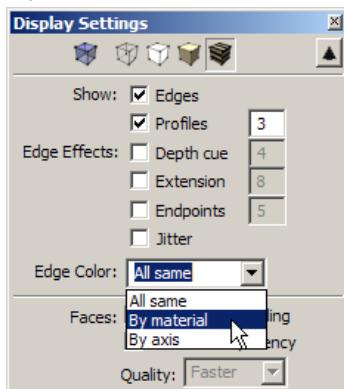
In this case, the vertical walls of the large building are all painted, but not the smaller building because it is detached.

**NOTE:** Faces painted using **Ctrl** must be **contiguous** to the selected face. A face that is already painted would break this continuity; see "Using Shift and Ctrl/Option Keys" on page 248. In the case of this exercise, the vertical faces are all considered contiguous because they touch at the back of the house.

10. **Undo**, and make sure Stone-masonry is still active. Now press Shift and click the same face. This applies the paint to all faces that share the same material as the selected face, contiguous or not.



11. You can set edges to take on the color of the material of the object. Open **Display Settings** and set **Edge Color** to **By Material**.

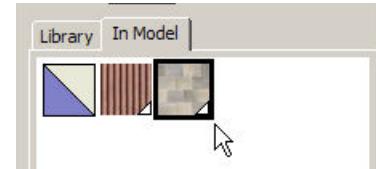


Now the edges are no longer black.

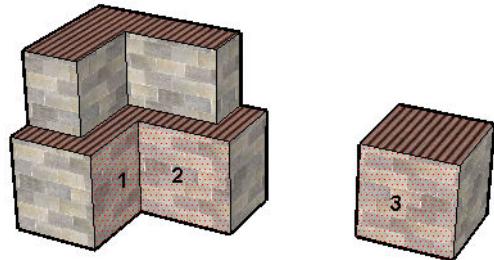


You can continue to work this way, or set the edges back to **All Same**.

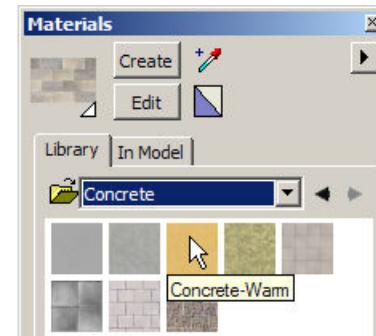
In the **In Model** tab (*Mac: Colors in Model*), there are now two in-use materials.



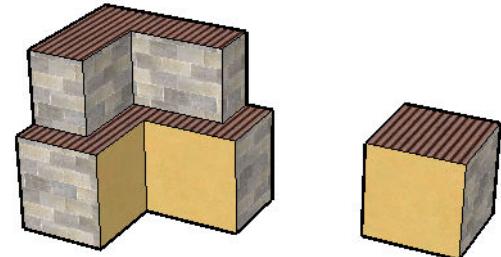
12. Another way to paint multiple faces is to select them first. Use **Select** to select the three faces shown.



13. Now activate a new material, like Concrete-warm.

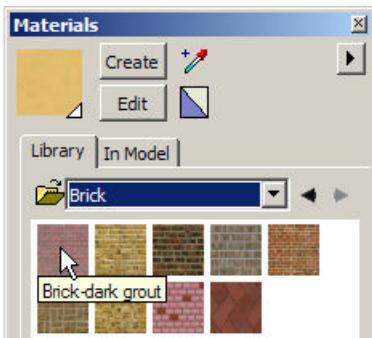


14. Click any one of the selected faces to apply the material to all three.

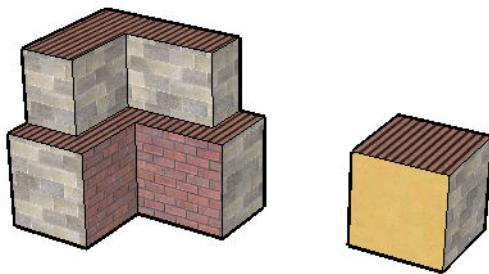


15. Deselect all faces.

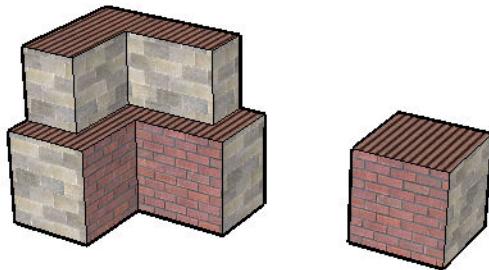
16. To demonstrate the use of Shift again, select yet another material, such as Brick - dark grout.



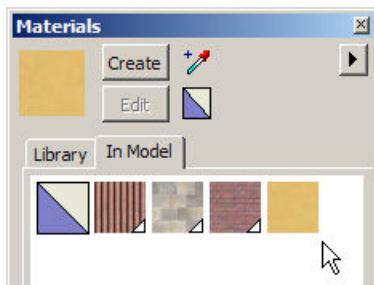
17. Press *Ctrl/Option* and Shift together. Then apply the brick to one of the “Concrete-warm” faces on the larger building. This replaces only similar, **connected** faces. The smaller building is not affected



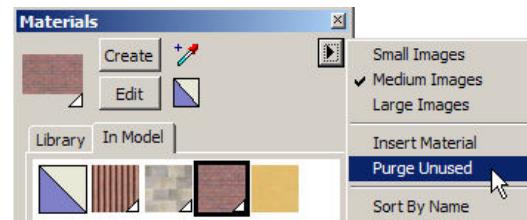
18. Undo, and reapply the brick while pressing Shift. Now each “Concrete-warm” face is replaced by brick.



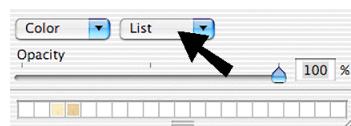
Even though Concrete-warm is no longer used, it still appears in **In Model / Colors in Model**. In Windows, its “in-use” triangle indicator is gone.



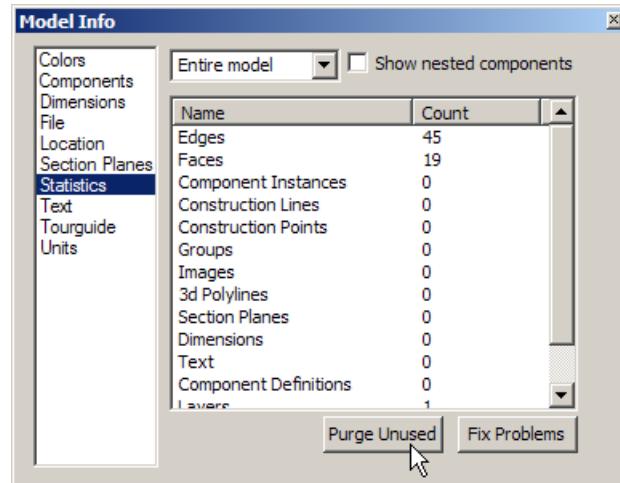
19. Keeping lots of unused materials can bog down your file, so it’s a good idea to get rid of the ones you don’t need. Right-click on the thumbnail of Concrete-warm select **Delete** (*Mac: Remove*). Or right-click on the right-facing arrow in **In Model** and select **Purge unused** (Windows only).



*Mac: Purge Unused is also located in the List dropdown menu.*



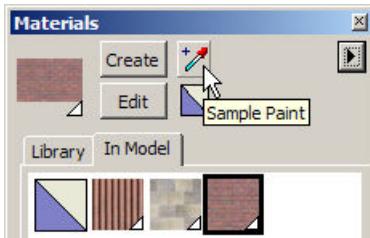
NOTE: You could also open the **Statistics** page of **Model Info**, click **Purge Unused**. (This also gets rid of unused components and layers.)



Now only the materials in use appear.

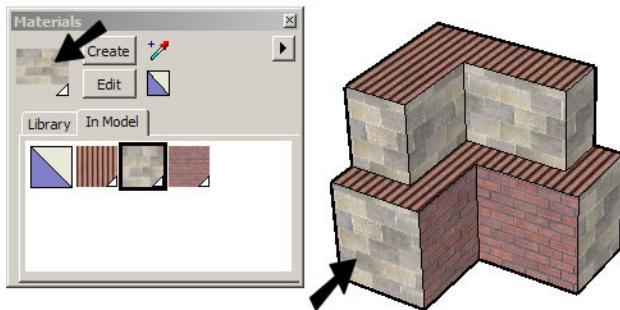


20. One of the neatest features of materials in SketchUp is the capability of real-time editing. In Windows, click the dropper icon, which is used to detect the material of a selected face. You can also activate the “dropper” function by simply pressing Alt/Cmd while in the **Paint** tool.

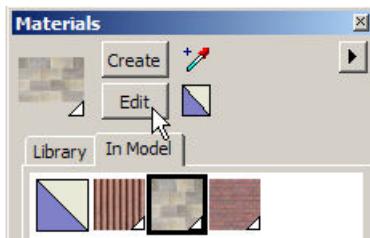


*Mac: There is no dropper icon, so you must use the Paint + Cmd method.*

21. Select the face shown, and its material (Stone-masonry) is indicated in the browser. (Sure, you could have figured that out without using the dropper, but imagine how useful the dropper is when you have dozens of materials in use!)

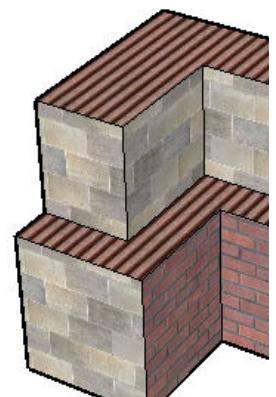
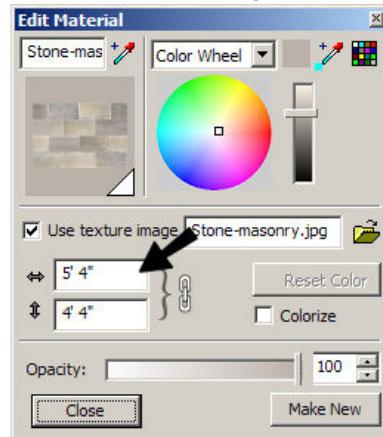


22. Click **Edit**, or select **Edit** from the material thumbnail's popup menu. You can also double-click a thumbnail to edit it.

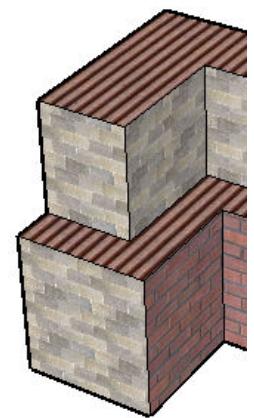
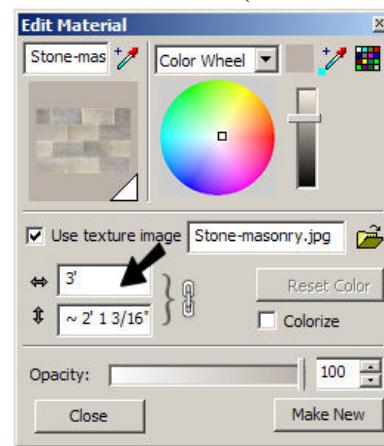


**NOTE:** In Windows, you can also select **Window / Material Editor**.

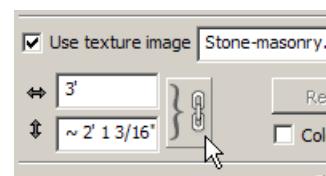
The first thing we'll change is the size, which is 5'-4" long and 4'-4" high. This is the size that is repeated for the tiled image.



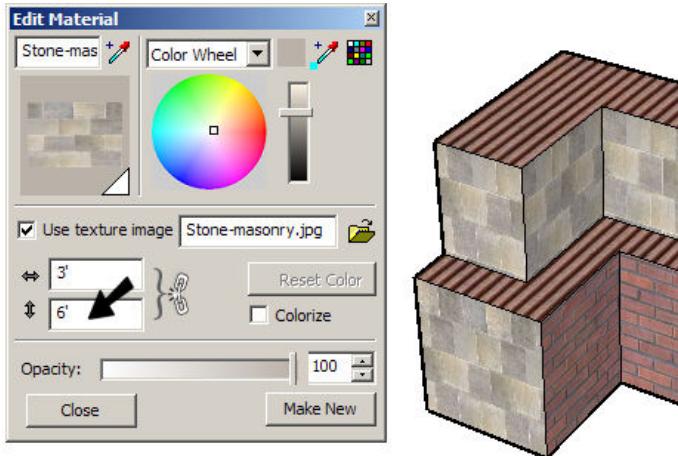
23. Change the length to 3' (don't forget the foot symbol if you're in Architectural units). The height updates as well, so that the aspect ratio is maintained. Also, as soon as you update a value, the material updates on the model itself (the stones look smaller).



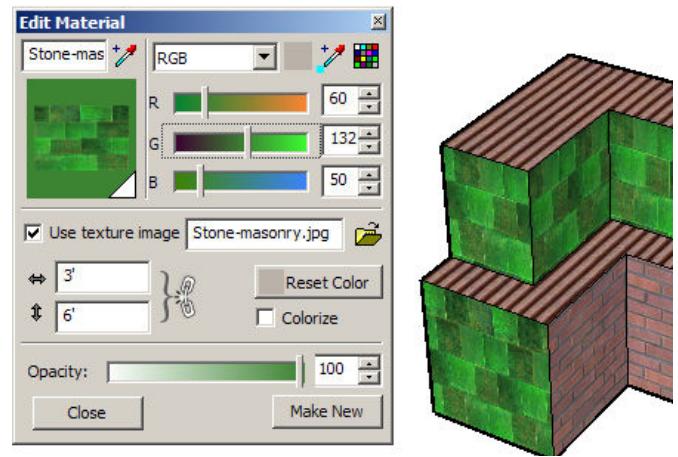
24. Now click the chain symbol, which unlocks the aspect ratio.



25. Now the chain symbol is broken, which means the width-to-height ratio can change. Enter 6' for some very tall stones.

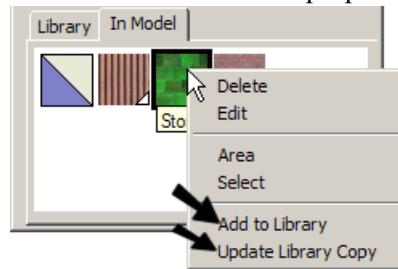


26. Another thing you can change is color. Use the color wheel, or adjust the RGB (red-green-blue) or HSL (hue, saturation, luminance) values to change the color. This example uses a nice, deep green.



*Mac: While the **Edit** pane is available, you can access any of the Mac color pickers (RGB, CYMK, greyscale, HSL, or Color Wheel) to change color. You can also change any material in the browser by editing it, then clicking on any other material in the browser window. If the other material is a bitmapped texture, the selected material will change to that texture; if the other material is a solid color, a bitmapped texture will be colored that color.*

27. Close the **Edit Material** window. The name of the material has not changed. In Windows, if you right-click on the edited material, you have two options: you can add it to the library or update the library material to have the new properties.

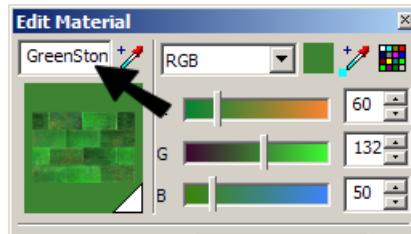


**NOTE:** If **Update Library Copy** is grayed out, open the Library and make sure the active category is Stone (the category where "Stone Masonry" came from).

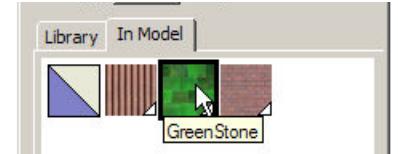
Be careful with **Update Library Copy** - you might not want to overwrite library materials. And if you use **Add to Library**, there will be two materials with the same name.

*Mac: You can change the name of a material in **Colors in Model** by editing it and entering a new name.*

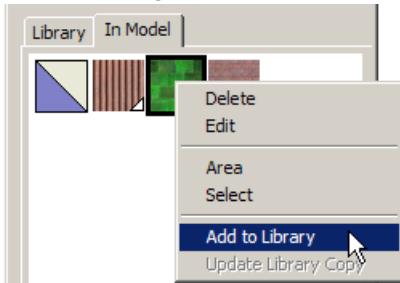
28. Don't change any libraries, and go back into edit mode. Change the name to something like GreenStone.



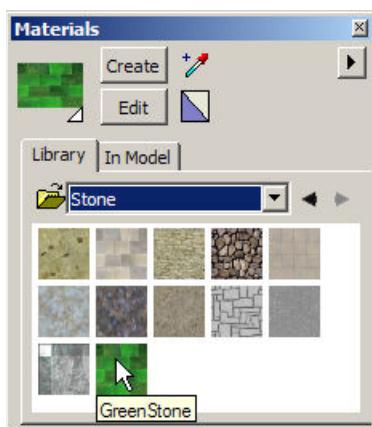
The new name is reflected in the tool tip.



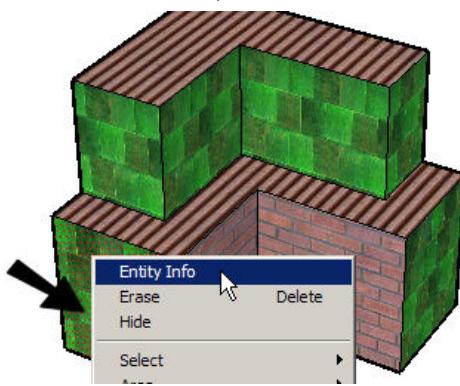
29. In Windows, right-click and select **Add to Library** (**Update Library Copy** is not available because the name has now changed).



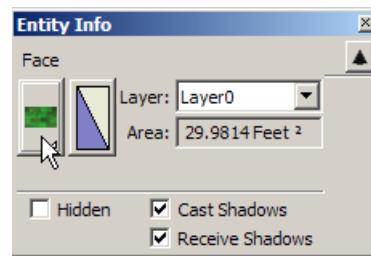
30. Switch back to the library, and here is your new material. The material is placed in whatever category is open under **Library**.



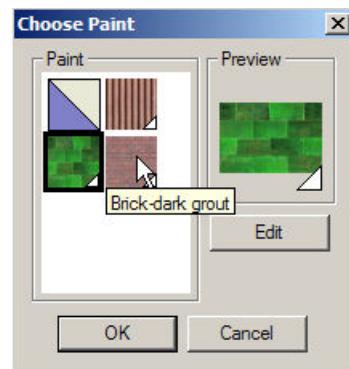
31. In Windows, you can change a face's material via its **Entity Info**. Right-click on one of the GreenStone faces and select **Entity Info**. (If the **Entity Info** window is already open, you can use **Select** and select one of the faces.)



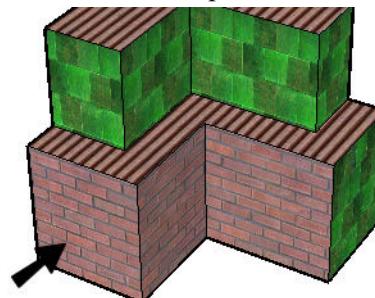
32. The material is displayed. Click the thumbnail.



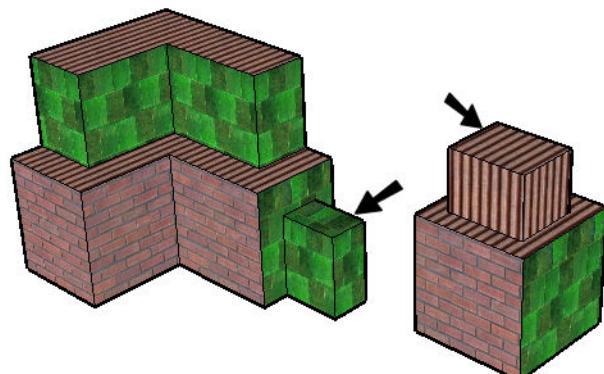
33. This opens a window in which you can choose any of the materials in the **In Model** tab. (Note that this does not open the entire library.) Select the brick, and click OK.



The selected face is now painted with siding.



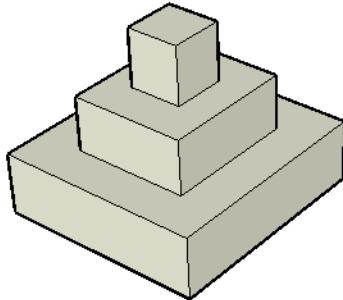
34. One last thing: Draw rectangles on a couple faces, and **Push/Pull** them in or out. New faces that are created like this have the same paint as the face from which they originated.



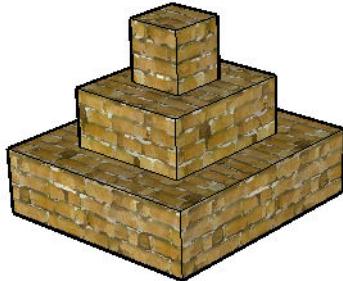
## Using Shift and Ctrl/Option Keys

The previous exercise involved the use of “mass-painting” keys - Shift and Ctrl/Option. As you’ve seen, Shift paints all faces that have the same material as the selected face. The Ctrl/Option key will paint the selected face plus all faces that are connected to it.

1. Start with a form like this.

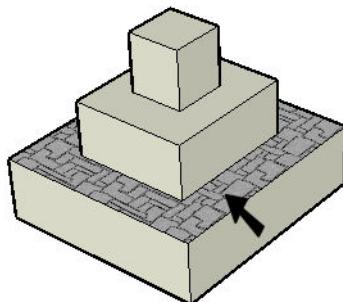


2. Pick a material and use either Shift or Ctrl/Option to select one face, which paints the entire form.



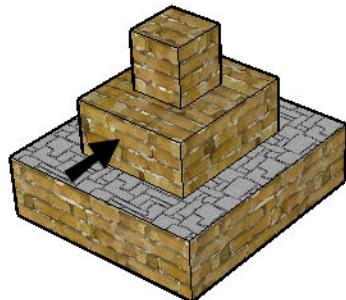
In this case, both keys produce the same result. All the unpainted faces are contiguous and are therefore painted.

3. Undo, and pick a different material. Apply it to the horizontal face shown.

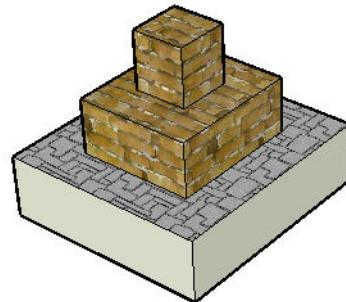


4. Go back to the previous material, press Shift, and click the vertical face shown. This paints all faces that have the same material as the selected face (in this

case, the default, unpainted material). If there were other forms that had unpainted faces, these would be painted as well.



5. Undo, and use Ctrl/Option to paint the same face. Only the faces above the already-painted face are painted.



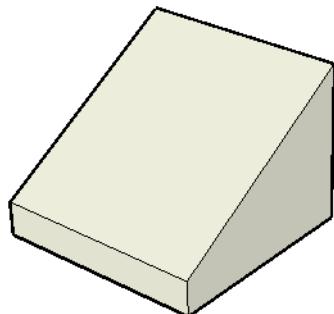
This is because these top unpainted faces are not contiguous to the bottom unpainted faces - the continuity is broken by the painted horizontal face.

## Material Transparency

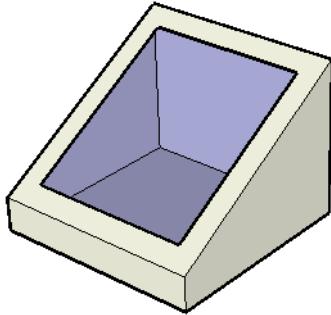
Any color or texture used as a material can have transparency properties - enabling you to create realistic windows, screens, or see-through walls.

**NOTE:** If you want to create a see-through fog effect, see "Using Transparent Faces to Simulate Fog Effects" on page 387.

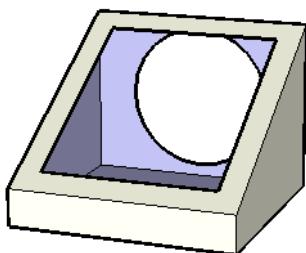
- Start with a sloped-top form like this.



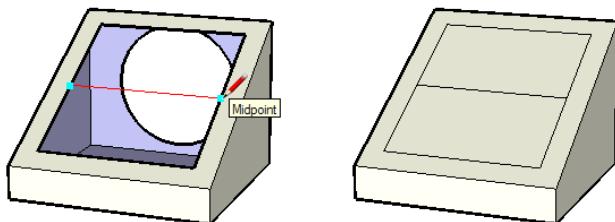
- Offset the top face inward, and erase the interior face.



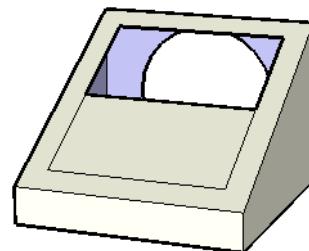
- Draw a circle on the back face and cut it out.



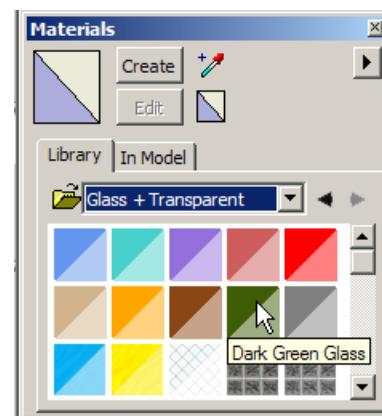
- Replace the front face by drawing a horizontal line midway down the face.



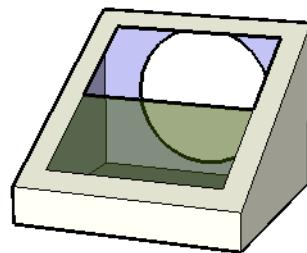
- Erase the top half of the front face.



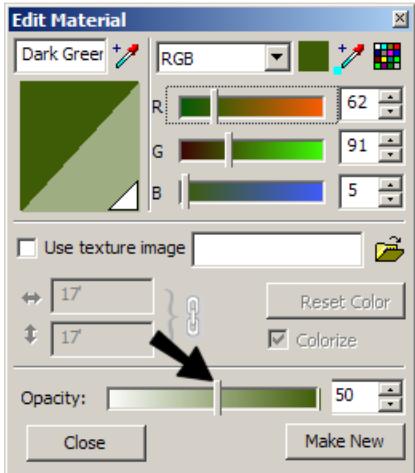
- In the Materials browser, locate the Glass - Transparent category. There are a few predefined materials here, but as you'll see, you can make any color or texture image transparent.
- Select a solid transparent material such as Dark Green Glass and apply it to the lower half of the front face.



The face is colored, but you can still see through it.

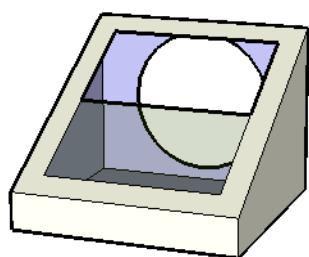
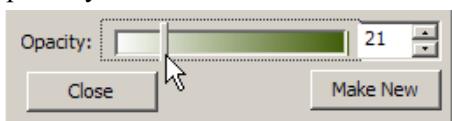


- Open this material for editing. When a material is transparent, its preview swatch is divided in two sections - the opaque color (top left) and its transparent appearance (bottom right). The level of transparency is controlled by the **Opacity** slider.

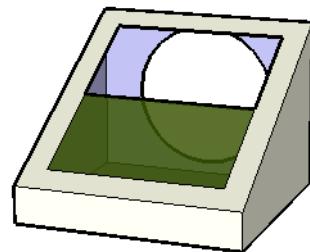
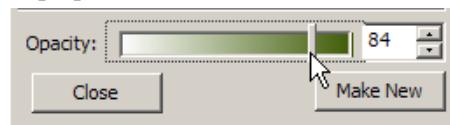


*Mac: Even though the opacity slider is present in the browser at all times, adjusting the opacity will not affect a selected material unless that material is immediately painted onto an object. When that happens, a new 'transparent' material is created in the browser and the original material remains unaltered. If the material is then edited, changing its transparency changes the material itself, without creating a new material.*

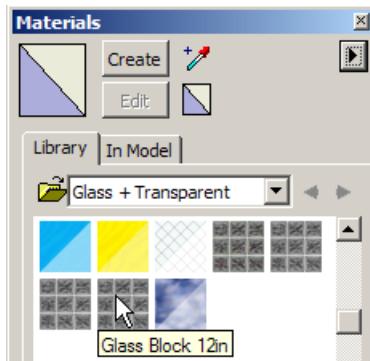
- Just like any other material property, adjusting opacity is reflected in real time on the model. Move the slider closer to zero percent to see the transparency increase...



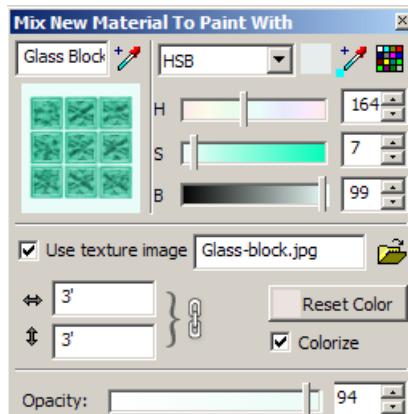
- ... and move it closer to 100% to make the material more opaque.



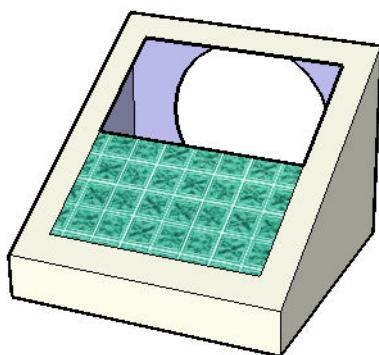
- Textures can be transparent as well. Change the transparent face to one of the Glass Block images.



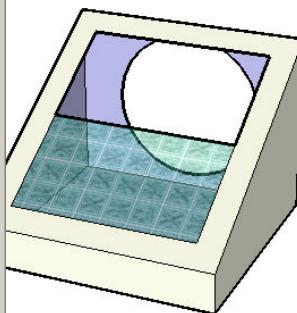
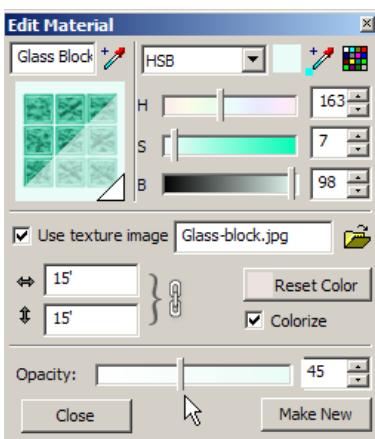
- This texture image is very dark, so changes in color will not be easily seen. Edit the material and make it something lighter.



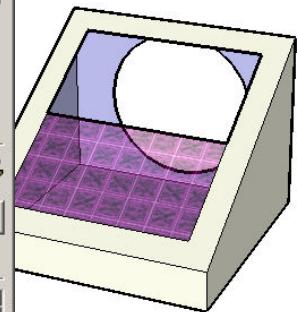
13. Apply the blocks to the half-face.



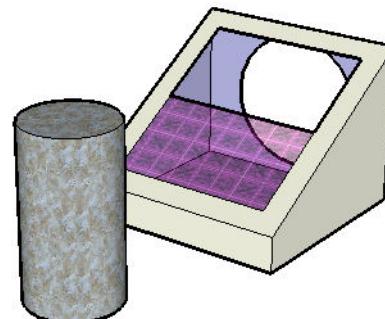
14. The default setting of this material looks rather opaque, so edit it and move the **Opacity** slider closer to the middle. As you increase transparency, note how the preview swatch changes, as well as the face itself.



15. Change the color of this material by using one of the color methods (**Color Wheel** is shown here). Select something dramatic like dark red. The color changes, but transparency is maintained.



16. Now add a cylinder in front of the form. Assign a texture to this cylinder such as Stone Vein (found in the Stone category). You can press *Ctrl/Option* to paint all cylinder faces at once.



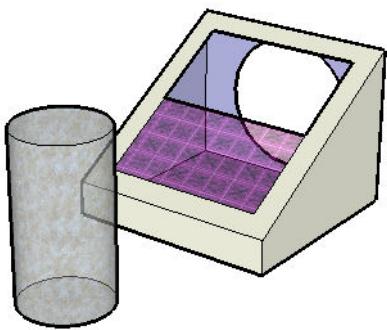
17. When you edit this material, its **Opacity** is 100%, and its preview shows a solid swatch.



18. Use the slider to increase transparency, and the preview splits accordingly.



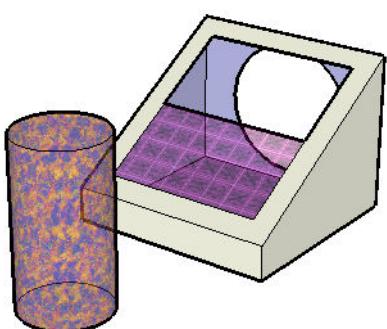
You can now see the sloped form behind the cylinder.



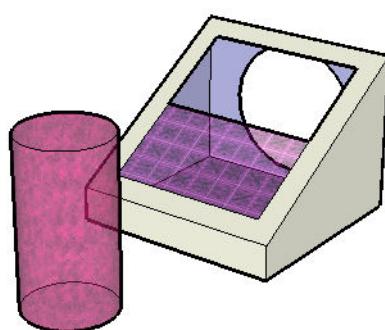
19. You can also play with the colors of texture materials. Make sure **Colorize** is not checked (Windows only), and assign a new color (reddish-purple) as shown.



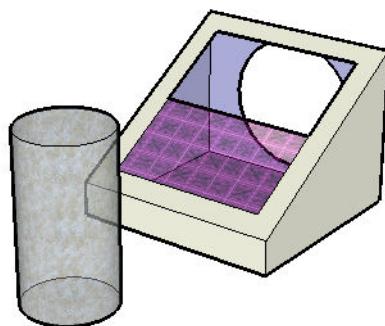
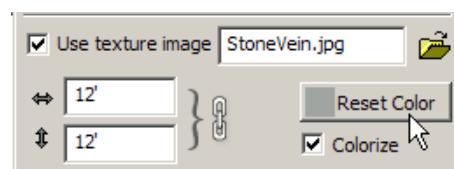
The transparent stone material should now have more of a multi-colored look.



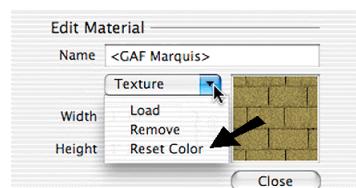
20. Check **Colorize**, and the material color is uniform.



21. To return the texture to its original state, check **Reset Color**.

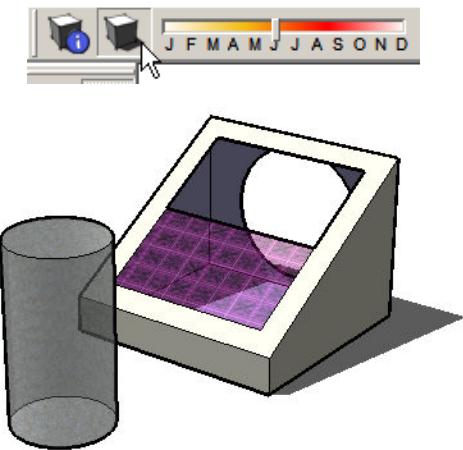


*Mac: You can reset any edited material, even if you have closed the editing pane and applied the edited material. Simply re-edit the material and select **Reset Color**.*



22. Here's another neat feature of transparent faces. Turn shadows on by clicking the icon, or selecting **View / Shadows**.

There are no shadows cast from the transparent cylinder.

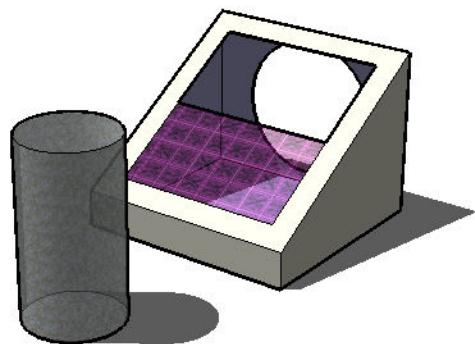



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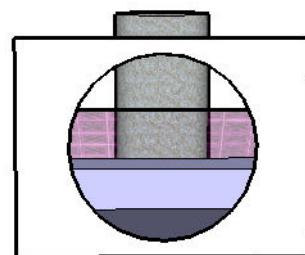
*NOTE: For more information on shadows, see "Shadows" on page 331.*

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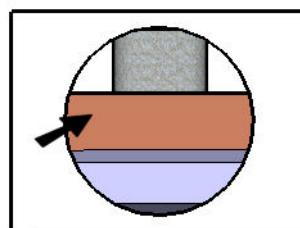
23. Set the **Opacity** of the cylinder to a value greater than 70%. Once this value is exceeded, the material casts shadows.



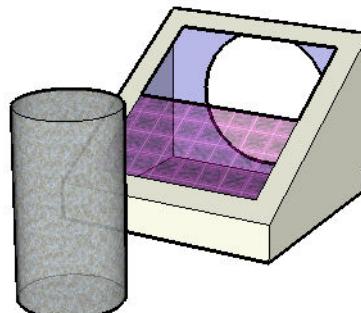
24. Turn off shadows (or leave them on), and orbit the model so that you are looking in through the circular back face.



25. Apply any non-transparent material or color to the glass-block face. This face now hides the cylinder.

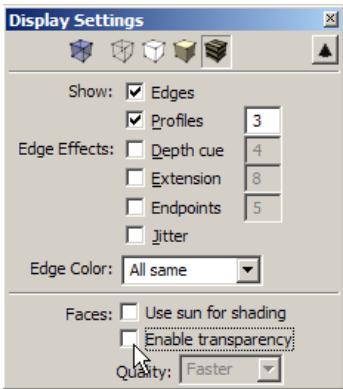


26. Orbit back to face the front; this side still shows transparent glass blocks.



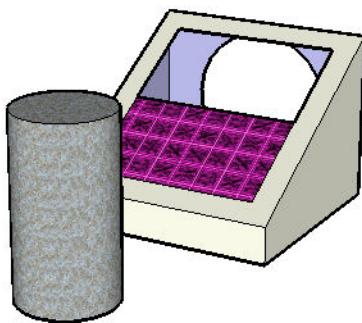
Faces in SketchUp are two-sided. By default a transparent material is first assigned to both faces, but you can then apply a different material to the opposite face. For more information, see "Double-Sided Faces" on page 254.

27. Finally, we will adjust some transparency display properties. Open the **Display Settings** (**Window / Display Settings**) and deselect **Enable transparency**.



**NOTE:** If you need to expand the window to see this option, click the down arrow at the top of the window.

This makes all materials appear opaque. Remember, the top section of the preview swatch shows how the material looks when opaque.

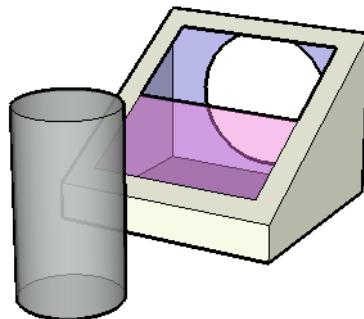
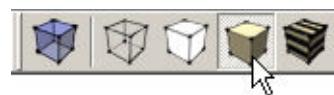


Transparency display can be memory-consuming, and when you're working with a large model that uses lots of transparency, your renderings can be slow. Working without transparency can speed things up.

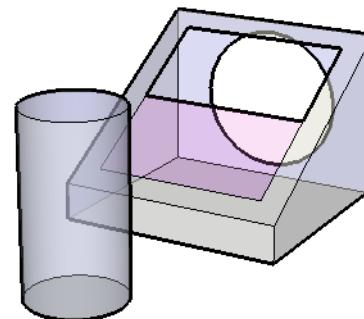
28. Turn transparency back on. Note that so far we have been working in **Shaded with textures** mode.



29. Switch to **Shaded**. This causes the textured materials to appear in their solid colors.



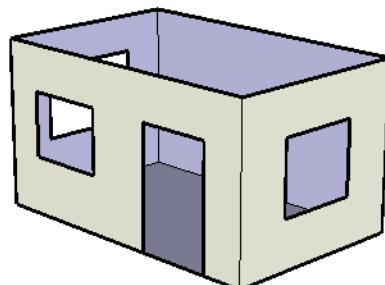
30. Lastly, turn on **X-Ray** mode. Now the entire model is transparent.



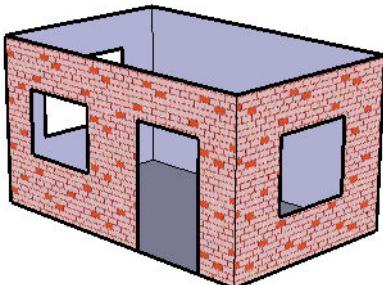
## Double-Sided Faces

As you may have noticed, faces in SketchUp have two sides. This is reflected in the fact that there is a **Face Front** and a **Face Back** color (set on the **Colors** page of **Model Info**.) This feature enables you to get very creative with materials - applying different ones to both sides of a face.

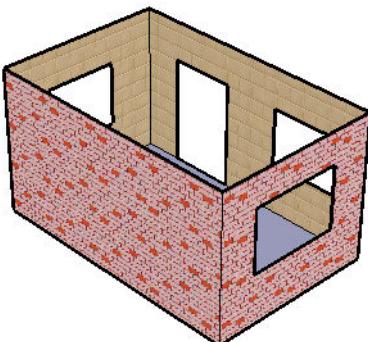
1. Start with a roofless house with a few cutouts.



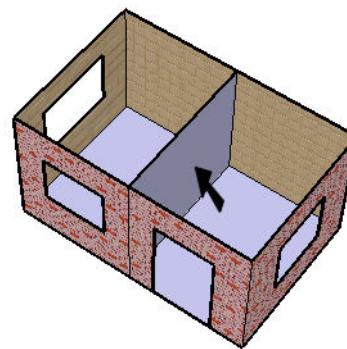
2. Apply an exterior texture, such as Sketchy Brick, to all four exterior faces. The interior faces remain unpainted.



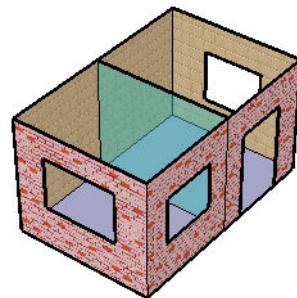
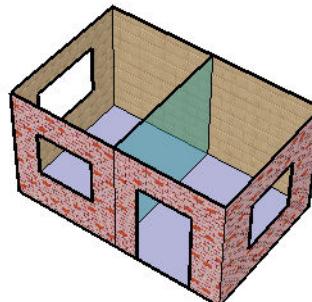
3. To these four interior faces, apply an interior finish like ceramic tile. This, in a nutshell shows how you can have two different materials on any face.



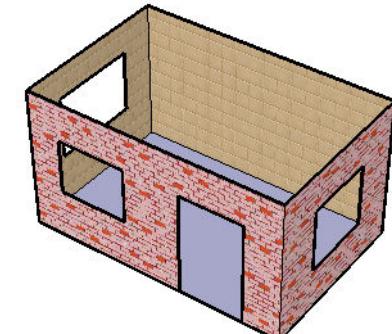
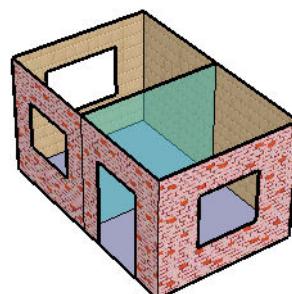
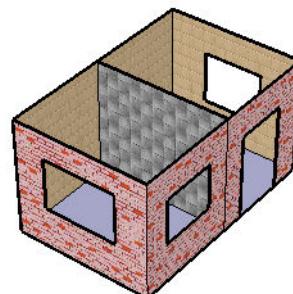
4. Add a vertical wall through the middle of the house.



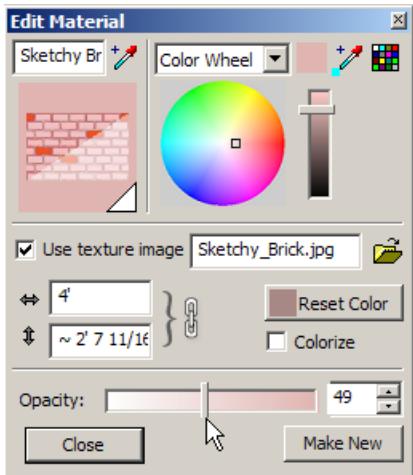
5. Pick a transparent material and apply it to one side of this wall. Because it is transparent, this material is automatically applied to **both** sides of the face.



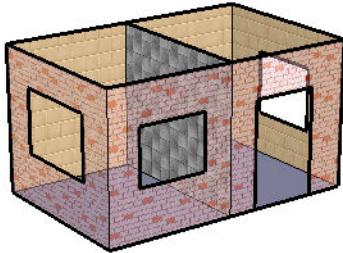
6. You can still make this face double-sided. Apply any other material, transparent or not, to one side of this wall. Orbit to the other side, and the original transparent material remains.



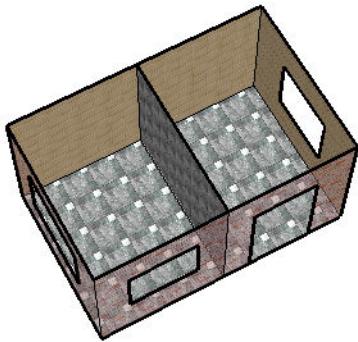
7. You can change a solid material to transparent, without affecting the material on the other side. Edit the material you applied to the exterior walls, and decrease its **Opacity**.



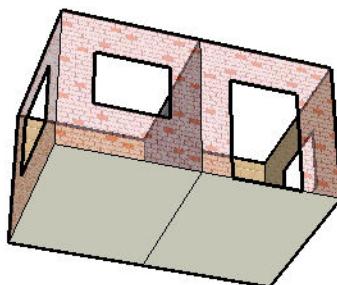
Now you can see in, but you can't see out.



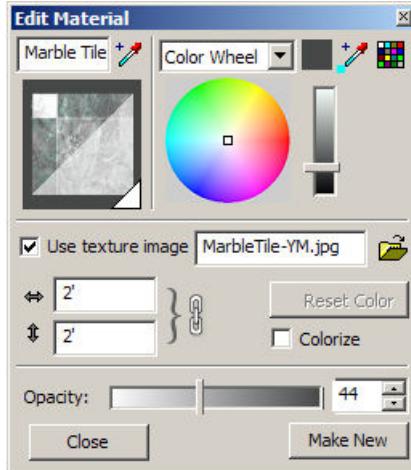
8. If you change a solid material to transparent, and the other side of the face is unpainted, both sides will take on the transparent material. Apply a solid interior material, like marble tile, to the floor.



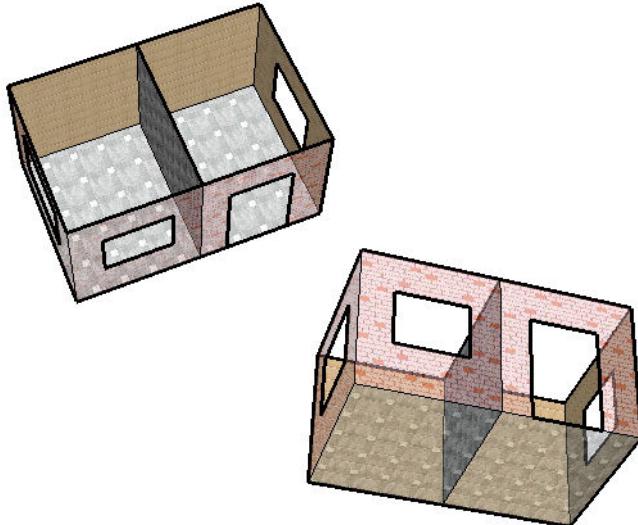
The underside of the floor is still unpainted.



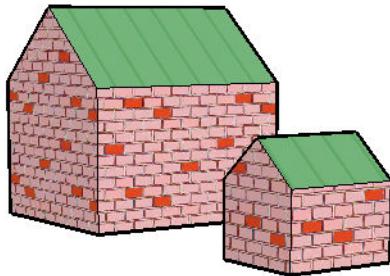
9. Make this floor material transparent.



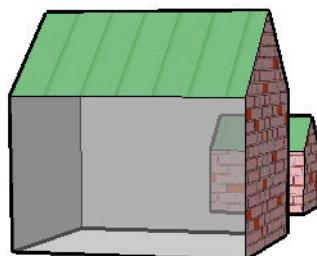
10. Now both sides of the floor are transparent.



This double-sidedness can be very handy for presentations. For example, at certain viewing angles, the small house would be hidden by the large house.



If the interior walls of the large house are transparent, and its rear wall is transparent on both sides, you can see the small house behind the large one.



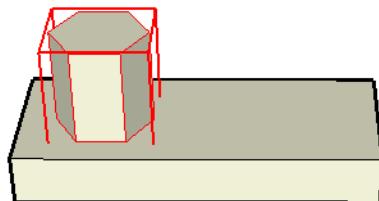
## Materials of Groups and Components

The previous exercises demonstrated how to apply materials using the Shift and *Ctrl/Option* keys. When groups and components are in use, this can change the way faces are painted. Just like individual faces, groups and components can have their own default materials. The exercises in this section will show you how this all works.

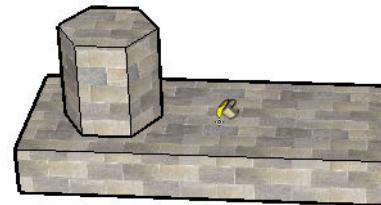
### Overview of Materials and Groups

This quick exercise will show you how groups are affected during mass painting, and how to handle painting groups themselves.

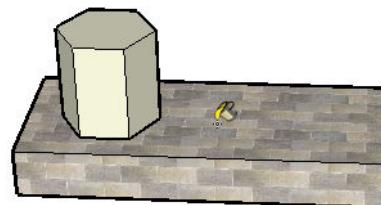
1. Start with a long box with a six-sided polygon on one side. **Push/Pull** the hexagon out of box and then create a group out of it.



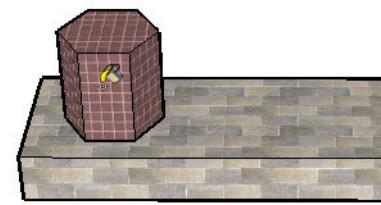
2. Use Shift to apply a material to any face of the box (not a face of the group). This applies the material to all unpainted faces, including those in the group.



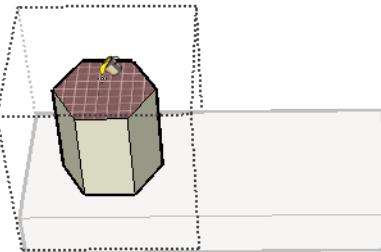
3. **Undo**, and use *Ctrl/Option* to apply paint to the same face. This time the faces of the group are omitted.



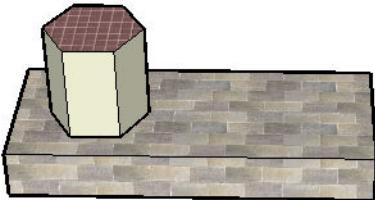
4. When you apply a material to any face of the group, the entire group is painted. Activate a different material and click any face of the group. All of its faces are painted.



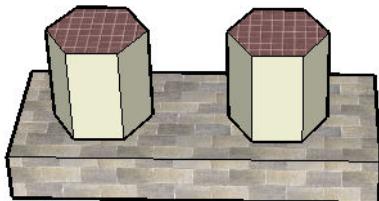
5. **Undo** to bring the group back to the unpainted state.
6. If you want to apply different materials to different faces of the group, you must do it from within the group. Edit the group, and apply a material just to the horizontal face.



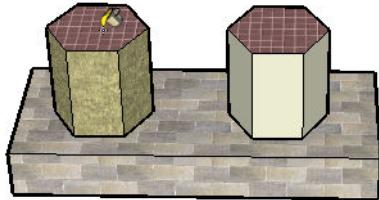
7. Close the group. Now the only unpainted faces are the sides of the group.



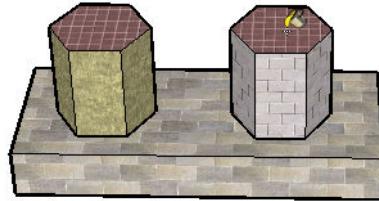
8. Make a copy of the group.



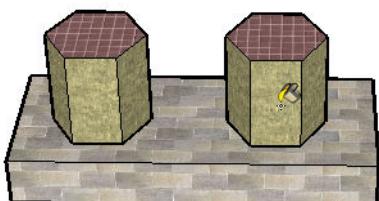
9. To paint the remaining faces of the first group, choose another material and select any of its faces (even the face that is already painted). This material is applied to all faces of the group that are not yet painted.



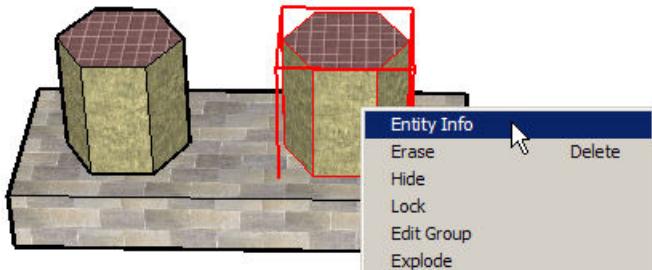
10. Choose a different material to paint the copied group.



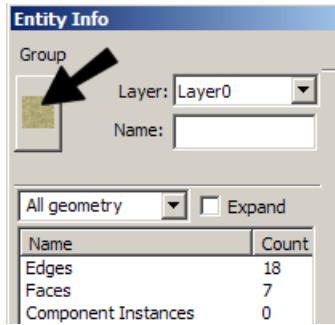
11. Just as you can always change a face's material, you can change the material of a group. Change the second so that it looks like the first.



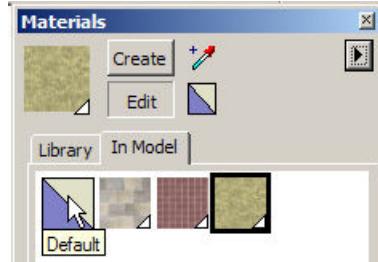
12. Just like with a face, to see the material of one of the groups, right-click on it and select **Entity Info**.



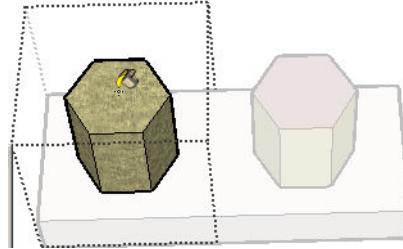
This is the group's default material, even though not all faces of the group use this material.



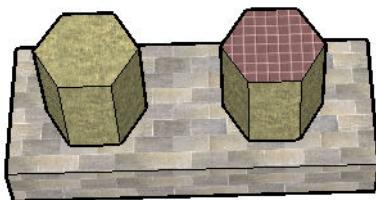
13. In the Material Browser, find the Default material in **In Model**.



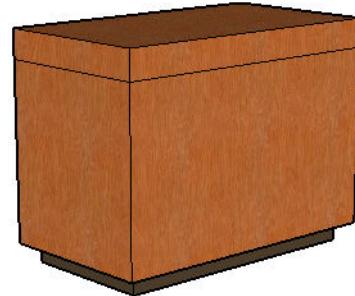
14. Edit one of the groups, and apply Default to the painted horizontal face. This face takes on the default material of the group, and not the global default (unpainted) material of the overall model.



15. Close the group to see the results.



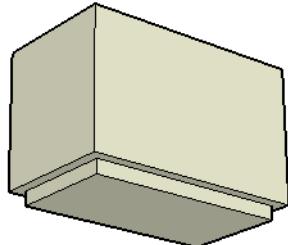
4. For one way to create the counter, use **Push/Pull** with *Ctrl/Option* on the top face. This creates the counter faces, but they have the same material as the cabinet, which is not what we want.



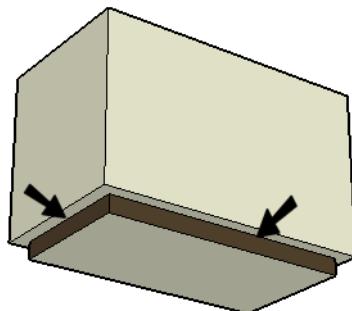
## Using Groups to Separate Materials

If you've read the chapter on Groups, you already understand how groups prevent objects from "sticking" to one another. This is also relevant for materials. This exercise will create a cabinet, and the use of groups makes it easier to apply various materials.

1. Start with the basic cabinet shape, and use **Offset** and **Push/Pull** to create a small base.



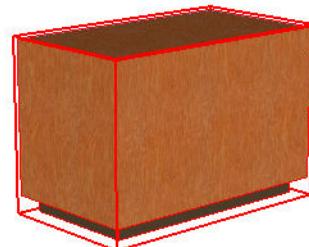
2. Apply a single color (found in the Markers category) to the four vertical faces of the base.



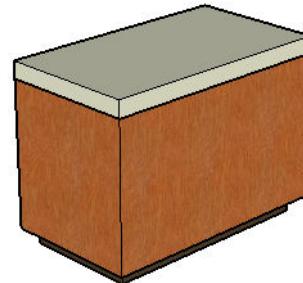
3. Activate a wood material, and use *Ctrl/Option* to paint the faces of the cabinet. (Because you used *Ctrl/Option*, the bottom face remains unpainted. Using Shift would have painted that face.)



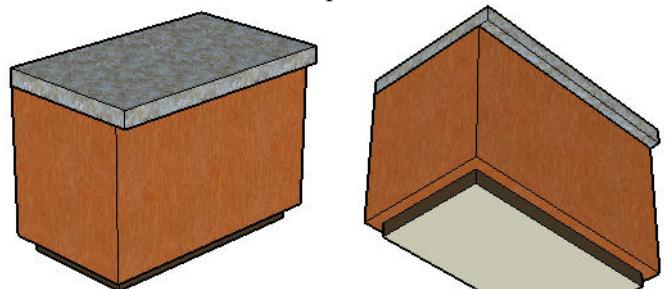
5. Undo the counter. Select the cabinet and its base, and make it a group.



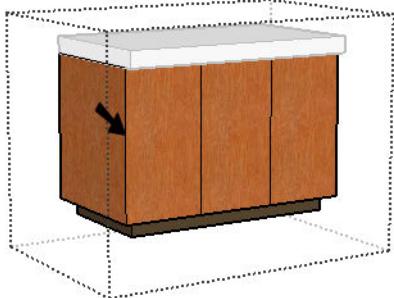
6. You can't use **Push/Pull** on a face inside a group, so create a rectangle along the top of the cabinet and **Push/Pull** it up. Because this counter is not connected to the cabinet group below it, it has the default (unpainted) material.



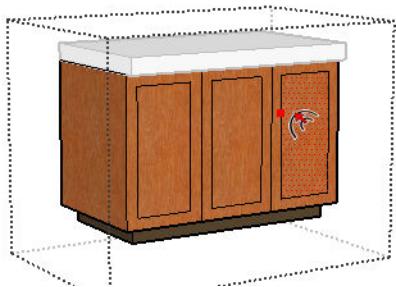
7. **Push/Pull** the front of the counter slightly outward. Activate a stone or marble material, and use *Ctrl/Option* to apply it to the entire counter. Again, because you used *Ctrl/Option* and not Shift, the bottom face remains unpainted.



- To complete the cabinet, edit the cabinet group. You can create vertical dividing lines by selecting and copying the edge shown to the other side, then specifying a dividing distance ( $/3$ , in this case).



- Use **Offset** to create one door rectangle. Then double-click the other faces to create the same offset rectangles.



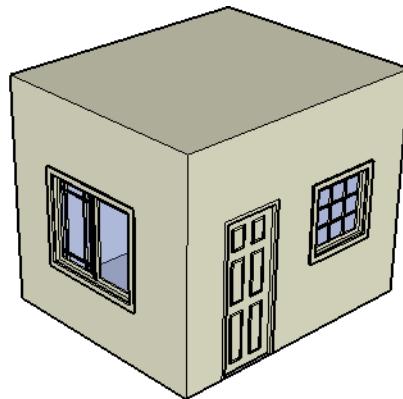
- While still in edit mode, **Push/Pull** the doors out slightly. Because they originated from a painted face, the extrusions are automatically given the same material. Close the group to see the final product.



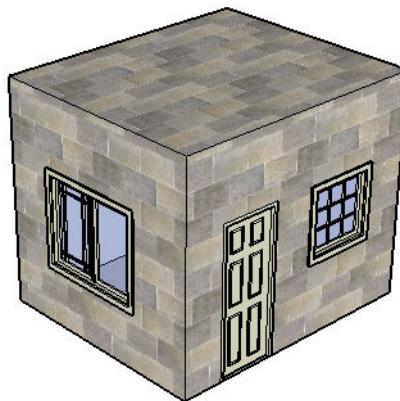
## Materials of Components

Using materials on components works pretty much the same way as for groups. The main difference is that you can implement material or color changes over all instances of a component, whereas each group would have to be edited separately.

As with groups, components can be omitted when mass-painting faces. This building has one door component and two window components.



If you press *Ctrl/Option* while applying a material to one of the walls, the windows and doors will not be painted. (Using *Shift* will paint them, assuming the components are originally unpainted.)



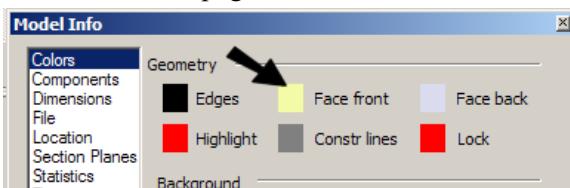
This exercise will focus on how components themselves are painted, and their default colors.

- We will use car components, since they are already created for you, and contain a variety of colors. In a new file, open the Components Browser to the *Transportation\_Sampler* category.

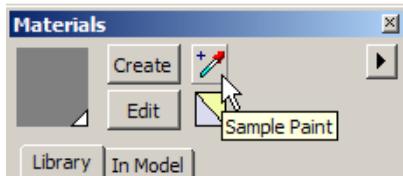
2. Bring in an armored truck. Some of the faces of this car are painted (transparent windows and black tires), but the body faces are created in the default material - **Face Front**.



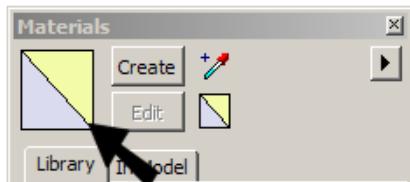
If you change the default colors of the model, the color of the truck body will change as well. This is set in the **Color** page of **Model Info**.



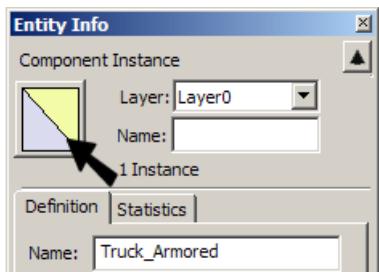
3. To determine the material assigned to any face, click on the paint dropper icon in the Materials Browser (Windows only). You can also press Alt/Cmd while the **Paint** tool is active, to get the dropper icon (*Mac: Cmd+Paint is the only way to sample material*).



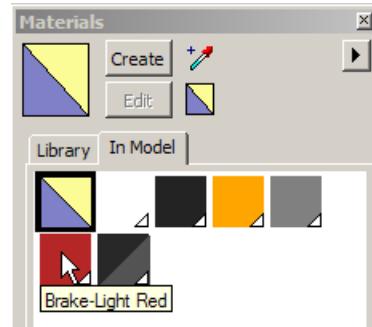
4. Click on any body face of the truck, and Default is indicated as the face's material.



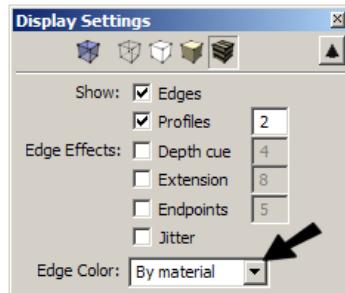
5. A component's (or group's) default material is also listed in its **Entity Info**. Right-click on the truck and select **Entity Info**. Default (unpainted) is the component material.



6. In the Materials browser, open **In Model**, where you can see the various colors used for the tires, windows, brake lights, etc.



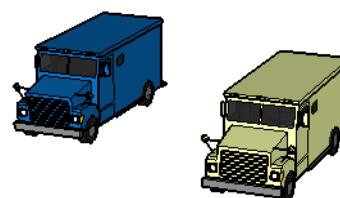
7. We will change the color of the truck body, but first we'll set the appearance of the edges. Open the **Display Settings** and set **Edge color** to **By Material**.



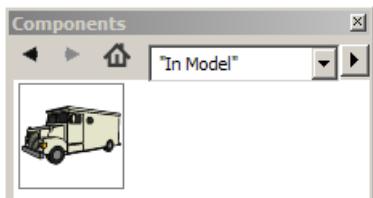
8. Select any new color (found in the Markers category) and apply it to any face of the truck - the body faces are painted. The windows and tires are already painted, so they retain their assigned colors. And all edges take on the color you just assigned.



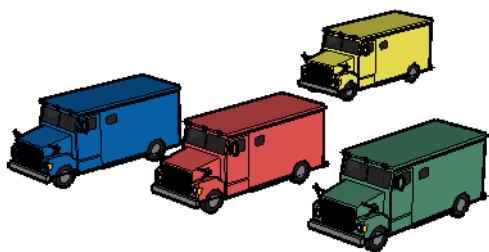
9. If you prefer, set **Edge color** back to **All Same**.  
10. Bring in another truck from either the Transportation category of the browser, or from **In Model**. The new truck will have the default color.



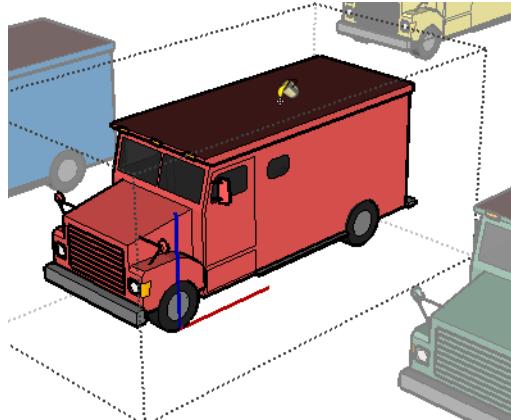
The **In Model** component browser still contains one component - the basic definition of the truck is the same.



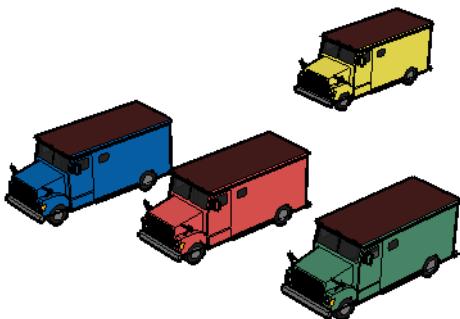
11. Bring in two more trucks, and color each one differently.



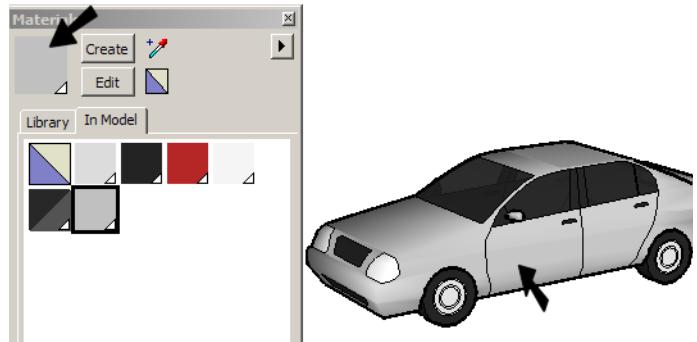
12. Open any truck for editing and change its roof to black.



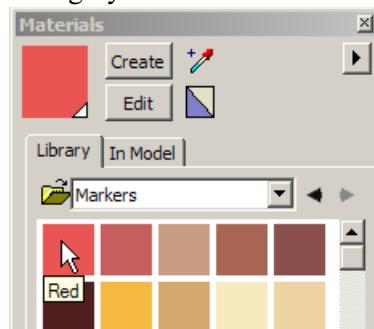
13. This changes the component definition in **In Model**, and each truck now has a black roof.



14. Start a new file, and bring in a sedan from the same component folder. All of its faces are already painted. Sample the body color - it is gray.



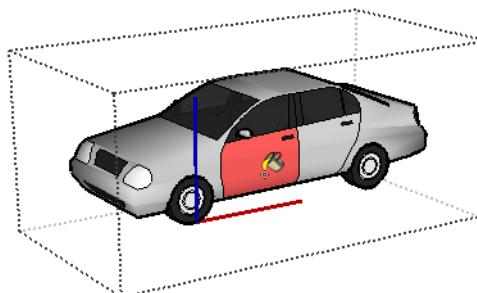
15. To change the car's color, pick a new color from the Markers category such as red.



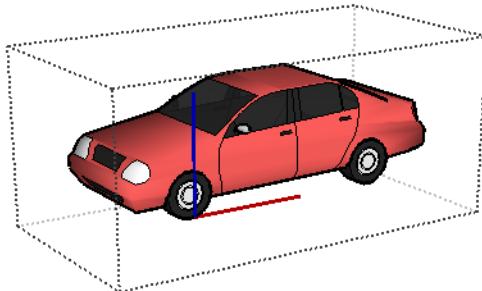
16. Click any body face - the color remains the same. All faces of this component are already painted, so there are no faces to take on the new color.



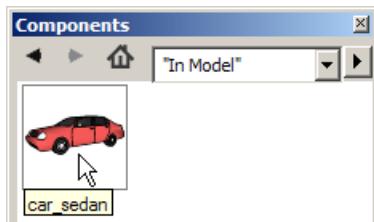
17. To change colors, you need to edit the component. Open it for editing, and apply the new color to one of the faces.



18. If you don't want different colored faces, you can paint all gray faces by using Shift or Ctrl/Option when clicking a gray face.



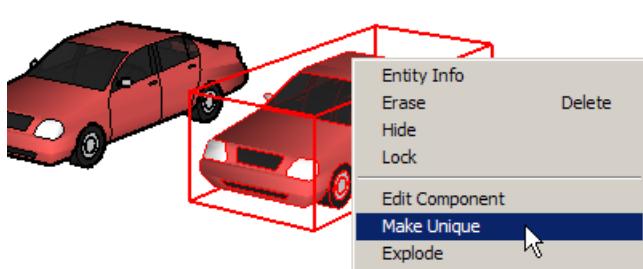
19. This color change does not affect the original component in the Transportation\_Sampler folder (which is still gray), but it has changed the version in **In Model**.



20. Bring in another red sedan from **In Model**.



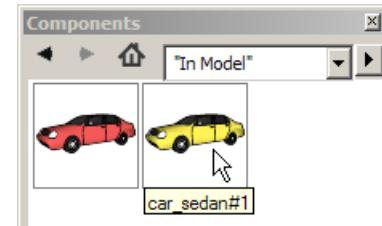
21. If you want different colored sedans, each will need to be a separate component. Right-click one of them and select **Make Unique**.



22. Edit this new car and make it another color.



23. **In Model** now contains two components, and the new one is given a name automatically. You can change its name via **Properties** (Windows only), **Entity Info**, or using the Outliner.



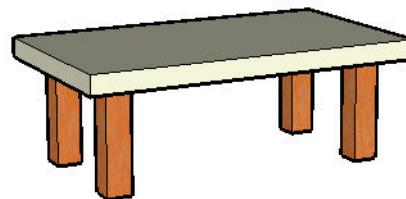
## Default Component Materials

As you've seen when painting a component, the material is applied to all faces of the component that have the component's default material. In the car exercises, all of the components had Default (unpainted) as their material, so their unpainted faces took on whatever material you applied.

*Mac: The default material is the first thumbnail in Colors In Model. You can change this color by changing the Face Front color in Model Info. However, you cannot set a texture as the default material. If you try, you only get the basic color of the texture, not the texture itself. Note that if you change this default color, that you must restart SketchUp in order to revert to the original color.*

Not all components have Default as their assigned material, however. If a component has a specified material or color, then it is faces of *this* material/color that will be replaced by an applied material. Confused? Try this short exercise.

1. Start with a four-legged table. Apply a wood material to the legs. (It's easiest to group-select the legs, then apply the material to any selected face.)



- Select the table and select **Edit / Make Component**. Assign a name like Table and check **Replace selection**.

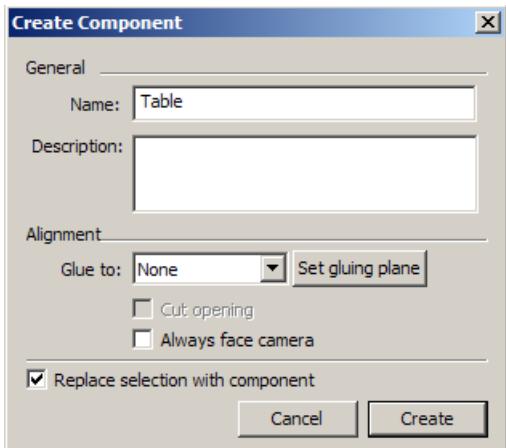
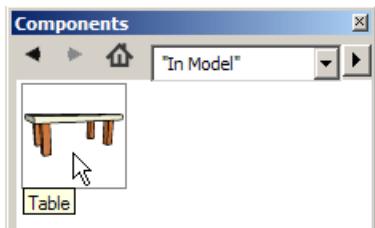
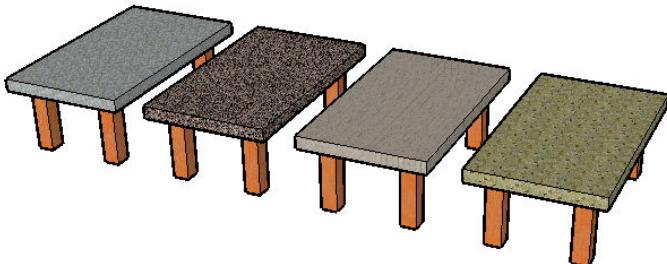


Table is now listed under **In Model**.

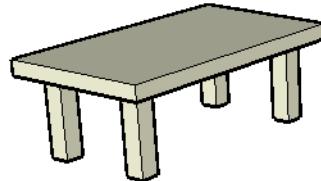


- Make three copies of the table (or insert three more). Apply a different material to each table. The material is applied to the table top only, because these are the faces that are still unpainted, that have the component material of Default. The legs already have an assigned material, so they stay wooden.

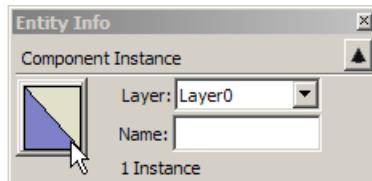


So far this is what you've already seen with the truck - replacing unpainted faces. The next component, though, will use a specific material.

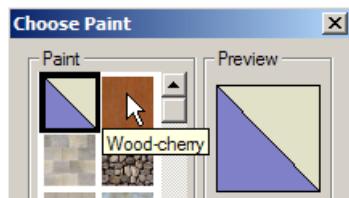
- Use **Undo** to return to the original, default table, and make it a component. Make sure the wood material is still in the model even if it is not currently assigned.



- Right-click on the new component and select **Entity Info**. Click on the material thumbnail.



- Select the wood material to make it the component default.



*Mac: Open **Model Info / Colors** and change the **Face Front** color - this will become the new default component material. You cannot specify a texture here; only its base color will be used. Remember, if you change this default color, you must restart SketchUp in order to revert to the original color.*

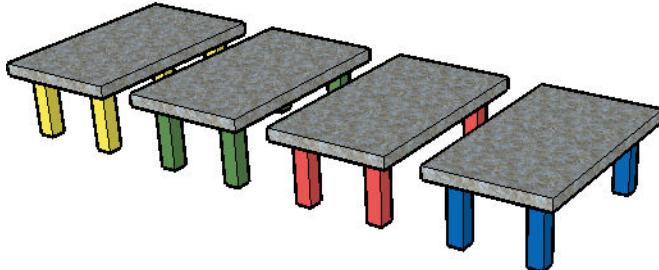
The table faces are now all wood.



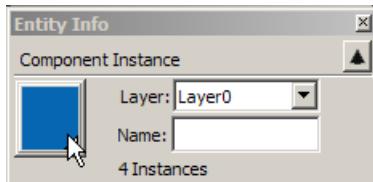
- Edit the component, and change the table top material. The default component material is still wood.



8. Make three more copies, and assign each table a different material. This time the **legs** are painted. This is because the legs were originally wood, which is the default material of the component. And the default material is what gets replaced when you assign a new material. The table tops already have another material, so they remain unchanged.



9. In Windows, as you've seen, a component's default material can be changed without affecting the component itself. Right-click one of the changed tables to open its **Entity Info**. The default material is no longer wood - it is the material you applied.



## Texture Positioning

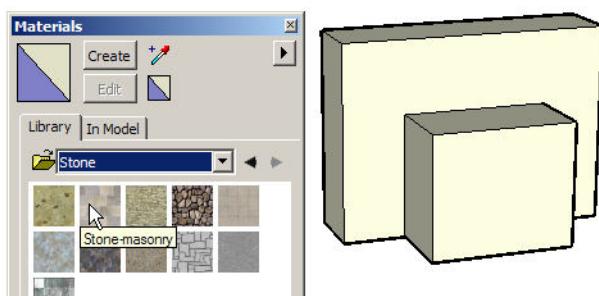
The rest of this chapter focuses on how you can manipulate texture files, including image files, to fit your model. To understand how this is done, this exercise gives you the basics on positioning texture.

There are two modes you can use to position textures: **Fixed Pins** and **Free Pins**.

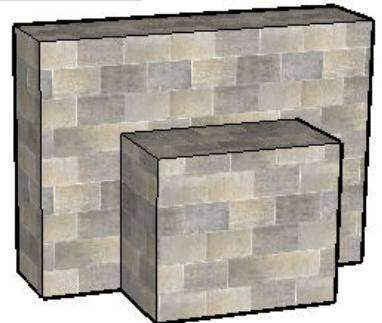
### Fixed Pins

Fixed pins is the more exact mode for texture positioning. You have four pins of different colors, each with its own function, each works relative to the anchor (red) pin.

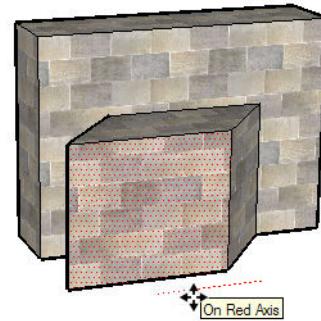
1. Start with a form like this, and locate the Stone masonry texture in the Stone category.



2. If necessary, edit the material size so that only a few stones fill the small front face.

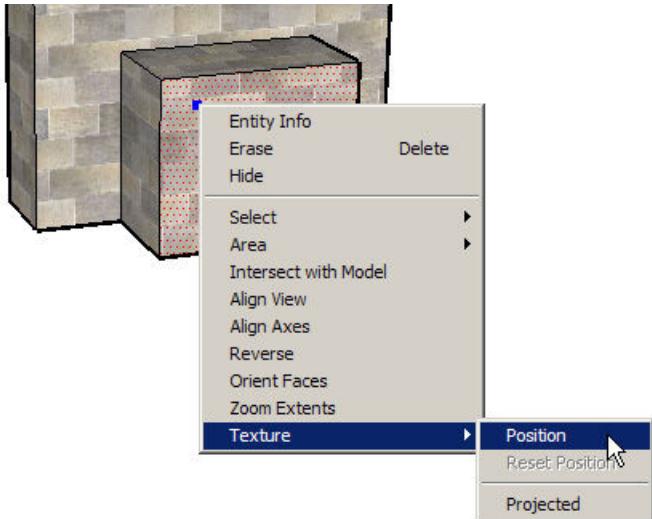


3. Select the smaller front face and move it from side to side. The texture stays in place while the face moves - the texture does not stick to the face.

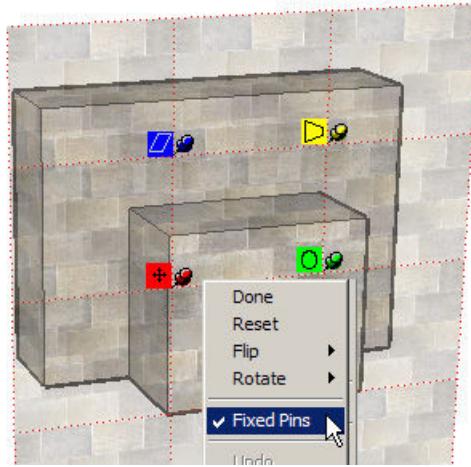


4. Return the face to its original position.

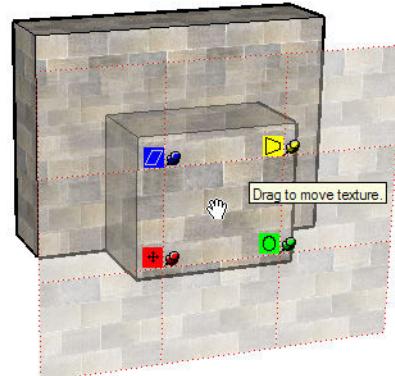
- To set the texture so that it sticks to the face, you must position it. Right-click on this front face and select **Texture / Position**.



- In this mode you will see four pins, either all yellow or four different colors. We want the four-color mode: **Fixed Pins**. If you're not in this mode, right-click and make sure **Fixed Pins** is checked. The pins surround one instance of the texture - the rest are tiled instances.

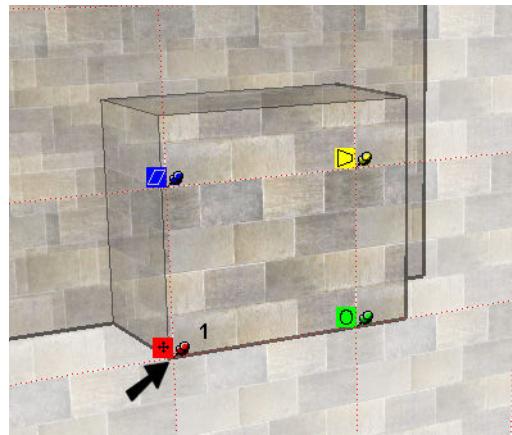


- Click anywhere on the texture and keep the mouse button pressed. Move the mouse around to drag the texture to a different location.



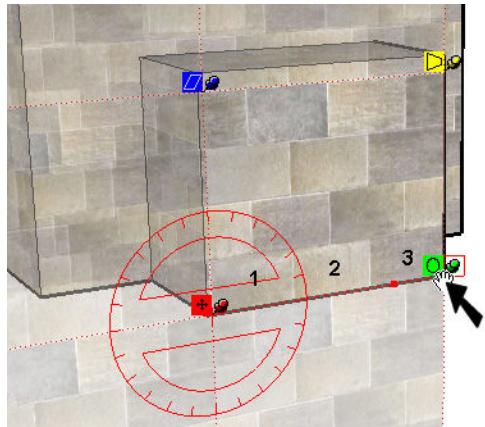
The **red pin** is the anchor pin. Scaling, shearing, rotation, and distortion are all done relative to this pin.

- Click and drag the red pin to the lower left corner of the face. (You can access inference points like endpoints and midpoints while in position mode.) Now Block 1 will always start at the lower left corner of this face.

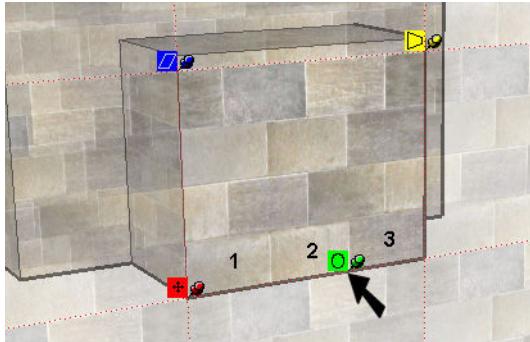


The **green pin** is used for overall scaling and/or rotation. Right now we will use it just for scaling.

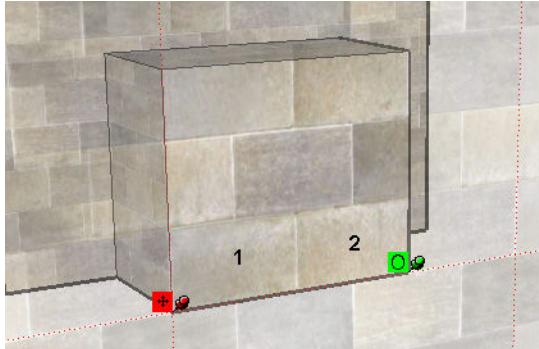
- Drag the green pin to the lower right corner. Now three full stone blocks fill the face horizontally.



- In addition to dragging pins, you can also move them. Hover over the green pin until you see a small square around it, then click. This lifts the pin out of its position. Move the mouse to the point between Blocks 2 and 3, and click to place the pin there. The point of the pin (not the pin body) determines the pin's location.

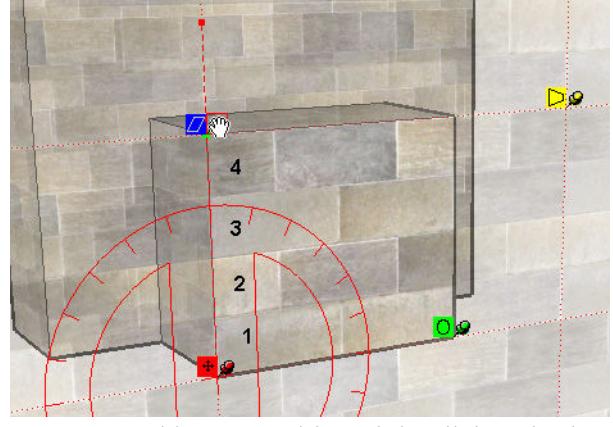


- Now drag the green pin back to the lower right corner. Two blocks are now spaced along the face.

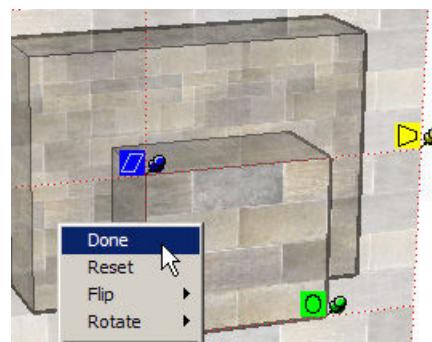


The **blue pin** is for shearing (making diagonal), as well as vertical scaling.

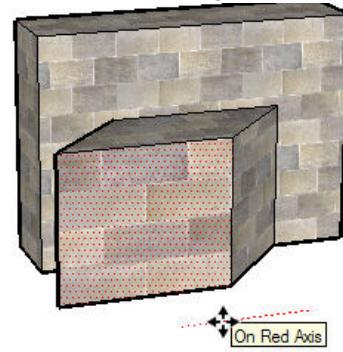
- Drag the blue pin up or down so that four rows of blocks fit vertically in the face.



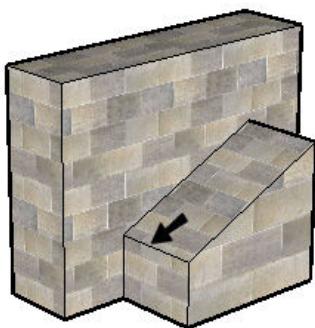
- To accept this new position, right-click and select **Done**. (You can also click anywhere in blank space to exit position mode.)



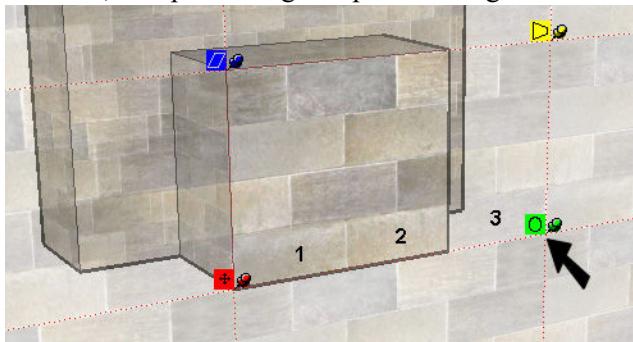
- Now move the front face again. No matter where it's located, the face contains two blocks along the bottom and four rows vertically. Also, note that the rest of the model has the original texture position; only the front face has changed.



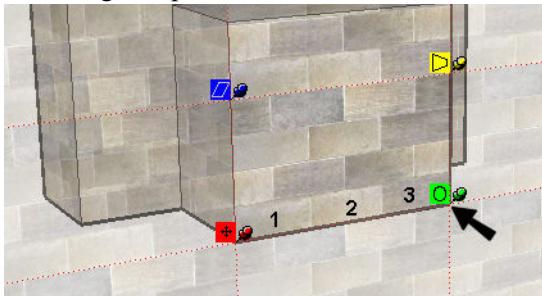
15. Slope the front face by moving the edge shown.



16. Enter position mode again. To shrink the overall scale, first place the green pin to the right of Block 3.

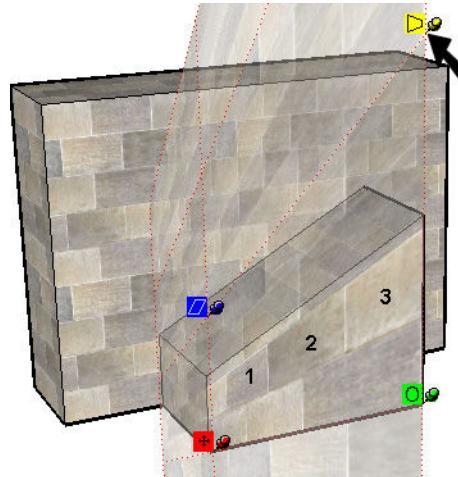


17. Then drag this pin back to the corner.

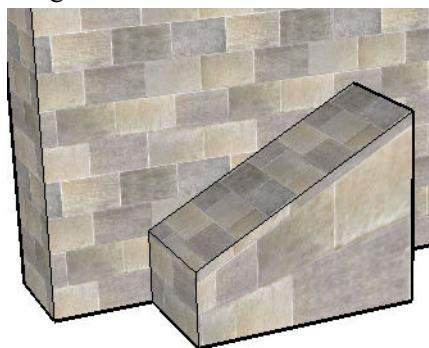


The **yellow pin** is used for out-of-plane distortion. (The result only looks out of plane - the texture always remains on the face). This is more useful for actual photographic images that you're trying to fit to a face, but we will use it here anyway.

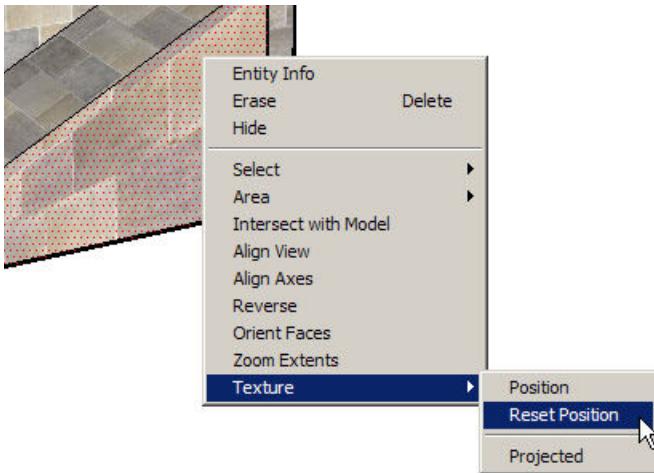
18. Drag the yellow pin straight up so that the seam line above Blocks 1, 2, and 3 is parallel to the diagonal edge.



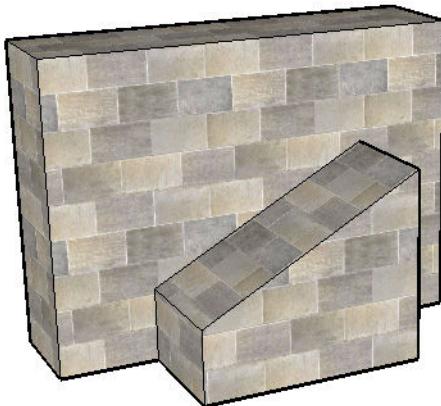
19. Exit position mode, and here is the result: the blocks look as if they are getting closer; their perspective has changed.



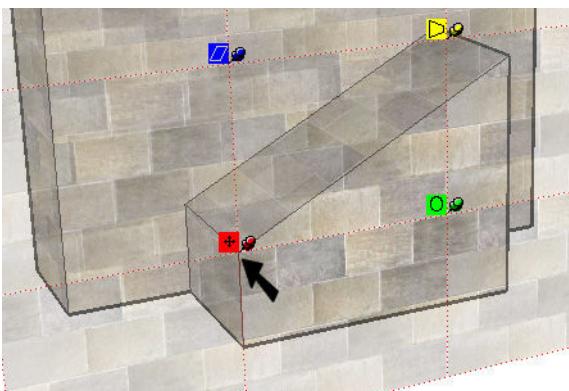
20. To return to the original texture, right-click on the face and select **Texture / Reset Position**.



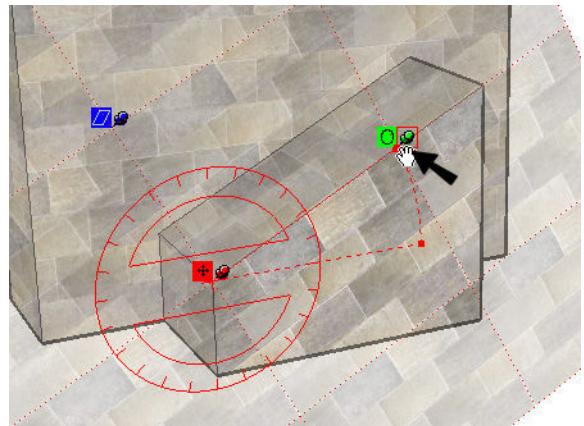
The blocks return to their original size and position.



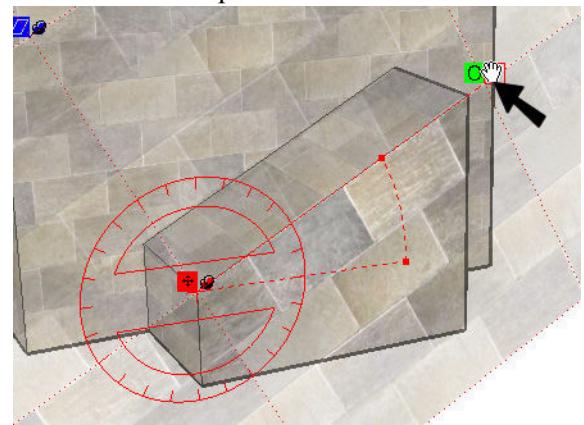
21. We will now look at rotation and shearing. Go back to position mode and drag the red pin to the corner shown.



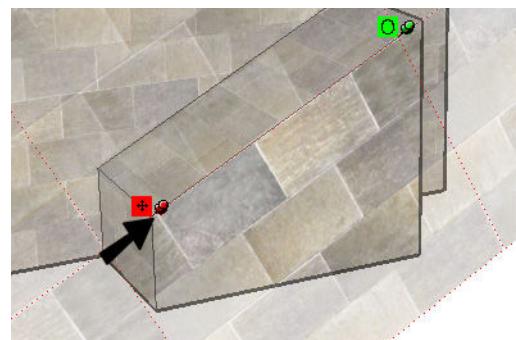
22. Drag the green pin upward so that the angle of the blocks matches the diagonal edge (do not release the mouse yet). If you stay on the dashed red rotation line, you will not change the scale of the blocks.



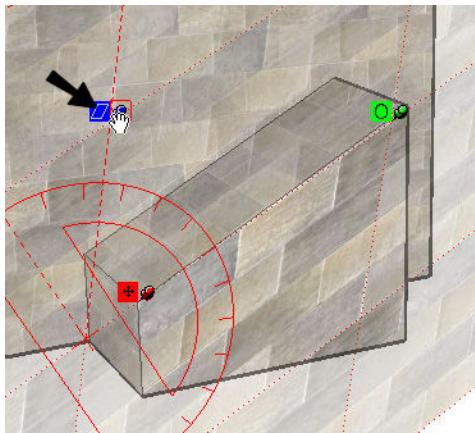
23. Now drag the green pin outward to increase the overall scale. This is how you can rotate and scale the texture in one step.



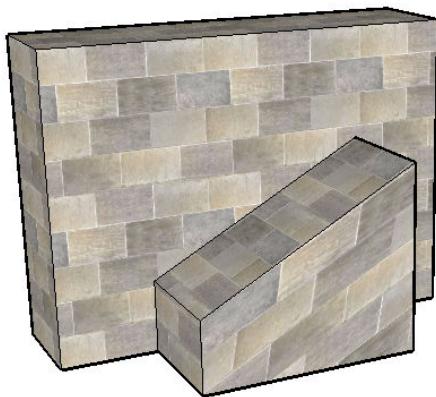
24. Now move the red pin and drag it so that a block starts at the corner shown.



25. Drag and rotate the blue pin to shear the blocks. The result is that the blocks are skewed and still have vertical sides.

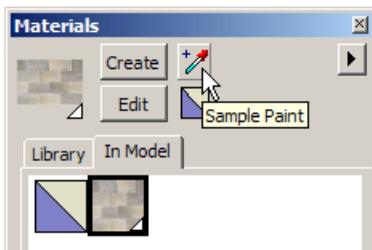


26. Leave position mode.

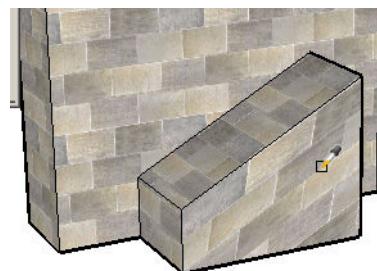


Now we will see how to apply this modified texture to the rest of the model. The texture in the Material Browser is the original one, so if you apply it to any face (including the changed one), you will get the original, unscaled, unsheared, unrotated blocks.

27. To sample a texture, use the **Paint** tool with Alt/Cmd pressed. In Windows, you can also click the dropper (**Sample Paint**) icon.

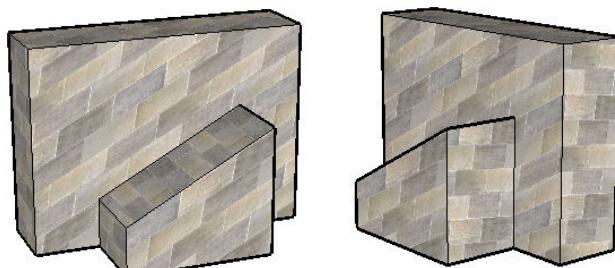


28. Click the front face to pick up this texture.



**TIP:** You can also pick up a texture by pressing Alt/Cmd while in **Paint** mode, and clicking on a face.

29. Now apply this material to the other faces (you can use Shift or Ctrl/Option when selecting any face). The sloped blocks now appear on all faces.



## Free Pins

Free pin mode is useful when you want to make an image fit within a certain shape. It is not as exact as Fixed Pin mode, but handy when you need to make adjustments by eye.

Imagine you've designed a house and your client hands you a picture of a friend's house that has the exact door he wants. You can use the picture as a texture on the door, and use free pins to fit the picture exactly to the door in your model.

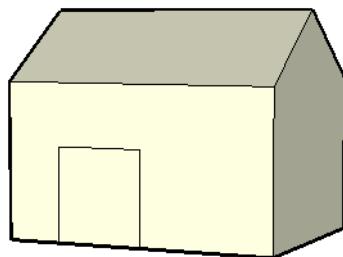
This example uses the door shown below. It was taken from the site [www.spiritelements.com](http://www.spiritelements.com), in the "Custom Doors" category.



You can also find this picture at [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm); download the file "CustomDoor.jpg."

**NOTE:** To save a picture from a website, right-click on the image and select **Save Picture As**. Some images are copyright protected and cannot be saved.

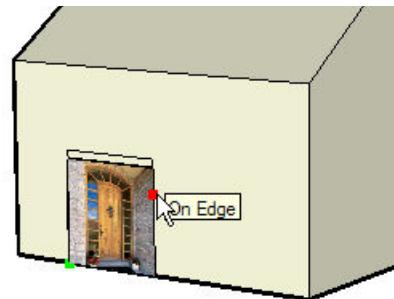
- Start with a house and an estimated rectangular outline for the door.



- There are a few ways to insert a picture to be used as a texture. One is to select **File / Import / 2D Graphic**. Locate the picture where you saved it. Place the picture on the door by first clicking the lower left endpoint.

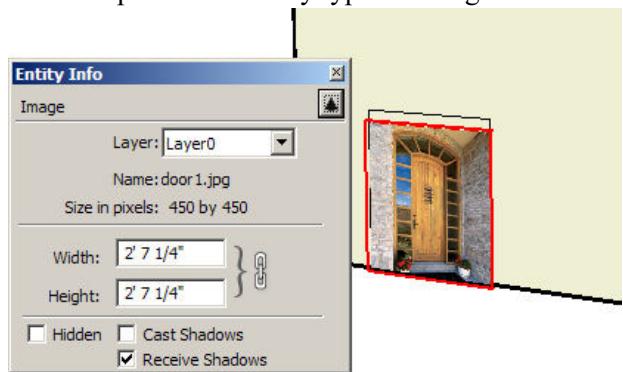


- Then size the picture approximately to the door by clicking somewhere along the right edge of the door. Unless you made the door outline with the exact aspect ratio of the picture, the picture probably won't fit exactly. But exact size does not matter, since the picture will be tweaked to fit.

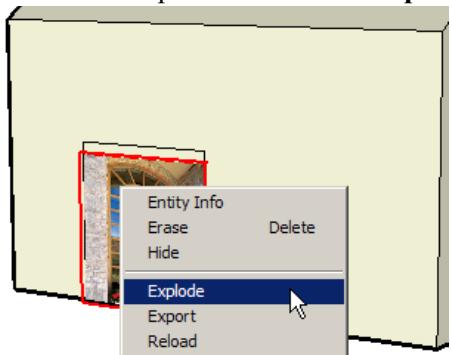


**TIP:** If you want to drop the picture onto a face at its current size, just double-click on the face. Press **Ctrl** if you want to place the picture by its center. Press **Shift** while placing the second corner point if you want non-uniform scaling.

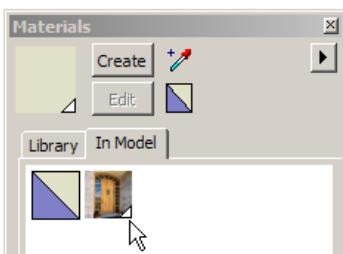
- Right-click on the picture and select **Entity Info**. The picture itself has a bounding box, similar to a group or component. Its entity type is "Image."



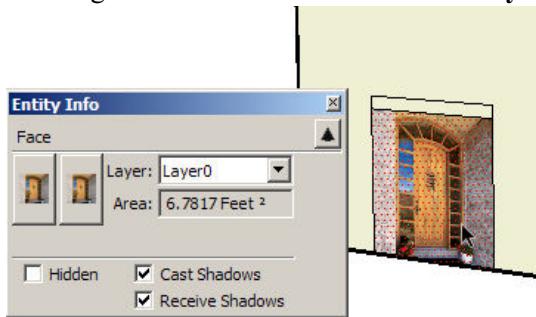
- Right-click on the picture and select **Explode**.



Exploding does two things. First, the picture is now included in the model as a material.



Second, the picture is now a painted face - no bounding box. This can be verified in **Entity Info**.




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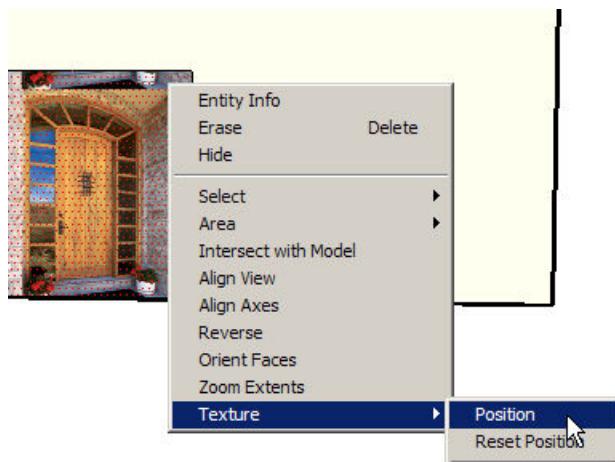
**NOTE:** There is a more efficient way to bring in a material like this. When you import a 2D graphic, there is an option at the bottom of the **Import** window to **Use as Texture**. This paints the texture automatically to the face, eliminating the need for exploding and resolving lines.

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- Erase lines as needed to get one face - the face you originally created for the door. The picture does not fit yet, but we're about to do just that.



- Right-click on the image and select **Texture / Position**.



- If you see colored pins, you are in **Fixed pin mode**. To enter **Free pin mode**, right-click and deselect **Fixed Pins**. In Free pin mode, there are four yellow pins around one of the tiled images.

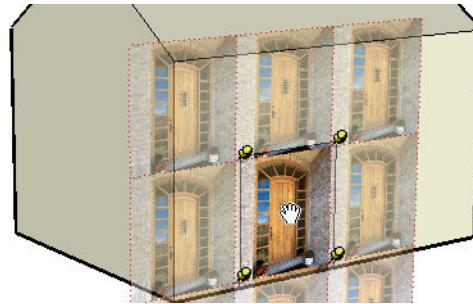



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**TIP:** While in either Free or Fixed Pin mode, you can switch modes temporarily by pressing Shift.

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- Like in Fixed pin mode, place the cursor anywhere on the image, and drag it to move the picture around. You can use this to place the door in its general location.



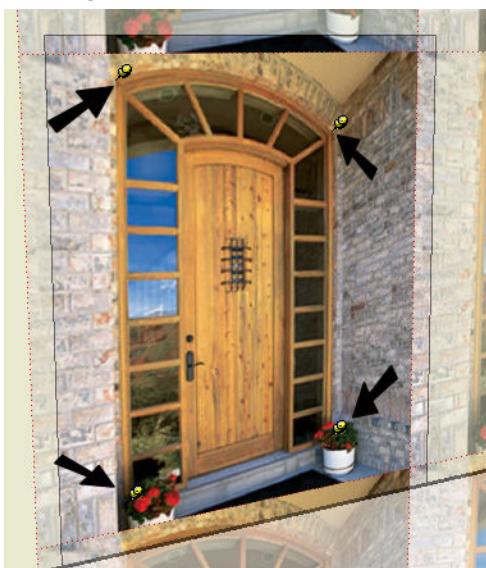
10. In Free pin mode, each pin has the same function - to pull its corner to stretch and distort the picture. Hover over one of the pins until you see a small square around it, and click to “lift” the pin off the image.



11. Place the pin at the closest door corner, disregarding (for now) the arch portion at the top.



12. Use this method to place the four pins at the four rectangular corners of the door picture. When one pin is directly above/below/left/right of another pin, a dotted line appears - very helpful for accurate positioning.



13. Now click and drag one of the pins to the closest corner of the model doorway.

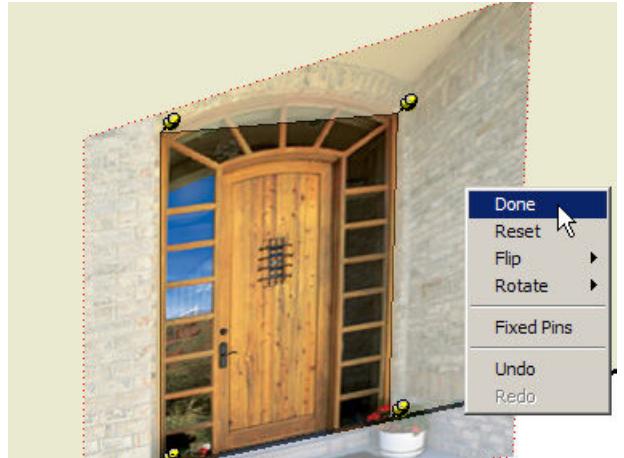


14. Do the same for the other three pins, to fit the rectangular part of the door into the model doorway.

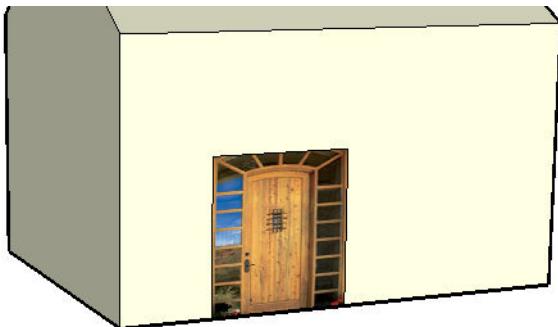


If the picture isn’t perfectly aligned, you can continue to lift, move, and drag pins until the alignment looks good.

15. To keep this image “distortion” (you distort the image to make it look right), right-click and select **Done**. (Or click anywhere in the blank space.)



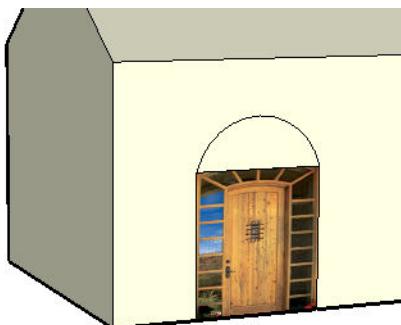
The door fills the rectangle, but the arch portion is missing.



Here is the completed door - looks good in **Front** view.

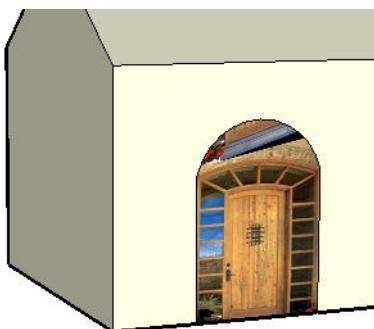


16. Use **Arc** to place an arc (size does not matter) at the top of the doorway.



If needed, you could return to position mode and place a pin at the top of the door in the picture. Then that pin would be moved to the midpoint of the arc.

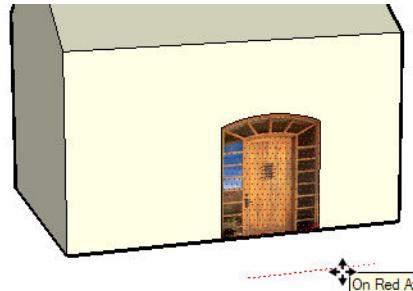
17. Erase the line between the rectangle and arc, and the image extends into the arc.



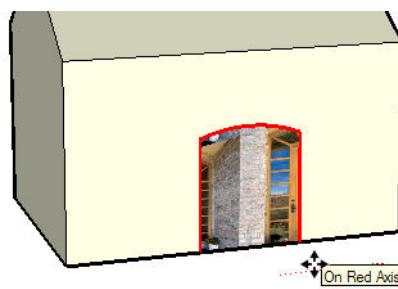
18. To fit the arc to the picture, activate **Move**. Hover to pick up a moveable endpoint and drag it down to resize the arc to fit the picture.



19. Move the door, and the image follows.



20. Now move just the door *edges*, not the face itself. This places the door shape on another portion of the door image, so be careful not to do this!



For a more in-depth exercise in which a single image is used to create a 3D object, see "Creating a Painted 3D Bus" on page 277.

# Using Pictures to Create Realistic Objects

If you have pictures handy, you can easily use them to create photorealistic objects you can place in your models.

**NOTE:** If you have pictures that include alpha channels for transparency, see "Alpha Transparency" on page 296.

## Creating a Painted 2D Tree

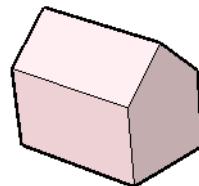
This exercise uses a picture to create a tree in your model. Here is the picture that will be used:



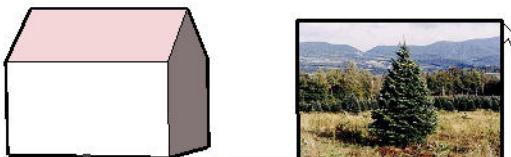
If you want to use this exact image, you can find it at [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm). Download the file "pinetree.jpg"

Any picture of a tree can be used. If you don't have tree picture, try a person, street lamp, road sign- something that you would always want to face you in a 3D model (not appear as a 2D cutout).

- For reference, start with a basic house.



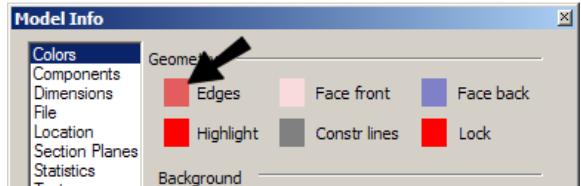
- Select **File / Import / 2D Graphic** and browse to your picture. Place it vertically, at a scale that makes sense, using the house size as a guide.



- Right-click on the picture and select **Explode**. Now the picture acts as a regular SketchUp face, and the picture appears in the Material Browser.

**TIP:** You also could have dragged the picture in right from your browser, and then scaled it.

- For this next step, it might help to change the edge color. Open the **Model Info** window to the **Colors** page and select a color for **Edges** that contrasts with the tree.



- Now use **Line** and/or **Arc** to trace around the tree.

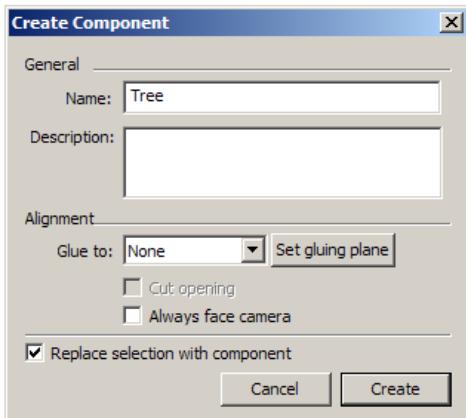


- When the outline is closed, the lines will become thin. When you've finished tracing, delete the rest of the picture.



**NOTE:** The picture is not positioned with respect to the edges around the tree. Therefore, if you select only the edges (not the face itself) and move them, the edges will no longer enclose the tree - they will move along the original picture. This can be fixed (see "Texture Positioning" on page 265) but for this exercise there is no need.

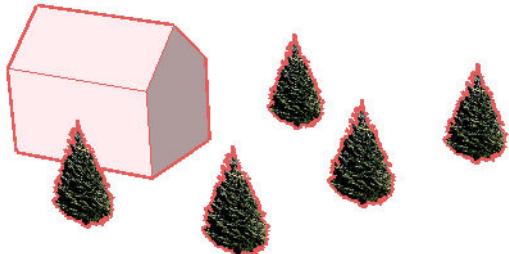
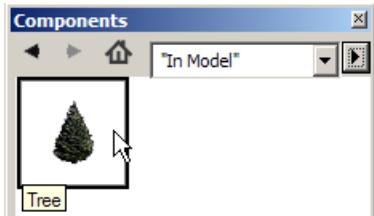
7. Select the tree (double-click it to select its edges) and make it a component.



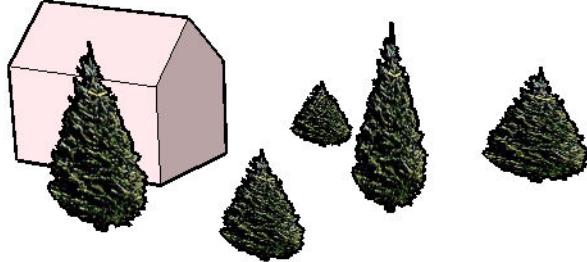
The tree is now enclosed by a bounding box.



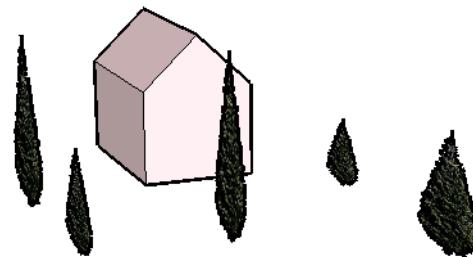
8. The tree now appears in the **In Model** tab of the Component Browser. Click the thumbnail and insert a few more trees around the house.



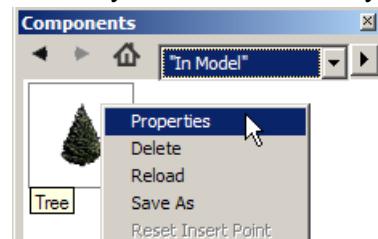
9. Use the **Scale** tool to make the trees different from one another. Some can be taller, some wider, some can be flipped to their mirror image. (You can also change the edge color back to what you usually use.)



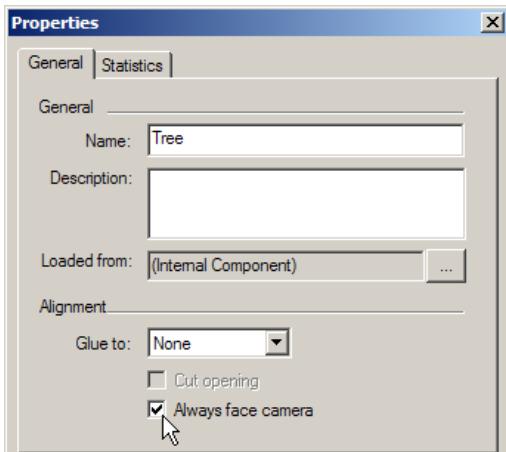
10. Orbit the model around - the trees look like how they were created - flat cutout faces.



11. This can be changed in the definition of the component itself. Even when components have different scales, their properties are still the same. In Windows, right-click on the tree thumbnail in the browser and select **Properties**. (You can also right-click on any tree and select Entity Info.)

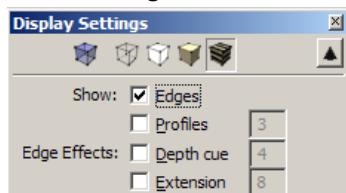


12. In the **Properties** window (or **Entity Info**), check **Always face camera**. (In the **Entity Info** window, if this option does not appear, click on the down arrow at the top of the window. This expands the window.)



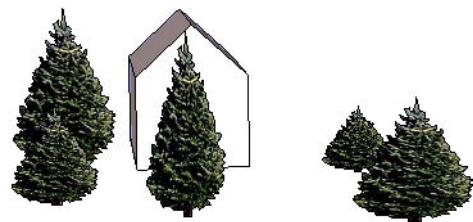
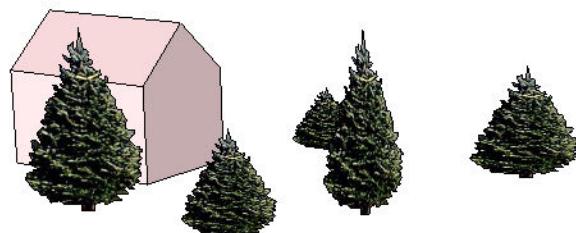
*Mac: The **Properties** option does not work as of this writing. To make a component always face the camera, this option must be set when the component is first created. To modify an existing component, you must explode it and redefine the component.*

13. If the edges surrounding the trees look too thick, open the **Display Settings** and uncheck **Profiles**. This will make all edges thin.

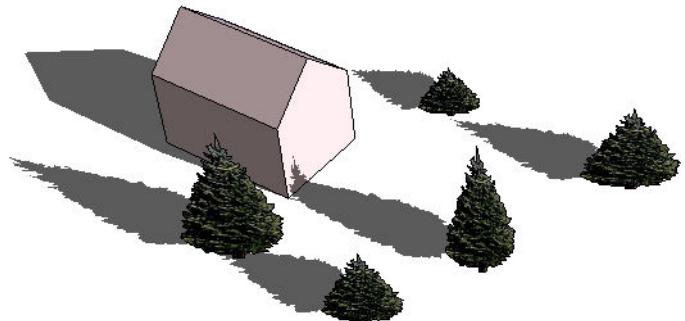


Or you could uncheck **Edges** to eliminate edges altogether.

14. Now orbit the model around. No matter what the angle, the trees are always facing you.shadows



15. Turn on shadows via the toolbar or by selecting **View / Shadows**. Adjust the month and time of day to see the shadows cast by the trees. (Make sure the bottom of the tree rests on the ground plane.) The shadows have the correct shape and orientation.



## Creating a Painted 3D Bus

This exercise uses a picture to create the side, front, and top of a bus. This will work for any vehicle, but a bus is handy because it's prismatic. You can do a web search for a bus picture, but the one used in this example is from the Greyhound web site - <http://store.yahoo.com/greyhoundlogoshop/>. (It's actually a toy bus, but it looks real enough!)

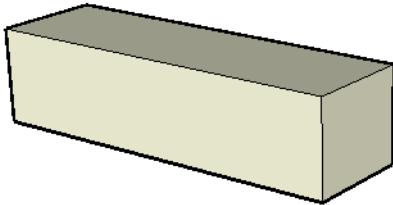
Here is the picture:



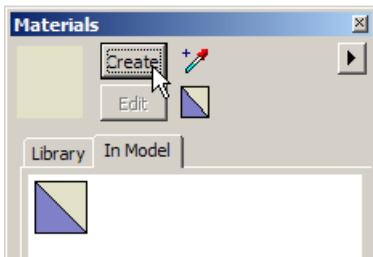
You can also find this picture at [www.fl1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.fl1help.biz/ccp51/cgi-bin/SU5Files.htm). Download the file "bus.jpg."

**NOTE:** To save a picture from a website, right-click on the picture in your browser and select **Save Picture As**. Some web graphics, such as clip art, are copyright protected and cannot be download this way.

1. First make a box in the general shape of a bus. If you care about making it realistic, use **Measure** to make the length something like 30'.

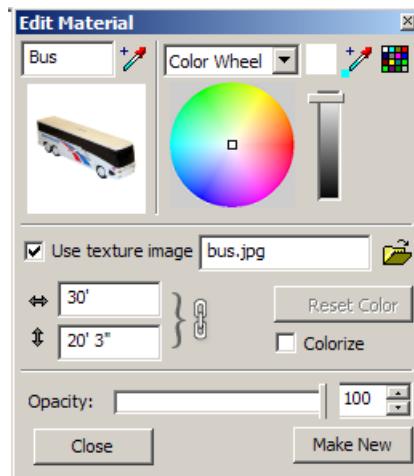


2. You can import a picture as a texture via the Material Browser. Click the **Create** button at the top.

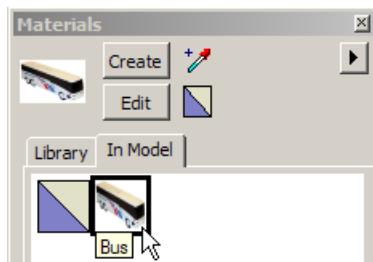


*Mac: Right-click on the texture swatches in **Colors in Model** and select **New Texture**. You can also click **Image Palette**, and select **New from file** to browse to the image you want to import. This method should be used only if you want to import an image from which you want to sample colors particular to that image.*

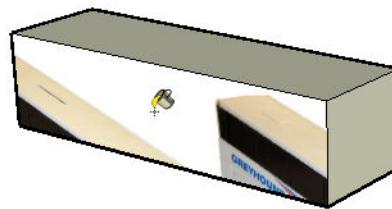
3. In the **Mix New Material** window, check **Use texture image** and browse to the bus picture. Make the size something realistic - if you keep the lock symbol as is, you can enter 30' for the length and the height will update automatically. Finally, enter the name of the new material ("Bus") at the top left.



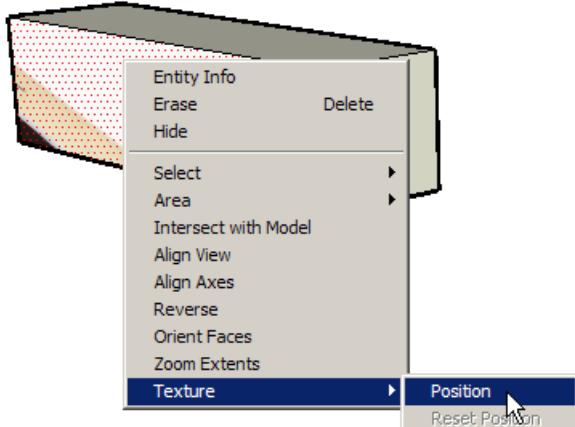
This new material now appears in the **In Model** tab of the Material Browser.



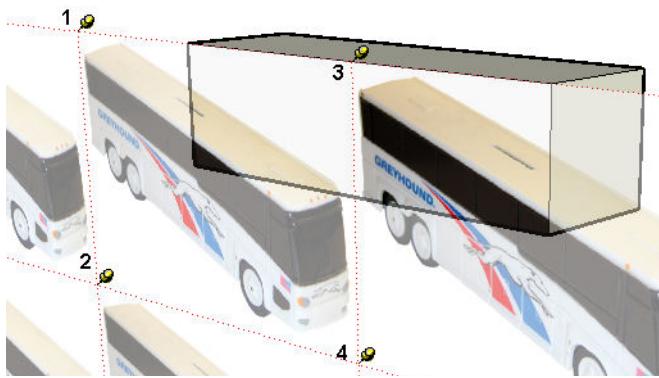
4. Paint this material onto the side of the bus.



5. To position the image correctly, right-click on the face and select **Texture / Position**.

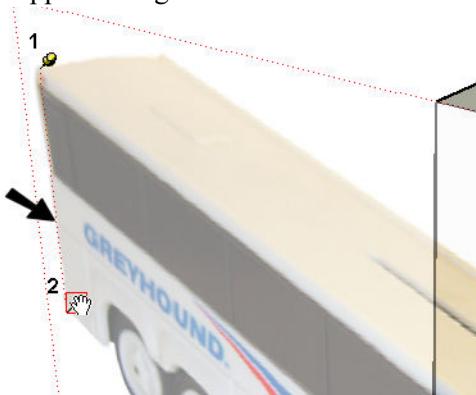


6. A tiled image now appears, with four pushpins at the corners of one image. These pins can be used to adjust the location and angle of the picture.



If you are in **Fixed pins mode** (four pins of different colors), right-click and deselect **Fixed pins**. Fixed pins are useful when you need to fine-tune a texture position, but this exercise can be done by eye in Free pin mode.

7. Click and lift Pin 1 and place it at the top left corner of the side of the bus. Place Pin 2 the same way. When Pin 2 is directly below Pin 1, a faint dotted line will appear as a guide.



8. Place Pins 3 and 4 the same way.



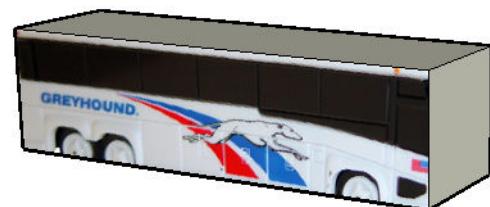
**TIP:** It's very helpful to use the zoom functions when placing pushpins. Use **Zoom Window** to lift the pin, then **Zoom Extents** to see the whole model. **Zoom Window** again to the target point, and click to place the pin.

9. Drag each pin to its corresponding corner on the model. The side of the box should now contain the portion of the picture that is the side of the bus, stretched and moved to the right scale and orientation.

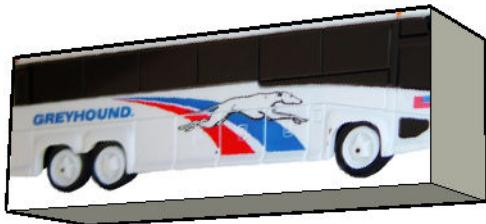


10. If necessary, move pins and drag them again to make the picture fit the way you want. When finished, right-click and select **Done**, or click in the blank space.

The side of the box looks good, but the tires are cut off.



- Push/Pull the bottom of the box so that the wheels from the picture are visible.

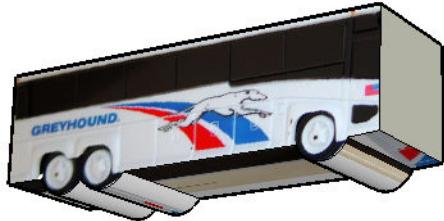


- Use lines and arcs to trace the bottom of the bus to include the wheels.



**TIP:** If you want to change the edge color to something more visible than black, open **Model Info** to the **Colors** page, and change the color for **Edges**.

- Push/Pull the lower part all the way back. Now the wheels are included in the bus.



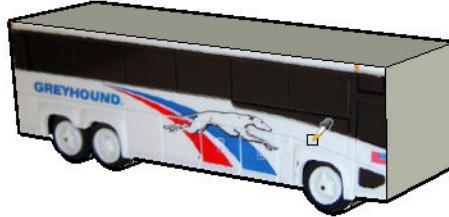
- Now for the front of the bus. There are two ways to apply the picture here. First, click the thumbnail in the Material Browser and apply it to the front face. With texture positioning this would work, but the initial placement of the picture is random - not connected to the picture on the side of the bus.



- Undo. A better way is to “sample” the material on the side of the bus. Use **Paint** + Alt/Cmd, or in Windows, you can click the dropper icon.



- Click the side face of the bus to sample its material.

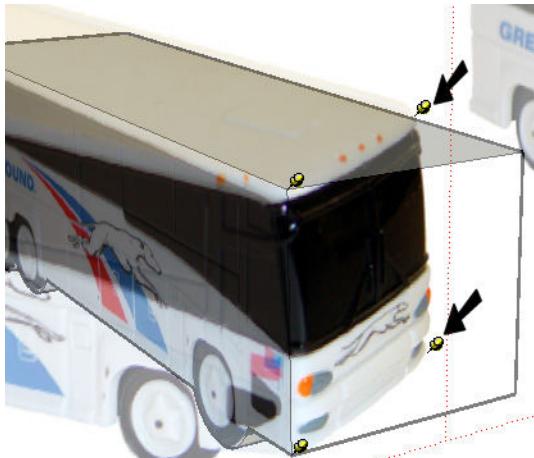


- Now click the front face. The picture still needs to be adjusted, but its placement is correct along the edge shared with the side face.



- If your picture isn’t facing the right way, or is upside down, you can right-click and select **Flip / Left/Right** or **Up/Down**. Enter texture positioning mode.

19. The pins along the common edge are already located correctly. But the two pins indicated below need to be moved to the correct corners.



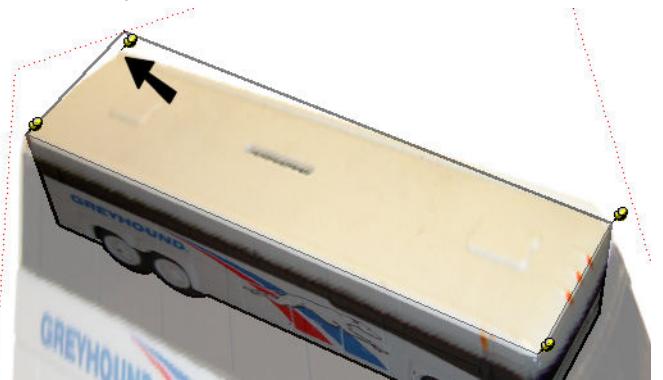
20. Drag these pins into place and exit position mode.



21. The top face is done the same way. Use the sample method to pick up either the side or front face material, and apply the material to the top. The roof is already aligned along the two edges common to the side and front faces.



22. In Position mode, adjust the one pin that isn't located correctly.



23. Here's the completed roof (with the coin slot - this example is actually a toy bank).



24. To apply the material to the opposite side face, sample the texture on the first side and apply it. It has the correct shape and orientation, only backward!



## Creating a Clubhouse

This exercise is very similar to the previous bus exercise, but rather than create the whole 3D shape at the start, we start with one section of it, then build out from there.

This picture is of a children's playhouse, taken from [www.thebeanbagstore.com/onlinecarlclubhouse.htm](http://www.thebeanbagstore.com/onlinecarlclubhouse.htm). (If this site disappears or changes, try a web search for "carl's club house.")



You can also find this picture at [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm). Download the file "clubhouse.jpg."

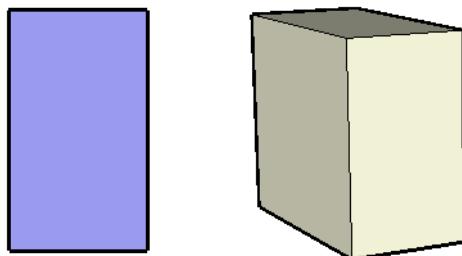
Any similar picture will work, including one of an actual house, or perhaps a group of townhouses.

1. We will start with the front face, so switch to **Front** view.



The easiest place to start with this clubhouse is the door: it has four easy-to-find corners. (In this example, the front face itself isn't so tough to position, but at the top it's a little tough to see where the roof starts. The door is much easier.)

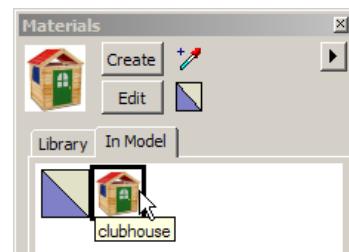
2. Draw a door-shaped rectangle, then **Push/Pull** it back to define the depth of the house.



3. Create a new material from this image by clicking **Use texture image** and browsing to the image file.



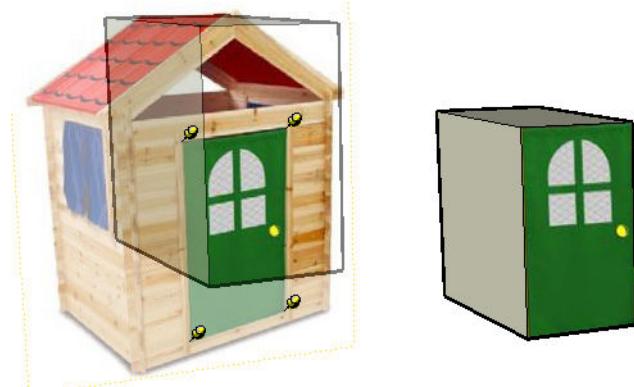
The image then appears in the Material Browser.



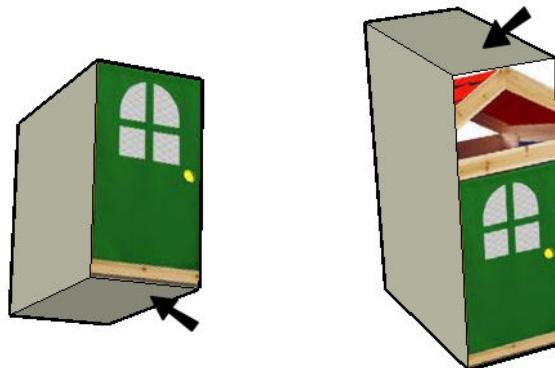
4. Apply the material to the door-shaped box.



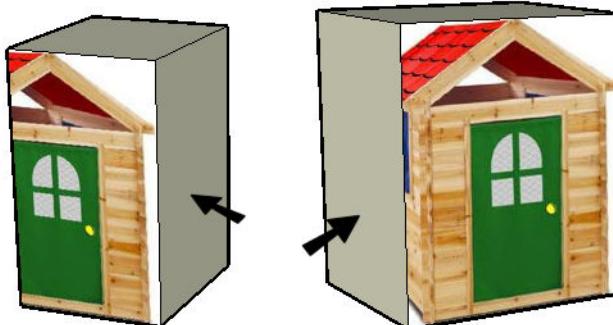
5. Position the material, locate the door corners, and fit the door to the face.



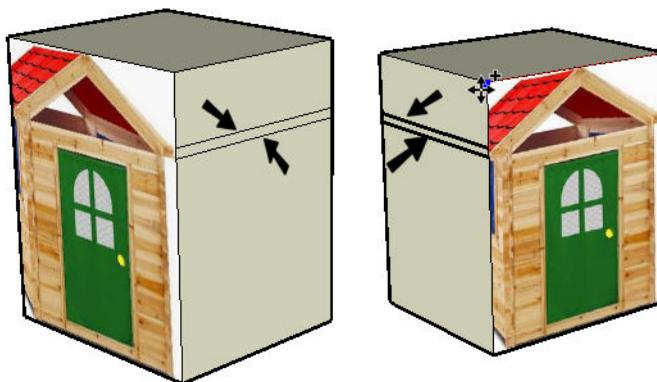
6. Now the rest of the house can be built from this. **Push/Pull** down to include the material below the door, then **Push/Pull** up to the top of the roof.



7. **Push/Pull** one side out to the edge of the roof. To ensure that the door is centered, double-click on the other side to pull it out the same distance.



8. On one side, add two lines for the roof edge. Copy these lines to the other side.



9. **Push/Pull** the sides in, using the same distance.



10. To complete the model, move the top edges to the center.



11. This example has a cutout below the roof. Use lines to trace the triangle and **Push/Pull** it all the way through. The material inside the cutout can be changed to something plain (not the picture).



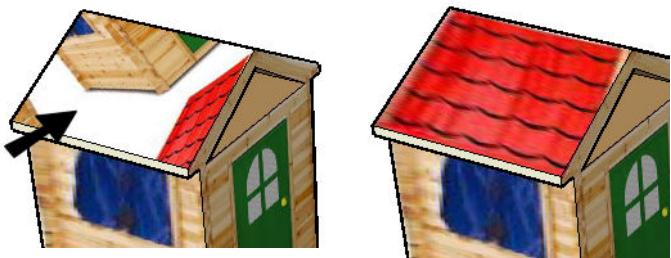
12. The rest should be familiar. Sample the front face and apply it to the side.



13. Position the image on this face.



14. Do the same for the roof.



15. If you want, you can sample the roof material and apply it to the small fascia.



Here is the completed clubhouse. If you need it all painted, you can sample the side face and apply its material to the other side.



## **Creating a Birdhouse**

This example is very similar to the bus and clubhouse exercises. The difference is that you use the imported graphic as a guide to create the model, rather than create the model first and fit the graphic to it.

The picture used here is of a birdhouse that you can find on several websites. Do a web search for “heartwood swiss chalet.”



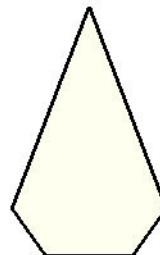
B N

You can also find this picture at [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm). Download the file “birdhouse.jpg”

1. Start again in **Front** view, and use **File / Import / 2D Graphic** to bring in just the image. Use two clicks to place its opposite corners, or double-click to keep its original size.

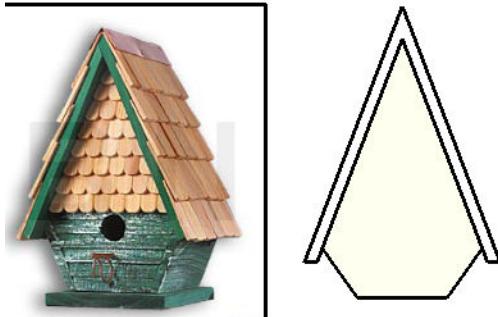


2. Use this picture as a guide to approximate the basic form for the front of the birdhouse.

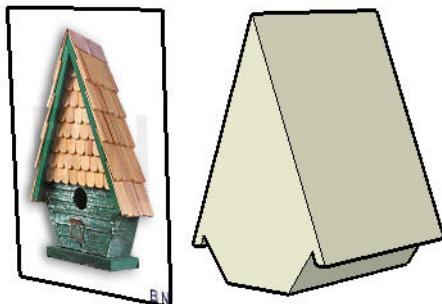


**TIP:** You can create half of the face, then copy it to the side. Use **Scale** to mirror the copy, then **Move** to connect it to the original lines.

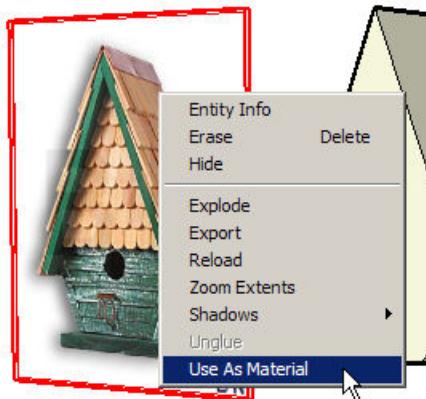
- To create the roof, you can use **Offset** and trim the lines as needed. Then add some small lines at the ends to close the roof face.



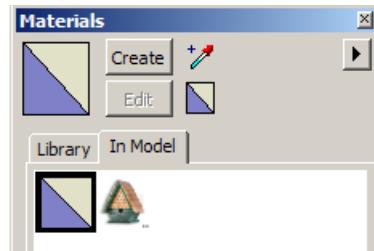
- Heal the front into one face, and **Push/Pull** it back.



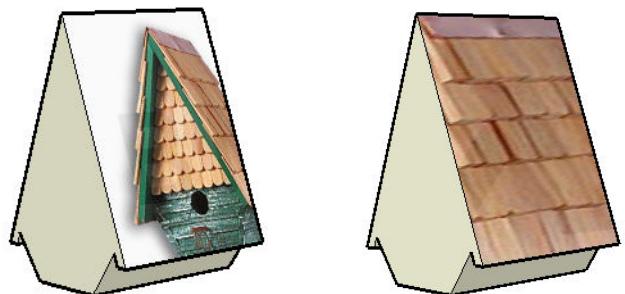
- Right-click on the image and select **Use as Material**.



- The image can now be deleted, and the material appears in the Material Browser.



- The easiest face to start with is the roof - it has four easy-to-find corners.



- Sample the roof and paint the front. It looks pretty good, but you can move two of the pins to improve it: one pin at the edge of the other side of the roof, and the other at the midpoint of the bottom edge.



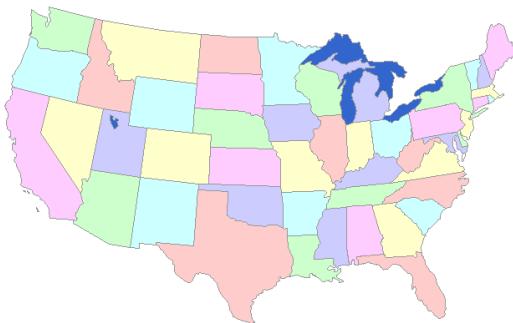
- As before, you can use the same method to paint other faces as well.



## Wrapping Images

This exercise shows you how to wrap a picture along planar faces from a set angle, and how to modify a picture wrapped around a curve.

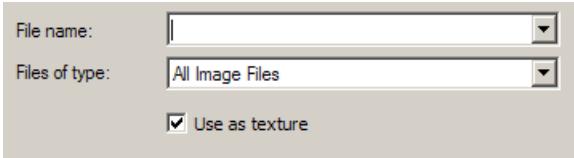
The picture used here is a map of the continental USA, but any image will work.



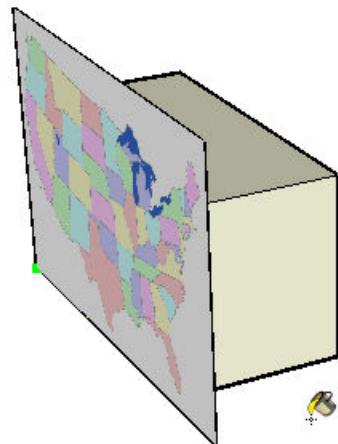
If you want to use this exact image, you can find it at [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm). Download the file "USAMap.bmp."

## Planar Faces

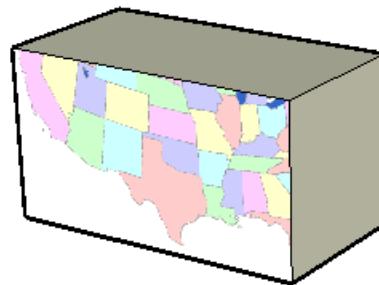
- Start with a cube and use **File / Import / 2D Graphic**. At the bottom of the **Import** window is a checkbox for **Use as texture**; make sure this is checked. Browse to the map image.



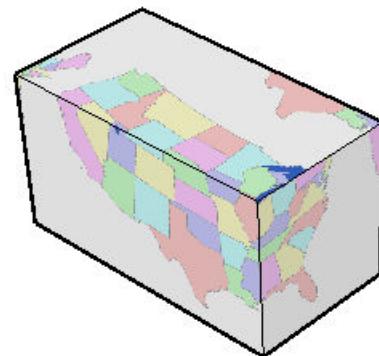
- Apply the map to one face. Start at one corner, and make the scale a bit larger than the face itself.



- If necessary, position the texture so that the top and right are off the face (and will spill onto adjacent faces).

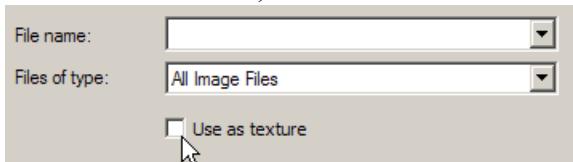


- Sample this positioned texture (**Paint + Alt/Cmd**) and apply it to adjacent faces. The wrapping is correct, according to the horizontal alignment of the original face.

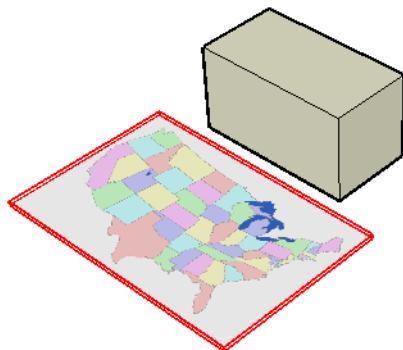


- If you want an alignment that is *not* along one of the faces, you must have a properly-aligned face for sampling. Undo to return to the unpainted box.

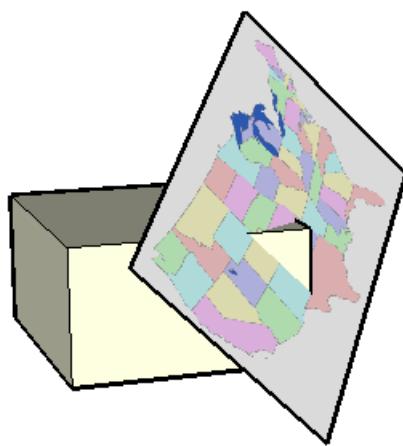
6. Insert the image again by itself (make sure **Use as texture** is unchecked).



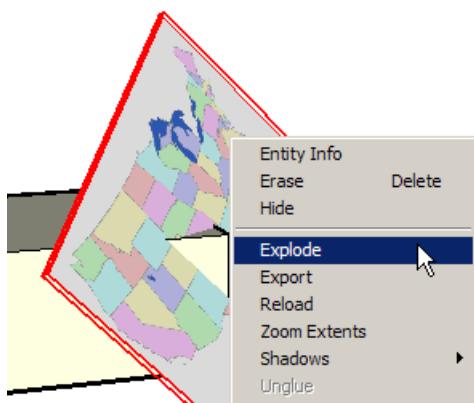
7. Place the image anywhere, at a similar scale as before.



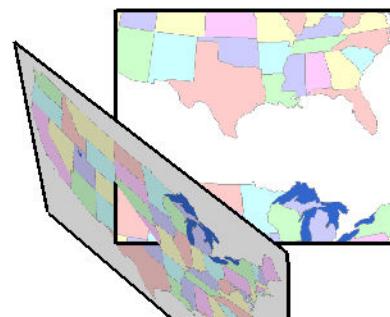
8. Activate **Move** mode, in which you can both move and rotate the picture. Move it to a position like this - at an angle in which a corner of the cube sticks out.



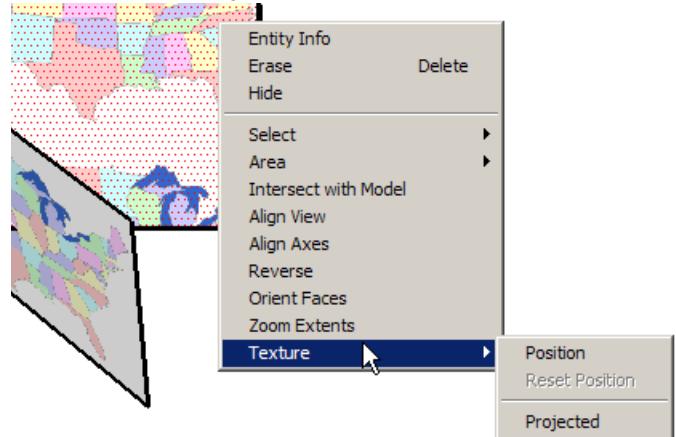
9. **Explode** the image. Now the image is a normal, painted face.



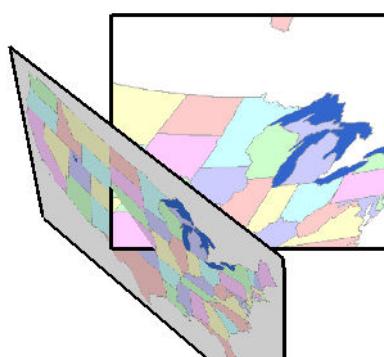
10. Click the thumbnail from the Material Browser (do not sample the face) and apply it to a face of the box. It is not skewed or tilted; it has the original projection.



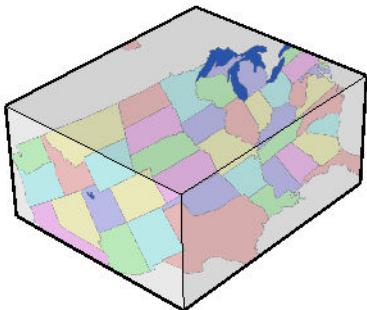
11. To verify this, right-click and select **Texture**. In the submenu, **Projected** is not checked.



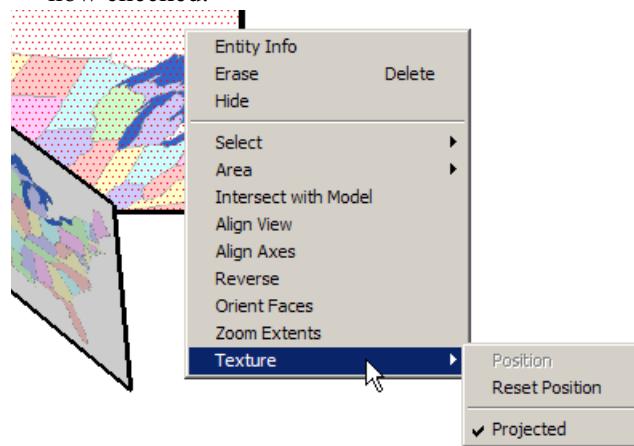
12. Undo. This time sample the paint on the tilted face and apply it to a face of the box. This time the image is skewed.



13. Sample the box face to wrap the skewed images to other faces.



14. Right-click again on one of the faces - **Projected** is now checked.

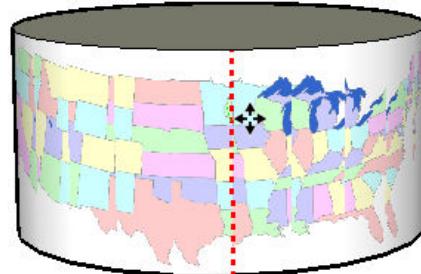


## Curved Faces

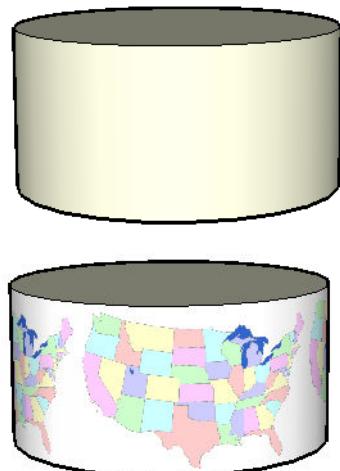
1. Now draw a cylinder and apply the picture to it. (Use the thumbnail from the **In Model** tab of the Material Browser, not the sampled skewed texture from the cube.) The image wraps smoothly.



2. Use **Move** to resize the cylinder. Now the image is no longer smooth. This is because the image is actually applied to each planar segment separately.

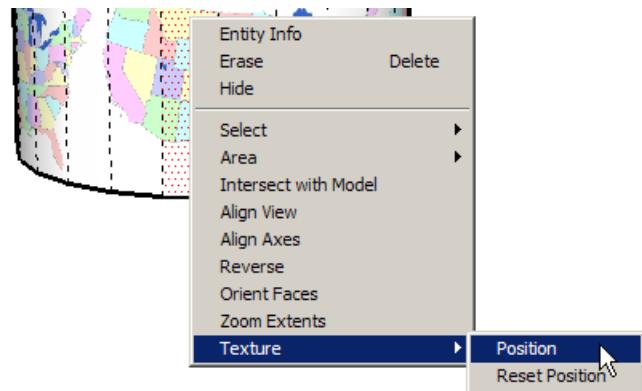


3. It's easy to fix this - remove the material (apply the Default material), and reapply the image.

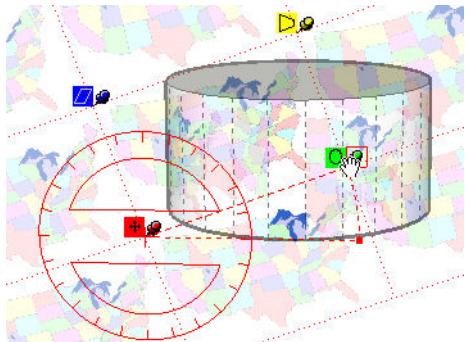


The picture wraps smoothly, but you cannot right-click on the face to access texture positioning.

4. To change the orientation or scale of the image on a curved face, first display hidden edges. Then right-click on any of the face segments and select **Texture / Position**.

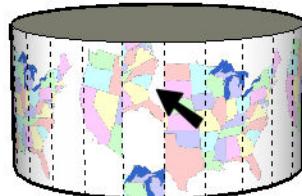


5. In Fixed pin mode, use the green pin to rotate the picture.

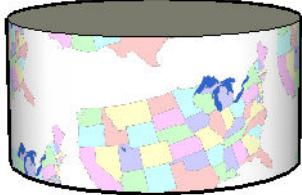


**TIP:** If you are in Free pin mode, you can press Shift to temporarily enter Fixed pin mode. And vice-versa.

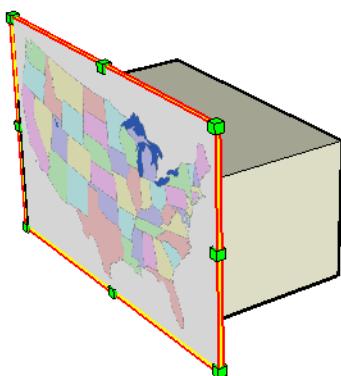
When finished, only the edited segment has the rotated picture.



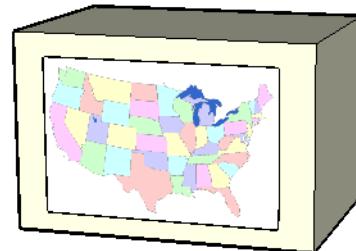
6. Sample the rotated image, and turn off the hidden lines. Then apply the texture to the cylinder - the rotated picture wraps around the whole cylinder.



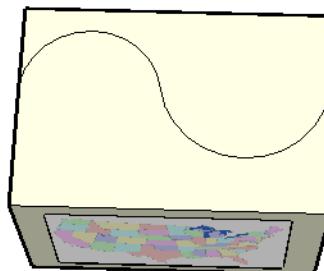
7. For another example of a projected image, start a new file and draw a box. Locate the map file in your browser, and drag it right into SketchUp, placing it along one of the vertical faces.



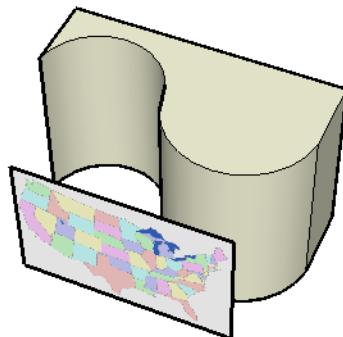
8. Use **Scale** on the image and/or **Push/Pull** the box, so that the image is enclosed within the face.



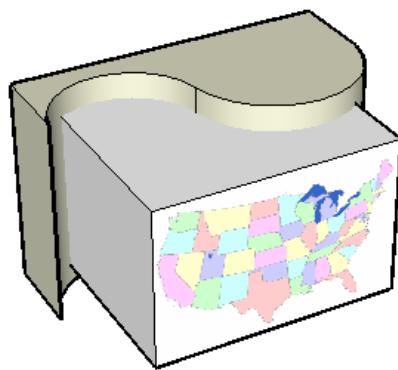
9. On the top face, draw two tangent arcs like this:



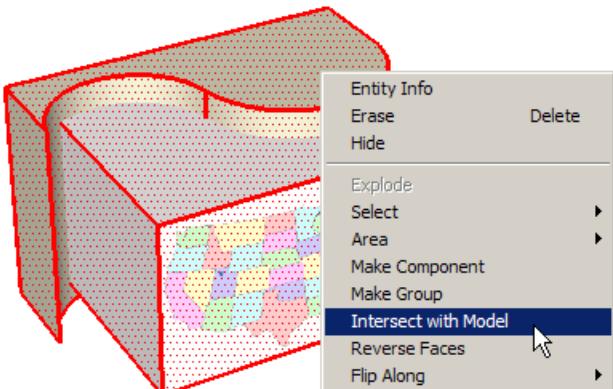
10. **Push/Pull** the front of the box all the way down.



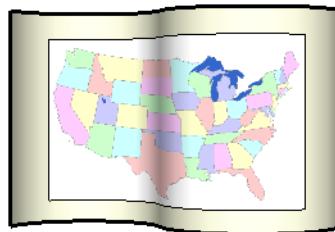
11. **Explode** the picture and **Push/Pull** it into the wavy form.



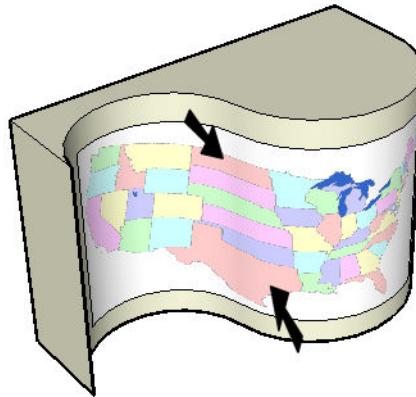
12. Select everything, right-click, and select **Intersect with Model**.



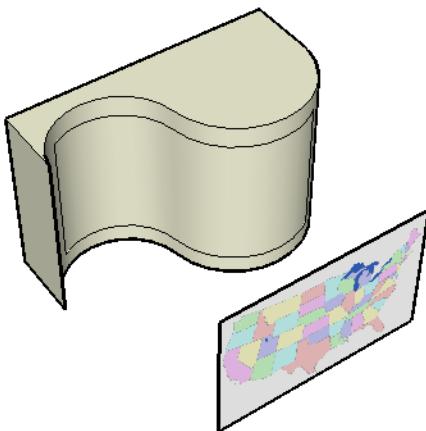
This is a projection, not a wrapping. Therefore, the wavy face looks fine in **Front** view . . .



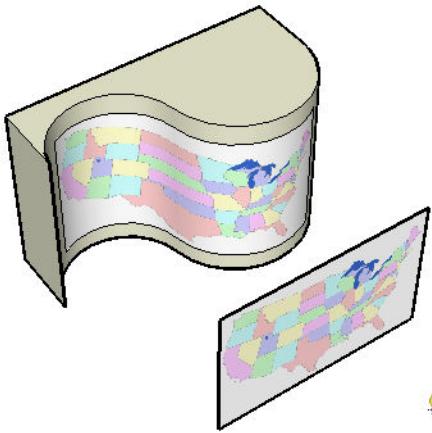
. . . but in an isometric view you can see distortion along the curved face.



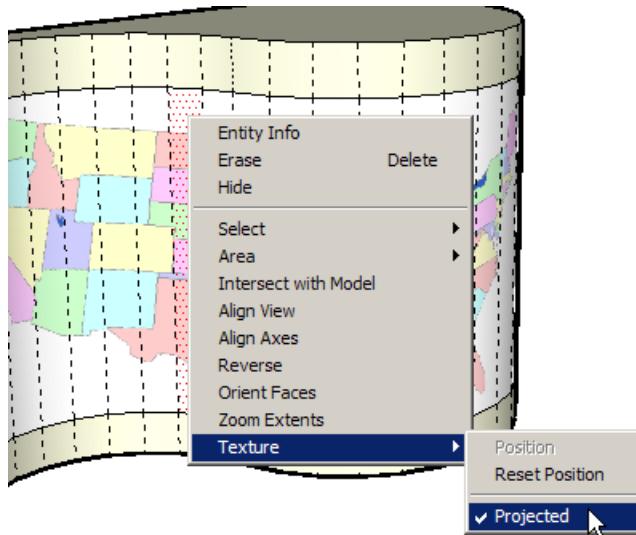
13. Trim all but the projected face, and use **Erase + Ctrl/Option** to soften any edges.



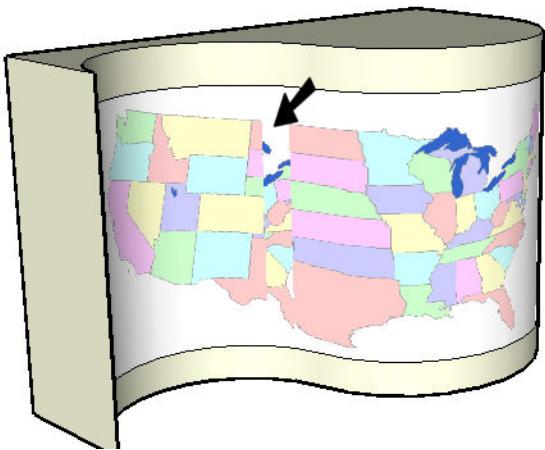
14. Sample the exploded picture, and apply it to the wavy face.



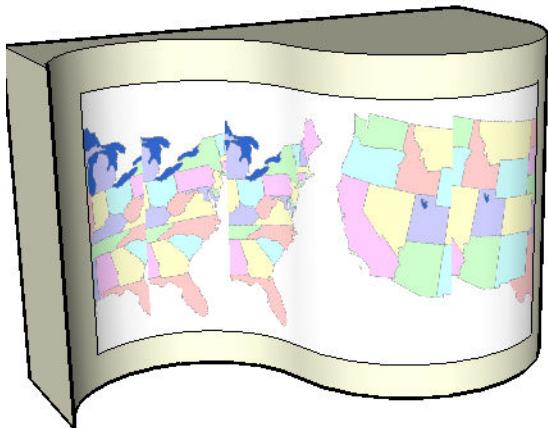
15. Just like with the cylinder, to manipulate the textures on this wavy face, you need to first display hidden edges. Then right-click on any face segment and select **Texture**. **Projected** is indicated as the current format; select this option to toggle it off.



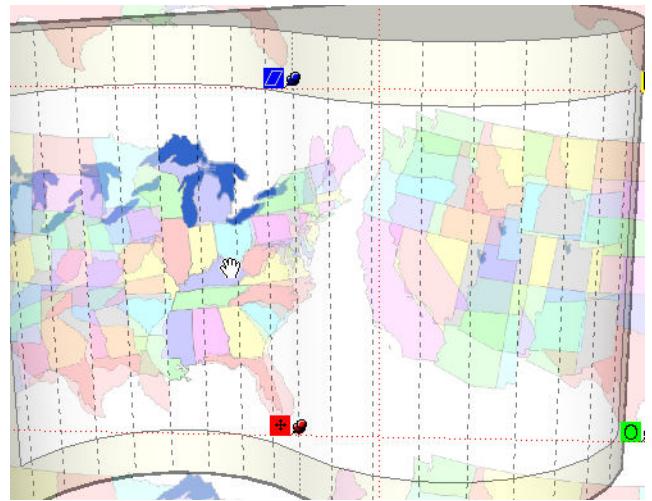
16. The texture of this face now has the “true” scale. Sample this texture, then turn off hidden edges.



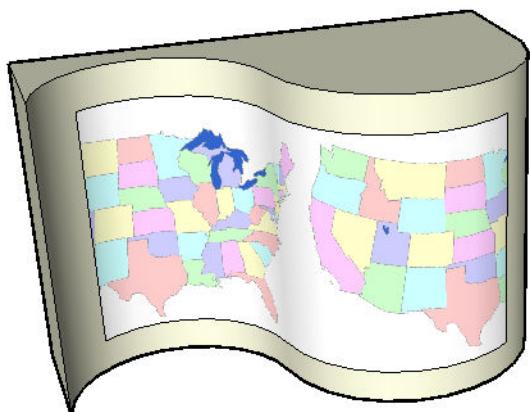
17. and apply the texture to the rest of the wavy face. In this example, many of the segments have a continuous pattern, but not all do - the pattern looks jumpy.



18. The solution: turn hidden edges back on, and position the texture in each face segment, one by one, in order. This case is easy - while positioning, drag the map to match that of the adjacent face segment.



Unless you’re working at a very large zoom scale, you probably won’t get perfectly matched results with this method, but it’ll look pretty close.



## Projecting an Image onto a Non-Planar Face (Topography)

Similar to the previous exercise, this exercise shows you how to project a map onto a topographical surface. This map will be used; it was taken from the site [www.mapquest.com](http://www.mapquest.com).



If you want to use this exact image, you can find it at [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm). Download the file "Mapquest.bmp."

**NOTE:** To use mapquest, type in any address and click **Search**. Zoom in or out as needed, then right-click on the graphic and select **Save Picture As**.

1. Start by selecting **File / Import / 2D Graphic**. Browse to where you saved the map picture, and insert it into the model. An image inserted this way does not need to be placed on a face.

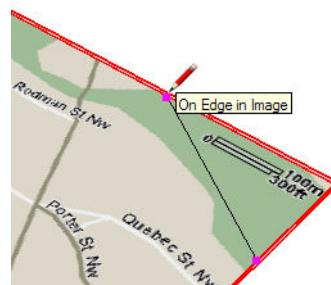


You can insert an image several ways:

- Double-click to drop it at its current size.
- Click one corner point, then the other to insert it at its current aspect ratio.

- To insert by its center, click the center point, then press **Ctrl/Option** and click the outer point.
- To change its aspect ratio, keep **Shift** pressed while placing.
- You can also drag a picture into SketchUp directly from the file browser. This inserts the picture at its original size, but you can change the scale after inserting.

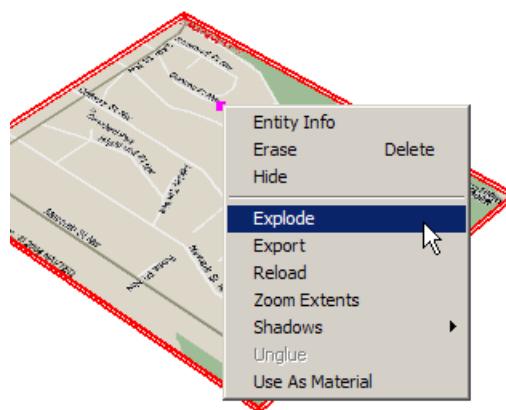
2. The image is inserted with a bounding box around it, similar to a group or component. We want the picture to act as a regular SketchUp face, but at this point it doesn't. To verify this, draw a line between two points on the picture's edges.



The line is thick, indicating that it is not aligned to the face.



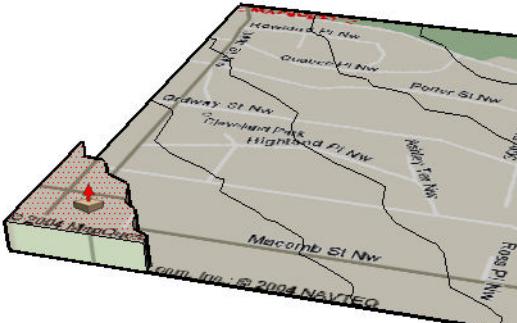
3. **Undo** this line. Right-click on the image and **Explode** it.



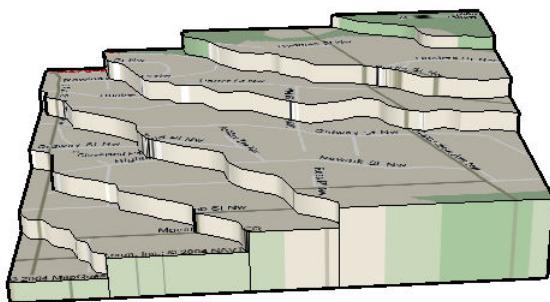
4. Now the image is a face. To represent the topographical lines, use **Freehand** to draw a few wavy lines on the face. If drawn correctly, (starting and ending on the face edges), they will be thin-lined and will divide the face.



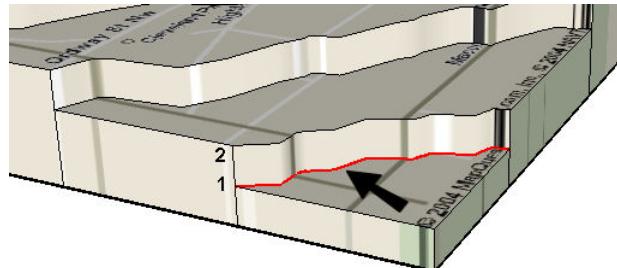
5. Use **Push/Pull** to pull up the first section.



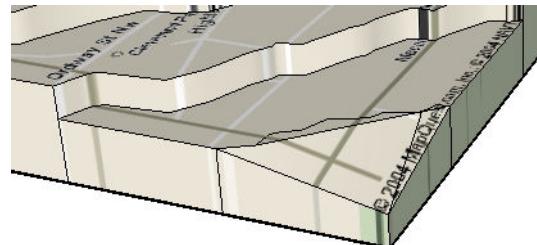
6. Pull up the remaining sections progressively higher. You can double-click repeatedly if you want to keep all height differences the same. Note that the map acts like a material, and follows the pulled sections.



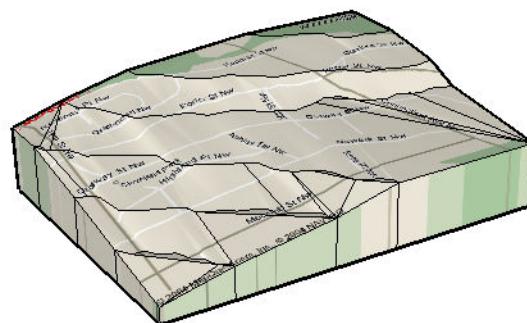
7. To smooth the face, we will join edges. First, select the edge shown. Activate **Move** and move the edge up from Point 1 to Point 2.



This is the result - the step is gone and edges are added where needed.



8. Use the same method to smooth out the entire surface.



This is one method for creating a realistic-looking topo surface. The advantage of starting with just the image is that you do not have to start out knowing the exact dimensions of the map - you can build the model based on the picture.

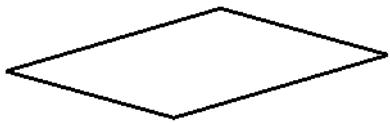
We will now try another method, using the **Sandbox** tools. For these tools to be available, open **File / Preferences** to the **Extensions** page and make sure **Sandbox Tools** is checked.

---

NOTE: *Sandbox tools are covered in Chapter 10.*

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9. Erase all but the lower four edges of the topo face.

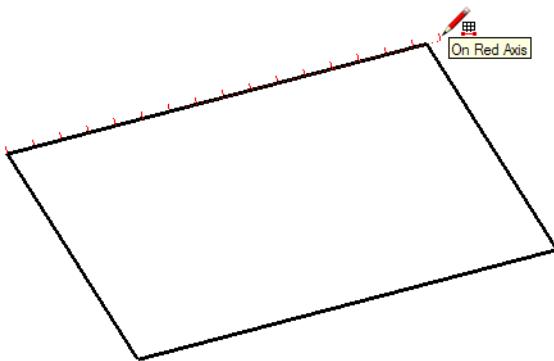


10. From the **Sandbox** toolbar, click **From Scratch**. This enables you to create a flat grid at a set spacing. Enter a value for the spacing (you can redo the grid if the spacing doesn't look right).

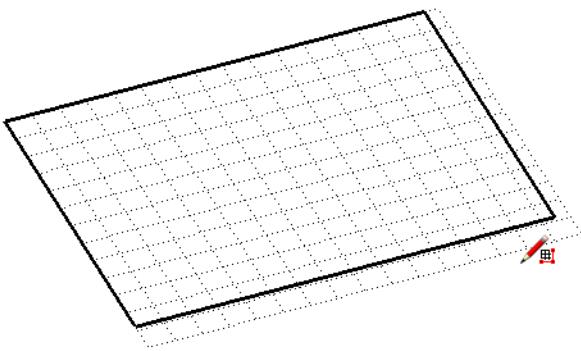


**Grid Spacing** 1'

11. Click one corner, then move the cursor along one edge to define the first grid edge. The tick marks represent the spacing you defined. Extend to the first tick mark past the end of the edge, and click.

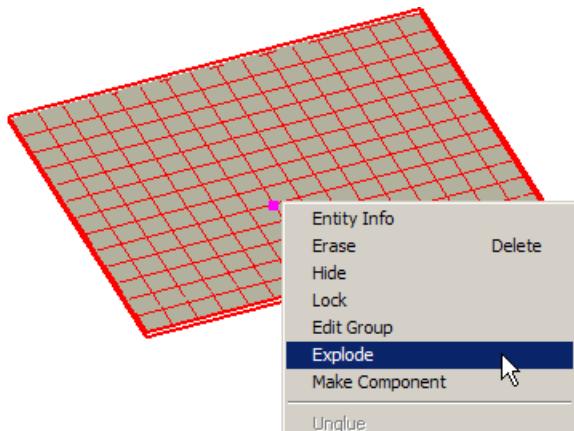


12. Move in the other grid direction, and click to define the size of the grid.



13. You can now erase the original four edges.

14. The grid is grouped, so **Explode** it.

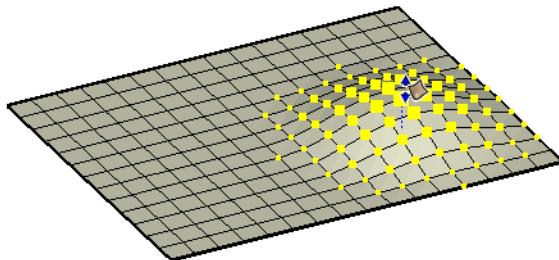


15. To modify grid heights, click the **Smooth** tool. Enter a radius - you'll be able to see whether your radius makes sense once you start.

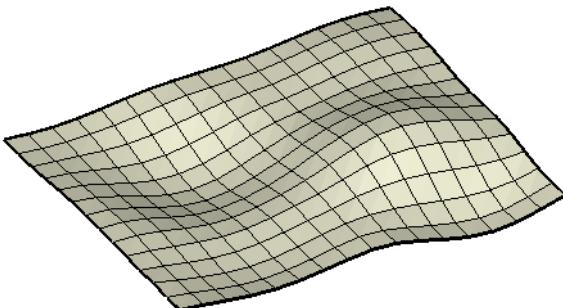


**Radius** 5'

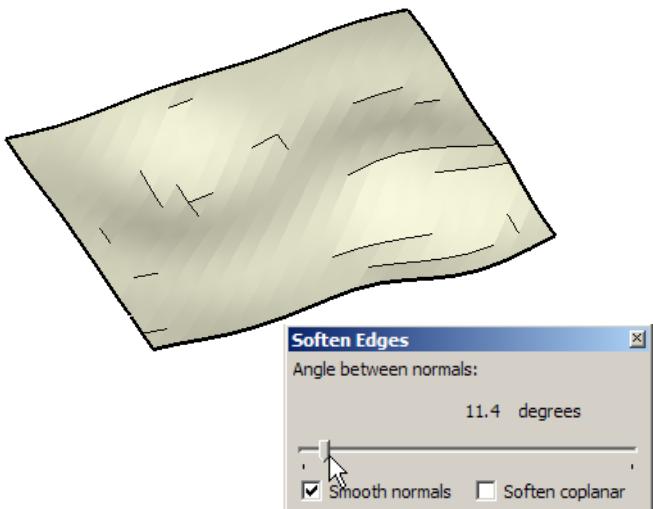
16. Click somewhere on the grid and drag the points up or down.



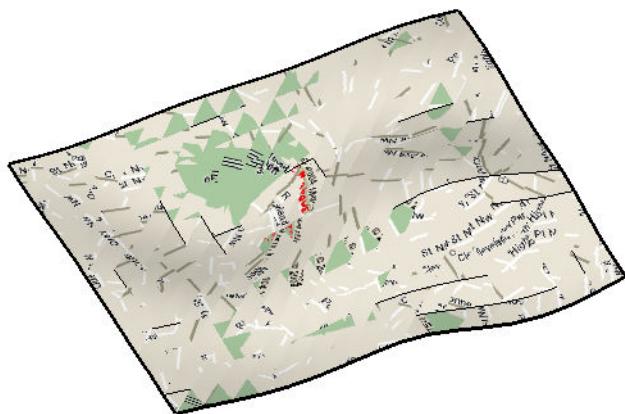
17. Do this in a few places to get a nice topo surface.



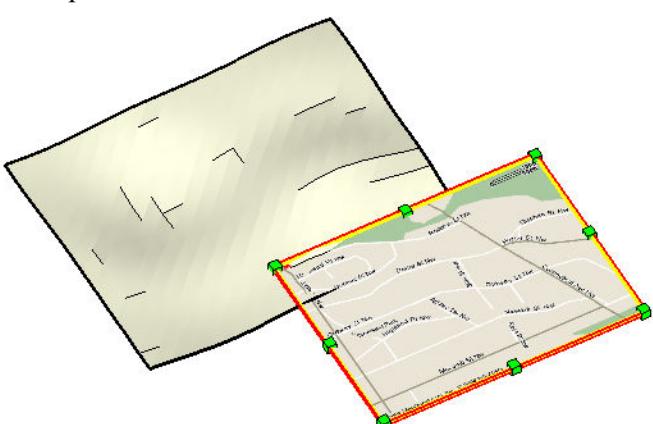
18. Select all and smooth the edges.



19. First, we'll see how **not** to apply the map to this surface. The map should still be present in the Material Browser; click it and apply it to the surface. The material is applied to each sub-face individually, resulting in a jumbled mess.



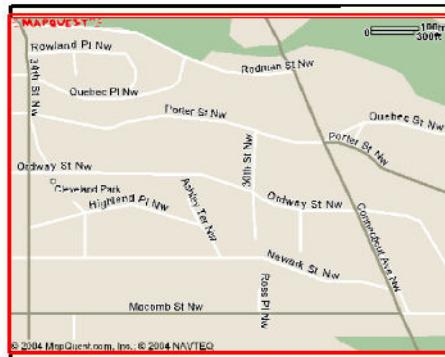
20. Undo, and bring the map in again, either using **File / Import**, or by dragging it right from your browser. Make sure it is flat - not aligned to any faces on the topo surface.



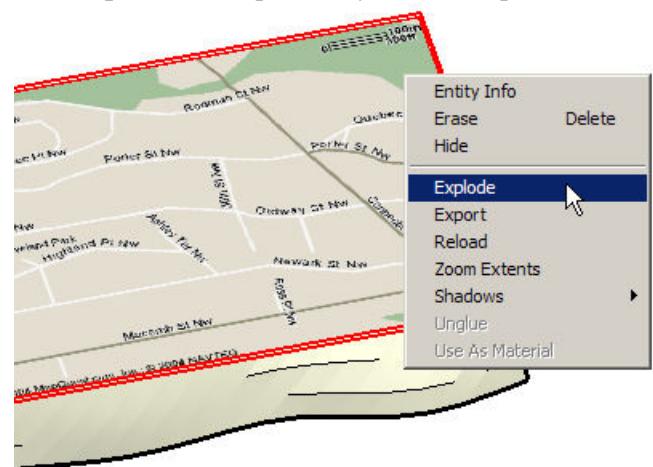
21. Position the map so that it is above the topo.



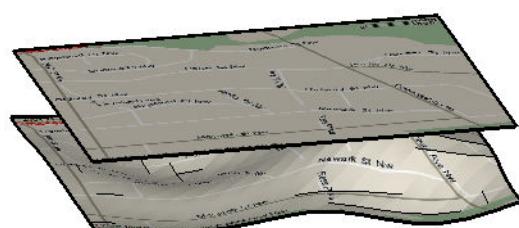
22. Switch to **Top** view. For exact placement, it is best to turn off **Perspective mode (Camera / Perspective)**. Use **Scale** and **Move** to size the map to the topo surface. (The topo may extend past the map slightly, depending on how you created your sandbox grid.)



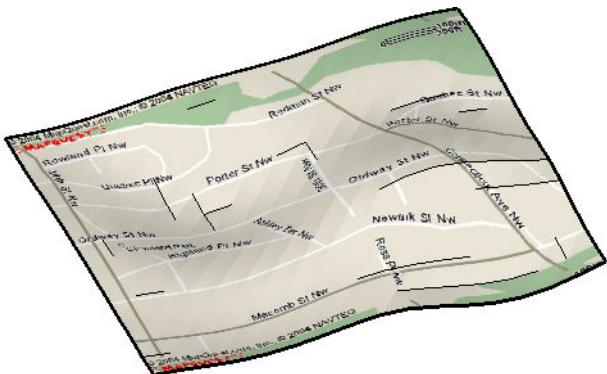
23. **Explode** the map so that you can sample its material.



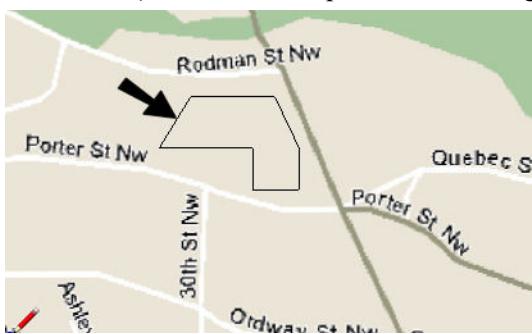
24. Sample the texture from the flat image, and apply it to the topo surface. It is projected directly onto the surface, and not subdivided.



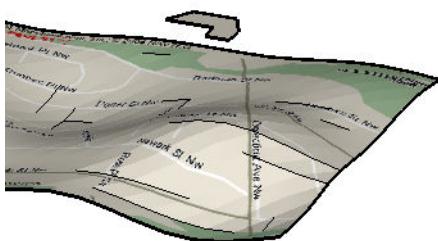
25. Hide (do not erase) the flat image to get a better look.



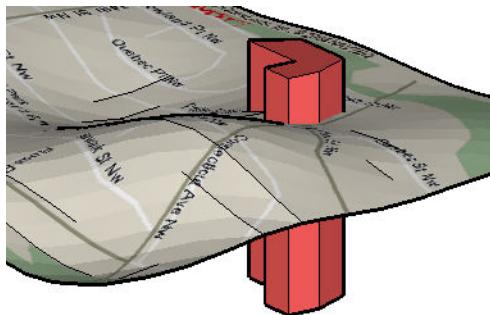
26. Now to place a building directly on this topo surface. Display the flat image if it was hidden (**Edit / Unhide / All**). Draw the footprint of a building.



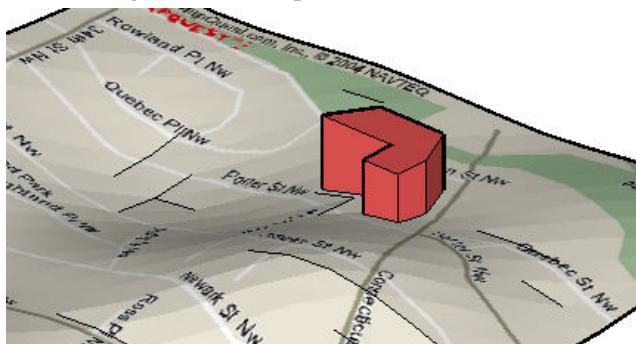
27. Erase all of the flat surface, minus the footprint face.



28. **Push/Pull** the footprint down past the topo surface.



29. Use **Intersect with Model** to erase all portions of the building below the topo surface.



## Alpha Transparency

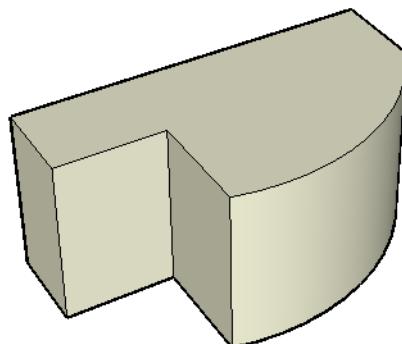
SketchUp supports graphics with alpha channels: areas of a graphic that are defined to be transparent are treated as transparent in SketchUp.

The image used in this example comes from [www.entouragearts.com](http://www.entouragearts.com). You can get all sorts of non-photo-realistic images here (mostly people and trees) that can be used as SketchUp components.

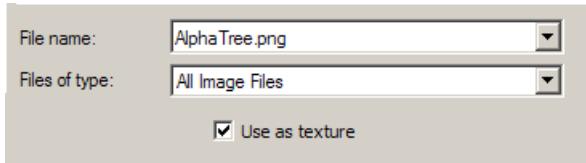
To get this picture, click “Downloads,” then click MatureTree.png. (This is a free download, but you’ll have to fill in some data.)



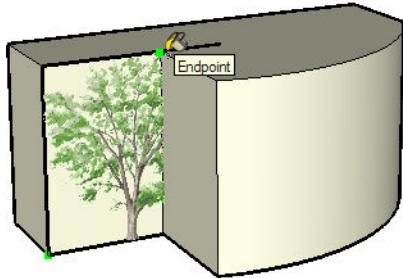
1. Start with a form like this, with one curved wall.



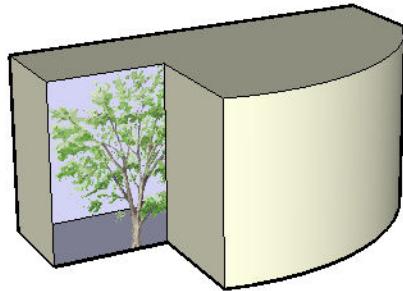
2. Select **File / Import / 2D Graphic** and browse to the image. At the bottom of the Import window, check **Use as texture**.



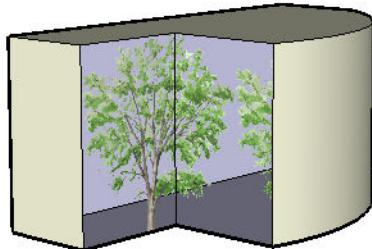
3. Place the tree on one of the flat faces.



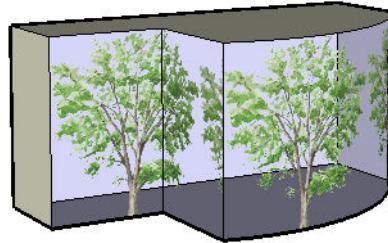
The flat face is painted, and the background of the image is transparent. The image also appears in the Material Browser.



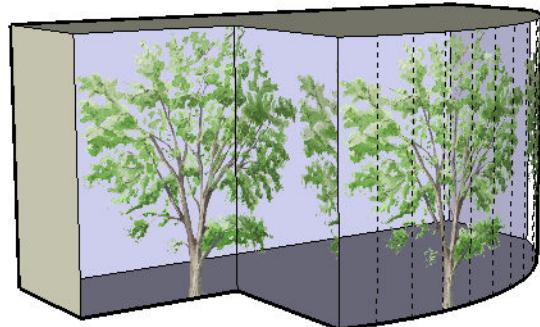
4. Apply the image to an adjacent flat face, and it wraps correctly.



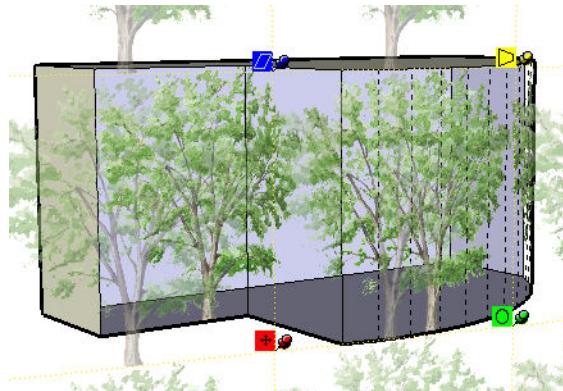
5. Now apply the image to the curved face. It may not wrap correctly.



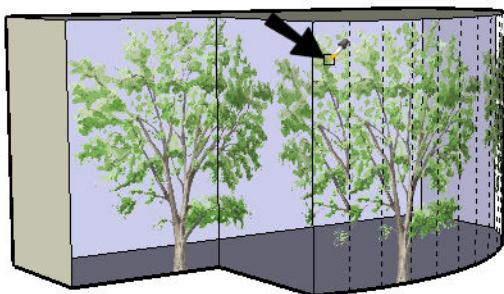
6. If you did the exercise “Curved Faces” on page 288, you’ll know how to fix this. First display hidden geometry.



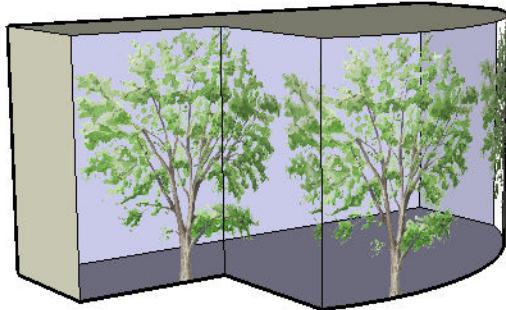
7. In the first segment of the curved face, **Position** the image so that it overlaps the image from the adjacent flat face.



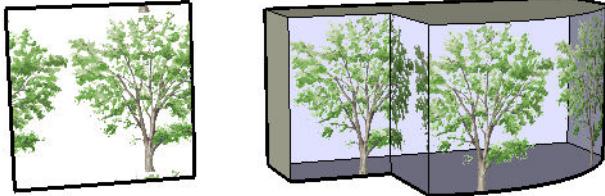
8. Sample the image in this segment.



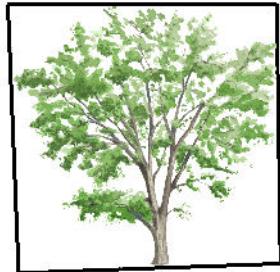
9. Turn off hidden geometry, and apply the sampled image to the rest of the curved face. Now it wraps correctly.



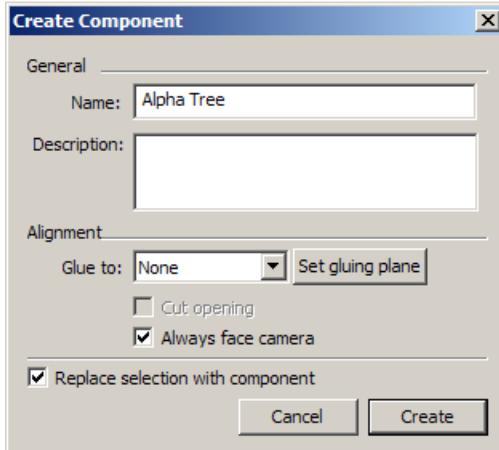
10. Alpha channel images can also be used as components. Start with a vertical rectangle and apply the image to it.



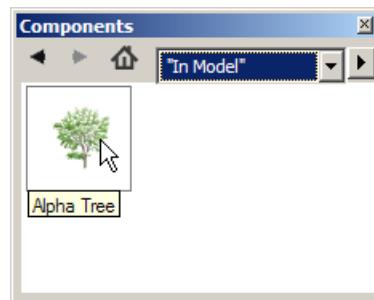
11. Use positioning and/or move the rectangle edges so that only one instance of the image appears.



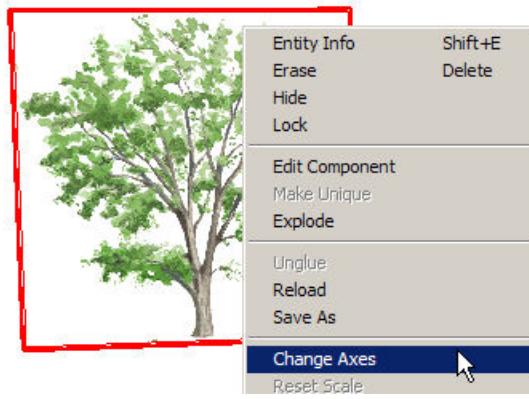
12. Select this face and its edges and make it a component (**Edit / Make Component**). Make sure **Always face camera** is checked.



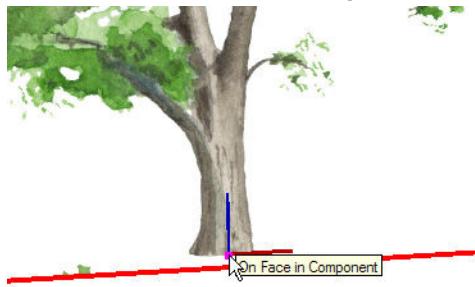
13. Display the Component Browser (**Window / Components**), and click the house icon to see the components you just created.



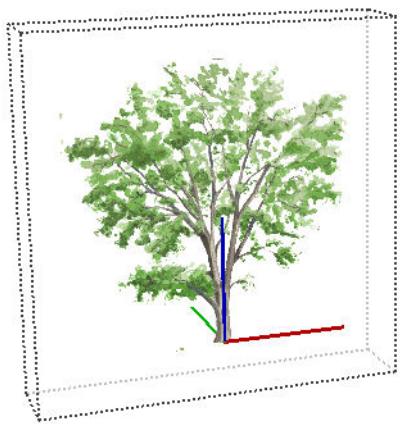
14. As it is now, the component will be inserted by its lower corner point. It would be better to insert it at the base of the trunk, so right-click on the component and select **Change Axes**.



15. Place the origin at the base of the truck. The next two clicks define the red and green directions; keep them at the same orientation as the original axes.

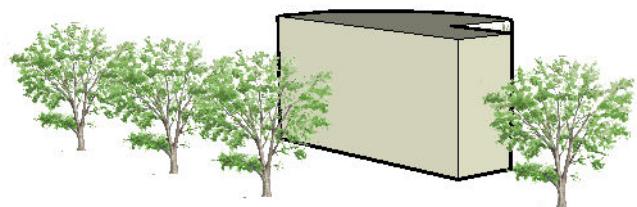
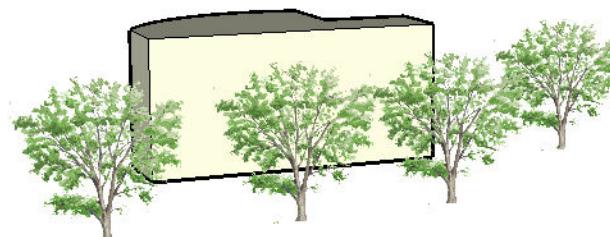


16. Finally, edit the component (right-click on it and select **Edit Component**) and select the rectangle edges. **Hide** these edges so that only the tree is visible.

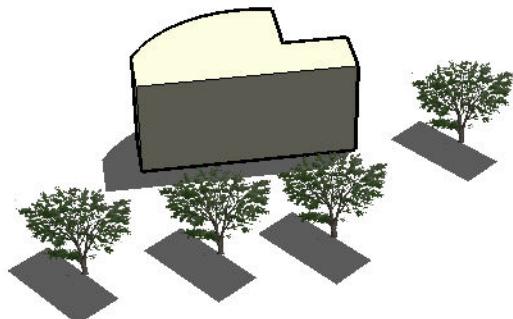


17. Right-click outside the component and select **Close Component**.

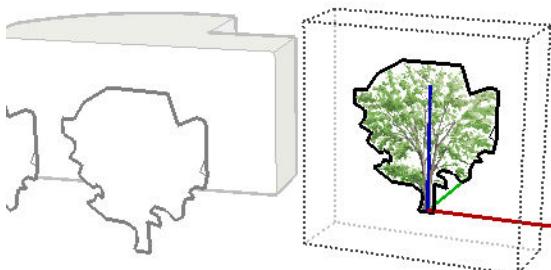
18. Now place some more of these components in the model. You can do this by clicking the component icon in the Component Browser and placing trees one by one. You can see through the trees to the building behind them. And they are always facing you, no matter what viewing angle you use.



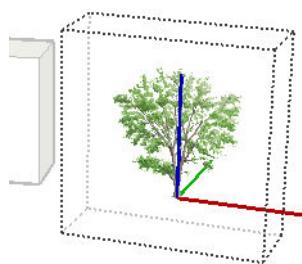
19. Here is one problem with alpha channel components. Turn on shadows by selecting **View / Shadows**. The tree shadows are actually cast by their rectangle - the transparent background is not taken into account.



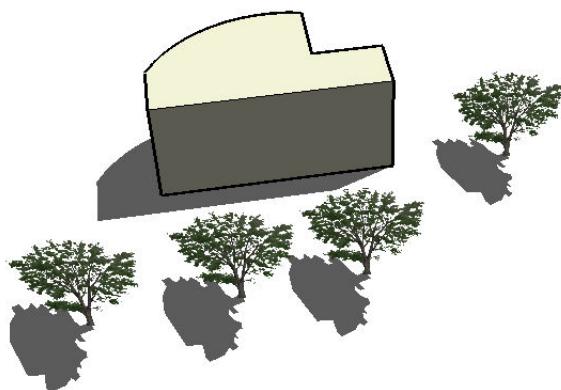
20. For now, the workaround is similar to what you did in “Creating a Painted 2D Tree” on page 275. Edit one of the trees and use **Line** to trim the background area around the tree. This outline used here is not very detailed.



21. Select the edges (double-click to select the face plus edges, then Shift-select to deselect the face), and **Hide** them.



22. Close the component for editing. Now the shadows are a bit more realistic.



## Tips for Efficiency with Materials

When applying and replacing materials in your model, the **In Model** tab (*Mac: Colors in Model*) lists all materials that are both in use and not in use. Materials that are not in use can either be materials that were replaced, or materials that were imported into the model from a library but not yet assigned to any face.

Having a large number of in-model materials can slow down performance. You can speed things up by getting rid of materials you’re not using. Right-click on any unused material and select **Delete/Remove**. To remove all materials, right-click on the right-facing arrow at the top of the **In Model** tab and select **Purge unused**.

*Mac: Purge Unused is in the List dropdown menu at the bottom of the Materials browser when Colors in Model is open. You can also right-click on individual thumbnails and select Remove, if it is available.*

You can also open **Model Info** to the **Statistics** page and click **Purge unused**. This also clears unused components and layers.

If materials still remain after purging, they are probably attached to components that are also no longer in use. Like materials, when a component is no longer in use it still appears in the Component Browser. You can purge components the same way - right-click and select **Purge** or use **Purge unused**.

Working with lots of transparent materials can slow your rendering. Switching off **Transparency** mode can speed things up. This option is found in the **Display** tab of **Model Info**.

Lastly, working with large texture graphic files can also slow performance. If you find this to be the case, consider using single-color materials while working in your model. Then when the model is ready for presentation, you can replace these materials with image files.

# 8 Sectioning

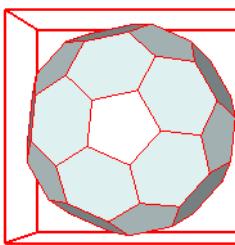
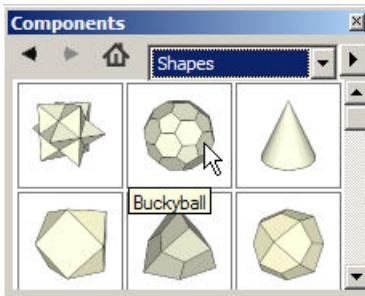
Section cuts enable you to look inside your model, providing a powerful way to visualize spatial relationships, and they can make documenting and constructing complex forms much more straightforward and accurate.

Section planes free you from having to constantly hide and unhide geometry, and they dynamically demonstrate the relationships of spaces.

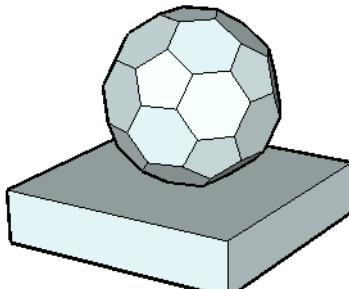
## Sectioning Overview

This exercise will show you the basics of using the section tools.

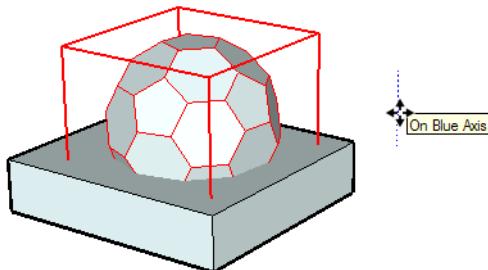
1. Open the Components Browser to the Shapes folder and insert a Buckyball.



2. Draw a rectangle at the base of the ball and **Push/Pull** down to create a base.



3. Move the ball down slightly into the base.

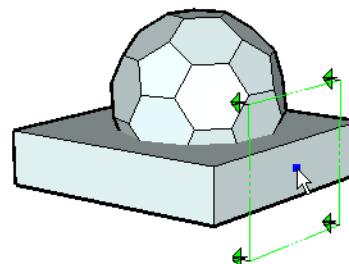


4. Explode the sphere (right-click on it and select **Explode**).

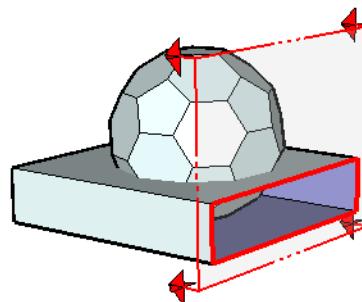
5. Click **Section Plane** (*Mac: Create Section Planes*).



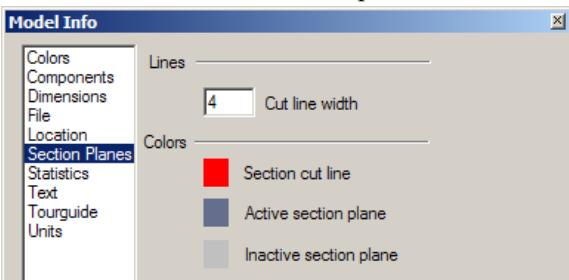
6. Move the cursor around the model, and notice how the plane indicator aligns to the various faces. Locate the section plane on the vertical face shown.



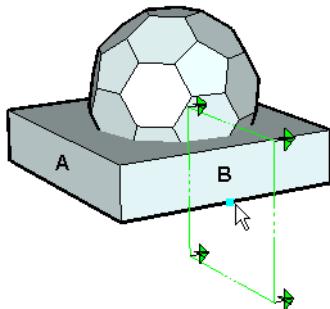
7. Click to make the section. The plane appears, with arrows indicating the direction that will be cut. Wherever a face intersects with the section plane, thick lines appear.



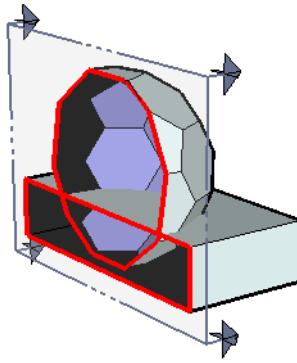
This default color of section lines can be changed on the **Section Planes** page of the **Model Info** window. You can also set the section line thickness and colors of active and inactive section planes.



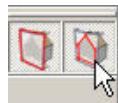
8. Select and erase the section plane.
9. Click **Section Plane** again, and align it with Face A, but do not click yet. Press Shift to lock the orientation, and locate the section plane at the center of Face B.



As you've seen, sections consist of two parts - the section plane and section cuts (those thick intersection lines).



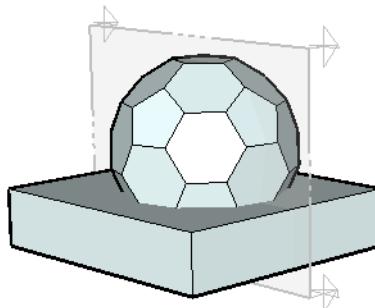
10. Click **Display Section Cuts** or select **View / Section Cuts**.



**NOTE:** If you do not see the **Section Planes** toolbar, select **View / Toolbars / Sections** (Mac: **Tools / Section Plane**).

**Mac:** This icon can be added to the toolbar via **View / Customize Toolbar**, or can be turned on by selecting **View / Section Cut**.

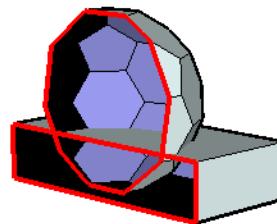
The cut lines disappear (the entire model is displayed), and the section plane is still visible.



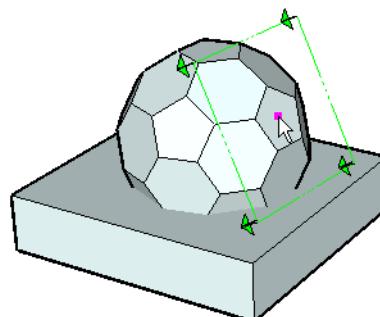
11. Display the section cuts again, and click **Display Section Planes** or select **View / Section Planes**.



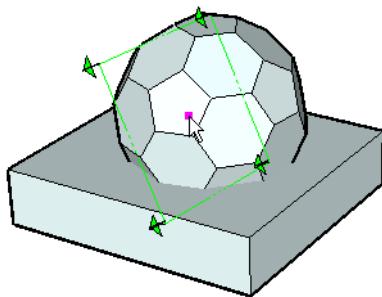
Now the plane is hidden. If you have multiple section planes, this command affects the display of all the planes.



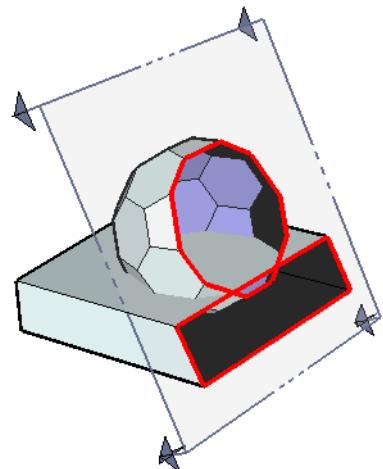
12. Display and then erase the section plane.
13. Now add a section plane and hover on one of the facets.



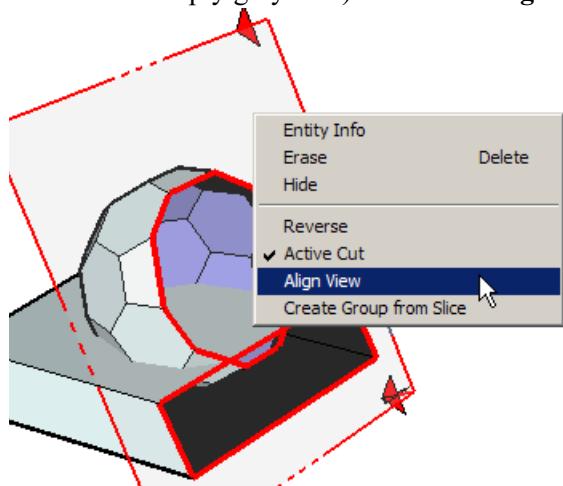
14. Press Shift to lock the orientation, and locate the plane a few corner points into the sphere . . .



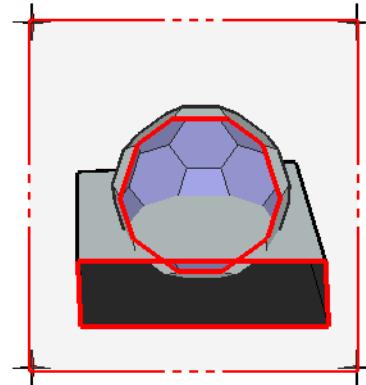
. . . then click.



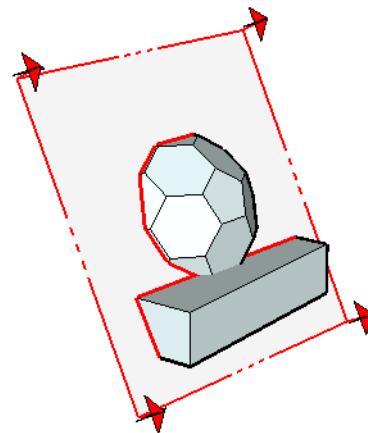
15. Right-click within the section plane (on an edge or within the empty gray area) and select **Align View**.



This aligns the section plane with the screen - you are looking straight into the section. You may have to zoom out to see the view better.

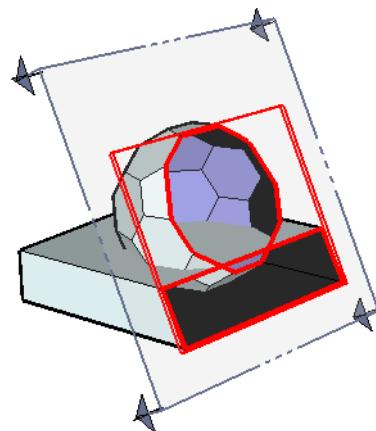


16. Orbit out of this view, right-click again, and select **Reverse**. The arrows change direction, and the opposite part of the model appears.

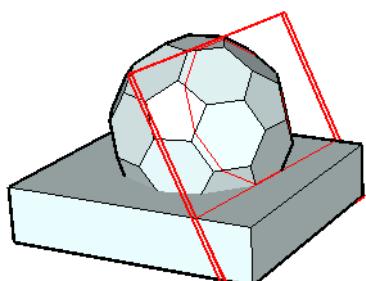


17. **Reverse** again.

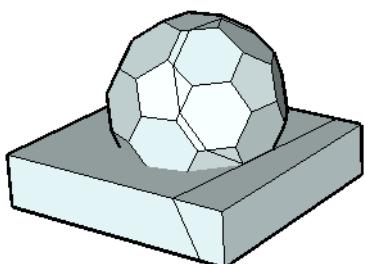
18. You can also save the cut lines as a group. Right-click and select **Create Group from Slice**.



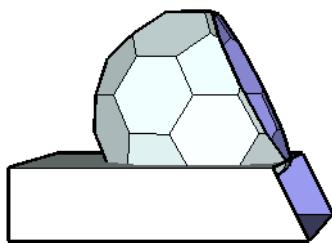
This leaves a group of line segments on the model where the section plane was. Erase or hide the section plane, or click **Toggle Section Plane display** to blank it.



19. Ungroup (**Edit / Group / Explode**) the group of lines. They become thin lines, aligned to the planes that contain them.



20. Erase all faces and edges in front of the cut lines, and your model is now trimmed by a plane.

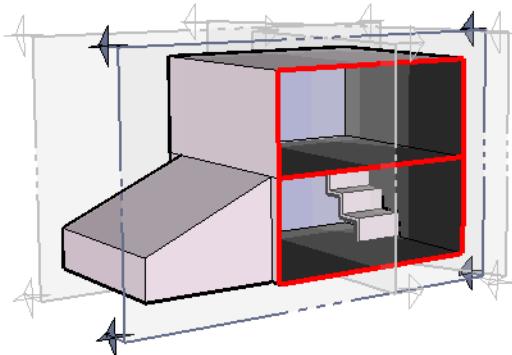



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**NOTE:** For another method of creating section edges, see "Using Inferences to Create Sections" on page 385.

## Using Sections for Interior Design and Presentation

If you are designing a closed building, you probably need to get inside to design walls, stairs, floor layouts, etc. You can hide and unhide walls, but for complex structures it may be more convenient to use section planes.

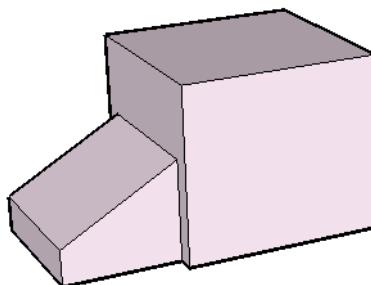



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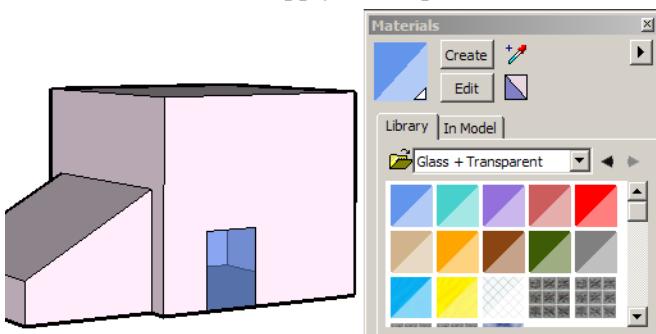
**NOTE:** You can also use the walk-through commands (**Walk**, **Look Around**) to get inside buildings. See Chapter 9.

This exercise will show a very simple house and a few interior elements. The last steps involve using sections to create a slide show presentation.

1. Start with a house like this.

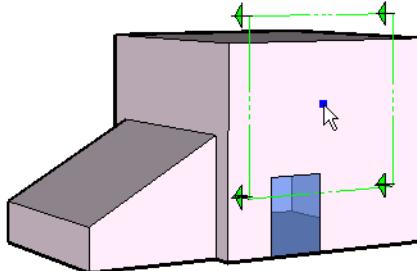


2. Create a door and apply a transparent material to it.

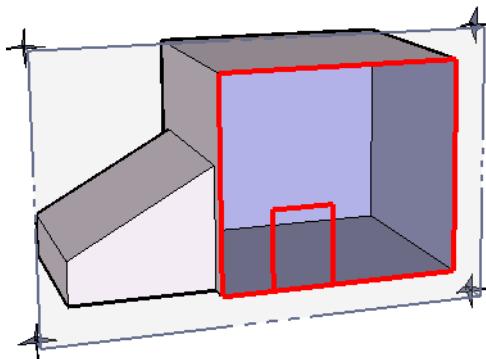


**NOTE:** For details on transparent materials, see "Material Transparency" on page 249.

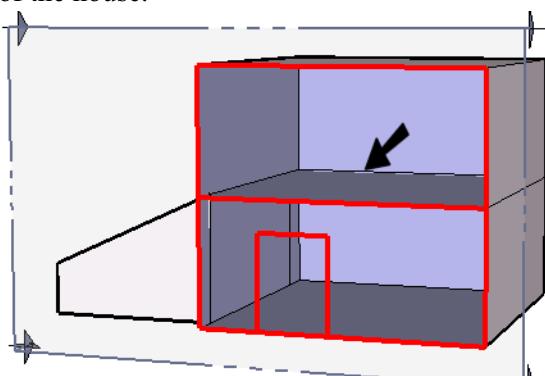
- Click **Section Plane** and place the plane on the front face.



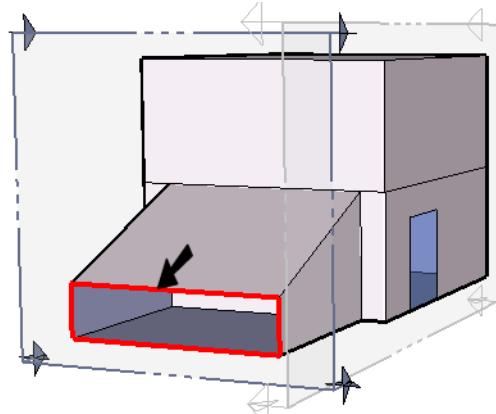
You can now see inside the house.



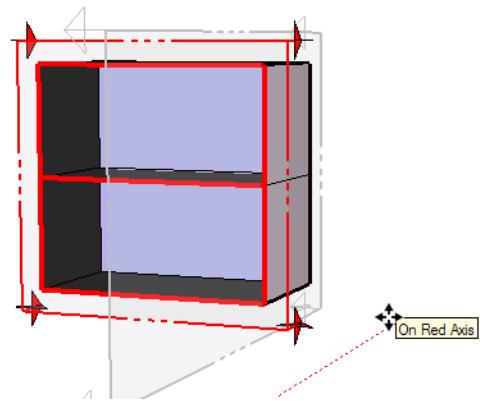
- Use lines to add the second floor. Note that this creates an additional section cut line along the front of the house.



- We now want to add a staircase along the right side wall. Start by add another section plane here, because this wall has the right orientation.

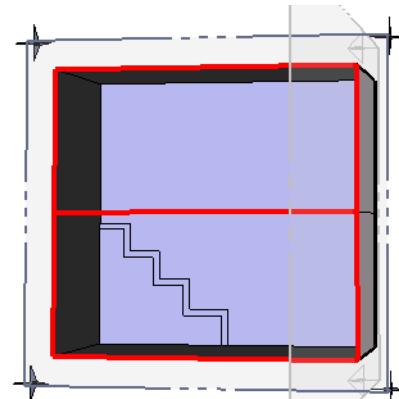


- You can't see much from this small opening, so select the plane and move it toward the other side. Moving section planes is done the same way as moving any geometric object - with the **Move** tool.

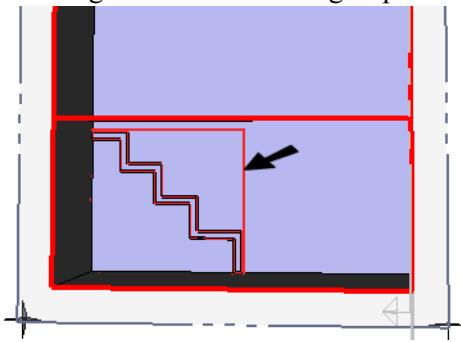


**TIP:** You could also have placed the section plane along the opposite wall, moved it slightly inward, and reversed it (right-click and select **Reverse**).

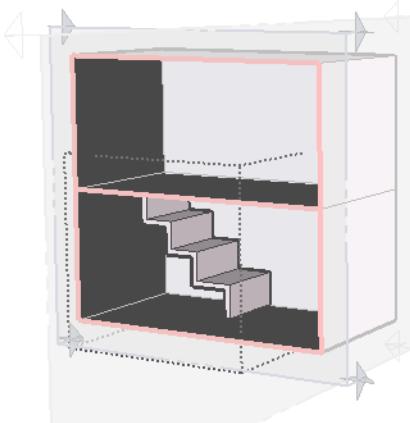
- Draw lines for the stairs (no need for accuracy) and offset them slightly.



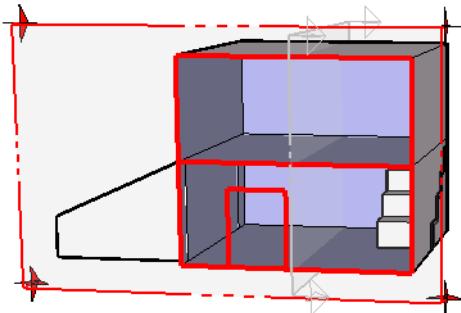
8. Select all edges of the stairs and group them.



9. Edit the group and use **Push/Pull** to create the staircase. Because this is a group, the outside wall of the house is not affected by it.



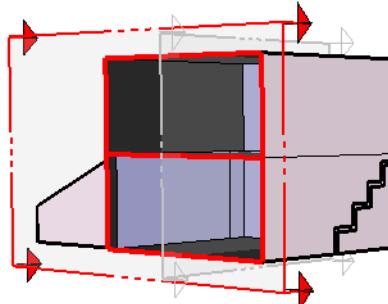
10. Right-click on the first section plane you created and select **Active Cut**. This returns you to the section at the front of the house. Though you can have an infinite number of section planes, only one section can be active at any time.



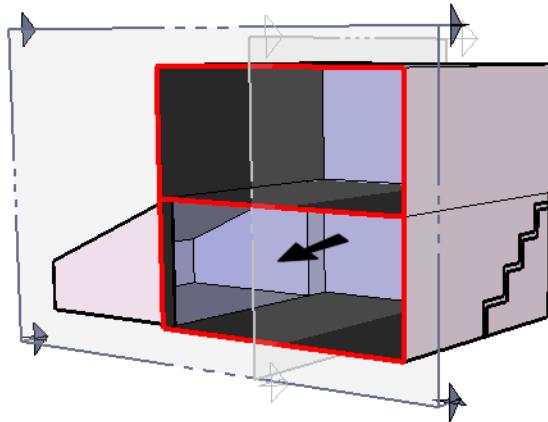

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*NOTE: There is actually a way to have more than one cut active - see "Simultaneous Section Cuts" on page 315.*

11. Move this plane very slightly inward so that you get past the front door.



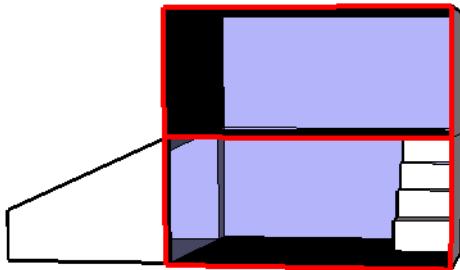
12. Now you can easily erase the wall separating the small wing from the main house.



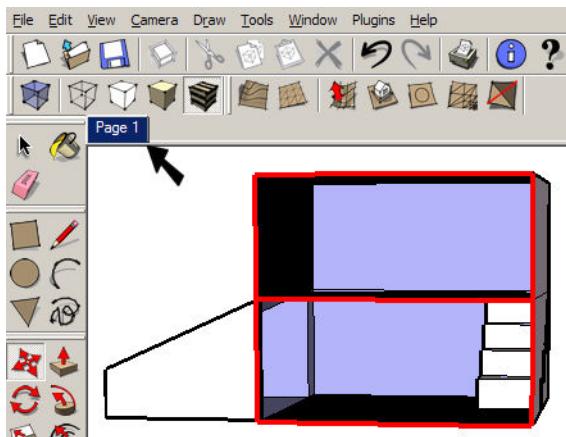
In this way you can use sections to build walls, add components such as doors and windows, furniture, plants, etc. Remember, if the display of section planes clutters your display, you can always toggle their display.

We will now use **Pages** to create a slide show in which you can see sections dynamically.

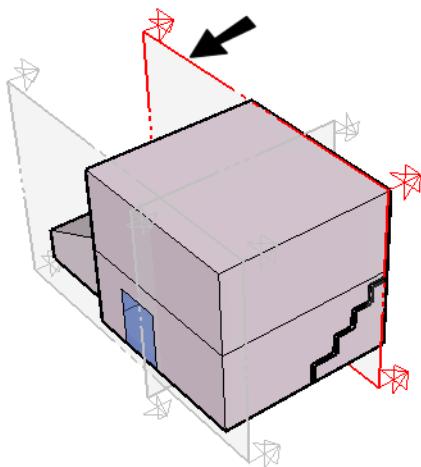
13. Click **Display Section Planes** to clear the planes, and orbit so that you are nearly facing the front of the house.



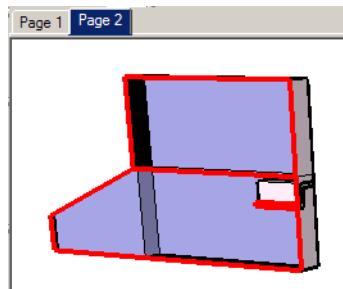
14. Select **View / Tourguide / Add Page**. The current view is saved as Page 1.



15. Display the planes again, and copy the active plane to the back of the house, just before hitting the back wall.

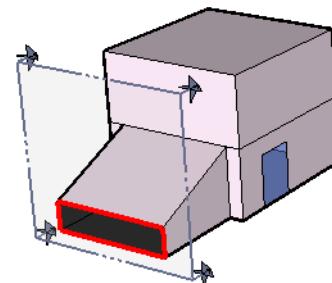


16. Activate this new plane, and turn off the plane display. Orbit to a similar orientation as you had for Page 1, and create a new page (Page 2).

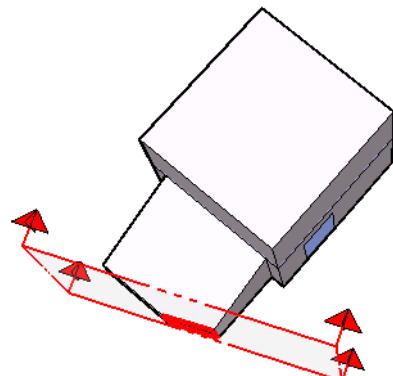


17. Turn the planes back on, but hide the ones that you have created so far. (You can leave them in place, but the display tends to get cluttered this way.)

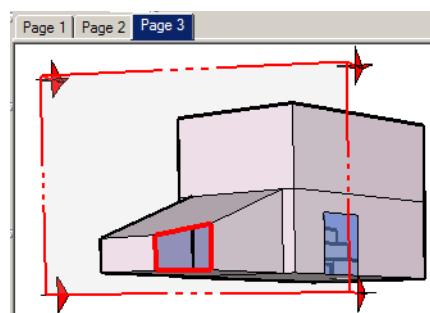
18. Create a new plane on the face shown.



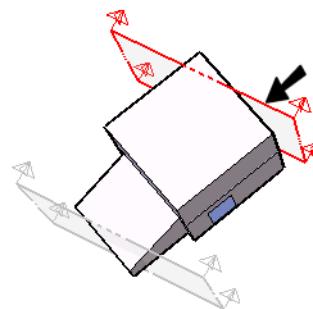
19. Select and rotate the plane so that it cuts the face diagonally. Move it so that it is just inside the front corner.



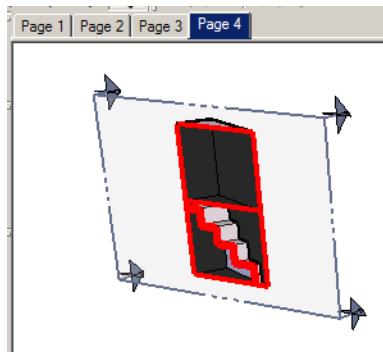
20. Orbit to the view you want, this time leaving the plane displayed. Save this as Page 3.



21. Copy this diagonal plane to the back corner and activate it.

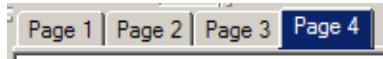


22. Orbit to a similar view as Page 3, and save as Page 4.



**TIP:** If you wanted to use the same exact view as Page 3, you could create the new plane and then click the tab for Page 3. Then activate the new plane and save the view as Page 4.

At the top left of the screen you can see the tabs for all the saved views. Clicking a tab moves the current view dynamically to the selected view.



23. Select **View / Tourguide / Play Slideshow** for a running presentation moving along the pages.

*Mac: You can also click the **Start Slideshow** icon.*



You can add these icons to your toolbar via **View / Customize Toolbar**.

Slideshow is detailed more in Chapter 9.

## Exporting Section Slices

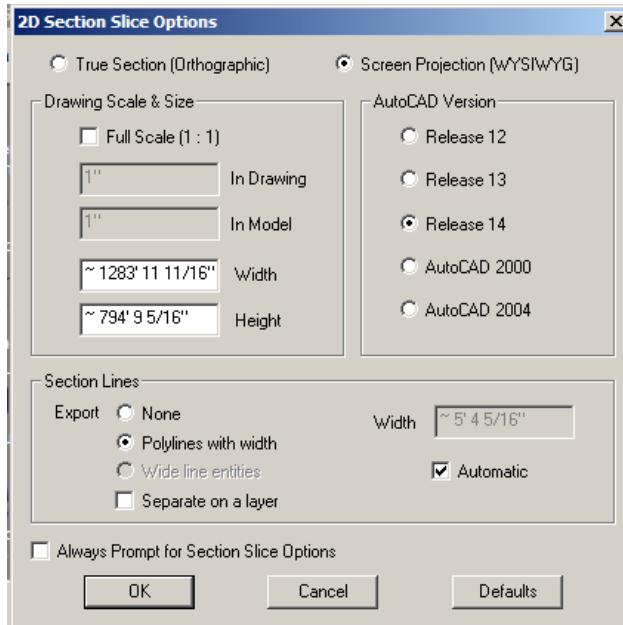
You can export an active section slice as a 2D file in the \*.dwg or \*.dxf format. This enables you to export vector information, which will reflect the precise measurements of your model.

**NOTE:** See "Export and Import" on page 455 for details on other ways to import into and export from SketchUp.

1. Select **File / Export / Section Slice**.
2. Under **Export Type**, select the type of file (which version of AutoCAD, \*.dwg or \*.dxf). Assign a file name. If you want to specify conversion parameters, click **Options**.



These are the options you can set for section conversion. They are explained below.



**True Section (Orthographic):** Outputs the section slice as a true orthographic drawing. This is useful when exact dimensions are important, such as creating drawing templates.

**Screen Projection (WYSIWYG):** Outputs the section cut as you see it on the screen, including any perspective distortion.

### Drawing Scale and Size:

- **Full Scale (1:1):** Outputs your section slice at a true 1:1 scale. If **Full Scale** is not checked, you can specify the overall dimensions of the slice output. These will update depending on the slice being exported and its scale.
- **In Drawing:** The measurement of the exported geometry.
- **In Model:** The actual measurement of the object in real scale. For example, for a scale of 1/4" = 1', simply enter 1 inch in the output equals 4 feet in SketchUp.
- **Width / Height:** The overall dimensions of the output. They will update depending on the slice being exported and its scale.

**NOTE:** You can't export a perspective screen projection section slice to scale. Also, even if perspective is off, many projection angles available via the **Orbit** tool cannot be measured once printed out. **Scale** is only available for paraline projections of the standard orthographic and isometric views.

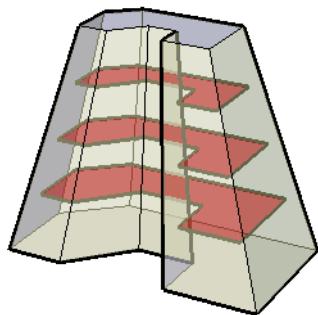
### Section Lines:

- **None:** Outputs section lines at normal width.
- **Polylines With Width:** Outputs lines as polylines.
- **Wide Line Entities:** Outputs lines as wide line entities.
- **Width:** Outputs section slice lines with a specific width.
- **Automatic:** Automatically sets the width of profile lines by matching the output to the proportions you see on screen. If disabled, you can specify an exact width.

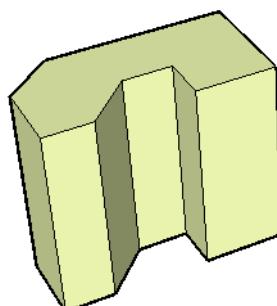
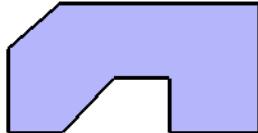
**Always Prompt for Section Slice Options:** The options dialog will come up each time you output a section slice. When disabled, SketchUp will use the options you selected last time. (*Mac: Not available*)

## Copying Section Planes for Floor Plans

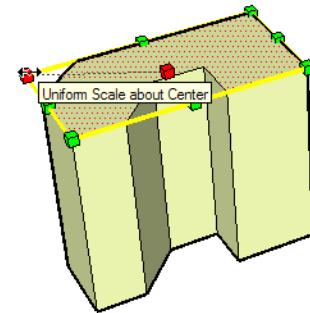
This exercise will show how you can easily use section planes to get floor plans for a multi-story building.



1. Start with a shape similar to this and **Push/Pull** it up.

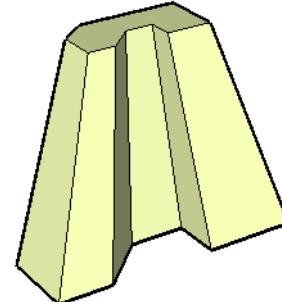


2. Select the top face and activate **Scale**. Press **Ctrl/Option** to scale about the center, and drag one of the corner handles inward.

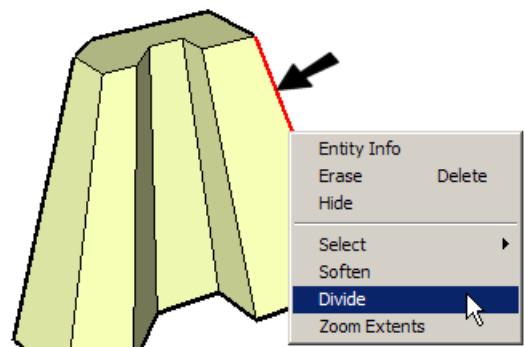


**NOTE:** For details on the **Scale** tool, see "Scale" on page 65.

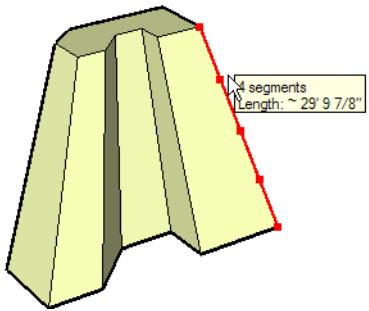
Now you have a building that looks like an Aztec pyramid.



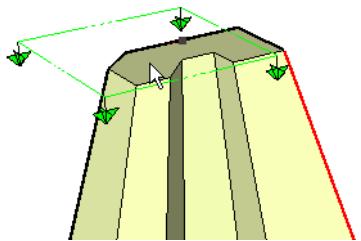
3. Assuming the floors inside are spaced evenly, we can divide one of the vertical lines into the proper number of segments. Right-click on any near-vertical line and select **Divide**.



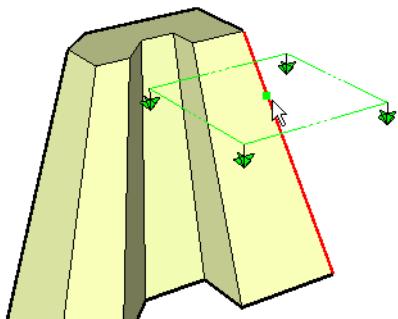
- Move the cursor to divide the line into the number of segments you want. Use a manageable number like four or five segments.



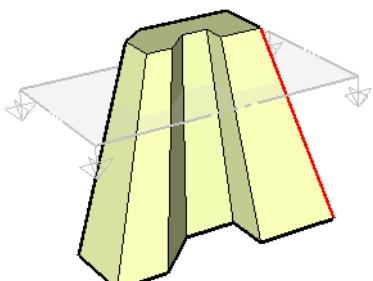
- Now click **Section Plane**. Align the plane with the top face and press Shift to lock the alignment.



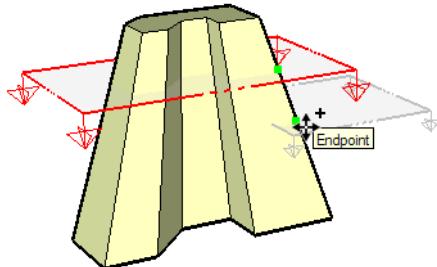
- Locate the first section plane at the endpoint of the first segment of the subdivided line.



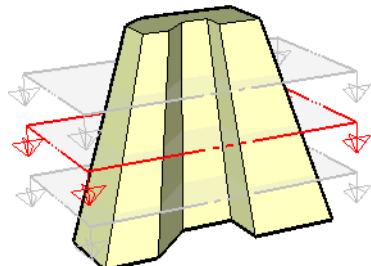
- The building is sectioned at this plane. Click **Display Section Cuts** so that the entire building is visible.



- Select the section plane and copy (**Move+Ctrl/Option**) it to the next segment.

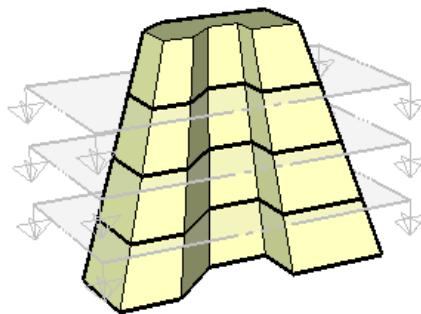


- Type 2x (or the number you need) to create the total number of copies.

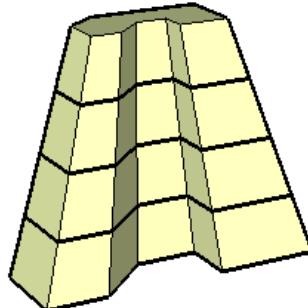


The floor plans will be created along these section planes.

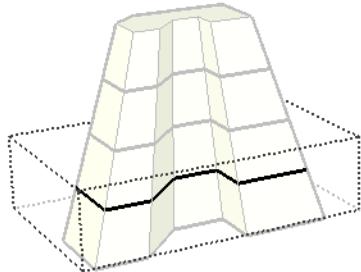
- Right-click on each section plane and select **Create Group from Slice**. A group of cut lines appears along each plane.



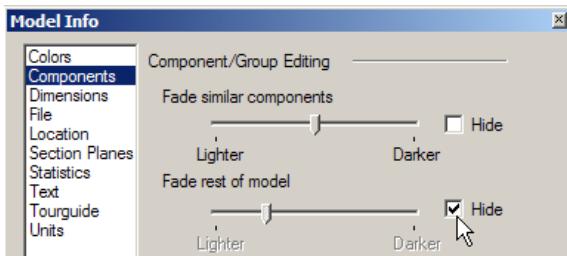
- Click **Display Section Planes** to hide the planes. (You could also erase them, since they are no longer needed.)



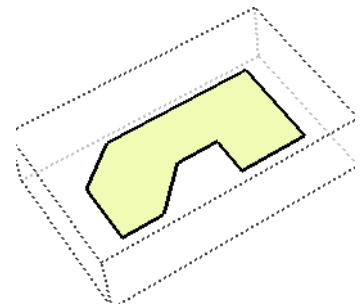
12. Right-click on one of the groups and select **Edit Group**. (You can also double-click a group in **Select** mode, to open it for editing.)



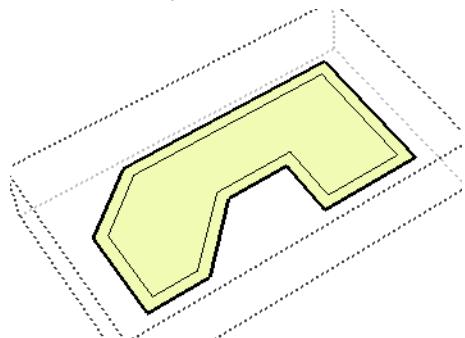
13. It's easier to work with these lines if the rest of the building is hidden. Open **Model Info** to the **Components** tab, and click **Hide** under **Fade rest of Model**.



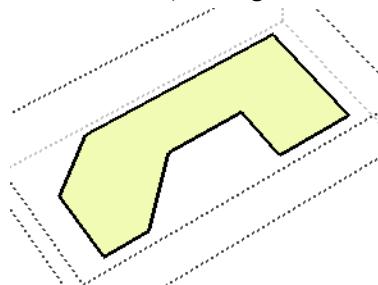
14. Now only the section cut lines are visible. Redraw one of the lines to create the face.



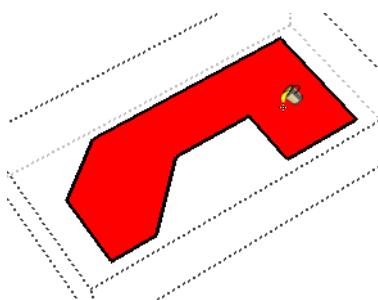
15. Use **Offset** to offset the face slightly inward. (This would represent the actual floor area after the wall thickness boundary is removed.)



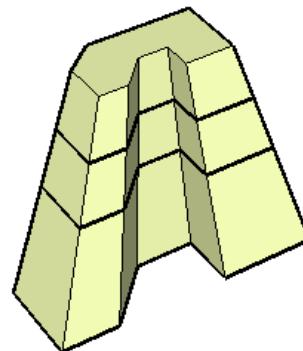
16. Erase the outer lines (the original cut lines).



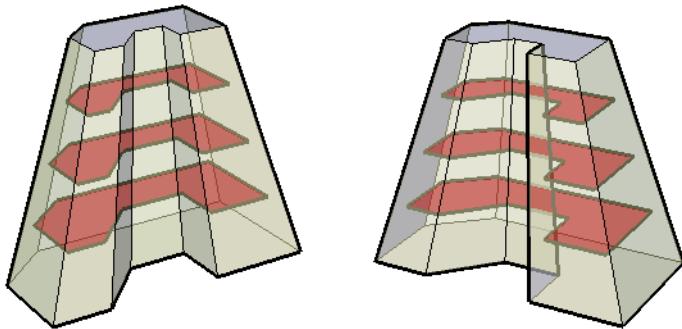
17. It's OK to leave the floor face in the default color, but for presentation purposes it's nice to assign contrasting colors. Use the Material browser to find a contrasting color, and click the floor face to apply the color.



18. Right-click and select **Close Group**. The building reappears, and the cut line of the group you just edited no longer appears. (It's still there, but is only visible inside the building.)



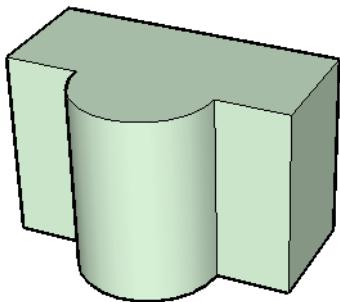
19. Do the same editing for the other floors (edit group, create face, offset, apply color). When you use **Offset** repeatedly, you can double-click a face to use the last offset distance.
20. When you are finished with all the floors, display the building in **X-Ray** mode.



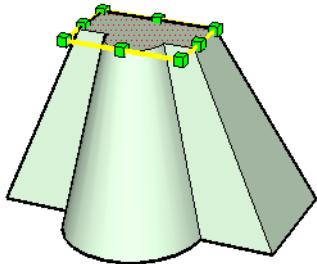
## Using Section Planes with Model Intersection

This exercise shows how to create a “Follow Me” series of striations along a drafted form.

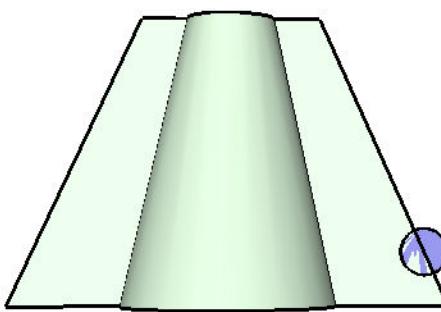
1. Start with a form like this . . .



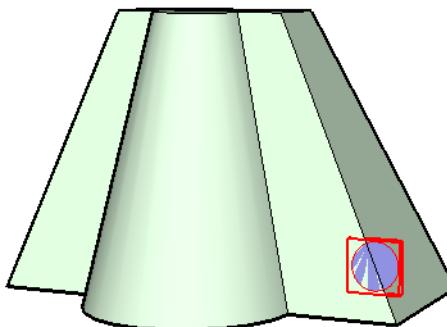
2. . . and use **Scale** to create a draft angle. Use Ctrl and drag one of the corner handles, in order to scale about the center point.



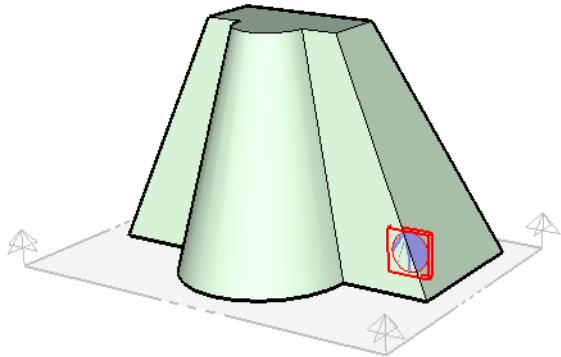
3. Draw a small vertical circle on one of the faces.



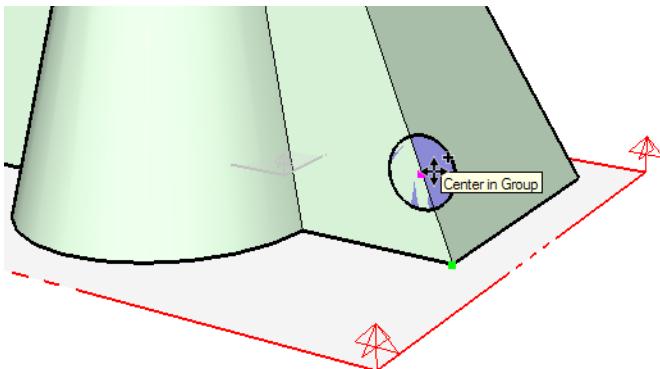
4. Select the circle (double-click it to select its edges also) and make a group of it (**Edit / Make Group**). This is so that you can easily use the whole circle later in the **Follow Me** tool.



5. Place a section plane on the top or bottom face.

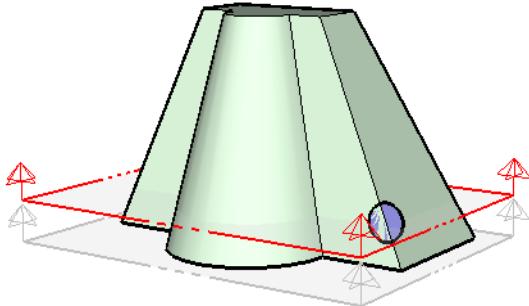


6. Copy the section plane to the center point of the circle.

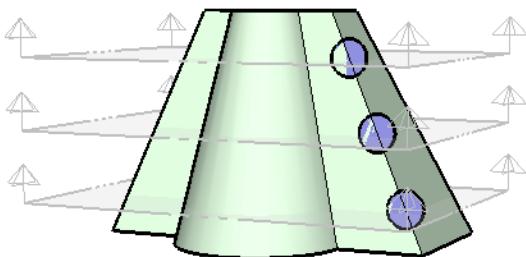


**TIP:** You could also have done this in one step, by aligning the first section plane to the top or bottom face, pressing Shift, and placing the plane at the circle center.

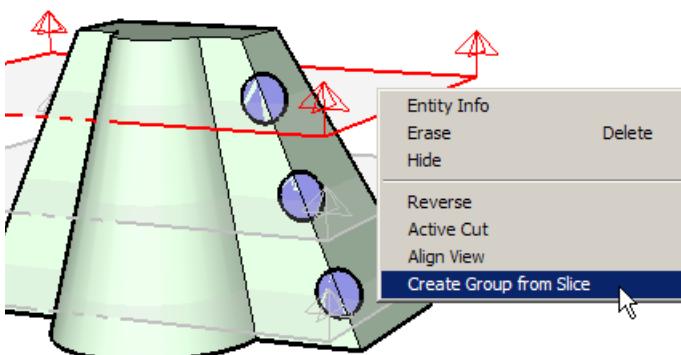
- To see the entire model, click **Display Section Cuts**.



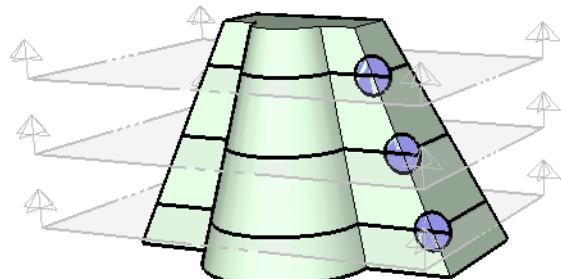
- Select both the circle and section plane, and make one copy along the diagonal edge. (Simply click two reference points along this edge.) Type 2x to make two copies. Adjust the spacing if needed by typing in a new distance and pressing Enter.



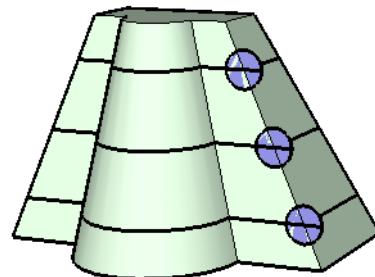
- Right-click on one of the section planes and select **Create Group from Slice**.



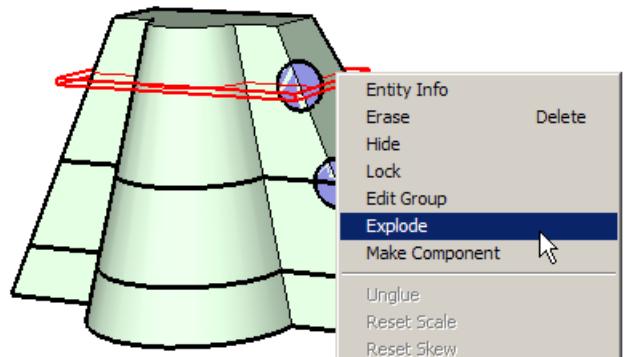
- Make slice groups on the other two section planes. You now have the paths needed to drive each circle around the building.



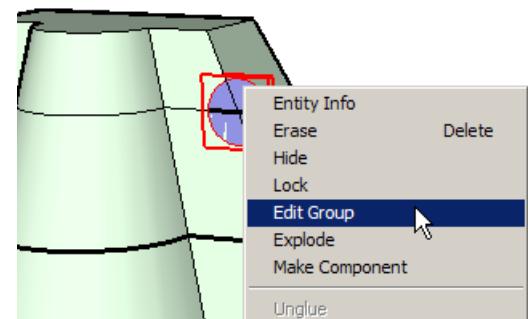
- Erase or hide the section planes.



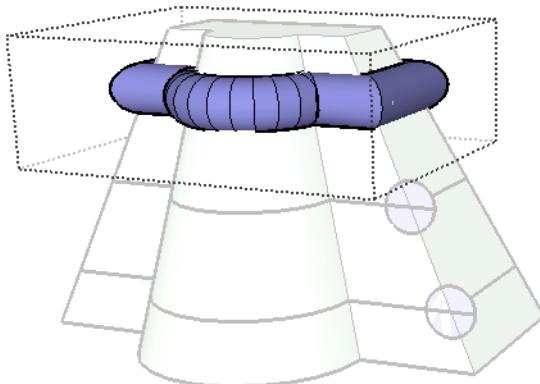
- Right-click one of the slice groups and **Explode** it. This leaves the path around the model ungrouped and selected.



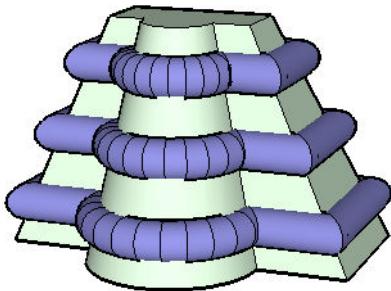
- With the path already selected, activate **Follow Me** (**Tools / Follow Me**).
- Then right-click on the circle group and select **Edit Group**.



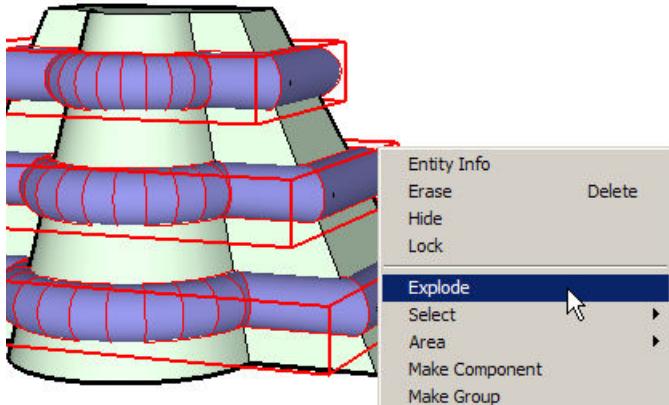
15. For the section to drive around the path, click on the circle face you are editing. It is driven around the path surrounding the building.



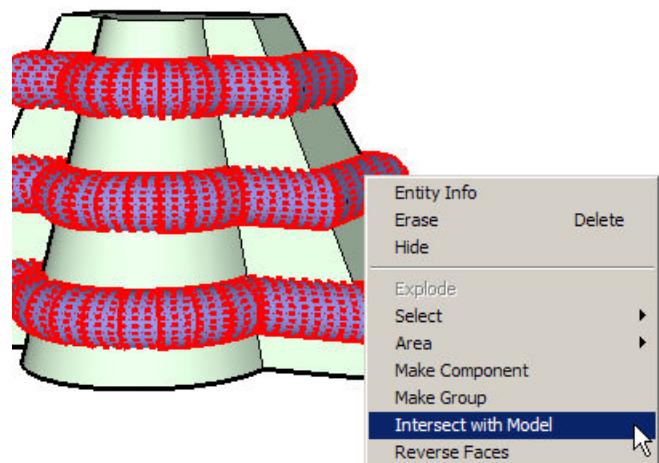
16. Do the same for the other two sets of groups: explode the path, activate **Follow Me**, edit the circle group, and select the circle face.



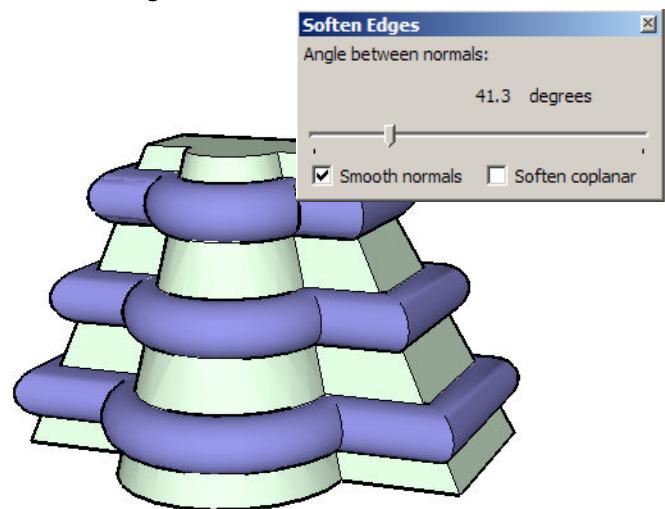
17. Now select each of the three “tube” groups and **Explode** them all at once. They need to be exploded because portions of the groups will be deleted.



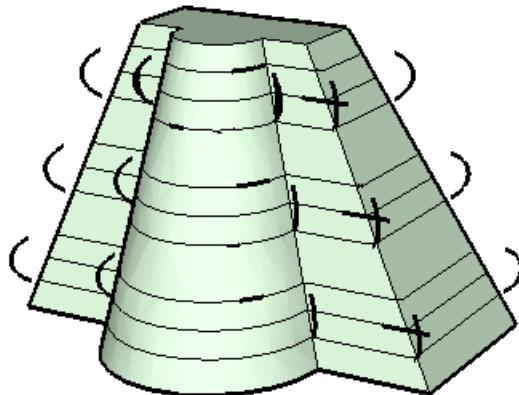
18. With the now-explored tubes still selected, right-click and select **Intersect with Model** (or select it from the **Edit** menu). This creates the edges along the tubes where they intersect with the building.



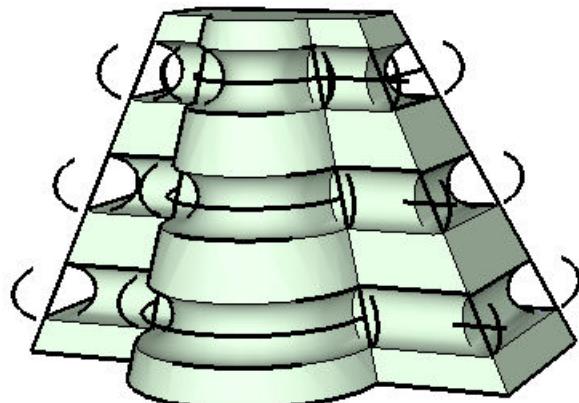
19. Orbit around to make sure all the intersection edges were created. If any are missing, you can select the faces on which they need to appear (or simply select everything) and rerun **Intersect with Model**.  
 20. Select all edges and smooth them. This makes it much easier to remove all the small, curved faces and their edges.



21. Now you can easily erase all the tube faces that protrude from the exterior of the building.

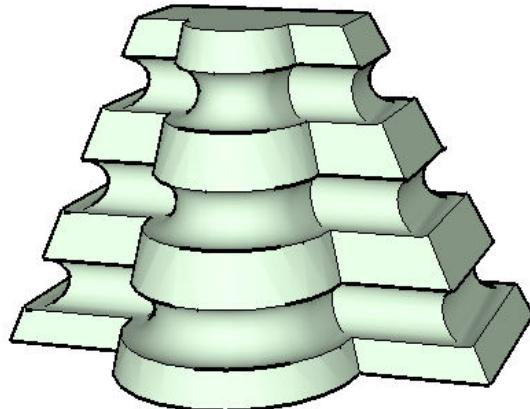


22. Erase the faces along the building that cover the cutouts. If you double-click on a common edge, both the edge and adjacent faces will be selected.



23. Now for the tedious cleanup - some tiny edges that remain. The easiest way to remove them (for me anyway) was to zoom in very closely and use numerous right-to-left selection windows to select all extra edges and delete them.

After getting all the edges - even the tiny ones along the cutout border - here is the pyramid with the evenly-spaced, perfectly located striations.

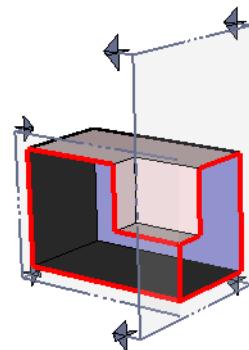


If your original form or cutout shape had no curves, there would be a lot less cleanup!

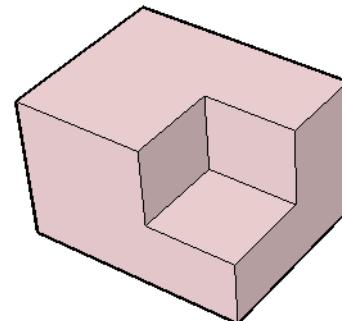
**TIP:** In **Select mode**, if you double-click on an edge, it selects the edge plus any adjacent faces. If you double-click a face, it selects the face and its edges. Be careful if you use this to delete faces of the outer tube, however, because the edges along the pyramid form will also be selected. You would need to delete these one by one, which would be easiest in **Wireframe** mode!

## Simultaneous Section Cuts

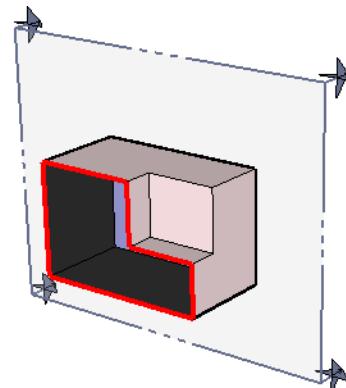
So far you've seen that, although you can have many section planes, only one can be active at any time. There is a workaround for this, involving the use of groups.



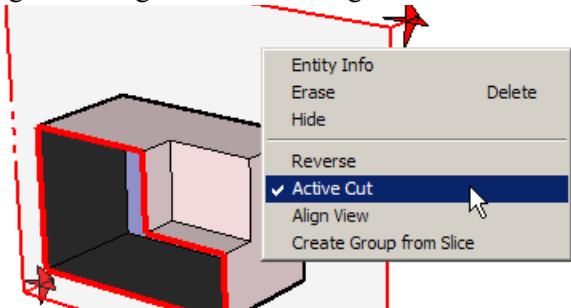
1. Start with a form like this.



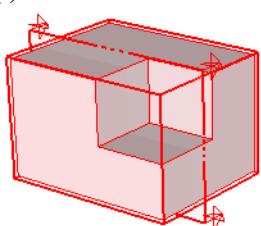
2. Add a section plane to one face and move it to the desired position.



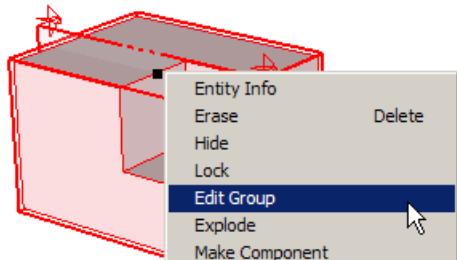
3. Deactivate the plane (make it non-cutting) by right-clicking it and deselecting **Active Cut**.



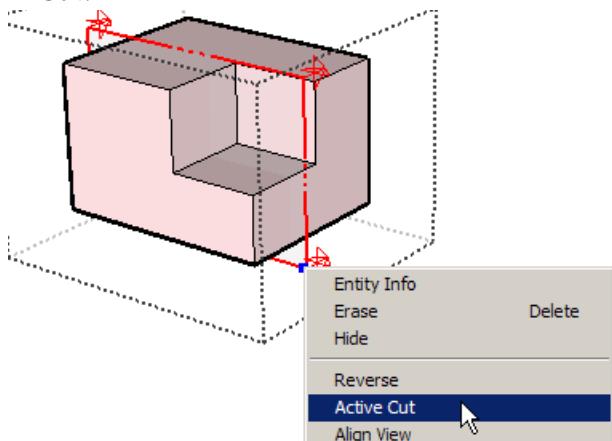
4. Now select both the form and the section plane (you can use *Ctrl/Option+A*) and group them (**Edit / Make Group**).



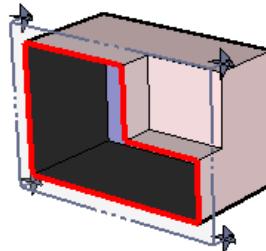
5. To activate the plane, it must be done within the context of the group. Right-click on the form and select **Edit Group**.



6. The group members are contained in a dotted-line bounding box. (If there were other objects in the model, they would be displayed as faded.) Right-click on the section plane and select **Active Cut**.

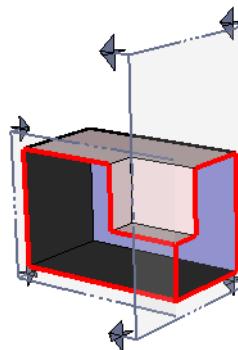


7. Right-click outside the group, and select **Close Group**.



**TIP:** An alternative to deactivating the section plane would be to move it away from the form **before** grouping. Then, while editing the group, you would move it to the desired position, thereby automatically activating it.

8. You can now add another section plane. This second plane can be moved easily, but to move the first one you would have to edit the group once again.



To add more section planes, you would have to create more groups. These would be progressively nested groups - i.e. the next group would consist of both the previous group and the latest section plane. For numerous sections, this can get confusing. But then again, there aren't too many cases in which you'd need dozens of section planes.

# 9 Presentation

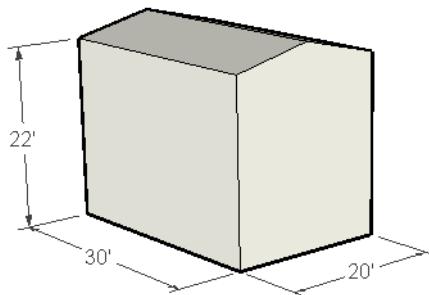
This chapter consists of one exercise which will show you how to walk through and look around a model, save views, place objects on different layers, create shadows, and create a slide show.

If you want to download the model used in this exercise, go to [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm) and download the file "PresentationHouse.skp." You can then skip to "Pages" on page 320.

## Layers

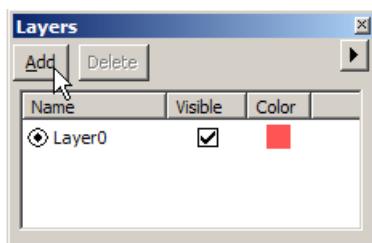
Layers are used in SketchUp for display purposes - to show / hide objects, or to display objects of a certain type by a certain color. You **cannot** use layers to isolate geometry, or prevent geometry from interacting with adjacent geometry - for this you can use groups or components.

1. Start with a house with the following dimensions. Use the **Dimension** tools to create the actual dimensions (three total).



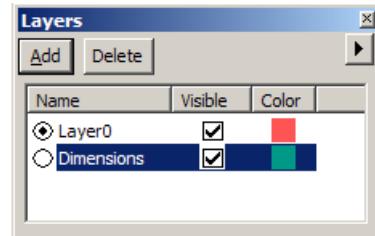
NOTE: For details on dimensioning, see "Dimensions" on page 82.

2. The dimensions will be placed on their own layer. Currently there is only one layer in the model - Layer 0 (the default layer for every file). To create new layers, select **Window / Layer**. Then click **Add**.

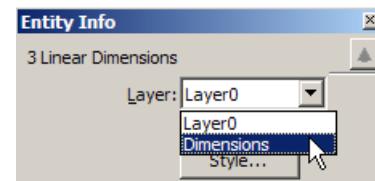


NOTE: **Layers** is one of SketchUp's stacking windows. See "Stacking Windows" on page 437.

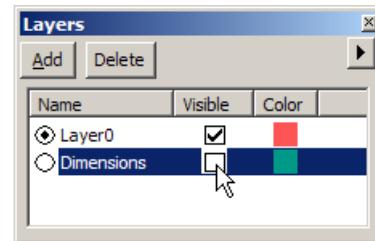
3. Name the new layer "Dimensions."



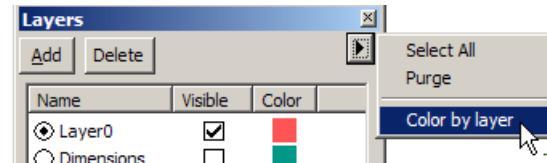
4. Now select all three dimensions and open the **Entity Info** window. Set the layer to "Dimensions."



5. In the **Layers** window, uncheck the **Visible** box. This blanks the display of the dimensions.



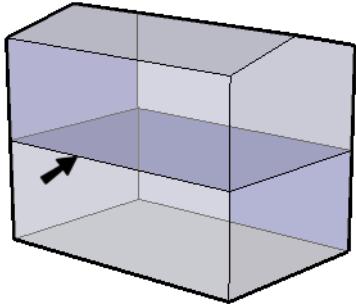
NOTE: The color box set for each layer can be used to show each layer in its own color. Click on the small arrow at the top of the Layers window and select **Color by Layer**.



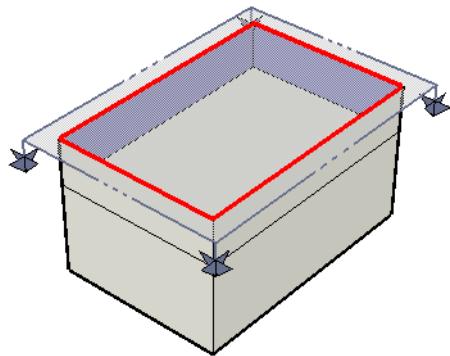
## Setting up the Model

In this section you will complete the model by adding a floor and adding some furniture and other components.

1. Add a floor halfway up the house - each floor should be 11' high.



2. Because in Shaded mode you can see the lines of this new floor from the outside, we can offset the floor a bit inward. Start by showing the floor itself. You can do this by adding a section plane like this, or by hiding the second floor.

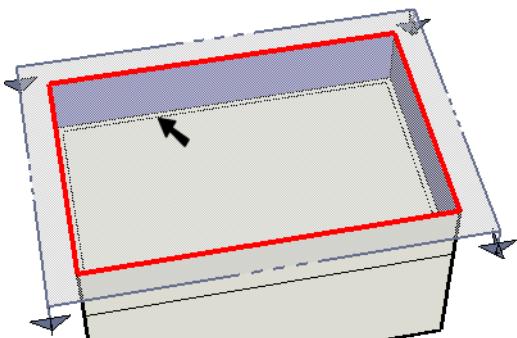



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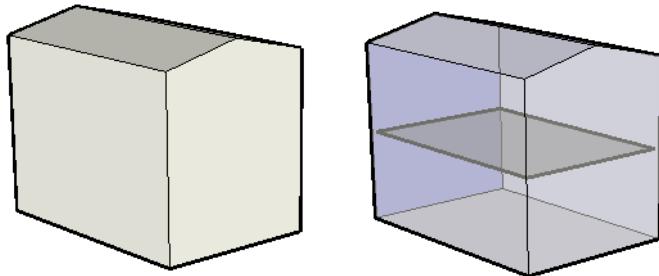
NOTE: *Sectioning is covered in Chapter 8.*

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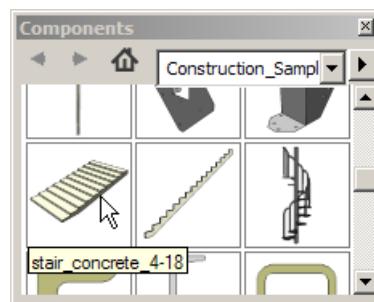
3. Now use **Offset** to bring the second floor in by a few inches.



4. Trim the old floor boundary lines, and the house should look like this, in **Shaded** and **X-Ray** modes:



5. For a staircase, you can find one in the **Construction\_Sampler** folder of the Component Browser.

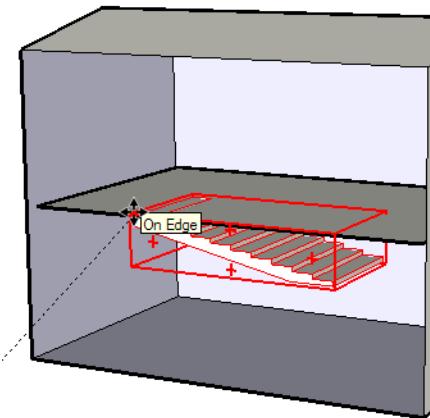



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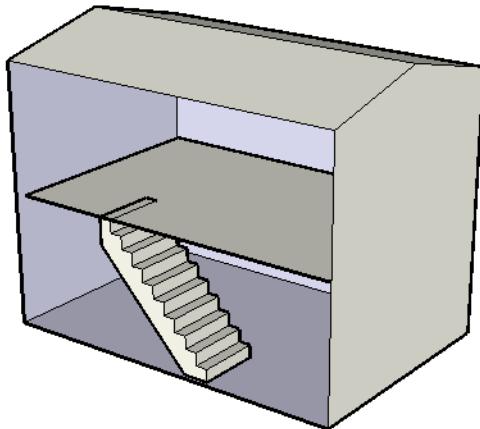
*NOTE: There are other places you can find staircases, as well as all types of components; see “Where to Find More Components” on page 193.*

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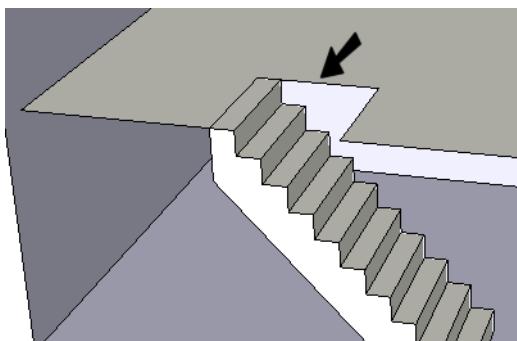
6. Locate the top outer corner along the edge of the second floor.



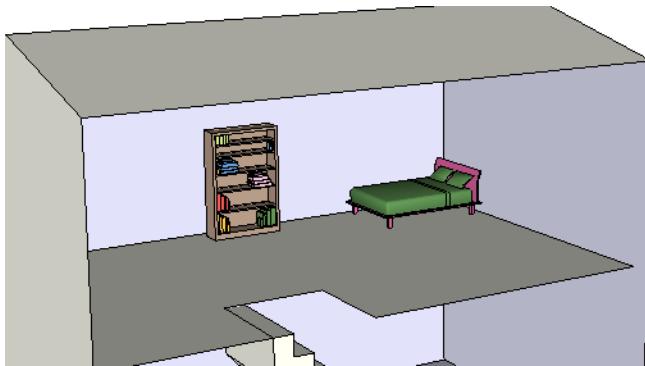
7. Use **Scale** to size the staircase better. You may want to adjust the width as well.



8. Use lines to create a cutout on this floor.

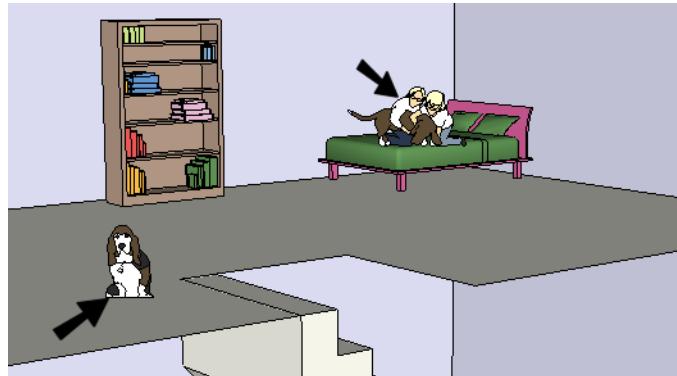


9. Now add some components. For example, you can place a bed and bookcase on the second floor, which can be found in the Architectural\_Sampler folder. In this example, color was added to the components.

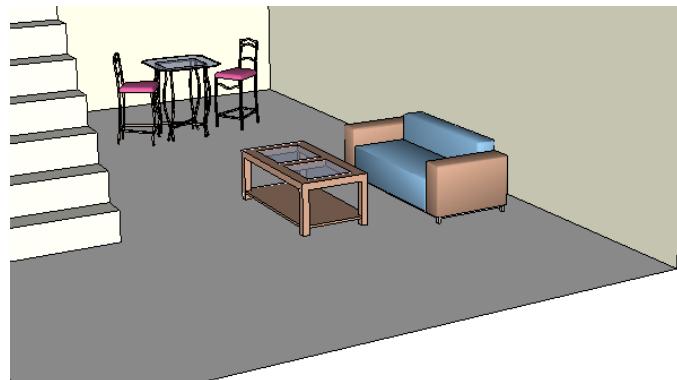


**NOTE:** To add colors to a component, you need to open it for editing. If the component has the default color, you can apply a single new color to it without opening it.

10. Add a dog at the top of the staircase, and maybe some kids on the bed. These can be found in the People\_Sampler folder.



11. Downstairs, place some more furniture such as a sofa, coffee table, and kitchen set. If the inside walls are dark, you might want to color them something lighter.



12. Complete the house with some doors and windows, and add some materials to the house itself, if you like.



---

**NOTE:** If the door and window glass seems too dark, you can adjust its transparency. Edit the glass material in the **In Model** folder of the Materials Browser. See “Material Transparency” on page 249.

---

13. On the back wall, add a patio door.



14. Create a patio or lawn off the back, and throw in some trees and a picnic table (found in the **Landscape\_Sampler** folder).




---

**NOTE:** There are both 2D and 3D trees you can use. The 3D ones look great, but are heavy and may slow down your system when you orbit or apply shadows. So use the 2D ones if things move too slowly.

---

15. Orbit to a view like this, and add a tree or two along the side as well.



## Pages

Pages are the equivalent of saving views. In addition, pages can be added to a slide show, which presents an animated view of the model.

(A model with a complete set of pages is available at [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm) - download the file “PresentationHousePages.skp.” You can compare these pages with ones you create.)

1. Open the **Pages** window by selecting **Window / Pages**. (This is another stacking window.) Click **Add**.



2. This page is automatically assigned the name “Page 1.” Assuming the current view is where you want it (isometric, filling the screen), assign a more useful name such as “Iso.”




---

**NOTE:** You can also add, delete, and update pages using the **View / Tourguide** menu.

---

Now the page called "Iso" appears as a tab at the top of the screen. Mac. You can click this tab at any time to return to this view.



- Now switch to **Front** view and zoom in on the front door.



- Assign a new page called "Facing front door."



## Walk and Look Around

These two tools basically represent a camera moving around the model. The camera can simulate a person, but it can also be placed at any height, using any zoom angle. The **Walk** tool moves the camera, while the **Look Around** tool pivots the camera about its base. These tools are easy enough to explain in words, but you really have to play with them to get a feel for it.

- Activate **Walk** (**Camera / Walk**).



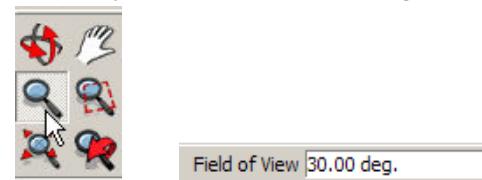
- To walk forward, drag the mouse up (holding the left mouse button).
- To walk backward, drag the mouse down.

- While walking or turning, you can press **Ctrl/Option** to move faster (this is called the "run" feature and is handy for large models).

- To turn left or right, drag the mouse to either side.
- To move (not turn) left or right, hold **Shift** while dragging the mouse to either side.
- To move up or down (for example, flying up to a higher or lower floor), hold **Shift** while dragging the mouse up or down.

- Perspective mode** must be on (**Camera / Perspective**); **Walk** does not work in **Paraline** mode. See "Perspective Mode" on page 444.

- You can use **Walk** in conjunction with **Zoom** (**Camera / Zoom**), which you can use to change your field of vision. Click **Zoom**, and the VCB shows the **Field of View** value. This can be in degrees (30 by default), or you can enter a focal length like 35mm.

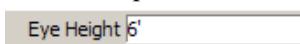


In **Zoom**, you can also press **Shift** and move the mouse up or down to change the number of degrees you can see.

- Keep the default field of view, and return to "Facing front door" if you changed the view. Activate **Walk**, and the cursor becomes a footprint symbol.

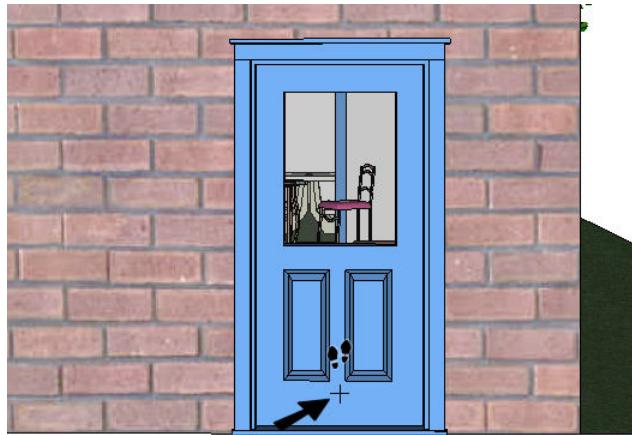


- The VCB now shows **Eye Height**, which you can change. Enter 6' to represent a tall man.



Now you can start walking into the house. When you click and drag the mouse, you will see a “+” symbol, representing where the feet start. To move straight ahead, keep the footprint directly above the cross. Keeping it slightly above the cross moves you slowly, farther above it speeds you up. If you move to either side of the cross, you will veer off to the side.

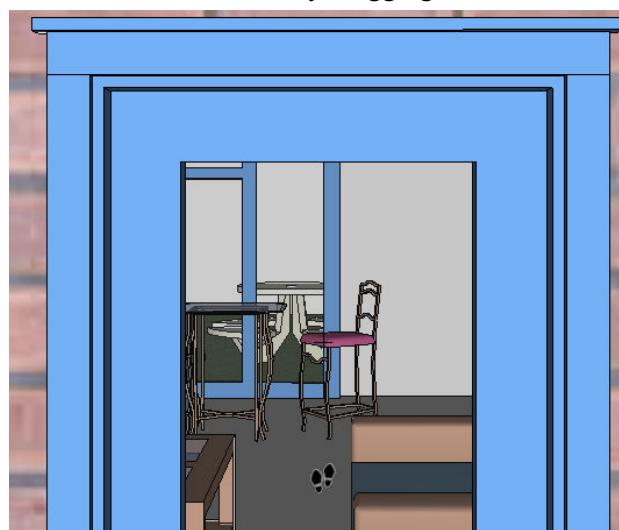
5. Click near the bottom center of the door and move forward slowly.



6. At some point, you cannot go any further - **Walk** has collision detection and stops you from walking through walls. The cursor becomes a person symbol. If you are the right height, you will actually hit the door glass - you can see in through the transparent glass but you cannot go inside.



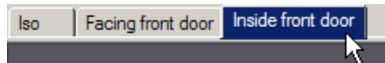
7. Move backward a bit by dragging the mouse down.



8. Now press Alt/Cmd and **Walk** forward again. Now you can walk through the door (and any other barrier). Once inside, you should be able to see the light-colored walls and the downstairs furniture.



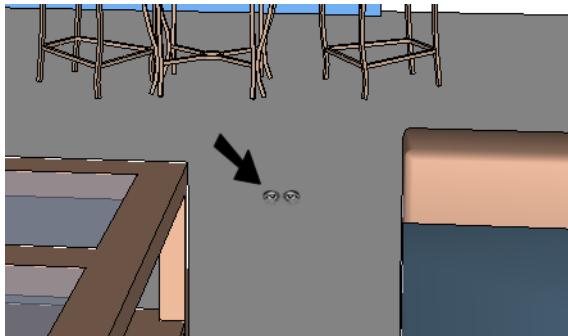
9. Make this view a new page - “Inside front door.”



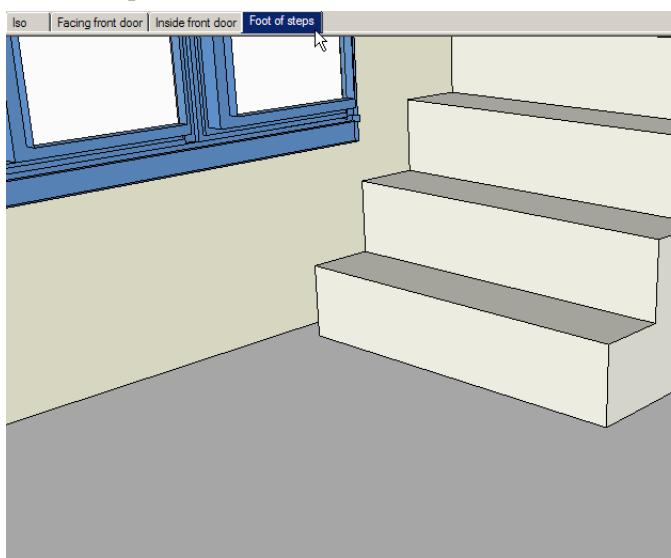
10. Now switch to **Look Around (Camera / Look Around)**.



11. The cursor switches to a pair of eyes. Drag the mouse from side to side and up and down to simulate standing still and turning your head.

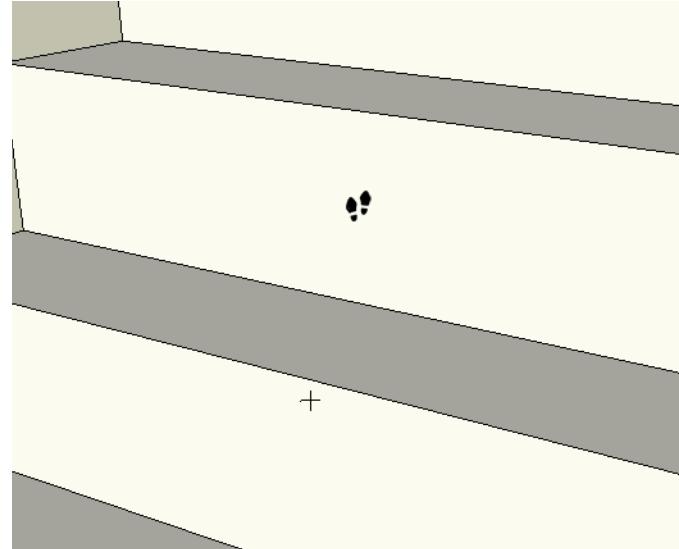


12. An easier way to **Walk** and **Look** at the same time is to return to **Walk**. Now when you drag the mouse with the middle mouse button pressed, you switch to **Look**. Use these two tools together to maneuver to the bottom of the staircase. Make a new page - "Foot of steps."

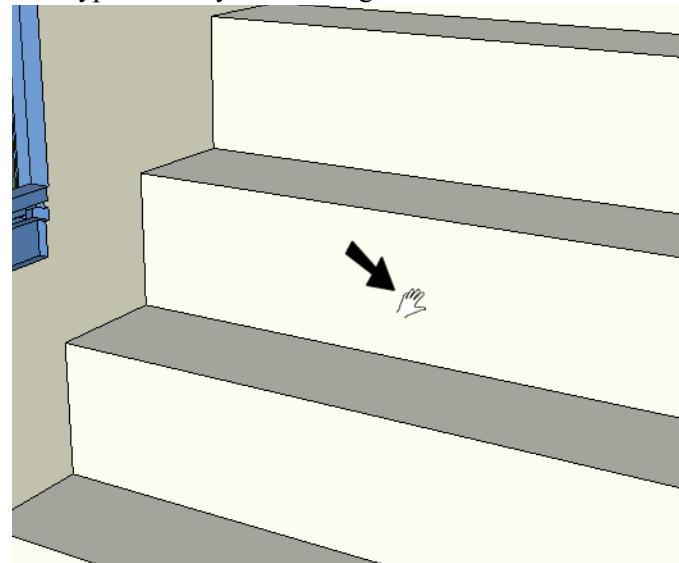


At first it may be difficult to walk to exactly where you want. You may find yourself going backward through walls, ending up outside the house. These tools take a little practice, but an advantage of saving views as pages is that you don't have to start all the way at the beginning!

13. The **Walk** tool also enables you to go up and down stairs. Start dragging the mouse up the steps - be careful not to go too fast.



14. While in **Walk**, you can press Shift while dragging to move up, down, right, or left. The cursor turns into a hand. You can use this to center yourself on the staircase if you find yourself veering to one side. Using Shift may change the eye height, but you can type 6' at any time during **Walk** to reset it.

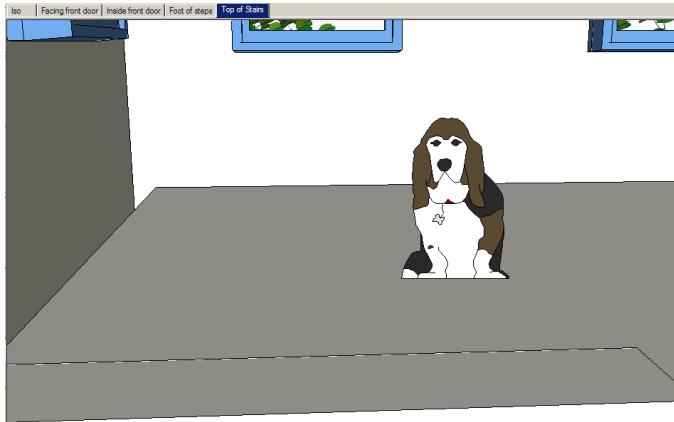



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*NOTE: You can use **Walk** with Shift to move up to the second floor. However, this will move you exactly vertically, while **Walk** alone will simulate what you actually see while going up the stairs.*

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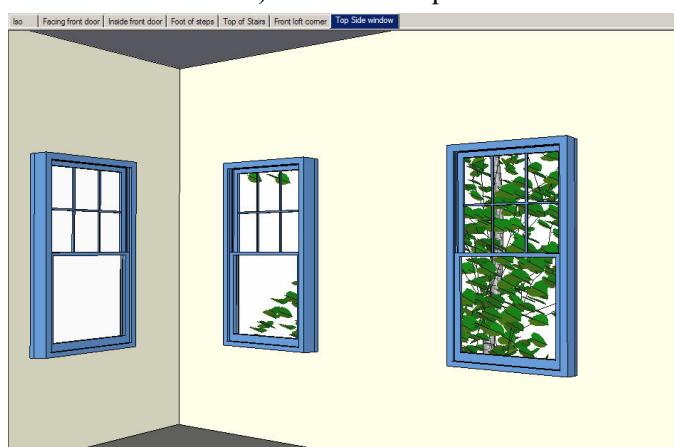
15. Stop at the top of the stairs, where your dog should be waiting. Create a new page called “Top of stairs.” It may be tough to reach this spot without overshooting, but you can always go back to the “Foot of steps” page and try again.



16. From the top of the stairs, use **Walk and Look Around** to reach the point where you’re facing the loft furniture. Call this page “Front loft corner.”



17. Keep going around the top floor and create a view looking out the side windows (you should see a tree or two from here). Call this “Top side window.”



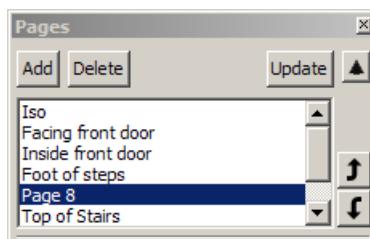
18. We now can create some pages for the first floor. To return to this floor, click the tab for the “Foot of steps” page.



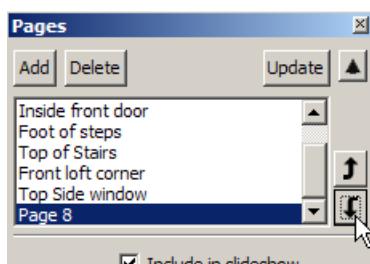
19. Go from the steps to a view like this, in which you can see the furniture.



20. Save this view as a page - it is automatically placed after “Foot of steps” - the view you started from.



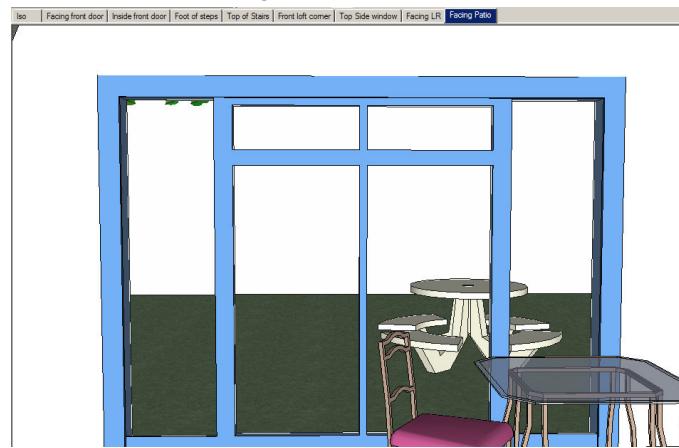
21. Before assigning the view a name, use the down arrow to move it to the last slot, after “Top side window.”



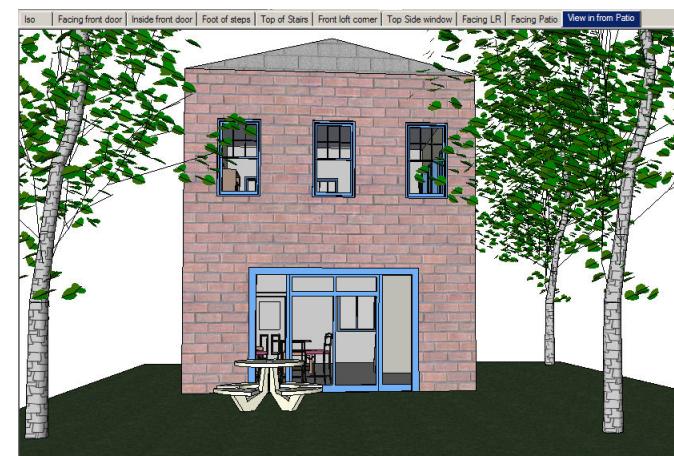
*NOTE: You can also move pages around after they are created, as we will see in a few more steps.*

22. Then change this view’s name to “Facing Living Room.”

23. Get to a view like this, looking out on the patio, and save it as “Facing Patio.”



24. One last view - standing at the back of the patio looking in on the house. Call this one “View in from Patio.”

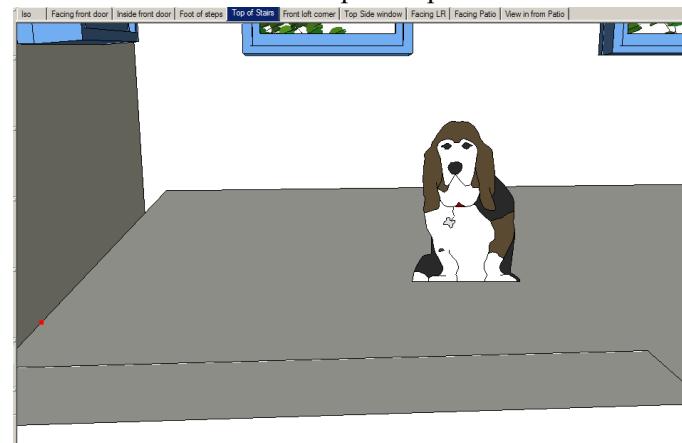


## Position Camera

The way the pages are set up now, there is no smooth flow between the first and second floors. Display the “Top Side Window” page, then “Facing Living Room.” It’s a rather abrupt change, so it would be nice to place in between these pages a view from the steps, looking toward the front door.

At the angle of the staircase as it is, it is not so easy to use **Walk** to get back down the stairs (try it and see). But we can use **Position Camera** to get an exact view.

1. Start at the view at “Top of steps.”



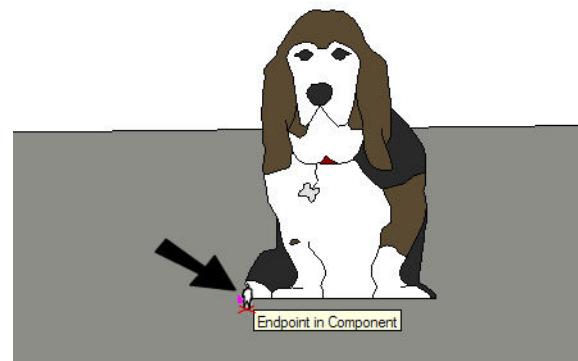
2. Activate Position Camera (Camera / Position Camera).



The **Height Offset** is automatically set at 5'-6", which we will accept. This is the height of the camera above the floor.

Height Offset 5' 6"

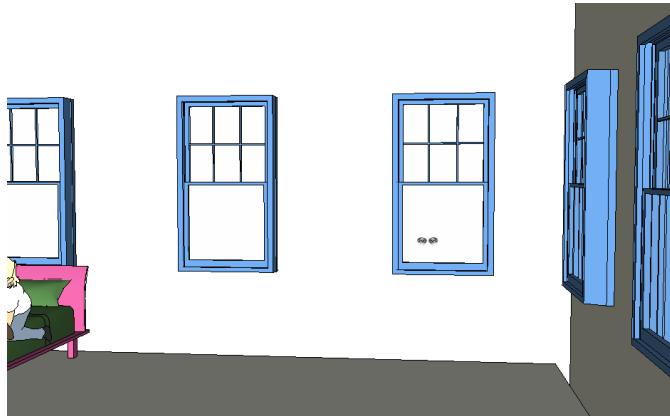
3. Place the base of the camera at the foot of the dog.



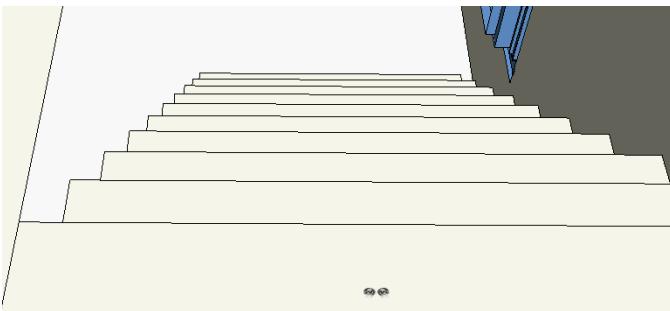
The Eye Height updates to 16'-6". Why? The overall height of the second floor is 11' from the ground, and another 5'-6" to the camera itself = 16'-6".

Eye Height 16' 6"

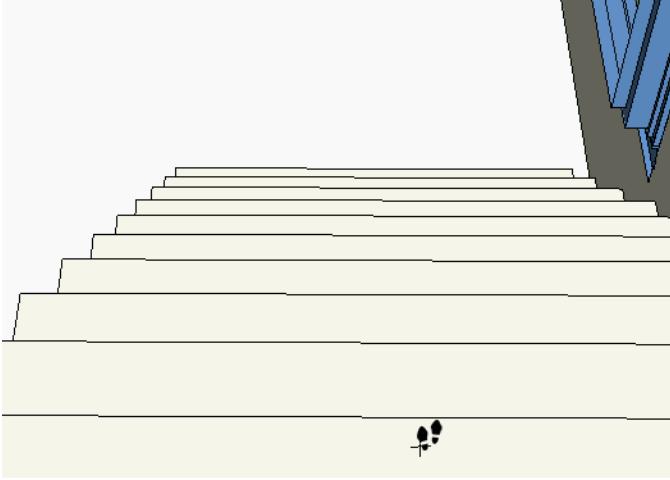
- From this point, drag the mouse to the right to pivot the camera about its base. Go around 180 degrees so that you are facing toward the front of the house.



- Then drag the mouse downward until you are looking down the stairs.



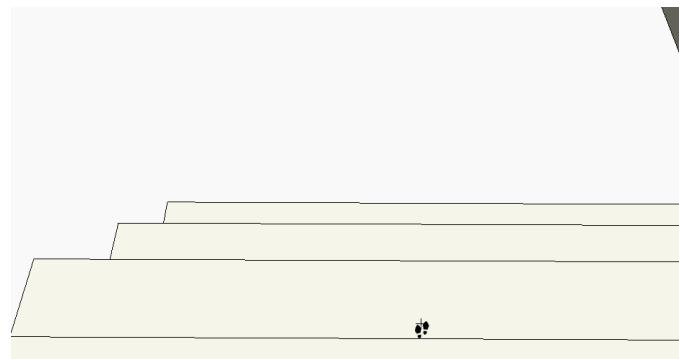
- Now we can walk down. Switch to **Walk**, and the cursor switches back to the footprint.



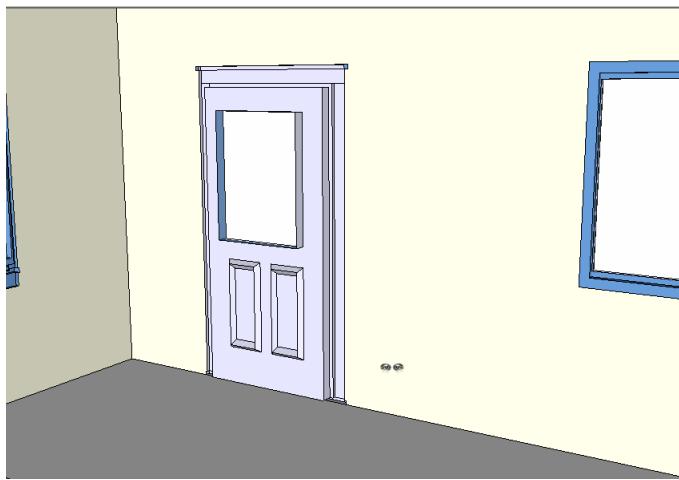
The Eye Height readjusts to 5'-6".

**Eye Height 5' 6"**

- Walk down until you are on the third step from the bottom.



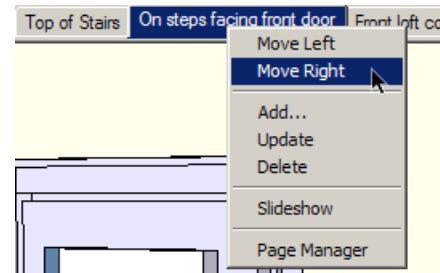
- Then **Look Around** until you see the front door. Create a page here called "On Steps facing front door." Even though the page will be placed in the wrong order, create it anyway.



This should be the order: "On steps" directly after "Top of stairs" - the view you started from.



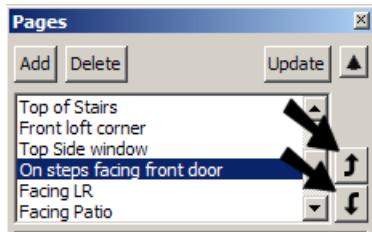
- To move this page, right-click it and select **Move Right**.



The "On steps" page moves one page over, but it needs to be placed before "Facing Living Room."



10. You could keep moving the page to the right, or use the **Page** window. Use the down arrow to move “On steps” to the position right before “Facing Living Room.”



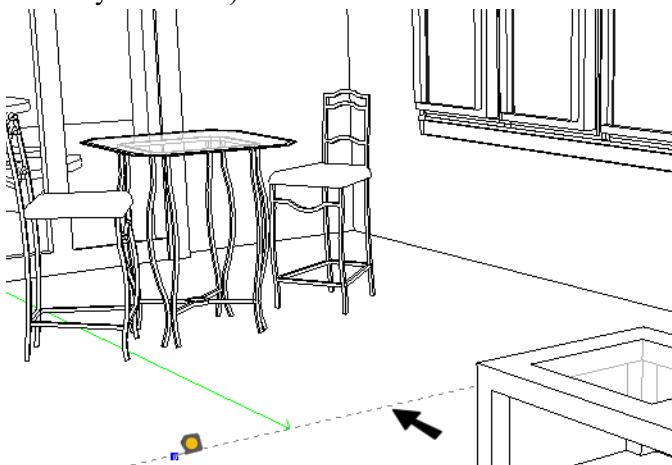
Another use for **Position Camera** is to get the exact view between two known points. We will use this to change the “Facing Patio” page.

11. Start in the “Facing Living Room” page.



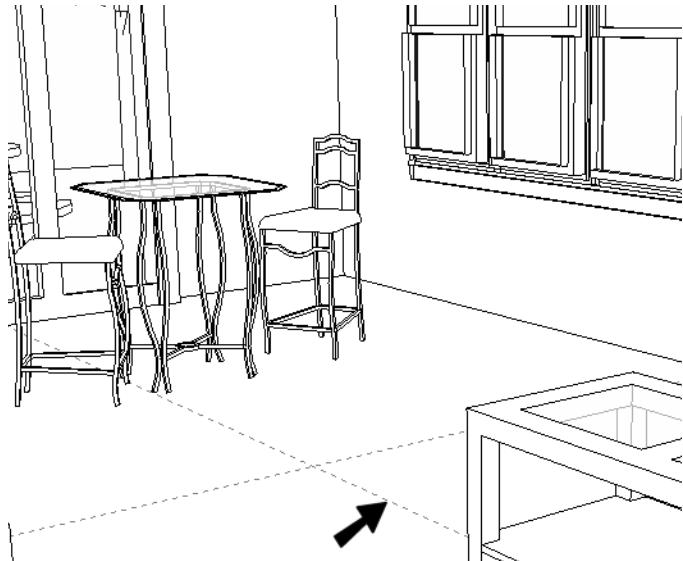
12. We will now use construction lines to approximate a person standing in the middle of the room. Switch to **Hidden Line** mode, so that it will be easier to see construction lines.

13. Use **Measure** to drag a construction line from the back edge of the house. Place it between the kitchen set and the coffee table (or a place that makes sense in your model).

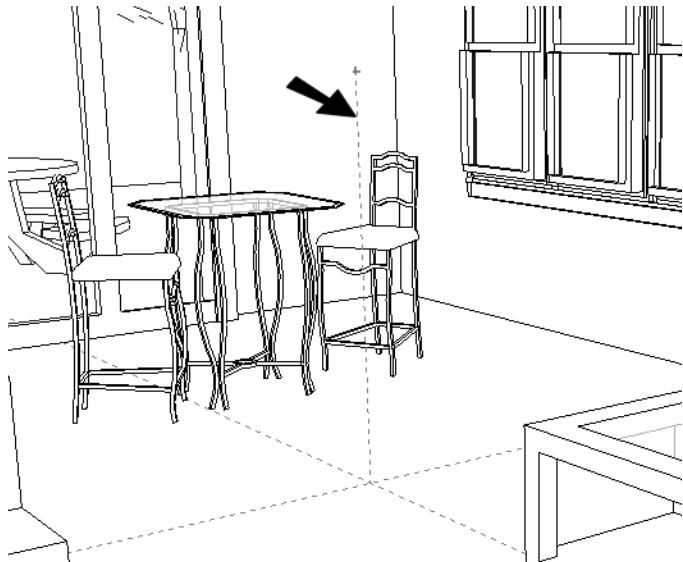


**NOTE:** For details on creating construction lines, see “Measure” on page 39.

14. Draw another construction line from the side of the house. The person will be standing where these lines intersect.

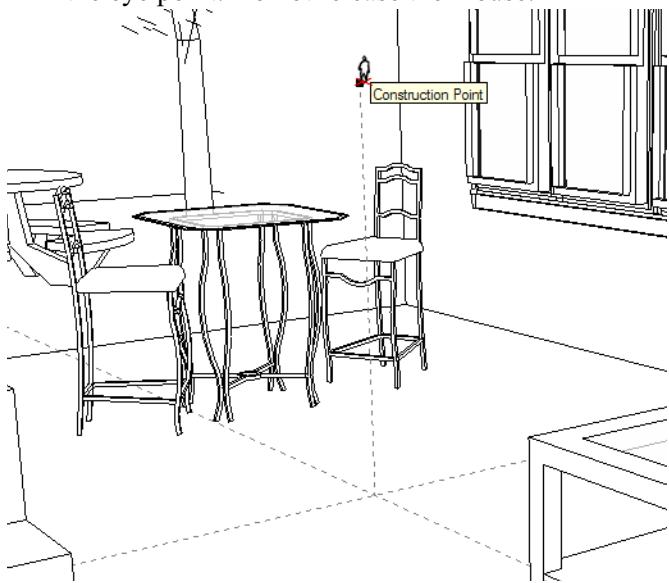


15. Draw one last construction line straight up 5'-6" from this intersection point. This is where the view will be seen from.

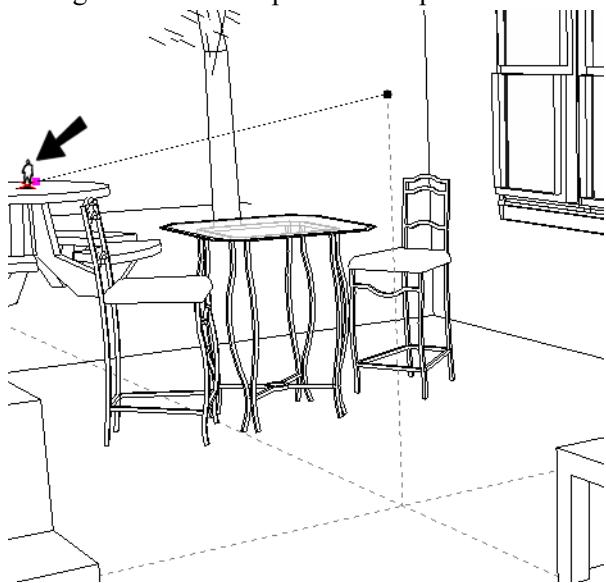


16. The view will end at the picnic table out back, so hide anything that blocks it, such as the back door.

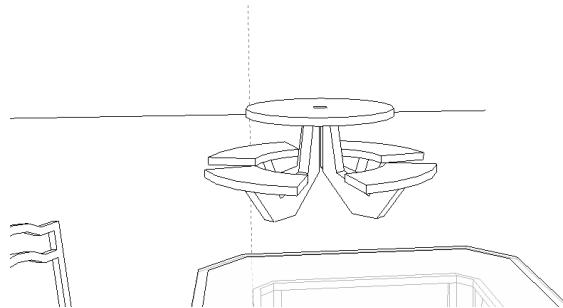
17. Activate **Position Camera** and place the camera at the eye point. Do not release the mouse.



18. Drag the mouse to a point on the picnic table.



19. Release the mouse and here is the exact view. This will replace the “Facing Patio” page you created before.

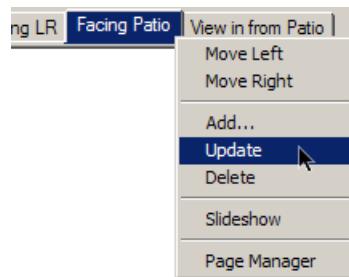


20. Unhide anything you hid before.

## Updating Pages

There are a few ways to update a page. You can update its actual view, and/or you can update what information is included in the view.

1. Right-click on the “Facing Patio” page and select **Update**. This is the easiest way to change the page’s view.

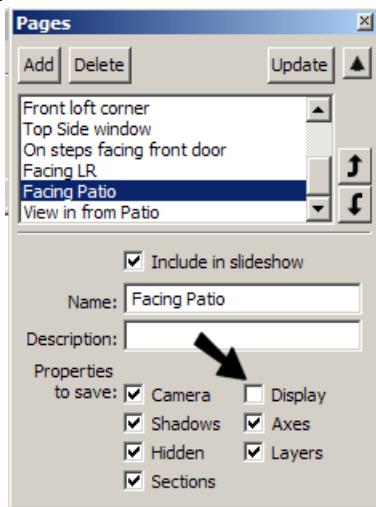


**WARNING:** Be careful when using **Update** - there is no Undo for this! So make sure you are updating the correct page, or you will have two pages to fix.

2. Switch from the “Facing Living Room” page, then back to “Facing Patio.” The display switches from Shaded to Hidden Lines.

**TIP:** You can use the Page Up and Page Down keys to scroll between pages. And you can double-click a page in the **Pages** window to switch to that page.

- The reason for the mode switching is that all properties of “Facing Patio” were saved with the page. This includes its Hidden Line setting. If there is a property not saved, the relevant property of the previous view will be used.
- In the **Pages** window, for “Facing Patio” uncheck **Display**. This means that its hidden line property will no longer be saved. If the view before it is shaded, this page will also be shaded.

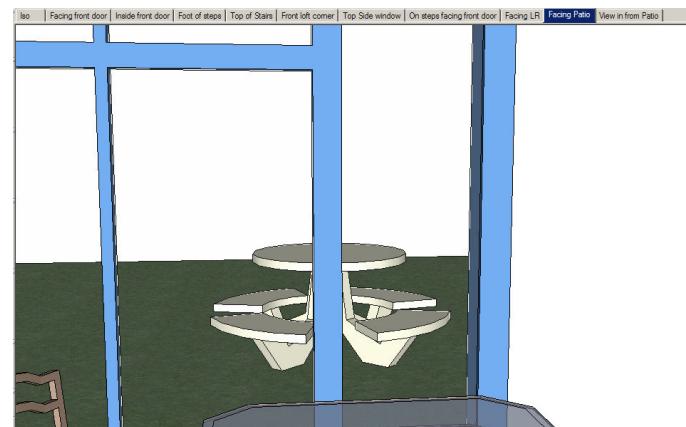


**Properties to save** lists the various conditions that can be preserved for the page. **If any of the items are unchecked, the page will use the relevant settings of the previous page.**

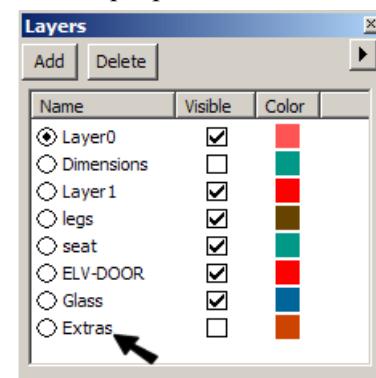
- Camera:** Preserves the current camera view and zoom distance. You need this option selected if you want to save pages with different views, as we've done so far in this exercise.
- Display:** Preserves settings such as wireframe, hidden, shaded, patterned, etc. See "Display Settings" on page 438.
- Shadows:** Saves shadow settings. See "Shadows" on page 331.
- Axes:** Preserves the display of the axes.
- Hidden:** Preserves the hide/show status of objects.
- Layers:** Preserves the show/hide status of layers. As you've seen, this is a good way to create multiple views that show different items.

• **Sections:** The active section plane will be restored when the page is activated. This is a good way to include dynamic sections in your slide show; see "Using Sections for Interior Design and Presentation" on page 304.

- There is nothing else to update, since the view itself is fine. Now switch from “Facing Living Room” to “Facing Patio,” and both are shaded.



- For another example of properties to change, we will look at layers. Create a new layer called something like “Extras” and make it invisible. Place anything that does not come with the house on this layer: furniture, trees, people, etc.

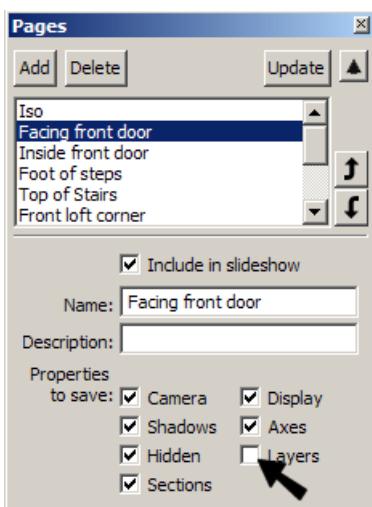


**NOTE:** Any other layers you see here, aside from “Dimensions,” were included with components that were inserted.

6. Display “Iso,” and no furniture should be visible inside the house. **Update** this page - the view definition changes because the layers on it have changed.



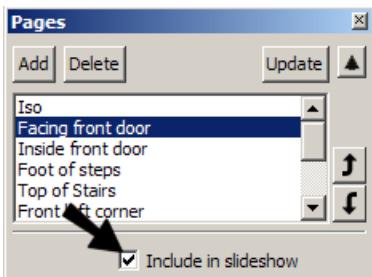
7. In **Pages**, uncheck **Layers** for several pages that come after “Iso.”



8. Now when you switch views in order, starting from “Iso,” no extras will appear on those pages you modified. They will appear again for pages that were not modified.

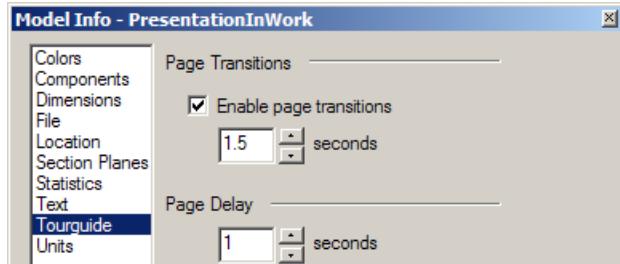
## Tourguide / Slideshow

The slide show is a great way to present an animated view, in order, of the pages in your model. For a page to appear in the slideshow, **Include in Slideshow** must be checked.



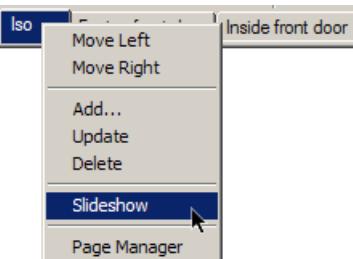
1. For the “Iso” page, update it with the “Extras” layer displayed.

2. Select **View / TourGuide / Settings**, which opens **Model Info** to the **Tourguide** page. In this window you can set the timing and transition options for the slide show.



- **Enable page transitions:** Smoothly and dynamically transitions between adjacent pages. If not checked, the slideshow will jump from page to page.

- **Transition Time:** The seconds for each transition.
  - **Page Delay:** The amount of time each page will be visible (not including transition time).
3. Set the options so that page transitions are enabled.
  4. Right-click on any page tab and select **Slideshow** (Windows only), or select **View / Tourguide / Play Slideshow**. Each page will appear on the screen, in order, starting from the active page.



*Mac: You can also click the **Start Slideshow** icon. You can add this icon via **View / Customize Toolbar**.*



5. The current page is indicated by the page tabs at the top of the screen. You can press **Pause** or **Stop** any time. (*Mac: Stop is available if you added the Start Slideshow icons to the toolbar.*)



The slideshow shows one page at a time, smoothly transitioning between pages.



6. Press **Stop** to end the slide show, or it will continue to scroll between slides.

Once your slide show has been created to your satisfaction, you can export it to an animation file. Among other things, this enables you to share your designs with those who do not have SketchUp installed, and without having to transfer \*.skp files. See "File / Export / Animation" on page 455.

## Shadows

SketchUp's shadow casting tools is a great way to present a realistic view of your model, and to see how the model will look under various conditions of time and location.

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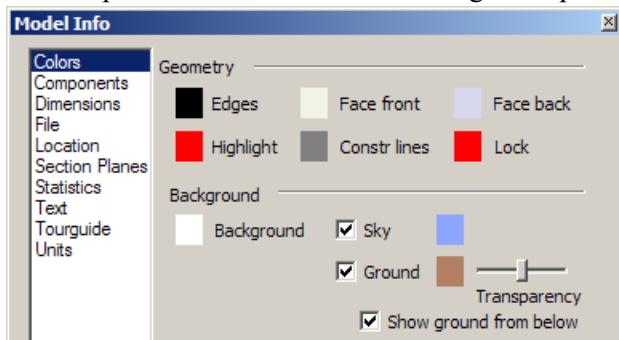
**NOTE:** *To view faces as though the sun is hitting them, without actual viewing shadows, check **Use sun for shading** on the **Display Settings** window.*

---

**Windows:** The shadow commands are available on the **Shadows** toolbar. If you don't see this, select **View / Toolbars / Shadows**.

**Mac:** There is a **Shadows** icon on the toolbar. You can also select **View / Shadows**, or **Window / Shadow Settings / Display Shadows**.

1. First, set the sky and ground conditions so that the shadows will look more realistic. Open **Model Info** to the **Colors** tab and check **Sky** and **Ground**. This examples uses a brown color for the ground plain.



This is how the "Iso" page should look with a sky and ground added.

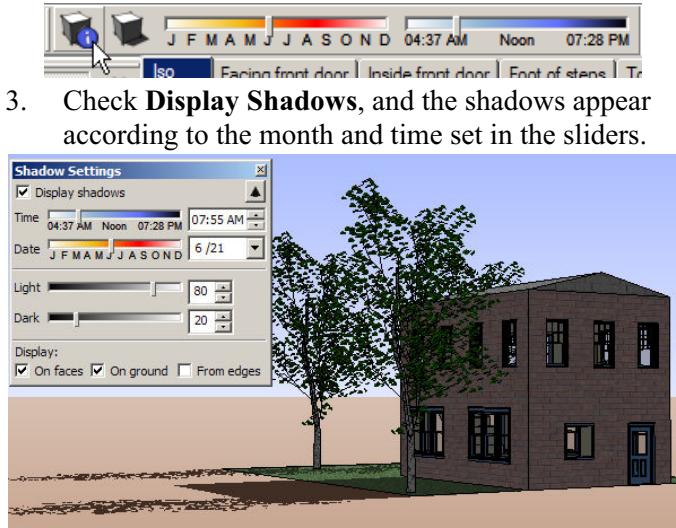



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**NOTE:** *Keeping these background effects active will slow down the performance of the model, so you might not want to use them all the time.*

---

- You can use the sliders on the **Shadows** toolbar to set the time and date, but to get more options, click **Shadow Settings** (Window / Shadow Settings).

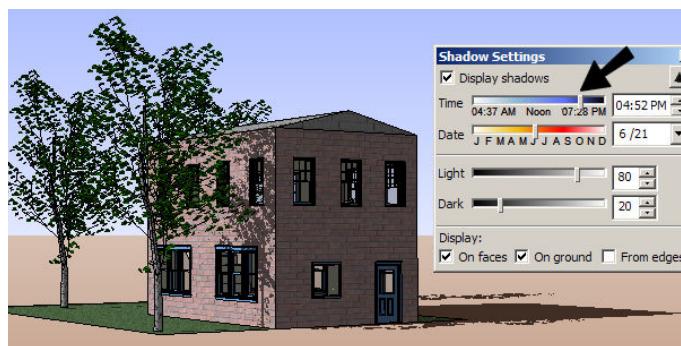


The shadows also depend on the location of the model. This can be set in the **Location** page of the **Model Info** window. See “Model Info > Location” on page 447.

At the bottom of the **Shadow Settings** window, you can choose how shadows will be created:

- On Faces:** Casts shadows on faces. This may impact performance on slower computers, or those using software rendering.
- On Ground:** Casts shadows onto the ground plane.
- From Edges:** Casts shadows from stand-alone edges (lines drawn in space that are not connected to any faces).
- Light:** Controls the tonal balance of the lighting in the SketchUp display. **Light** controls the amount of diffuse lighting, and **Dark** controls the amount of ambient lighting.

- Move the **Time** slider from morning to afternoon, to reverse the direction of the shadows.

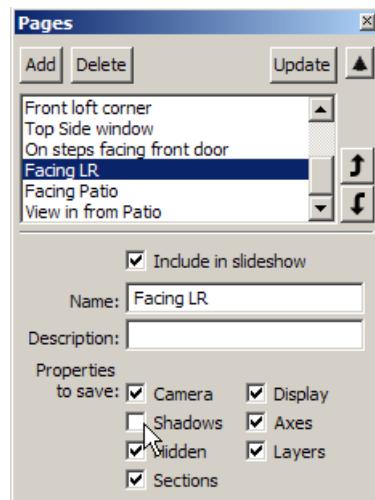


**TIP:** If you make two pages, each with the same view but different shadows from different times of day, you can scroll between the pages to view effects of the sun passing over the sky.

- Update the “Iso” page to include this shadow.



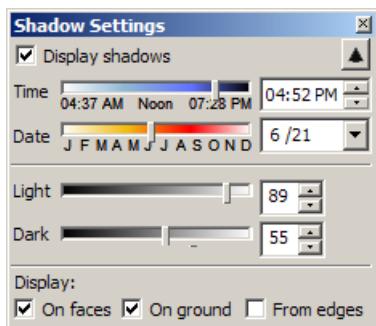
- For the “Facing Living Room” page, uncheck **Shadows**. As you know by now, this means the shadow information originally saved with this page (i.e., no shadows) will be overridden by the shadows of the page you view before this one.



7. Now switch from “Iso” to “Facing Living Room.”  
The afternoon shadows can be seen inside the house.



8. You can use the **Shadow Settings** window to control how dark the shadows are. Adjust the **Light** and **Dark** sliders to brighten up the room.



Now the room is more inviting, and still has its shadows.



This chapter covered several topics, but by now you can see how they are all related. You can combine the walk-through tools, layers, pages, shadows, and/or slide show to create a masterful presentation of your model!



# 10 Sandbox Tools

SketchUp's sandbox tools enable you to create terrains, as well as other organic shapes. The actual surface created is called a TIN - triangulated irregular network. A TIN is simply several connected flat triangular faces that, when smoothed, appear like one continuous smooth surface.

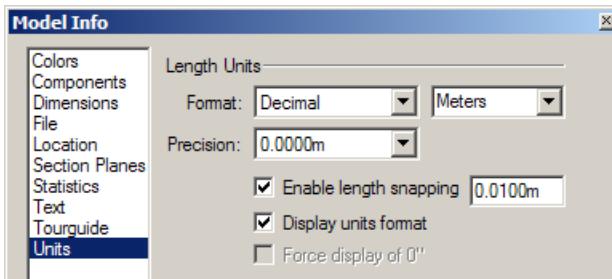
You can create a TIN from scratch as a flat grid, or create it from a set of contours. You can also import a TIN from a \*.dtm file.

TIN contours can be created within SketchUp or imported. (For details on the ArcGIS plugin, see [www.sketchup.com/markets/gis.php](http://www.sketchup.com/markets/gis.php).) Or you could import an image of a site plan or contour map and use **Freehand** to trace its contours.

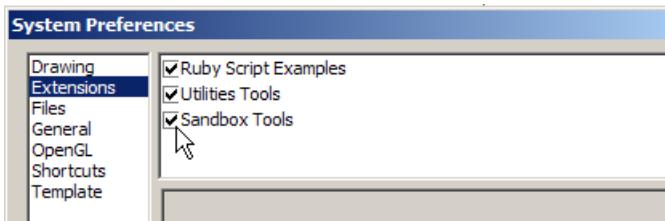
**NOTE:** If you have a site map and want to create a stepped (not smooth) topographical surface, see "Projecting an Image onto a Non-Planar Face (Topography)" on page 292.

## Creating a Sandbox (TIN)

### 1. Set the Units to Decimal Meters.



### 2. In order for the sandbox tools to be available, you must activate them. Open **Window / Preferences** to the **Extensions** page and check **Sandbox Tools**.



### 3. If the **Sandbox** toolbar does not appear, select **View / Toolbars / Sandbox**.



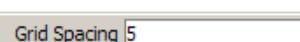
### Sandbox from Scratch

With this tool, you can create a flat TIN surface, divided into a grid. This TIN surface can then be modified using the other sandbox tools.

#### 1. Click **From Scratch**.



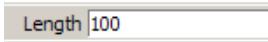
#### 2. The VCB indicates the **Grid Spacing**. Enter 5 (the meter unit is assumed since you set the units).



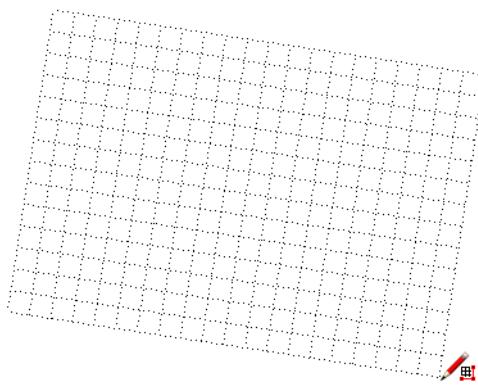
#### 3. Click to start the first side of the grid and move the mouse to create the first side. Do not click yet. The tick marks are 5m apart.



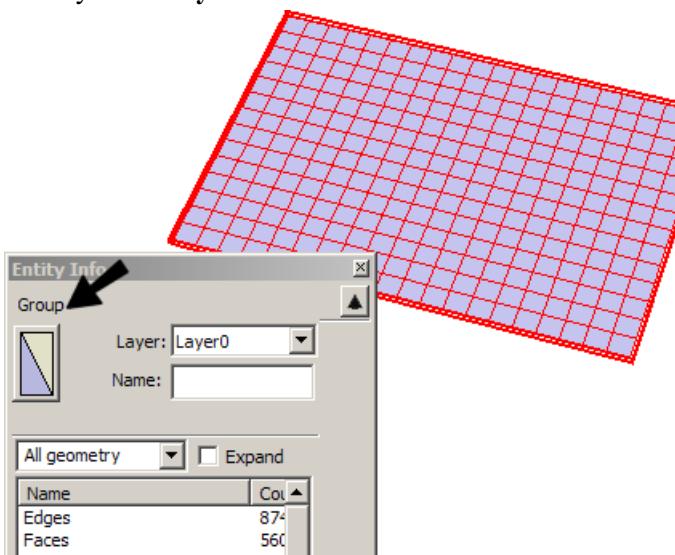
#### 4. You can use the VCB to enter an exact length, Type 100 and press Enter. The side is extended to be 100m long, and you may have to zoom out to see it.



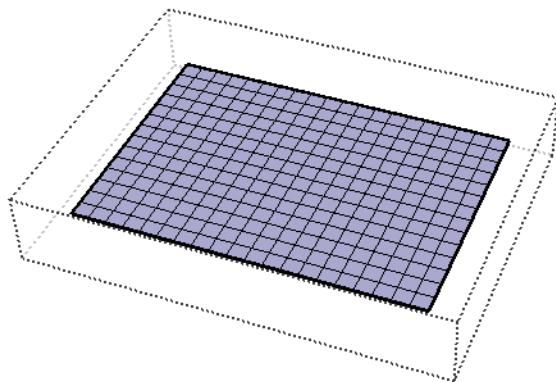
#### 5. The next click defines the other grid direction. Make it something like this:



The surface is created as a group, which is indicated by its **Entity Info** window.



6. To work on a sandbox, you must either open the group to edit it, or explode it. Do the first - double-click the group to edit it.



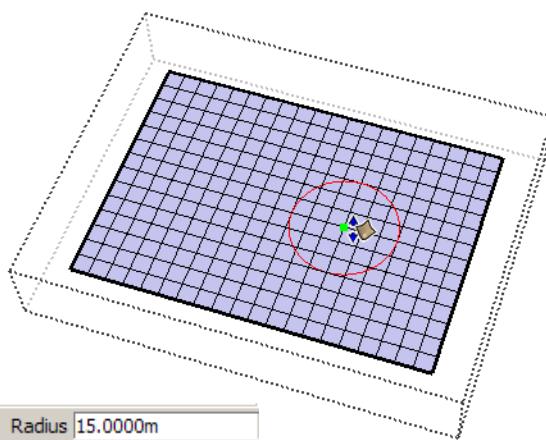
## Smoove

The **Smoove** tool is a combination of smoothing and moving (but the name still sounds a bit weird). You can use it to sculpt a TIN - to make hills and valleys, or to smooth out areas that are too jagged or bumpy. By moving a circular area of a TIN up or down, you get a smooth deformation.

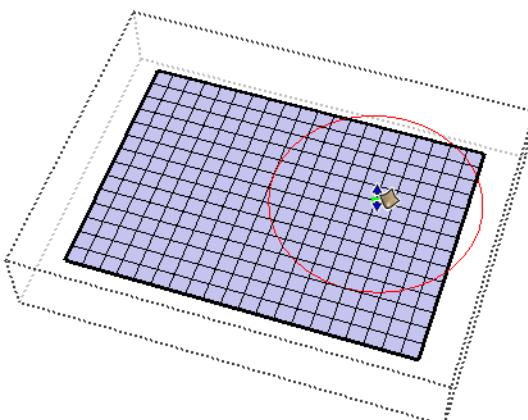
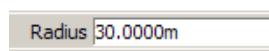
1. Click **Smoove**, or select **Tools / Sandbox / Smoove**.



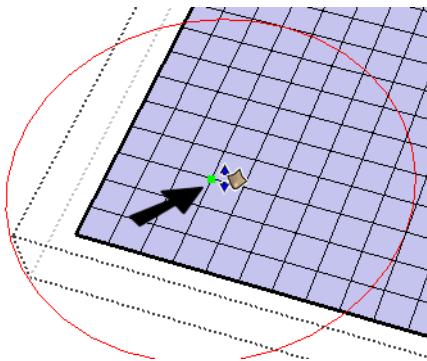
2. A red circle appears around the cursor - this is the tool's area of influence. The radius of this circle is listed in the VCB.



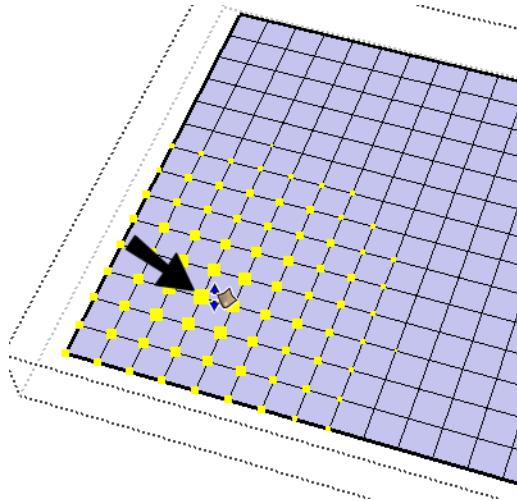
3. Enter 30 to set a 30m radius circle.



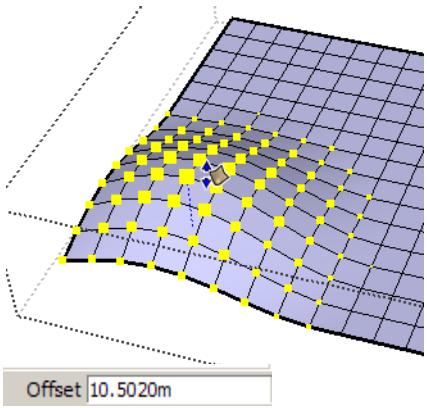
4. You can place the center of the **Smoove** circle in one of several places. Click to place the center at a grid intersection point.



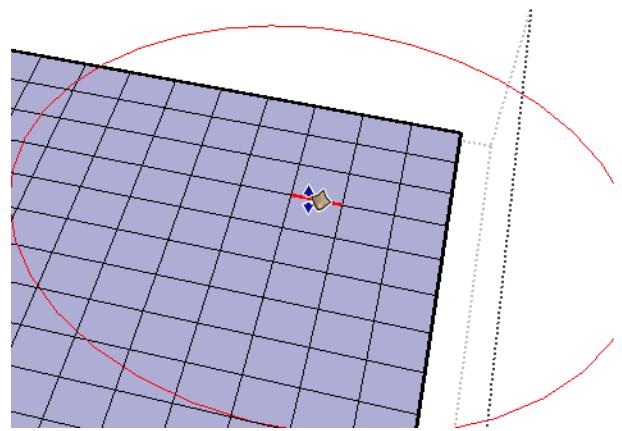
The grid points that will be affected (those within the circle radius) are highlighted by squares. The largest square is where you placed the circle center, and the squares get progressively smaller farther out.



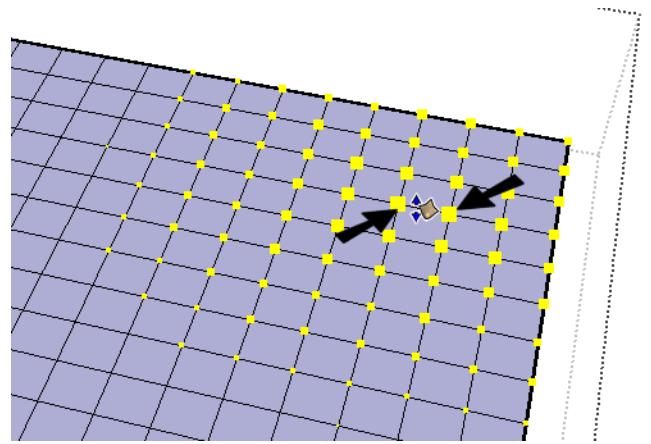
5. You can move these grid points up or down. The **Offset** value is indicated; you can do it by eye or enter an exact value. Raise the center of this area about 10m upward.



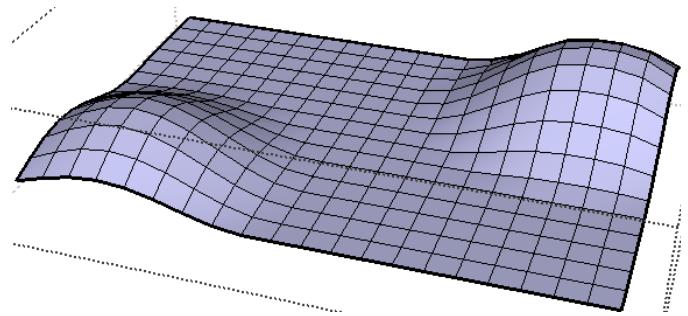
6. For the next smooove, place the center at a grid edge.



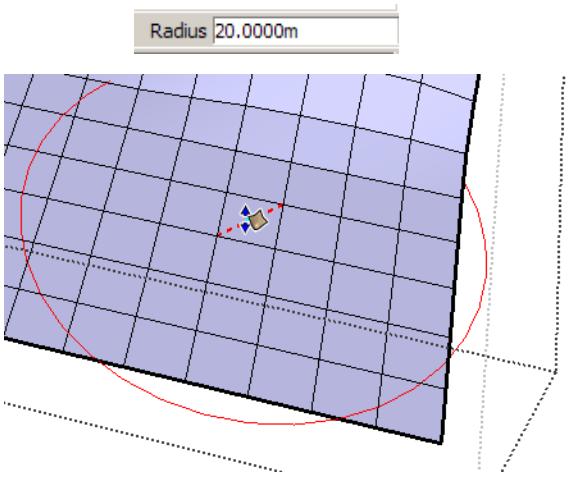
The two largest squares are at both ends of this edge.



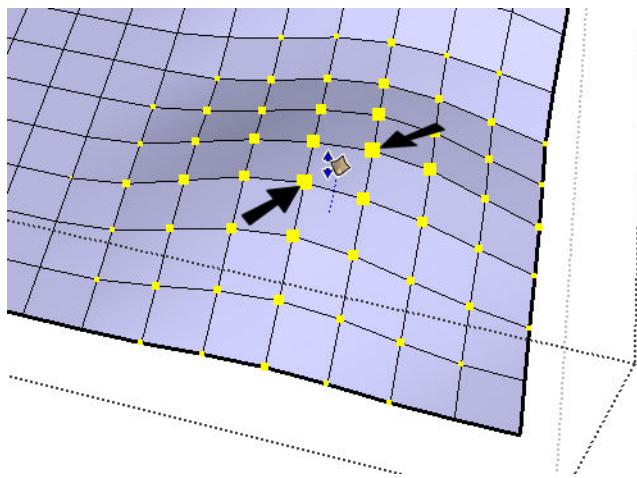
7. Pull this area up as well. You've now created two hills.



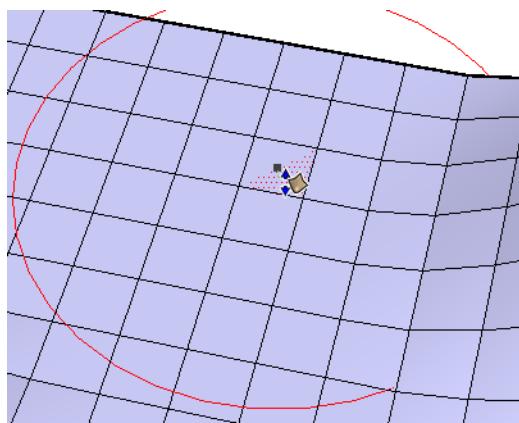
8. Reduce the radius to 20m, and this time place the center on one of the hidden diagonal edges. Hidden edges appear when the cursor passes over them.



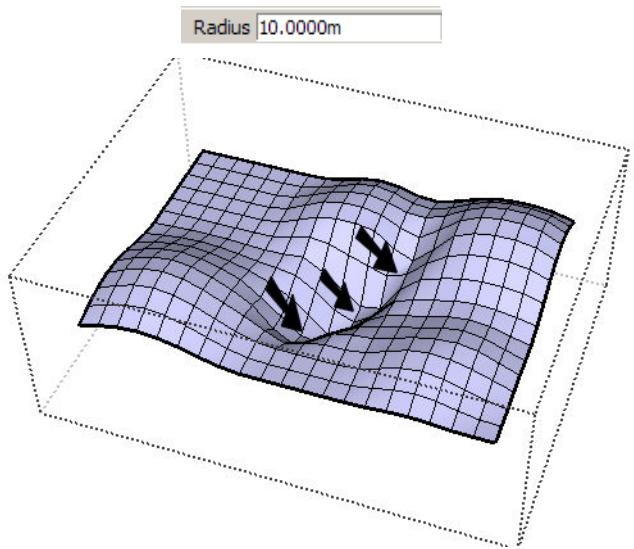
9. Again, the endpoints of the edge have the largest squares. And there are now fewer grid points affected.



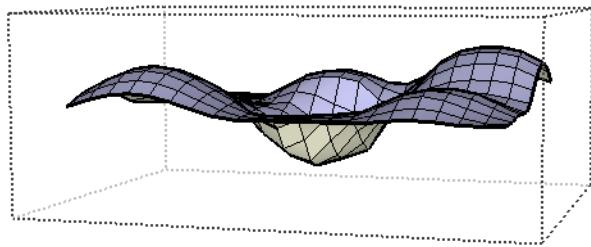
10. Pull up one more small hill by placing the center on one of the triangular faces. These faces also appear when the cursor passes over them.



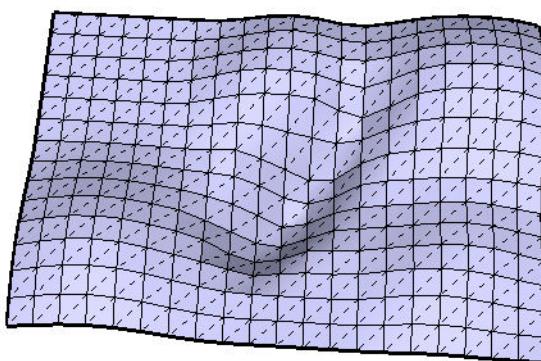
11. Reduce the radius once again to 10m. Create a few depressions in the center to simulate a lake bed.



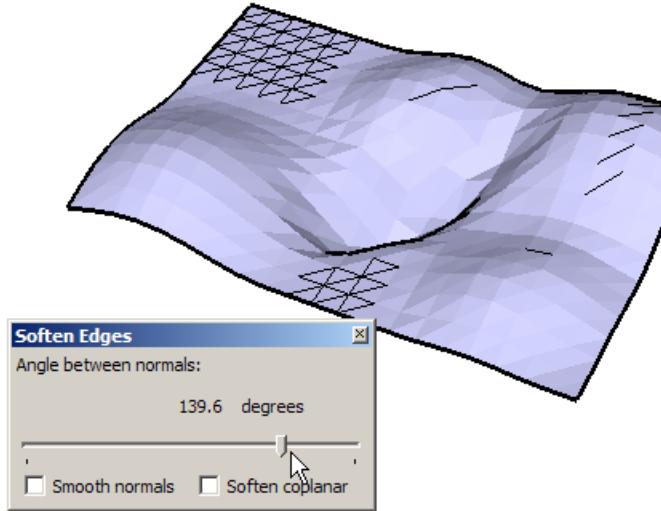
From the side, your TIN should look something like this:



12. Display hidden geometry to see all edges that comprise the TIN. Each triangular face is flat, but all together they create a smooth look.

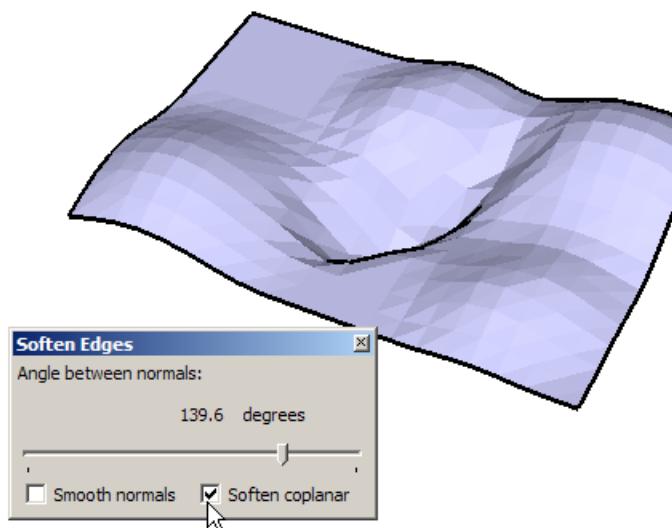


13. Turn off the hidden geometry, and open the **Softener Edges** window (**Window / Soften Edges**, or select the entire TIN and right-click). Move the slider to the right to see the edges start to disappear. With nothing else checked, the surface has a faceted look.

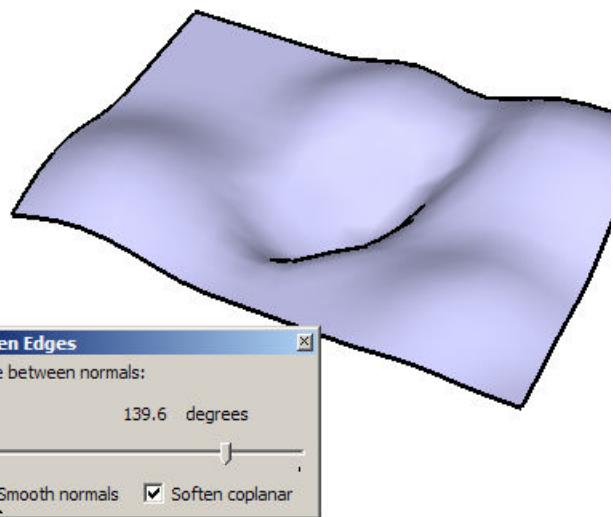


**NOTE:** **Softener Edges** is one of SketchUp's stacking windows. See "Stacking Windows" on page 437.

14. Check **Softener Coplanar**, and edges along flat areas also disappear.



15. Check **Smooth Normals** to remove the faceting.



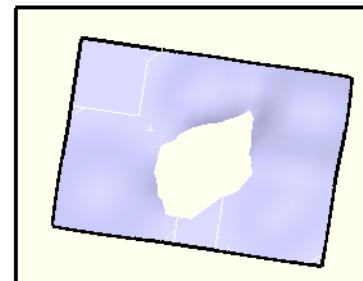
## Sandbox from Contours

Another way to create a TIN is to create it from contours you already have. These could be curves you create within SketchUp, or curves you import from another application. Because we already have a TIN surface from the previous exercises, we can get its topographical contours and then re-create the TIN.

**NOTE:** If you want to compare the **From Contours** TIN to the **From Scratch** one, make a copy of the TIN to work on, keeping the original.

If you want to download this set of contours, go to [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm) and download the file "SandboxContours.skp." You can then skip to Step 6.

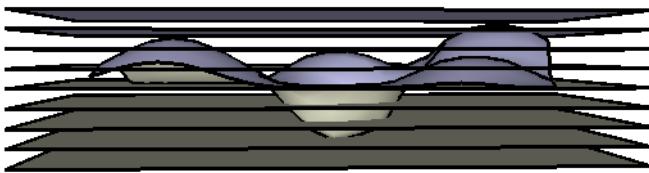
1. Switch to **Top** view and draw a rectangle around the TIN you created in the previous exercise.



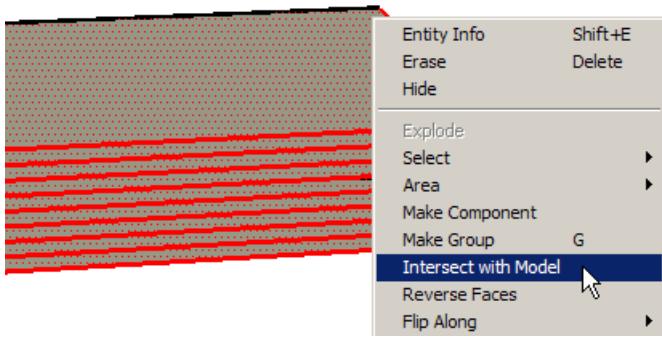
From the side, it should look something like this:



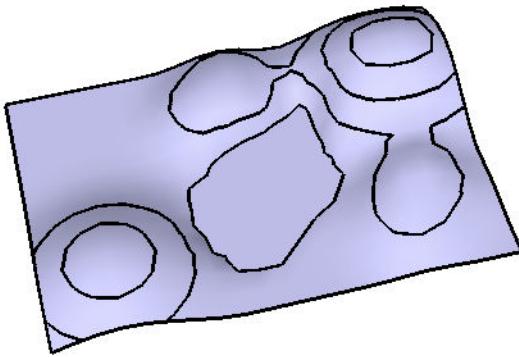
2. Make vertical copies of this rectangle. In this example, the rectangle spacing is 4m.



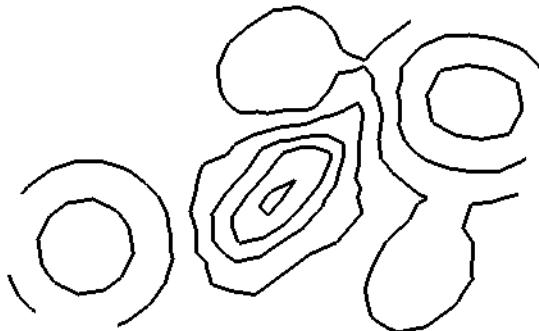
3. Select all rectangles and run **Intersect with Model**.



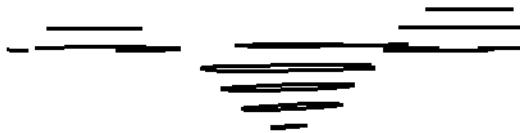
4. Erase the rectangles, and you are left with the intersection edges. These are the topographical contours.



5. Erase the TIN (easily done since it should still be a group). Contours that are closed loops may contain faces - erase these as well.



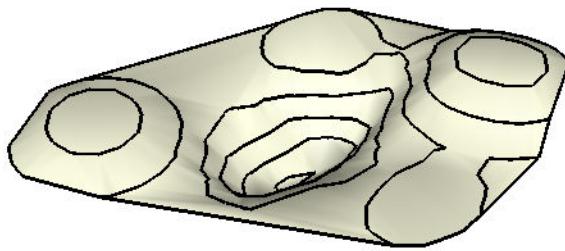
Here are the curves from the side:



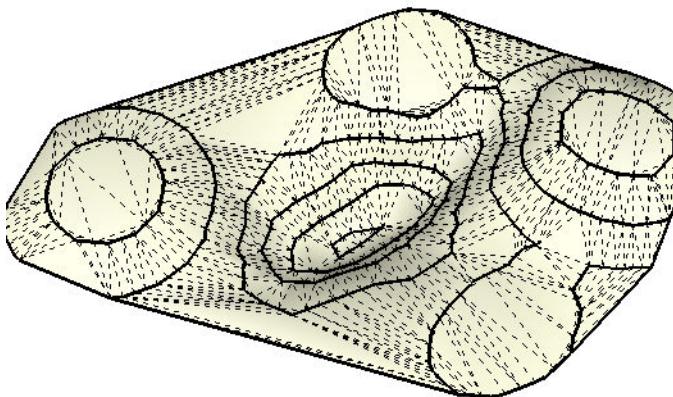
6. Select all contours, and click **From Contours (Tools / Sandbox / From Contours)**.



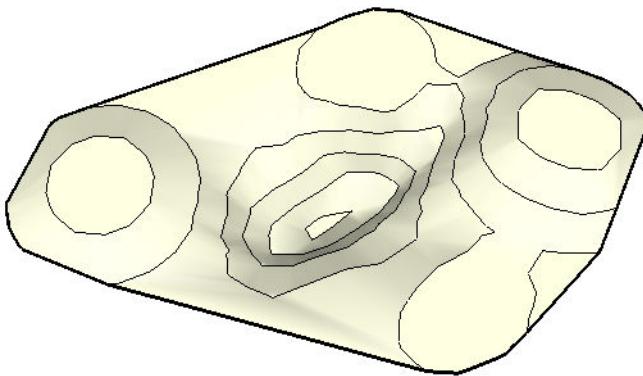
The TIN is created, and it almost exactly matches the one you had created from scratch. The contour lines are thick because the TIN itself is a group, and the contour lines do not align to it.



- Display the hidden edges. These are more complex than those of the **From Scratch** TIN.



- Turn off hidden edges, and **Explode** the TIN (it may take a minute or so). Now the contour lines are thin.

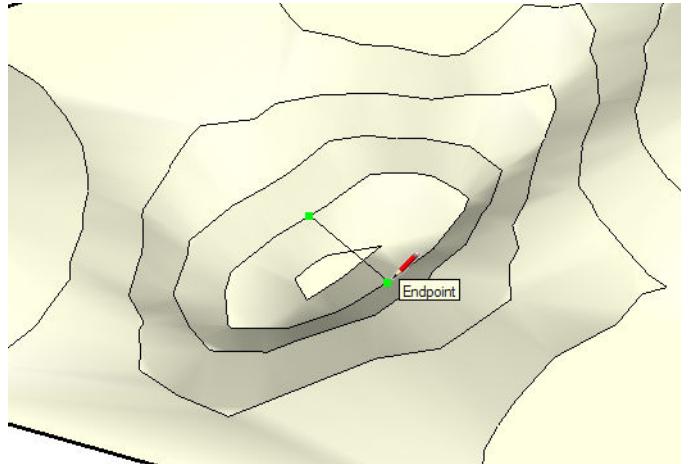


## Drape and Stamp

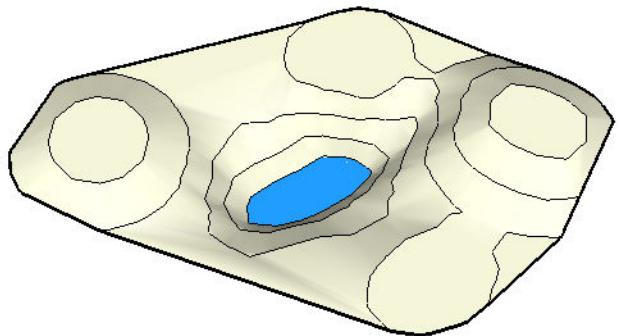
**Drape** and **Stamp** are two tools that enable you to project objects onto a TIN. **Drape** projects boundary curves only, while **Stamp** pushes a 2D or 3D object into a TIN.

We will continue working with the previous TIN model. If you want to download this TIN file, go to [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm) and download the file “SandboxDrape.skp.”

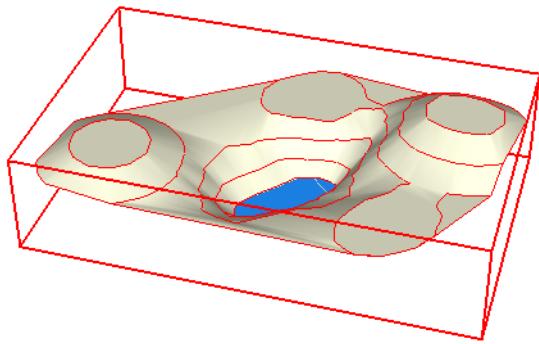
- To create a lake at the bottom, connect any two points on a contour near the bottom.



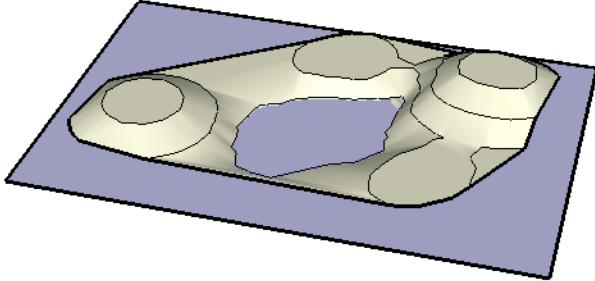
- Erase any extra lines, and assign a different color if you want.



- The projection curves can now be created, and they will be placed on a flat rectangle. To prevent the rectangle from sticking to the TIN, make it a group.



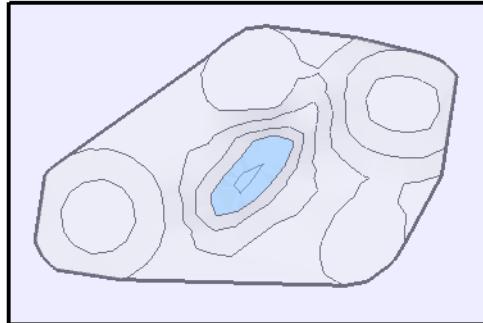
- Now create a flat rectangle that encloses the TIN.



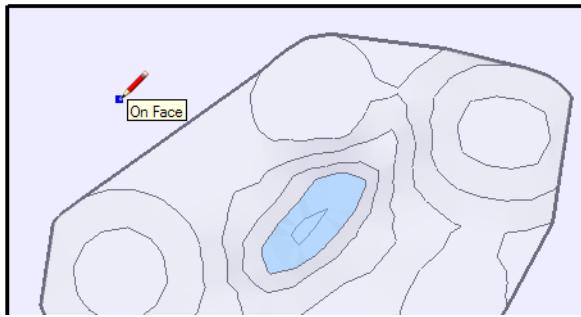
- Move the rectangle directly above the TIN.



- Switch to **Top** view and turn off **Perspective** (**Camera / Perspective**). This is so you can create lines directly above the relevant points on the TIN, with no depth distortion. Switch to **X-Ray** mode so that you can see the TIN through the rectangle.



- We will create a line that represents the center of a roadway that will cross this terrain and the lake. If you click above a point on the TIN, the point will not be aligned to the rectangle, so first press Shift to lock the point to the rectangle face.



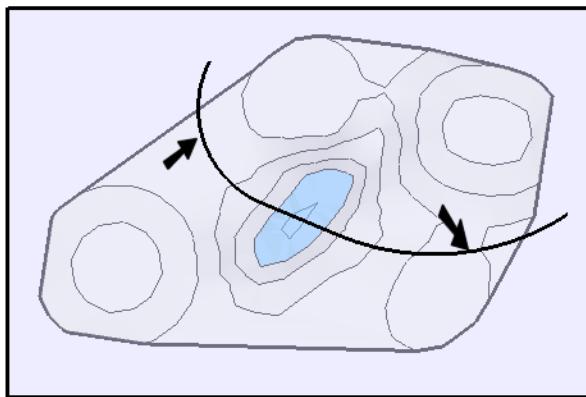
- With Shift pressed, click a point directly above a point on one side of the lake.



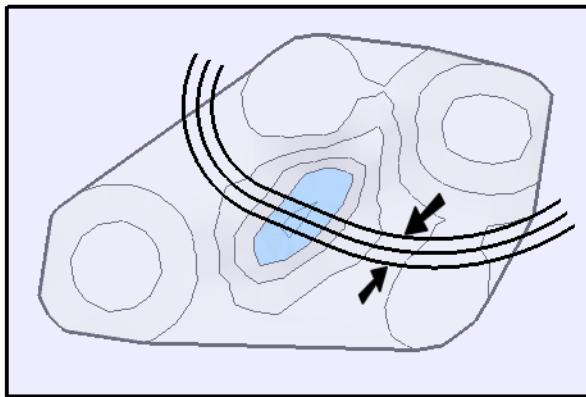
9. Do the same for a point on the other side of the lake.



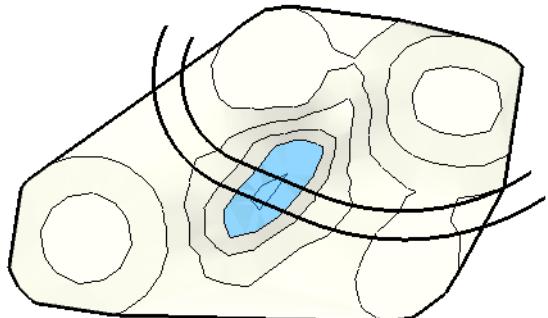
10. Now complete the road line with two arcs on either side of the line.



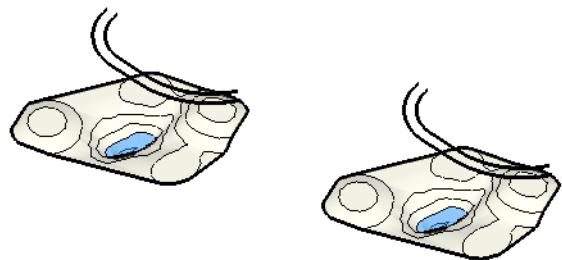
11. **Offset** this set of curves 3m to either side. These are the roadway boundaries.



12. Erase the rectangle and roadway center lines, so that only the boundary lines remain.



13. To compare **Drape** and **Stamp**, make a copy of the entire model so far. **Drape** will be used on one, **Stamp** on the other.

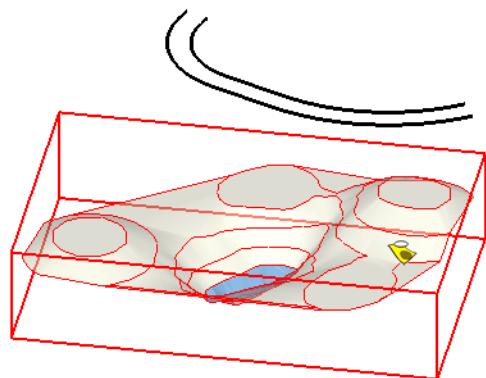


### Drape

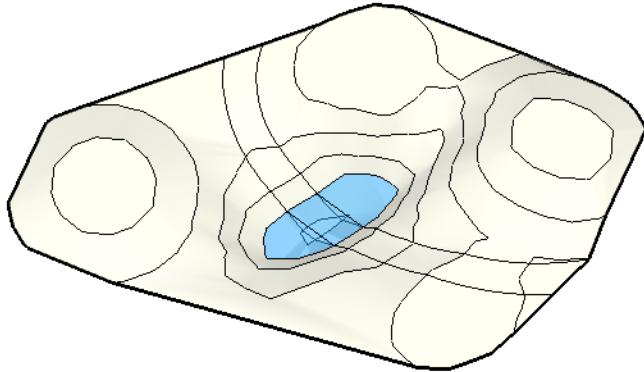
1. Select the roadway boundary curves - there should be six total.
2. Click **Drape** (Tools / Sandbox / Drape).



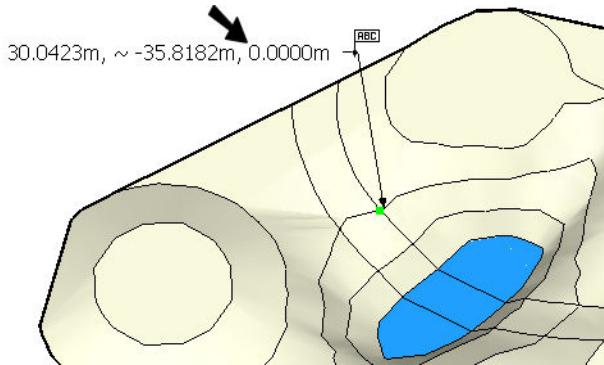
3. Click the TIN. Even though it is grouped, you can still select it as a whole (you could select it ungrouped as well).



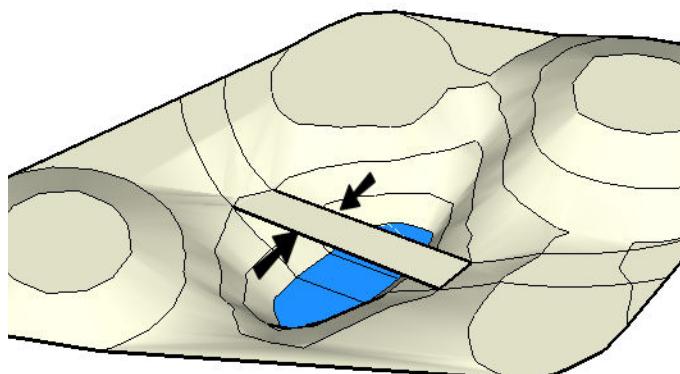
- The roadway lines are projected onto the surface. **Explode** it to resolve the roadway to the TIN. (If you are still in **X-Ray** mode, you can see the roadway lines through the lake.)



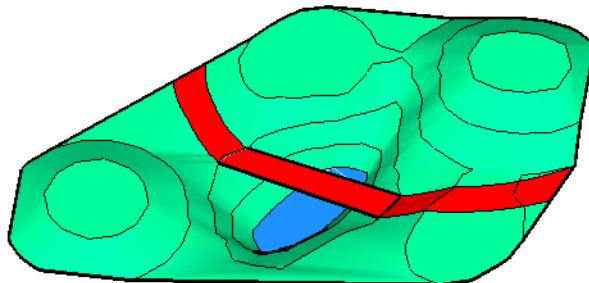
- Though it is not necessary for this simple model, the **Text** tool is handy for checking elevations. Activate **Text** and click any point. The default text is the point's coordinates, the last of which is the point's elevation.



- To create a bridge, draw lines between two sets of intersection points, all of which should have the same elevation.



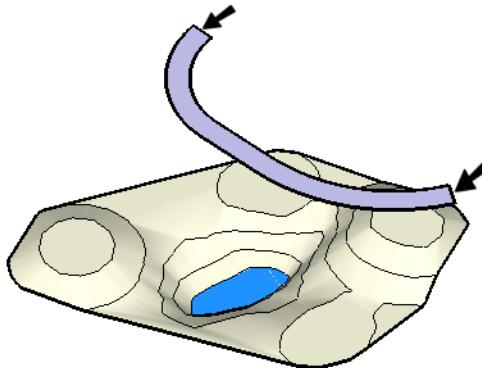
- Erase any extra lines, and apply colors if you want. Now you have a roadway over hilly terrain, with a bridge crossing the lake.



## Stamp

This exercise uses the copy of the model you created earlier.

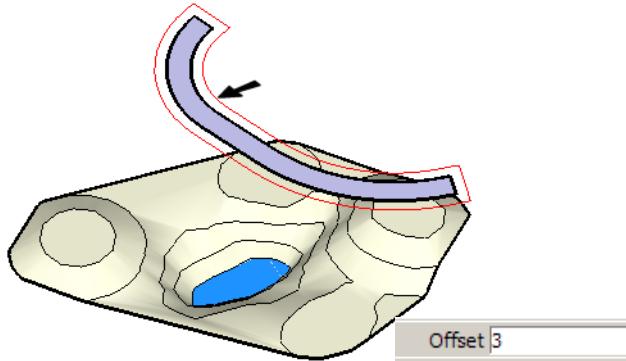
- This tool requires one or more 2D or 3D objects, but you cannot select lines or curves. So add two lines between the open ends of the roadway.



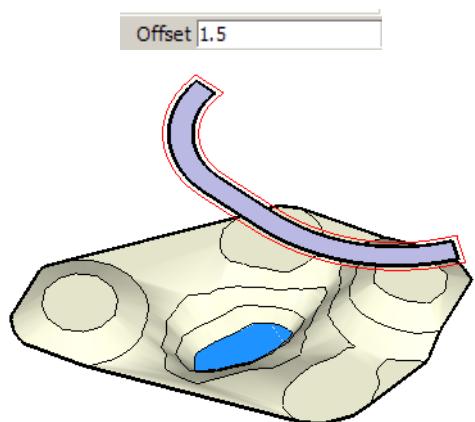
- Click **Stamp** (**Tools / Sandbox / Stamp**).



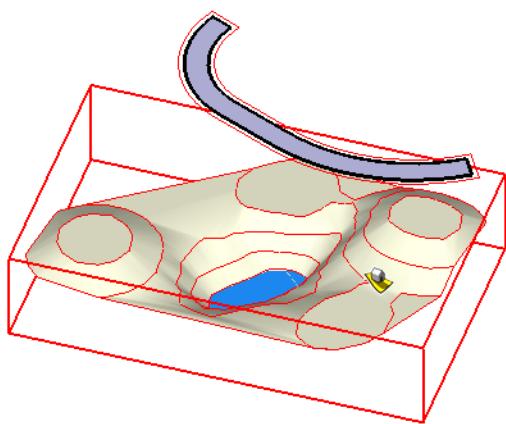
3. A red offset line appears around the roadway face, and the offset distance is listed in the VCB. This is like the area of influence of the **Smoove** circle - it shows the area around the stamped object that will be added or removed from the TIN.



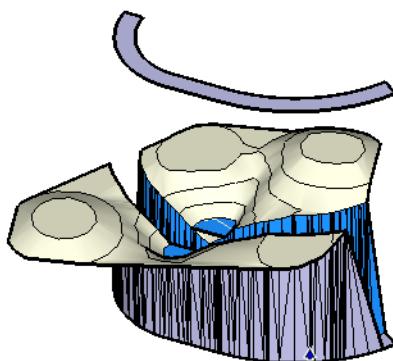
4. Enter 1.5 to set an offset like this:



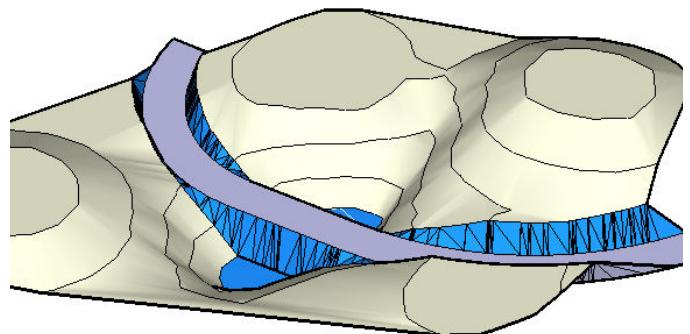
5. Then click the TIN.



6. The roadway face can now cut through the TIN - move the cursor up and down to see how terrain material can be added or removed.



7. Place the roadway like this, so that it is above the lake but below the tops of the hills.



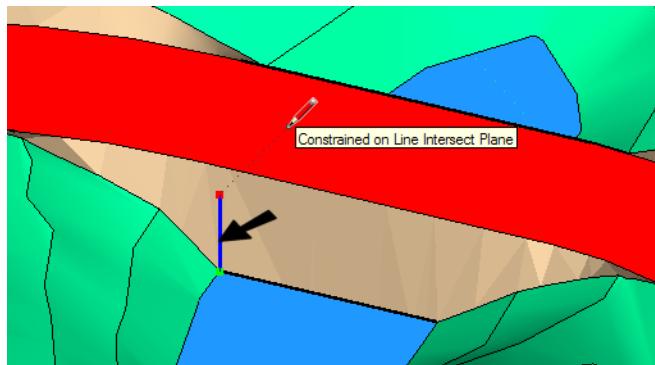

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**TIP:** If there is a surface of the TIN you do not want to be affected by **Stamp**, such as the face of the lake, you can **Group** it in advance.

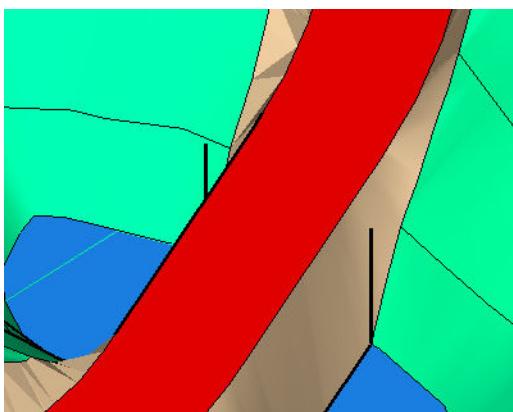
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All the new material on either side of the road above the lake should be removed. Here's a way to do it that involves creating vertical abutment faces. In this example, color was added to match the previous example.

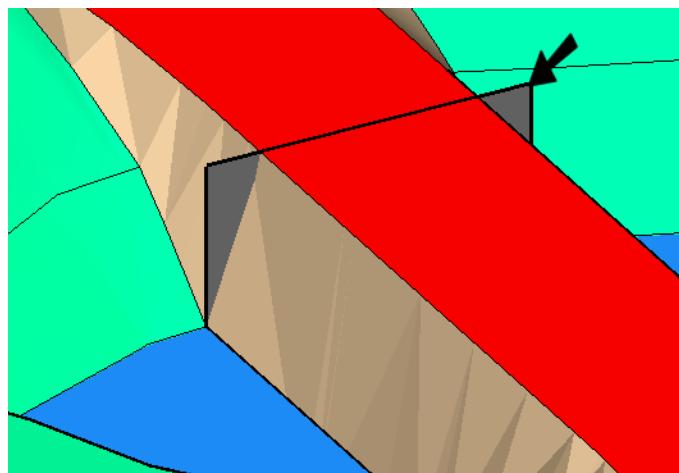
- Start at the intersection of the added terrain and the lake surface. Draw a line straight up, stopping at the level of the roadway.



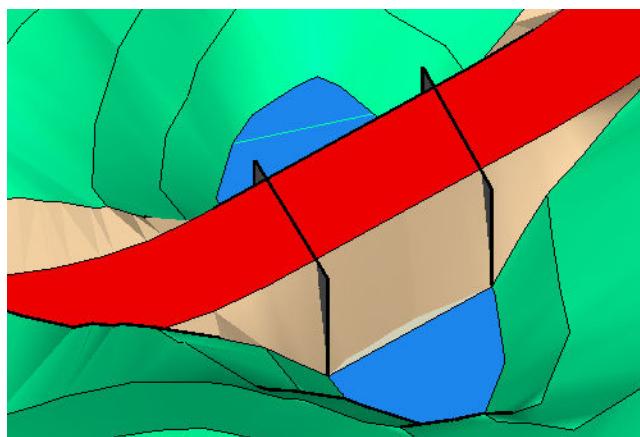
- Draw a similar line on the other side.



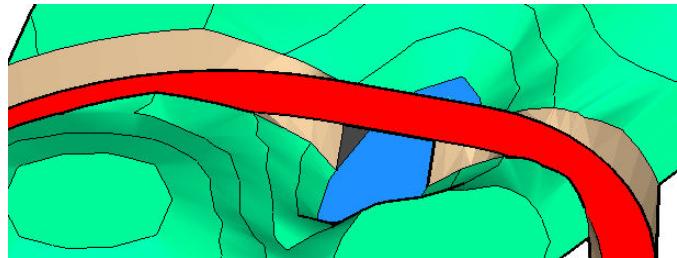
- Connect both sets of endpoints of these two vertical lines with horizontal lines. This creates the abutment face.



- Create a similar face for the other side of the lake.



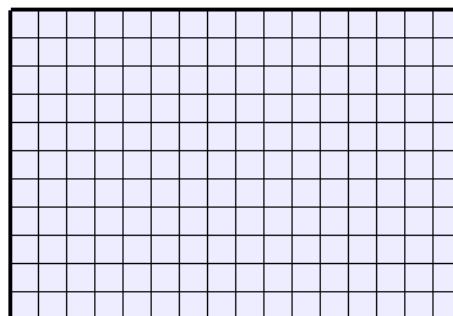
- Select both faces and run **Intersect with Model**. You can then erase all material between the abutments.



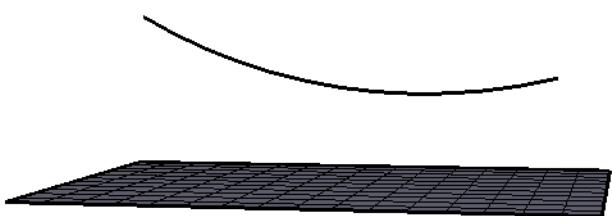
### **Stamp in 3D**

The **Stamp** tool can be used on one or more objects of any shape - 2D or 3D. This exercise shows a very simple example of this.

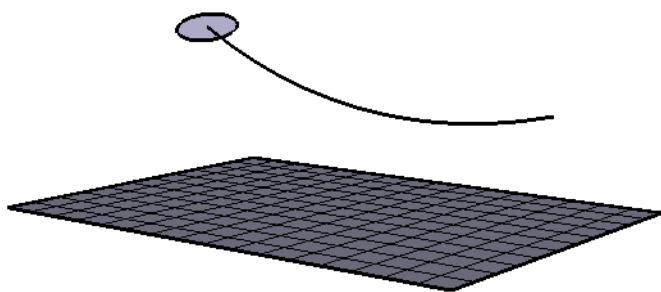
- Start with a basic grid using **From Scratch**.



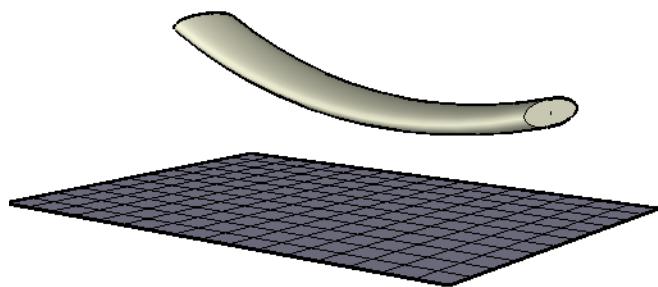
- Above the grid, make a vertical arc.



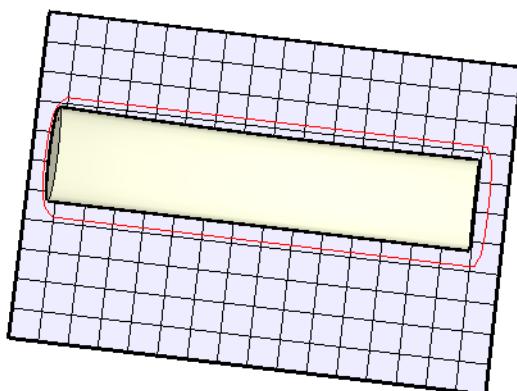
3. Place a small vertical circle at one of the arc, and use **Scale** to squash it into an oval.



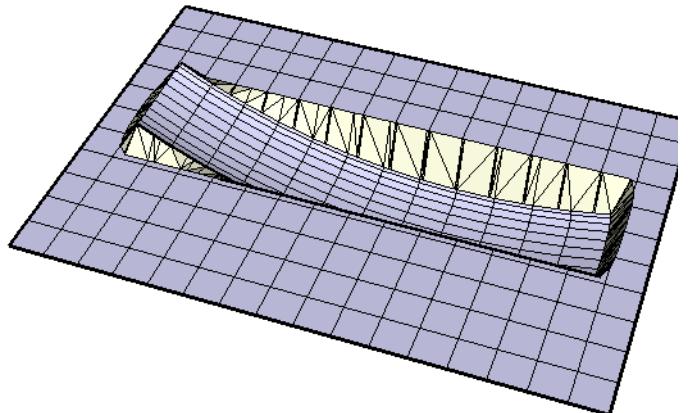
4. Use **Follow Me** to drive the oval along the arc.



5. Select the oval tube (for lack of a better term) and activate **Stamp**. Set the offset something like this:



6. Push it down into the TIN. It creates something like a concave ramp within the grid.



## Adding Detail to a Sandbox

The **Add Detail** and **Flip Edge** tools enable you to make detailed changes to a TIN surface.

If you want to download the TIN surface used in this exercise, go to

[www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm) and get the file “SandboxDetailing.skp.” You can then skip to Step 5.

1. Start in **Top** view and use **Freehand** to sketch some terrain curves.



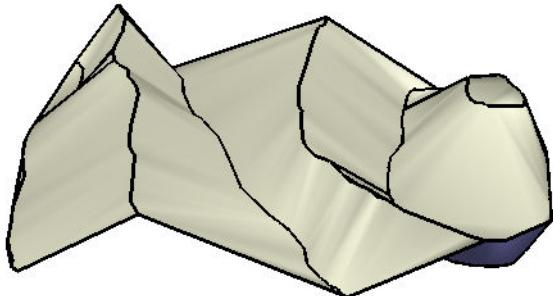
2. To make a bumpy surface, some of the curves will be moved vertically. Select alternating curves . . .



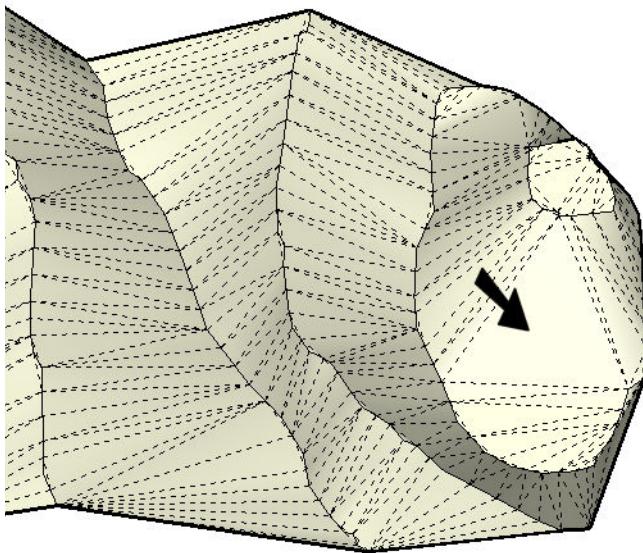
. . . and move them up or down.



3. Select these curves and use **From Contours** to create a TIN.



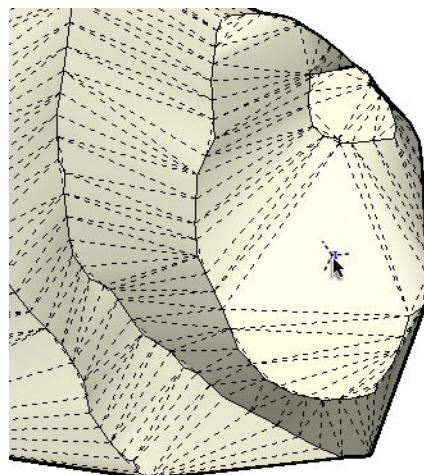
4. **Explode** the TIN and display hidden geometry. In this example, there is one large triangular face (if yours does not have a large face, any face will do).



5. Click **Add Detail** (**Tools / Sandbox / Add Detail**). This tool enables you to subdivide a triangular face into smaller faces.

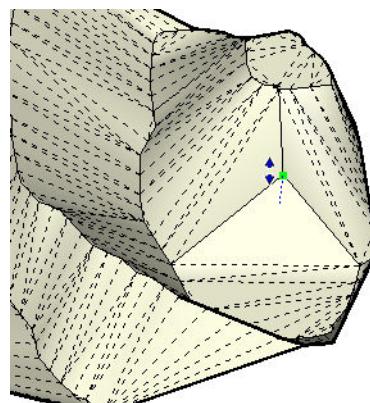


6. Place the cursor inside the large face . . .

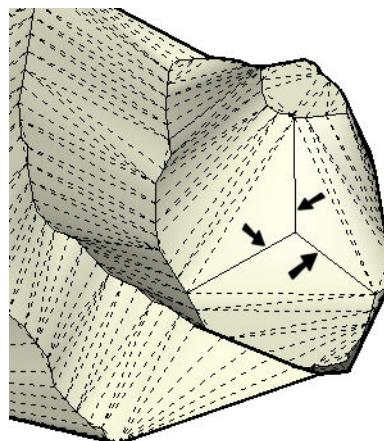


. . . and click. Three “hard” edges (not softened) are created, and you can move their center up and down. The offset distance is listed in the VCB.

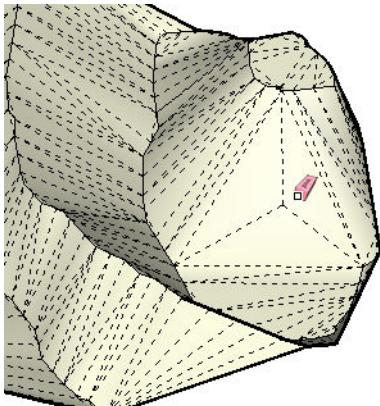
Offset ~ 1' 8 1/2"



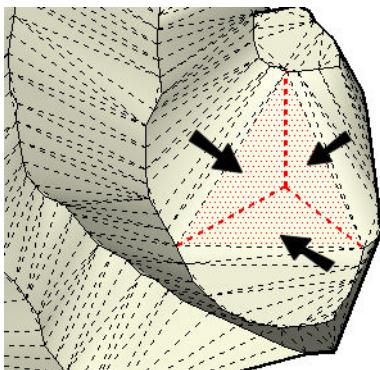
7. Press Esc to keep the elevation as is. Here are the three new edges.



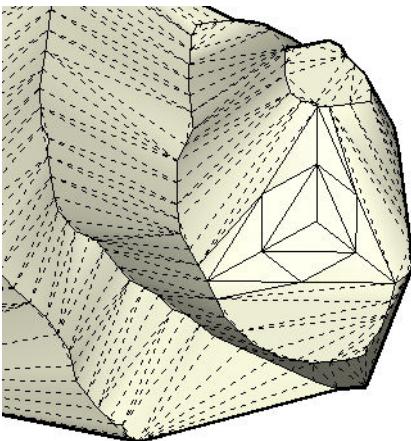
8. Soften them to match the rest of the TIN. This is done most easily using the **Erase** tool with *Ctrl/Option* pressed.



9. You can also select one or more faces in advance for adding detail. Select the three new faces.



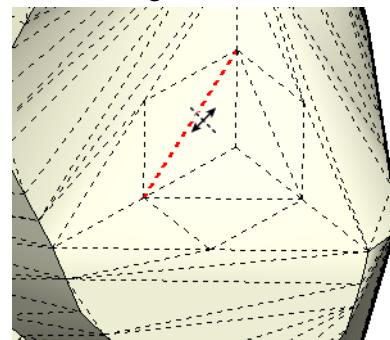
10. Then click **Add Detail**. The three faces were subdivided into several smaller faces.



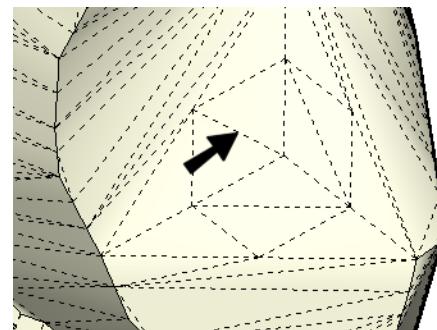
11. **Flip Edge** is used to change the shape of a single triangular facet. Click **Flip Edge** (**Tools / Sandbox / Flip Edge**).



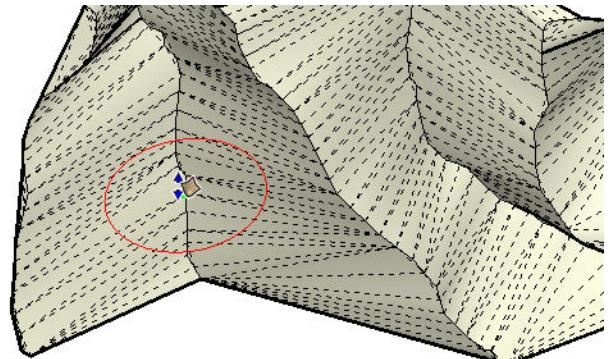
12. Click a hidden edge of a facet . . .



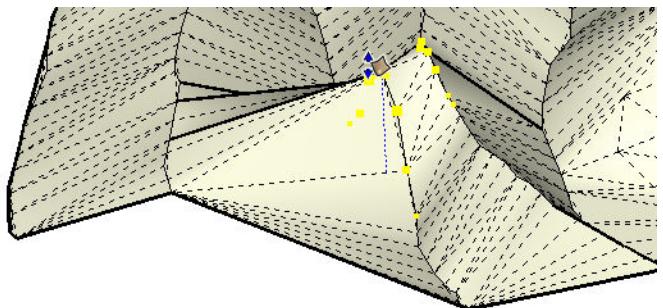
13. . . and it flips.



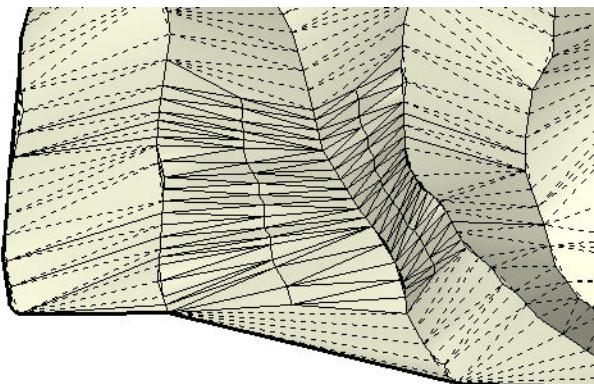
14. Another use for **Add Detail** is smoothing out sharp ridges or bumps. Activate **Smoove** and use a radius like this one:



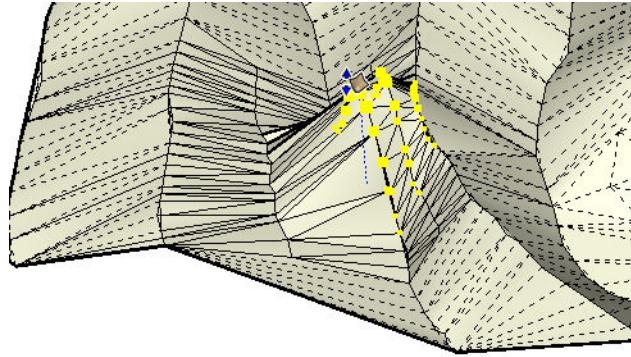
15. Click on a valley edge and move it up. This creates a wide hill.



16. If you want a narrower hill, the triangular faces in this area must be subdivided. Select a section of the TIN in this area and use **Add Detail**.



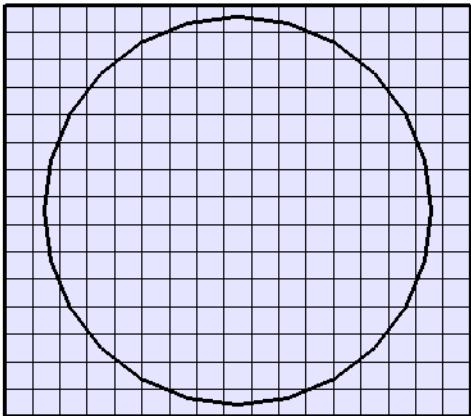
17. Now you can use **Smoove** to create a smaller hill.



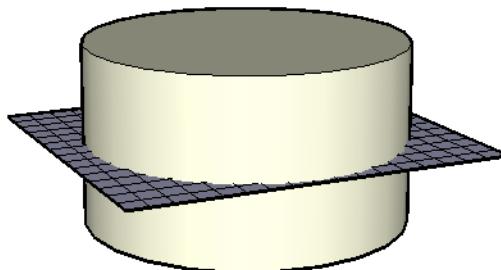
## Organic Shapes

The most common use for the sandbox tools probably involves topography and terrains, but they can also be used to create organic shapes. As a simple example, try the following:

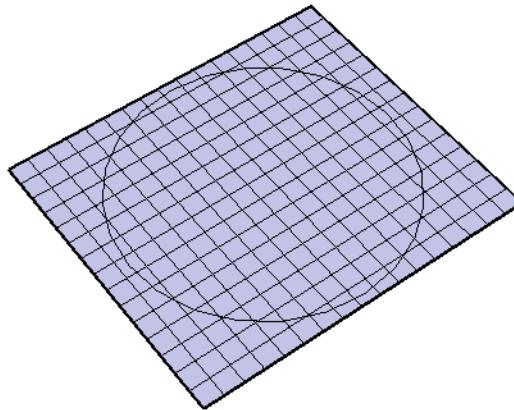
1. Start with a square **From Scratch** grid and place a circle on it.



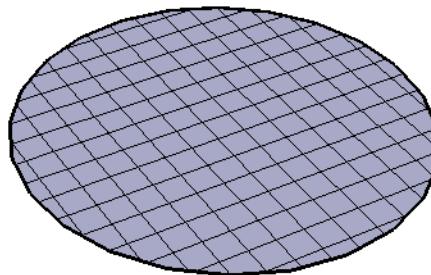
2. **Push/Pull** the circle out on either side.



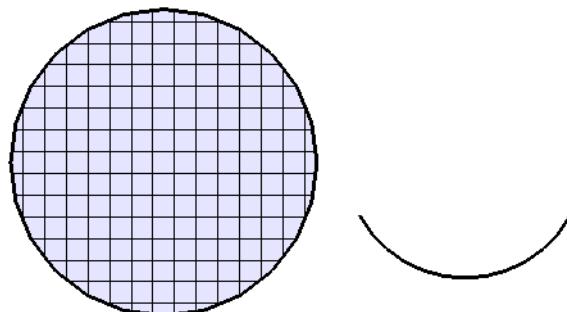
3. **Explode** the TIN, and while it is still selected, run **Intersect with Model**. Hide or erase the cylinder, and you are left with intersection curves on the TIN.



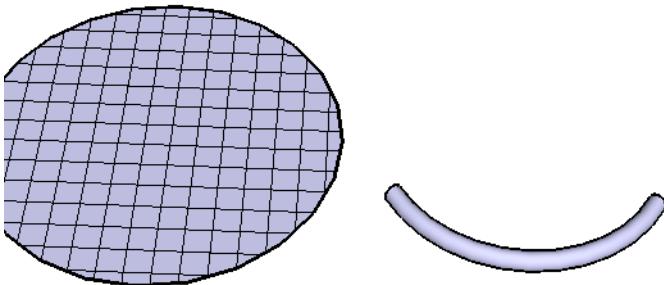
4. Trim the TIN around the circle.



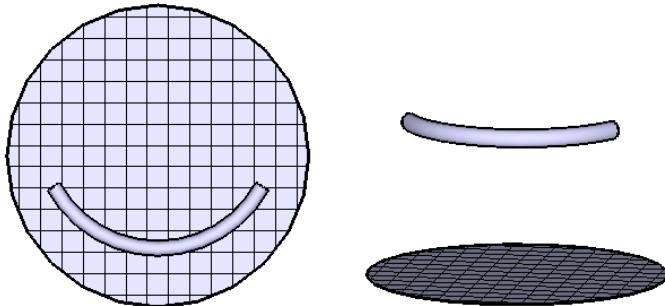
5. In **Top** view, draw an arc like this.



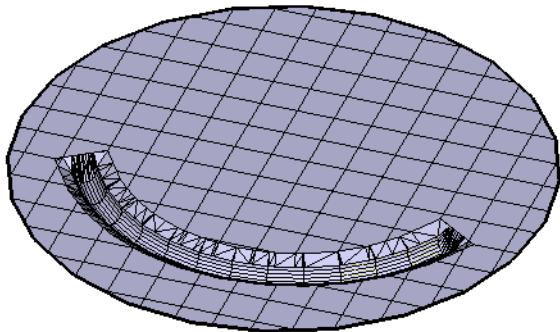
6. Draw a circle at one end of the arc and use **Follow Me** to create a tube.



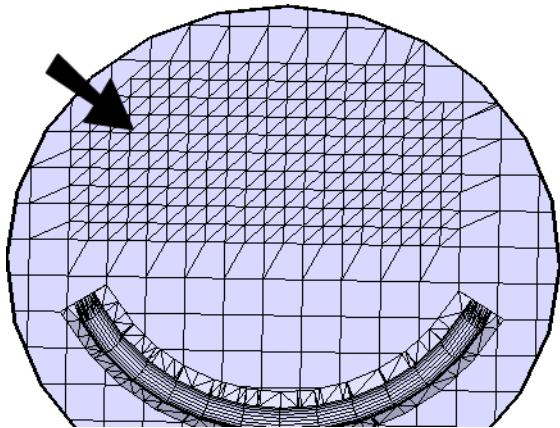
7. Move the tube up, and then directly over the TIN.



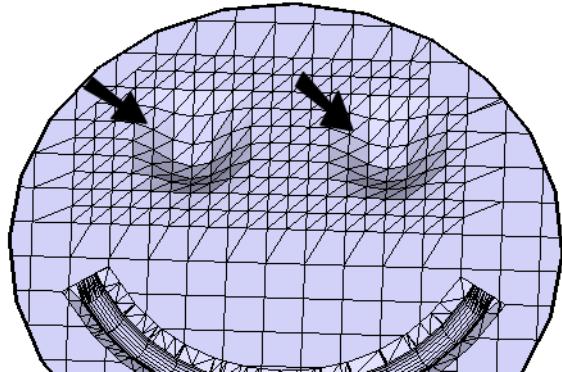
8. Select the tube and use **Stamp** to push in into the TIN. (You may have to reverse a lot of small faces to get the overall TIN color to be uniform.)



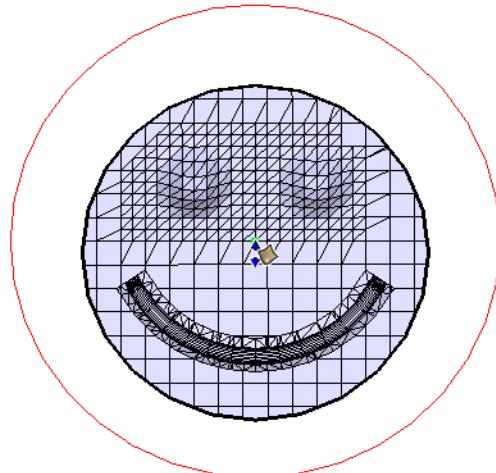
9. To create small impressions, use **Add Detail** in this area to subdivide the faces.



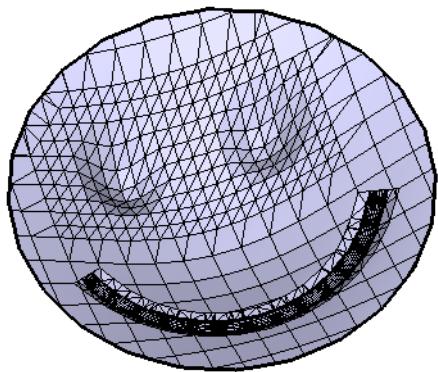
10. Then use **Smooove** to push down two circles.



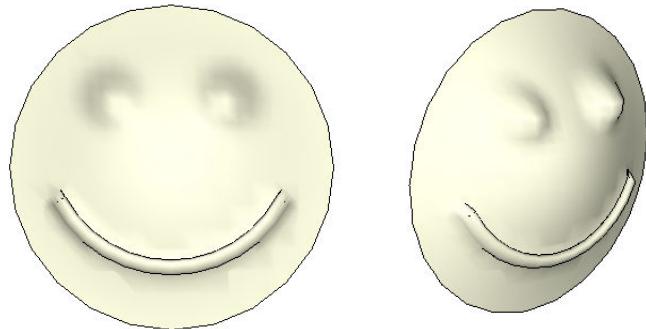
11. Finally, use **Smooove** with a large radius . . .



12. To give the entire TIN some curvature.



Here is the TIN from the other side - a happy ending.



# 11 Using Exact Dimensions

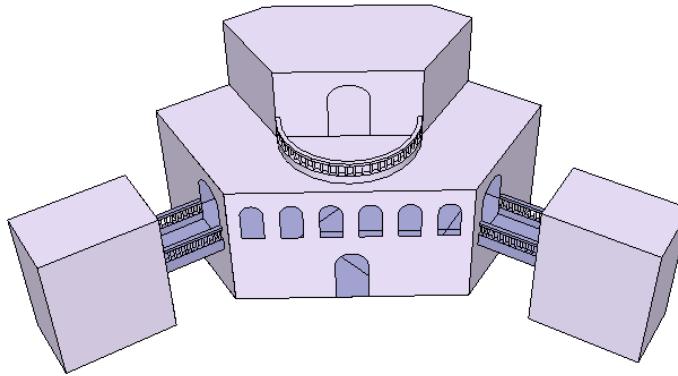
## Creating Exact Geometry

SketchUp is not CAD; its intent is for simple design and easy modification - in a word, conceptualization. So, designing using exact dimensions isn't exactly what makes SketchUp so unique, it is certainly doable.

When using SketchUp as intended, you probably won't use exact values for an entire design. But it is certainly conceivable that part of your work will require working with known numbers. Perhaps you'll be working with a specific area on a site plan, or you'll need to incorporate components of known dimensions.

**NOTE:** You can add dimensions to your model to display your measurements. See "Dimensions" on page 82.

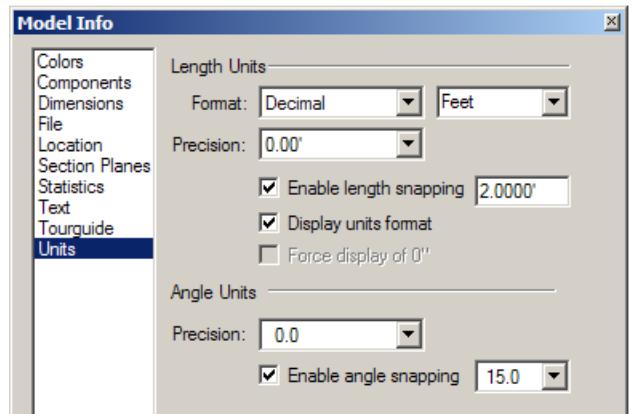
This chapter focuses on the design of a building (three buildings, actually) in which all of the drawing tools are used. And for each tool, you will see how to enter exact values.



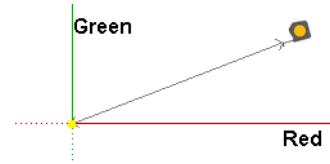
1. The first step is always to set the units you will be working in. Open the **Model Info** window to the **Units** page.

Let's work in **Decimal Feet**. This sets the default method of input, and the way units are listed in the Value Control Box (VCB). This does not limit the

way you can input dimensions; you can always enter any type of number in any unit. Click **Enable length snapping**, and set the snap length to 2'.



2. Let's assume the first point of the building is at a known distance from the origin. One way to find this point is to draw a construction line to it. Activate **Measure**, and click the origin for the first point.

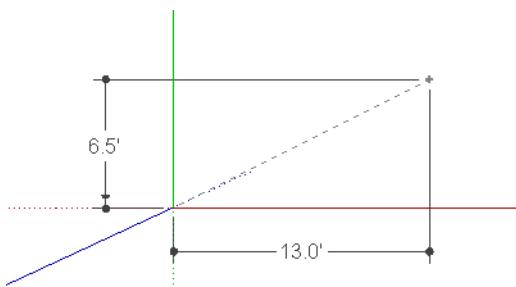


3. Exact coordinates are entered in square brackets. All three values (red, green, blue) must be entered. Type [13,6,5,0] - using square brackets - which appears in the VCB, and press Enter. (You do need to specify 0 for the blue direction.)

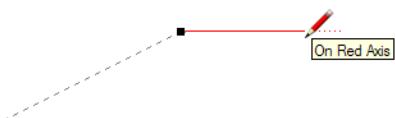
Length [13,6,5,0]

**NOTE:** You do not have to use the foot symbol because you set **Feet** as the default unit. If you add a foot symbol, the value will still be interpreted correctly. If you wanted inches or different units, however, you would have to add the appropriate symbol, as we will see later.

The end of the construction line is the point where the building footprint will start.



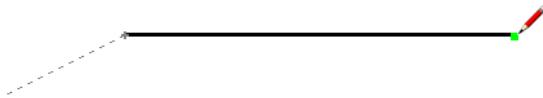
4. If you want to hide the axes (which can cause the screen to get cluttered), select **View / Axes**.
5. Activate **Line**. The first line will be in the red direction. Start at the end of the construction line, and move the cursor so that the **On Red Axis** inference appears.



6. You can use snapping to make a 40' line (the values in the VCB update every 2 feet), or type 40 and press Enter.

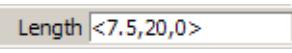


7. The 40' line is created.

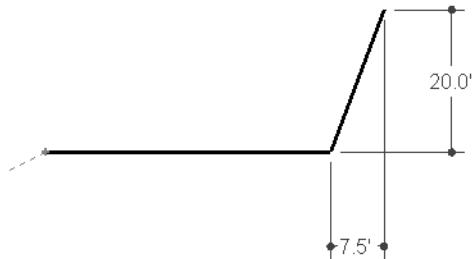


The next line will be diagonal. Angle brackets are used to specify relative distances - distances from the line's start point.

8. Type  $<7.5, 20, 0>$  and press Enter.

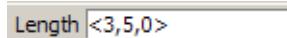


The diagonal line is created.



As long as another line has not yet been started (so don't move the mouse), you can still change the line you just drew. Assume we know the desired slope and total length.

9. Start with the slope. For a 3: 5 slope, you can simply type  $<3,5,0>$  and press Enter.



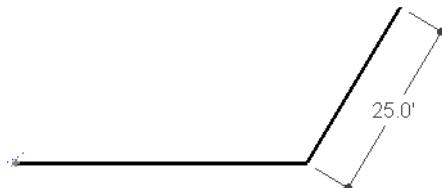
This line is too short, but it establishes the correct direction.



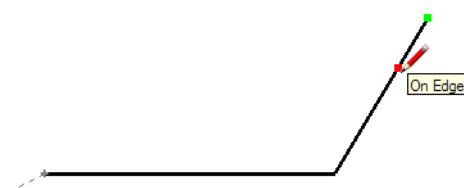
10. Now type the desired length: 25.



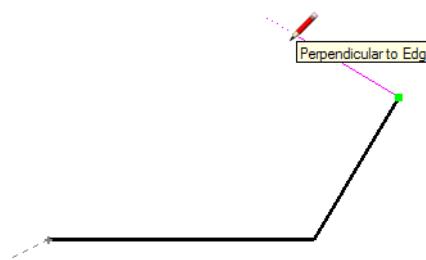
The line is extended to the correct length, keeping the 3:5 slope.



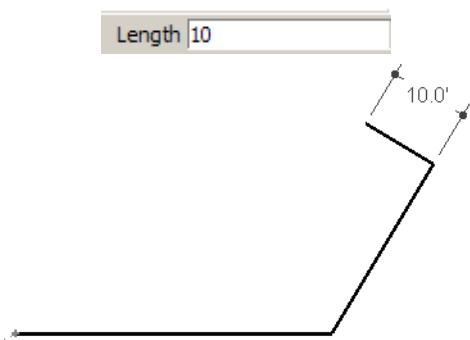
11. The next line is to be perpendicular to this last line. Hover over an edge point of this line . . .



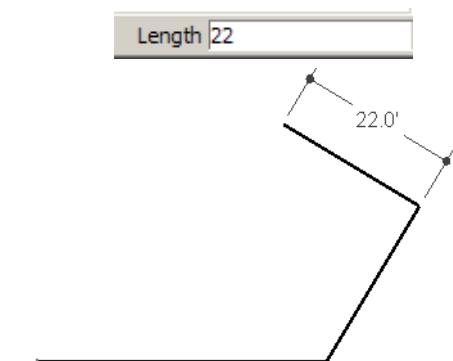
12. . . and move the cursor so that the Perpendicular inference appears.



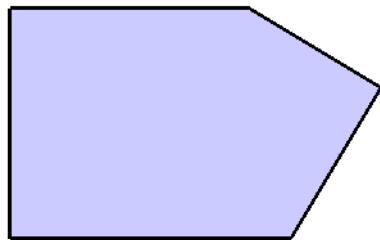
13. While the line is oriented correctly, type 10.



14. Too short; type 22.

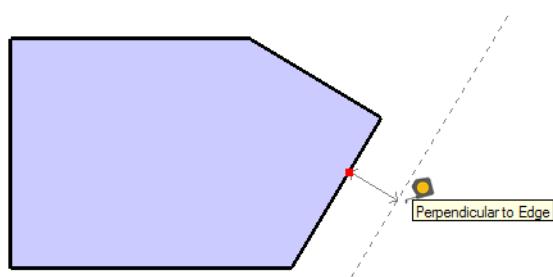


15. Add two more lines in the red and green directions to complete the footprint.

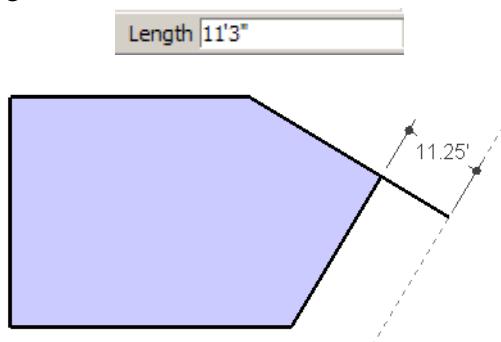


16. The construction line is no longer needed, so you can erase it.

17. The next form, a rectangle, will be located a set distance from the first diagonal line you drew. Activate **Measure** to create a construction line. Click the diagonal line and move the cursor outward to indicate the direction.

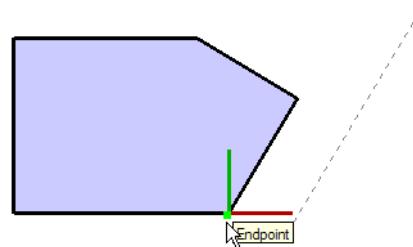


18. Even though you are working in Decimal Feet, you can still enter other types of units. Type 11'3" (or 11.25) to set the construction line 11'-3" from the diagonal line.

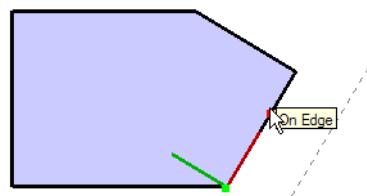


19. If you draw a rectangle now, it will be aligned in the red and green directions, but we want a diagonal rectangle. For this, we need to change the axes. Activate **Axes** (**Tools / Axes**).

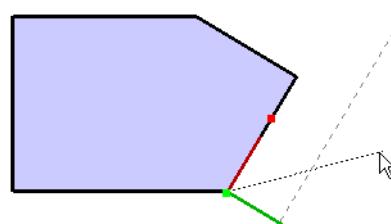
20. Place the origin at either endpoint of the diagonal line.



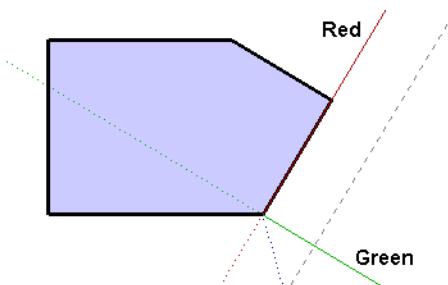
21. Click the other endpoint to define the red axis.



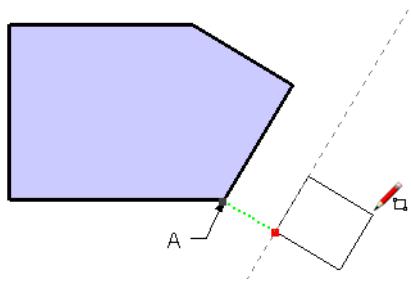
22. Click on either side of the origin to define the positive green direction (it doesn't really matter which side is positive).



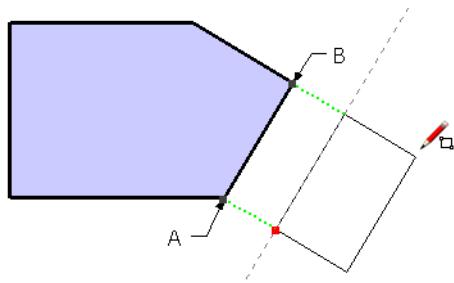
The red and green axes are now aligned in the correct directions.



23. Now activate **Rectangle**, and for the first corner click the point on the construction line in the green direction from Point A.



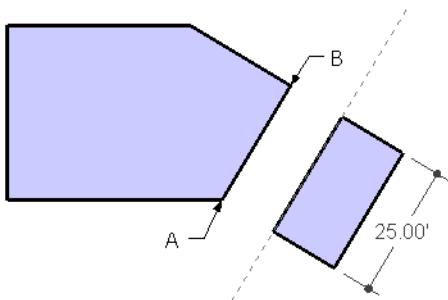
24. Set the other corner in the green direction from Point B. Do not click yet.



25. Look in the VCB. Two lengths are displayed - red and green lengths. The first (red) length should be 25' - the length of line A-B. The green length updates as you move the mouse.

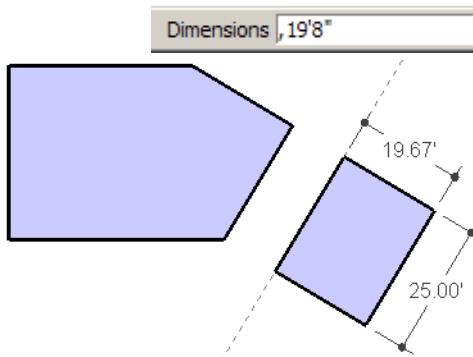
Dimensions [25.00', ~ 17.32']

26. Click to create the rectangle; its width can be set after this.

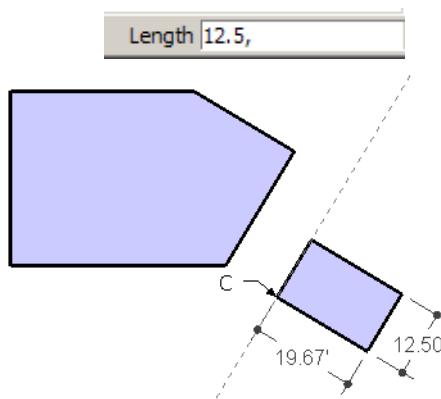


Just as you can change line lengths after they are created, you can do the same for rectangles. You can change both lengths or just one length. Assuming the 25' length is to be fixed, we can still adjust the other length.

27. To leave one length as is, leave it blank in the “red, green” format. Type ,19'8” (note the comma at the beginning) to change the width only. Press Enter. The width changes, but the length remains 25'.

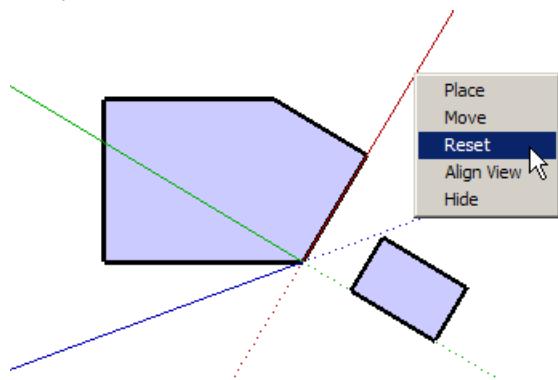


28. To change the other dimension, type 12.5, (comma at the end). Note that the lengths change relative to the first point you selected for the rectangle - (Point C).

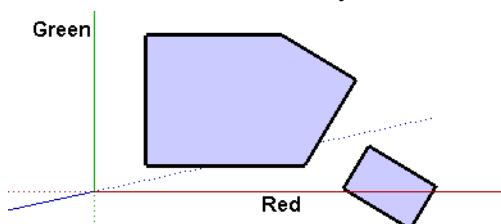


The rectangle will later need to be copied and mirrored (scaled) relative to the original axes. Also, the first form will be changed to become symmetric. Therefore, we need to switch back to the default axes.

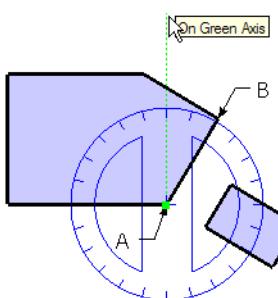
29. If the axes are hidden, display them. Right-click on any axis and select **Reset**.



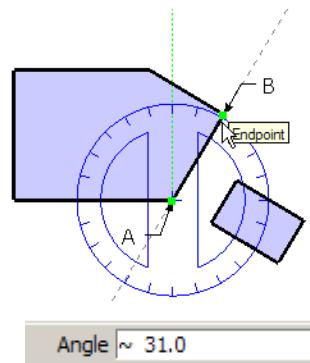
The axes are back to where they were before.



30. You can now erase the construction line, and once again hide the axes.  
 31. Let's modify the first form to be symmetric. To mirror line A-B, we need to know its angle. Activate **Protractor**, anchor it at Point A, and set the orientation in the green direction.

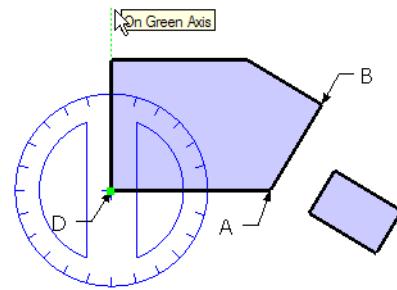


32. Hover over any point on line A-B (do not click or you will create a new construction line). The angle (31 degrees) appears in the VCB.

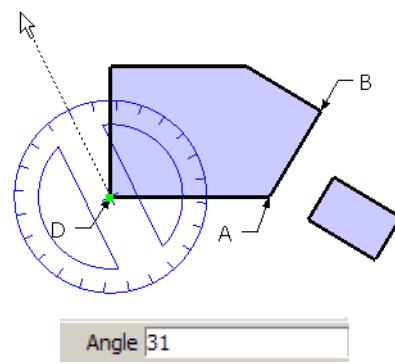


*TIP: You could also have calculated this angle yourself, based on the 3:5 slope of this line, but why take out your calculator?*

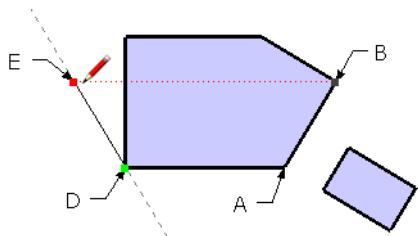
33. Press Esc to release the protractor. Anchor it to Point D, and orient it again in the green direction.



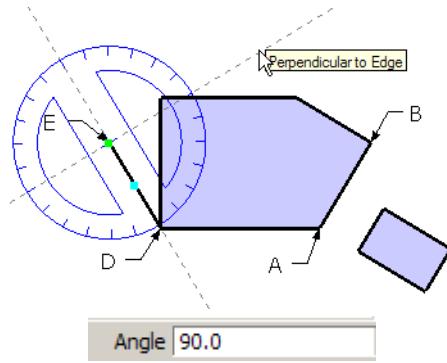
34. Move the cursor to indicate the direction, and enter 31 to create the angled construction line.



35. Draw a line starting at Point D, ending at the point along the construction line in the red direction from Point B. (Remember, you have to hover over Point B to pick up its inference).

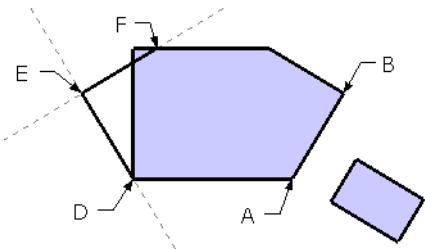


36. The next line is perpendicular to line D-E, so you can draw another angled construction line. Anchor the protractor to Point E, orient it along D-E, and type (or snap to) 90 degrees.



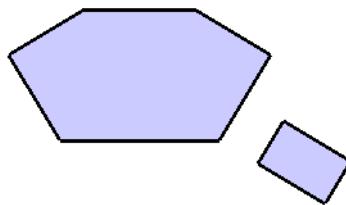
**TIP:** Another way would be to anchor the protractor at Point E, orient it in the red direction, and enter 31 degrees. Or you could just use the magenta Perpendicular inference.

37. You can now create line E-F.



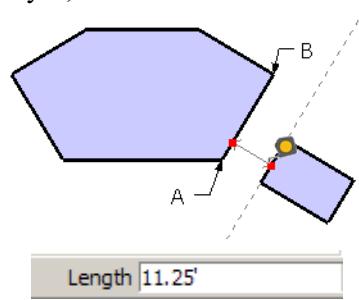
**TIP:** You could also have created the two angled construction lines first, then drawn the two lines.

38. Trim the lines, erase the constructions (You can use **Edit / Construction Geometry / Erase**) and redraw as necessary to complete the symmetric form.

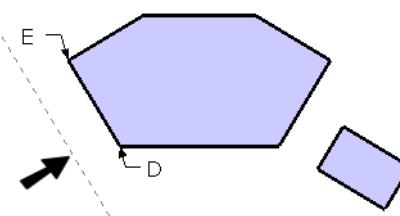


Now we'll create a mirror image of the rectangle, on the other side of the larger form.

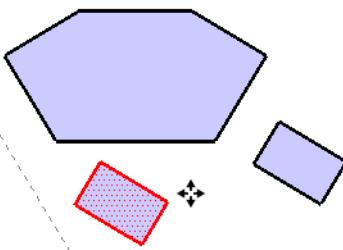
39. Assuming you don't remember how far the rectangle is from line A-B, activate **Measure**. Click a point on AB, then move the cursor to the rectangle (do not click). Oh yes, it's 11'-3".



40. Use **Measure** to create a construction line the same offset distance, from line D-E. You can type 11.25 or 11'3" (with units symbols) in the VCB.

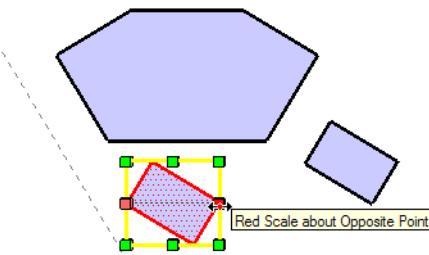


41. Use **Move + Ctrl/Option** to copy the rectangle. It doesn't matter where you place the copy; it will be flipped and then moved into the correct place.

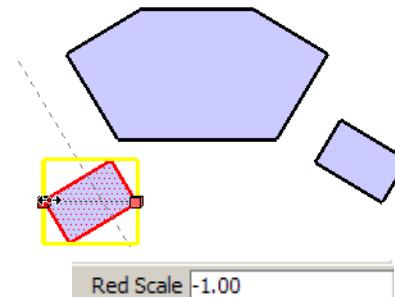


**NOTE:** For a basic exercise on copying, see "Copy" on page 49.

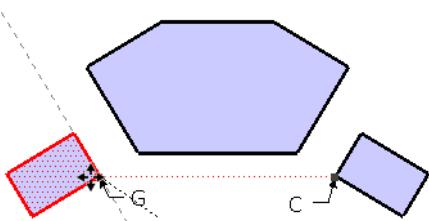
42. With the copied rectangle still selected, activate **Scale**. Click one of the side drag handles.



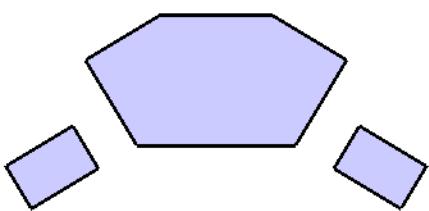
43. Drag the handle toward its opposite handle to turn it inside-out. Stop when the scale factor is -1.0.



44. The rectangle is still selected; activate **Move**. Drag it by Point G, to the point along the construction line in the red direction from Point C.



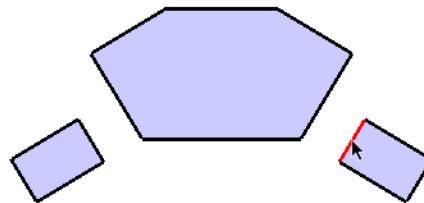
45. Erase the construction line, and you have three forms.



## Entity Info

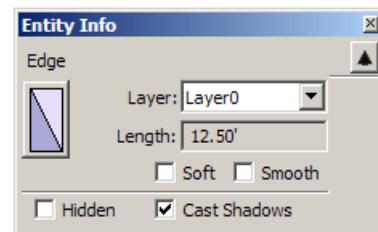
With Entity Info, you can obtain lengths and areas of one or more objects.

- In **Select** mode, select the edge shown.



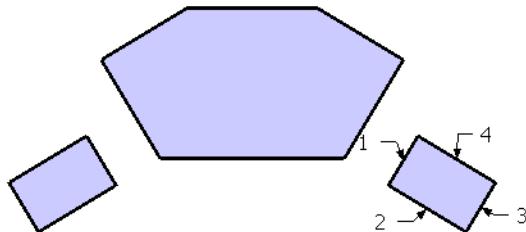
- If the **Entity Info** window isn't open, display it (**Windows / Entity Info**). You can also right-click on the edge and select **Entity Info**.

The window tells you that an edge is selected, and its length is 12.5'.

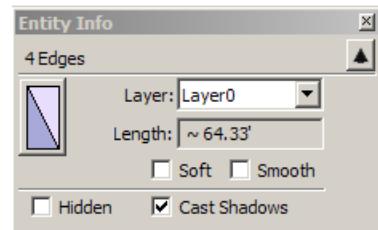


The length is listed in the units and precision you set at the beginning of the exercise. If you change the units (in **Model Info**), you need to reselect the edge to see the change.

- Now select the other three edges of the rectangle.

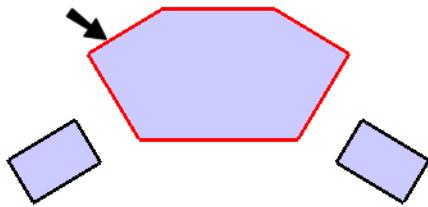


In Windows, **Entity Info** now informs you that four edges are selected, and their total length is listed ( $12.5 + 12.5 + 19.67 + 19.67 = 64.33$ ).

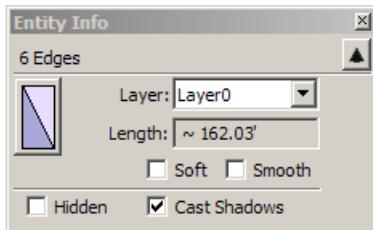


This works for curved edges as well.

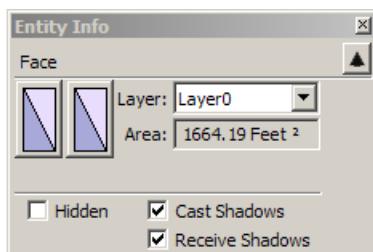
- To get the perimeter of the main building, you could select all six edges separately. But for an easier way, double-click the face to select it and all its bounding edges. Then Shift-select the face to deselect it.



This is the perimeter of the 6-edge building.

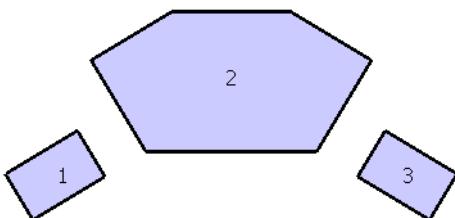


- Now select only the face (no edges). This gives you the area of the selected face.

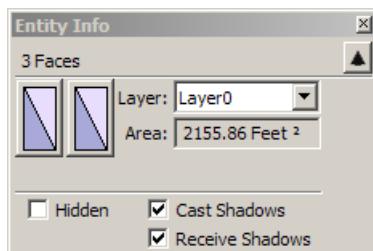


If you select a combination of edges and faces, **Entity Info** will tell you how many total entities are selected. But length and area are only listed for entities of the same type.

- Select all three faces created so far.



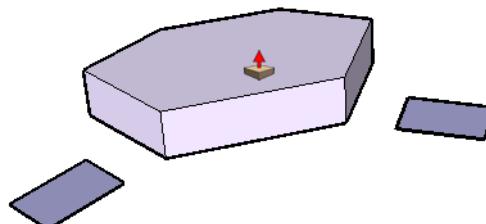
In Windows, you get the total area - the footprint of the three buildings.



## Exact Moving and Copying

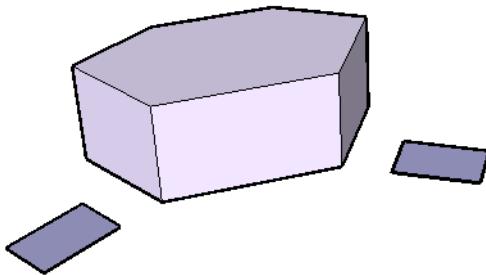
In the exercises under "Move" on page 46, "Copy" on page 49, "Rotate" on page 57, and "Rotate - Copy" on page 61, you learn the basics of working with the **Move** and **Rotate** tools. This section extends that knowledge to using exact move / copy distances and rotation angles.

- Activate **Push/Pull** and pull one of the forms upward.

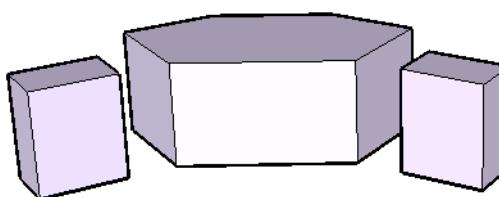


- The VCB tells you the height of the form. Enter 24.

Distance 24

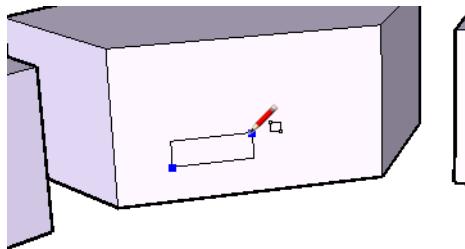


- Double-click the other two forms to pull them up to the same height.



We will now create cutouts that will be used as windows and doors of the center building.

4. Start creating a rectangle on the front face. The way you draw the initial rectangle is important when applying dimensions; **the first dimension number is applied to the longer side!** So start with a rectangle whose horizontal sides are longer than the vertical sides.



Before, or immediately after, clicking the second corner, you can specify the dimensions. You can also use units other than the default units. This can be useful, for example, if you use certain components that are in metric dimensions, but you design buildings in English units.

5. Type 1700mm,2400mm. Since these are different units than the default (decimal feet), you need to include the “mm” symbols.

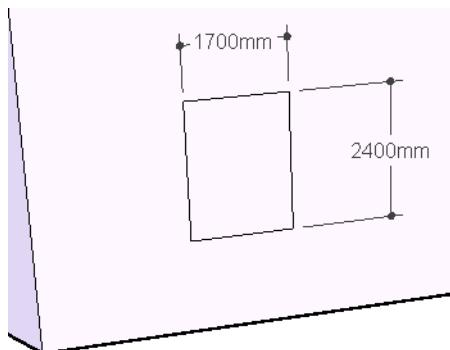
Dimensions 1700mm,2400mm

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*NOTE: If you changed the units to decimal mm, you would not have to type mm - it would be the default input unit.*

---

6. Press Enter to create the rectangle. Because the horizontal legs were initially longer, the first dimension (1700) is applied to this side. So the rectangle switches from horizontal to vertical.

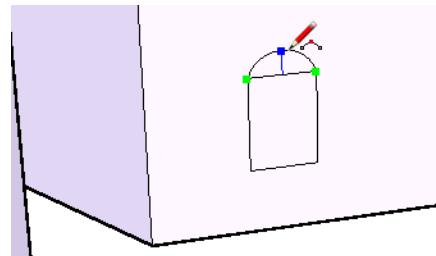



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*NOTE: You would have gotten the same result if you started out with a vertical rectangle, and entered 2400mm, 1700mm.*

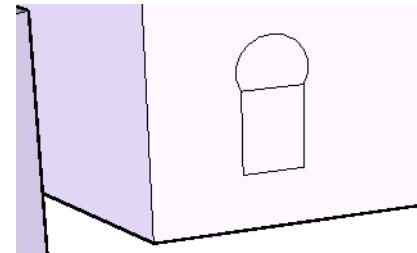
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7. To create the archway above the door, activate **Arc**. Click the two endpoints of the top edge of the rectangle, and move the cursor upward to define the direction of the arc.



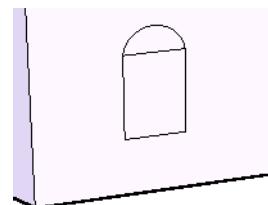
8. Enter 1500mm for the arc bulge.

Bulge 1500mm

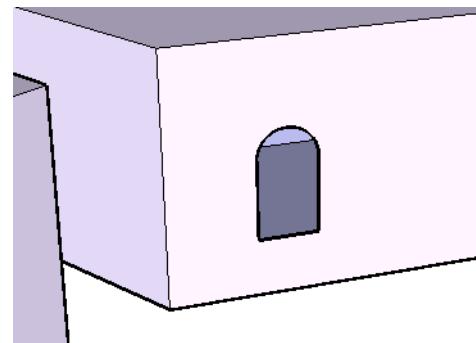


9. Too large, but it's not too late to change it. Enter 750mm. Better!

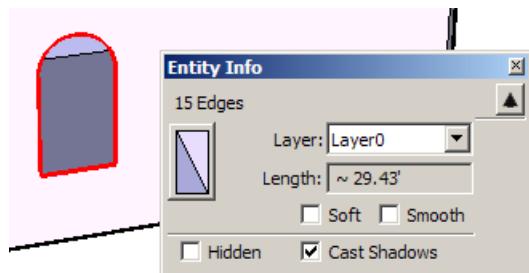
Bulge 750mm



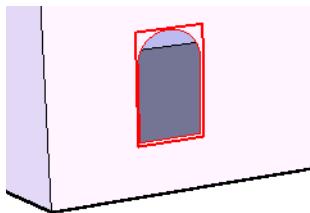
10. Erase the dividing line, and erase the face to create a cutout. This cutout shape will be used for the windows and another door.



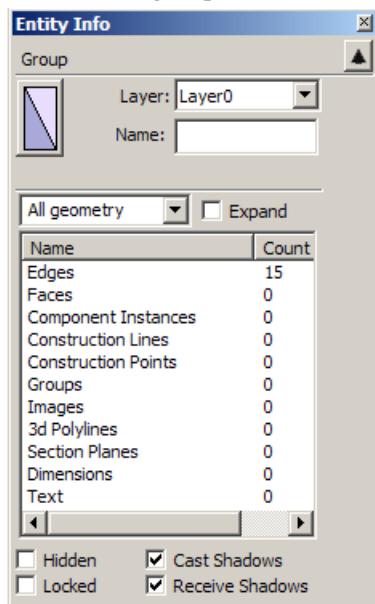
11. To make moving and copying easier, the door should be made into a group. Select all edges that make up the door. In **Entity Info**, it lists 15 selected edges (yours may differ depending on the number of segments in your arc). Even though the arc can be selected as one edge, this arc actually consists of 12 segments.



12. Press G (or select **Edit / Make Group**). A bounding box appears around the door.

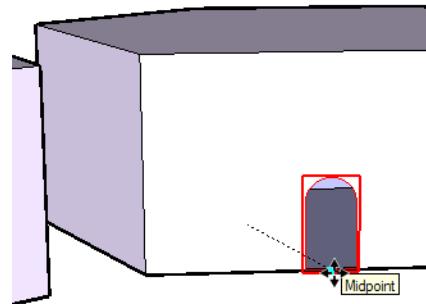


In Windows, **Entity Info** now lists a group as selected, and tells you how many edges, faces, etc. are contained in the group.

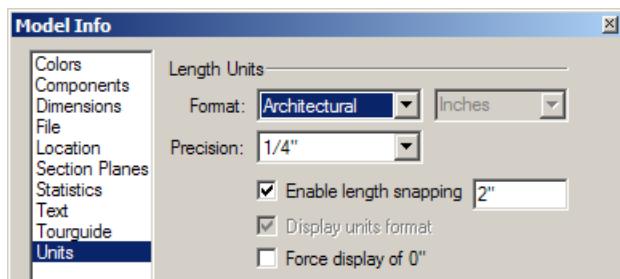


Mac: **Entity Info** will tell you that a group has been selected, but provides no details.

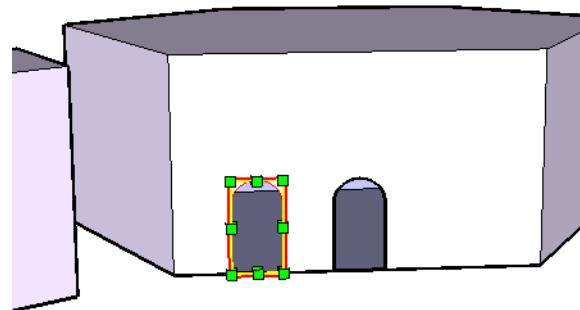
13. Move the door by the midpoint of its lower edge, placing it at the midpoint of the bottom of the face.



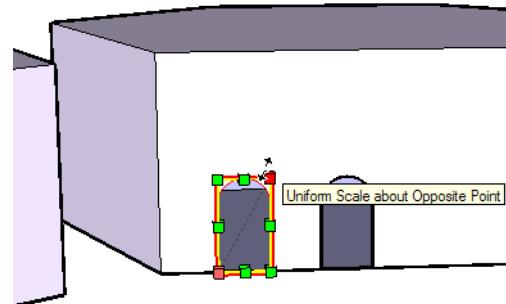
14. At this point it's useful to go back to **Architectural** units, so do this in the **Units** page of **Model Info**.



15. Make a copy of the door and activate **Scale**. This will be used as a window.



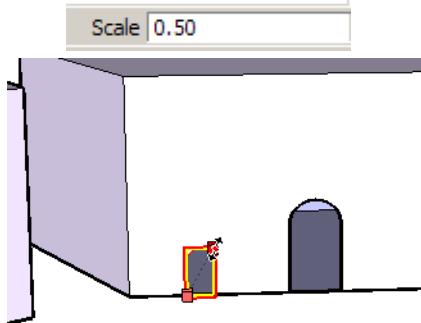
16. Click one of the corner handles. This causes uniform scaling - the aspect ratio is maintained.



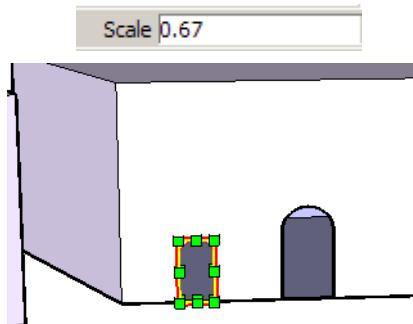

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NOTE: For a basic exercise on the **Scale** tool, demonstrating uniform and non-uniform scaling, see "Scale" on page 65.

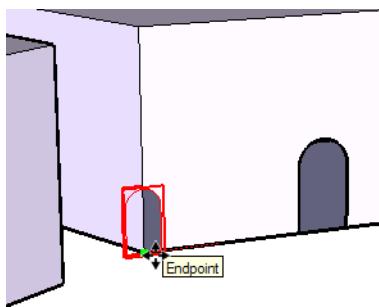
17. Shrink the window so that the scale factor snaps to 0.5. You can also type this value manually.



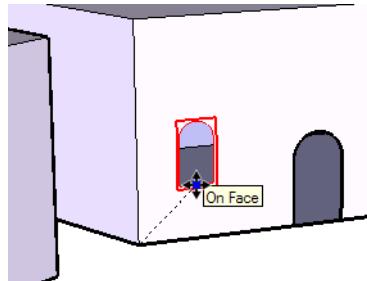
18. A bit small for the window we want, so type 0.67. This is a more reasonable size.



19. Move the window so that its lower midpoint sits at the endpoint of the lower edge of the face. This is a good base from which to move the window in the next step.

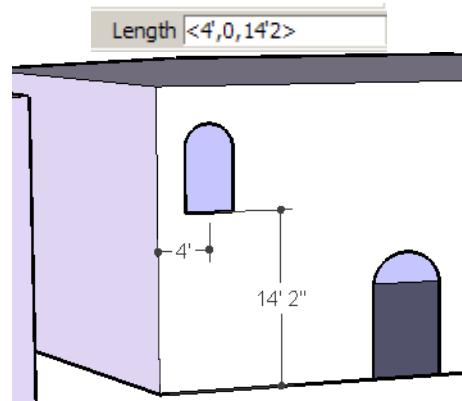


20. Start to move the window by its lower midpoint

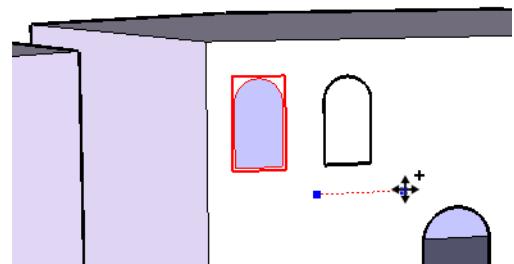


21. To place it exactly relative to the face corner, we will use the angle bracket format. Enter  $<4',0,14'2>$ . Don't forget the foot symbols, because the units are

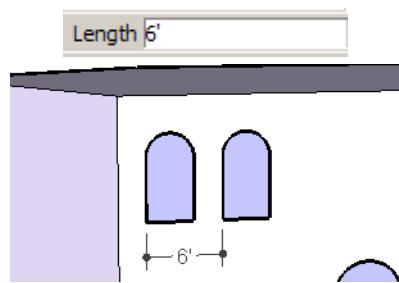
now set to architectural. Also, the movement is in the red-blue plane, so don't forget to include a zero placeholder for the green direction.



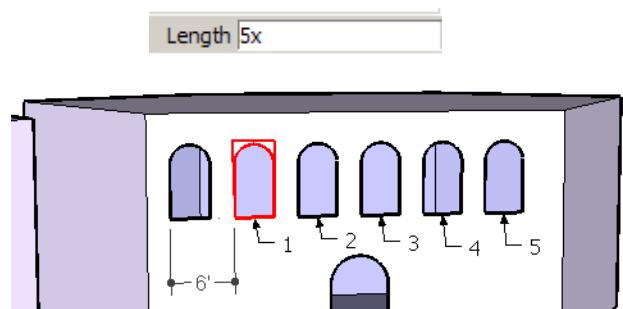
22. Copy this window by clicking any reference point and setting the copy in the red direction.



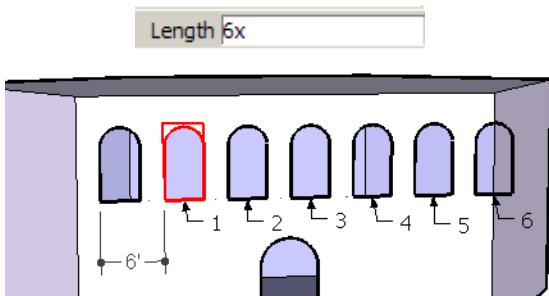
23. Type 6' to set the window spacing.



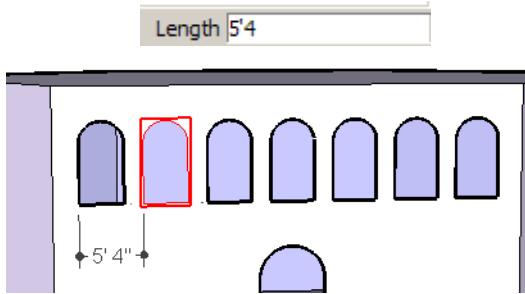
24. Now type 5x. This creates a total of five copies, evenly spaced at 6'.



25. We can squeeze in one more window on this face, so type 6x.



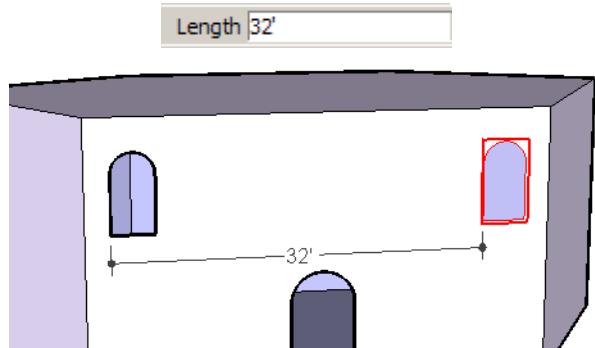
26. This won't work at the current spacing, so try 5'-4".



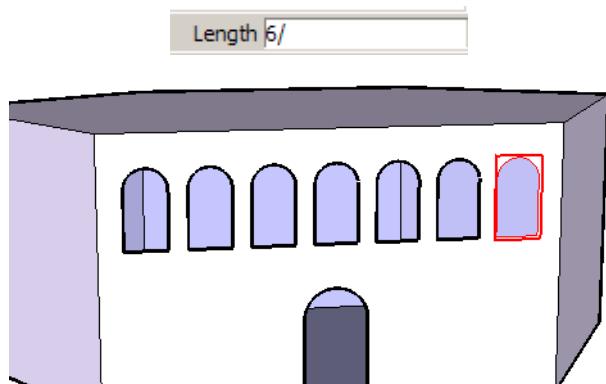
**TIP:** Even though you're working in architectural units, you can still type in decimal values - in this case, 5.33'.

- A better way to copy windows on this face would be to create a copy at the farthest spacing, then divide the space in between.

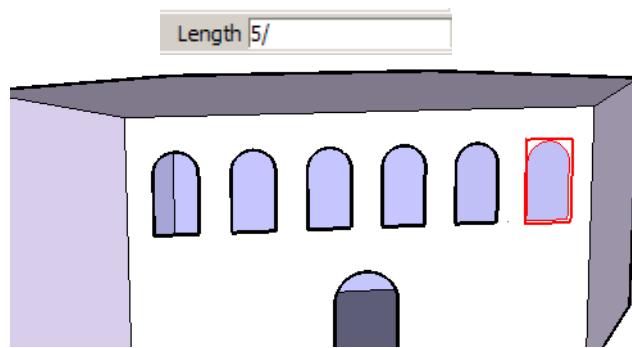
27. This face is 40' long, and we want 4' from each side to the window centers. Therefore, the spacing between the first and last window is 32'. Enter this value.



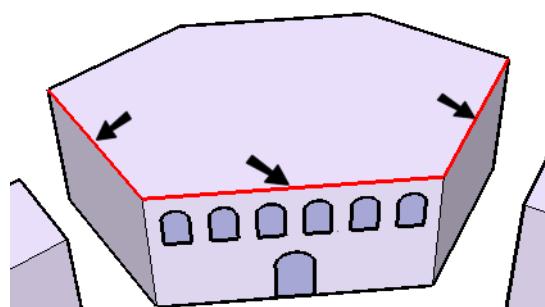
28. Type 6/ (note the division symbol) to divide this 32' length into six spaces between windows (seven total windows).



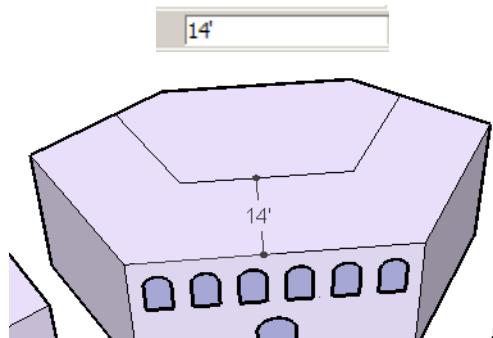
29. The windows are a bit crowded, change the number of windows by entering 5/.



30. We will now create the top floor. Select the three front edges of the roof.



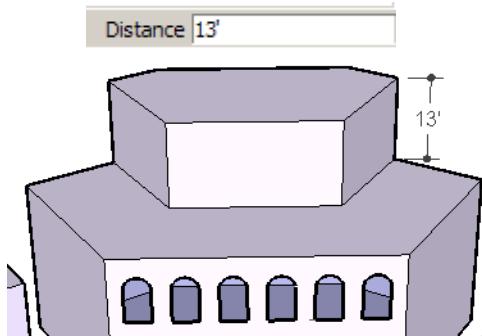
31. Activate **Offset**, and offset the edges inward. Type 14' to set the offset distance.



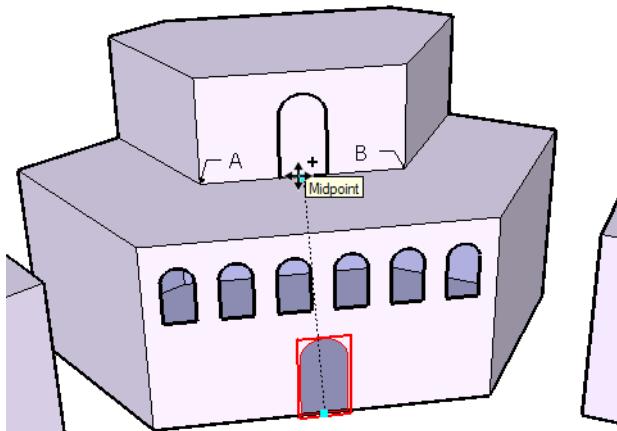
If the offset edges are thick, zoom in closely to see if there are slight overhangs, and fix them. This would happen if there were slight innaccuracies when creating the footprint, such as rounding digits of angles.

**NOTE:** Like with the other tools where exact values are used, you can continue to update the offset distance.

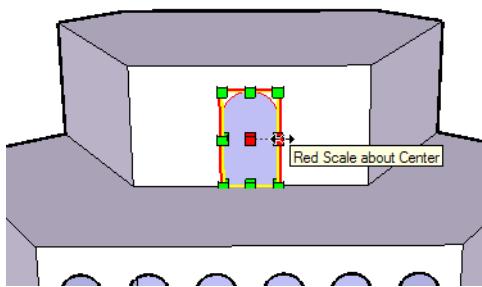
32. Push/Pull this face upward 13'.



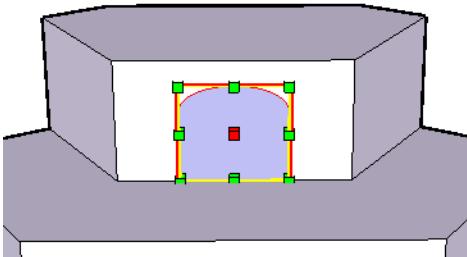
33. Copy the arched door to the top floor, by dragging its lower midpoint to the midpoint of Edge A-B. Be sure to align it with the vertical face, not the horizontal one.



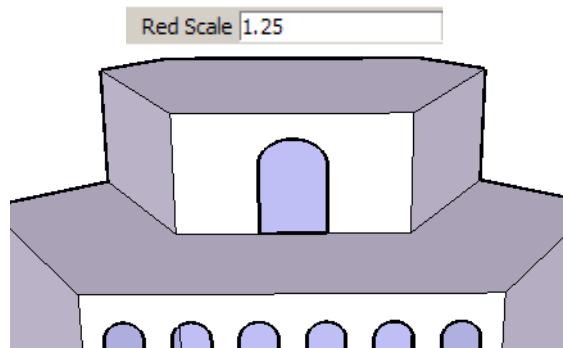
34. Let's make this door a bit wider. Activate **Scale**, and click one of the side handles. Press *Ctrl/Option* so that the scaling will be relative to the center of the door, rather than from the opposite handle.



35. The scale factor appears in the VCB, but you cannot update it while *Ctrl/Option* is pressed. So click anywhere to scale the door, and the factor will be adjusted afterward.



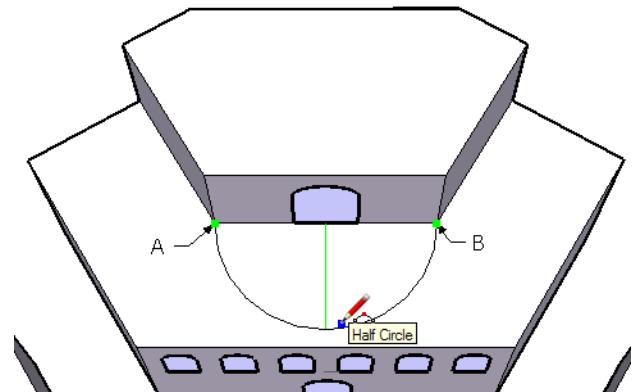
36. Type 1.25 to increase the original width by 25%.



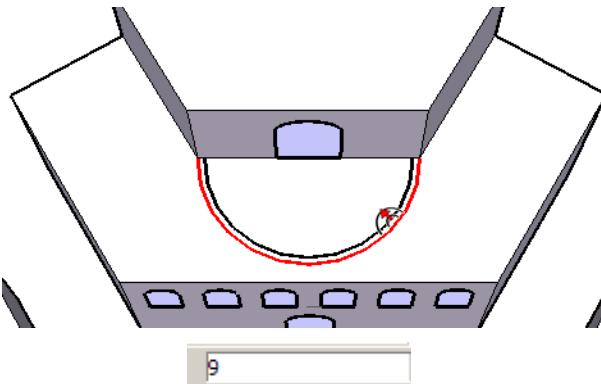
If you want, you can verify the new width by switching to decimal mm units, and measuring the width. It should be 2125mm, which is 1.25 times 1700 mm. If you do this step, be sure to switch back to architectural units.

## Exact Rotated Copies

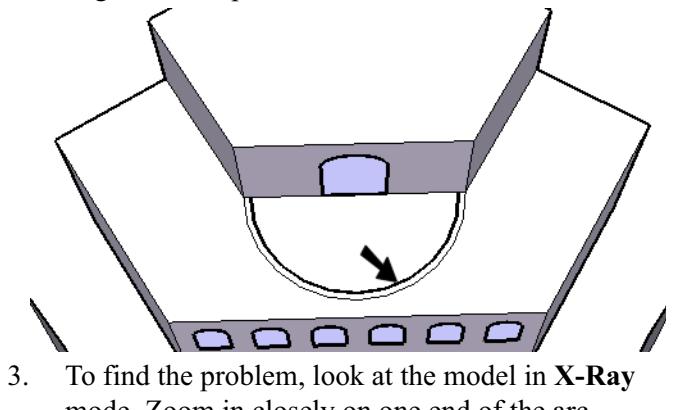
1. Now for the roof deck. Draw a horizontal half-circle arc whose diameter is Edge A-B.



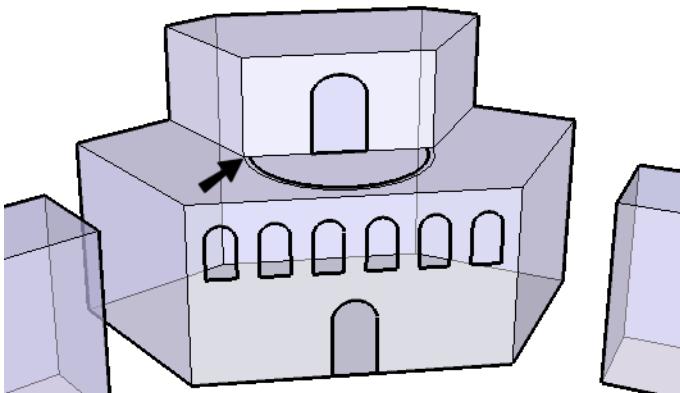
2. Select the arc and use **Offset** to create an inner arc. Use a value of 9 (for inches you do not need to include the “ symbol).



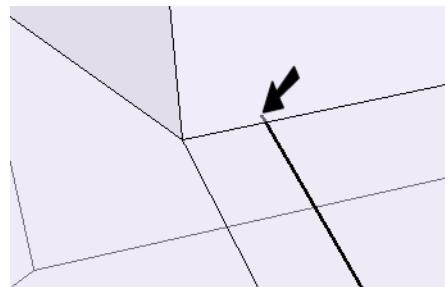
The inner arc has thick lines, indicating that it is not aligned in the plane of the lower roof.



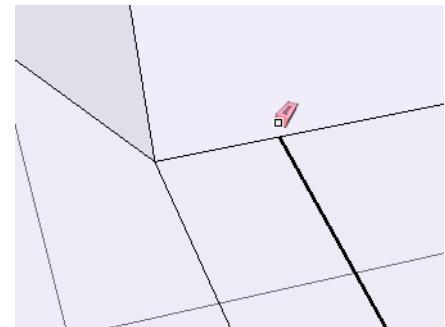
3. To find the problem, look at the model in **X-Ray** mode. Zoom in closely on one end of the arc.



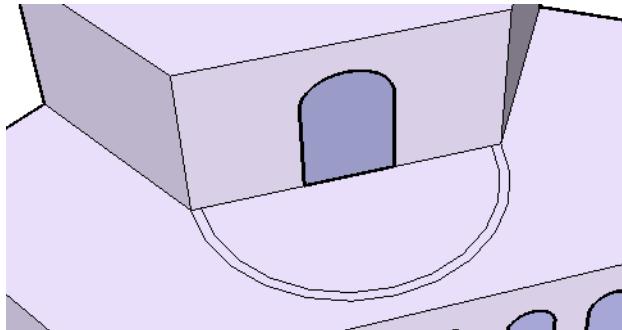
If you look closely enough, you can see that the offset arc extends slightly past the end of the roof.



4. Resolve this arc segment by redrawing one of its sections, and then erase the overhanging line.

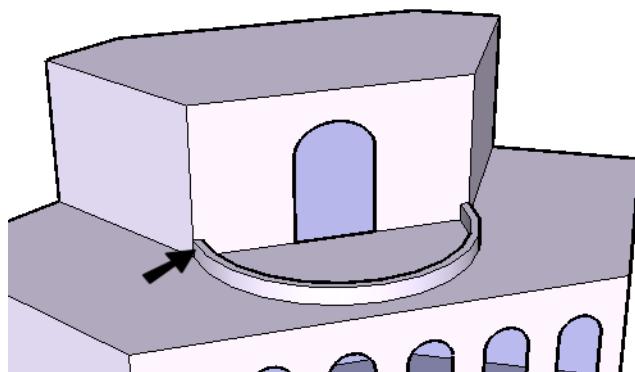


5. Do the same on the other side, and the offset arc is now thin-lined.

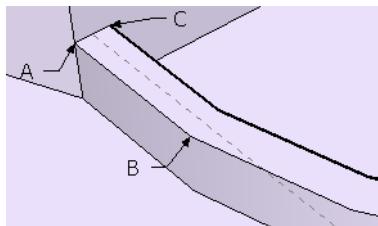


6. **Push/Pull** this parapet to a height of 1'-6". You can type 18, or 1'6, or 1.5'.

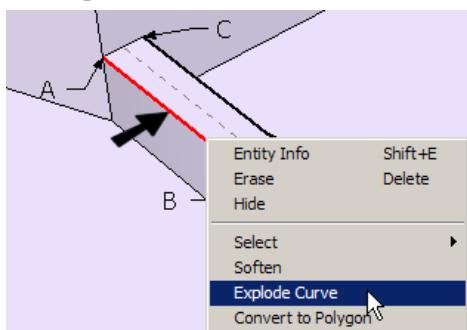
We will now add some railing posts. Zoom in on the first segment of the parapet wall.



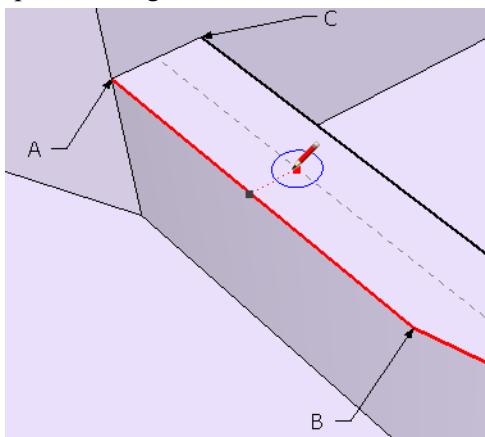
7. To place the post exactly in the center of the wall, create a construction line (use the **Measure** tool) parallel to Edge A-B, that passes through the midpoint of Edge A-C.



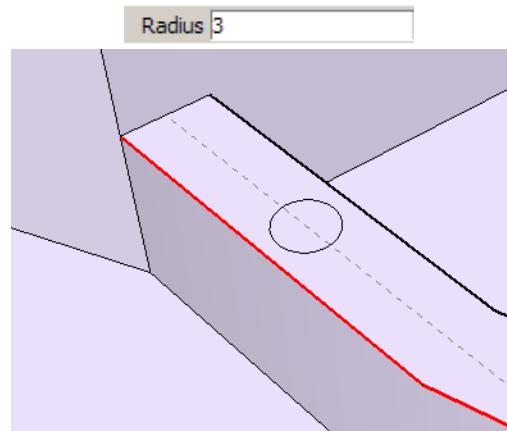
8. We want to locate the midpoint of Edge A-B, but you cannot do this while the arc is a “pure” arc. Right-click on the outer arc, and select **Explode Curve**. This breaks the arc into separate segments whose midpoints can be found.



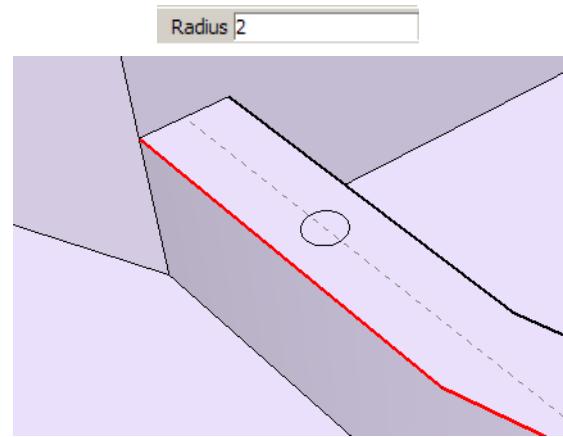
9. Activate **Circle**, and place its center on the construction line, in the red direction from the midpoint of Edge A-B.



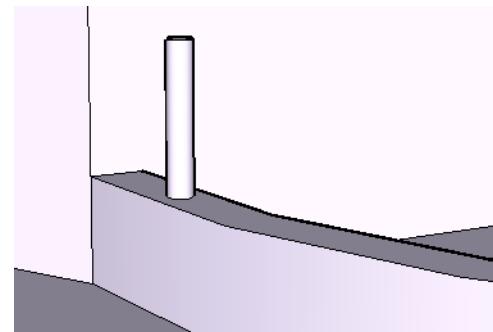
10. Either before or after clicking the second point to create the circle, type 3 to define the radius as 3".



11. As always, you can still change this value. A 6" diameter post is a bit large, so type 2 (for a 4" diameter post). This is a good size.

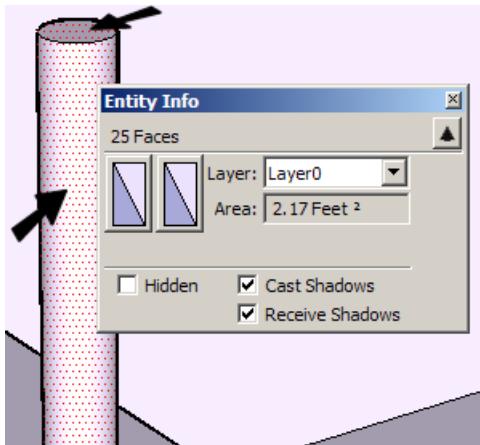


12. Use **Push/Pull** to make a 2' post from this circle.

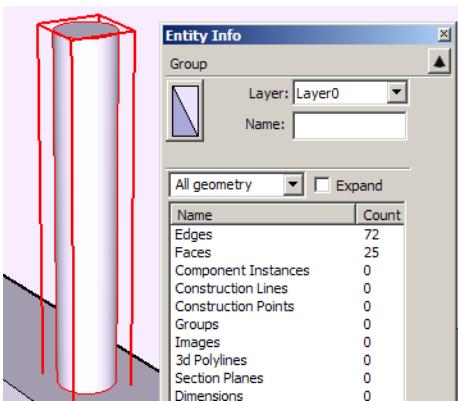


Like we did with the windows, the post should be made into a group. This will make it easier to select and manipulate, and will prevent other objects (like the top rail, which we will create later), from sticking to it.

13. Select both faces of the post (top and cylinder). **Entity Info** lists the combined area of the flat and curved faces.

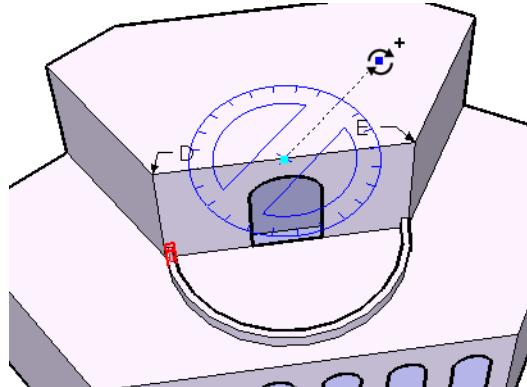


14. Make the post a group. In Windows, **Entity Info** tells you how many faces and edges are in this group. The edge count includes edges along the cylinder that are currently hidden; you could display hidden edges to see them.



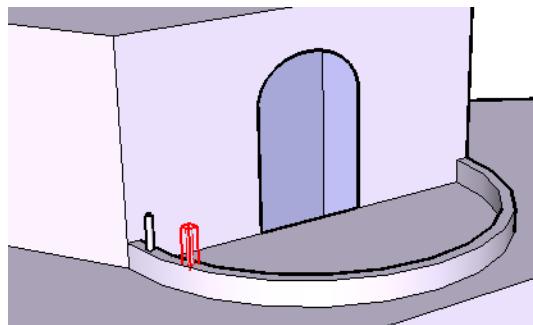
*Mac: Entity Info tells you only that a group has been selected.*

15. Now to make rotated copies. The post should still be selected, so activate **Rotate** (**Tools / Rotate**). Anchor the protractor to the midpoint of Edge D-E (or at the midpoint of the arched doorway). Press **Ctrl/Option** for copy, and orient the protractor anywhere.



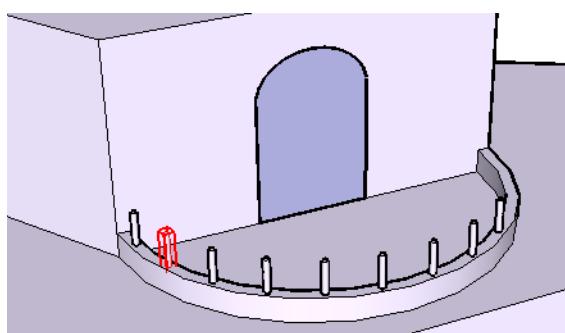
16. Type (or snap to) 15 to make a copy at a 15-degree angle.

Angle 15

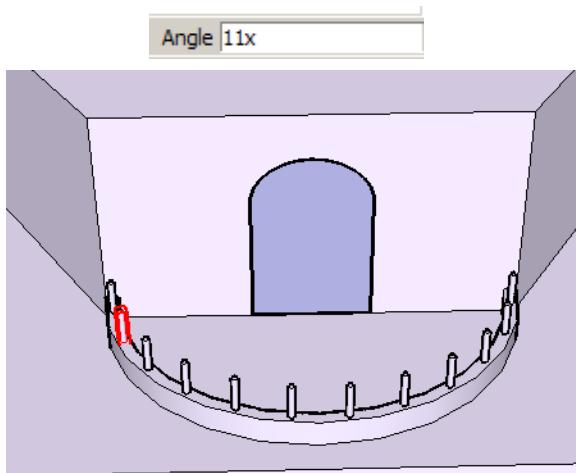


17. To make an array, we use the same format as for linear copies. Type 8x for eight copies (nine posts).

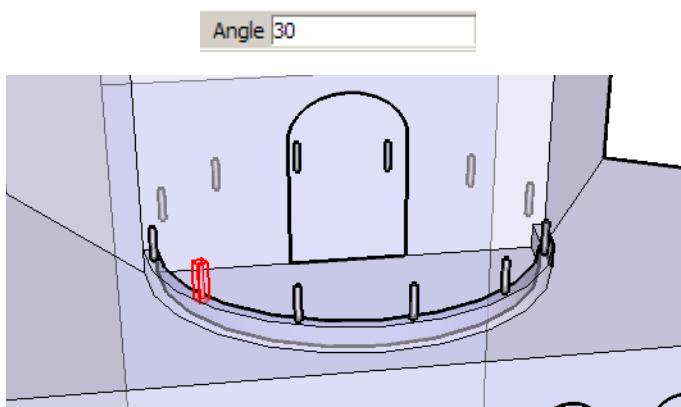
Angle 8x



18. Not enough to go all the way around, so type 11x.

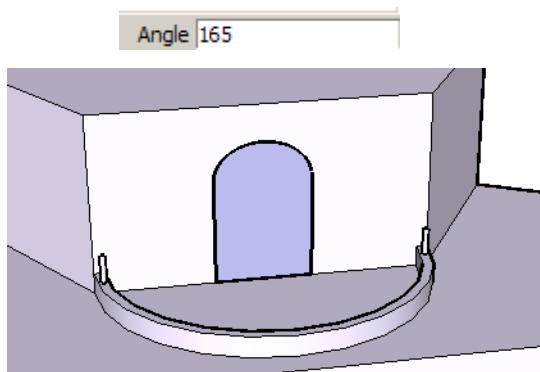


19. You can still change the rotation angle as well. Enter 30 to double the spacing, and remove every other post. Because the number of copies was not changed, they are all still there, as you can see in X-Ray mode.

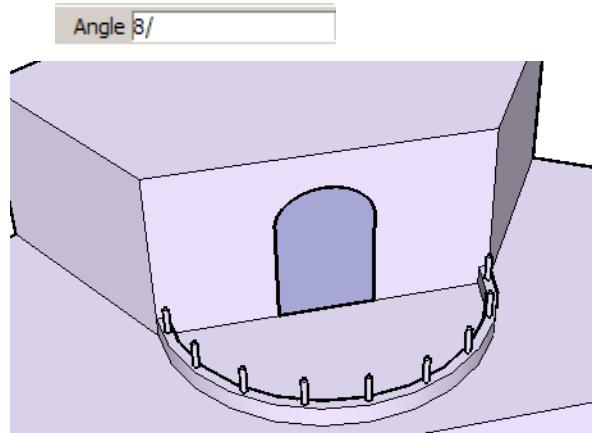


20. Undo the copies.

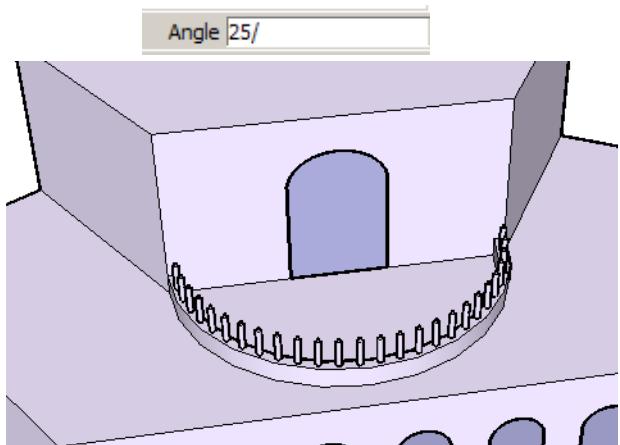
21. Rotate-copy the same post once more. As with linear copies, you can set the angle between the first and last copy and set number of spaces in between. Type 165 to place the last copy.



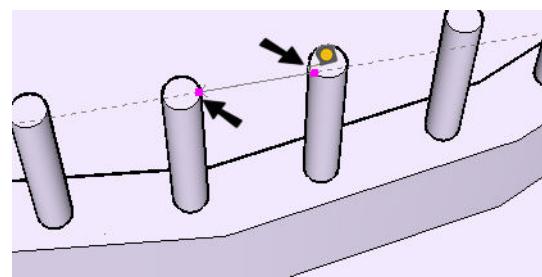
22. Now type 8/ to create eight spaces (nine posts).



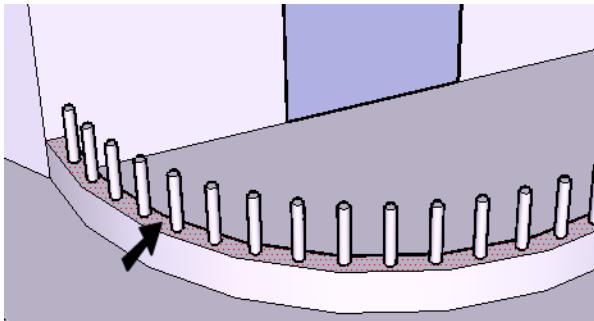
23. This looks nice, but the posts are wide enough to for someone to fall through. Change the spacing to 25/.



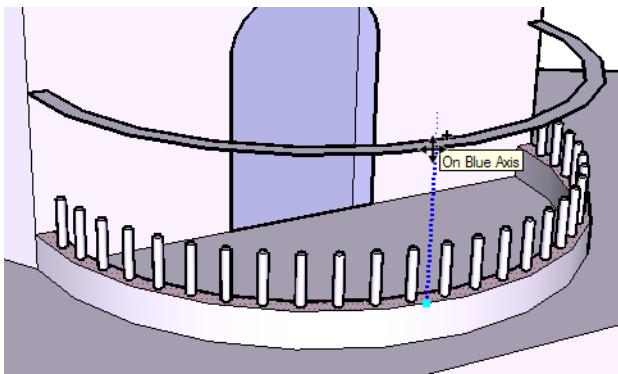
24. This looks much safer, but we can check to make sure. Activate **Measure** and click two points to measure the clear distance between posts.



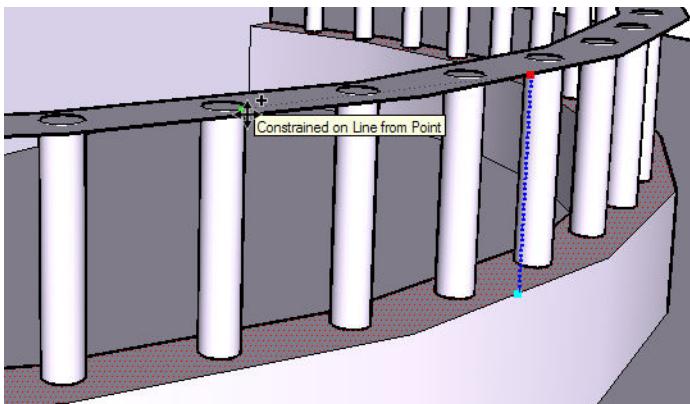
25. It should be about one foot - a pretty safe clear distance. Now for the top rail; select the top face of the parapet wall.



26. Activate **Move**, press **Ctrl/Option** and select any point on this face. Move the face up in the blue direction, and press Shift to lock the direction.



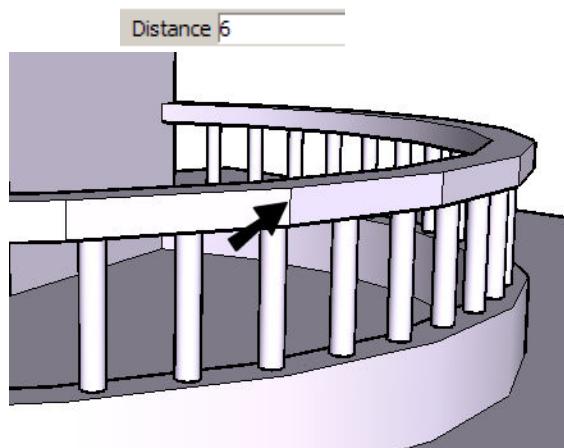
27. With Shift pressed, click any point on top of any post.



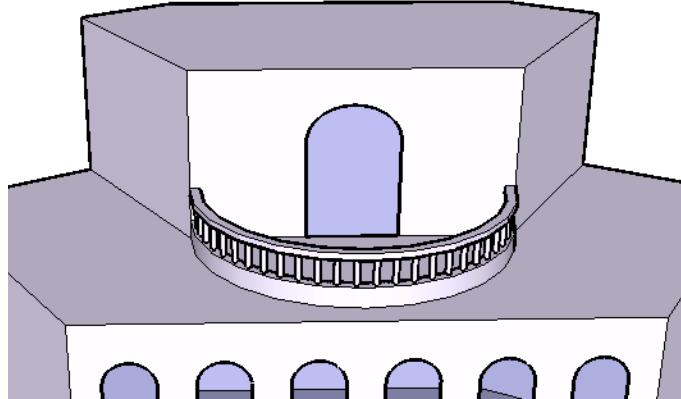
**TIP:** You could also enter a relative move value of <0,0,2'>.

Note the circles on this face, indicating where the posts meet the face. If the posts had not been grouped, these circles would be separate faces within the rail face. But since they are groups, the posts do not affect this rail face; the face is a single face.

28. **Push/Pull** the face up 6" to create the top rail. The outer face of the top rail is segmented because we exploded the original outer arc. (The inner face is smooth.)



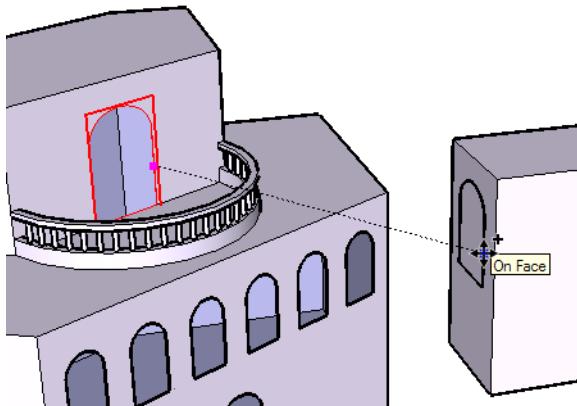
29. To soften these vertical segment edges, activate **Erase**, press **Ctrl/Option** and click or pass over the edges. Here is what your roof deck should look like.



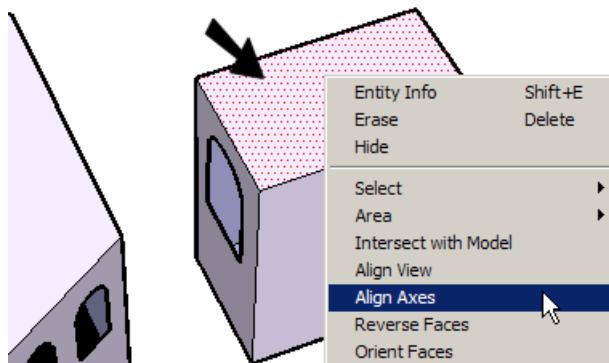
**NOTE:** For information on edges of curved faces, see "Displaying and Smoothing Edges" on page 72.

## Symmetry

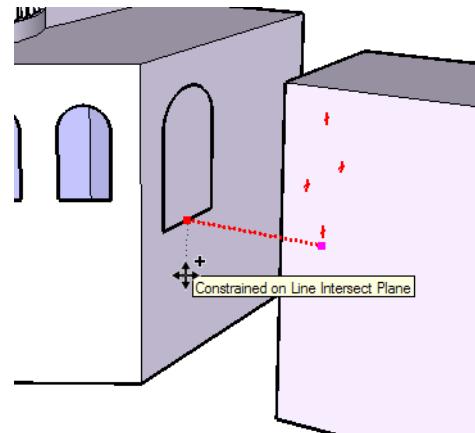
- Continuing on, we will join the main building with the two side buildings. Start by copying the doorway on the top floor onto the side of the box that faces the main building. Don't worry about exact placement - you already know how.



- To copy this doorway onto the main building, it's easy if you change the axes. Rather than bother with the **Axes** tool, you can simply click on the top face of the box and select **Align Axes**.

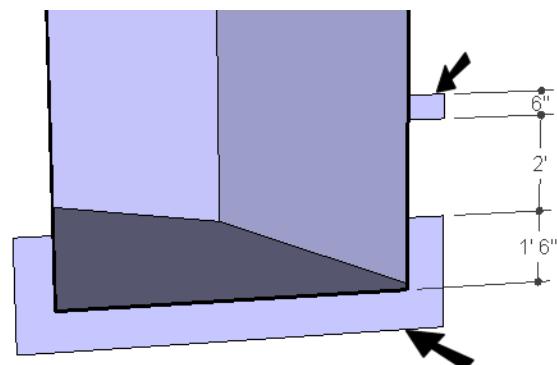


- You can now copy the doorway from the cube, straight along the red axis, until it hits the parallel face of the main building.

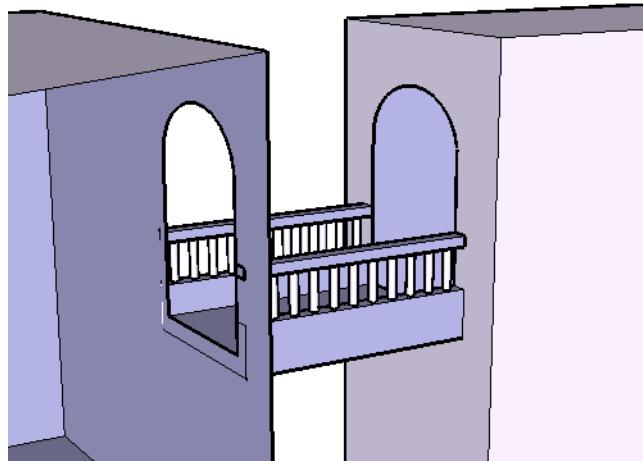


You can now create a bridge linking these two doorways. One way is to draw the shape for the bridge on one face (like the larger building) while the other building is hidden.

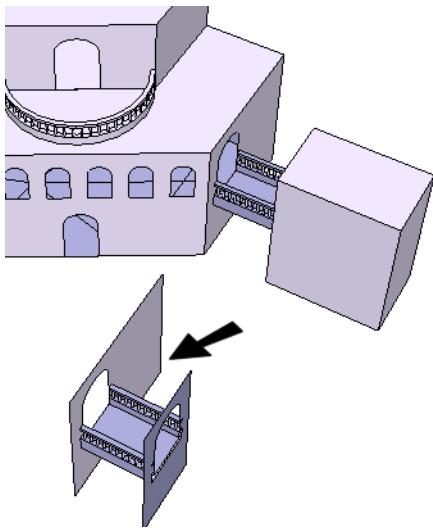
- The one shown below (with faces reversed) has the same overall dimensions as the rail on the roof deck: 9" width, 1'-6" parapet, 2'-0" posts, 6" top rail.



5. The posts are copied from the main building, and are spaced about 1' apart. You can create something simpler, but this looks pretty nice and ties the structures together. This picture shows the view when the front face and its windows are hidden.

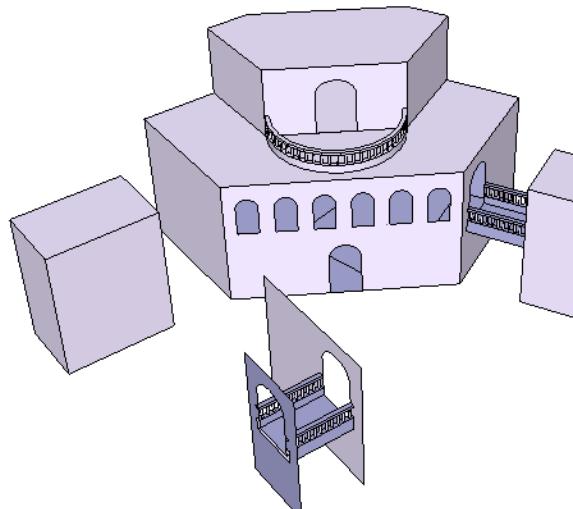


6. To place the same bridge on the other side, we will use the same method as we used for copying the rectangles. Start by making a copy of the bridge plus the adjacent doorways and walls.

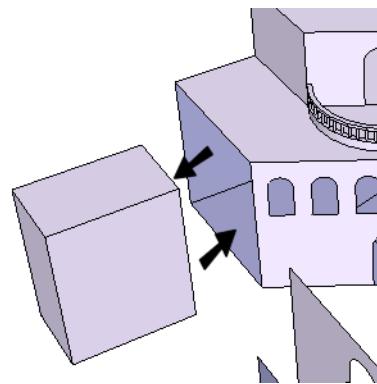


7. Reset the axes so that you can mirror this copy relative to the main building.

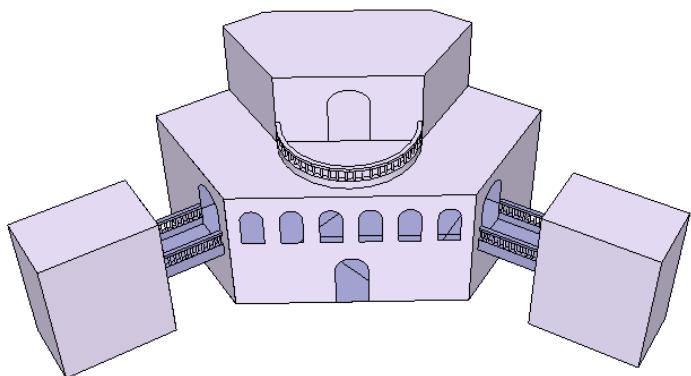
8. Use **Scale** to turn this copy inside out, dragging a side handle and using a scale factor of -1.



9. Erase the faces on the main building and box where the copied faces will be placed (moving a face on top of another face can get unnecessarily messy).



10. Select the copy again, and move it into place. Easy!

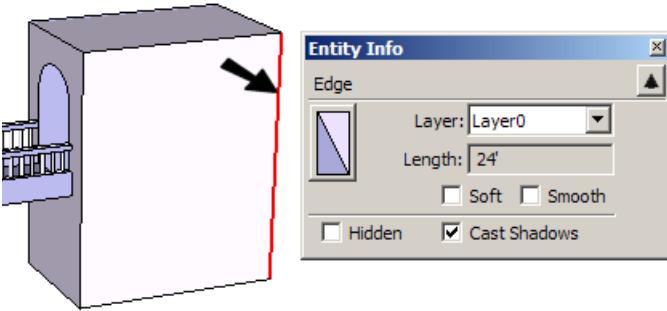


**NOTE:** Another way to create mirrored objects is to use components together with the **Scale** tool. With this method you wouldn't have to copy objects from one out-building to the other; all edits you make to one building are automatically reflected in the other. For an exercise that demonstrates this, see "Using Components for Mirroring" on page 229.

## Measuring Length and Area

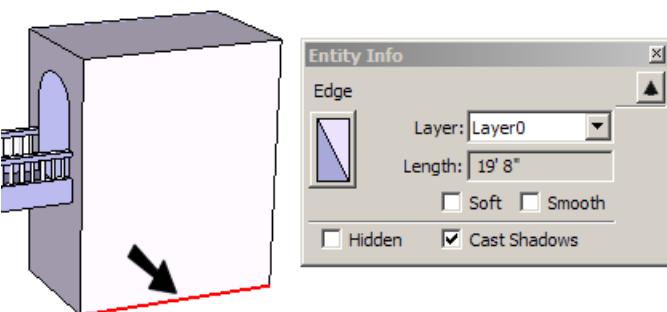
You can check lengths of edges and areas of faces, and use the **Text** tool to label these measurements.

1. On one of the out-buildings, check the **Entity Info** window for the edge shown. The length of the edge is displayed, in the current units

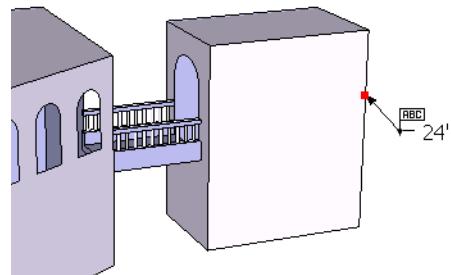


The units should still be **Architectural**, which is the format of the measurement.

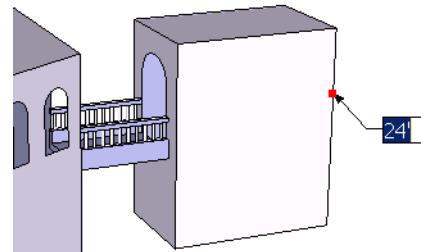
2. Do the same calculation on the edge shown. As you've already seen, when **Entity Info** is open, you only have to select the new edge to see its length.



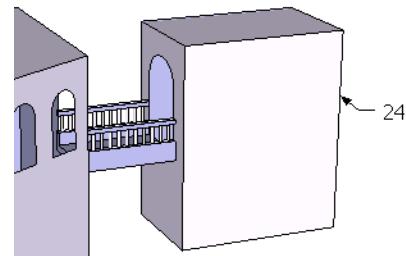
3. Now activate the **Text** tool (**Tools / Text**). Click first on the 24' edge and move the cursor away from the edge. The length of the edge is shown.



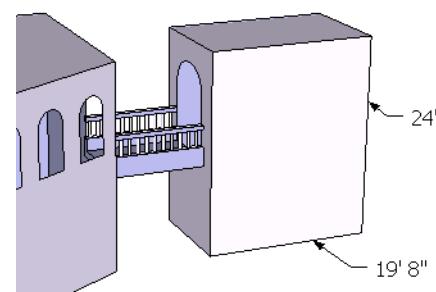
4. Click again to place the text. At this point you can change the text, but leave it as is.



5. Click outside the text area to create the label. As with all measurements, the text is created in the current units. If you change the units, all subsequent labels will reflect the change. Existing labels will not update, however.



6. Apply a similar label to the 19'-8" edge.

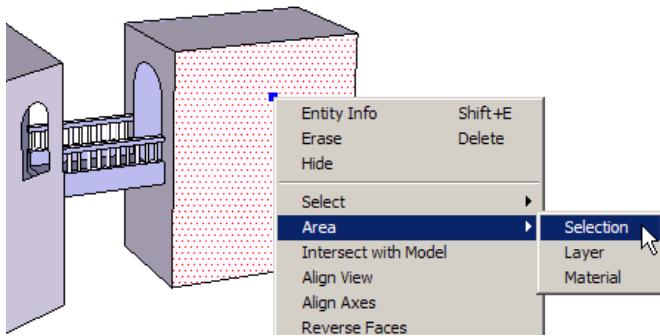


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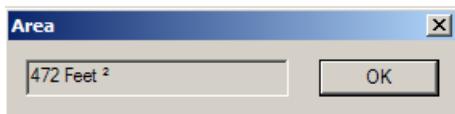
**NOTE:** **Text** works well for labeling dimensions, but labels are not associative (they will not update if there are geometric or unit changes). A better way to show measurements is to use **Dimensions**. See "Text" on page 78 and "Dimensions" on page 82.

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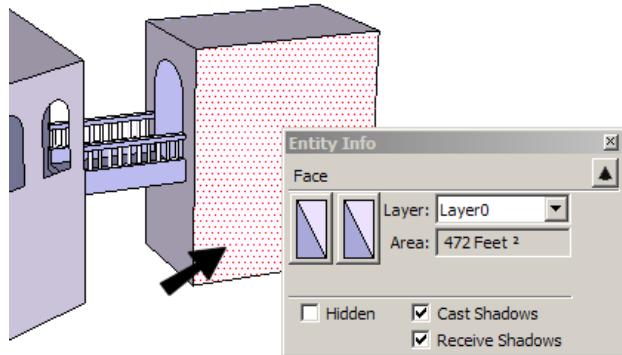
- Now for area measurements. Right-click on the face and select **Area / Selection**.



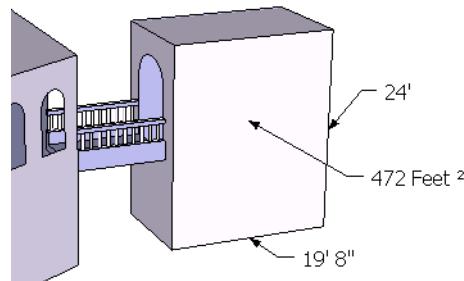
The area is displayed:  $24.00 * 19.67 = 472$ .



- Another way to get the area of a face is through its **Entity Info**, similar to edges.

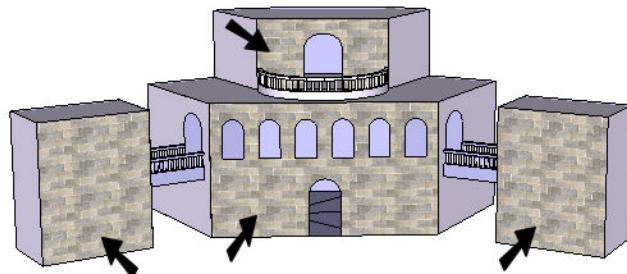


- To label the face, use **Text** and click anywhere on the face for the first point. The default text for a face is its area.



The **Area / Selection** method works for a multiple faces as well. If you want the area of multiple faces, you can also use **Entity Info** (which can also calculate the length of multiple edges). Or you can assign materials or manipulate layers, as described below.

- Open the Materials Browser and assign any material to the four front faces shown below.

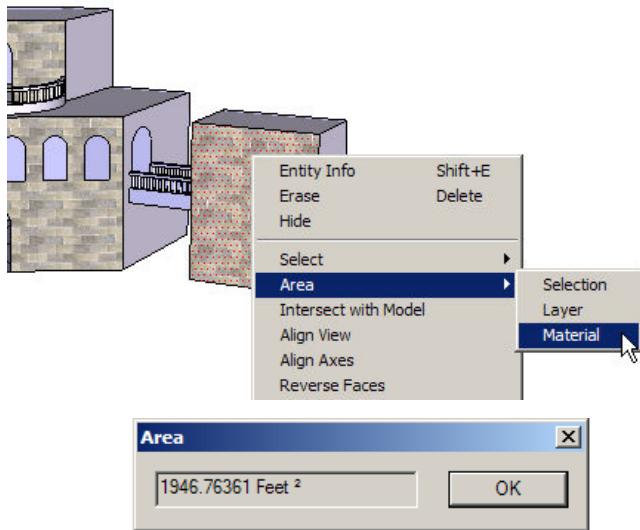



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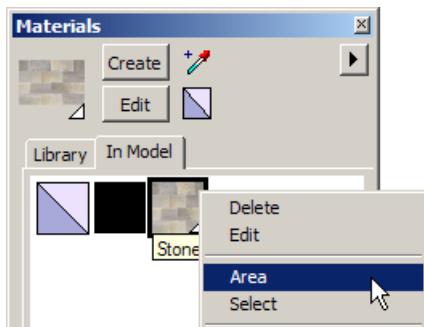
**NOTE:** Materials are covered in Chapter 7.

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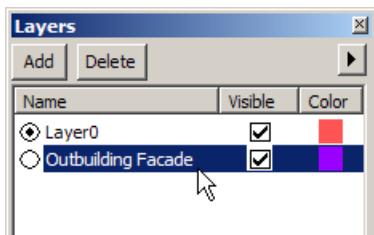
11. Right-click any of these faces and select **Area / Material**. The combined area of all four faces is calculated.



**NOTE:** You can also right-click on the material thumbnail in the **In Model** tab of the Material Browser, and select **Area**.

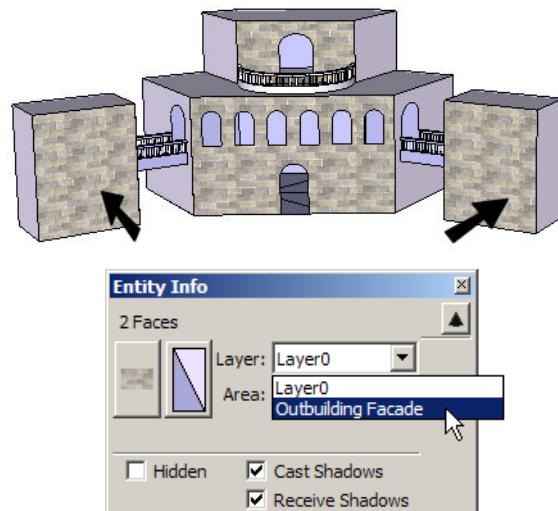


12. Another way to get a multiple-face area calculation is to place all faces on the same layer. Create a new layer (**Window / Layers**, click **Add**) called something like “Outbuilding Facade.”

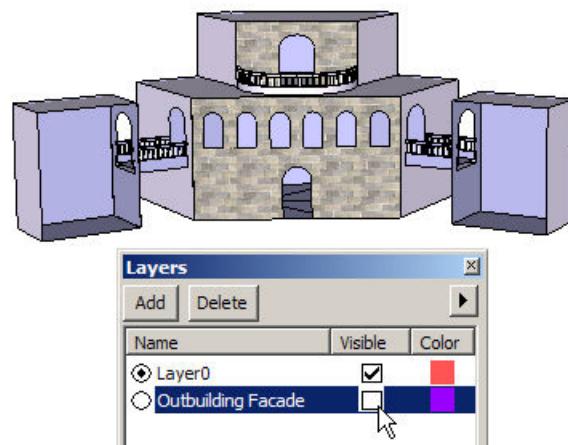


**NOTE:** For details on layers, see "Layers" on page 317.

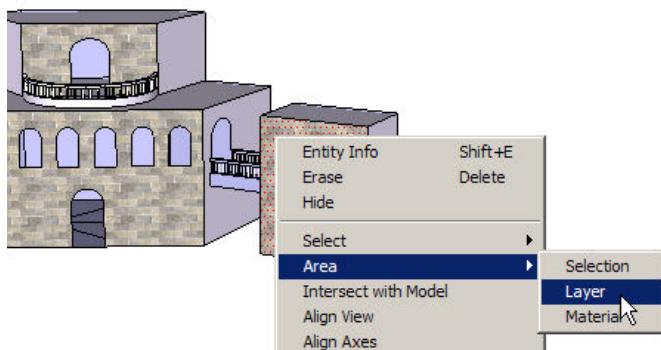
13. Place the two front out-building faces on the new layer. You can do this with the **Entity Info** window.



14. To verify that the faces have switched layers, make the layer invisible (uncheck the **Visible** box).



15. Display the layer again, and right-click on either of the faces. Select **Area / Layer** to see the combined area of the faces.



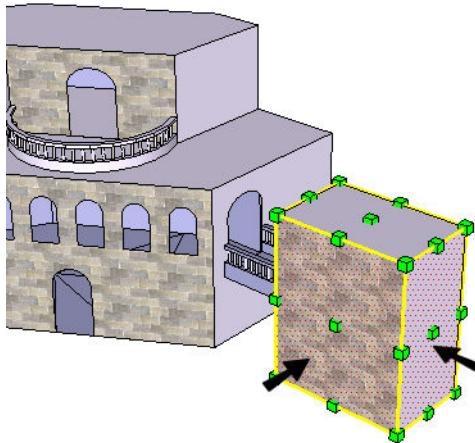
16. Remember, the area of one face was 472, and 944 is twice that value.



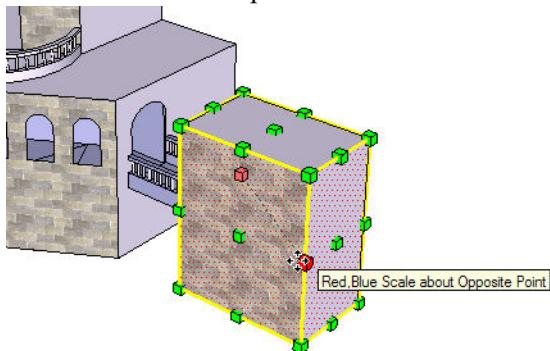
## Scaling in 3D

This last, short section demonstrates using exact scale values when scaling in 3D. You can replace the modified materials and layers, or leave them as they are.

1. Align the axes once again to the box (right out-building) form. Otherwise, the box will be scaled relative to the current red and green axes.
2. Select the two faces shown and activate **Scale**.



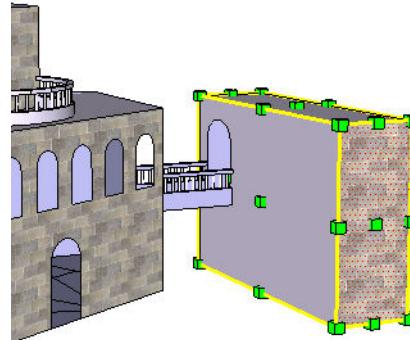
3. Select the corner midpoint handle shown.



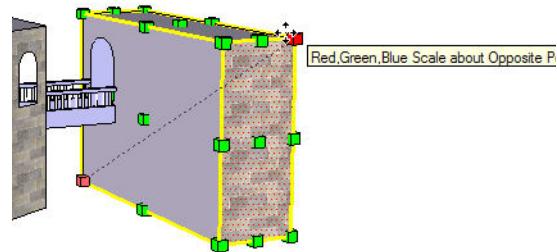
Because this handle allows non-uniform scaling by default (though you can change this by pressing Shift), you can change the scale factor in two dimensions - red and green.

4. Move the cursor to see how this handle can be moved, and note the two comma-separated values in the VCB. Enter 0.5,3 to reduce the red dimension to one-half, and multiple the green dimension by three.

Red,Blue Scale 0.5,3

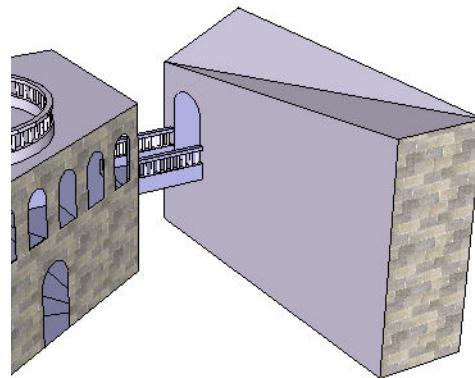


5. Now click the corner handle shown. By default this handle scales uniformly. But press Shift, and you can change the scale in all three directions.



6. You cannot enter values while Shift is pressed, but you can click anywhere to scale, then enter values to modify the scaling. Don't forget to separate the values by a comma, and to list them in order of red, green, blue.

Scale 1.22,1.25,1.33



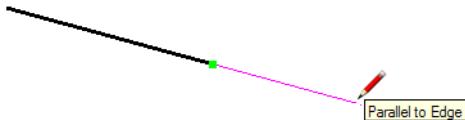
Note that adjacent faces are automatically folded when required by the scaled faces.

# 12 Tips and Tricks

## Healing a Divided Line

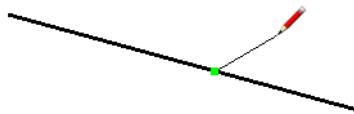
If you have two adjoining segments of a line, you can easily make them into one line.

1. Draw one line, then start a new, colinear line from the first line's endpoint.



(You can also segment a line by right-clicking on it and selecting **Divide**.)

2. Draw a line, oriented in any direction, from the common endpoint between the two lines.



3. Erase this line, and the two segments are healed into one line.



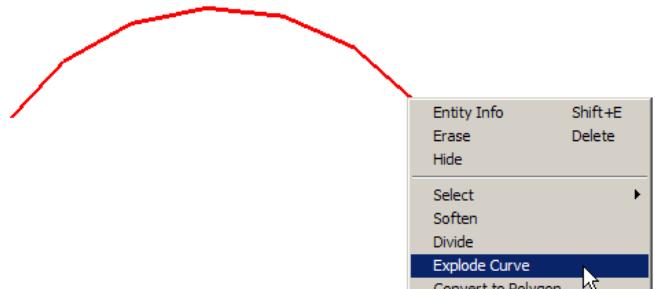
## Finding the Center of an Arc

For arcs, circles, and polygons, you can easily find the center - just hover over an endpoint then move the cursor toward the center to see the green inference point. You can also create a center point by right-clicking on a circle or arc and selecting **Point at Center**.

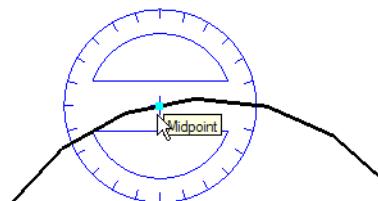
**NOTE:** For **Point at Center** to be available, open **File / Preferences** to the **Extensions** page and check **Ruby Script Examples**.

But if the arc is more or less than 180 degrees, and you've exploded it into individual segments, it takes a little more work to find the center point.

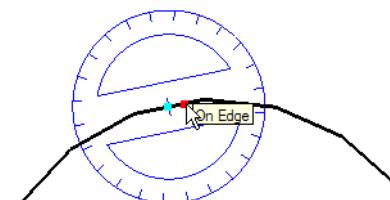
1. Start with an arc and **Explode** it.



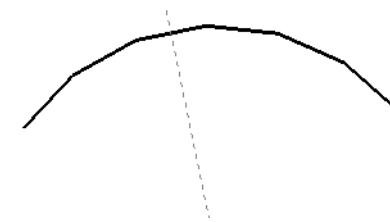
2. Activate **Protractor** and place it at the midpoint of one of the segments.



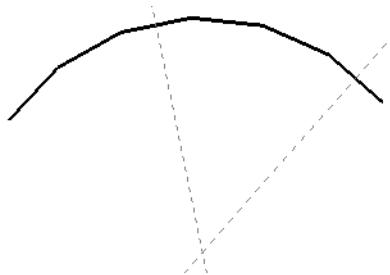
3. Align the protractor along the segment.



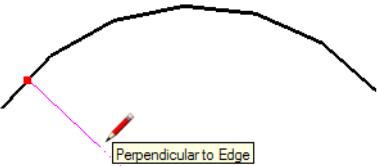
4. Draw a construction line 90 degrees to the segment.



5. Do the same for the another segment. The intersection of the construction lines is the center.

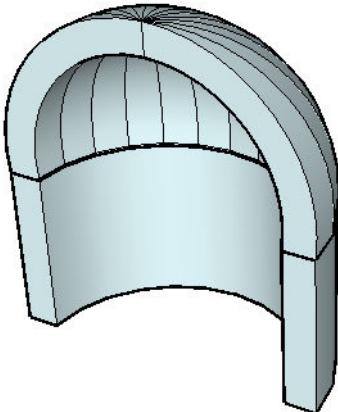


You could also use **Line** for this - start a line at a segment midpoint and find its perpendicular constraint. Extend the line past where you know the center is. Do the same for another segment, and the line intersection is the arc center.

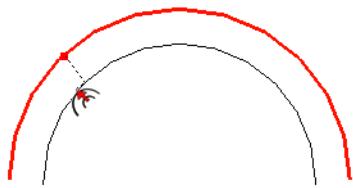


## Domed Apse

Here is a neat way to create a domed apse. Extruding a face along a curved that is less than a complete circle is slightly problematic, as you'll see. This method shows you how to extrude a face along a 180-degree arc.



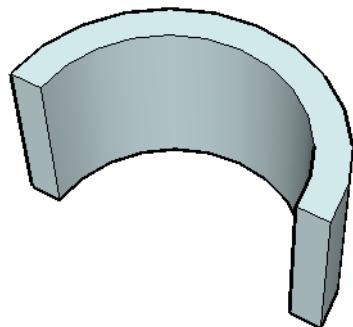
1. Start with the base, which will be an arc. Start with a half-circle in **Top** view, and **Offset** it inward.



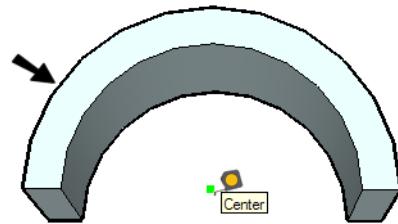
2. Close both ends of the arc with a small horizontal line extending from the outer arc. Delete the small extra segments of the inner arc.



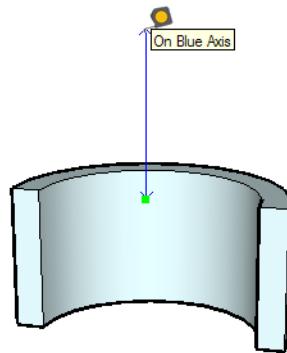
3. **Push/Pull** to create the base.



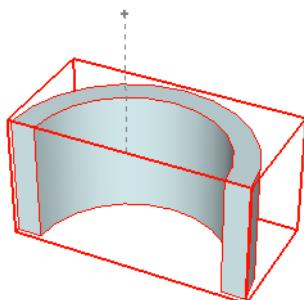
4. To create the dome, you will need to know where the arc center is. Activate **Measure** to draw a construction line. Pick the center of the top outer arc as the start point...



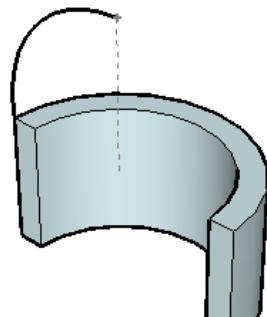
5. ... and draw the line up in the blue direction.



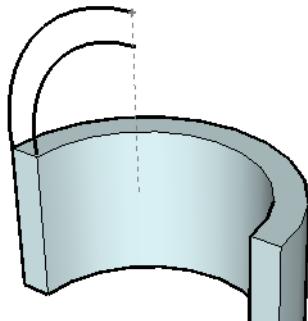
6. Select the base and make it a group. This will help you hide the base later, and keeps other objects from sticking to it.



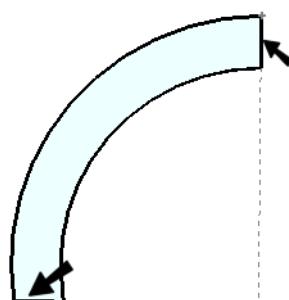
7. Use **Arc** to draw an arc from the outer vertex of the base to the height point you just defined.



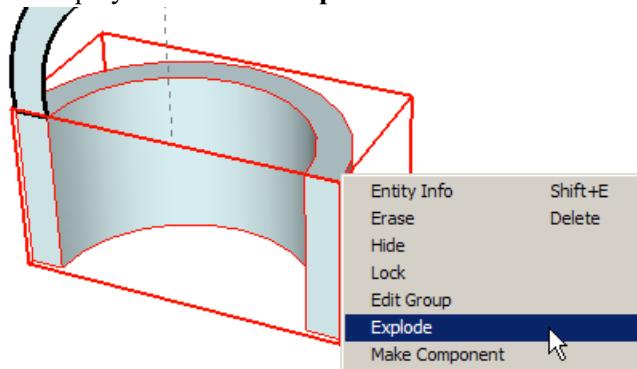
8. Select the arc and use **Offset** to create an inner arc, stopping at the inner base.



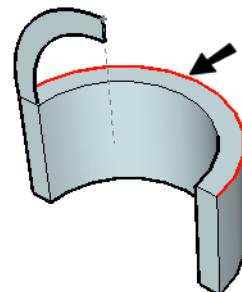
9. This is where the grouped base will come in handy. Hide it so that you can see the arcs more clearly. Connect the two arcs with horizontal/vertical lines starting from the outer arc. Then trim or extend the inner arcs as needed.



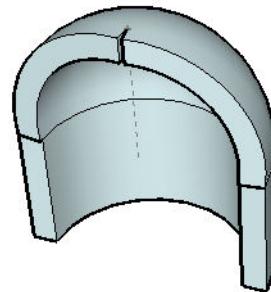
10. Here's why **Follow Me** won't work in this case. Display the base and **Explode** it.



11. Select an outer arc on the base, then activate **Follow Me**.

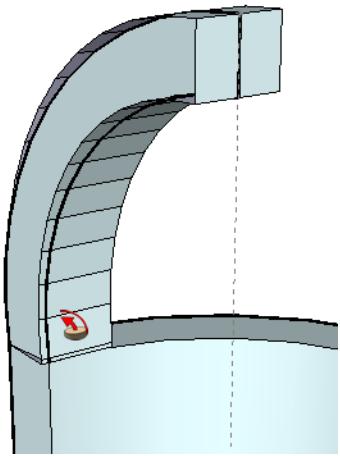


12. Extrude the arc face you just created along the selected arc. There is a small notch in the center - not the results we want.

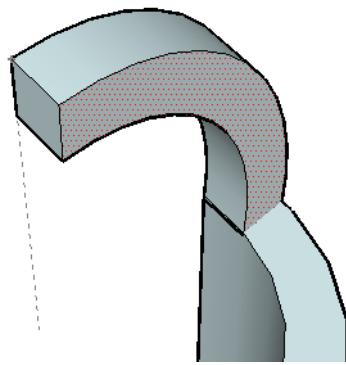


13. Why does this happen? **Undo** and activate **Follow Me**, then select the arc face. Zoom in closely and manually extrude the face along the arc. The face is **Push/Pull**'d along the first arc segment - a

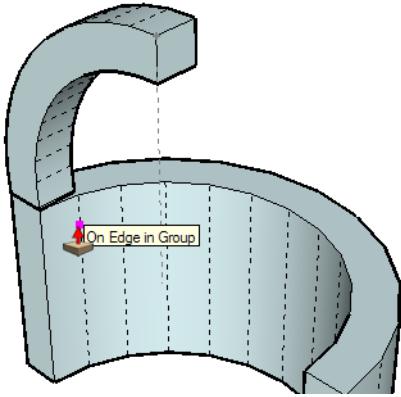
straight-line extrusion, not a curved one. This first extrusion segment is the reason for the notched result.



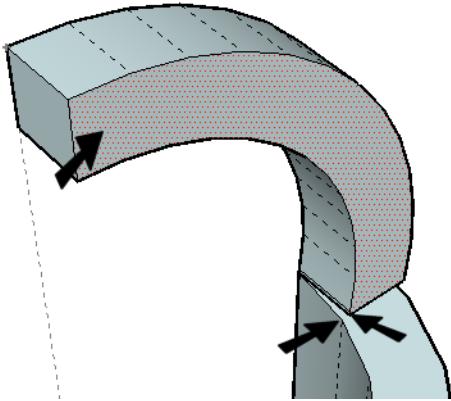
The dome slice is now aligned with the base.



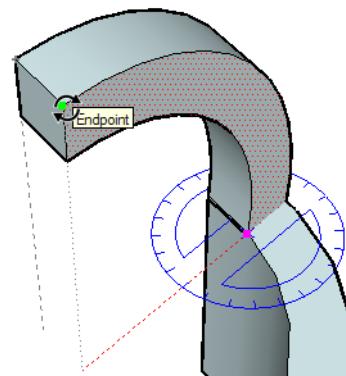
14. Undo back to the point at which the base is still grouped, and we'll try this using another method.
15. Display hidden edges by selecting **View / Hidden Geometry**. Push/Pull the arc form to the first inner edge of the base.



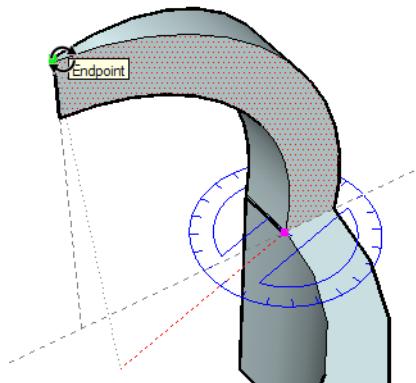
16. Select the inner arc face, and activate **Move**. Press Alt/Cmd for Autofold, and move the inner vertex of the dome slice to the inner vertex of the base.



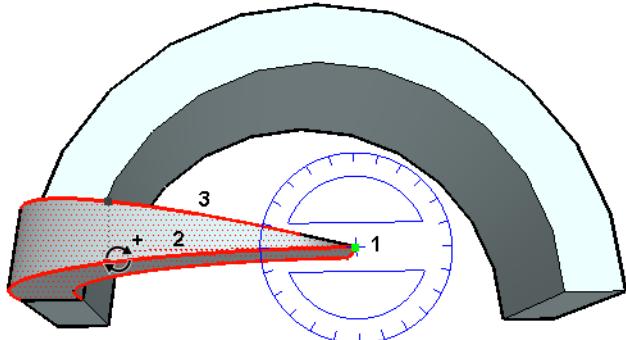
17. With the inner face still selected, active **Rotate**. Place the protractor as shown, along the top of the base at the inner vertex. Align it using a point on the inner edge of the section slice . . .



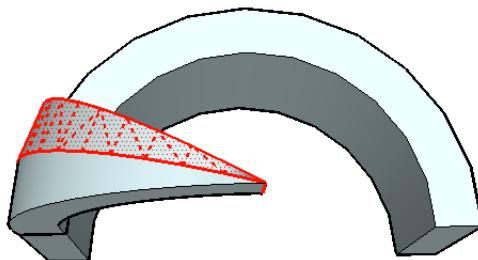
. . . and rotate the slice into a wedge shape.



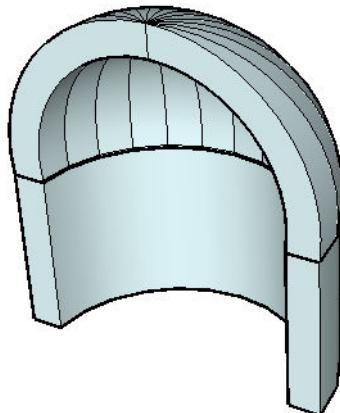
18. Select the dome wedge and activate **Rotate**. Position the flat protractor horizontally at the Point 1, press **Ctrl/Option**, and align it with any point on Edge 2. Rotate it toward any point on Edge 3.



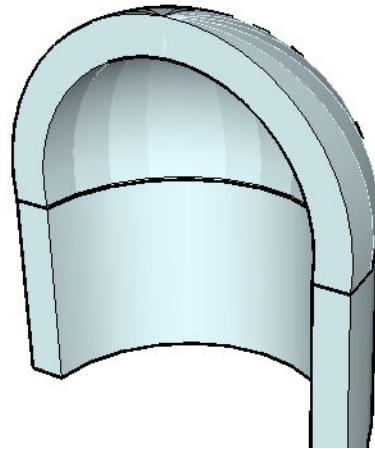
The copy should be exactly adjacent to the original.



19. Enter 11x (or whatever works in your case), to finish the dome. Done!

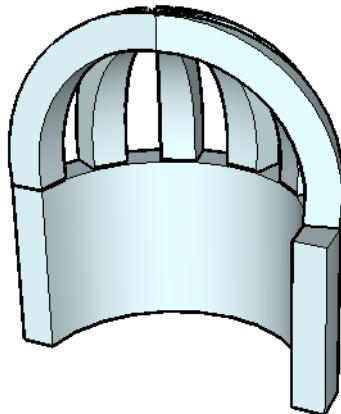


This is how the apse appears with softened edges (**Erase** with **Ctrl/Option**).

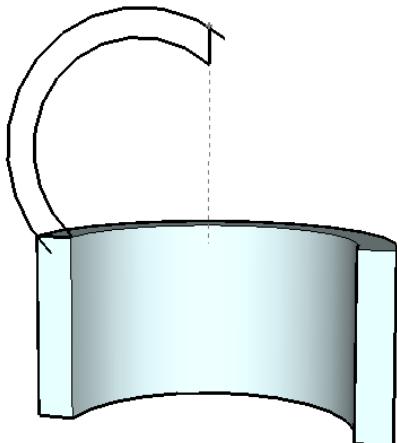


**NOTE:** If you soften edges on the model created here, the surface would still have a faceted look. For the surface to truly appear smooth, you would have to create the copied slice without its side faces, or remove all interior faces. See "Smoothing Faces of Rotate-Copied Curved Objects" on page 382.

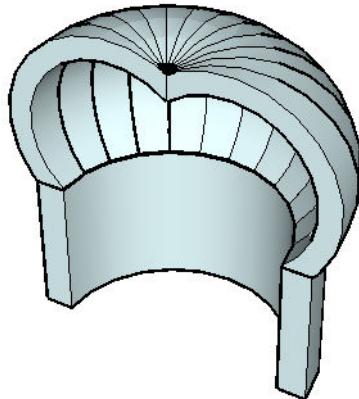
You can create some neat variations on this. For instance, if you double the rotation angle, you can get this:



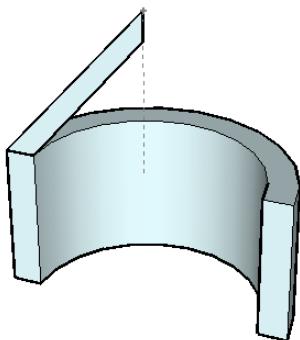
You could start out with an arc that bulges past the base. If you use an arc like this, draw the first one at the inner corner, then **Offset** to the outer corner.



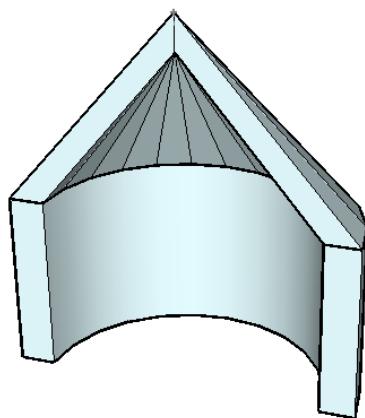
Following all the dome steps, this would be the result.



You could also use a simple linear shape . . .



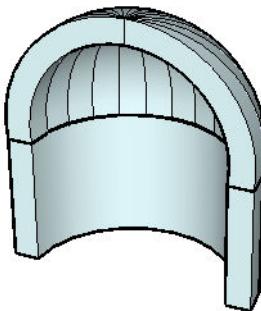
. . . to create a conical top.



## Smoothing Faces of Rotate-Copied Curved Objects

For exercises such as the previous "Domed Apse" on page 378, you need to consider the interior walls of copied objects and how they affect edge smoothing.

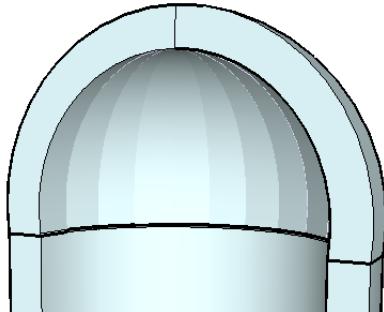
1. Work the previous Domed Apse exercise.



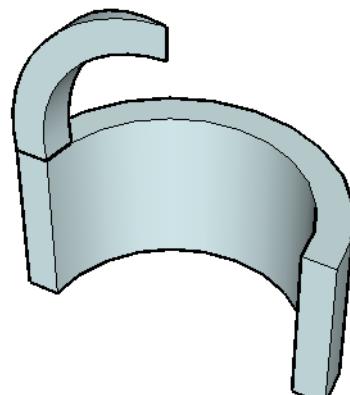
2. Look at the results in X-Ray mode. Each copied wedge has side walls.



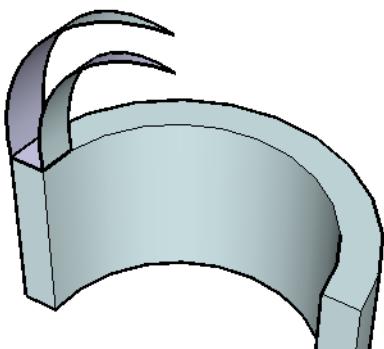
This explains why, when you smooth the edges, it still has a faceted look. As long as interior walls are joined to the exterior wall, the wall cannot be smoothed.



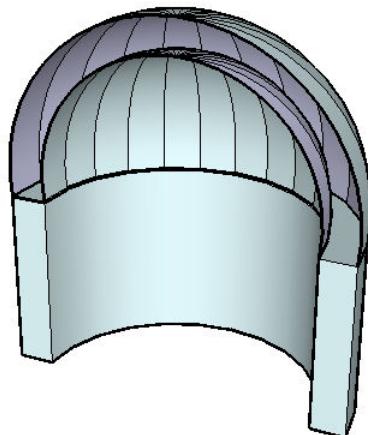
3. To change this, the side faces should be removed. Undo or erase as needed, to return to this step:



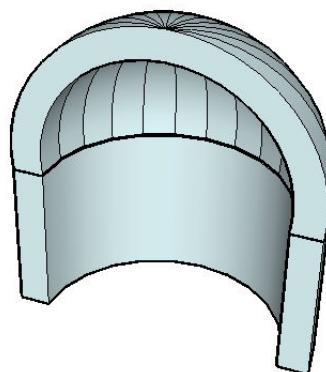
4. Erase the vertical faces on both sides of the slice. The slice should now consist of two curved faces.



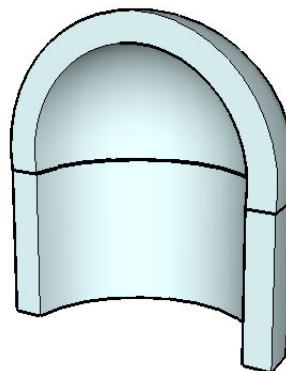
5. Select these two faces and rotate-copy them along the 180-degree arc.



6. Replace the front faces by creating lines.



7. You can now soften the edges without the facets.



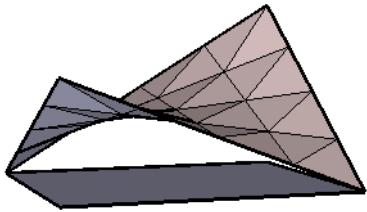

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*NOTE: For the smooth version (without interior faces), if you smooth each edge individually by right-clicking and selecting **Soften**, you will still get a faceted (not smooth) look. Use the **Erase** tool with Ctrl/Option pressed, or select all edges, right-click and select **Softensmooth Edges**.*

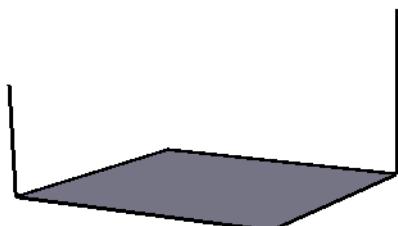
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## Hyperbolic Parabola (Saddle Shape)

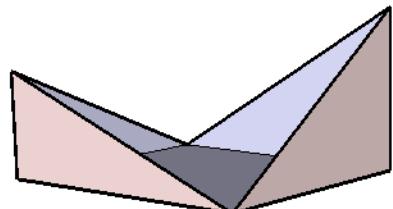
This is a handy form for tensile structures.



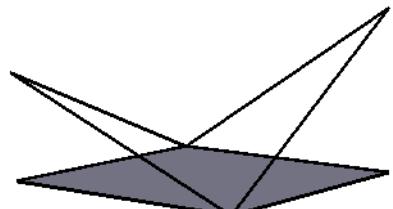
1. Draw a rectangle, and draw two vertical lines from the opposite corners.



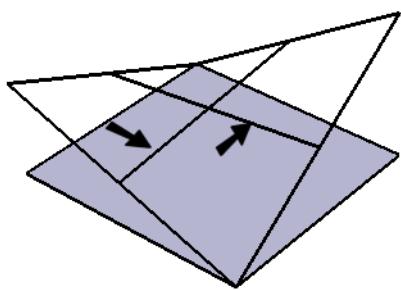
2. Draw lines from the vertical lines to the rectangle corners.



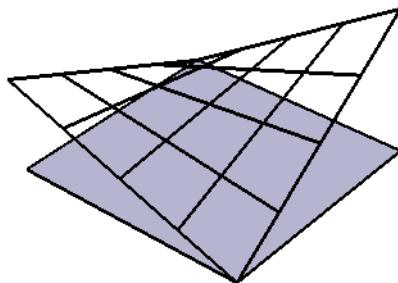
3. Erase the side faces and the vertical lines. Leave the rectangle because it will help you visualize the final shape.



4. Draw lines between the midpoints of opposite lines.

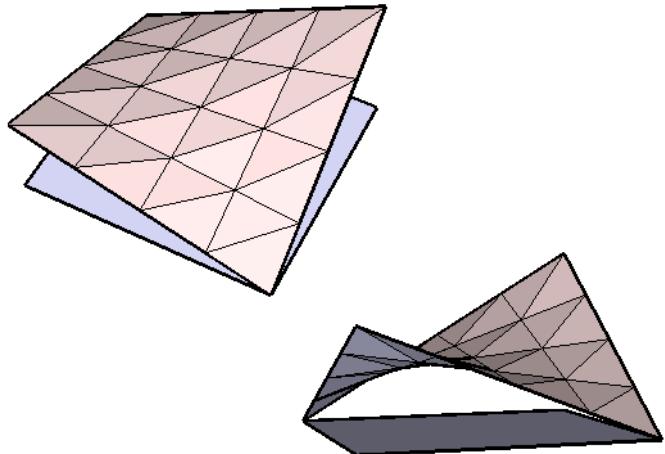


5. Draw lines between the midpoints of the divided lines. You can continue subdividing this way, but we'll stop here at quarter-points.

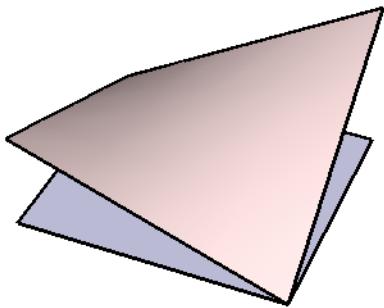


**TIP:** You can also right-click on a line and select **Divide** if you want to specify a number of segments.

6. Create faces by triangulating each section. Reverse faces if necessary. Here is the final shape.

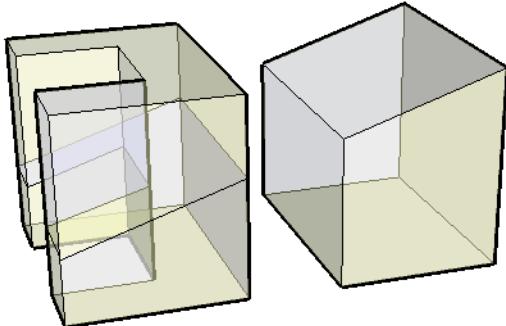


7. Soften the edges to get a smooth tensile surface.



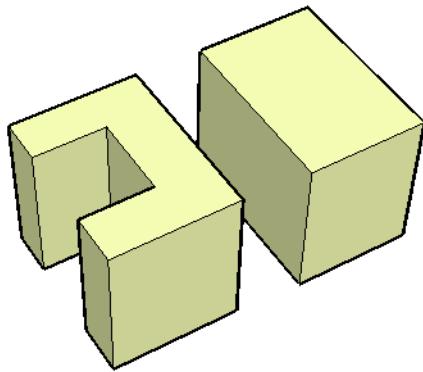
## Using Inferences to Create Sections

You can easily use section planes (see Chapter 8) to slice any plane through your model. But if you already have a face in your model that defines the section plane, you can use inference locking to section a form as well.

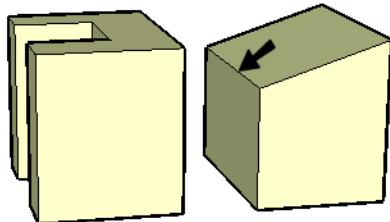


This method is not necessarily quicker or easier than using the **Add Section Plane** tool, but it presents another solution.

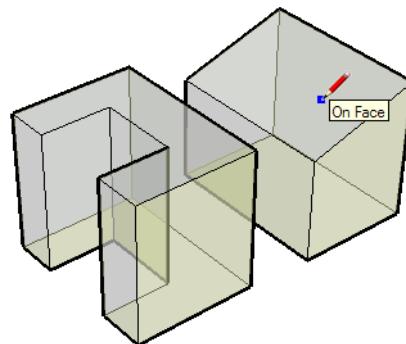
1. Start with two rectangular forms, **Push/Pull**'ed to the same height.



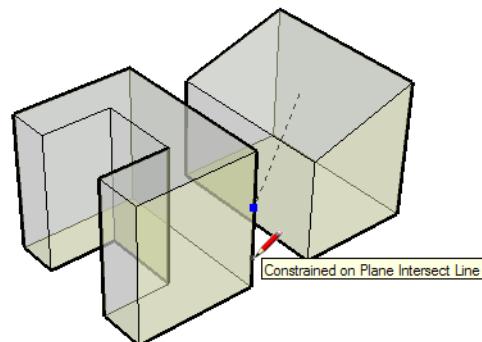
2. To create a sloped plane, move the indicated edge straight down.



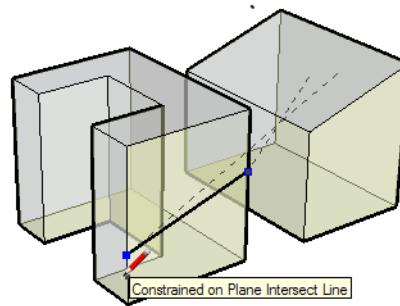
3. Switch to **X-Ray** view. The building on the left will be sectioned. Activate **Line**, and for the first point, hover over the sloped face. Press Shift to lock the **On Face** constraint.



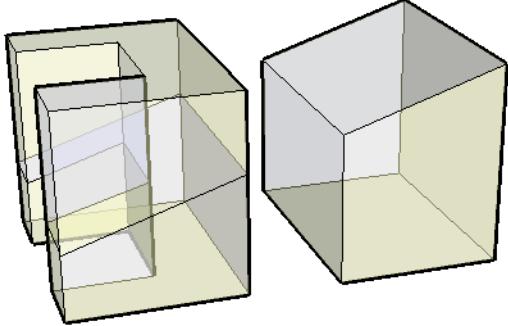
4. Keep Shift pressed, and click on the edge shown.



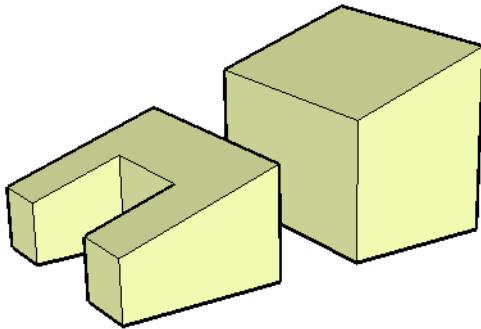
5. For the endpoint of the line, hover over the face again, press Shift, and click the edge shown. This creates a line that lies in the same plane as the sloped face.



6. Use this Shift-locking method to draw lines between all of the vertical edges. Because you are in **X-Ray** mode, you can see the face form when the last line is completed.

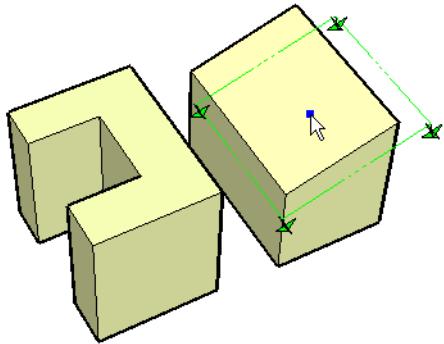


7. You can now erase everything above this section face.

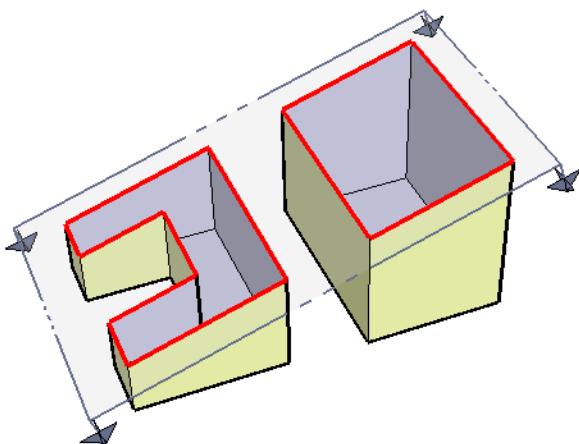


Compare this method to using an actual section plane:

1. Activate **Add Section Plane** and click the sloped face.

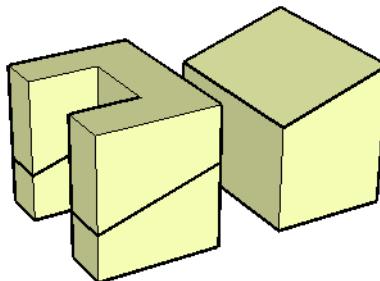


This creates a slice of both buildings.



2. Right-click on the section plane and select **Create Group from Slice**, then erase the section plane.

The section lines are left on the building, as a group.

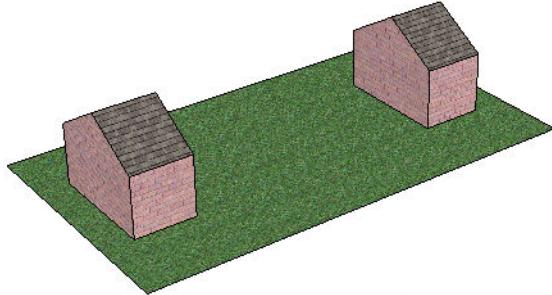


3. Explode (**Ungroup**) the section group, and you can erase the portions of the edges above the section lines.

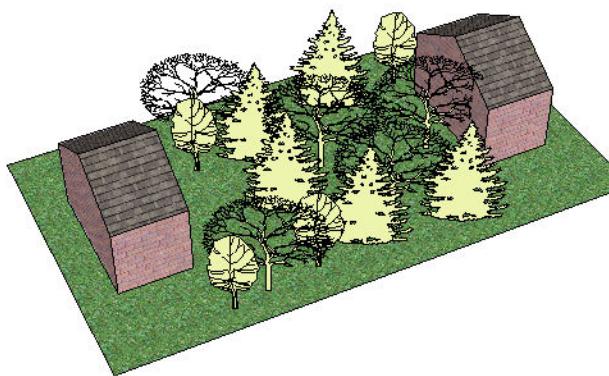
## Using Transparent Faces to Simulate Fog Effects

This is very neat and easy way to simulate fog.

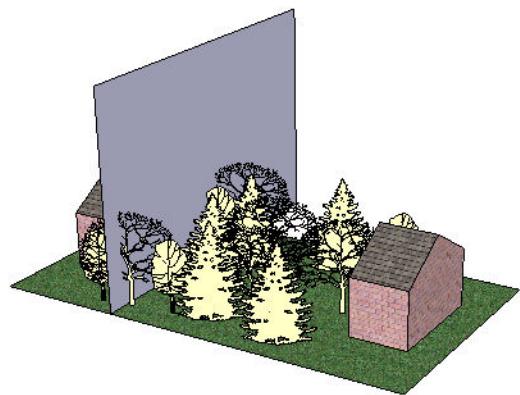
1. Make a rectangular plot of land and place two houses on it, one at each end. Apply materials if you like.



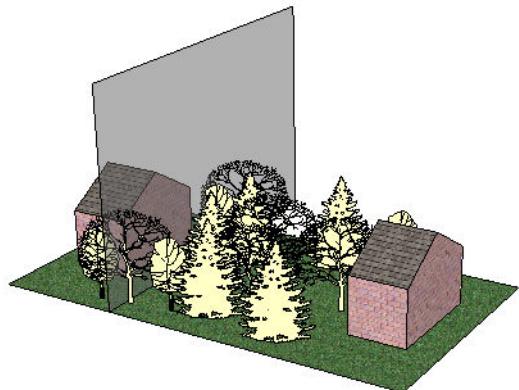
2. Open the Landscape\_Sampler category of the Components browser (or anywhere you have tree components) and insert a few trees between the houses. This example uses 2D trees, since the 3D ones are heavy and can slow down your display. If the scale isn't right, use **Measure** to resize the model.



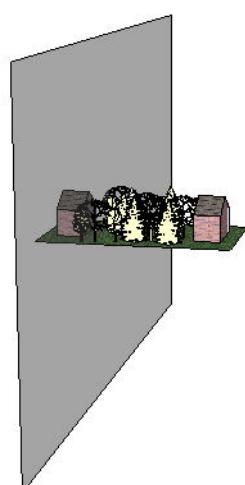
3. Draw a large vertical rectangle behind one of the houses.



4. Open the Materials Browser and apply a transparent material to this face. Gray glass would be the most realistic.



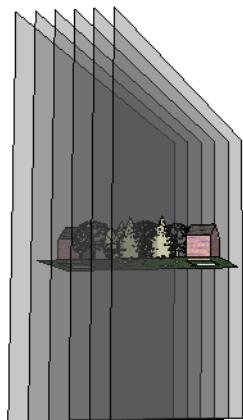
5. Zoom out and increase the size of the transparent face.




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**NOTE:** Don't know how to do this? Activate **Measure** and click any two points on the house. Type the length you want it to be and press Enter. This will resize the entire model, except for any components.

6. Make several copies of the transparent face.

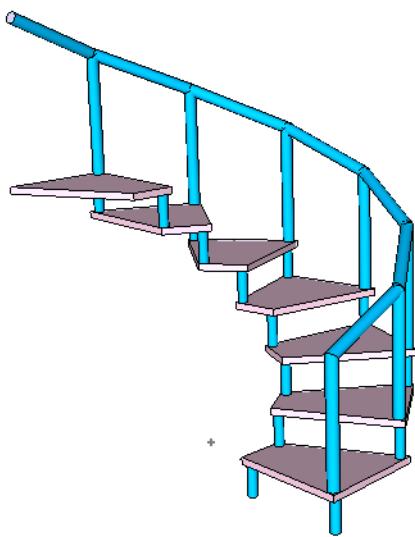


7. Zoom back in on the house and trees, which become more shrouded the farther back they are located. You can adjust the severity of the fog by adjusting the opacity of the transparent material.



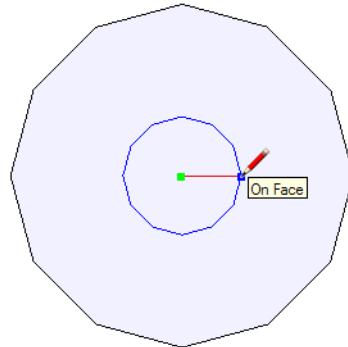
## Creating a Spiral Staircase

Spiral staircases look complex, but they are actually pretty easy to create using the components and the Outliner.

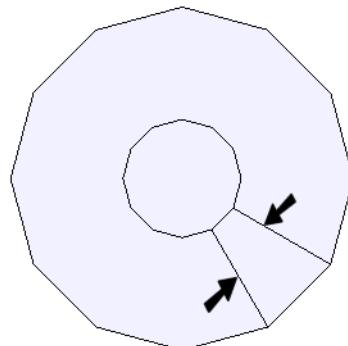


(If you want to download the completed model, go to [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm) and download the file “SpiralStairs.skp.”)

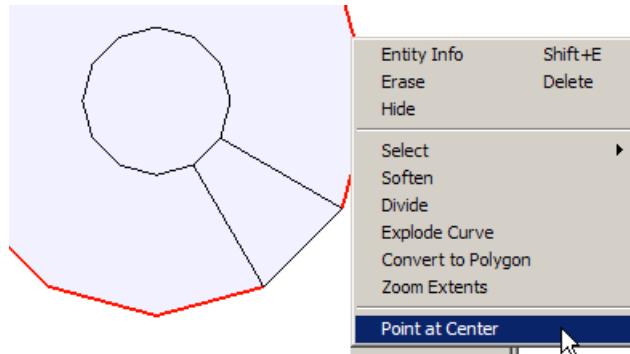
1. The first step is to outline one step. Start in **Top** view with a circle or polygon which has a small number of segments (12 in this case). Align it to the red or green direction. Draw a second concentric circle aligned in the same direction.



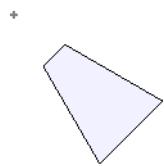
2. Draw two lines connecting segment endpoints of concentric circles. This is the outline for one step.



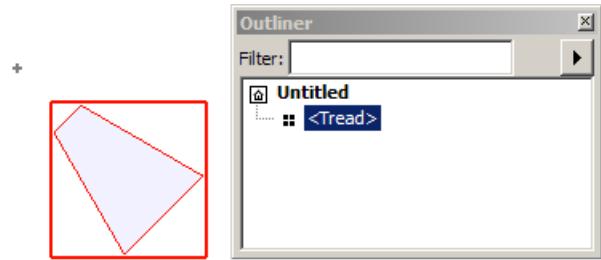
3. For reference later, create a construction point at the center of either circle.



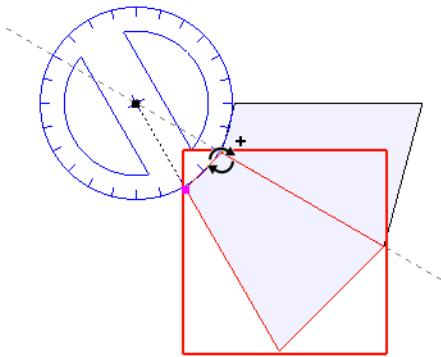
4. Erase everything except one step and the center point.



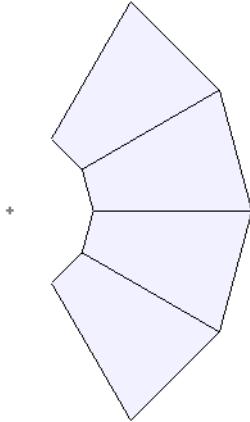
5. Make the step a component called something like "Tread." It appears in the Outliner as well as the In Model folder of the Component Browser.



6. Rotate-copy this step component, using two step endpoints to set the angle.



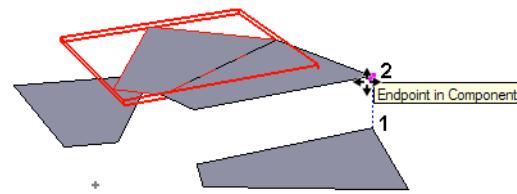
7. Enter 3x to make a total of four steps (a partial staircase for now).



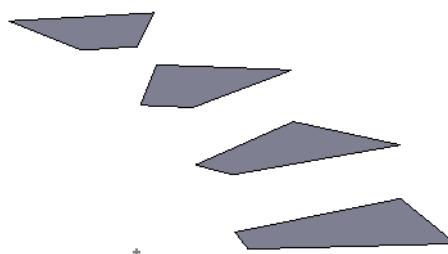
8. Select the second step and move it straight up to set the riser height.



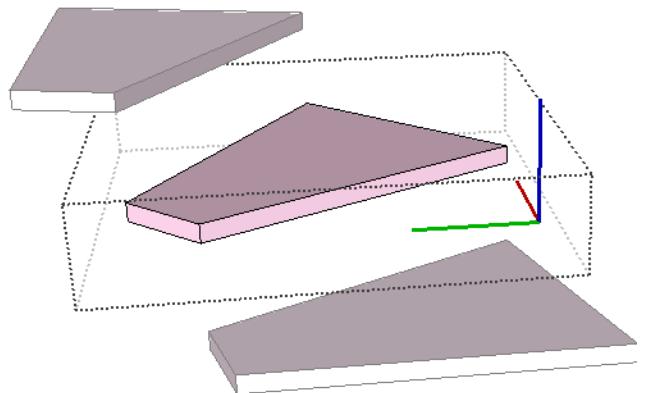
9. Select the third step and move it straight up as well (Shift-lock the blue direction). Use Points 1 and 2 to set the vertical distance.



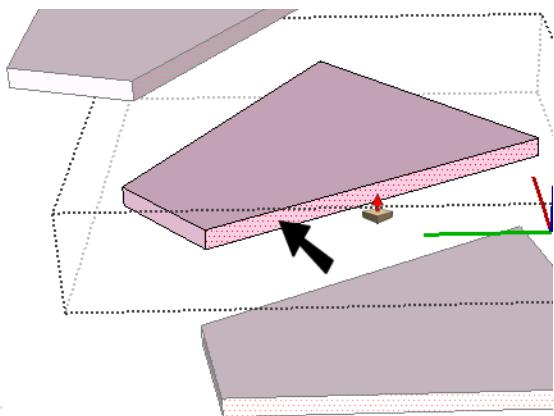
10. With the third step still selected, repeat the move by the same distance. Do the same for the fourth step (adding one vertical step) to get the four steps.



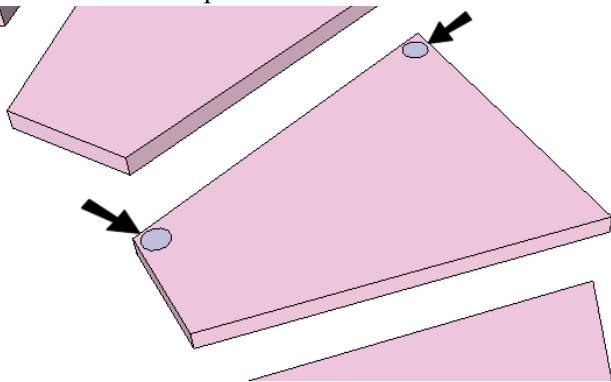
11. Edit any step and **Push/Pull** to give it some height.



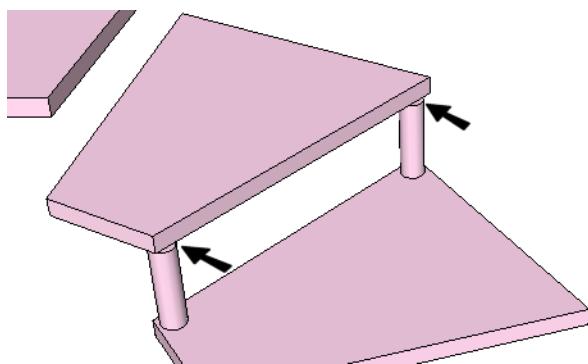
12. Use **Push/Pull** with Alt/Cmd to pull out the front face of the step. This will overlap the steps horizontally so that vertical connector posts can be created between steps.



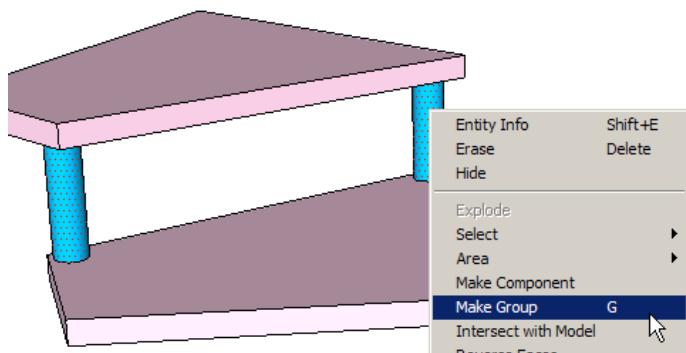
13. Close the step. Then add two small circles along the back of the step.



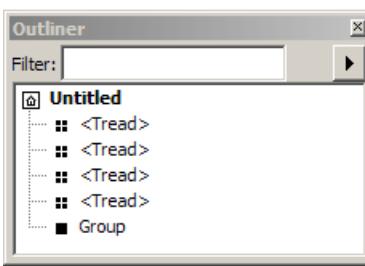
14. **Push/Pull** these circles up to the bottom of the step above. If the top face of either post is not covered by the step, edit the step component again and pull the front face out a bit more.



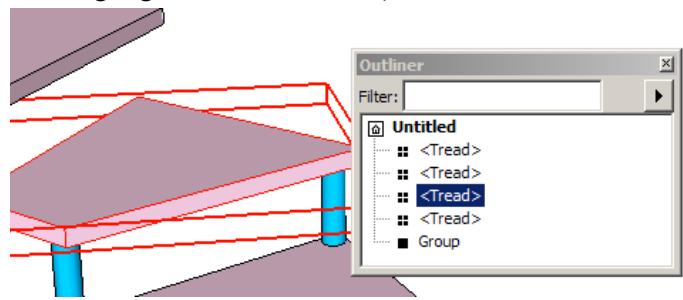
15. Select both posts and make them a group. (If you assign the posts a different color, do this before grouping.)



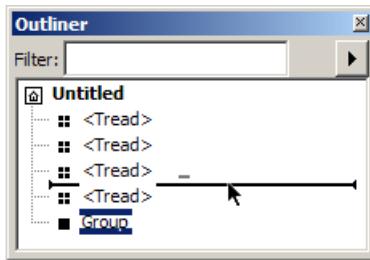
The Outliner should look like this: four step components and one group of posts.



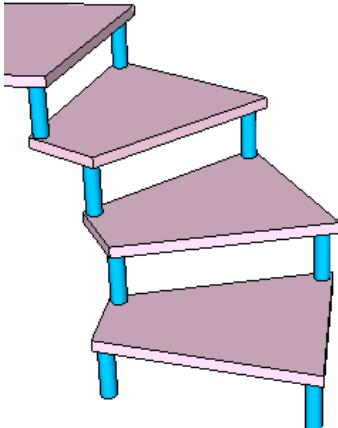
16. Select the step above the posts to see which one it is in the Outliner (selected components and groups are highlighted in the Outliner).



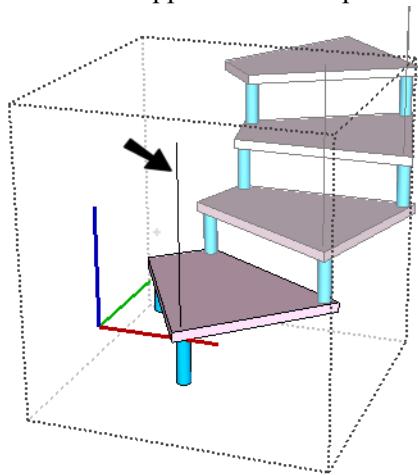
17. In the Outliner, select and drag the group of posts below the step that was highlighted.



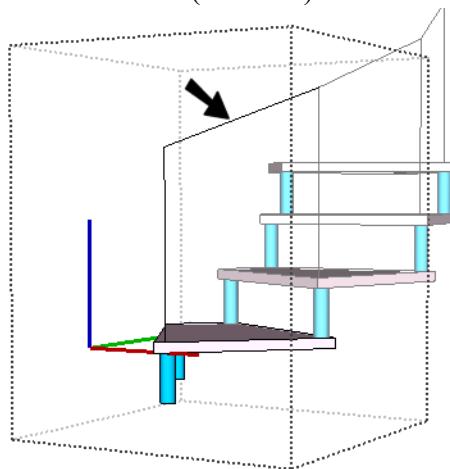
18. This makes the posts a sub-component of the step. And because all steps are identical, they each get their own group of posts.



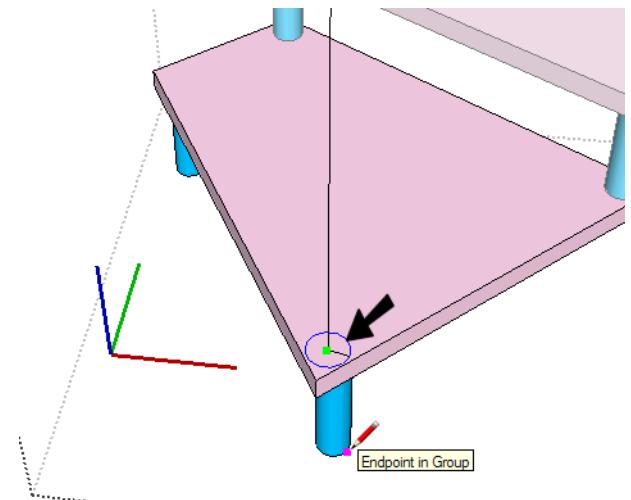
19. To create a railing, start by opening a step component and adding a vertical line from the outer bottom corner. The line appears on all steps.



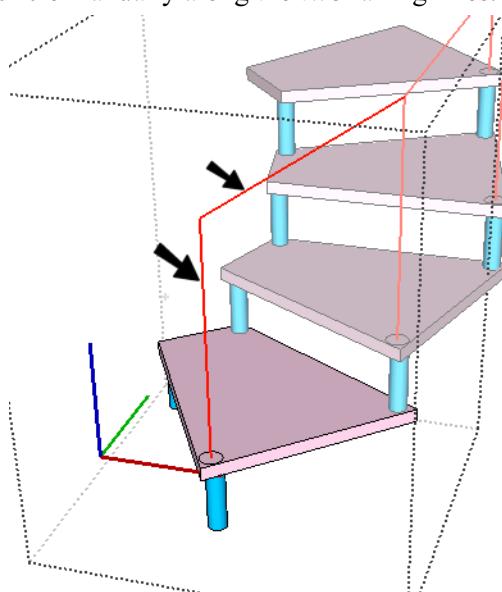
20. Draw another line connecting the vertical line to the end of the line above (or below) it.



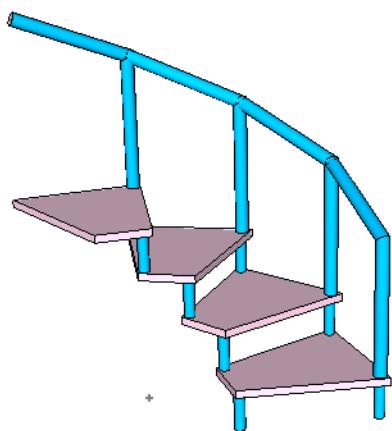
21. For the railing section, use another circle. Start it at the vertical line and click the post below to make it the same diameter.



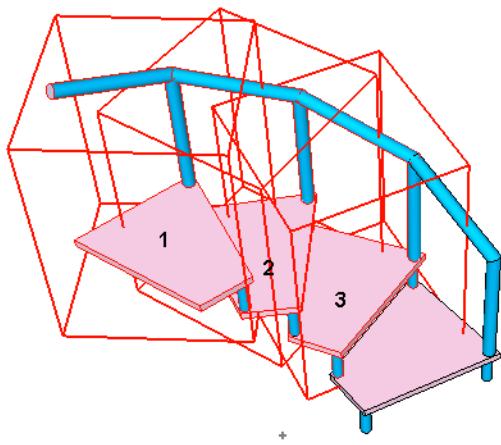
22. Use **Follow Me** to create the railing. You can either select the two railing lines first, or you can drag the circle manually along the two railing lines.



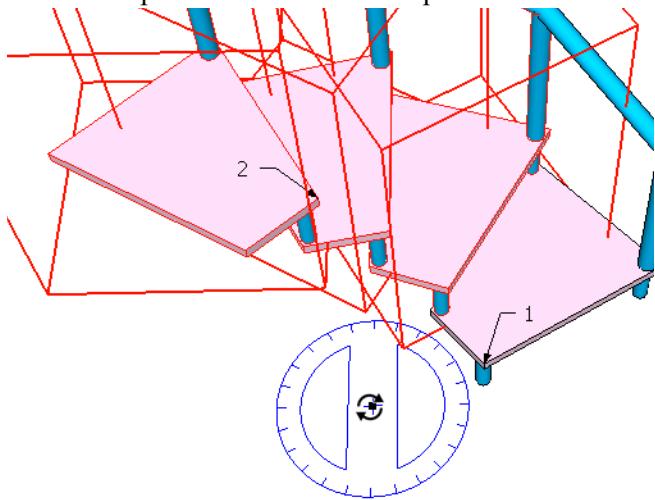
Here is the staircase so far.



23. Adding more steps is easy. Since there are now four, we can add three more (always one less than the current number). Start by selecting three adjacent steps.

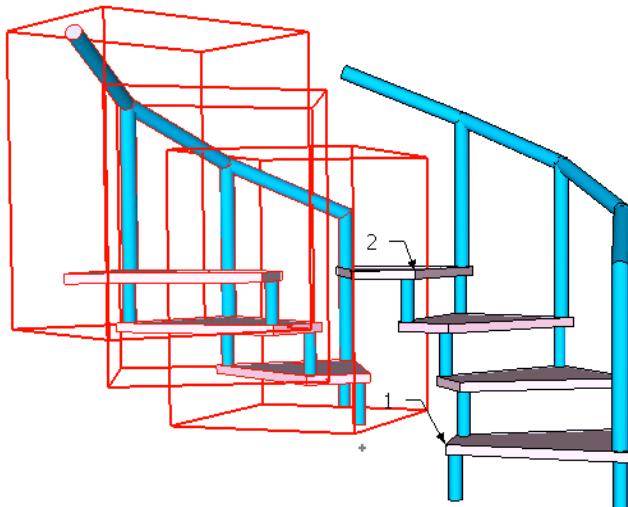


24. Activate **Rotate** and place the protractor at the center construction point. For the angle, click any two similar points between three steps.

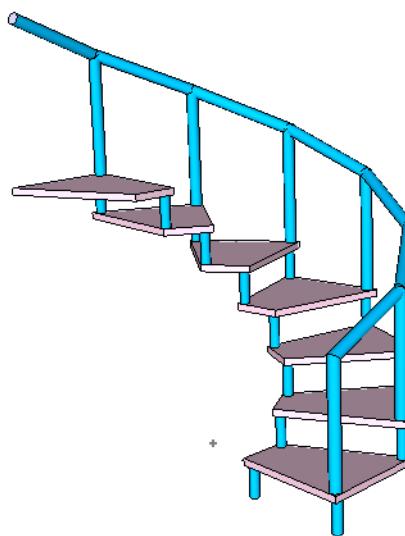


**TIP:** If you have trouble clicking points inside components, you can try adding temporary lines whose endpoints you can use.

25. With the three copied steps still selected, activate **Move** and use the same points you used for rotation. Be sure to keep the blue direction locked while moving.

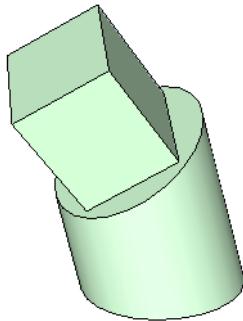


Here is the longer staircase - seven steps. If you want to continue, you can now add six more for a total of 13.



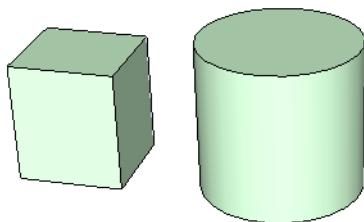
## Aligning Any Two Faces

This may not be a situation you run across very often, but it's still useful to understand how this works. It's actually not as complex as it seems when you sit down and try it.

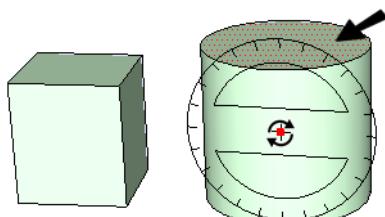


While this example is simplistic, you might find it applicable for components - inserting a component onto a face that does not conform to the red-green-blue planes.

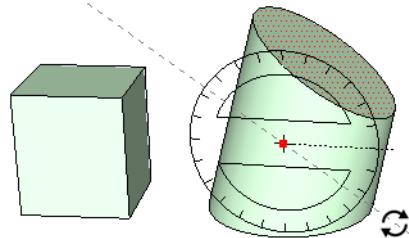
1. Start with a cylinder and a small cube. The top face of the cylinder will be rotated, and the cube will be aligned to sit on top of it. (So make the cube small enough to fit on top of the cylinder.)



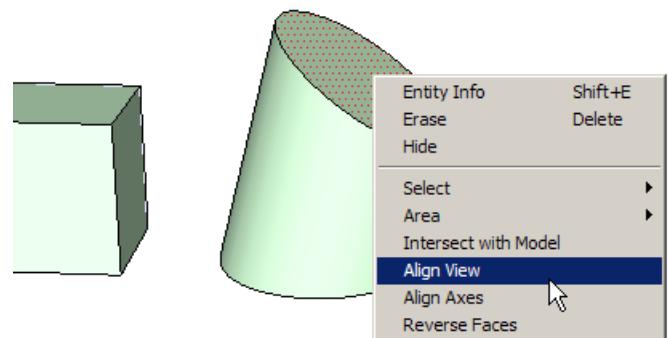
2. Select the top face of the cylinder and activate **Rotate**. Place the protractor on the cylinder as shown, facing you.



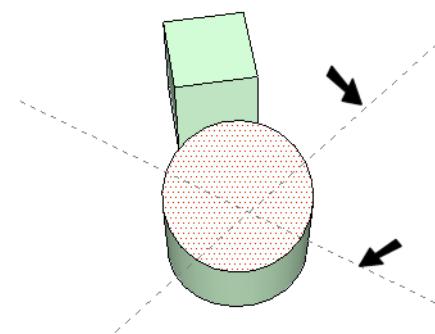
3. Align the protractor anywhere and rotate so that the cylinder bends over.



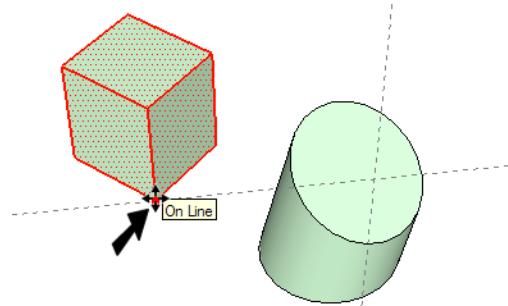
4. Two construction lines are now needed on the top face. To see this face head-on, right-click on it and select **Align View**.



5. Use **Measure** to create two construction lines on this face. They can be anywhere on the face - just select any two pairs of segment endpoints.

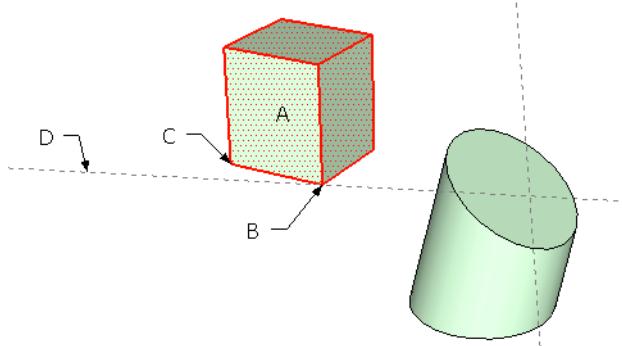


6. Select the cube and move it by dragging one of its corners to meet one of the construction lines.

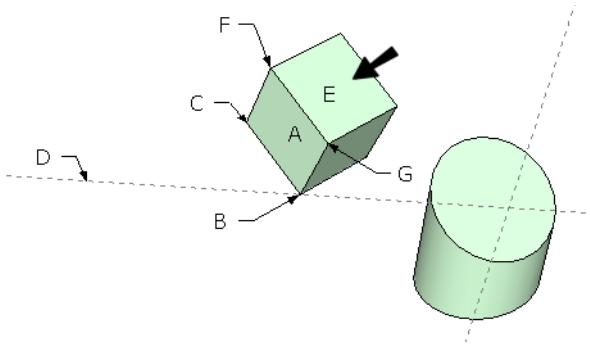


The cube must be rotated three times to have the correct orientation. The first two rotations will reference the construction line where the cube now sits.

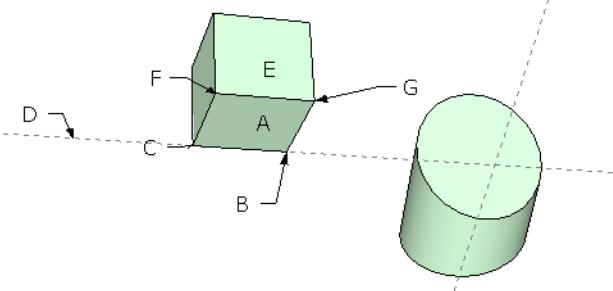
7. With the cube still selected, activate **Rotate**. Align the protractor with Face A, anchor it to Point B, and orient it toward Point C. Rotate it by clicking anywhere on Construction Line D.



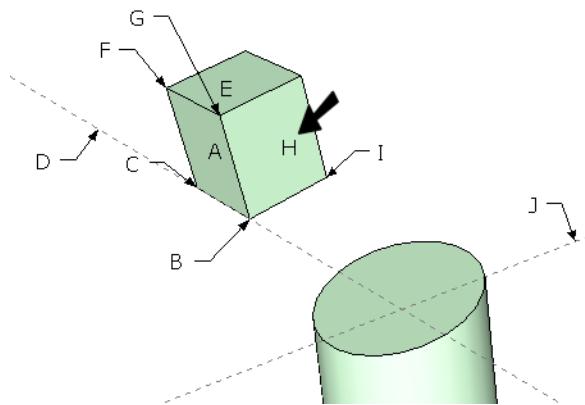
Face A is now rotated (though it may be hard to tell.) Face E will now be aligned to the same construction line. With the cube still selected, and **Rotate** active, align the protractor with Face E, anchored at Point G, oriented to Point F. Rotate it toward Construction Line D.



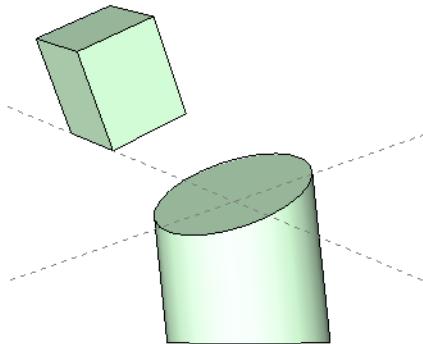
Edge BC should now sit on Construction Line D.



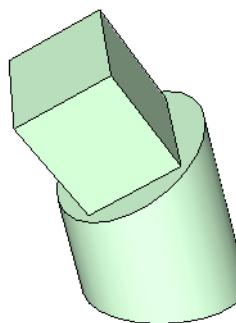
8. The last unaligned face can now be rotated. Align with Face H, place the protractor on Point B, orient toward Point I, and rotate to the other construction line (J).



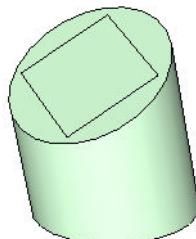
The cube now has the correct orientation.



9. Move the cube to sit atop the cylinder.



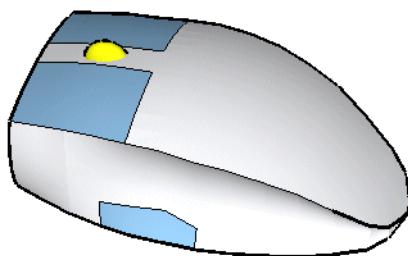
10. To verify that it is properly aligned, erase all but the bottom rectangle of the cube. Its lines are thin, indicating that all four edges are coplanar with the circular face.



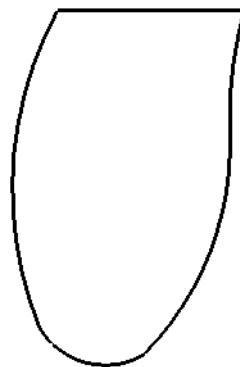
An example of a case in which you'd have to use this method would be inserting a window into a rotated face - perhaps a skylight. Obviously in such a case you'd probably rather draw the window directly into the face, but if you need to use a certain component you may need to know how to align it.

## Curvy Things

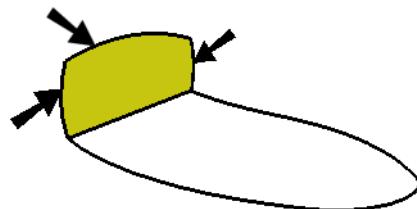
SketchUp can be used to model almost anything, using some simple tools and a bit of creativity. This exercise will create a mouse, but the method can be applied to anything.



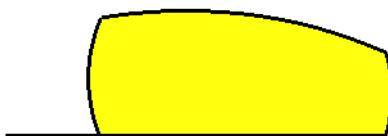
1. In the red-green plane, draw a few tangent arcs plus a line across the top, to approximate the bottom face of the mouse. Erase the face enclosed by the curves.



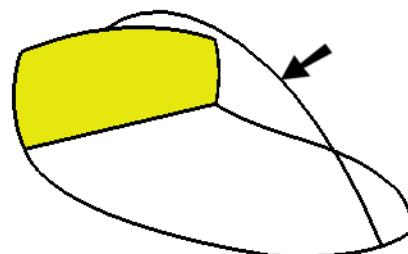
2. Draw three arcs to create a vertical face representing the section of the mouse at the top.



In Front view, the section face should look something like this:



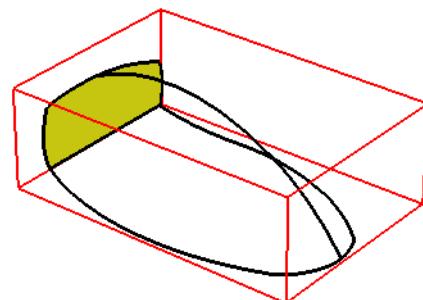
3. Now draw an arc to represent how the mouse changes shape from top to bottom.



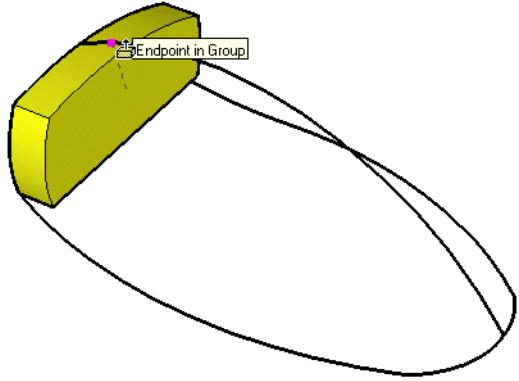
4. From the side, the curve should look like this:



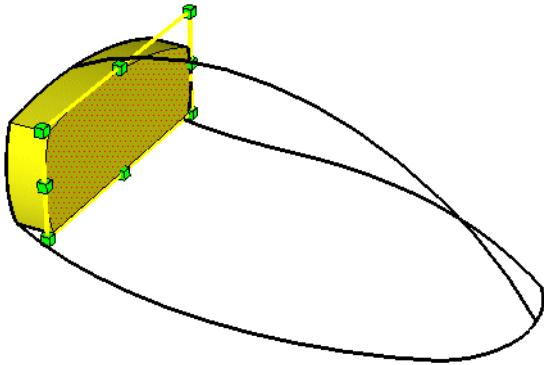
5. You now have a section face and three profile curves. Select all profile curves (do not select the face) and group them.



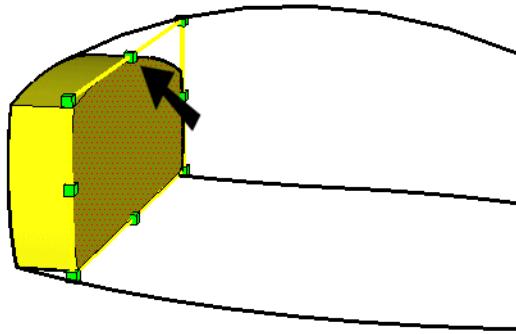
6. **Push/Pull** the section face out. You can use the endpoint of the first segment of one of the profile curves as the limit. Or you can just use an offset distance that feels right.



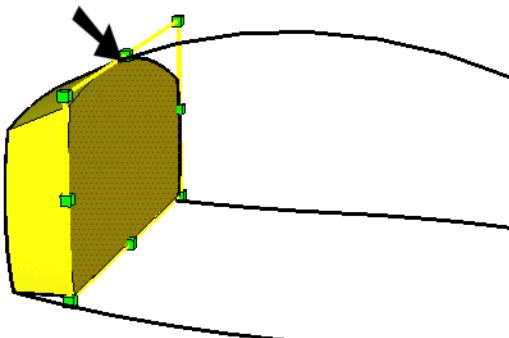
7. Select the front face of this “slice” and activate **Scale**.



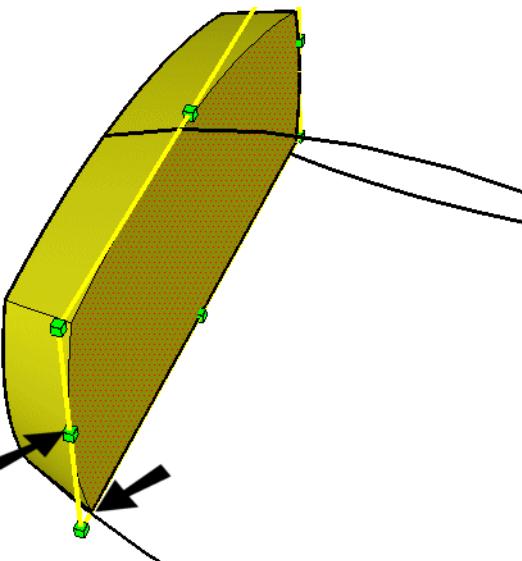
8. You want to scale this face so that it meets each of the three profile curves. First, drag the top center handle up . . .



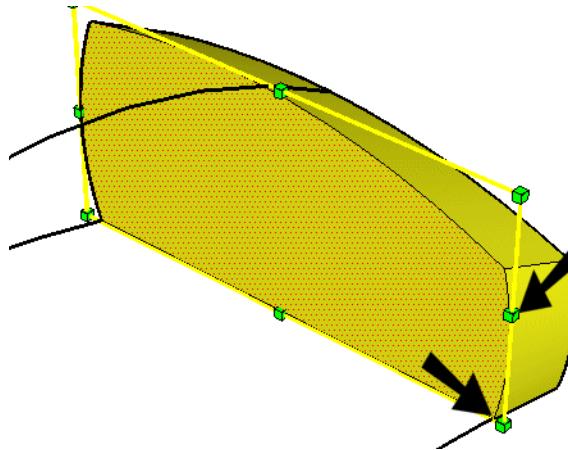
9. . . so that the face meets the top profile curve.



10. Move the left side handle so that the bottom corner meets the left profile curve.

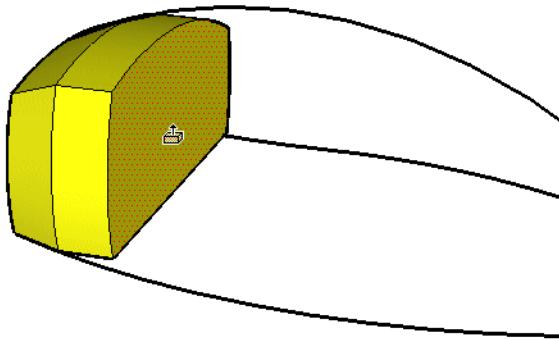


11. And do the same on the right side.

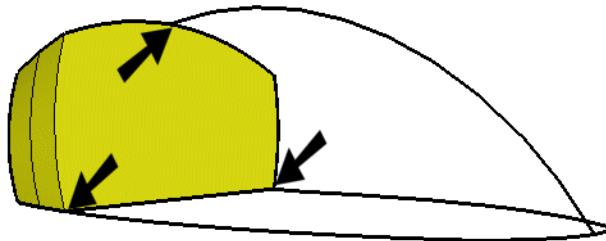


**TIP:** Non-uniform scaling is required here, so that the bottom face will stay flat. You can drag using a corner handle to scale two sides at once, but be sure to keep Shift pressed.

12. **Push/Pull** this scaled face, either by the same distance you used before (simple double-click the face), or to the next segment endpoint.

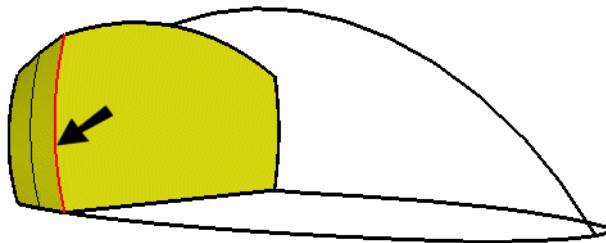


13. Scale the front face as before, so that the top and lower two corners meet the profile curves.

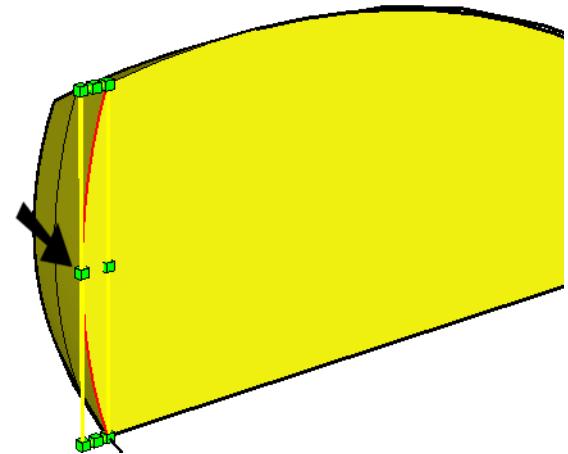


Usually a right-handed mouse has an indentation on the left side for your thumb. The way to handle this is to scale the left arc gradually so that it turns from convex to concave. We'll do this over three segment iterations.

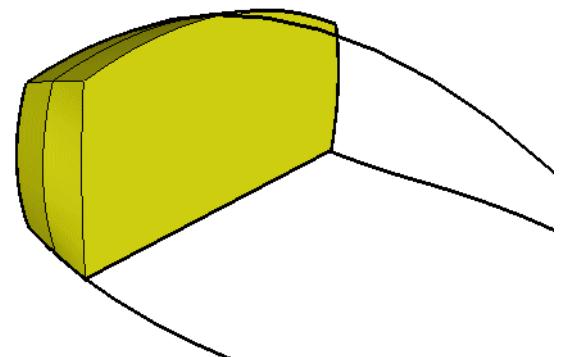
14. First, select this arc.



15. Activate **Scale**, and drag the outer side handle slightly inward.

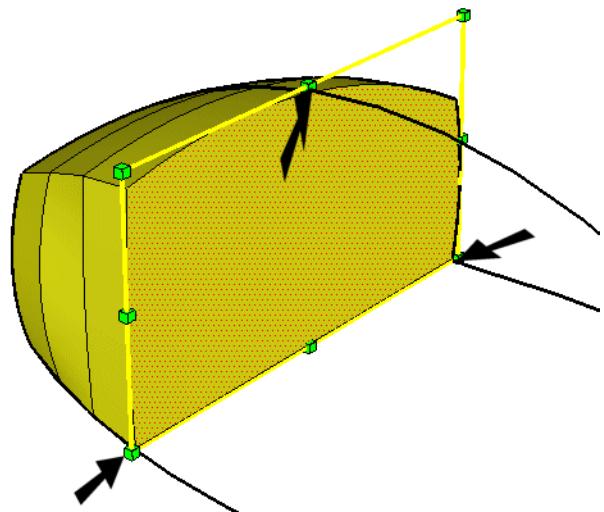


16. The side is starting to look pushed in.

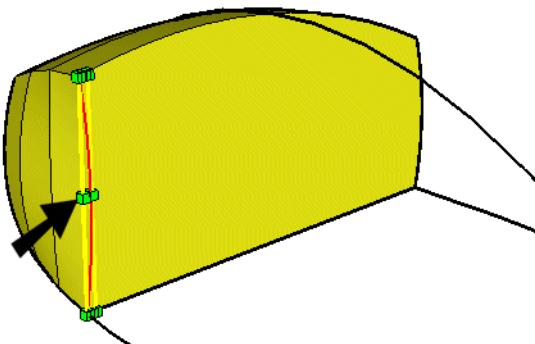


Over the next three iterations, perform the same series of steps:

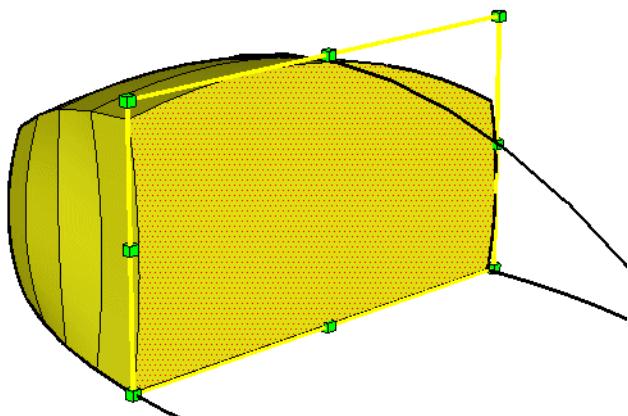
17. **Push/Pull** and scale the front face.



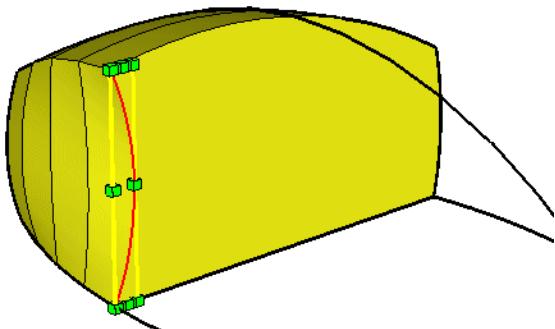
18. Scale the left arc slightly inward.



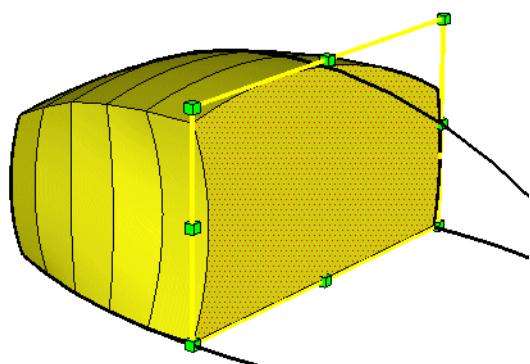
19. **Push/Pull and Scale.**



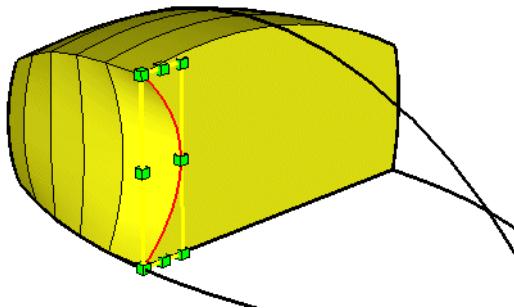
20. Scale the arc.



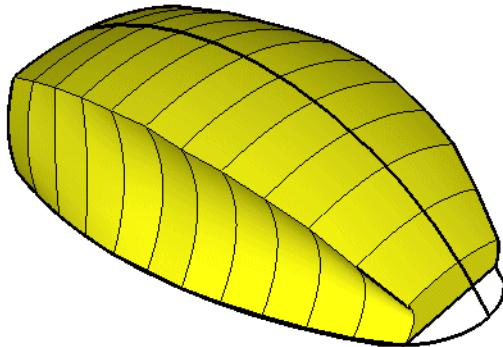
21. **Push/Pull and Scale.**



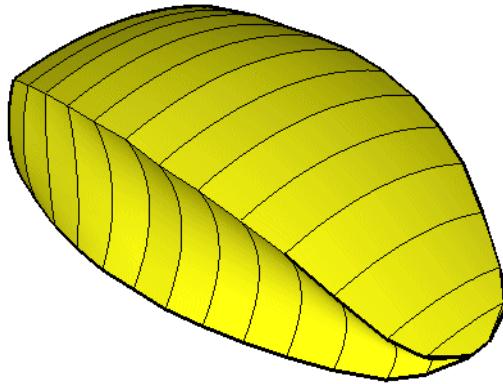
22. Scale the arc. It should now look pretty concave.



23. For the remainder of the mouse, do the **Push/Pull** and **Scale** step, but leave the left arc as is - it is scaled enough.

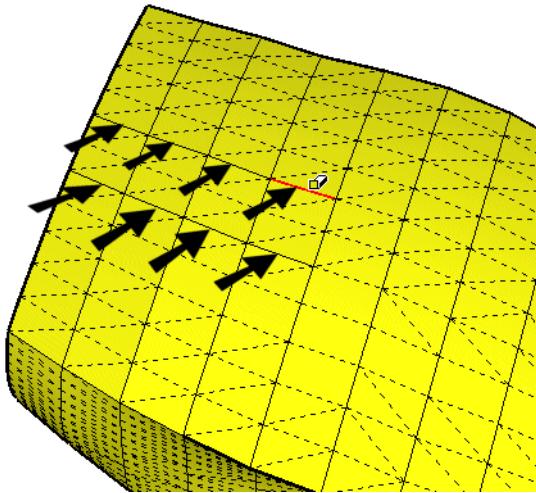


24. For the last segment, you may want to use divide the area into two or three iterations. You can fill in the last few lines by hand, or you can **Push/Pull** to the end of the profile and scale the face almost to nothing. The profile curves are no longer needed.

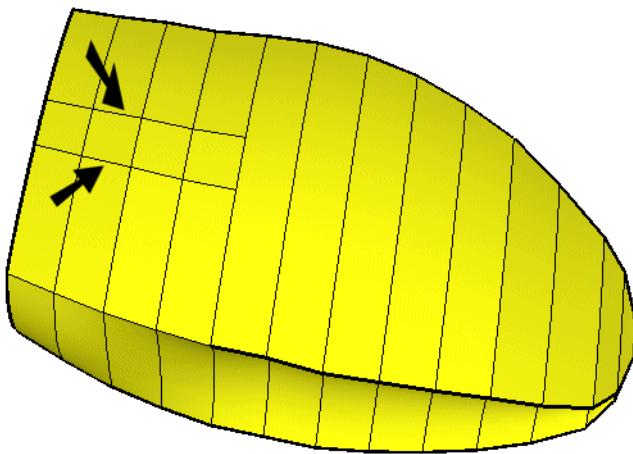


The basic shape is complete, but we can dress up the mouse a bit.

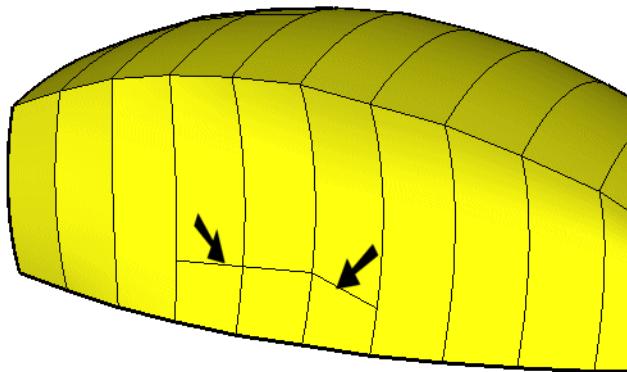
25. Display hidden edges. Unsoften a few edges, as shown below, by activating **Erase** and clicking on them while pressing Shift+Ctrl/Option.



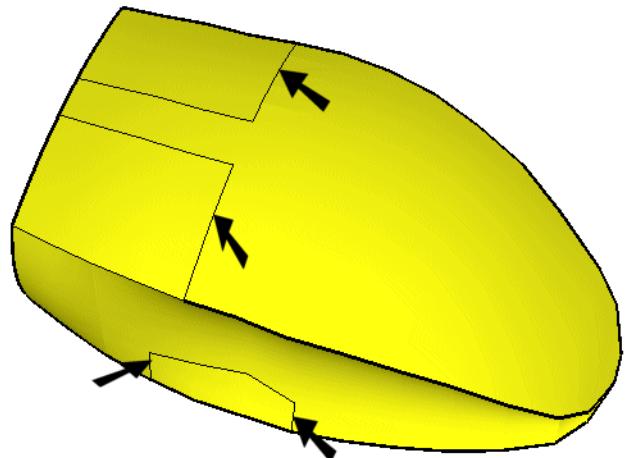
26. Hide the edges, and you should now see two lines. These represent where the left and right mouse buttons will go.



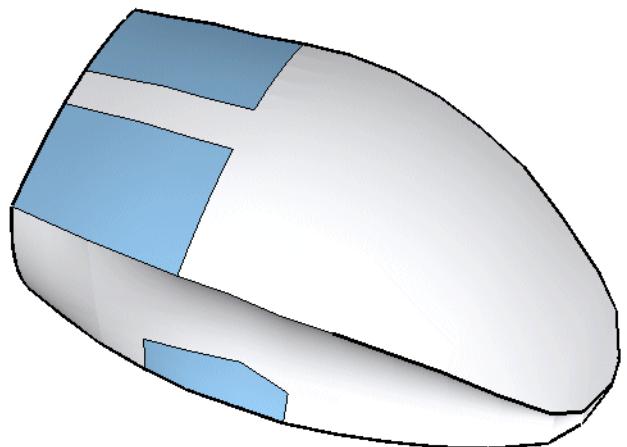
27. Use the same method to create some lines for the thumb button.



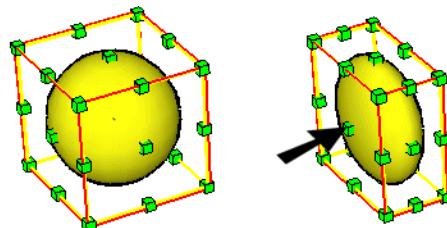
28. To block off these areas, add a few extra lines as shown. It's probably easiest to do this while displaying hidden edges as a guide. Soften the remaining segment edges by using **Erase + Ctrl/Option**.



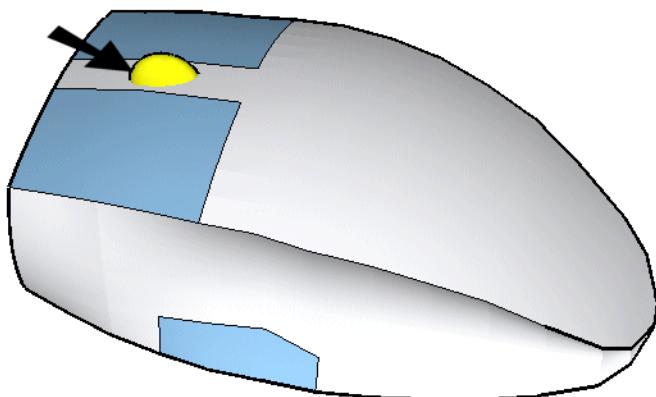
29. Use your Materials browser to color the mouse and its three buttons.



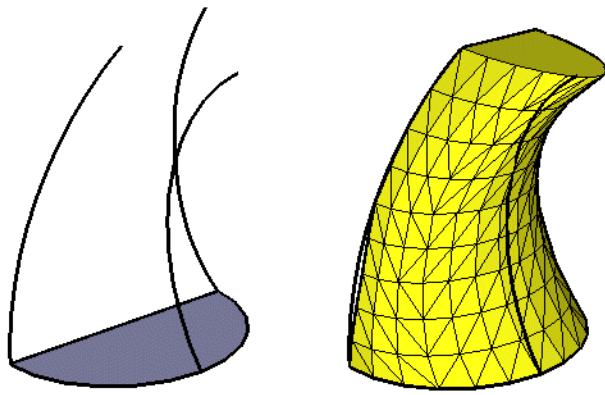
30. For the mouse wheel, bring in a Sphere component from the Shapes category. Use **Scale** to adjust the overall size, and to push in the sides.



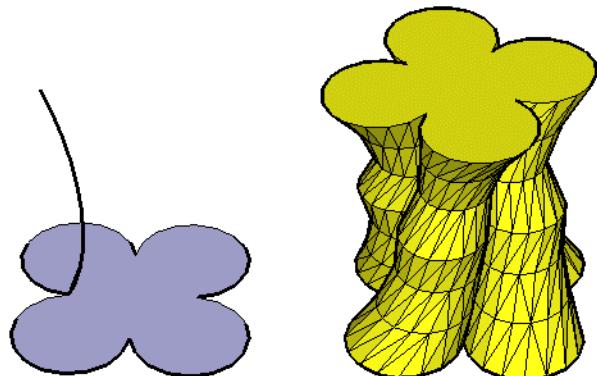
31. Use **Move** to place the wheel where it belongs.



This method is so flexible - it can be used to make anything. Here's another example with a section face and three profile curves:



To add another “twist,” you can even rotate the scaled faces.

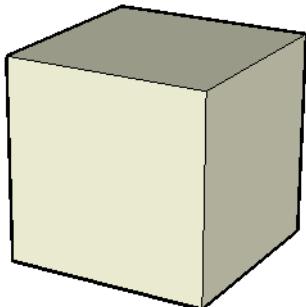


## 3D Geometric Objects

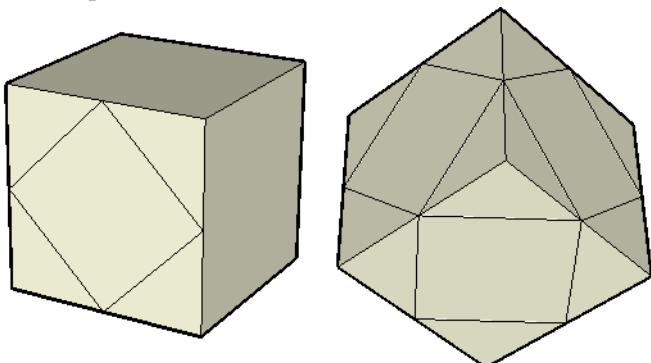
SketchUp is great for applications you might not have thought of: for instance, creating geometric objects like polyhedrons. Here are a few examples, some simple and some a bit more complex. These probably won't help you much in your job, but I included them because they appeal to the geeky engineer in me (plus they're pretty cool).

### Starting from a Cube

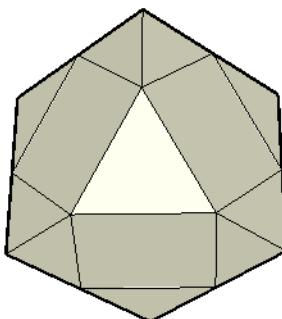
1. Start with a cube. To make it exact, create the initial rectangle with equal side, using the format “100,100.” Then **Push/Pull** it up the same distance.



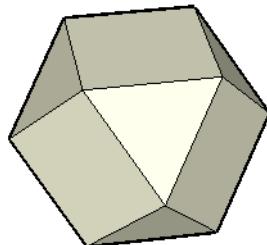
2. On each face, draw diagonal lines to connect edge midpoints.



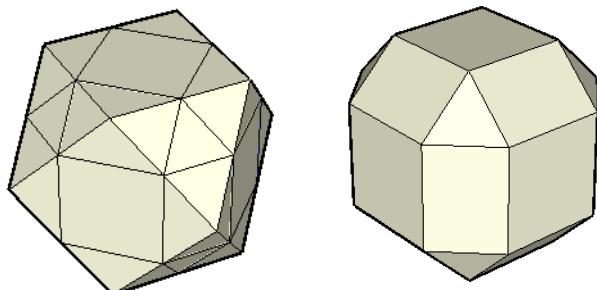
3. Between the diamond shapes on each face is a triangular pyramid. Erase the edges of one of these pyramids.



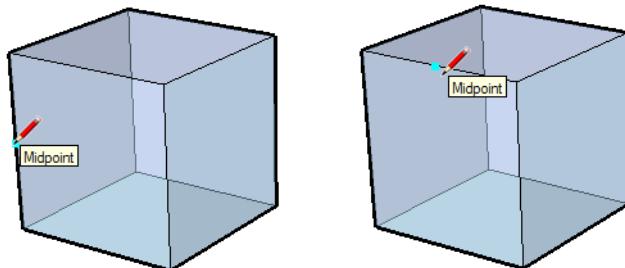
4. Continue doing the same around the entire cube. You should be left with a series of connected squares and equilateral triangles. This is called a cube-octohedron.



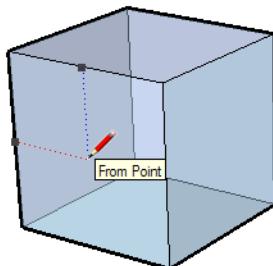
5. For more facets, perform the same steps: connect midpoints on each square and triangular face, then delete the pyramids.



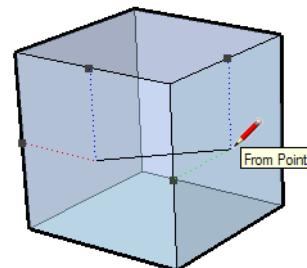
6. Here's another thing you can create from a cube - a tetrahedron. Start with another cube. Because the lines you draw will be inside the cube, switch to **X-Ray** mode. Activate **Line** and hover over the midpoint of one edge and then a midpoint of an adjacent edge.



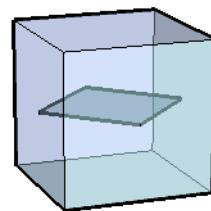
7. Start the line at the center of this face.



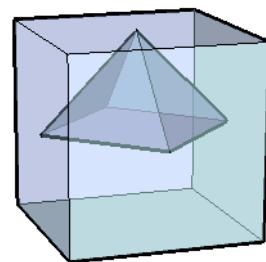
8. End the line at the center of an adjacent face.



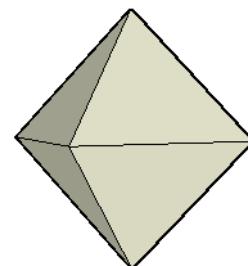
9. Continue like this, connecting centers of the four side faces.



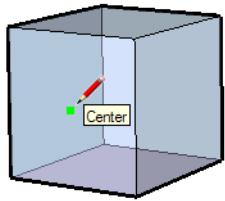
10. Then connect each corner of this new face to the center of the top face. This creates a tetrahedron - a four-sided pyramid.



11. You could copy the tetrahedron, flip the copy over and join it to the first one to make an octohedron.

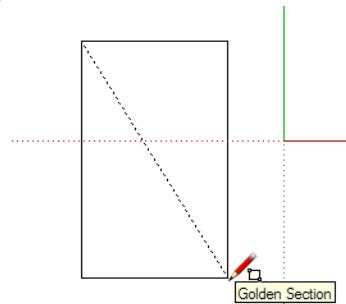


**TIP:** If you had created the cube using four-sided circles or polygons, you could have easily found the center of each face.

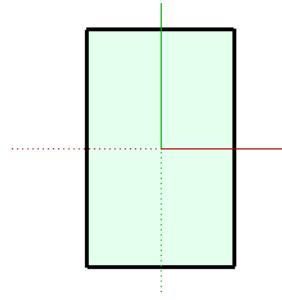


## Starting from a Golden Section

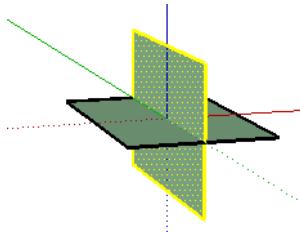
1. Display the axes and in **Top** view, use **Rectangle** to draw a golden section.



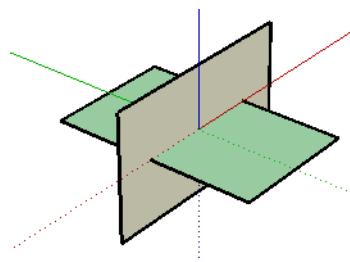
2. Move the rectangle so that it is centered at the origin.



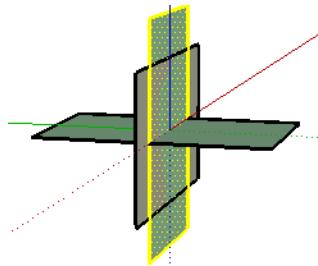
3. We will now create two rotated copies of the rectangle. First rotate-copy the rectangle 90 degrees about the green axis.



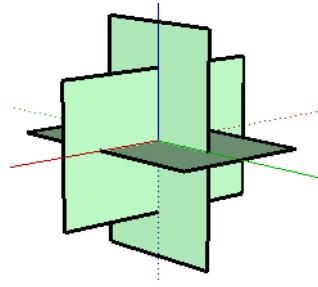
4. Rotate this copy 90 degrees about the blue axis.



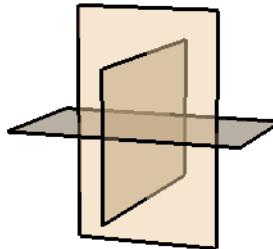
5. Do the same for the third copy: rotate-copy the original rectangle 90 degrees about the red axis . . .



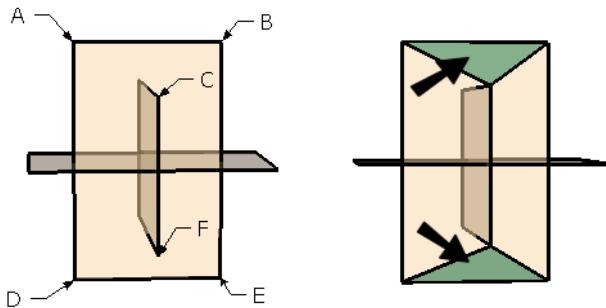
6. . . then rotate this copy 90 degrees in blue.



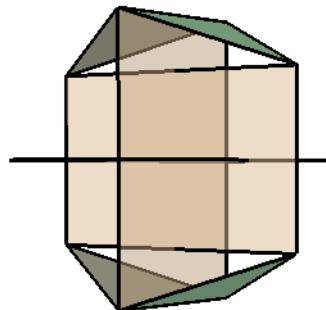
7. For display purposes, you might want to assign a different color, or transparency, to these rectangles.



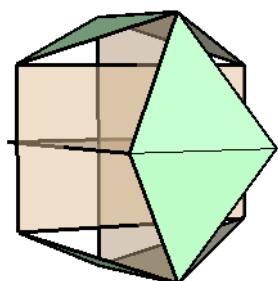
8. The corner points of these three planes can be connected to create 20 equilateral triangles. In this view, add lines to connect A-C, B-C, D-F, and E-F. Two triangles are created. (Extra faces will be also created - you can keep these or erase them.)



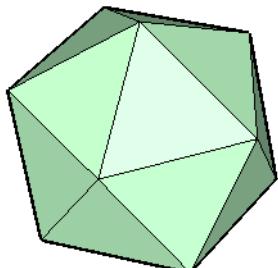
9. Spin around to the other side and create similar triangles.



10. Continue orbiting around and adding triangles this way.



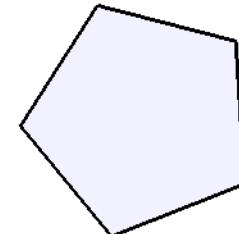
Eventually you get an icosahedron: a 20-sided polyhedron comprised of equilateral triangles.



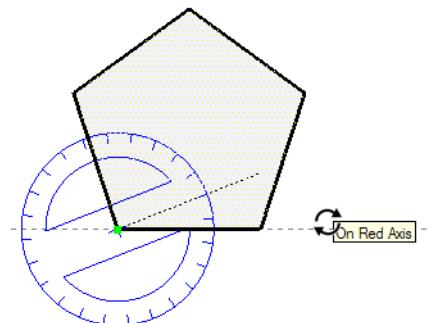
## Starting from a Polygon

This last exercise is the most complex, resulting in a dodecahedron. There are other ways to create it, but here's what I came up with:

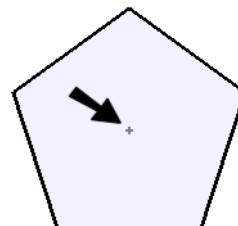
1. Start with a single pentagon. Use **Polygon** for this, and specify five sides. Place it in **Top** view, using any orientation.



2. It's easier if one edge is along a standard axis, so select the pentagon and activate **Rotate**. Click the endpoints of any edge and orient the edge horizontally (red axis).



3. We will be rotating often about the center of the pentagon, so right-click on it and select **Point at Center**.

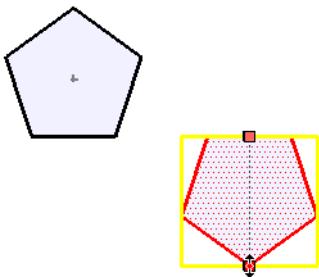



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**NOTE:** For **Point at Center** to be available, open **File / Preferences** to the **Extensions** page and check **Ruby Script Examples**.

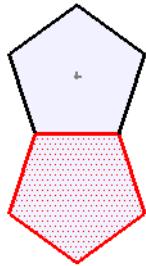
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4. A second pentagon will be added along the horizontal edge of the original one. Select and copy the pentagon, then use **Scale** to flip the copy over.



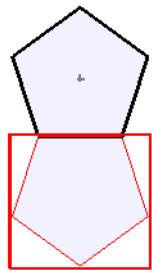
**TIP:** You could also right-click the copy and select **Flip Along / Green direction** to flip it over.

5. Move the copy into place like this.



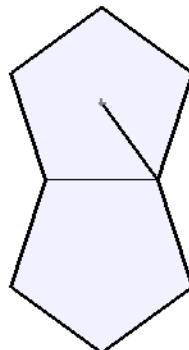
The copy needs to be folded over the original. You could easily look up the angle in geometric tables (it should be 63.454 degrees), but here's a way to do without knowing the angle in advance.

6. To make things easier later, make a **Group** of this copied pentagon. It will be clear why in a few steps.

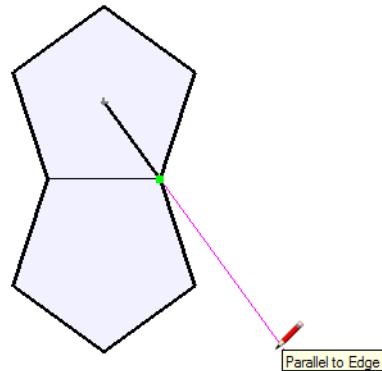


The next few steps are performed to find the rotation angle you need to use when folding over the pentagon faces.

7. From the center of the top pentagon, draw a line to one end of the common edge.

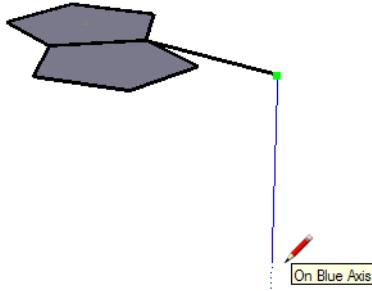


8. Draw another line in the same direction, going past the copied pentagon.

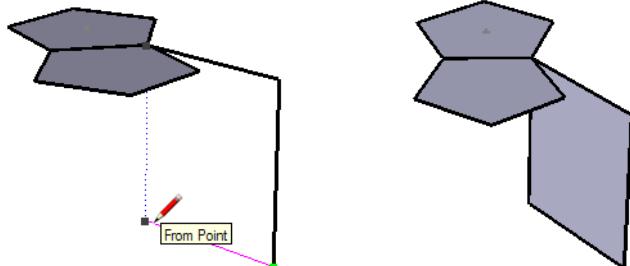


This line will be used to create a vertical rectangle. When you fold over the copied pentagon, the rotation stops when you intersect this face.

9. Create the rectangle by adding a vertical (blue) line.

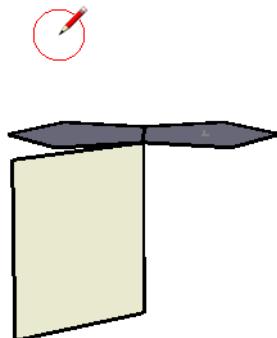


10. The next edge should be parallel to the one above it.

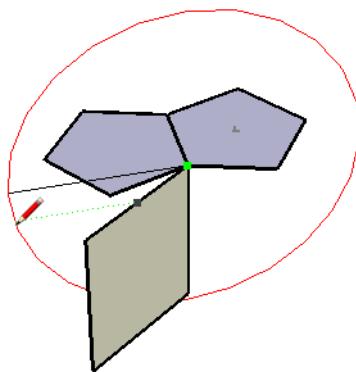


Now for the tricky part. We will use **Follow Me** to drive the copied pentagon along a circle that is normal to the common edge. Sounds confusing, but when you do the steps it should become clear!

11. Activate **Circle** and specify a high number of sides, such as 120 (the higher the number of sides, the more it approximates a real circle). Lock the circle preview so that it is normal to the common edge between the pentagons. In other words, it should be vertical and red. Press Shift to lock this orientation.



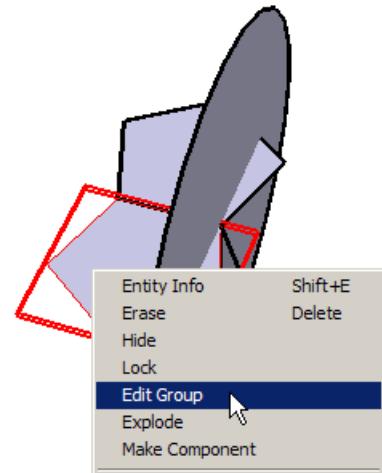
12. Place the circle center at the common endpoint, and make it large enough so that it sticks out past the pentagon (this makes it easy to delete later).



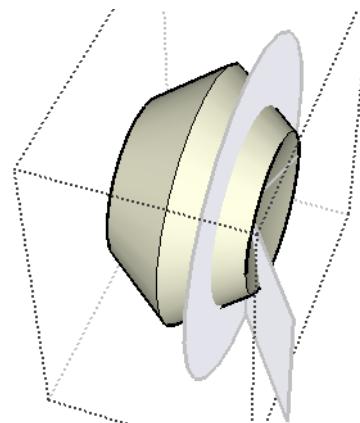
Here's what you should have now: a vertical rectangle and a vertical circle.



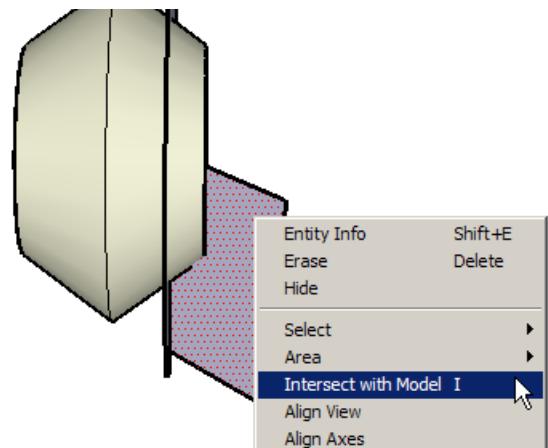
13. Select the circle and then activate **Follow Me**. Then right-click the copied pentagon (which is a group) and select **Edit Group**.



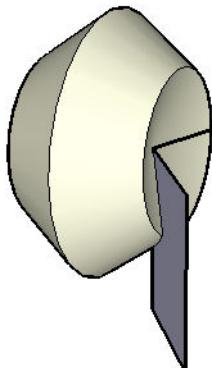
14. Select the pentagon face (the only thing in the group), and it is driven around the circle.



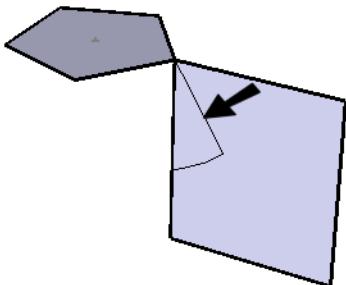
15. Close the group. Then right-click the vertical face and select **Intersect with Model**.



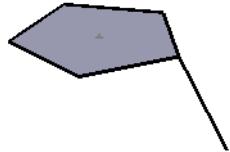
16. This gives you the intersection edge where the extruded pentagon meets the vertical face. To see this better, first erase the vertical circle.



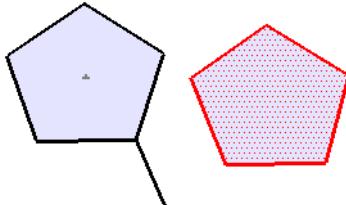
17. Then erase the **Follow Me** group (this is why you grouped it in the first place). What's left is the vertical face and a few intersection edges. The important one is shown here:



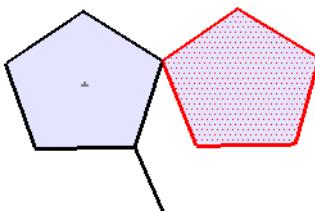
18. Erase everything but this edge. This edge tells you how far to fold the flat pentagons that are placed around the center pentagon.



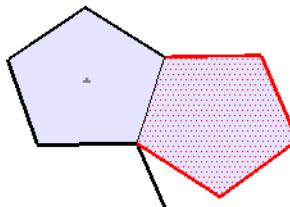
19. Copy the original pentagon again.



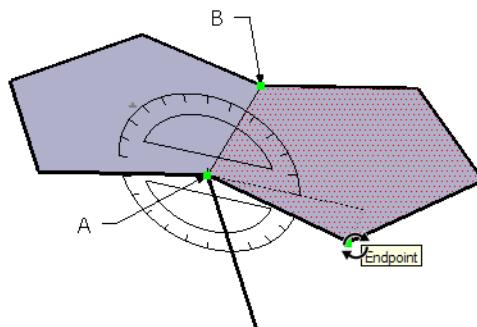
20. Use **Move** to place it here . . .



21. . . and **Rotate** to join the edges.



22. With the copied face still selected, activate **Rotate**. This time we need to define a rotation angle, since the fold direction is not along the red or green axis. Place the protractor at Point A, keep the mouse button pressed, and then click Point B. This makes the rotation normal to Edge A-B. Click the endpoint shown to set the protractor orientation.

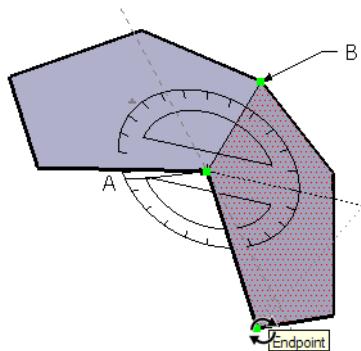



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*NOTE: We could have copied the pentagon to meet the horizontal edge instead, so that you could just use the Red axis for rotation. But this is a good place to show how to define a rotation axis.*

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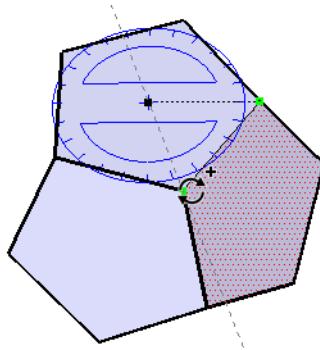
23. End the rotation at the end of the intersection edge.



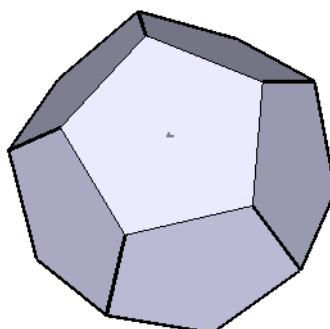
24. Check the VCB for the rotation angle, which should be 63.454. (It will probably be slightly off, since the circle wasn't really a true circle. That's why a high number of sides was used.)

**Angle ~ 63.4**

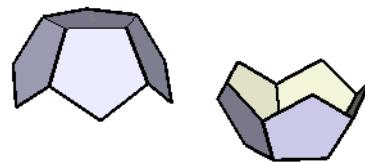
25. With the folded pentagon still selected, and still in **Rotate**, place the protractor at the center of the original pentagon, and make a copy between adjacent corner points. The common edges should all line up.



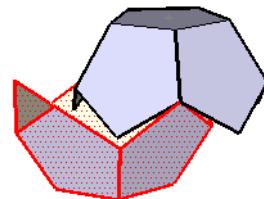
26. Enter 4x to get five total folded pentagons.



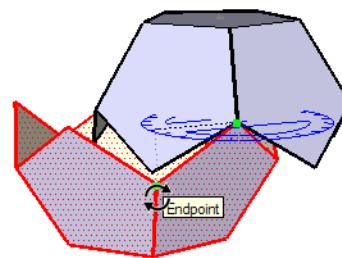
27. To complete the other half, make a copy and flip it over.



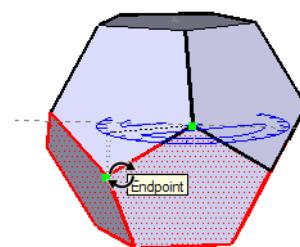
28. Use **Move** to join two endpoints.



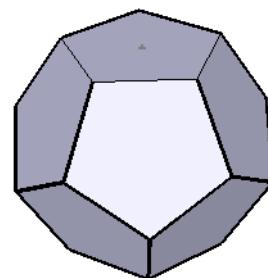
29. Then use **Rotate**, making sure the protractor is oriented in the red-green plane (should be blue). Click the endpoint shown . . .



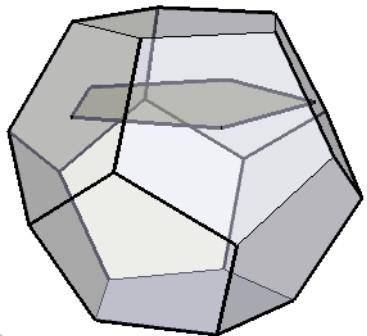
. . . and rotate it into place.



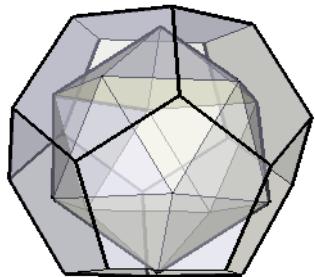
Here's the final result, a dodecahedron.



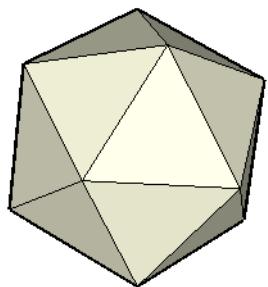
30. If you really like this stuff and want to continue, here's something neat you can do with a dodecahedron. Like you did with the cube to make a tetrahedron, use lines to connect the centers of adjacent faces. These faces should still be polygons, so you can easily find their centers.



31. If you connect all the faces correctly, you should get an icosahedron inside.



32. Erase the outer dodecahedron to see the 20-sided object.

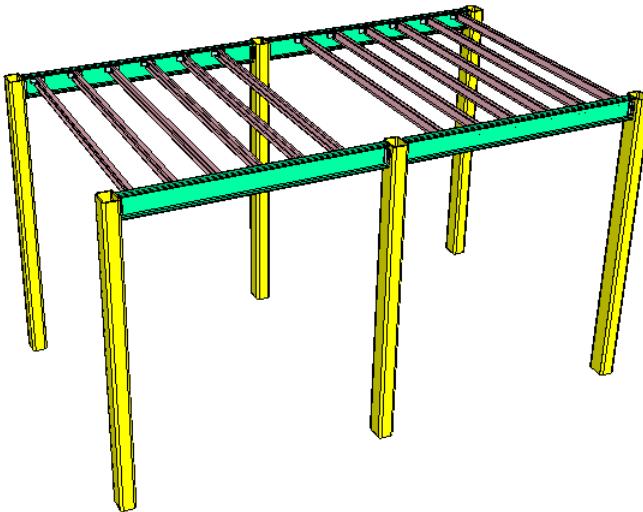


# 13 In-Depth Exercises

This chapter contains two exercises that combines many of the concepts presented throughout this book. While mainly an exercise in the use and editing of components, you will also use most of the drawing tools, as well as move, copy, and rotate.

## Creating a Steel Frame

The final result will be a building frame created from structural shapes that were imported as components.



For those of you not familiar with structural design or architectural construction, “rolled shapes” refers to the standardized steel cross-sections used to make I-beams, channels, tubes, etc. These shapes have standard names, and their properties can be found in steel industry handbooks.

(If you want to download the completed model, go to [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm) and download the file “SteelFrame.skp.”)

### Downloading Structural Shapes

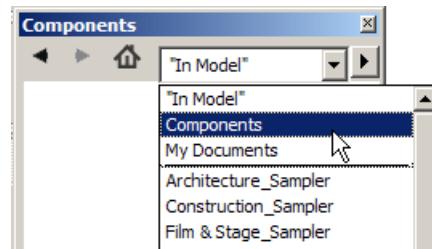
SketchUp has created components of many structural shapes, and has made them available for free download. So if you don’t want to take the time to create your own shapes, do the following:

1. Go to [www.sketchup.com](http://www.sketchup.com) and click “Downloads.”
2. Click “Components” which is located near the top of the page.
3. Find the “Mechanical Design” set and follow download instructions.

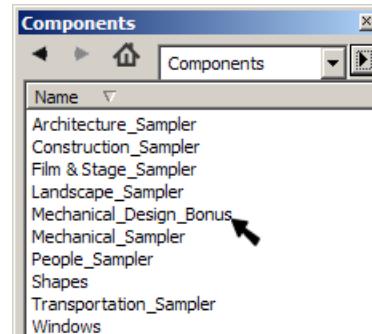
4. Follow installation instructions. If SketchUp is open, close it and re-open it.

TIP: *“Where to Find More Components” on page 193 for more information on downloading components.*

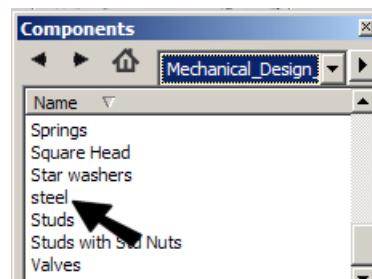
5. Open the Component Browser and click on Components in the drop-down menu.



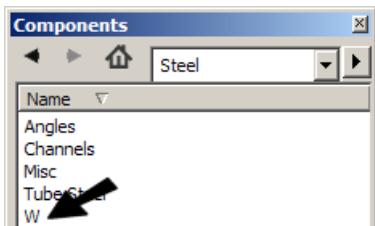
6. Click the Mechanical Design Bonus folder, which is what you just downloaded.



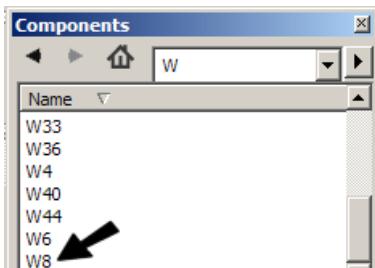
7. Find the “Steel” folder.



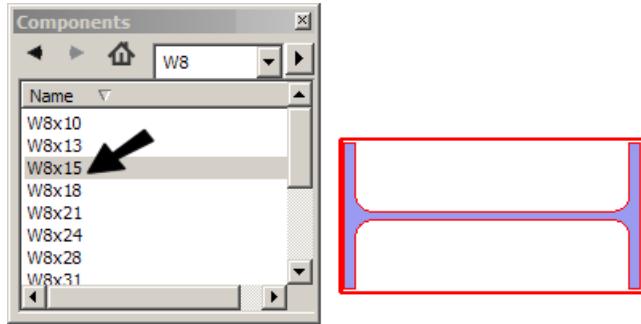
8. Steel shapes are divided into angles, channels, tubes, etc. The first shape to get is W8x15, so open the W folder.



9. Then find the W8 folder.

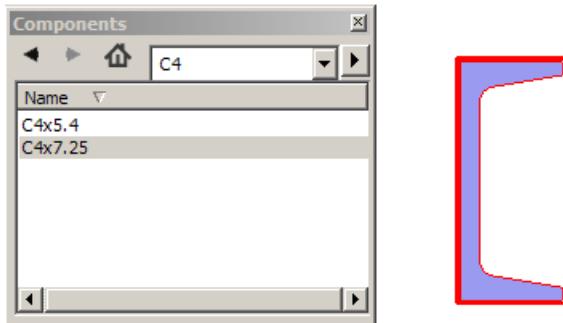


10. Click W8x15 and bring it into the file.

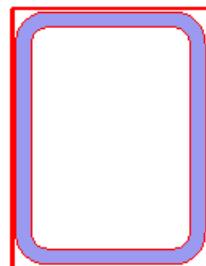
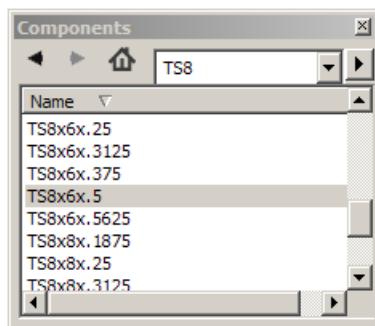


The other shapes to find are:

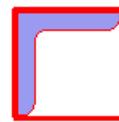
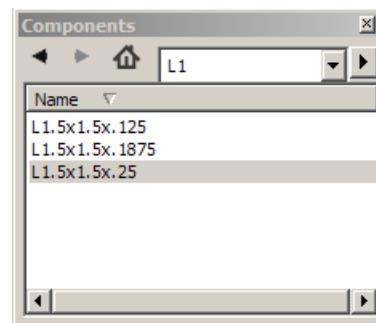
11. C4x7.25 (under “Channels”)



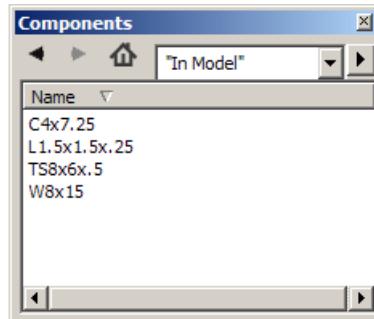
12. TS8x6x.5 (under “Tube Steel”)



13. L1.5x1.5x.25 (under “Angles”)



These four shapes should now appear in **In Model**.



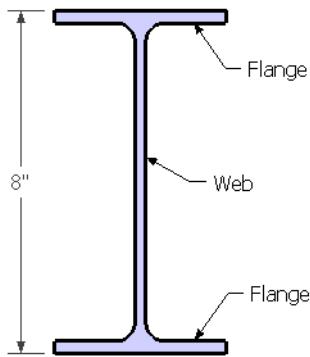
Once you have these shapes, you can skip to “Creating the Frame” on page 415.

## Creating Your Own Shapes

Each cross-sectional shape should be located so that its geometric center is *approximately* at the origin of the file (the point where the red, blue, and green axes meet). This is because the component you create from the cross section includes the file's origin. If the shape is created far from the origin, the entire component will include a large area, and will be unwieldy to insert into another file.

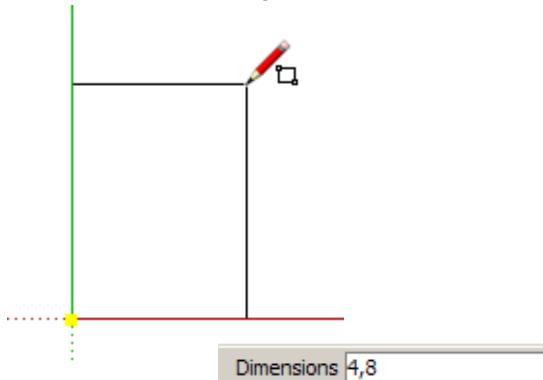
**TIP:** If you create the shape elsewhere and want to move it to the origin, select the entire shape and activate **Move**. Click the point on the shape by which you want to move the shape (the reference point), and then enter [0,0,0] - note the square brackets. This will move the shape so that the reference point moves to the origin.

We will create four shapes. The first is W8x15. This refers to an I-shaped beam 8" high, whose weight is 15 pounds per linear foot. A W beam consists of two flanges and a web, with rounded interior corners.

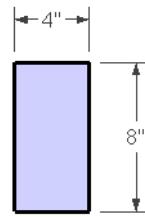


### W8x15

1. Open a new file and start in **Top** view. Create a rectangle 4" wide and 8" high, at or near the origin. To size it, start drawing and enter "4,8".

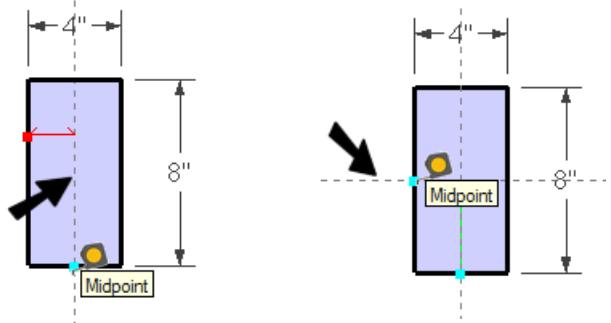


The rectangle should look like this. You can use the **Dimension** tool or **Entity Info** to verify the lengths.

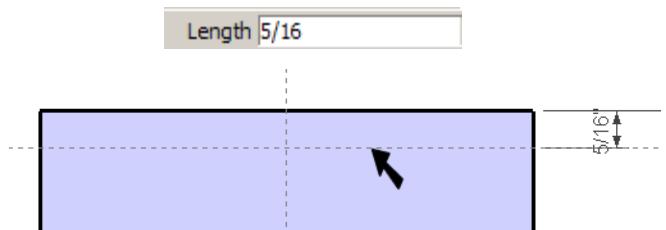


The remaining lines will be drawn for one quadrant of the shape, then mirrored and copied to the other quadrants. First, we will divide the rectangle horizontally.

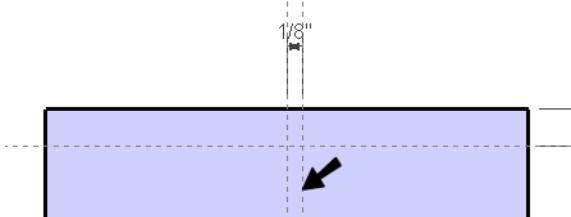
2. Use **Measure** to create a construction line, parallel to one of the horizontal legs, intersecting the midpoint of a vertical leg. Do the same with a vertical construction line. This divides the rectangle into four equal quarters.



3. The flanges are about 5/16" thick. Use **Measure** to create another construction line - click the top edge, start dragging the line downward, type "5/16" and press Enter.



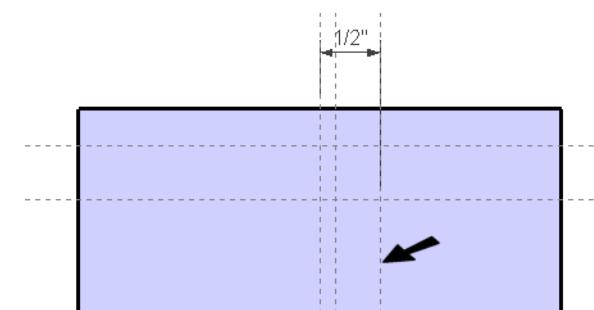
4. The web is 1/4" thick, so create another construction line 1/8" (half the web thickness) from the vertical construction line. You can enter 1/8 or 0.125.



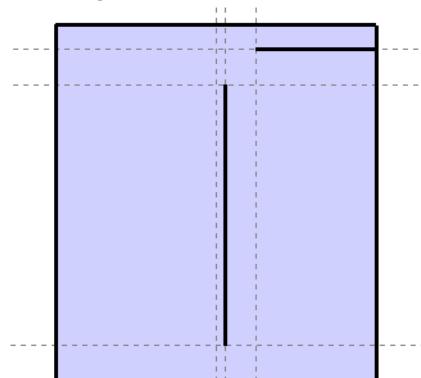
5. There is a fillet (rounding) between the flange and web, so we need two more construction lines. Create a horizontal one  $3/4"$  from the top . . .



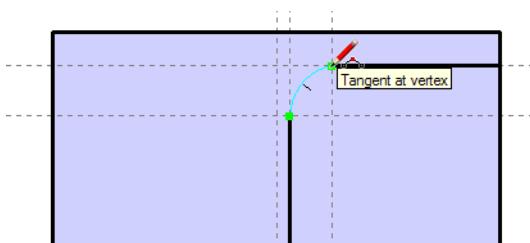
6. . . and a vertical one  $1/2"$  from the vertical midpoint construction line.



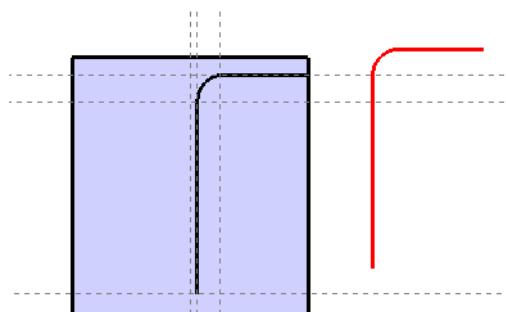
7. Draw the two lines along the straight portions of the web and flange.



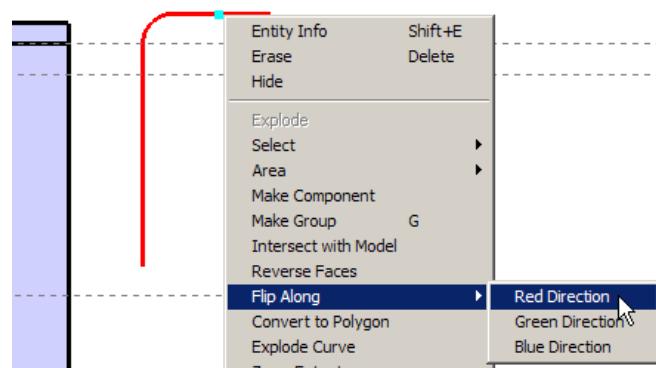
8. Use **Arc** to create the fillet. Use the Tangent at Vertex constraint.



9. These three objects (two lines and arc), are what need to be copied to the other quadrants. Select these objects and copy (**Move + Ctrl/Option**) them to another location.

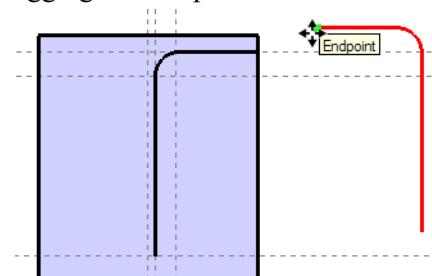


10. Right-click on the three copied objects while they are still highlighted as selected. To make a mirror image, select **Flip Along / Red Direction**.

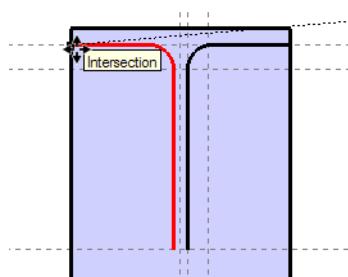


**TIP:** You could also use **Scale** for this. Select all three objects, **Scale** them, and drag any handle toward the center to turn the objects inside out. Stop when the scale value is -1.0.

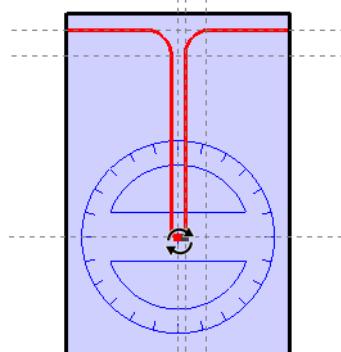
11. The objects are now oriented correctly. Move them by dragging this endpoint . . .



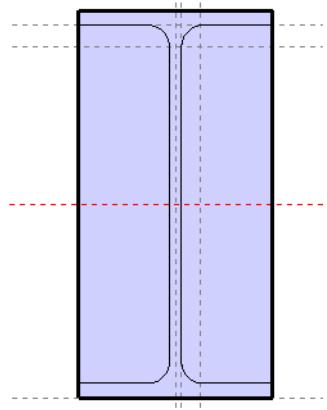
... to this intersection point.



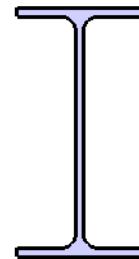
- Now select the six objects that need to be flipped for the bottom of the shape. Activate **Rotate** and place the protractor at the center of the rectangle.



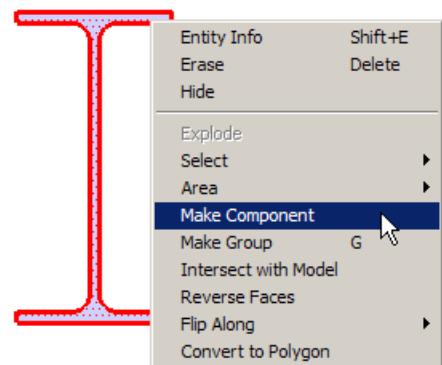
- Press **Ctrl/Option** and set any point for the rotation axis. Type 180 for the rotation angle, and the lines and arcs are mirrored to the bottom.



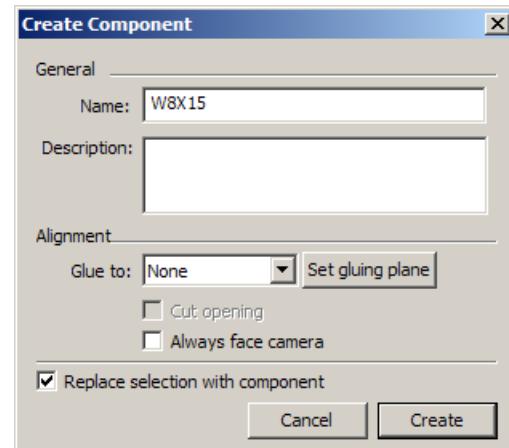
- Erase the unneeded lines, and get rid of the construction lines as well. Here is your W8x15 shape.



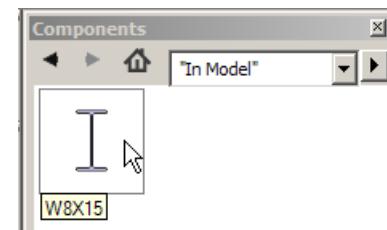
- Select the entire shape and make it a component.



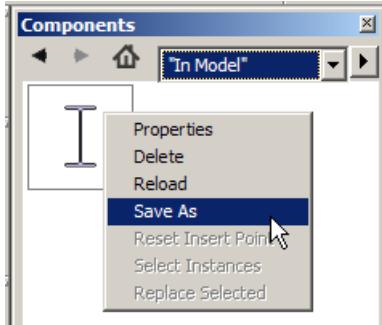
- Assign it a logical name, and check **Replace selection**.



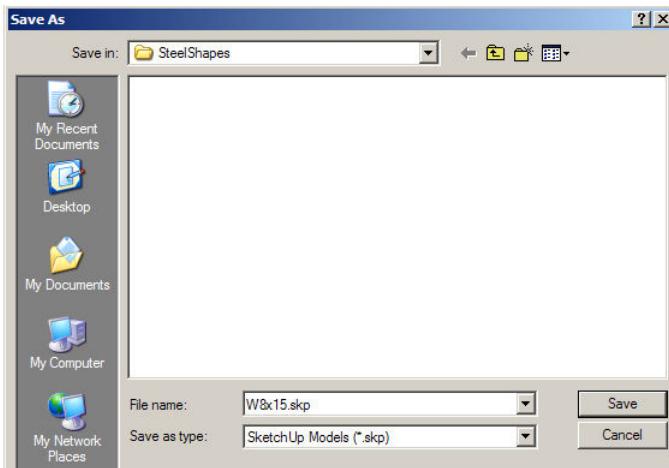
- Open the Component Browser to **In Model** to see the shape.



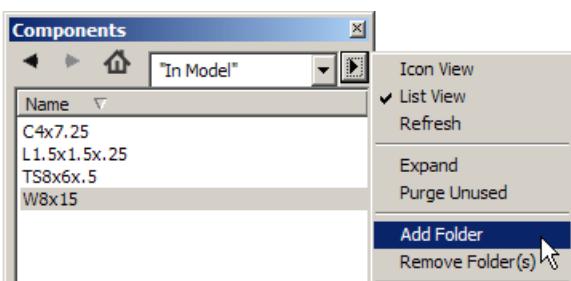
18. Because the shapes will be modified (it will be given a length and made 3D), you should save the component as it is now to an external file that you can reference later. Right-click on the component in the browser or in the model and select **Save As**.



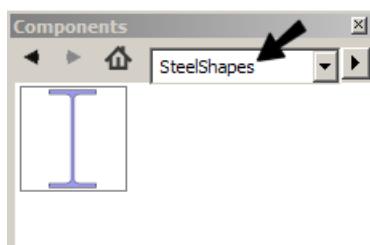
19. The browser opens to the folder set in the **Preferences (Window / Preferences)** under **Files**. Place them here, or create a new folder for the shapes. You can also save them to an existing folder in the Components folder in the SketchUp installation.



20. To see this folder in the Browser, click the small arrow and select **Add Folder**.



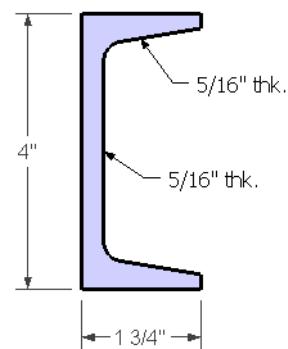
21. Browse to the folder where you saved the shape.



There are three more shapes to create. If you want to skip this and download ready-made files, see “Downloading Structural Shapes” on page 409.

### C4x7.25

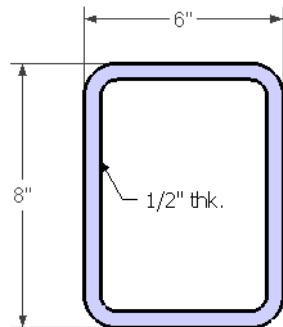
1. Open a new file, in which we will create a C4x7.25 channel. A channel is a C-shaped section with two horizontal flanges (top and bottom) connected by a vertical web. The flange thickness is 5/16 on average - it actually slopes a bit. Don’t worry about any exact values that aren’t shown. If you don’t want to get into too much detail, you can just create something by eye that resembles this shape, keeping the overall dimensions.
2. Use the methods described in the previous section to create the shape shown below. Connect the flanges to the web with a small arc. The flange thickness is 5/16 on average - it actually slopes a bit. Don’t worry about any exact values that aren’t shown. If you don’t want to get into too much detail, you can just create something by eye that resembles this shape, keeping the overall dimensions.



3. Save this file as C4x7.25.skp, in the same folder where the W8x15 was saved.

## TS8x6x1/2

- The third shape is a steel tube (TS8x6x1/2). Open a new file.
- Start with a 6" x 8" rectangle, and create the filleted shape shown below. To get the inner shape, use the **Offset** tool.

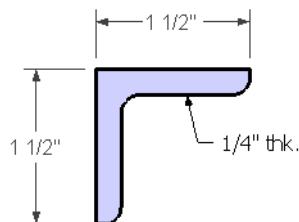


**HINT:** Forgot how to offset? Activate **Offset**, select the face, drag the offset inward, and enter 1/2.

- Save it as TS8x6x0.5.

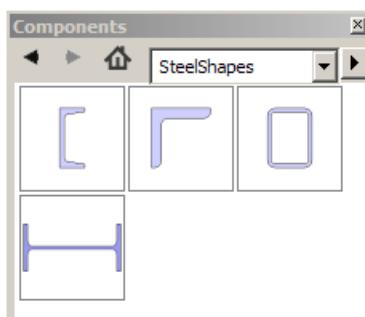
## L1.5x1.5x1/4

- Now for the angle (L1.5x1.5x1/4). Open a new file, and start with a 1.5 x 1.5 rectangle.
- Create the shape shown below, adding rounding arcs at the interior corner and at both ends.



- Save it as L1.5x1.5x0.25.

Now in the folder you defined, all four shapes should appear.

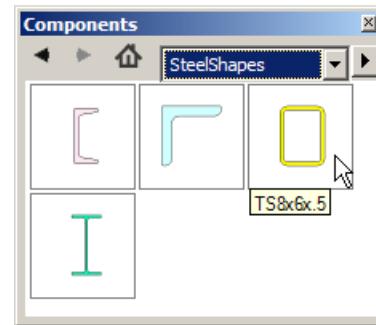


## Creating the Frame

Now we'll take these shape components and make a steel building frame.

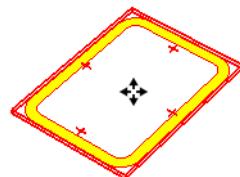
### Main Column

- Start a new file, and open the Component Browser to the folder where your shapes are. (If you downloaded SketchUp's components, each will be in a different folder.) Click the TS shape.



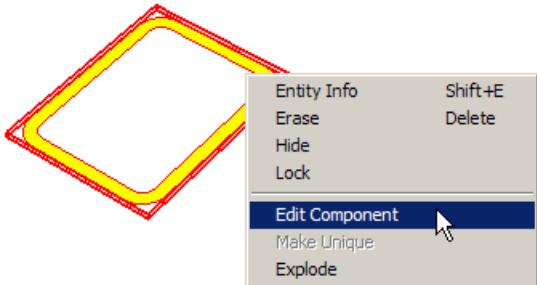
**NOTE:** For purposes of this example, each shape component was assigned a different color. If you choose to do this, open each component in its own file and assign a color or material to both faces (front and back). Save your changes. See "Applying Materials" on page 241 for details.

- Drag the shape into the file. It appears in a bounding box to indicate that it's a component, and "+"-shaped rotation handles appear when the cursor is on the shape.

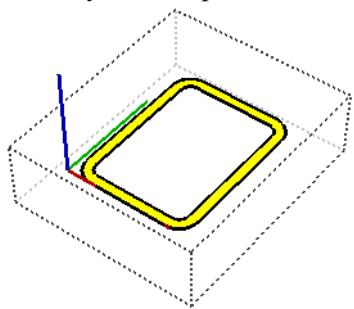


**TIP:** You can also use **File / Import / 3D Model** to import a component. And you can drag a component straight from your file browser right into SketchUp.

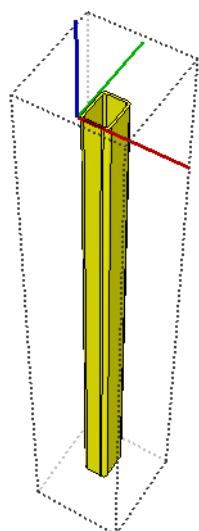
- The shape needs to be given some height. Right-click on the shape and select **Edit Component** (or double-click it while **Select** is active).



During editing, the component appears in a dotted box, and all tools can be used to edit it. Until the component is closed, you cannot edit anything else in the model - only the component.

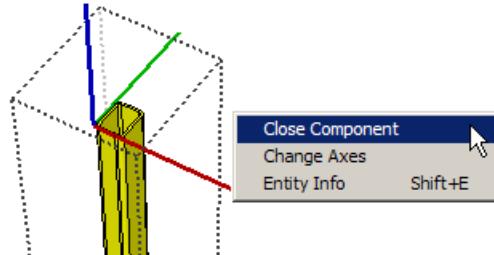


- Push/Pull** downward to a depth of 10' to create the column. (It's better to pull down here rather than up, because other components will need to be inserted at the top of the column, which is closer to the model origin.)

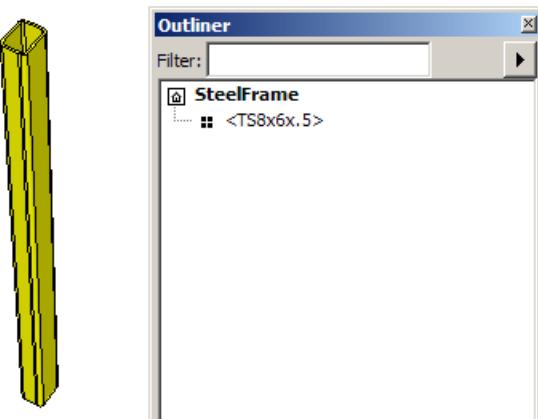


**NOTE:** The steel shapes provided on the SketchUp website were created in a previous version, in which arcs were represented as a series of segments. Therefore, when **Push/Pull**'ed, these shapes contain separate flat faces representing each curved portion, rather than one, smooth face. You can replace the arcs in the original component files, if you want the faces to be smooth.

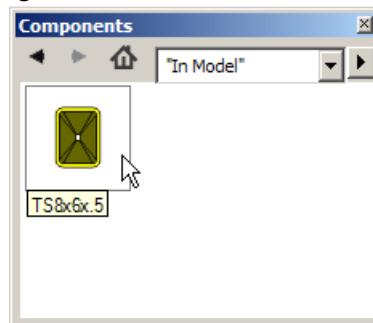
- Right-click outside the component and select **Close Component**. You can also click anywhere outside the component, while in **Select** mode.,



- Here is the first column in the frame. Open the Outliner (**Window / Outliner**) to see the component.



- In the Component Browser, open **In Model**. This window shows a list of all components used in your model. So far there is only one - the TS shape. And it is the 3D version in the model, not the 2D version you brought in.



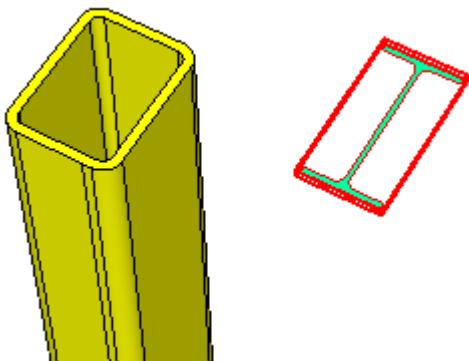
8. Click on the component in **In Model** (not the original 2D one) and drag another into the model. It is the same length, which shows that this component is already different than the one you imported originally. (The original TS shape has not changed, of course.)



9. Delete the second TS shape.

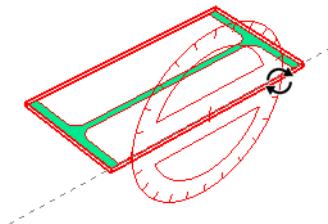
## Main Beam and Connectors

1. Now go back to the where your 2D shapes are saved and bring in the W8x15.

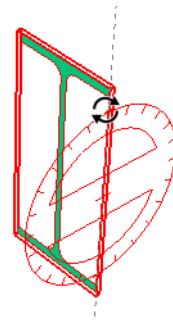


This beam needs to be rotated into the correct position. This will require two rotations. When you pass the cursor over the rotation handles, the protractor appears. You may have to zoom or rotate the beam to get the proper protractor to appear.

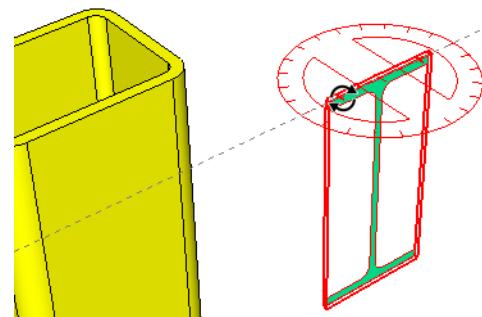
2. To make the section vertical, click the rotation handle that invokes the protractor shown below.



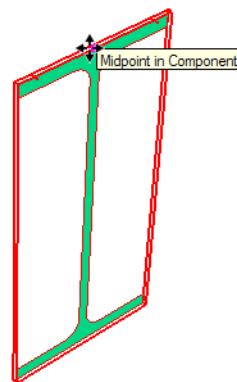
3. Rotate the section 90 degrees.



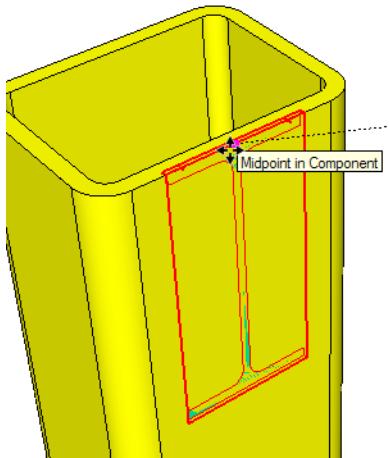
4. Rotate the section again so that it is perpendicular to the column.



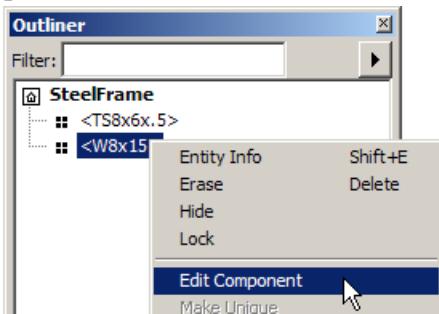
5. As long as the component bounding box is displayed, you are still in **Move** mode. Click on the midpoint at the top of the flange.



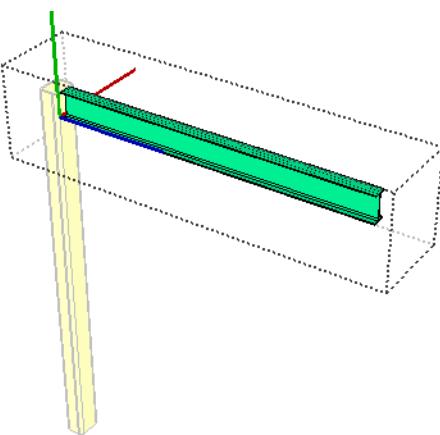
- Drag this point to the midpoint of the top of the column.



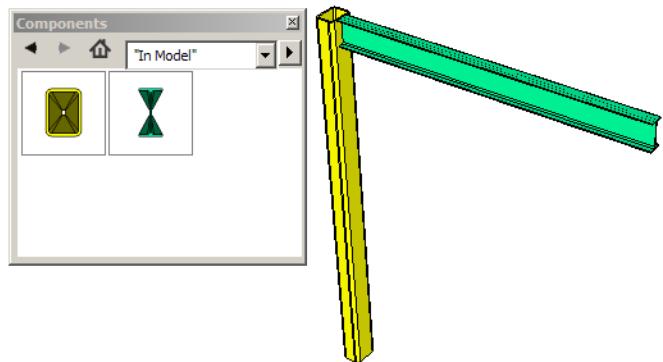
- Now the beam needs some length. Right-click on the component in the Outliner and select **Edit Component**.



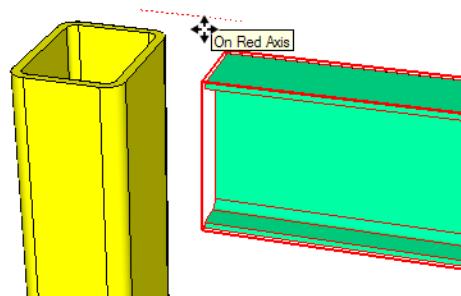
- and **Push/Pull** the beam out 8'.



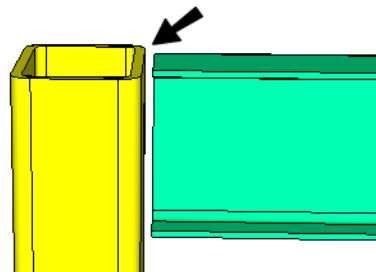
- Close the component. Now when you open **In Model**, the long W shape appears with the long TS.



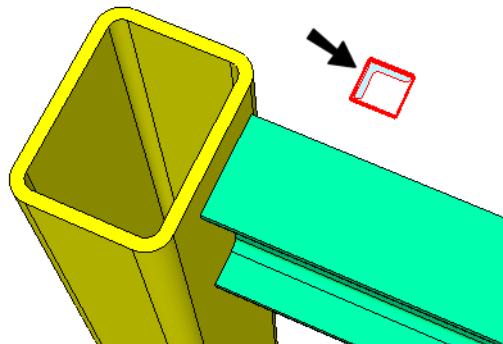
- Select the W beam, and activate **Move**. Start moving the beam away from the column, along the beam's axis (do not click to place it yet).



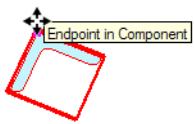
- Enter a distance of 0.5" to represent an expansion joint.



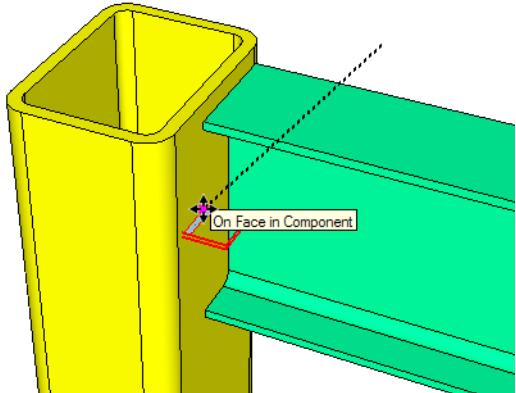
- Bring in the L1.5x1.5 shape.



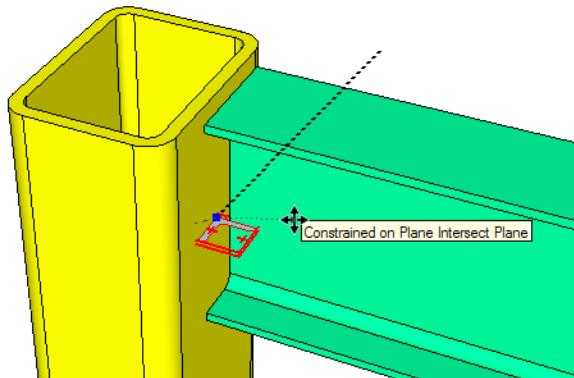
13. Move the angle into place by dragging the corner point . . .



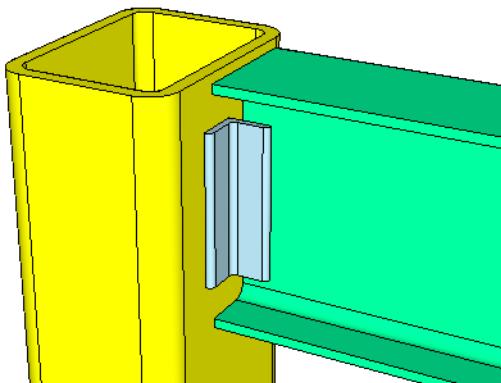
14. . . .using Shift to constrain it to the column face . . .



15. . . .and to the web face.

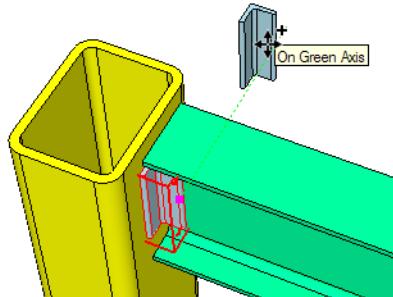


16. Edit the component and **Push/Pull** it up or down as needed to create the connector.

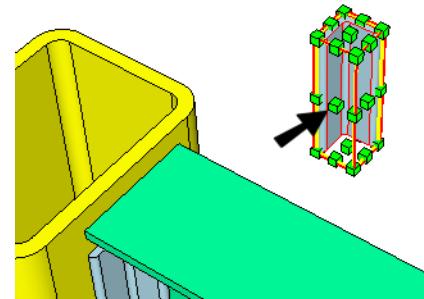


This angle is to be copied to the other side of the W beam. The **Scale** tool will be used to mirror it

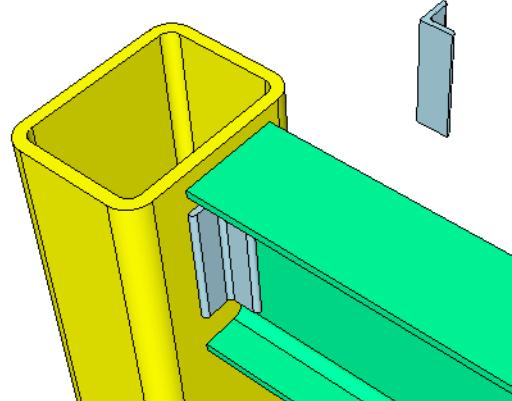
17. Copy the angle along the green axis into the blank space.



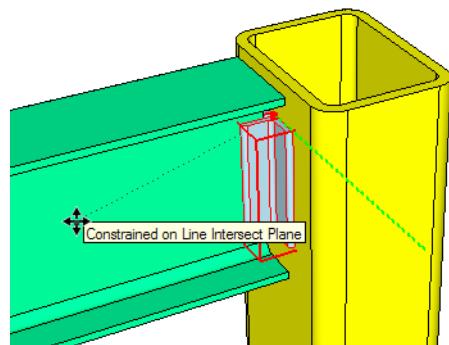
18. With the copied angle still selected, activate **Scale**. To mirror it, drag the handle shown into the shape. Stop when the VCB snaps to -1.0, or type in the value manually.



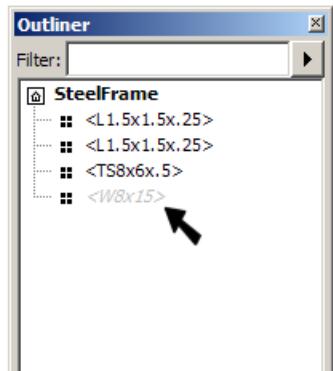
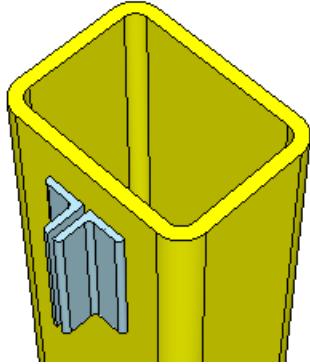
The copied angle is now oriented correctly.



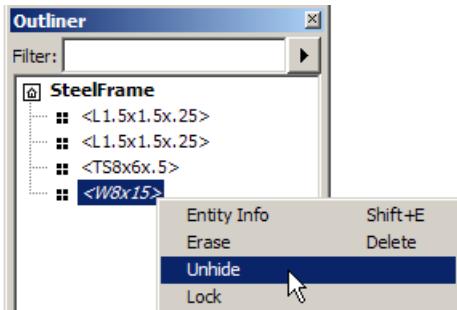
19. Now move the angle back, Shift-locking it in the green direction and placing it along the web face.



20. To verify that the angles are mirror copies, right-click on the beam and select **Hide**. The W component is listed in italics in the Outliner, indicating that it is hidden.

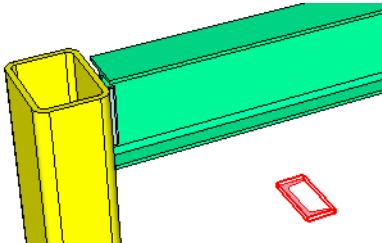


21. Display the beam again by using **Undo**, or by right-clicking on the italicized component and selecting **Unhide**.

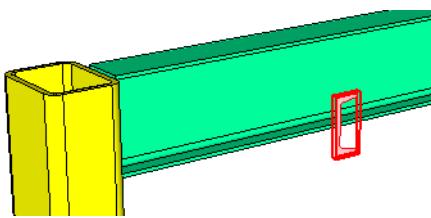


## Floor Joists and Connectors

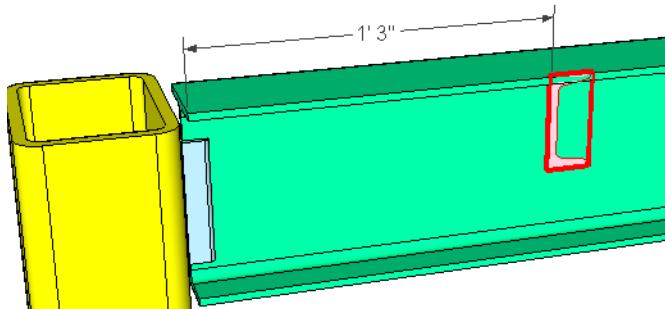
1. Bring in the channel.



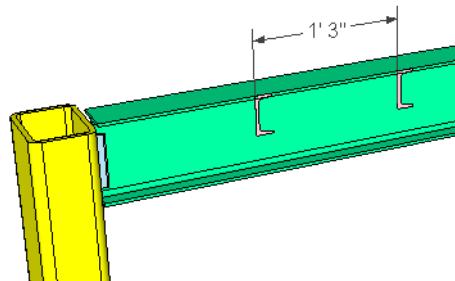
2. Rotate it so that it is vertical.



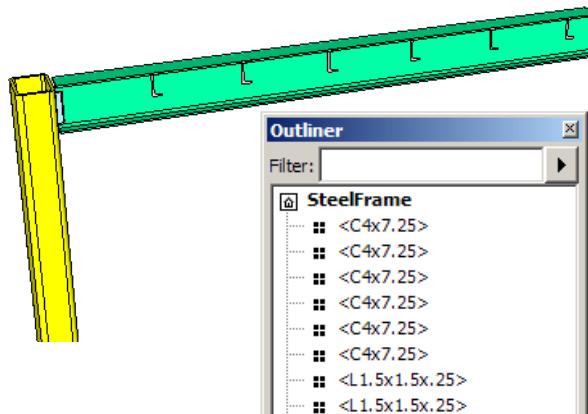
3. Move it so that its top flange is flush with the W beam flange, aligned at the top. The distance between the channel and column should be about 15" (but it doesn't have to be exact).



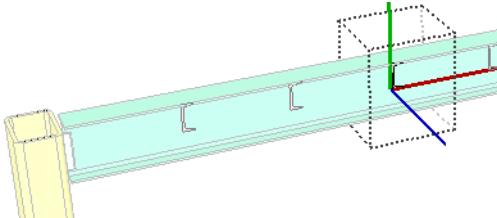
4. Copy the channel once along the beam, using a distance of 15".



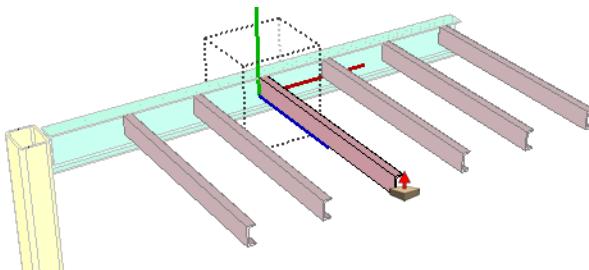
5. Enter 5x (or \*5) to make five total copies. The Outliner should show six channels.



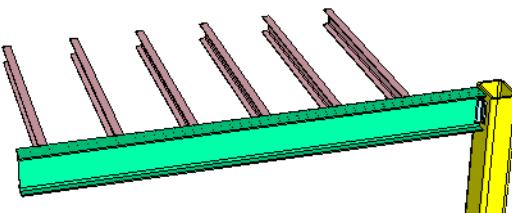
6. Now open any of the channels for editing.



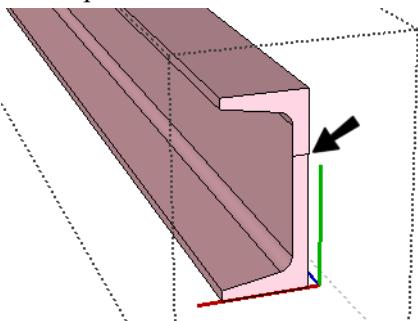
7. **Push/Pull** the channel out, and all instances of the channel reflect this change.



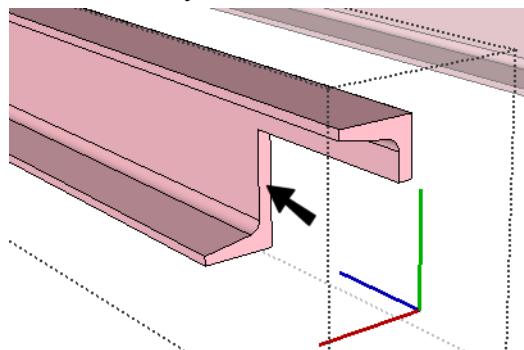
8. Close the channel, and spin the model so that you are facing the side of the channel that is attached to the beam.



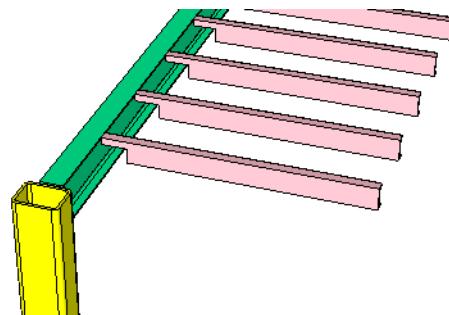
9. Hide the W beam as before. Edit one of the channels, and draw a line across the web, slightly below the flange. This will divide the section so that the bottom part can be pulled back to the W beam web.



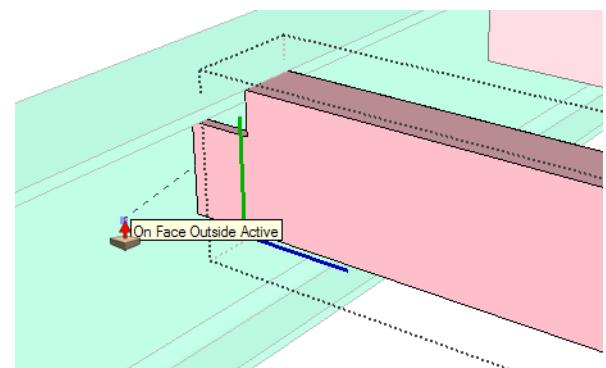
10. For now, **Push/Pull** the bottom part back, so that this face can be easily found later.



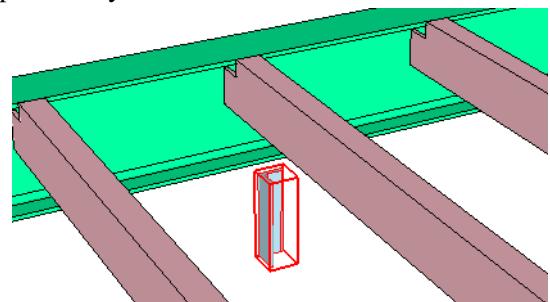
11. Close the component, and unhide the beam. The notch has been removed from all channels.



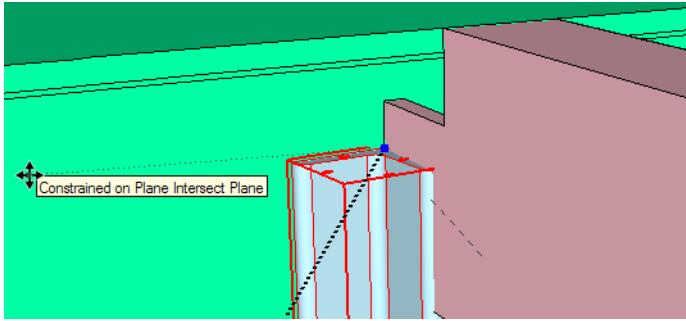
12. Open one of the channels again, and **Push/Pull** the notch face back to the web face. Since you have to rotate the model during the **Push/Pull**, click the notched face, rotate, then click the web face.



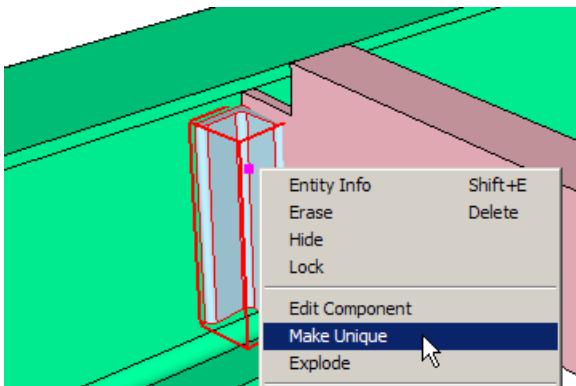
13. Close the channel component. Now the channel connections can be created. From **In Model** bring in another angle. This is another instance of the angle previously used to connect the beam to the column.



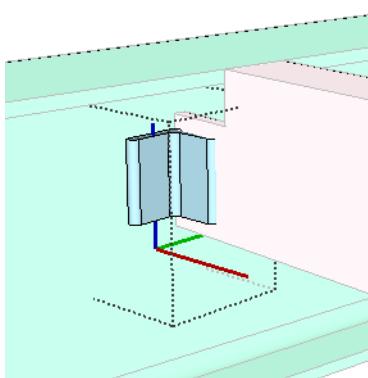
14. Rotate it and move it to the correct position (corner point aligned with both webs, or simply place it on the edge of the C flange).



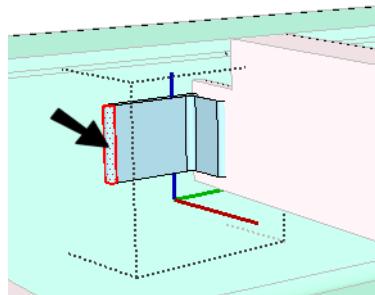
15. This angle doesn't need to be as long as the other one. Right-click on it and select **Make Unique**.



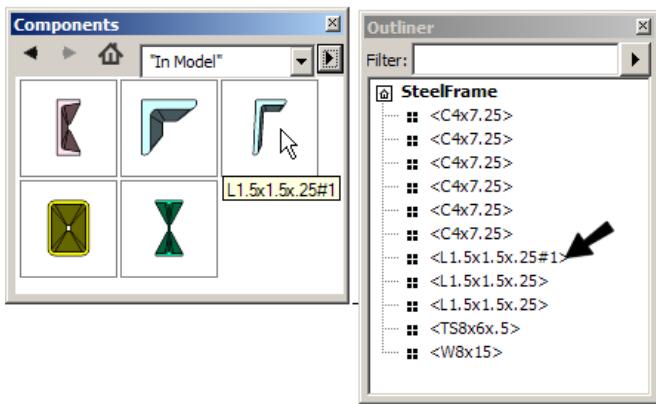
16. Use **Push/Pull** to adjust the length so that it fits the channel.



17. Also, select the entire edge on the W beam side, and use **Move** to lengthen the angle leg.

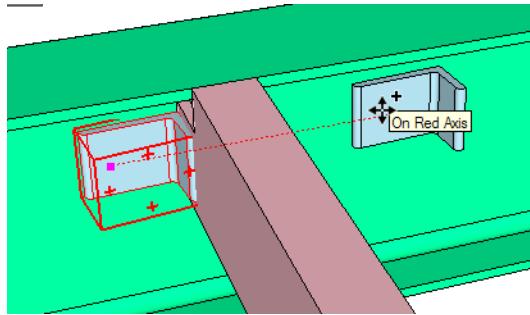


18. Close the component. This component was made into a new component, whose name appears in **In Model** and the Outliner, with a "#1" after the name from which it was copied.

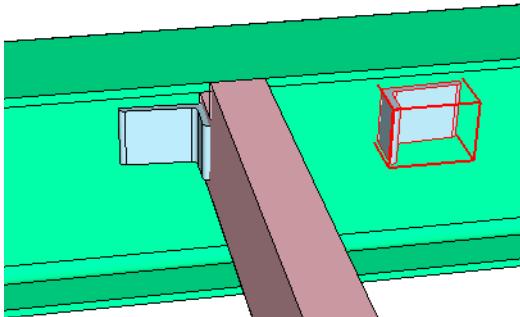


If you right-click the component in **In Model**, you can use the **Properties** to change the component's name. This will update all names in the Outliner as well. However, If you right-click a component in the Outliner and use **Rename**, only that component *instance* will have its name changed.

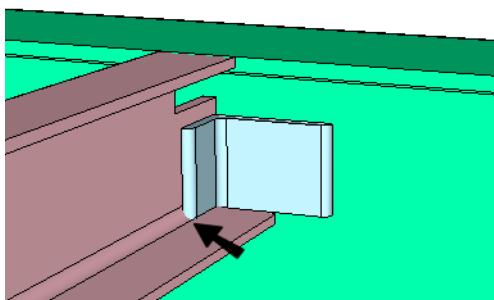
19. Copy this new angle along the axis of the W beam.



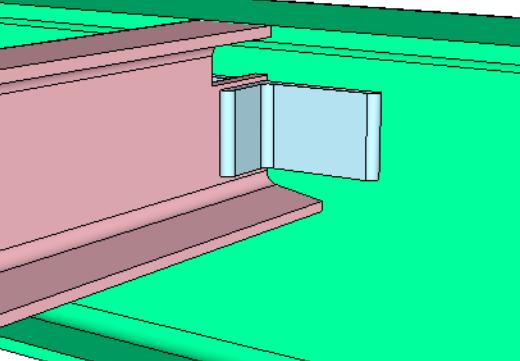
20. To flip the angle over, you can right-click and use one of the **Flip** commands, or use **Scale**, or use the protractor to flip it about the midpoint of its length.



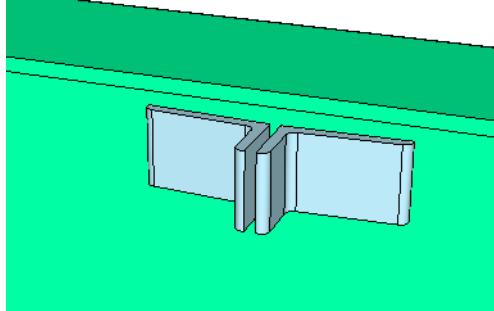
21. Slide the copy into place, using the axis and inferences. If the connector is too long on this side of the channel . . .



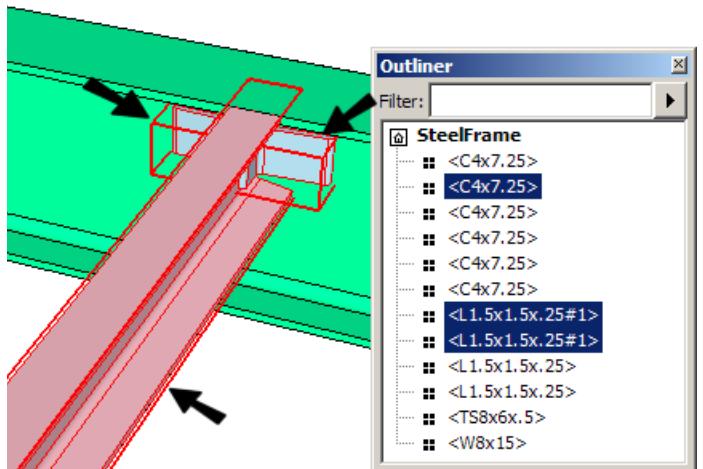
. . . edit the component and shorten it.



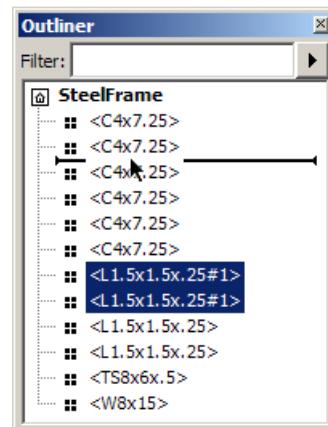
22. Hide the channel to verify that the angles are in the right place and are the same length.



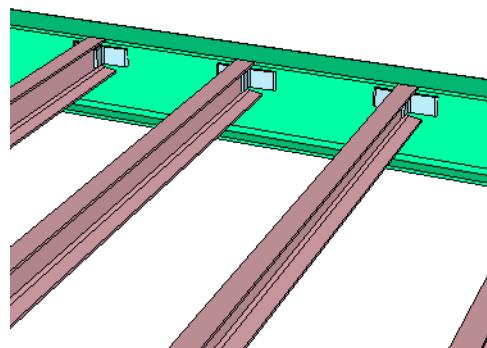
23. Display the channel again. This double-angle connection needs to be repeated at every channel. The easiest way to do this is with the Outliner. Select the two angle connectors and the channel, to identify them in the Outliner.



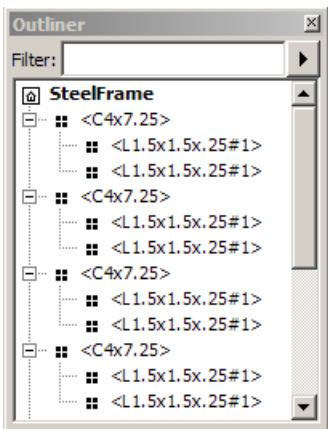
24. In the Outliner, select the two angles, and drag them below the channel.



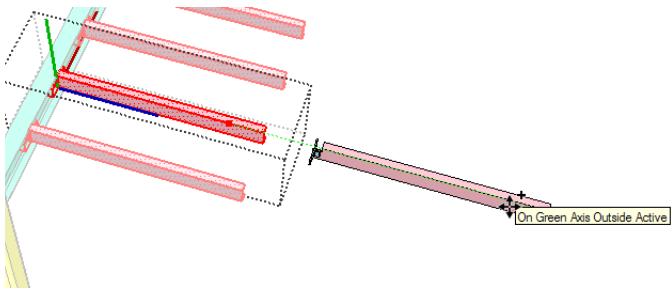
The angles are now part of each channel component.



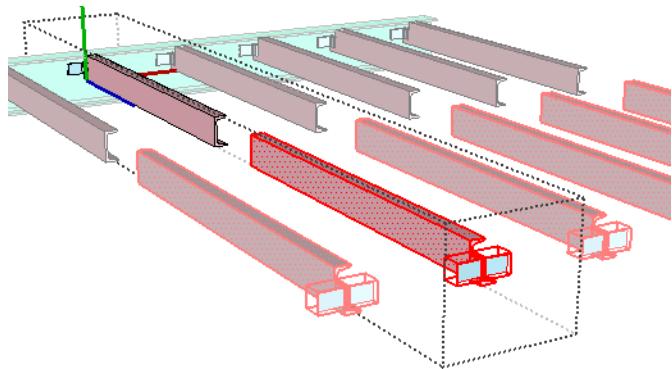
In the Outliner, each channel component contains two angles.



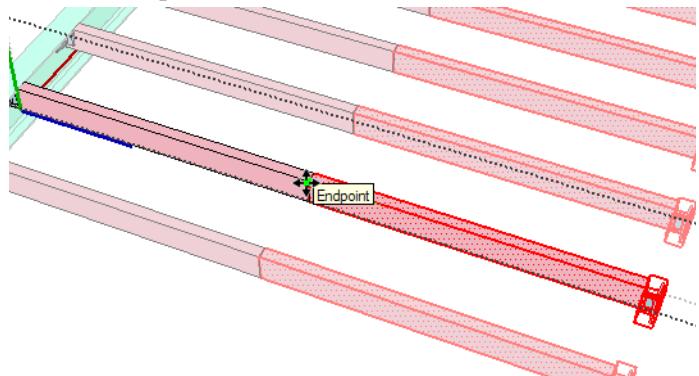
25. The connection angles need to be transferred to the other side of the channels. Edit one of the channel components, and make a copy of it along the channel axis.



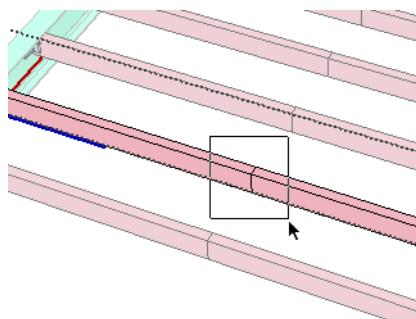
26. Flip, scale, or rotate the copy to get the connection on the other side.



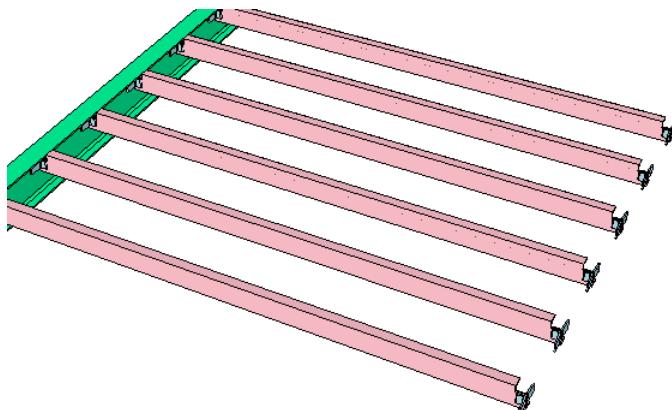
27. While the copy is still in **Move** mode, move it so that the endpoints meet.



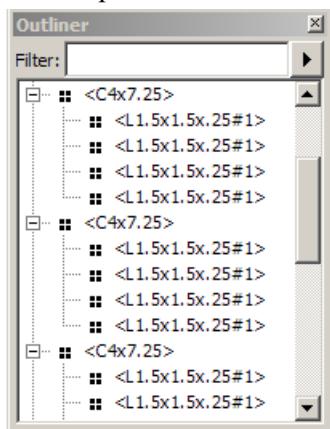
28. Erase the joint lines. Rather than try erasing each line individually, use a selection window to select all lines on the outside and inside of the channel, then press Delete.



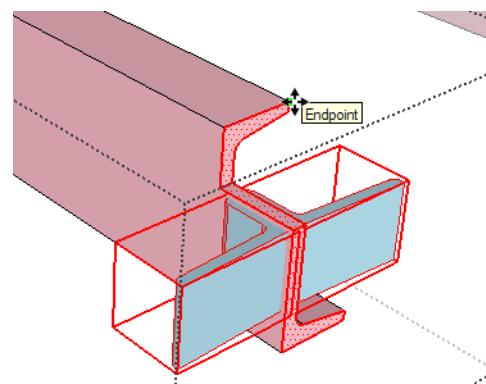
29. Close the component. Each channel component now contains connectors on both sides. The channel length is too short, but we'll fix that when we create another W beam.



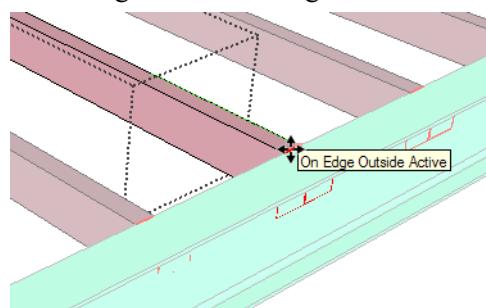
The Outliner now shows four angle connected for each channel component.



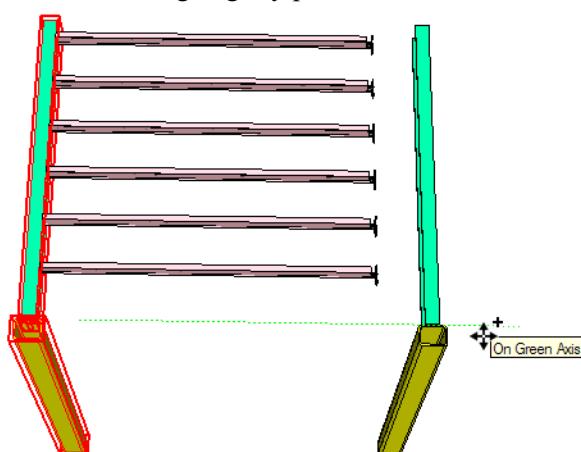
- Move the end of the beam by dragging from the endpoint shown ...



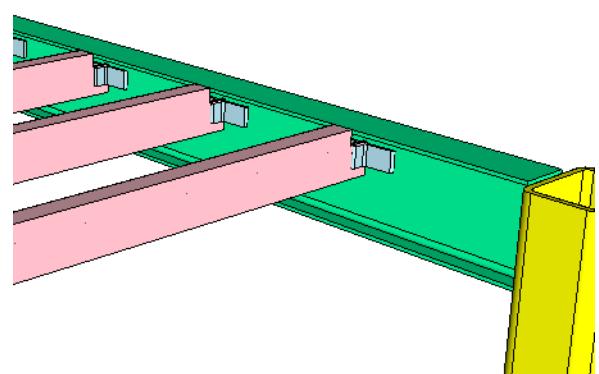
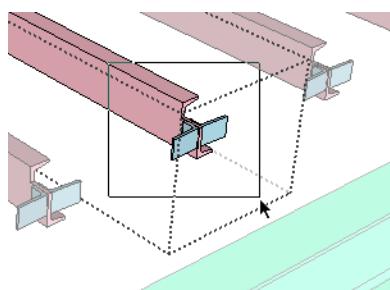
... to the edge of the W flange.



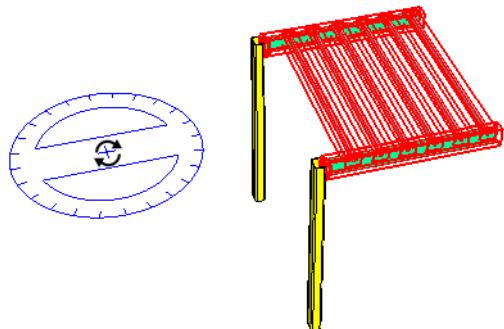
- Close the component, and check the connections you just made. All angles should be flush with the copied W beam.



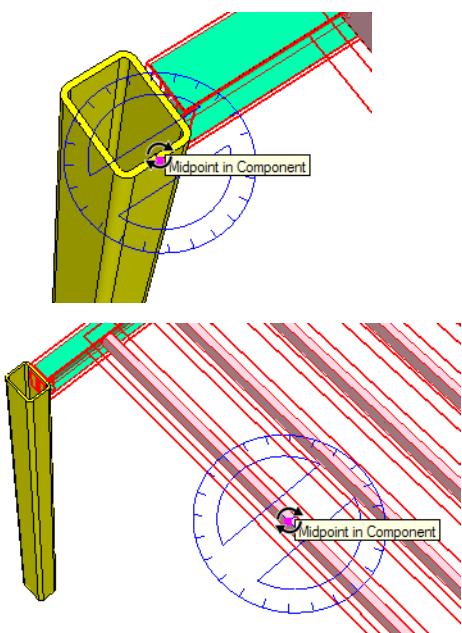
- To extend the channels to meet the beam, open one for editing. Select the end plus the angle connectors, using a selection window.



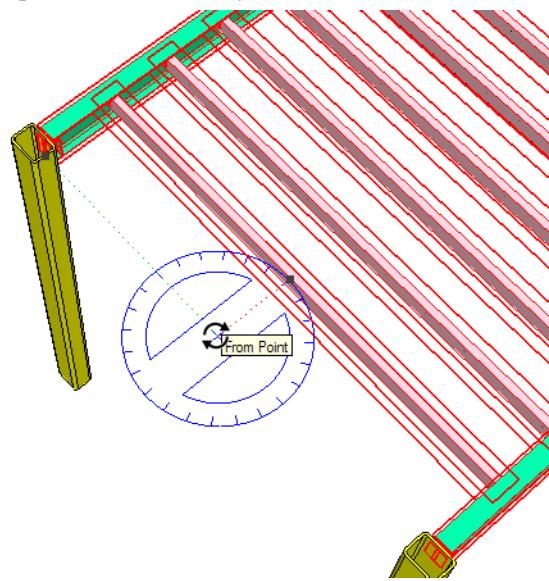
- Now select the beams and channels making up the floor joists. Include also the beam-column connection angles. The whole set will be rotate-copied to the other side of the columns. Activate **Rotate**, and shift-lock the protractor to the red-green plane.



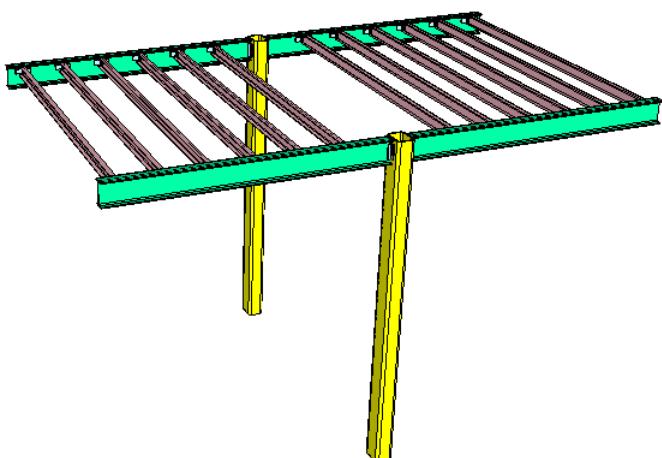
- For the rotation point, pass the cursor over the midpoint of one of the columns and a midpoint of one of the channels.



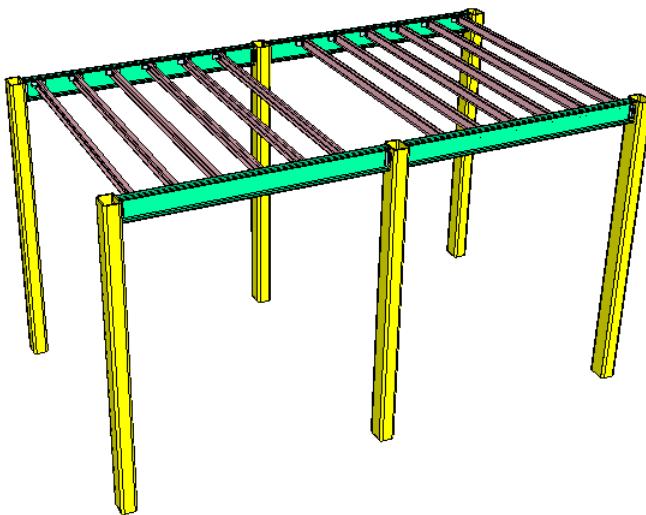
- Use these two midpoints to place the protractor at the midpoint of the floor system.



- Press **Ctrl/Option** to copy, click to orient the protractor, and copy the objects 180 degrees.



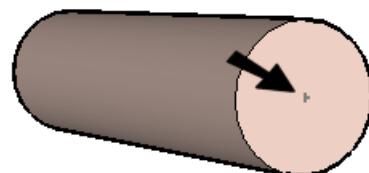
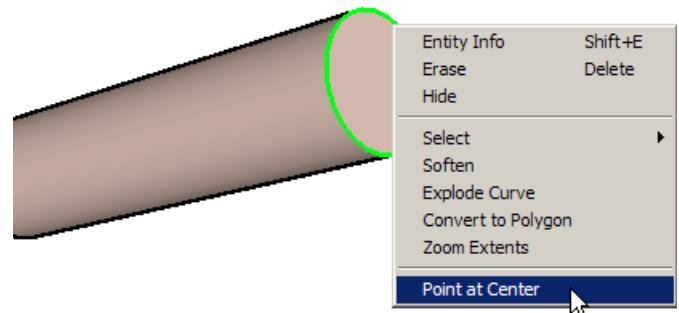
9. You can also use **Copy** or **Rotate** to create two more columns on either side of the beams. Here is the completed floor system.



2. Draw a circle, making sure to align it with the red or blue axis.

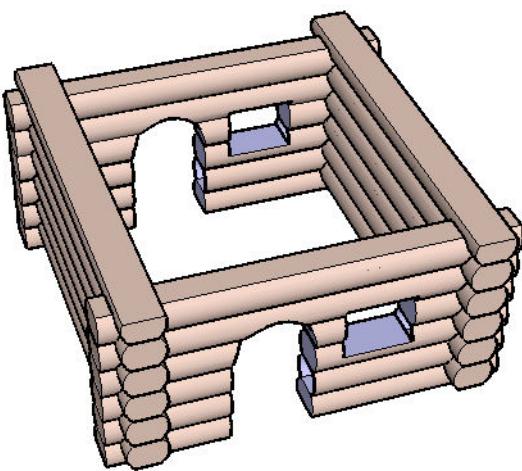


3. **Push/Pull** into a cylinder and place a construction point at the center point at one end.



## Creating a Log Cabin

This shorter exercise also focuses on components, and on the **Intersect with Model** tool.



(If you want to download the completed model, go to [www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm](http://www.flhelp.biz/ccp51/cgi-bin/SU5Files.htm) and download the file “LogCabin.skp.”)

## Creating Flat-Sided Logs

1. To create the first log, start in **Front** view, so that the log will lie flat.

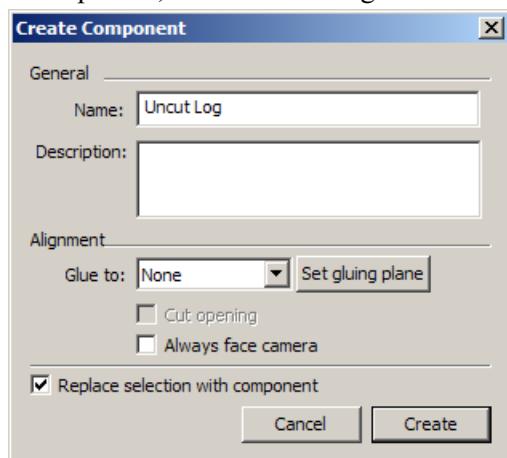



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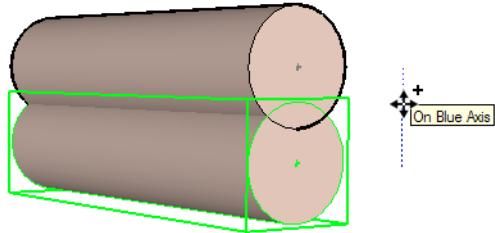
NOTE: If **Point at Center** does not appear in the context menu, open **File / Preferences** to the **Extensions** page and check **Ruby Script Examples**.

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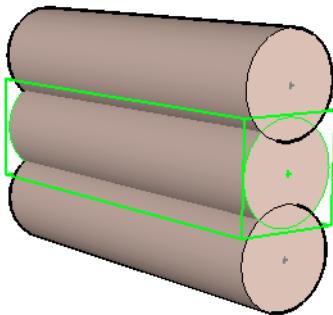
4. Select the cylinder and construction point and make it a component, called Uncut Log.



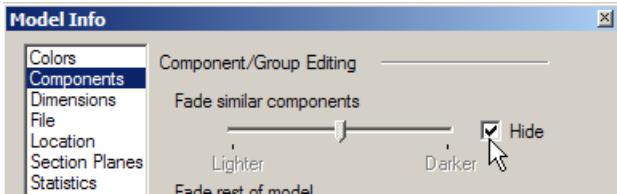
- Select the log component and use **Move** with **Ctrl/Option** to make a copy straight up. Place the copy vertically so that the two logs overlap.



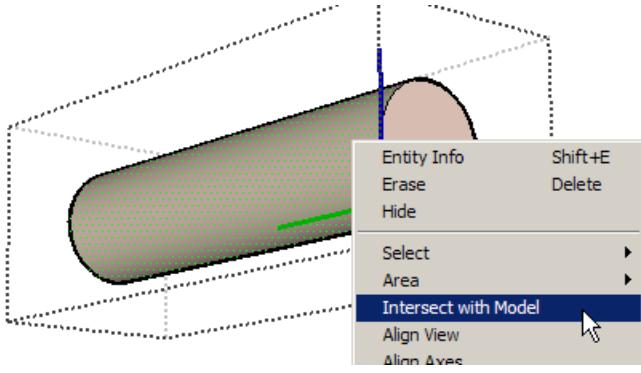
- Type **2x** to make three total logs.



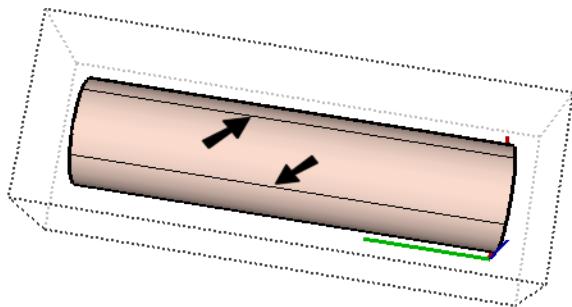
- Now we will modify the log component so that it has a flat top and bottom. First, open **Model Info** to the **Components** page and check **Hide** for similar components.



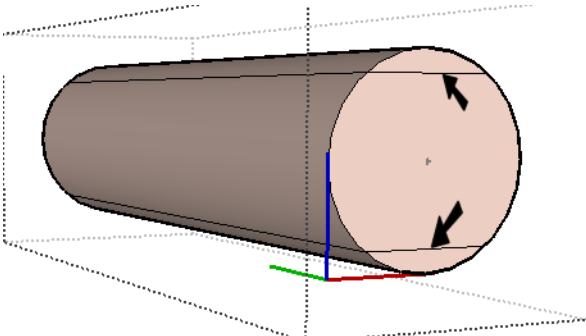
- Open the middle log for editing. Right-click on the cylindrical face and select **Intersect with Model**.



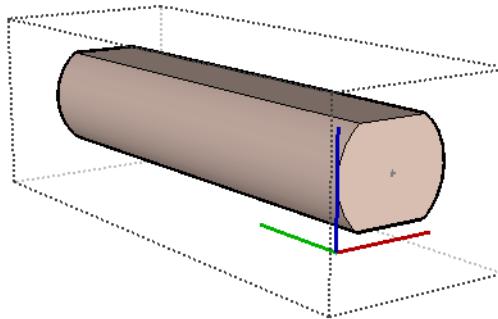
This creates straight lines along the top and bottom of the log, where the logs above and below intersect it.



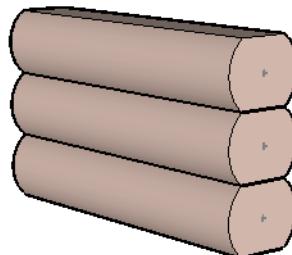
- To trim the log, create two lines on one circular face, joining the intersection edges.



- Use **Push/Pull** to trim the portions above and below.

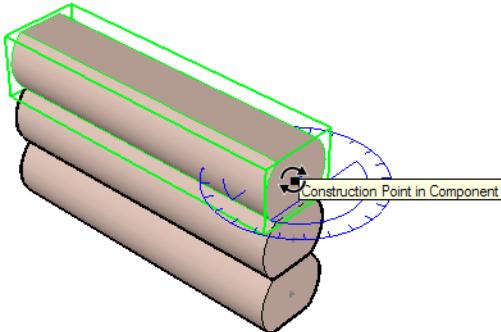


- Close the edited component, and all logs are now flattened.

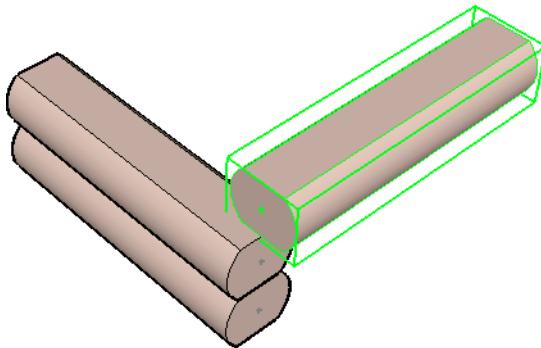


## Creating Notches

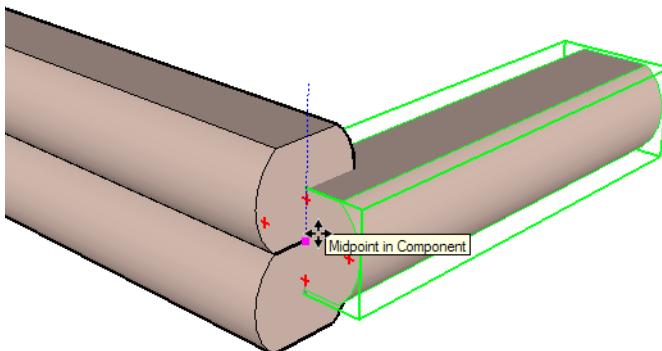
- Select the top log and activate **Rotate**. Lock the protractor in the red-green plane, and set the rotation center at the construction point.



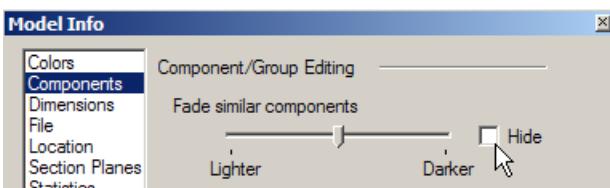
- Rotate this log 90 degrees.



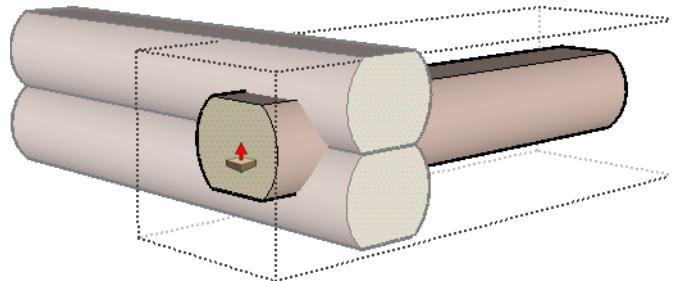
- With this log still selected, activate **Move**. Move the log straight down by its center point, placing where the two lower logs meet.



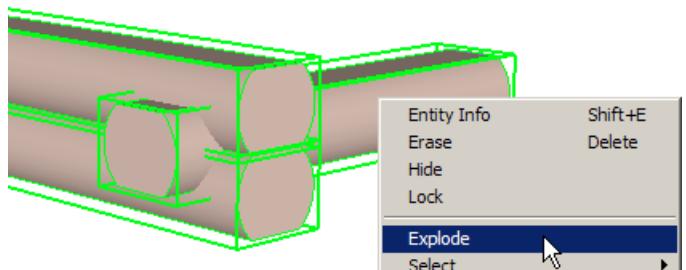
- Before editing one of these logs, make sure the similar components are *not* hidden.



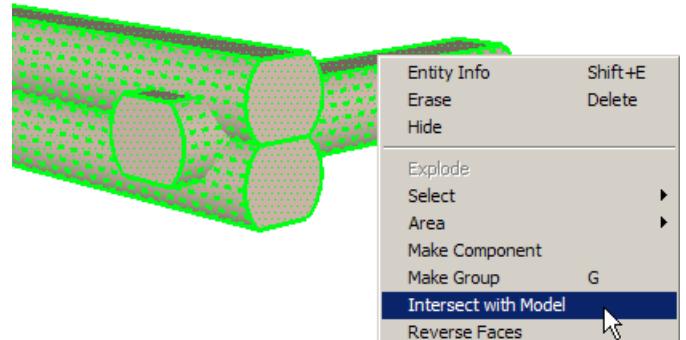
- Edit one of the logs and use **Push/Pull** to make the ends overlap.



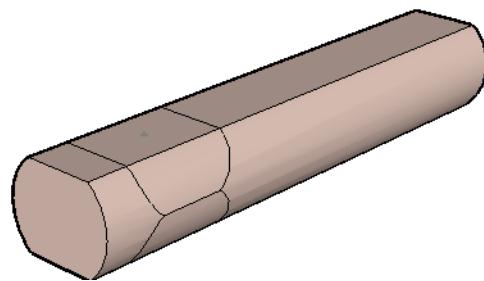
- Select all three logs and **Explode** them.



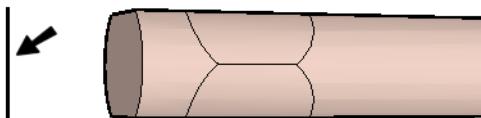
- With the three exploded logs selected, run **Intersect with Model**.



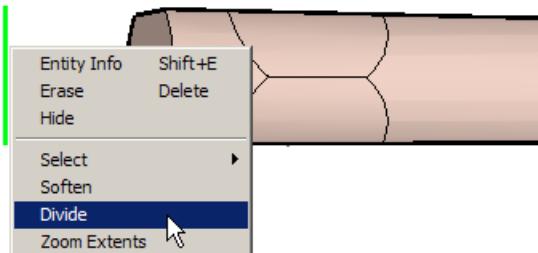
- Erase the two unrotated logs, and you should have the intersection edges all around the rotated log.



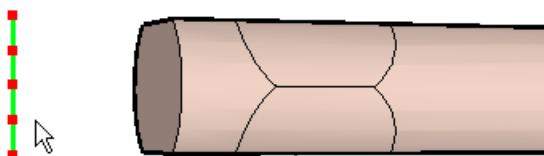
- The notch should be created so that its depth is 1/2 that of the log. For reference, create a vertical line that is the same height as the log.



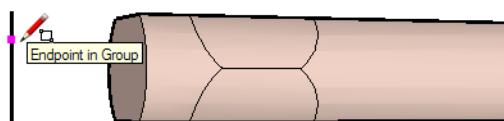
- Right-click on this line and select **Divide**.



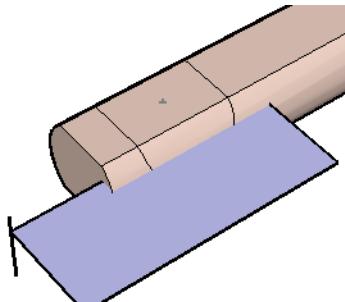
- Move the cursor to divide the line into four quarters.



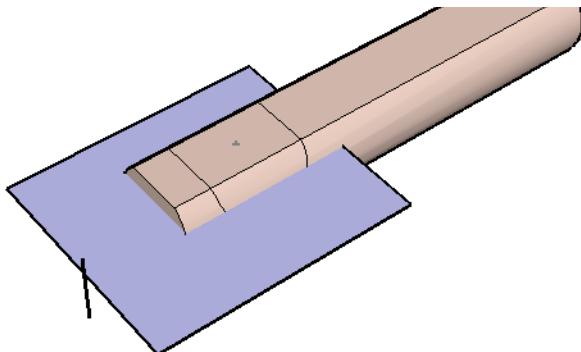
- So that subsequent objects won't stick to this line, select it (all four segments) and make it a group.
- Activate **Rectangle** and start it at the end of the top line segment.



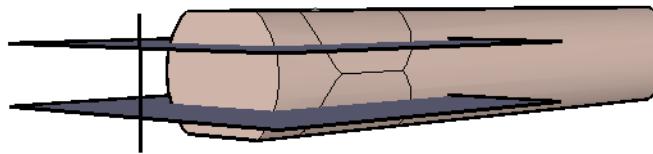
- Draw out a flat face so that it ends beyond the notch cutout.



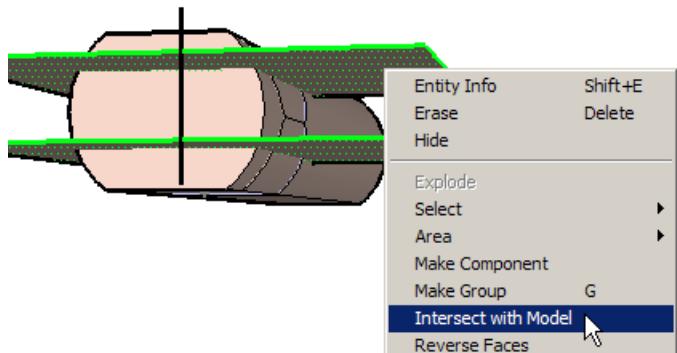
- Move the side edge so that the face surrounds the notch.



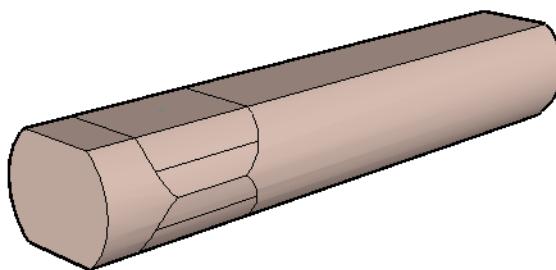
- Copy the face to the lower quarter of the log.



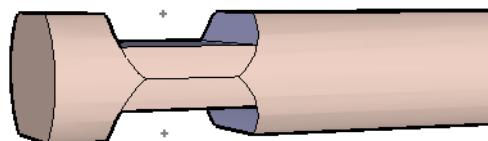
- Select both rectangular faces and run **Intersect with Model**.



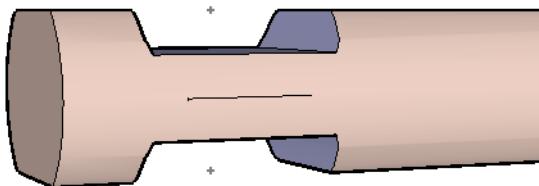
- Trim the faces and extra edges.



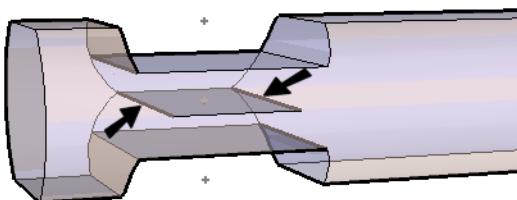
- Erase the faces of the log in the top and bottom quarters.



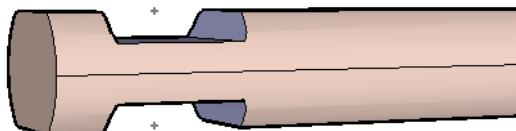
20. Now to erase the edges in the middle half. It may be a little tricky to get rid of edges without losing some round faces of the log itself. The easiest way is to start on one side and erase all the round edges so that only the horizontal line shown remains.



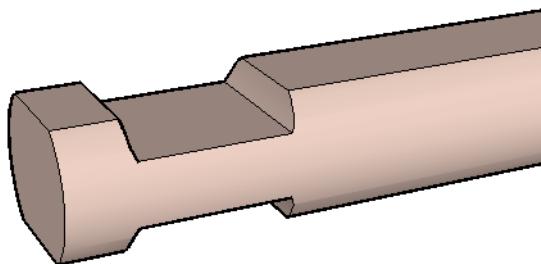
21. Then switch to **X-Ray** mode and erase the side edges of the center face.



22. Now trim the extra edges on the other face. If you are left with a long horizontal edge, you can soften it (**Erase** with *Ctrl/Option*).

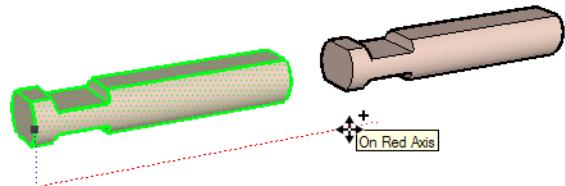


Here is the final notch, with faces reversed to give the entire log a uniform color.

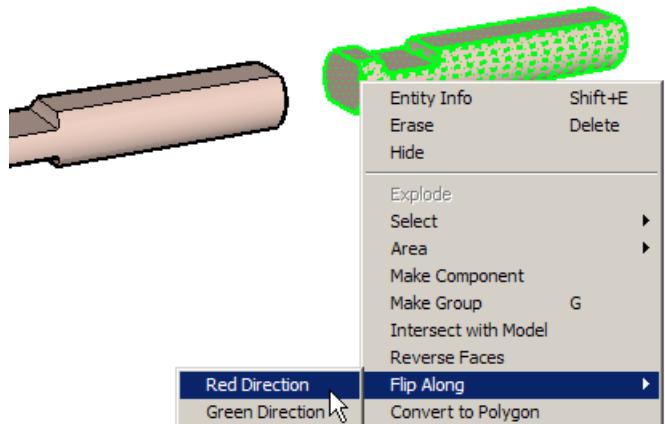


## Building the Cabin

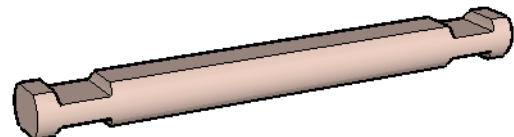
1. The notch should be on both ends of the log. So, select and copy the log along the log's axis.



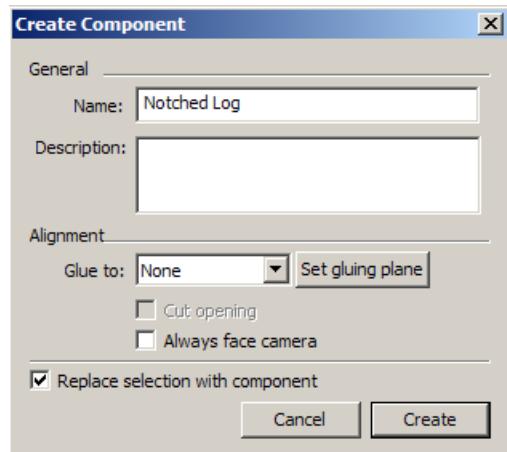
2. Right-click on the copied log and **Flip** it along the axis you used to copy it. (**Scale** or **Rotate** would also work.)



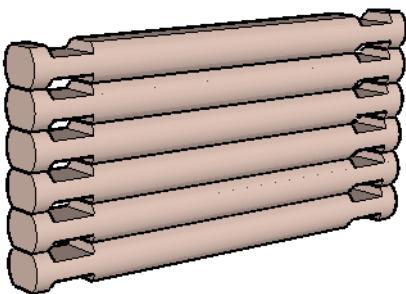
3. Now move the flipped log back to the original so that they meet. Trim the extra edges; here is the final notched log.



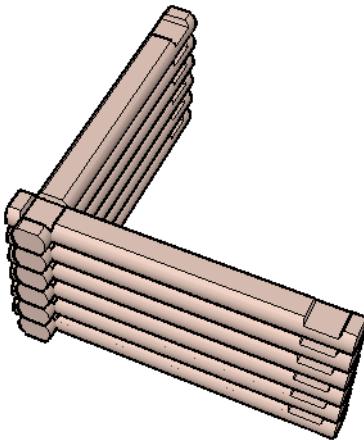
4. Select this log and make it a new component.



5. Use **Move** to make several copies of this component.

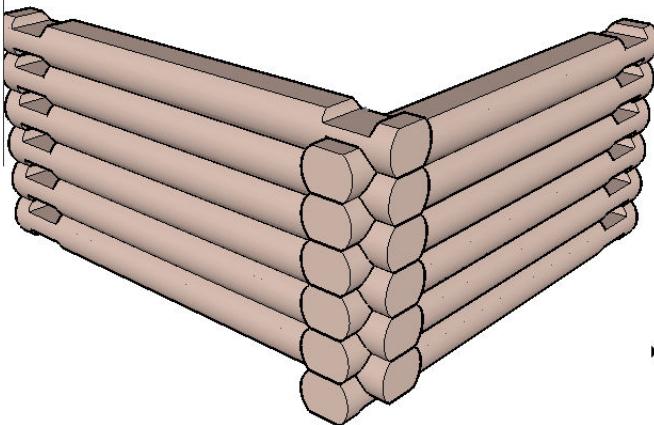


6. Select all components, and rotate them 90 degrees, using the construction center point as before.

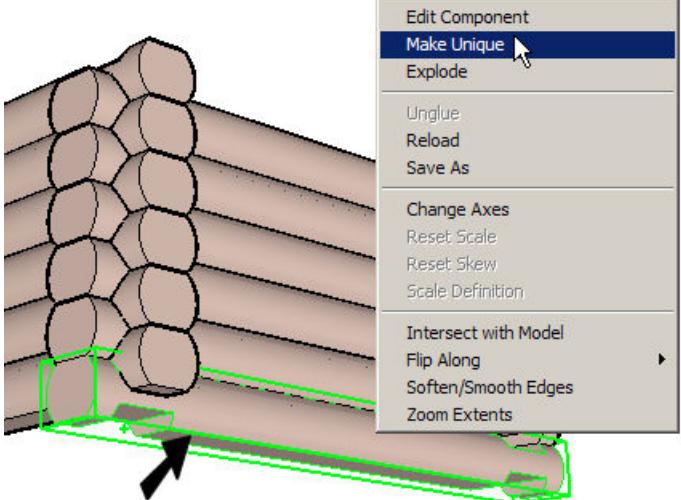


**NOTE:** If you want to make these rotated logs a different length, just rotate one log, use **Make Unique**, and edit it to change its length. Then copy the new component to make the second wall.

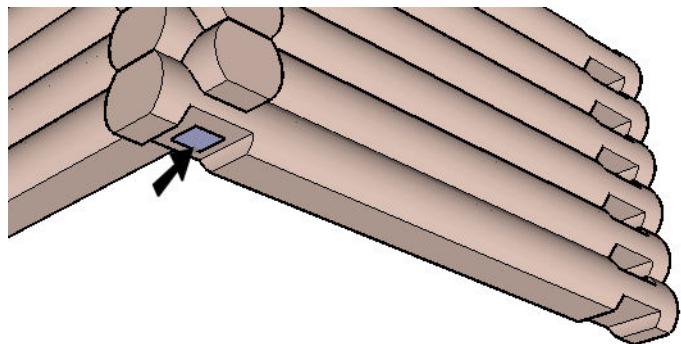
7. Select all rotated components and move them down. Drag them by the top construction point and stop at the midpoint of the first log.



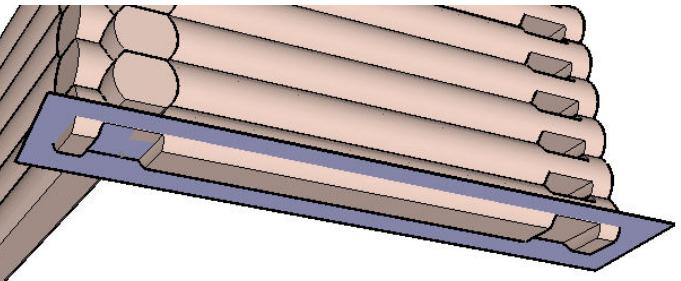
8. The bottom log should lie flat, so right-click it and select **Make Unique**.



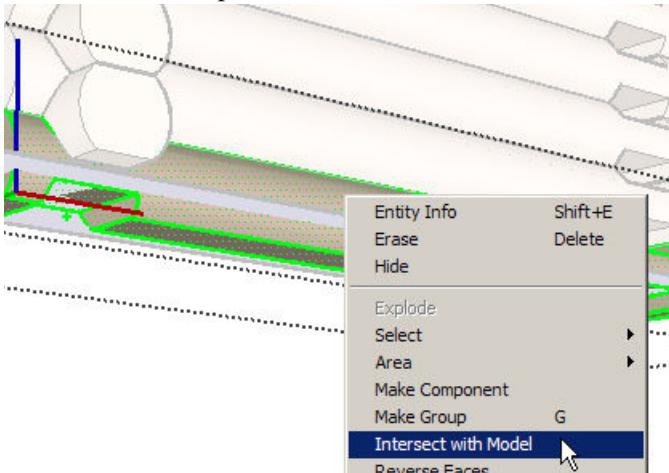
9. Draw a rectangle on the bottom notch face. This rectangle will be enlarged and used to trim the log. (The rectangle edges stay thick because you are drawing them on a component.)



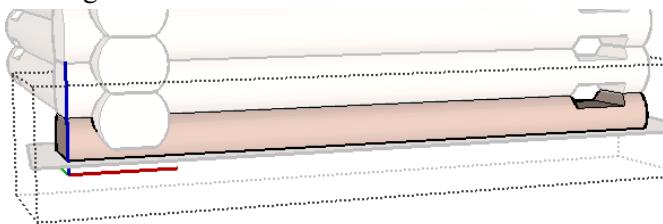
10. Move the edges so that the rectangle surrounds the log.



11. Edit this component, select it all, and **Intersect** it.

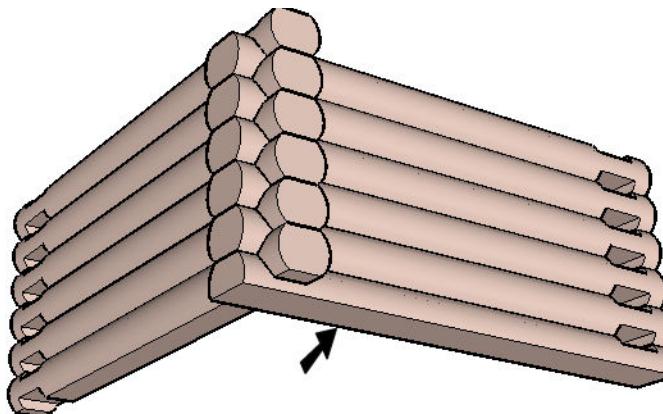


12. Trim the portion of the log below the intersection edges.

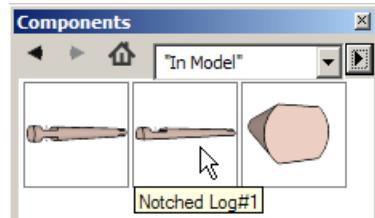


*NOTE: You also could have skipped making the rectangle and just drawn long lines along the log.*

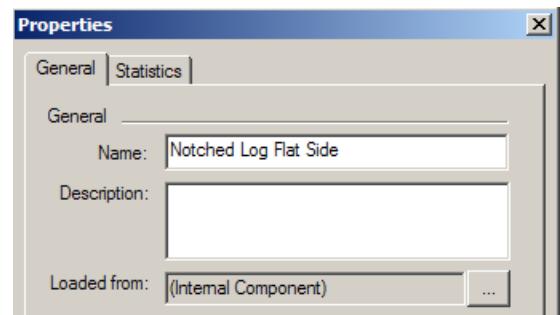
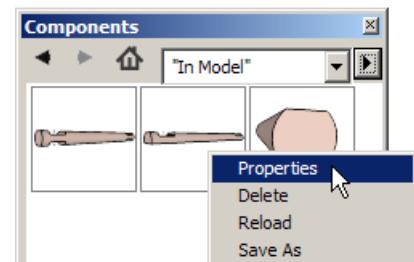
13. Close the component, and the bottom of the cabin is flat.



14. In the Component Browser, the component you just edited was assigned the name **Notched Log#1**.

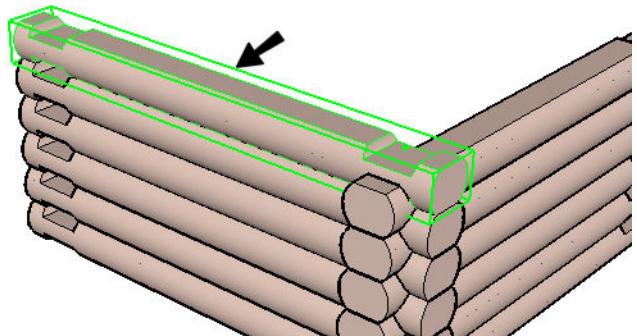


15. In Windows, to change the name, right-click the thumbnail and select **Properties**. Use a name such as Notched Log Bottom.

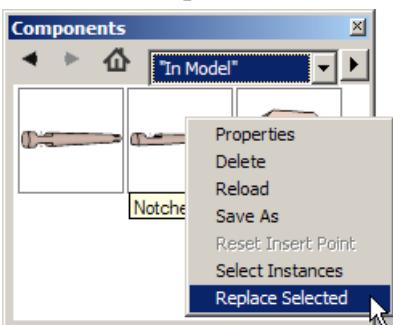


*Mac: The **Properties** option does not work as of this writing, but you can use **Entity Info** to rename a component.*

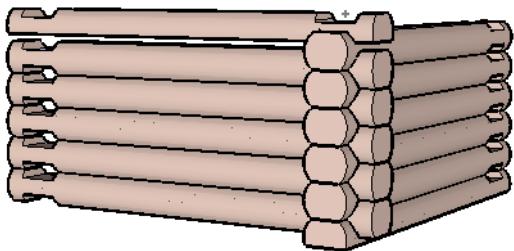
16. The top log here should also be flat. Select it.



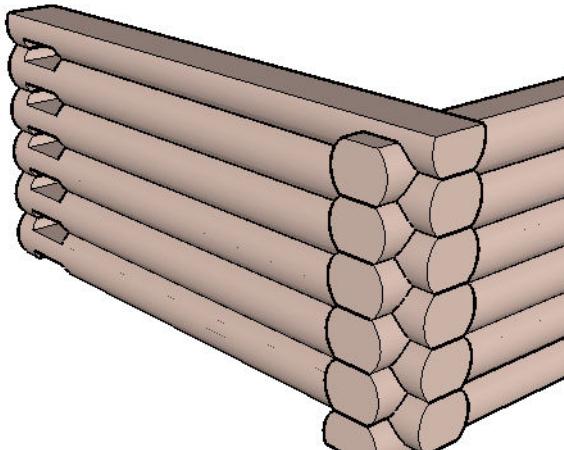
17. Right-click on the flat notched log in the Component Browser and select **Replace Selected**.



The flat log is inserted, but here it is upside-down.

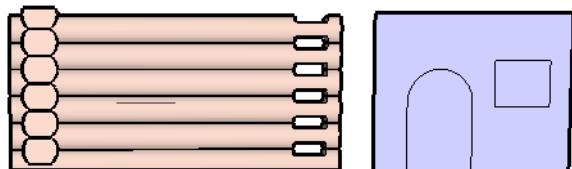


18. Use **Rotate**, **Flip**, or **Scale** to turn the log over, then move it into place.

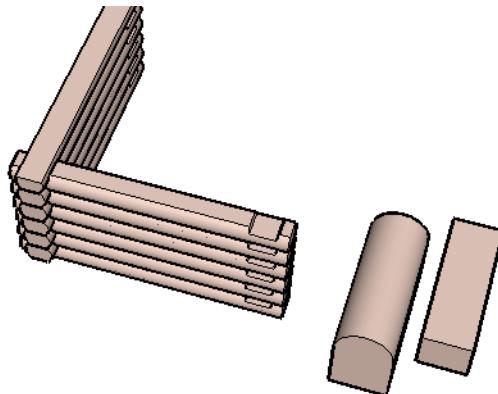


## Door and Window Cutouts

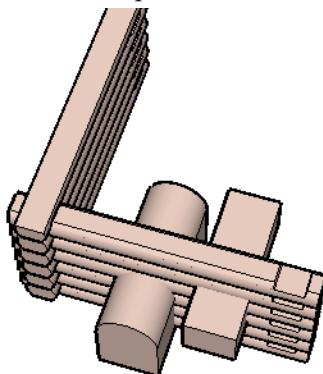
1. To create the cutout shapes, it's easiest if you make a vertical rectangle away from the house itself. Make an arched doorway and a rectangular window.



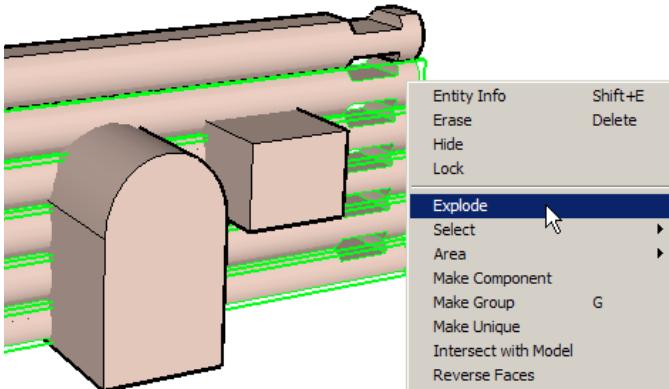
2. Trim so that only the door and window shapes remain. **Push/Pull** them to make them long.



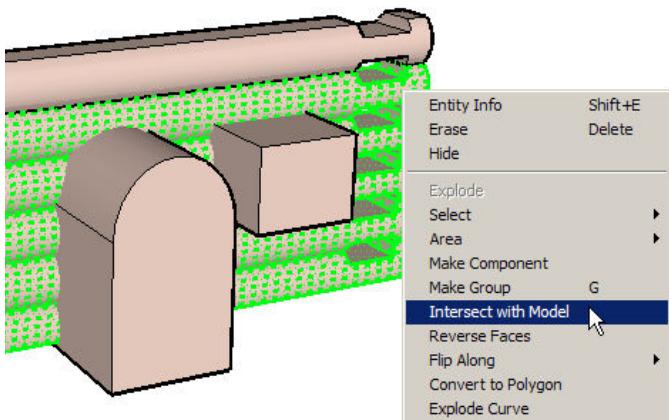
3. Move the cutouts into place.



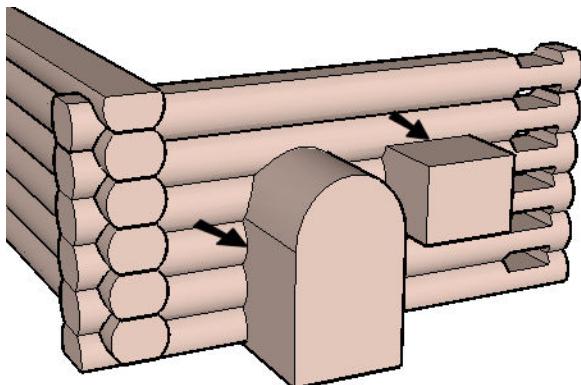
4. Select all logs that are affected by the cutouts and **Explode** them.



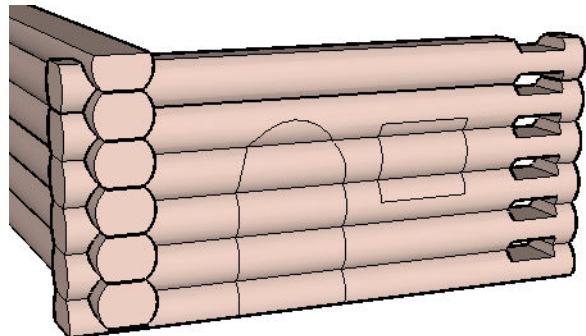
5. Run **Intersect** on the exploded logs.



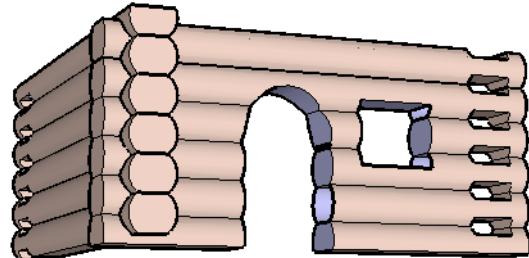
Now you have all the intersection edges you need to make the cutouts.



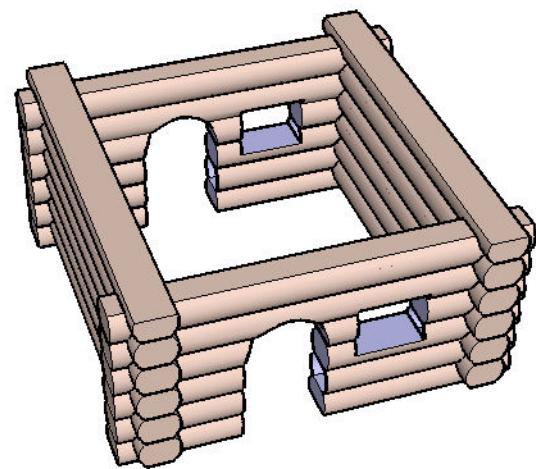
6. First trim the cutouts shapes away from the cabin.



7. Then erase the cutout portions within the logs.



8. If you want, copy the walls to the side and back to complete the house.





# 14 Program Settings

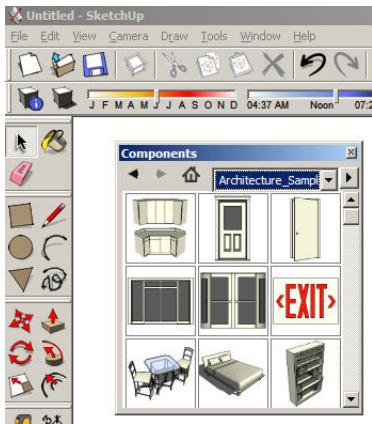
This chapter covers certain aspects and settings of the user interface you may want to manipulate.

## Stacking Windows

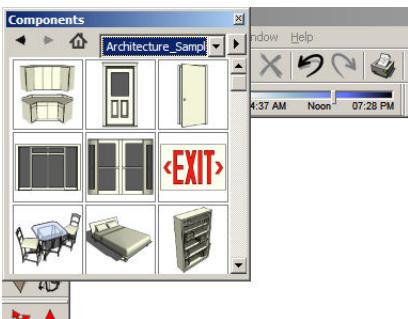
This is a great new feature of SketchUp, enabling you to keep all your UI windows available but not fully open, thereby maximizing your work space.

**TIP:** It's a great idea to set up shortcut keys to open and close windows you use often. See "Shortcuts for UI Windows, Toolbars" on page 453.

1. As an example, open the Component Browser. You can place it anywhere on the screen.



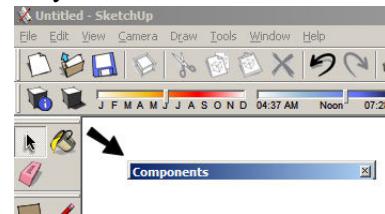
2. You can also drag it by its title bar to dock it to any edge of the screen, or any corner. Dock it to the top left corner (not that you'd want to work with windows placed right here).



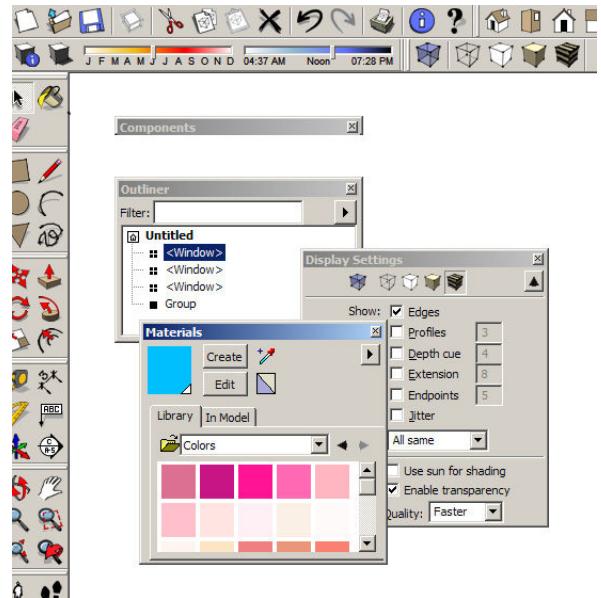
3. Now click the Component Browser's title bar. This closes the window, while keeping the title bar available when you want to open the window again.



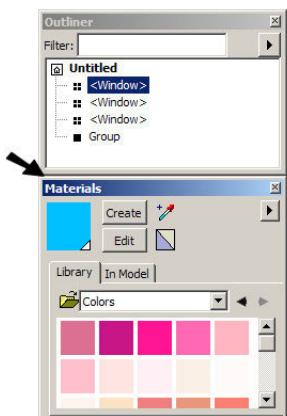
4. Drag the window by its title bar - you can place the window anywhere.



5. Now open some more windows (Material Browser, Outliner, etc.) With all the windows open like this, your screen quickly gets cluttered.

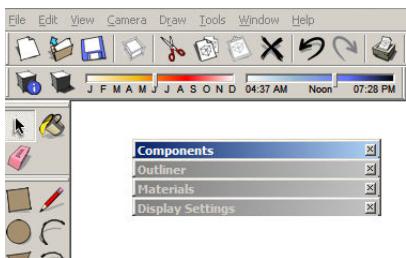


- To make the windows “sticky,” drag one window by its title bar directly above or below another window.



Now when you move the top window, any window below it moves with it.

- Make a stack of windows and minimize them all. If you work with these stuffed down in a corner, you can keep most of your screen available while you work.



- When you open a window, the adjacent title bars move down to accomodate.

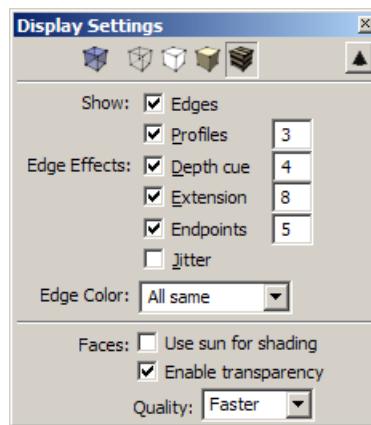


You can change the order of the stack by dragging a title bar to its new location. And to unstick a window, just drag it away from the stack.

## Display Settings

There are several places in the user interface that control aspects of how the model is displayed.

- The toolbars contain icons for adjusting shading, textures, and transparency display. You can also define hotkeys for these functions.
- The **Display Settings** window is one that you may want displayed all the time. You can toggle the display of this window by selecting **Window / Display Settings**, or you can set up a hotkey to show and hide this window (see “Preferences > Shortcuts” on page 452).



**TIP:** You can define shortcut keys to invoke all options on this window. This is very handy when you switch often between wireframe and shaded, endpoints and jitter lines, etc. See “Shortcuts for Render Settings” on page 453.

Clicking the arrow at the top of this window enables you to show or hide the lower section of the window.



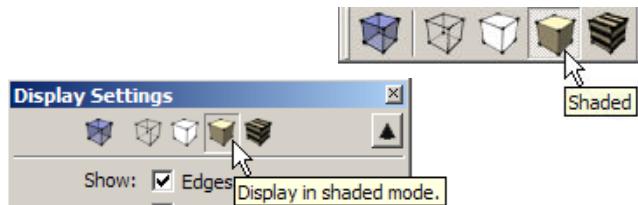
Click the title bar of the window if you want to collapse it. This is useful if **Display Settings** is “stuck” to other windows and you want to save drawing space.



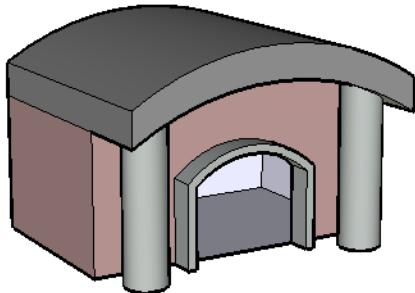
## Rendering Modes

This section covers various ways to display your model.

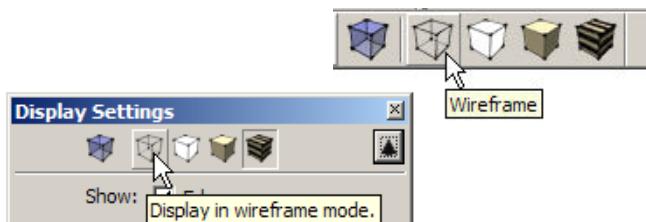
### Shaded



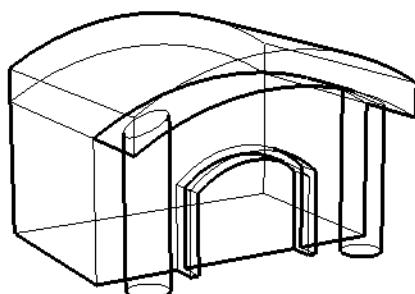
Color and shading is applied to the faces. The front and back of a face can have different colors, which are set in the **Colors** page of **Model Info**. If any materials were applied to faces, the default render mode is **Shaded with Textures**. If you then switch to **Shaded**, the materials will be represented by single colors.



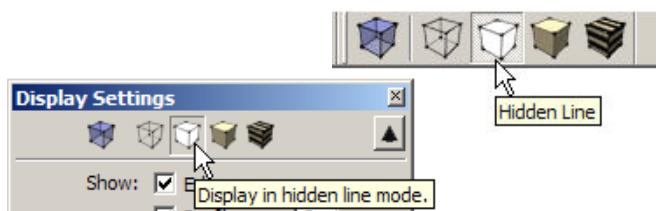
### Wireframe



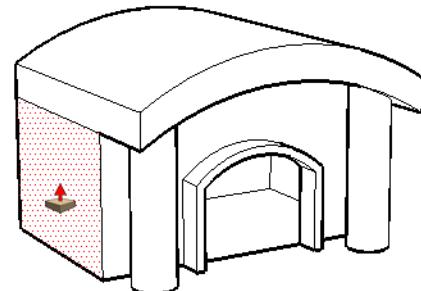
Displays the model as a collection of simple lines. There are no faces displayed, and faces cannot be selected.



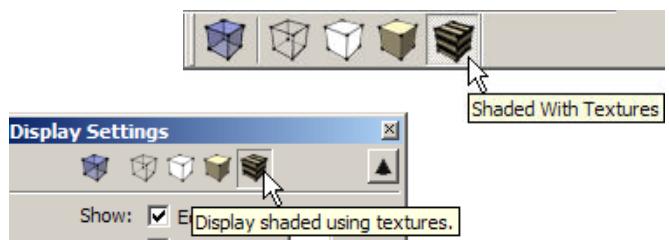
### Hidden Line



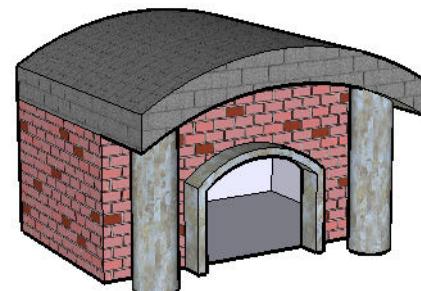
Looks like wireframe display, but lines behind faces are hidden. Faces are displayed, though they are not colored. In other words, you can select or **Push/Pull** a face, which you cannot do in wireframe.



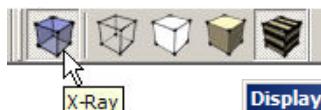
### Shaded with textures



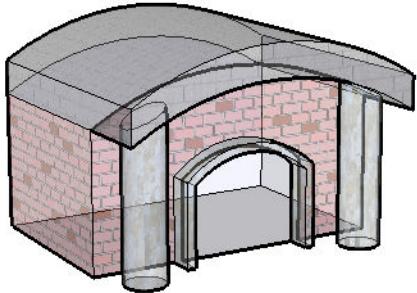
Displays any material that has been applied to faces. Materials are covered in Chapter 7.



### X-Ray



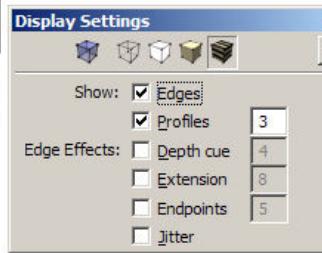
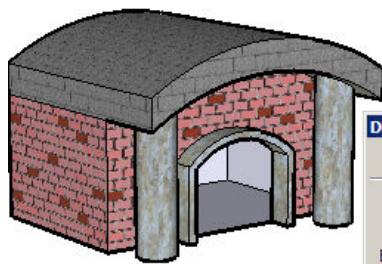
All faces become transparent. This is a good way to see the interior of a model.



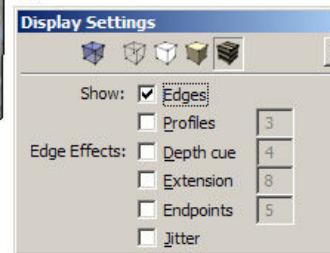
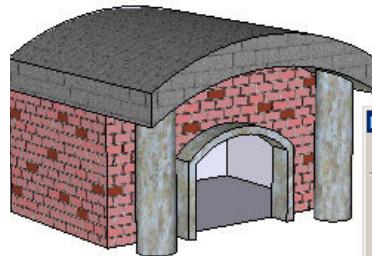
### Displaying Edges and Profiles

You can use **Display Settings** to control edge display, as well as the thickness of profile lines.

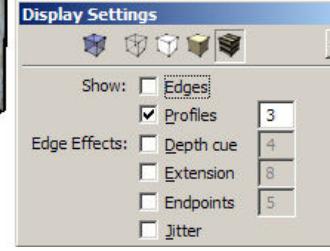
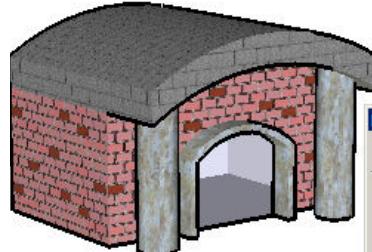
The default setting displays both **Edges** and **Profiles**. Profiles are outside edges. Edges between two faces are also considered profile edges when only one face can be seen in the current view. The profile thickness can be adjusted as well.



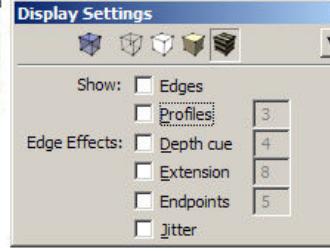
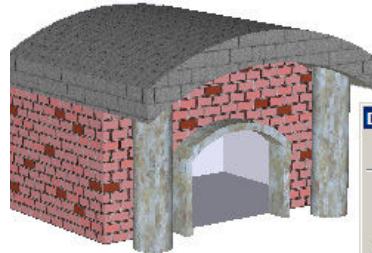
For a crisp display, checking only **Edges** shows all edges as thin lines. This looks nice when your model is crowded and/or has lots of detail.



You can also check only **Profiles**.



For a slightly more photorealistic look, uncheck both **Edges** and **Profiles**.

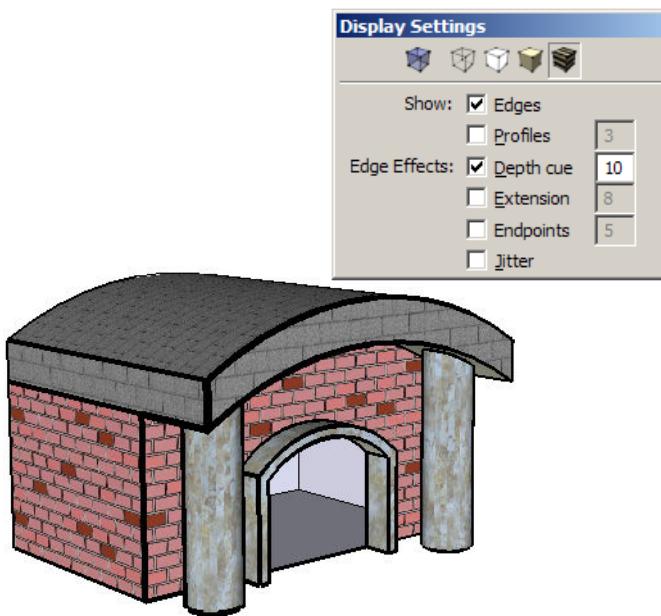


## Edge Effects

The following four settings can add some non-photorealistic effects to your model.

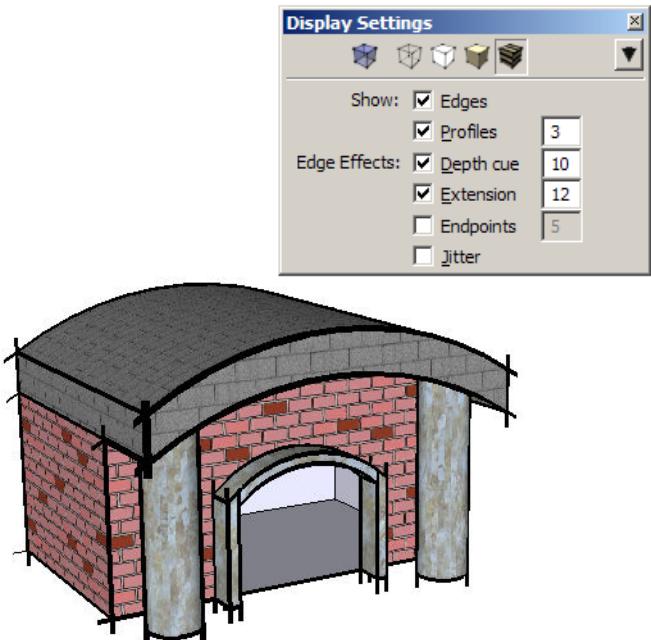
### Depth Cue

Thickens edges closer to you, while farther edges are thinner.



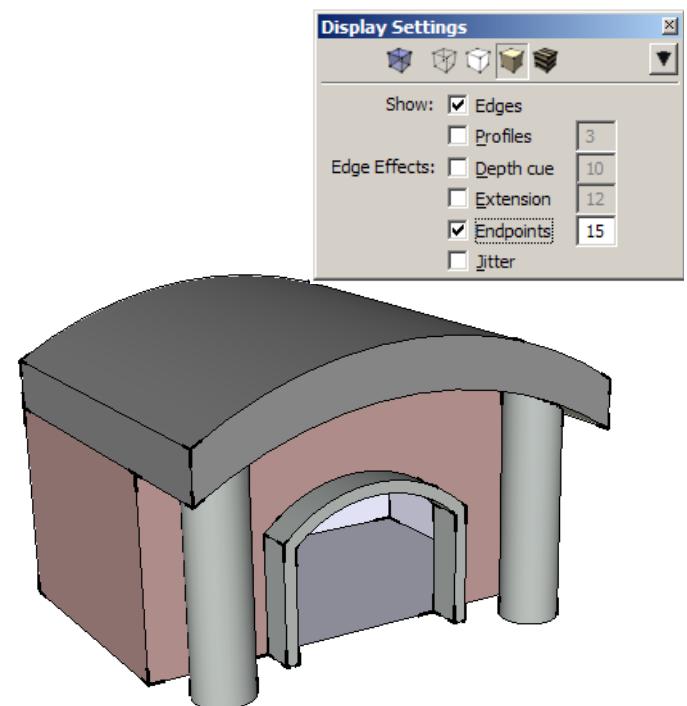
### Extension

Extends each edge slightly past its endpoints, similar to a hand-sketched drawing.

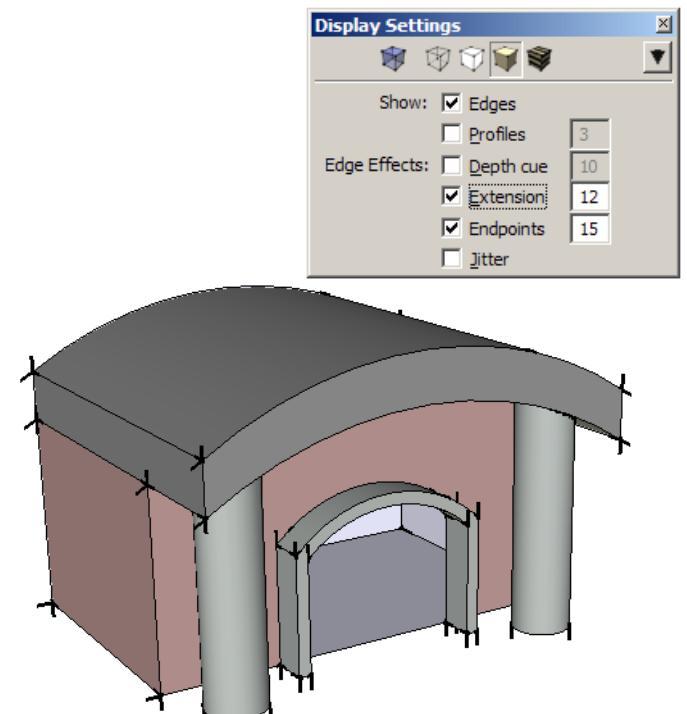


### Endpoints

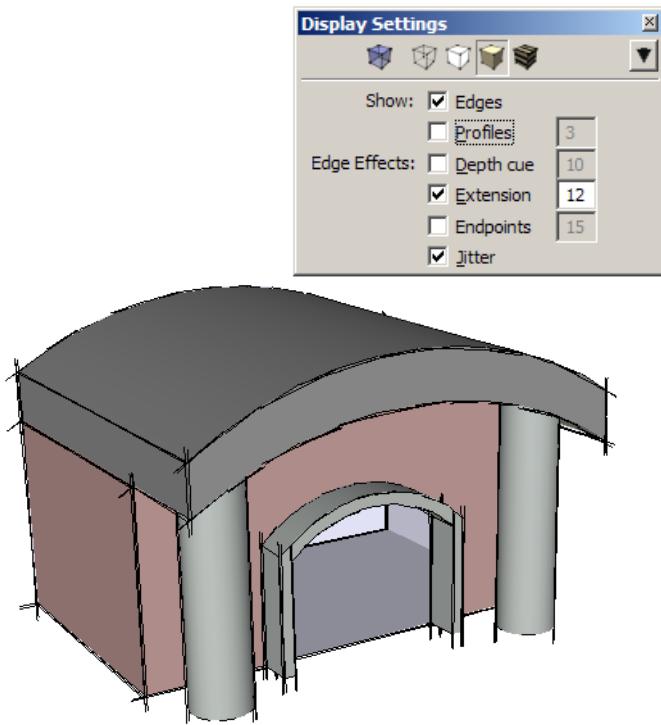
Adds additional thickness along ends of edges.



You can get thick extension lines if you combine **Extension** with **Endpoints**.



**Jitter:** Applies a hand-sketched look to edges. It looks good with or without extensions.

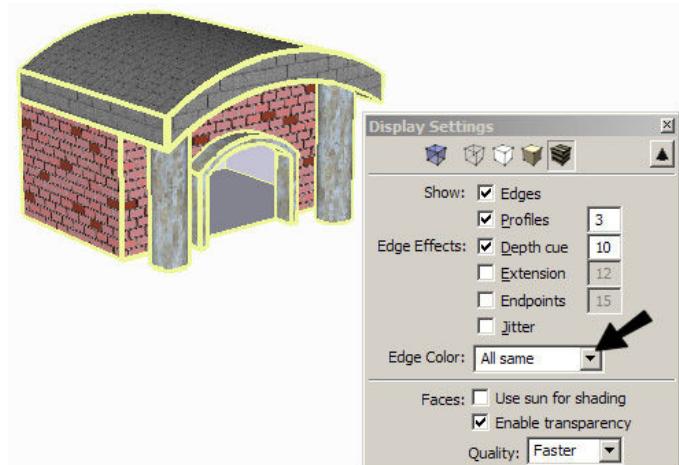


## Edge Color

For these options to be available, click on the arrow at the top right corner of the **Display Settings** and **Show Details**.

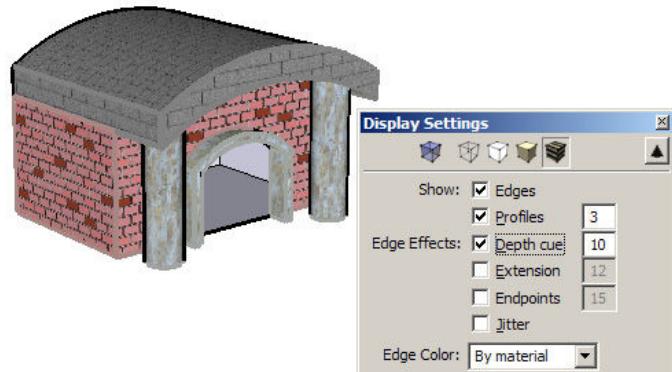
### All Same

All edges have the edge color assigned on the **Color** page of the **Model Info** window.



## By Material

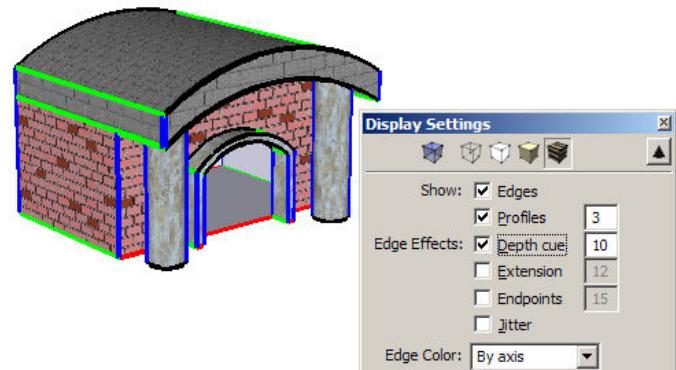
Edges are colored according to the applied material. For this to work, material has to be applied to *both faces and edges*. Applying material only to faces will not affect edges.



TIP: You can select both a face and its surrounding edges by double-clicking on it. This makes it easy to be sure edges are included when applying materials.

## By Axis

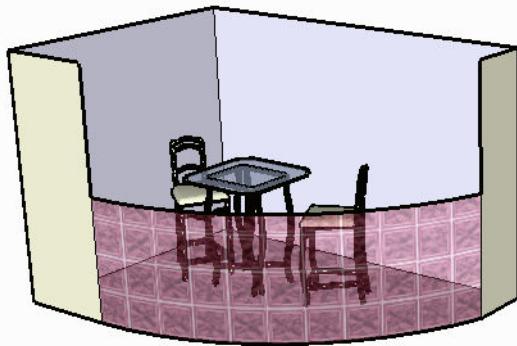
Edges have the color of the axes to which they are parallel (red, green, or blue). Edges that are not parallel to any axis take on the assigned edge color on the **Color** page of the **Model Info** window.



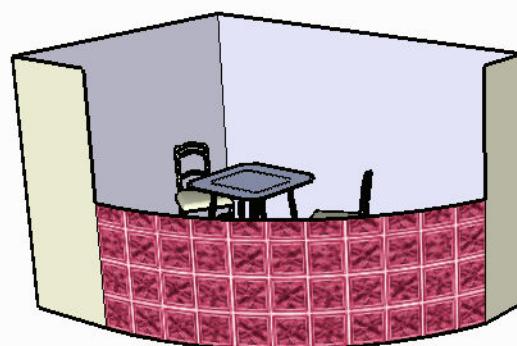
## Face Display Settings

**Use sun for shading:** Uses the current shadow settings to shade the faces. The faces look the same as when shadows are enabled, but shadows are not actually created.

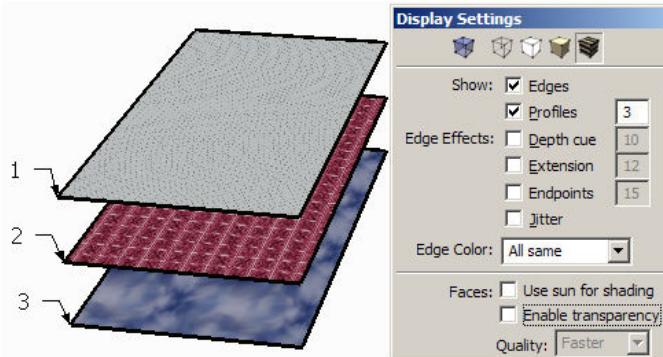
**Enable Transparency:** Enables you to see through materials defined as transparent. See "Material Transparency" on page 249.



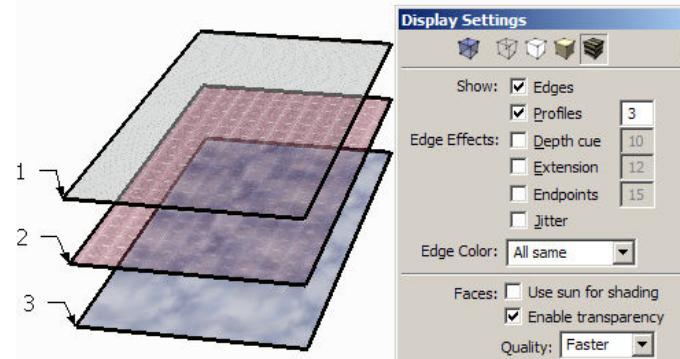
If this option is not checked, transparent materials will be displayed as opaque.



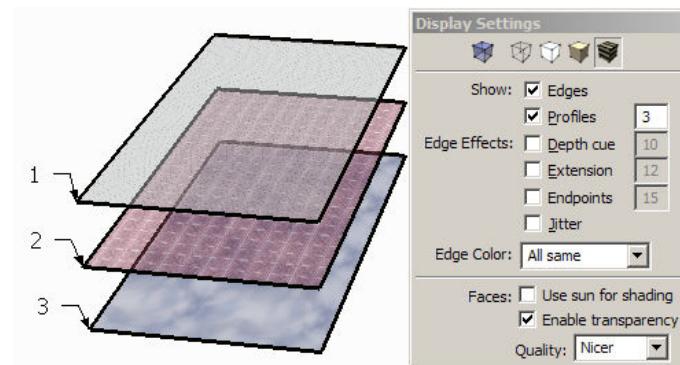
**Quality:** Choose **Faster** for a render that is quick, but with less sorting accuracy. In this example, Face 1 is above Face 2, which is above Face 3. It's easy to see the sorting order when **Enable transparency** is not checked.



When **Faster** is selected, Face 3 appears to "jump" in front of Face 2.

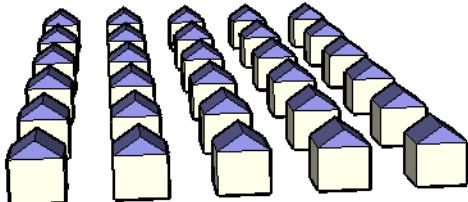


Use **Nicer** if you want to maintain sorting accuracy, thereby requiring heavier calculations and possibly a slower render. In this case, the display order of transparent materials is accurate.

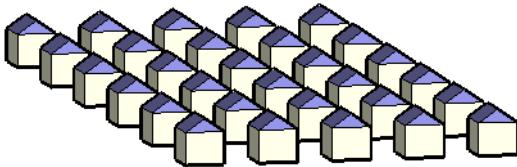


## Perspective Mode

In **Perspective** mode (**Camera / Perspective**), which is the default, the model appears to shrink in the distance, representing how the human eye actually views 3D objects.



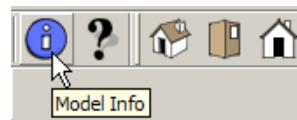
The alternative is **Paraline** mode, in which parallel lines remain parallel on the screen. This is also referred to as axonometric projection, and reflects what is usually presented in construction drawings.



You can switch between these modes by toggling **Camera / Perspective**, or by setting a hotkey for it.

## Model Info

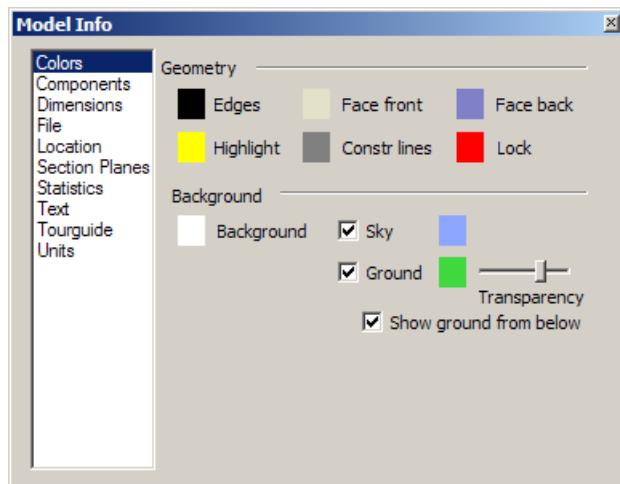
To set properties of your model, select **Window / Model Info** or click the **Model Info** icon.



**TIP:** If you access this window often, you might want to set up a shortcut for it - see "Preferences > Shortcuts" on page 452.

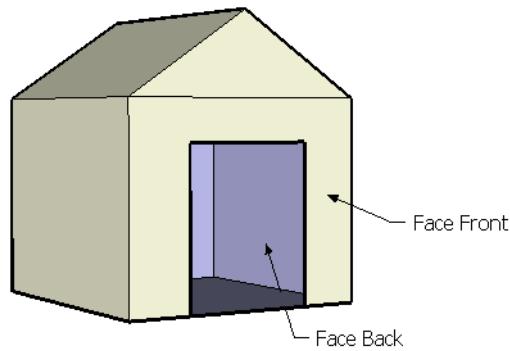
**NOTE:** If you want to set up global properties for SketchUp itself, see "Preferences" on page 450.

### Model Info > Colors



#### Geometry:

- **Edges:** To see edges displayed in this color, select **All Same** for edge display in the **Display Settings** window.
- **Face Front, Face Back:** Faces have different colors on the front and back.

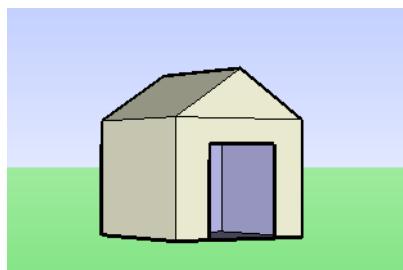


The way a face is oriented generally depends on how it was created, but you can always switch front and back by right-clicking and selecting **Reverse Faces**. These colors apply to faces that have the default (none) material. Once a material is assigned, it paints only the selected side. The reverse side will remain the default color, unless a material is assigned to that face as well. (The exception is for transparent materials, which are applied to both sides of a face. See “Double-Sided Faces” on page 254.)

- **Highlight:** The color of a face, edge, or group when selected. Use a color that will contrast well with the **Face Front** and **Face Back** colors.
- **Construction lines:** The color of construction geometry, created by the **Measure** and **Protractor** tools. See "Measure" on page 39 and
- **Lock:** The color of the bounding box surrounding a locked component or group. Locking is covered in “The Outliner: Manipulating Groups and Components” on page 206.

**Background:** The background color of the SketchUp window.

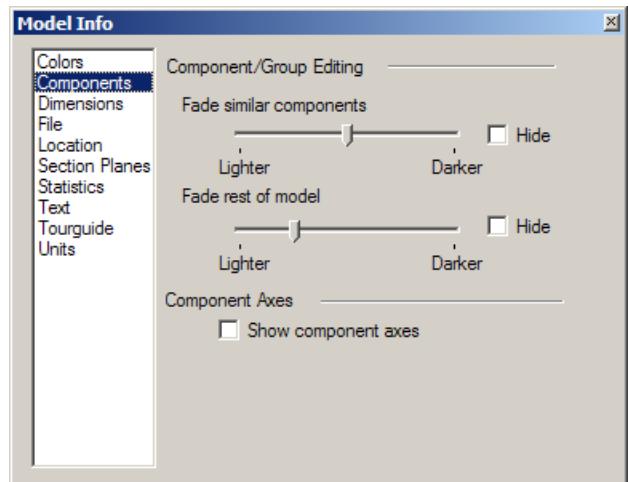
- **Sky, Ground:** Enables you to use sky and ground backgrounds, and to set their colors. **Sky** is visible above the horizon, **Ground** is visible below the horizon.



Use the **Transparency** slider to make the gradient ground effect transparent to various degrees, allowing you to see geometry below the ground plane. If you are using software-based OpenGL rendering, don't use this option.

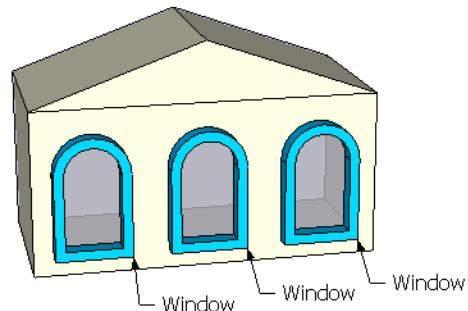
- **Show ground from below:** Makes the ground visible when looking up from below the ground (worm's eye view).

## Model Info > Components

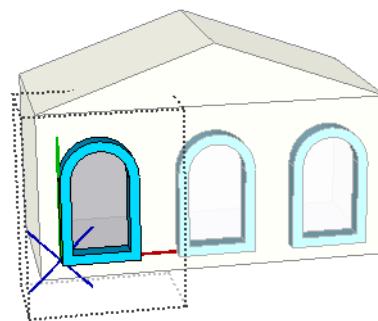


Components are groups of objects that can be inserted multiple times in your file. For more information, see Chapter 6.

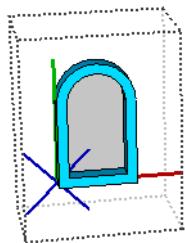
**Fade similar components, Fade rest of model:** When editing a component or group, these options control the display of similar components and all other objects.



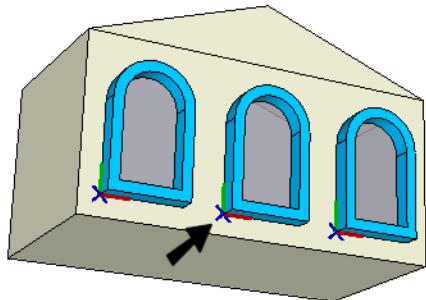
When editing one component, you can use the **Fade** slider if you still want to faintly see the rest of the mode and other components.



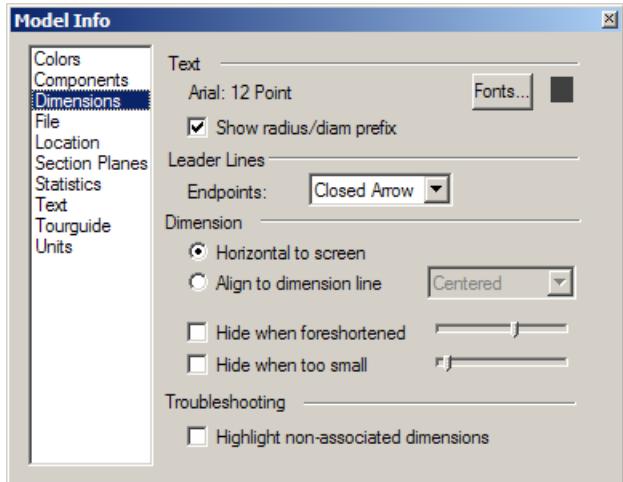
Check **Hide** for both to blank them completely, leaving only the edited component on the screen.



**Component axes:** Check **Show component axes** to show the origin and axes for each component.



## Model Info > Dimensions



NOTE: All dimensioning options are detailed in the exercise "Dimensions" on page 82.

**Text:** Click **Choose Font** to set the font, font style, and font size of dimension text. For text color, click the color box to set the font color.

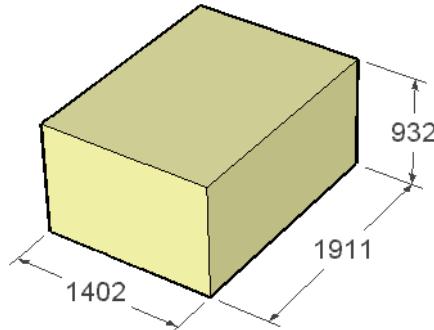
**Show Radius/Diam. Prefix:** Displays an "R" in front of arc dimensions, or a "DIA" in front of circle dimensions.

**Leader Lines:** Choose from five types of arrows.

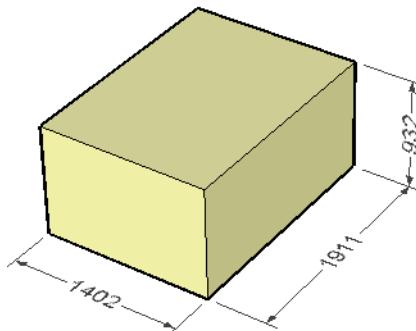


### Dimension

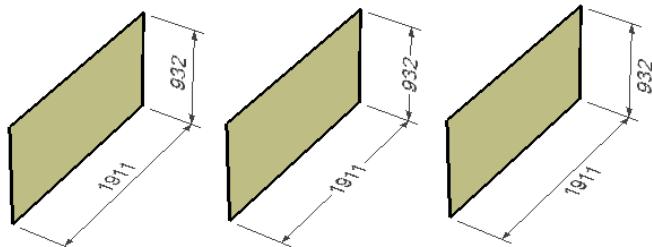
- **Horizontal to Screen:** Dimension text is always horizontal.



- **Align to Dimension Line:** Dimension text is aligned to the plane of the dimension itself.



For aligned dimensions, select whether the dimension text appears **Centered**, **Above**, or **Outside** the dimension line.

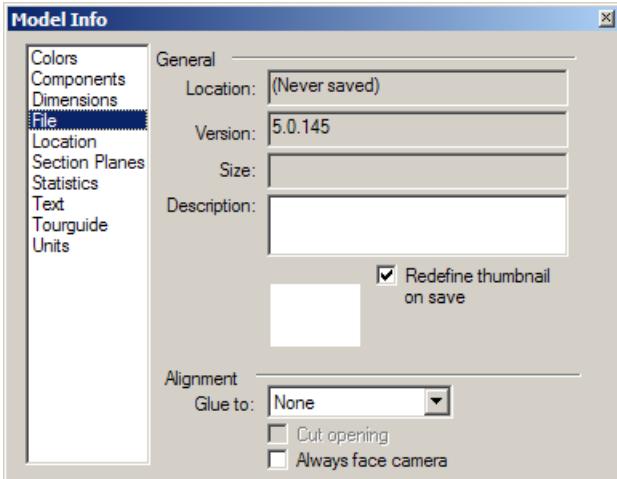


- **Hide when foreshortened:** Hides dimensions that are oblique to the viewing plane. The slider sets the tolerance angle at which dimensions are hidden.
- **Hide when too small:** Hides dimensions that become hard to read when you zoom out. The slider controls the size of dimensions that will be hidden.

## Troubleshooting

- Highlight non-associated dimensions:** Highlights dimension whose geometry has changed, or dimension text that has been edited. Click the color box to select the highlight color.

## Model Info > File

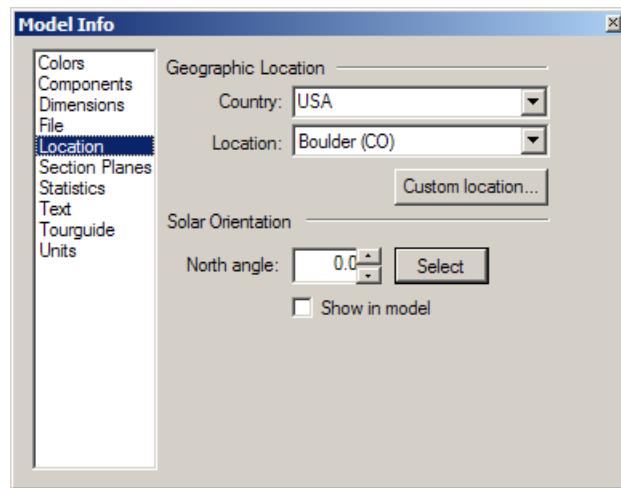


**General:** Information about the file itself: where it is saved, the version of SketchUp in which it was created, file size, and description.

**Alignment:** If the file is saved to be used later as a component, this is where you can set its component properties.

- Glue to:** Sets the type of face to which the component will align.
- Cut opening:** Should be checked if the component is a window or door (or something similar) that cuts through walls.
- Always face camera:** Keeps a component facing you no matter the orientation of the camera. This is handy for 2D components like people, signs, trees, etc.

## Model Info > Location

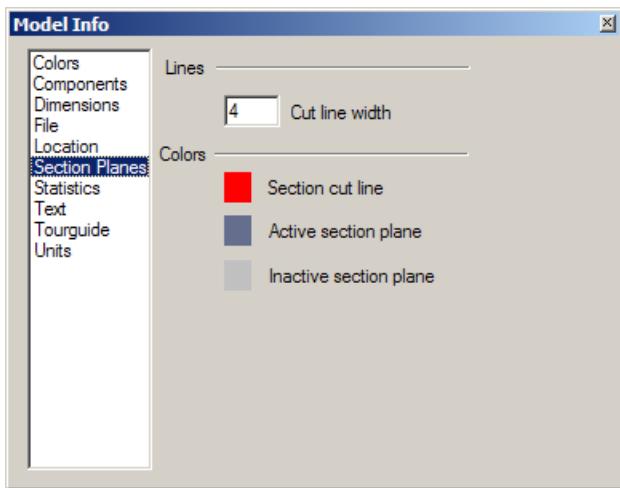


These options are relevant for creating shadows, see "Shadows" on page 331.

**Geographic Location:** Select the country and city in which your model is located. A vast number of locations around the globe is provided, but you can add a custom location. Click **Custom location** and enter the relevant information: latitude, longitude, and time zone.

**Solar Orientation:** Enter the north angle manually, or click **Select** to set the north direction on the screen. To set it this way, first click the reference point and then any point in the north direction. To show the north angle on the screen, click **Show in Model**.

## Model Info > Section Planes



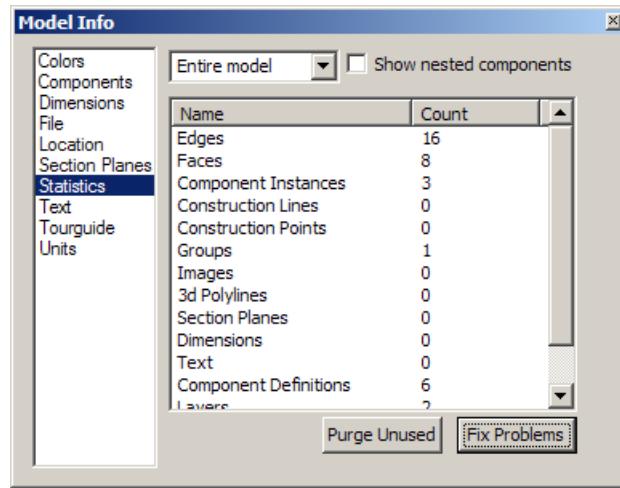
See Chapter 8 for details on using section planes.

**Lines:** Enter the width of cut lines. A high width helps you better see the section plane.

### Colors:

- **Section Cut Line:** The default color for section slices. If you assign a material to a section plane, that material color is used instead.
- **Active Section Plane:** The color for active section planes.
- **Inactive Section Plane:** The color for inactive section planes.

## Model Info > Statistics



On this page you can count the numbers of certain types of objects in your model, such as edges, faces, or groups. You can obtain these numbers for the entire model or only components. If you check **Show nested components**, all objects within components will be included in the count.

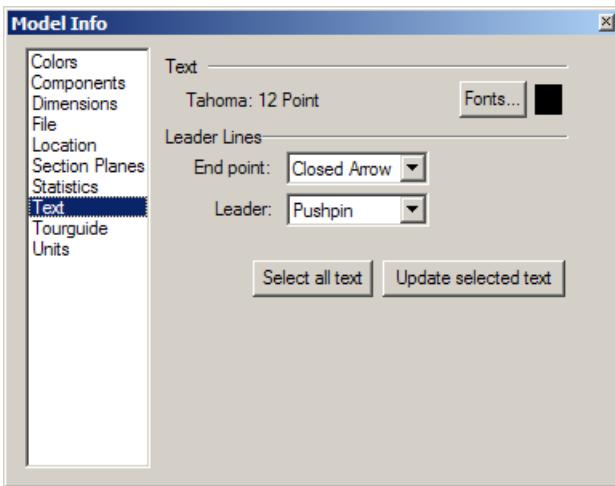
**Purge unused:** Removes any unused components, materials, image objects, layers, and other extraneous information from your file.

**Fix Problems:** Causes SketchUp to scan your model, report any invalid geometry, and attempt to fix any problems. The scan checks that:

- faces are bounded by a loops of at least three edges.
- a face has a pointer to the loops that bound it, and a loop has a pointer back to the face that it bounds.
- a face adheres to a plane equation. If not all vertices lie on the same plane, SketchUp tries to recompute the plane equation and then check to see if the vertices are on the re-computed plane.
- all edges that are used by a face are in the same component that the face is in.
- a face does not have zero area
- an edge does not have two ends at the same point.

In some cases, **Check Validity** can fix things. For example, recomputing a plane equation for a face will correct the face. In other cases, there is nothing that can reasonably be done to fix the problem. For example, a face that does not have edges bounding it will be deleted.

## Model Info > Text



**NOTE:** All text options are detailed in the exercise "Text" on page 78.

**Text:** Click **Choose Fonts** to select the font, font size, and font style for the text. For text color, click the color box.

### Leader Lines

- **End Point:** Choose from four different types of end points.

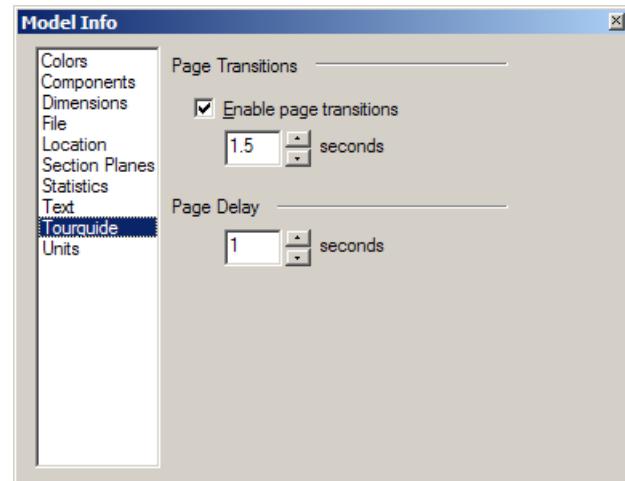


- **Leader:** A **View-Based** leader maintains its 2D orientation, and will disappear when any part of the leader is hidden. A **Pushpin** leader maintains 3D orientation, and is always visible as you orbit your model.

**Select All Text:** Selects all text objects.

**Update Selected Text:** If you have text objects selected, click this to apply new settings to those objects.

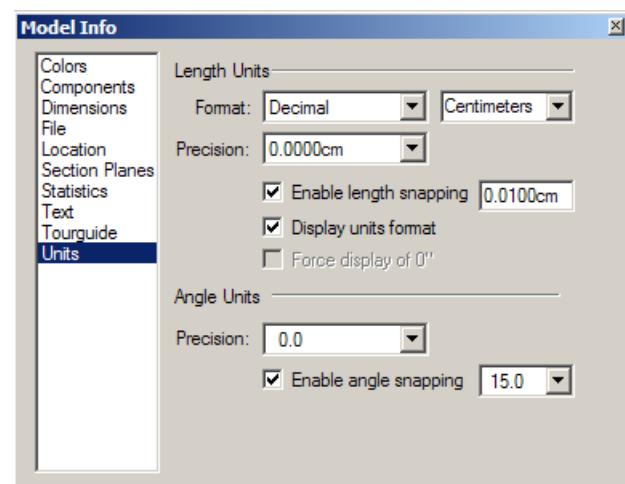
## Model Info > Tourguide



These options are relevant for creating animations of saved pages. See "Tourguide / Slideshow" on page 330.

- **Enable page Transitions:** Smoothly and dynamically transitions between adjacent pages. If not checked, the pages will switch immediately.
- **Transition Time:** The seconds for each transition.
- **Page Delay:** The amount of time each page will be visible (not including transition time).

## Model Info > Units



The units you set are used in the Value Control Box, and affect the dimensions and text labels you create.

**Length Units:** Controls how lengths are measured and displayed.

- **Format:** Controls units and type of measurement that appears in the Value Control Box.

**Architectural:** 3'-2 15/16".

**Decimal:** 106.5", 3.25', 1042mm, etc. You can use Imperial or Metric units.

**Engineering:** 32.5320' Only Imperial units (feet) are used.

- **Precision:** Depending on the type of unit, controls the degree of accuracy. You can use up to 1/64" and 6 decimal places. (For architectural work, you don't need more than 1/8" precision.)
- **Enable length snapping:** Enables you to snap to drawing increments set by the **Snap Length** (the box to the right). **Snap Length** must be greater than **Precision**.
- **Display units format:** Relevant for Decimal units. When creating dimensions, the unit will not be displayed after the dimension number.
- **Force display of 0':** Relevant for Architectural units. When creating dimensions, a zero will be displayed for inches, even when the value is an even foot value (12'-0" vs. 12').

**Angle Units:** Controls the measurements of angles.

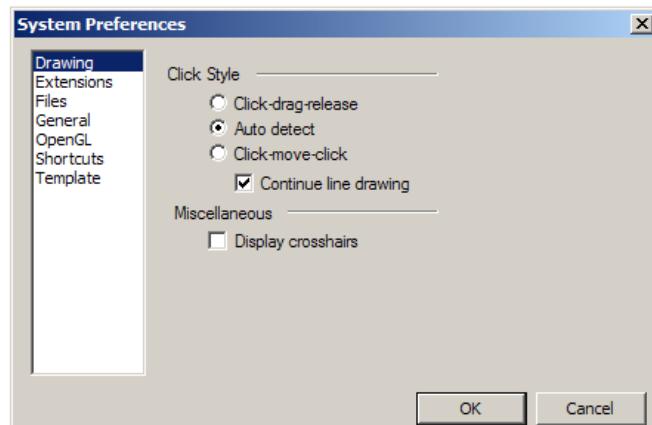
- **Precision:** You can specify zero or one decimal place.
- **Enable angle snapping:** Enables you to snap to increments defined by the **Snap Angle** (the box to the right). This angle may be 1, 5, 10, 15, 30, or 45 degrees.

## Preferences

SketchUp Preferences are settings that apply to the application itself. You can open this window by selecting **Window / Preferences** (Mac: **SketchUp / Preferences**).

NOTE: *For settings that apply to the current model only, see "Model Info" on page 444.*

### Preferences > Drawing



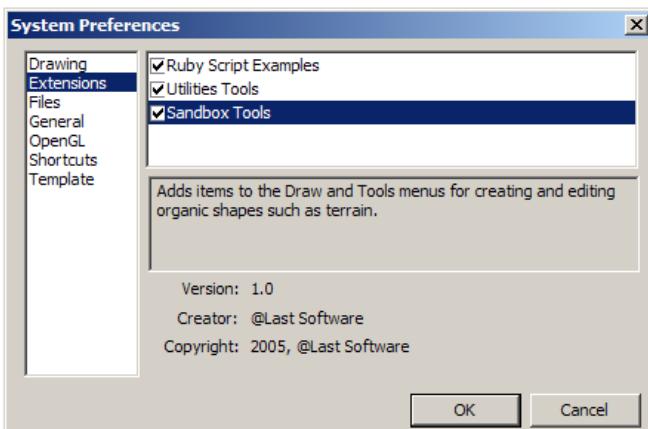
**Click Style:** Controls how you draw lines with the **Line** tool.

- **Click-drag-release:** Draw lines by clicking on a point, dragging the cursor, and ending the line when the mouse button is released.
- **Auto detect:** Both techniques will work - SketchUp will figure it out by how you draw.
- **Click-move-click:** Draw lines by clicking on each endpoint.
- **Continue line drawing:** Automatically starts a new line at the endpoint of the previous line. Otherwise you are free to draw from any point. If you use **Auto Detect**, lines are continuous when using **Click-Move-Click**, but not with **Click-Drag-Release**. This way you can draw single or multiple lines at will.

**Display Crosshairs:** Displays the red, green, and blue axes with the cursor when drawing. This can help orient you in 3D space, but will also add a lot of lines to the screen.

**Auto-activate paint tool** (Mac only): Causes SketchUp to automatically activate the **Paint** tool after you select a color swatch.

## Preferences > Extensions

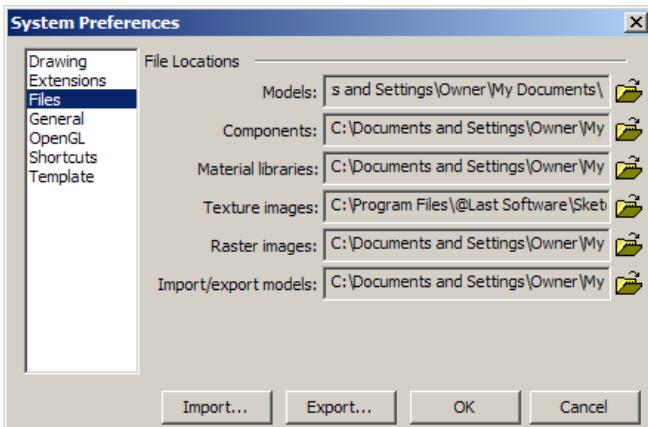


Extensions are groups of commands or functions that are not necessarily part of core SketchUp functionality, so they can be turned on or off. For example, not everyone needs the **Sandbox** tools, so you can work without seeing the menu items and toolbar icons.

**Ruby Script Examples** and **Utilities** tools can be checked to activate sets of Ruby scripts. For details, see “Provided Scripts” on page 465.

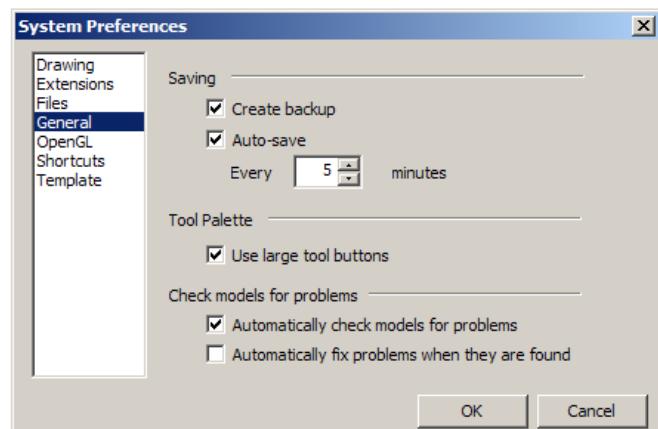
## Preferences > Files

(Windows only)



This page displays the default paths in which certain types of SketchUp files are stored. To change a path, select it and click **Modify**.

## Preferences > General



**Create backup:** A backup file will be created each time you save your file. The backup is located in the same folder as the file, and has the extension **\*.skb**.

**Auto save:** Saves your file to a temporary file at a specified time interval (i.e. every 10 minutes). If your computer (or SketchUp - nothing's perfect!) crashes, you may be prompted to open the recovery file instead of the original file. For large files, or if you are working on a slow computer or a laptop, recovery may be disruptive.

**Use large tool buttons:** Great when working with high screen resolution, this enlarges all the SketchUp icons.

**Automatically check model for problems:** Options for scanning for, and fixing, geometric problems. The model is assessed for problems when it is loaded or saved. It's a good idea to check this box so that problems will be corrected proactively.

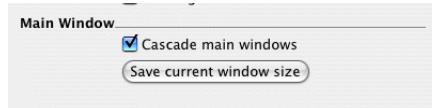
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*NOTE: If this is unchecked, you can manually check for problems using **Fix Problems**. This is found on the **Statistics** page of the **Model Info** window.*

---

**Automatically fix problems when they are found:** Problems are fixed automatically, without a message window.

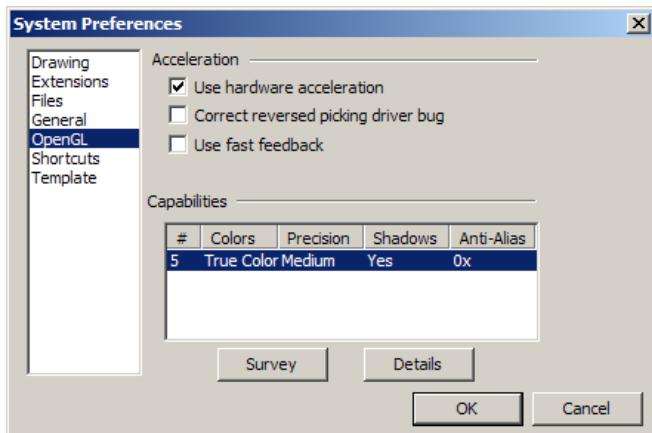
### Additional Mac options:



**Cascade main windows:** New file windows will appear cascaded below the previous file windows. If disabled, new windows will appear directly on top of previous windows.

**Save current window size:** Saves the size of the current window as the default size for SketchUp.

## Preferences > OpenGL



**Use Hardware Acceleration:** Enables SketchUp to use the 3D hardware acceleration features of your system. SketchUp defaults to using software rendering (acceleration disabled) While this option may impact speed and quality, it dramatically increases your chances of SketchUp working correctly. Also, if you are lucky enough to own a graphics card that truly supports OpenGL acceleration as advertised, all you have to do is enable the checkbox.

Depending on your card and driver, hardware acceleration may only be available at certain resolutions and color depths. In Windows, you can control this in the **Windows Control Panel / Display / Advanced / Performance**.

---

**WARNING:** Please be careful when changing this setting! The majority of drivers shipped today do not fully support the OpenGL specification, yet routinely advertise otherwise.

---

**TIP:** If you notice artifacts appearing on faces when you apply materials, try turning off hardware acceleration.

---

**Correct Reversed Picking Driver Bug (Windows only):** Some drivers exhibit a strange bug that makes SketchUp select the reverse of faces with the **Select** tool. This setting provides a work-around. Do not change this setting unless you are experiencing this problem.

**Use Fast Feedback:** For large models or complex renders due to shadows and materials, this setting can speed up your file. **Fast Feedback** will automatically engage only when rendering is slow. You may see a flicker when creating large elements.

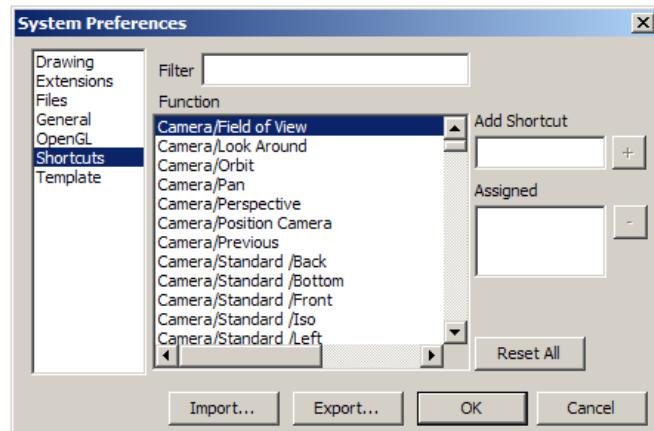
**Capabilities (Windows only):** Certain OpenGL modes do not fully support shadows cast on faces. Some modes may exhibit rendering artifacts in low precision modes. Please

be careful when changing this setting; there is no way of knowing in advance whether the mode you choose will work properly.

**Survey:** Guides you through a series of questions that allow @Last technical support to better identify certain problems.

**Details:** Displays important information about your video card, resolution and color depth settings, OpenGL driver, and the current rendering mode that SketchUp is using. This information can be very helpful when diagnosing technical problems.

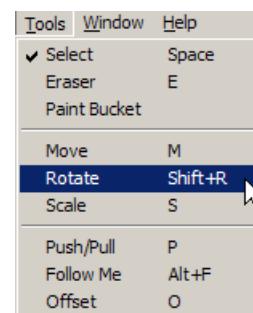
## Preferences > Shortcuts



You can set up keyboard shortcuts, otherwise known as accelerator keys or hotkeys, to enable you to invoke commands faster than with the mouse or menu.

All the SketchUp commands are listed in the **Commands** menu. If a shortcut has already been defined for a command, it will appear in the **Accelerators** window. To add your own shortcut, select the command and place the cursor in the **Add Accelerator** field. Then simply type the shortcut (i.e. F2, G, Ctrl+B, Shift+Ctrl+P, etc.) and click the + icon. Numbers cannot be used, since they could be confused with data entered in the Value Control Box.

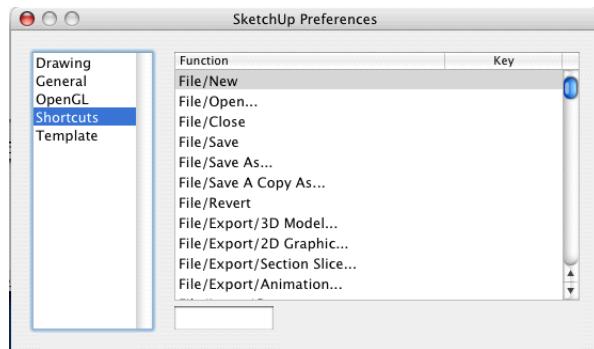
Once shortcuts are defined, they will appear in the pull-down menus.



In Windows, you can save your shortcuts by exporting all your preferences. You can then import them later. If you have a large set of shortcuts defined, it's a good idea to export them, in case of future system failure.

**TIP:** If you want to download a ready-made set of shortcuts, see "Shortcuts You Can Download", this page.

**Mac:** Commands are listed under **Function**. Assigned shortcuts are listed under **Key**.

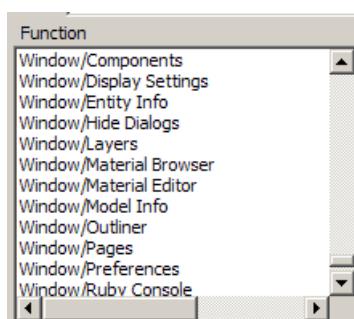


Select the command and simply type the letter(s) you want assigned to it. The shortcut will appear in the field at the bottom of the pane. Do not press Return; simply click on another command to implement the shortcut.

## Shortcuts for UI Windows, Toolbars

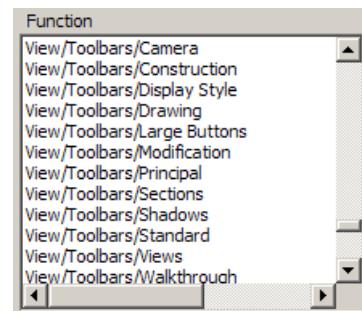
In addition to defining shortcuts for tools like **Line** and **Push/Pull**, it's very handy to define shortcuts for toggling the display of windows you use often. There is also a command to hide all windows.

These commands are found under the **Window** header.



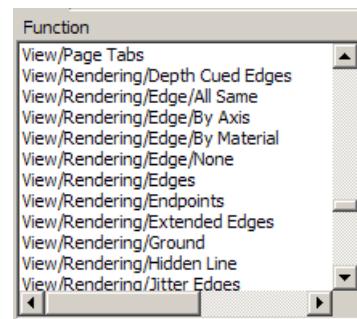
**TIP:** To make it easy to remember the shortcuts, use a pattern according to the first letter of the window. For example, define Shift+C for Components, Shift+D for Display Settings, Shift+E for Entity Info, etc. Shift+H could be used to hide all windows.

You can also set up shortcuts to toggle the display of toolbars, or groups of icons. These are found under the **View** header.



## Shortcuts for Render Settings

If you switch often between X-Ray, Shaded, Wireframe, etc., you should set up shortcuts for this. These commands are found under the **View** header.

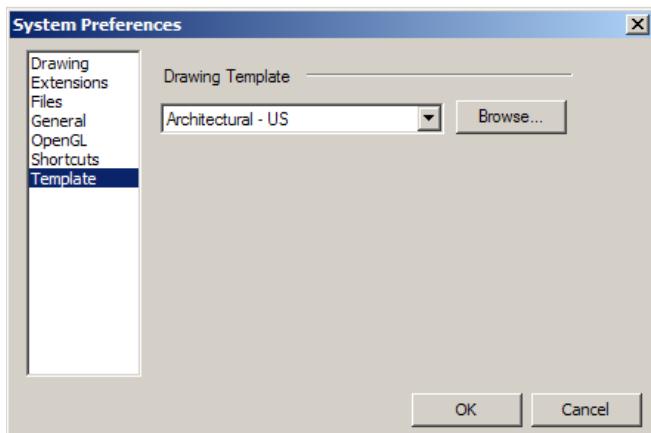


**TIP:** The F keys (F4, F5, etc.) are great to use as shortcuts for quick view-switching.

## Shortcuts You Can Download

If you use Windows and you want to download a set of shortcuts (actually, the ones I've set up for myself), go to [www.f1help.biz/ccp51/cgi-bin/SU5Files.htm](http://www.f1help.biz/ccp51/cgi-bin/SU5Files.htm) and download the file "PreferencesBonnie.dat." To load these into SketchUp, open **Window / Preferences** to the Shortcuts page and click **Import**.

## Preferences > Templates

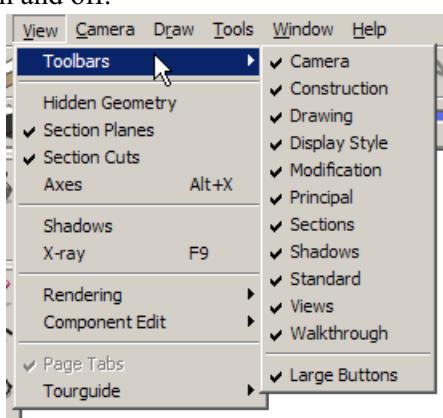


You can set default settings and add your own base geometry to a file you want to use as a template. To make a template, open a new SketchUp document, modify it to suit your needs (units, location, etc.), and save the file to a convenient directory. In the **Template** page of the **Preferences**, click **Browse** to find this template file. Now every time you create a new SketchUp document it will be created as a copy of your template file.

The templates that appear in the drop-down menu on this page are either those that are stored in your template folders (.../SketchUp5/Templates), or any other file that has ever been used as a template.

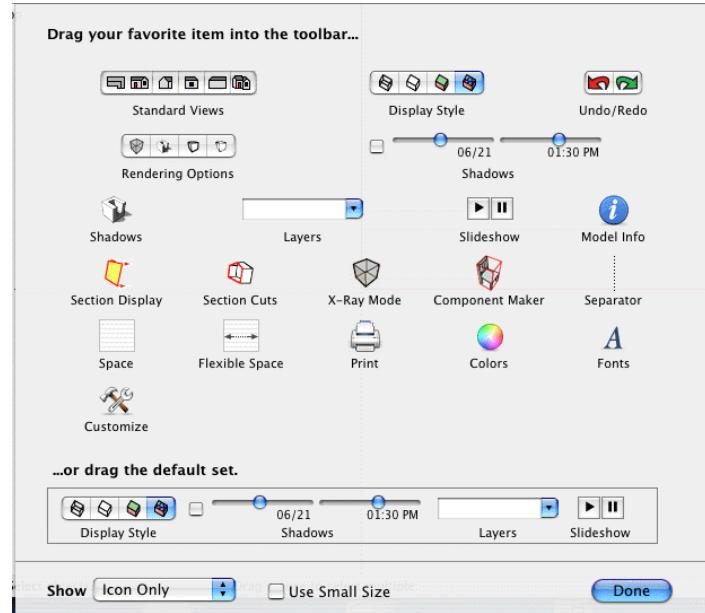
## Toolbars / Tool Palettes

Windows users can customize the icons that appear by selecting **View / Toolbars**. Select a toolbar to toggle its display on and off.



*Mac: These are called **Tool Palettes**, and only **Standard** and **Sandbox** can be toggled.*

*Mac users can customize what icons appear on toolbars by selecting **View / Customize Toolbar**.*



To remove icons, simply drag them off the bottom of the bar and they will disappear. To add icons, drag them into the toolbar where you want them placed. (This is a function of the OSX graphic interface called Aqua.)

## Export and Import

You can save (export) your model in multiple formats, and import certain formats into SketchUp.

In most cases, the **Import** and **Export** windows have an **Options** button, by which you can control certain conversion settings. Please refer to SketchUp's online help for descriptions of these options.

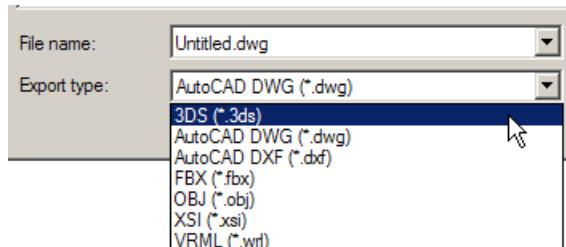
**TIP:** For advice on importing and exporting to various CAD file types, see SketchUp's FAQ page. From [www.sketchup.com](http://www.sketchup.com), click Support, then FAQs.

### Exporting

You can export a SketchUp file into another CAD format, or you can export it as a 2D graphic. You can also save section slices and animation files.

### File / Export / 3D Model

A SketchUp model can be exported into the following formats:



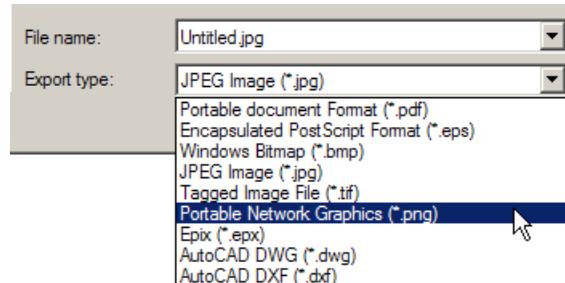
To specify conversion settings, click the **Options** button of the **Export** window.

When exporting, SketchUp uses the current units as a reference for translation. For instance, if the SketchUp unit setting is Decimal/Meters, SketchUp will export the DWG file accordingly, and AutoCAD must be set to Decimal in order for the units to translate correctly as meters.

**TIP:** Refer to SketchUp's online help for information on all export options.

### File / Export / 2D Graphic

You can export a SketchUp model into numerous graphic formats, which are listed below. Click the **Options** button of the **Export** window for a list of adjustable parameters for each format.



For each file format, don't forget to look at the settings when you click **Options**. That is the place to control resolution, file size, etc. Also, be careful when using **Anti-alias**. In many cases it does not significantly help file quality, and may use up so much memory that the export will fail.

### File / Export / Section Slice

See "Exporting Section Slices" on page 308.

### File / Export / Animation

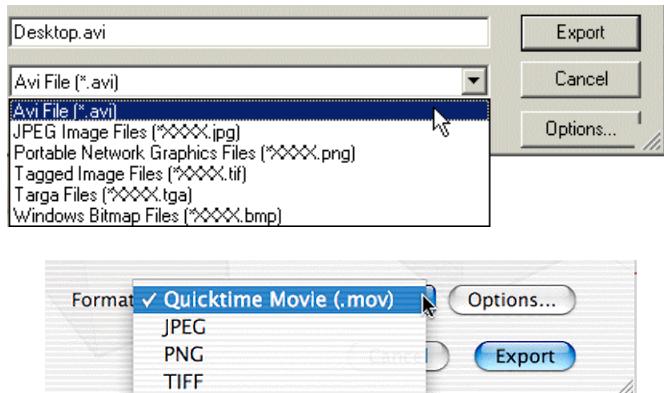
If you create pages of your model (see "Pages" on page 320) and save them as a slide show (see "Tourguide / Slideshow" on page 330), you can export the slide show as an animation file.

This enables you to share your designs with those who do not have SketchUp. You can burn a DVD, so that you don't even need a computer to view the animation. For large and complex models, a movie file may play back more smoothly than the SketchUp slide show. And, you can use video editing applications to enhance your animation by adding music, voice, or text.

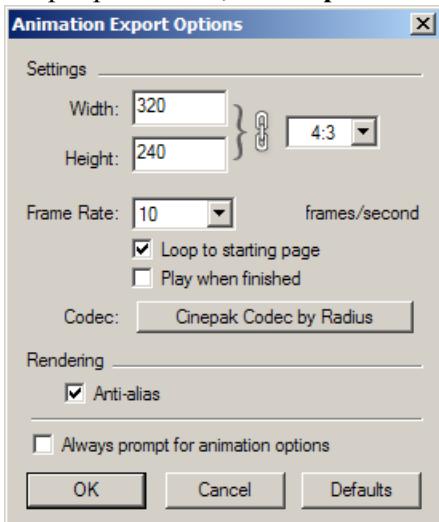
The main disadvantage of animation export is the large resulting file size. While a typical \*.skp file is small and easy to transmit via the web, the video from such a file could be prohibitively large. Therefore, it helps to know how you can control video file size, primarily by manipulating frame size and frame rate.

**TIP:** Before creating an animation file, read about animation and exporting animation in the SketchUp online help.

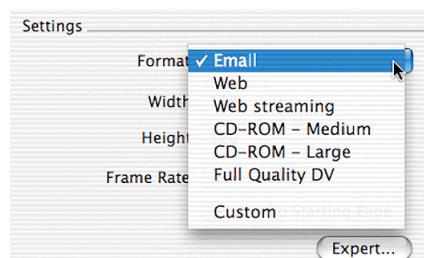
To create an animation file, select **File / Export / Animation**. Select the file type from the drop-down menu.



To specify output parameters, click **Options**.



**Format (Mac):** Specify the codec (compression plug-in) and adjust quality settings. There are preset configurations designed for common cases, or you can select **Custom** to specify settings.



**Width / Height:** Frame size in pixels. 320x240 is a good size for CD-ROM and for transfer to videotape. 640x480 is considered a “full screen” frame size, and usually requires robust compression. Values larger than 640x480 are not recommended unless specifically required.

**Aspect Ratio:** A 4:3 ratio is standard for television, most computer screens, and pre-1950 movies. A 16:9 ratio is the standard for wide screen displays, including digital televisions, plasma displays, and so forth. Locking this aspect ratio maintains a fixed proportion of video at any frame size.

**Frame Rate:** A setting between 8 and 10 frames per second is considered the minimum required for convincing movement, between 12 and 15 is good for keeping file size down while providing smooth playback, and between 24 and 30 is considered “full speed.” A setting of 3 fps is a great way to quickly create draft quality test videos.

---

*NOTE: Certain applications have exact frame rate requirements, such as 29.97 fps for television in the US and other countries, 25 fps for television in Europe, 24 fps for film, etc.*

---

**Loop to Starting Page:** Generates an additional video segment that transitions from the last page back to the first, making an infinite loop.

**Codec:** Enables you to specify which codec (compression plug-in) to apply to your video, as well as adjust quality settings. For detailed information, refer to the **Codec List** and **Video Compression** pages in SketchUp’s online help.

**Play When Finished:** SketchUp will start your default video player and play the file immediately after it is created.

**Anti-alias:** The technique by which software softens the transition between the edge of an object and the background. Without anti-aliasing, the edge is composed of a single color while the background is a different single color. The result on a diagonal line is a stepped or jagged look; a vertical or horizontal line could have a harsh edge. Anti-aliasing samples the edge color and the background color and interposes a range of transitional colors between them so that the edge ‘blends’ into the background in such a way as to minimize the jagged effect. This creates a much more realistic image, but requires more processing power. So, while anti-aliasing is highly desirable in a still image, it takes a heavy processor to run a smooth animation that has been anti-aliased.

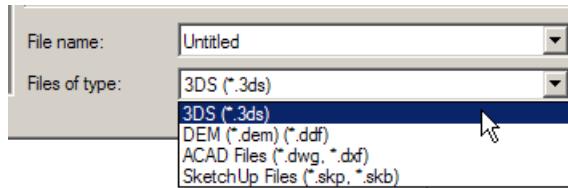
## Importing

You can import a model from other CAD formats into SketchUp, and you can import graphics to be used as backgrounds or textures.

### File / Import / 3D Model

When you bring a 3D model into SketchUp, it is imported as a component, and must be exploded or edited before it can be changed.

Models from the following formats can be imported into SketchUp:



**TIP:** You can also import a 3D model by dragging it directly into SketchUp from your browser.

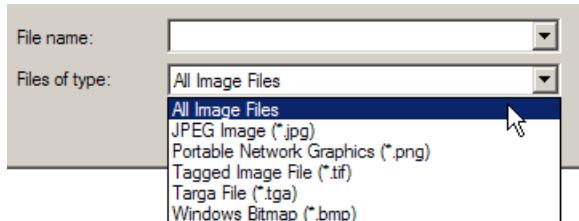
Because SketchUp must translate the contents into usable drawing elements, importing may take some time for large CAD files. To specify conversion settings, click the **Options** button of the **Import** window.

**TIP:** Refer to SketchUp's online help for information on all import options.

Once a file is imported, you may have to use **Zoom Extents** to see it. Imported files come in with their layer system intact and all elements are grouped together.

### File / Import / 2D Graphic

You may want to import an image file so that you trace over a scan or photograph. You can insert images of the following formats:



By default, the file is imported as an image object, which is basically a rectangle with the image mapped on it. You can move, rotate, or scale this rectangle, but it stays a

separate object unless you **Explode** it (at which time it becomes a regular face with material on it). Chapter 7 contains numerous examples on using inserted images as materials.

**TIP:** You can also import a graphic by dragging it directly into SketchUp from your browser.

If you want to import a graphic as a texture, be sure to click **Use as texture** at the bottom of the window. The image will be placed in the Material Browser, in the **In Model (Colors in Model)** tab.

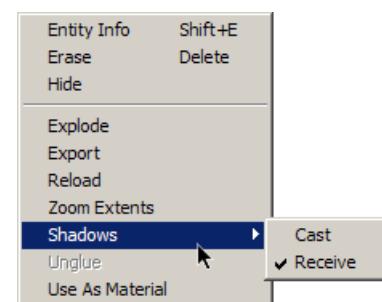


By default, image objects retain the aspect ratio of their original file. You can press Shift while importing to change this. You can also press Ctrl to scale it about its center point.

The image file becomes embedded into your SketchUp document, which enables you to send your SketchUp files to others without any information loss, but it also means that file size can increase dramatically. Therefore, be very careful not to insert immensely large files. You can also adjust resolution to control file size, or even convert the image to gray-scale.

Another way to limit file size is to use compressed file formats such as \*.jpg and \*.png.

Image objects have their own local (right-click) menu:



- **Entity Info:** Displays a window containing information such as source file, dimensions, shadows, visibility, and layer.
- **Explode:** Enables you to use the image as a texture, and to project it onto a non-flat surface.
- **Export:** Enables you save the embedded image to a format you can edit in another graphics package.

- **Reload:** If you change the image's source file, and the link still appears in the **Entity Info**, you can use **Reload** to update the image in SketchUp.
- **Shadows:** Cast will cause the image to cast shadows on other objects; Receive enables the image to receive shadows cast by other objects.
- **Unglue:** If you attach an image to a face, the image cannot be removed from that face, unless you use **Unglue**.
- **Use as Material:** Creates a material from the image, and places the thumbnail in the **In Model** tab of the Material browser.

---

*TIP: Because importing a large file can be time-consuming, and because a large file can slow SketchUp's performance, you may want to crop the imported file so as to import only necessary entities. You could also import different layers as different **Groups** (see Chapter 6). You can then use **Pages** to control visibility (see "Pages" on page 320).*

---

# 15 Ruby Script

Ruby scripting will thrill the programming techies out there. This chapter will not cover how to program in the Ruby language - that would take another book. Besides, information on creating code is available elsewhere (see the next section).

This chapter will explain how to use the Ruby console, and to create some very basic scripts and routines (methods). It also shows how to implement the scripts that are provided with SketchUp. At the end of the chapter is some information on obtaining scripts from other locations.

## SketchUp Ruby Basics

Within SketchUp, select **Help / Ruby Help** for some basic information. You can also open the file index.html located in the Ruby\Docs folder, under the SketchUp installation. This section will include some of the information from the Help system, with some embellishment.

### Entering Code on the Ruby Console

First, open the **Ruby Console** within SketchUp by selecting **Window / Ruby Console**. You can type in lines of code here, or use the console to run scripts saved within text files. We'll start with the first option - entering code directly in the console.

To create a SketchUp message window with some text in it, type this line at the bottom of the console (you can use whatever text you want between the quotation marks.):

```
UI.messagebox("Hello, World")
```



Press Enter, and a window with your text appears on the screen.



Now for a slightly more useful script - one that draws a line between two specific points. This involves first defining two sets of numbers - one for each point. Each set of numbers is listed under a unique name, also called a variable.

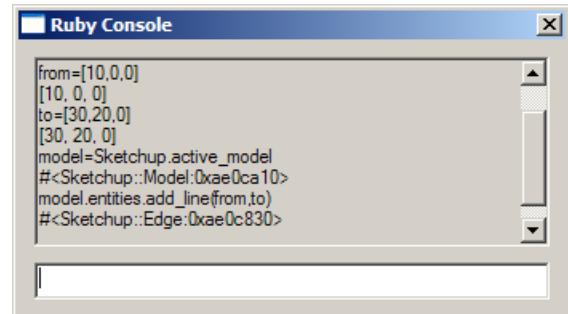
SketchUp's Ruby Help page includes this example, but we'll do it slightly differently here to show that you can use different variable names.

Type these four lines, pressing Enter after each one.

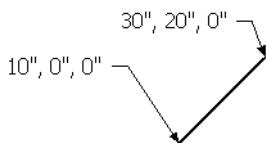
```
from = [10, 0, 0]
to = [30, 20, 0]
model = Sketchup.active_model
model.entities.add_line(from,to)
```

You can use names (variables) other than "from" and "to," as long as you keep them consistent in the 4th line. Not all terms and characters can be used. For instance, "end" is actually a command in Ruby, so you can't use it as a variable. Be aware that Ruby is also case-sensitive.

Each line you enter appears in the console with verification text below it. (Errors will appear here if you make a mistake.)



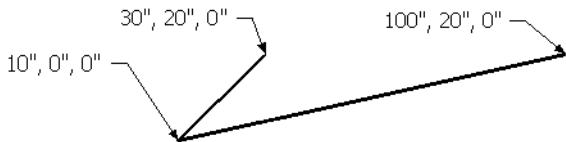
The last line of code is what actually creates the line from “from” to “to.” After you enter the last line of code, the line is created.



The variables can be changed by entering new values. Change “to” and recreate the line by entering these two lines:

```
to = [100, 20, 0]
model.entities.add_line(from,to)
```

This creates a second line, starting from the original “from” point to the new “to” point.



## ***Creating a Script***

Every time you want to create a line between two points, you will not want to bother typing in these four lines. This time we will save these lines to a text file, and then run it from within SketchUp. This is a script - a file external to SketchUp that can be called when needed.

The script is a text file with the extension “rb.” It will be placed in the SketchUp\Plugins folder, since scripts in this folder are loaded automatically when SketchUp is launched. *Mac: the folder is in Contents\Resources\*

Create a text file with the six lines below. This creates a routine, referred to in SketchUp as a method.

The first line assigns the name “line\_from\_to” to the method, and the last line tells SketchUp to end the method.

```
def line_from_to
from = [0, 10, 0]
to = [30, 20, 0]
model = Sketchup.active_model
model.entities.add_line(from,to)
end
```

Name this script file something like “line\_from\_to.rb” and save it in the Plugins folder. (You could also add these six lines to an existing script file in the Plugins folder.)

Now close and restart SketchUp. If there are errors in the script, the Ruby console will open and show you an error message to let you know. If the console doesn’t open, your script is OK.

To run the script, open the Ruby console and type the name of the method: line\_from\_to.



This creates the line as before, from the defined “from” point to the defined “to” point.

## ***Creating a Script that Requires User Input***

What if you want to create a line between two points with different coordinates each time? We can change the script to include prompts, then take the input values to run the same line creation tool.

The “line\_from\_to.rb” script will now include some extra lines. Here is the new script, in which each line is numbered for reference. (Do not include these numbers in your actual script!)

1. def line\_from\_to
2. prompts = ["From X", "From Y", "From Z", "To X", "To Y", "To Z"]
3. values = [0.inch, 0.inch, 0.inch, 10.inch, 0.inch, 0.inch]
4. results = inputbox prompts, values, "Start and End Points"
5. fromx, fromy, fromz, tox, toy, toz = results
6. from = [fromx, fromy, fromz]
7. to = [tox, toy, toz]

```

8. model = Sketchup.active_model
9. model.entities.add_line(from,
   to)
10. end

```

Here are the explanations of the new lines of code:

#### Line 1:

```
def line_from_to
```

Same as before, assigns a name to the method.

#### Line 2:

```
prompts = ["From X", "From Y",
   "From Z", "To X", "To Y", "To Z"]
```

Defines the names of the six values the user will be prompted for.

#### Line 3:

```
values = [0.inch, 0.inch, 0.inch,
 10.inch, 0.inch, 0.inch]
```

Defines initial, default values. It's a good idea to include units, because the inputbox method tries to return the same kind of object that you give it. If the default values are lengths, then it will parse your entries as lengths. This means that if your units are set to metric, the script will parse the entered values in the correct units. You can also enter values in other units, like 10' 6" or 100cm .

#### Line 4:

```
results = inputbox prompts,
 values, "Start and End Points"
```

Creates the prompt window that will ask the user to define the six values.

#### Line 5:

```
fromx, fromy, fromz, tox, toy,
toz = results
```

Assigns variable names to the six input values, in order of input.

#### Lines 6 and 7:

```
from = [fromx, fromy, fromz]
```

```
to = [tox, toy, toz]
```

Defines start point “from” and end point “to,” based on the input variables.

#### Lines 8, 9, and 10:

```

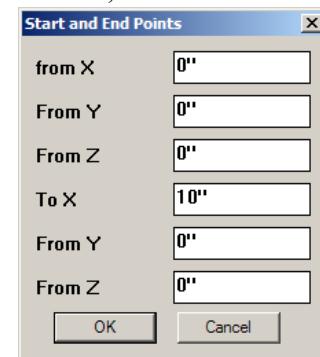
model = Sketchup.active_model
model.entities.add_line(from,
to)
end

```

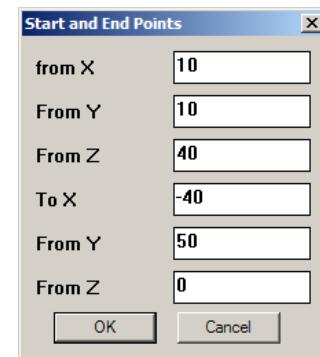
Same as before - creates the line from the “from” point to the “to” point.

**TIP:** If you want to add text in your script that will not be read as code, simply place a # symbol at the start of the line. This is helpful when you want to add text to explain what the lines of code are for.

Now close and restart SketchUp once again and run “line\_from\_to.” You now get a prompt window asking for two sets of coordinates, which have default values.



Change the values as needed . . .



. . . and click OK to create your custom line.



If this is a tool you will use often, you probably don't want to run it each time via the Ruby console. Here is how you can add the tool to one of the SketchUp menus for easy access.

In the script file, add these three lines at the end (after the last "end" line):

```

11. if( not
    file_loaded?("linefromto.rb") )

12 UI.menu("Draw").add_item("Line
    between two points") {
    line_from_to }

13 end

```

Explanations:

#### Line 11:

```
if( not
    file_loaded?("linefromto.rb") )
```

Checks to see that the file is already loaded so that it is only added to the menu once.

#### Line 12:

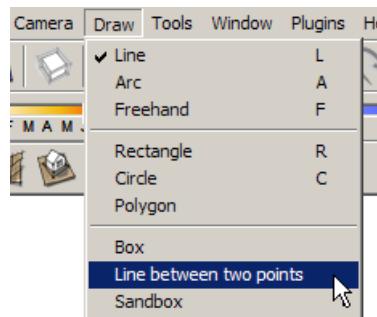
```
UI.menu("Draw").add_item("Line
between two points") {
line_from_to }
```

Adds an item to the **Draw** menu called **Line between two points**, that runs the `line_from_to` script.

#### Line 13:

```
end
```

Close and restart once again, and now the tool appears in the **Draw** menu:



Here's how the entire script file should look, with no comment lines:

```

line_from_to.rb.txt - Notepad
File Edit Format View Help
def line_from_to
prompts=[ "From X", "From Y", "From Z", "To X", "From Y", "From Z" ]
values = [ 0.inch, 0.inch, 0.inch, 10.inch, 0.inch, 0.inch ]
results=inputbox prompts,values,"Start and End Points"
fromx,fromy,fromz,tox,toy,toz=results
from=[fromx,fromy,fromz]
to=[tox,toy,toz]
model=sketchup.active_model
model.entities.add_line(from,to)
end
if(not file_loaded?("linefromto.rb"))
UI.menu("Draw").add_item("Line between two points"){line_from_to}
end

```

Lines can be indented, and line spaces added, with no effect to the code itself.

## Using the Help Files to Create Code

Ruby Help can be accessed by selecting **Help / Ruby Help**. This opens an \*.htm file in your browser. (If this file does not open automatically, your web security settings may be interfering. You can open this file manually by browsing to ...SketchUp 5\Ruby\Docs\index.html.)

As an example of another very simple script, we will create a vertical cylinder. This involves three steps:

Creating a circle in the red-green plane, completing a face within the circle, and **Push/Pull**'ing it up. The provided Help files can tell you what the syntax should be for each command.

Here is the complete script. When you create yours, name it "cylinder.rb" and save it in the Plugins folder.

Explanations of each line follow:

```
vertical_cylinder.rb - Notepad
File Edit Format View Help
def vertical_cylinder
  prompts=["Radius", "Height"]
  values=[10.inch, 2.inch]
  results=inputbox prompts,values,"cylinder settings"
  radius,height=results
  center=[0,0,0]
  vec=Geom::Vector3d.new(0,0,1)
  model=sketchup.active_model
  entities=model.entities
  baseedges=entities.add_circle(center,vec,radius)
  baseface=entities.add_face baseedges
  height=-height if baseface.normal.dot(vec)<0
  baseface.pushpull height
end
```

First, like in the "line\_from\_to" script, create a UI box that asks for all the needed values. This method will be called "vertical\_cylinder."

Remember, do not include the line numbers below in your actual script.

1. def vertical\_cylinder
2. prompts = ["Radius", "Height"]
3. values = [10.inch, 2.feet]
4. results = inputbox prompts, values, "Cylinder settings"

5. radius, height = results

6. center = [0, 0, 0]

(Line 6 sets the center of the base at the origin.)

Next, we will draw the circle. We need to consult the Help file for the syntax of the "add\_circle" command. Open **Help / Ruby Help**, scroll down, and click the link for **SketchUp Ruby Method Index**.

### SketchUp Ruby API

The SketchUp Ruby API consists of a series of SketchUp-specific Ruby modules, called classes in the object-oriented programming (OOP) world, and corresponding commands, called methods in the OOP world, for creating macros and manipulating geometry in SketchUp. Classes can be thought of as a mechanism for grouping related SketchUp ruby commands. Click below to reference the SketchUp Ruby API documentation using either an index of Classes or Methods.

[SketchUp Ruby Class Index](#)

[SketchUp Ruby Method Index](#)

Scroll to the "adds" and locate "add\_circle." Click **Entities**.

add : [Layers](#)  
 add : [Materials](#)  
 add : [Pages](#)  
 add : [Selection](#)  
 add\_arc : [Entities](#) ↗  
 add\_circle : [Entities](#)  
 add\_cline : [Entities](#)  
 add\_context\_menu\_handler : [UI](#)  
 add\_cpoint : [Entities](#)

Here is the syntax you need to provide in the code:

<b>add_circle</b>
The add_circle method is used to create a circle
<b>Syntax:</b>
circle = entities.add_circle center, normal, radius, <numseg>
<b>Arguments:</b>
center - a Point3d object representing the center
normal - a Vector3d object representing normal for the arc
radius - the radius of the arc
numsegs - (optional) number of segments in the arc

You need to provide a center point, normal vector, radius, and, optionally, the number of circle segments. The input box of this script doesn't ask for the number of segments, so the default value of 24 will be used.

To get the syntax for a vector, this time go back to the main page and consult the **Ruby Class Index**.

## SketchUp Ruby API

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[SketchUp Ruby Class Index](#)  
  
[SketchUp Ruby Method Index](#)

### Click Vector 3D.

<a href="#">ConstructionPoint</a>	<a href="#">Menu</a>	<a href="#">Toolbar</a>
<a href="#">Curve</a>	<a href="#">Model</a>	<a href="#">Transformation</a>
<a href="#">DefinitionList</a>	<a href="#">Numeric</a>	<a href="#">UI</a>
<a href="#">DrawingElement</a>	<a href="#">OptionsManager</a>	<a href="#">UTM</a>
<a href="#">Edge</a>	<a href="#">OptionsProvider</a>	<a href="#">UVHelper</a>
<a href="#">EdgeUse</a>	<a href="#">Page</a>	<a href="#">Vector3d</a>
<a href="#">Entities</a>	<a href="#">Pages</a>	<a href="#">Vertex</a>
<a href="#">Entity</a>	<a href="#">PickHelper</a>	<a href="#">View</a>

There are three ways you can create a new vector. We will use the second one, because we know the coordinates of the vector parallel to the X, Y plane.

The new method is used to create a new vector.  
**Syntax:**  

```
vector = Geom::Vector3d.new
vector = Geom::Vector3d.new(x, y, z)
vector = Geom::Vector3d.new(vector2)
```



Continue the code:

7. `vec = Geom::Vector3d.new(0, 0, 1)`
8. `model = Sketchup.active_model`
9. `entities = model.entities`
10. `baseedges = entities.add_circle(center, vec, radius)`

Explanations:

### Line 7:

```
vec = Geom::Vector3d.new(0, 0, 1)
```

Creates a vector along to the Z axis - normal to the X-Y plane.

### Lines 8 and 9:

```
model = Sketchup.active_model
entities = model.entities
```

These two lines initialize what's included in "model" and "entities."

### Line 10:

```
baseedges =
entities.add_circle(center, vec,
radius)
```

Creates the circle for the cylinder base based on the center point, normal vector, and radius. The 24 edges created by this command are grouped under the name "baseedges."

Now we will create a face within the base circle edges. Look up "add\_face." With the first option you can define an array of edges, which is what "basecircle" is.

<b>add_face</b>
The add_face method is used to create a face.
<b>Syntax:</b>
<code>entities.add_face edge1, edge2, edge3, ...</code>
<code>entities.add_face [edge1, edge2, edge3, ...]</code>
<code>entities.add_face point1, point2, point3, point 4</code>
<code>entities.add_face [point 1, point2, point3, ....]</code>
<code>entities.add_face curve</code>

11. `baseface = entities.add_face baseedges`

Creates a face called "baseface" from the "baseedges" edges.

Now look up "pushpull."

<b>pushpull</b>
The pushpull method is used to perform a push/pull on a face.
<b>Syntax:</b>
<code>face.pushpull distance</code>
<b>Arguments:</b>
<code>distance - the distance, in current units, to push/pull the face</code>

The "distance" value is what the user entered as "height." The face is the one just created, called "baseface."

**12.** baseface.pushpull height

**13.** end

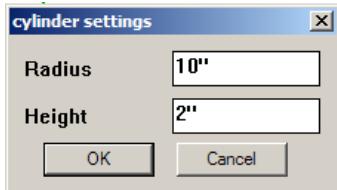
If you run the “vertical\_cylinder” script now, it will work but the cylinder will be created downward. If you want it upward, add the following line before the pushpull line (before Line 12):

```
height = -height if
baseface.normal.dot(vec) < 0
```

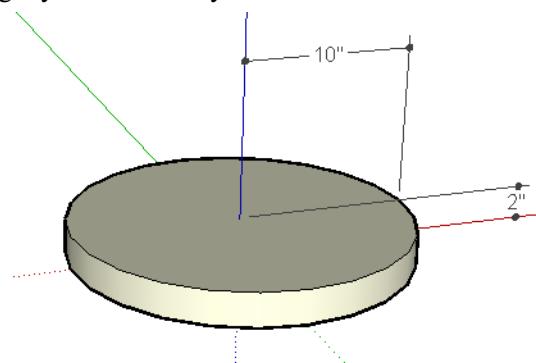
Make sure the script file is in the Plugins folder, and run the script in the Ruby console:



Type in the values, or leave the defaults:

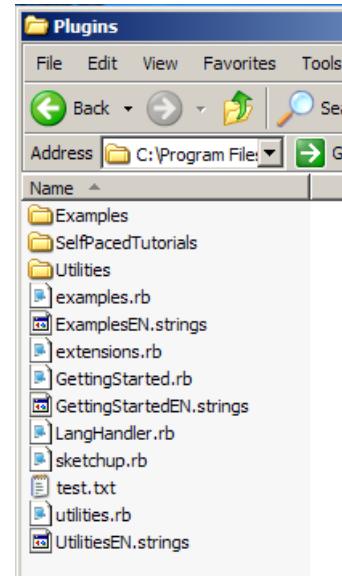


And get your vertical cylinder.



## Provided Scripts

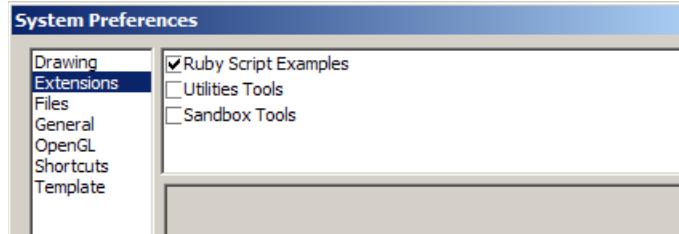
SketchUp comes with several scripts already provided. These are in the Plugins folder of the SketchUp installation. There should be several scripts in this folder, plus sub-folders named Examples and Utilities.



This section describes the scripts that are included with SketchUp. You can open a script in any word processing program. Any line that starts with the # symbol is not read as code - it provides explanatory information for the user. If you are looking for a way to learn how to use Ruby in SketchUp, it's a good idea to look through these files. The scripts contain numerous comment lines to explain the code lines. You can test your understanding by changing some things around, and you can also use these files as a base for new script files.

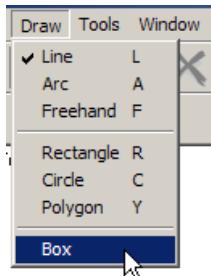
## Ruby Script Examples

For these functions to be available on your UI, open **File / Preferences** to the **Extensions** page. Check **Ruby Script Examples**.

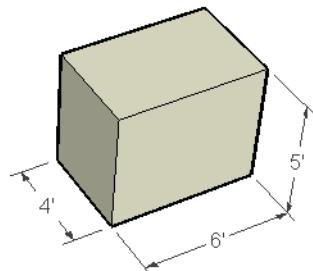
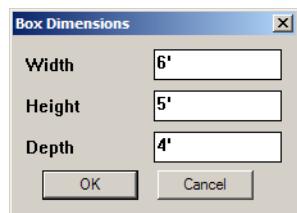


### Box

This function is from the “box.rb” script found in the Examples subfolder. **Box** is found on the **Draw** menu.

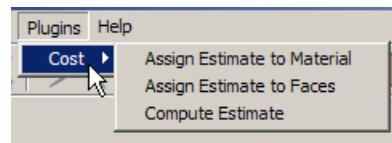


Run this function - it enables you to create a box with specified lengths on all three sides.

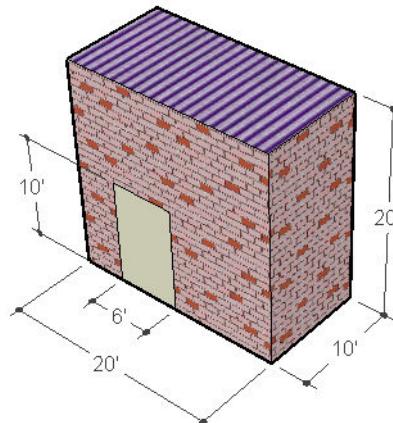


## Estimating

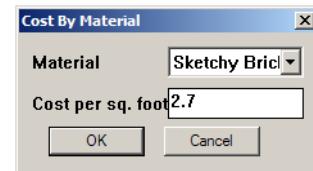
These tools come from the “attributes.rb” script found in the Examples subfolder. These three tools are found on the **Plugins** menu.



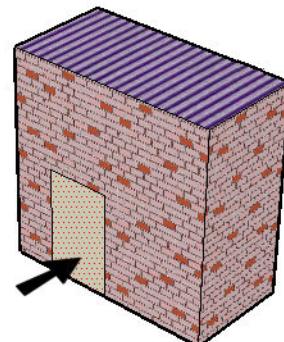
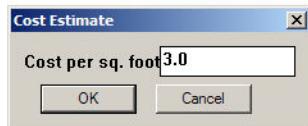
As an example, the following model uses two materials and has one rectangular face with no assigned material.



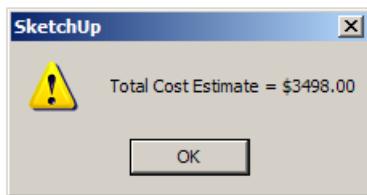
Run **Assign Estimate to Material** to assign a unit cost to any material in the **In Model** tab of the Material browser.



To assign a unit cost to specific faces, regardless of material, first select the face(s). Then run **Assign Estimate to Faces**. In this case, only the 6' x 10' face was selected.



To get the entire cost, run **Compute Estimate**.



Check the results:

Top face:      area = 200  
                  cost =  $200 \times \$1.20 = \$240$

Side faces:     area =  $2(200) + 2(400) - 60 = 1140$   
                  cost =  $1140 \times \$2.70 = \$3,078$

Inner face:     area = 60  
                  cost =  $60 \times \$3.00 = \$180$

Total cost =  $\$240 + \$3,078 + \$180 = \$3,498$

The bottom face has no material and was not assigned its own cost, and therefore is not included in the cost estimate.

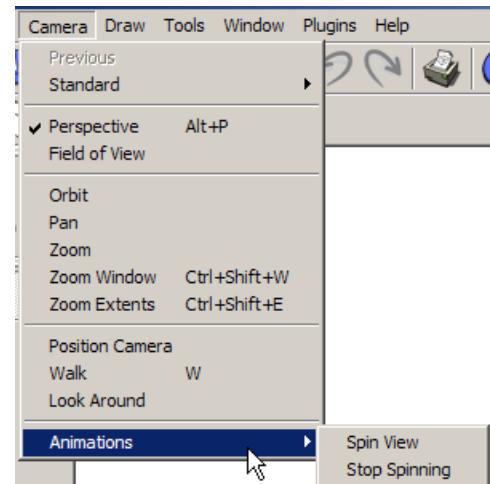
If you make changes to any of the faces, simply re-run **Compute Estimate** for the new cost.

## Animation

These tools come from the “animation.rb” script found in the Examples subfolder. They are found on the **Camera** menu.

This script creates two new functions, one for spinning the model and one to stop spinning it.

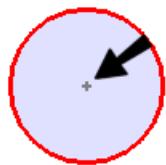
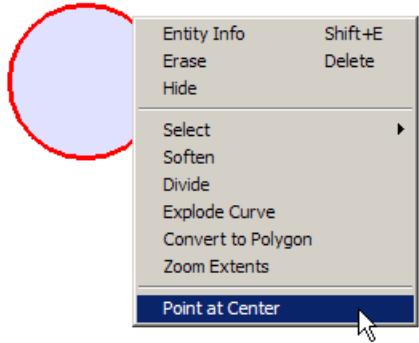
The last section of the script is the code that assigns command names and places them in menus. By default, the **Spin View** and **Stop Spinning** commands are placed in the **Camera** menu.



## Point at Center

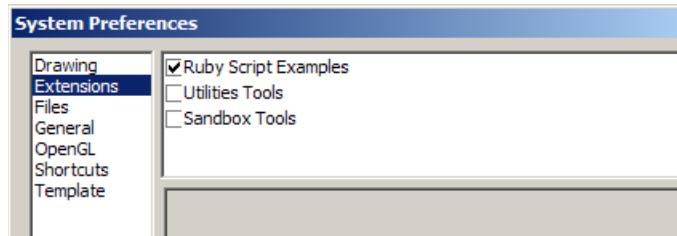
This tool comes from the “contextmenu.rb” script found in the Examples subfolder. It appears on the context (right-click) menu when clicking on a circle, arc, or polygon.

It enables you to add a construction point at the center of an arc or circle. First, it checks whether the right-clicked object is in fact a single arc. If it is, the item **Point at Center** is added to the context menu.

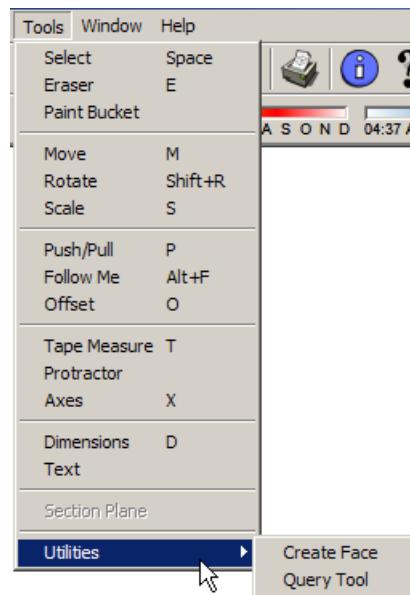


## Utilities

For these functions to be available on your UI, open **File / Preferences** to the **Extensions** page. Check **Utilities Tools**.

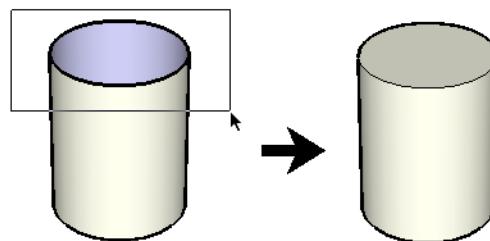


This file contains several scripts, three of which are placed by default in the **Tools / Utilities** menu.



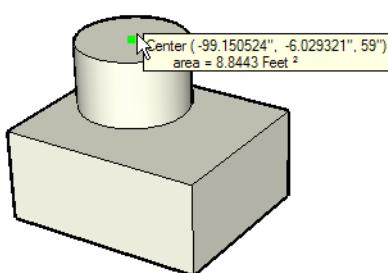
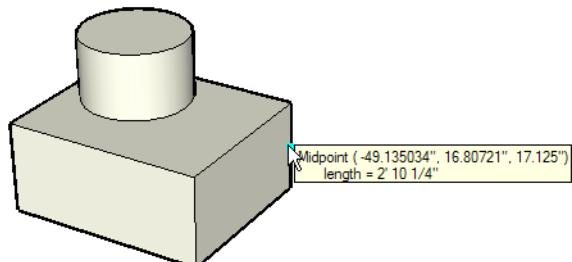
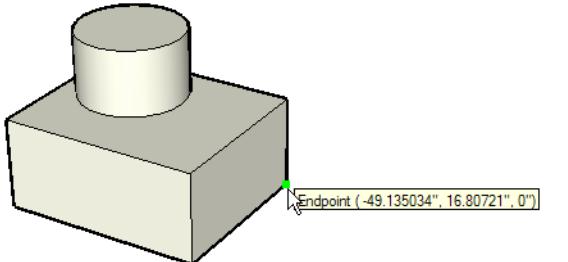
## Create Face

First select all edges that surround the face you want to create. Then run the script, or select **Tools / Utilities / Create Face**. As long as the edges form a closed loop and are all on the same plane, the face will be created. This is handy, for example, when you want to close the top of a cylinder without redrawing one of the many circle segments.

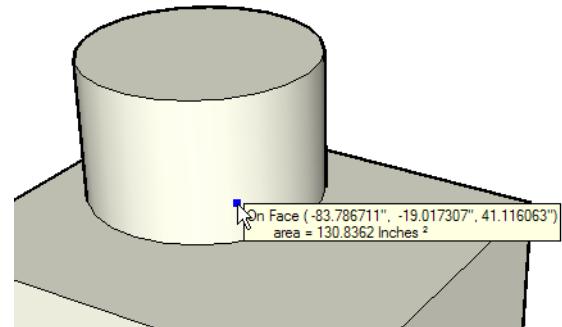
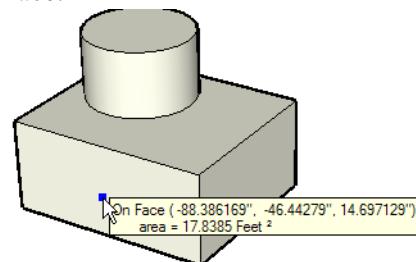


## Query Tool

Shows coordinates of points and screen positions, as well as lengths of selected edges and areas of selected faces. You can access this tool via **Tools / Utilities / Query Tool**. To use the tool, simply hover over a point, such as an endpoint, midpoint, or center point, to get its coordinates.



You can also hover on a face to get the coordinate of the cursor, as well as the area of the face. For a curved face, the area is calculated for individual segments, not the entire face.



## Other Scripts

There are additional scripts in the Examples subfolder that are not available directly from the UI. You can run these by typing their names in the Ruby console. To load the script itself, use this format (for the example linetool.rb):

```
load 'Examples/linetool.rb'
```

---

**TIP:** If you place the script files in the Plugins folder, they will be loaded automatically.

---

Then to run the actual method (or routine), type the method name in the Ruby console:

**linetool**

**linetool.rb**

This file contains a class called **linetool**. To implement it, you can type “linetool” in the Ruby console. With this class active, SketchUp works as if the **Line** tool is active, but you create construction lines instead of edges.

## examples.rb

This file contains explanations of what can be found in some of the other script files, as well as a few short examples of additional scripts:

**setLayer(layerName):** First, select objects you want to move to another layer. Then use the syntax `setLayer "layername"`. If the layer you type does not exist, it will be created.

**totalArea:** Calculates the total area of all faces in the model.

**perimeter:** Calculates the perimeter of all selected faces. Edges that are common to more than one face are only counted once.

## selection.rb

This file contains several scripts that enable you to manipulate selection sets. Type any of these script names into the Ruby console to run them.

**invert\_selection:** First select some entities, then run this script. The selection set is inverted - all unselected entities become selected, and vice-versa.

**hide\_rest:** Hides everything that is not selected. This is very handy if you want to display only a few selected objects in a large model.

**do\_select:** This script can be typed with expressions that enable you to select objects with certain characteristics. You can select by layer, by type, etc., and combine variables to get even more specific.

```
do_select {|e| e.layer.name == "Joe"}
```

Selects all objects on layer Joe.

```
do_select {|e| e.layer.name == "Joe" || e.layer.name == "Bob"}
```

Selects all objects either on layer Joe or Bob.

```
do_select {|e| (e.layer.name =~ /W.*/) == 0}
```

Select objects on layers that start with the letter W.

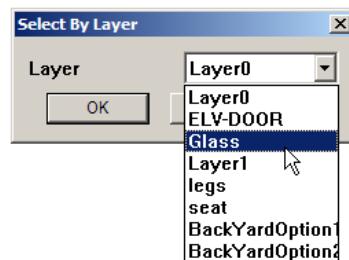
```
do_select {|e|
  e.kind_of?(Sketchup::Edge) }
```

Selects all edges.

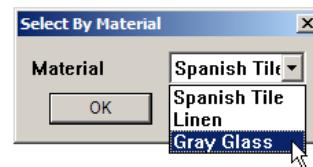
```
do_select {|e|
  e.kind_of?(Sketchup::Edge) &&
  e.layer.name == "Joe"}
```

Selects all edges on layer Joe.

**select\_by\_layer:** Brings up a window that lists all the layers used in the model. Select the layer, click OK, and all objects on that layer are selected.



**select\_by\_material:** Brings up a window that lists all the materials used in the model. Select the material, click OK, and all objects on that layer are selected.



## sketchup.rb

This file contains some general scripts that are often used by other scripts.

## Where to Find More Ruby Scripts

The first place to check for more scripts is SketchUp's website - [www.sketchup.com](http://www.sketchup.com). There is a link for Downloads, and then a link for Ruby Scripts. At this writing the library is small, but check back often, since @Last intends to place a number of scripts here.

Also check the SketchUp User Forum ([www.sketchup.com/forum](http://www.sketchup.com/forum)). Click the link to the **Ruby Forum**, where users have posted their scripts for public use. You'll find scripts to create windows, spiral stairs, helixes, fog - the possibilities (and scripts) are endless. You don't have to be a programmer, or even proficient at SketchUp, to download and use these.

A simple web search for "sketchup ruby scripts" will provide a few more places for script downloading. One is [http://amazone.crai.archi.fr//Ruby/RUBY\\_Library\\_Depot.htm](http://amazone.crai.archi.fr//Ruby/RUBY_Library_Depot.htm), and another is [www.ohyeahcad.com](http://www.ohyeahcad.com).

## Scripts for Film and Stage

SketchUp has gained so much popularity within the entertainment industry, particularly set and stage design, so @Last has created Ruby scripts specifically for this purpose. Go to [www.sketchup.com](http://www.sketchup.com), and go to the Downloads page. Under Plugins, there is a download that includes a series of Ruby scripts for enhanced camera features.

Under component downloads, you can install a wealth of cameras, dollies, props, etc.



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