Tutorial — Building the Nave Arcade

Overview:
Step 1: Determining and Drawing The Arch (Quinto Arch)
Step 2: Extrude Molding Profile
Step 3: Adding Walls
Step 4: Align the Arch, the Wall and the Pier

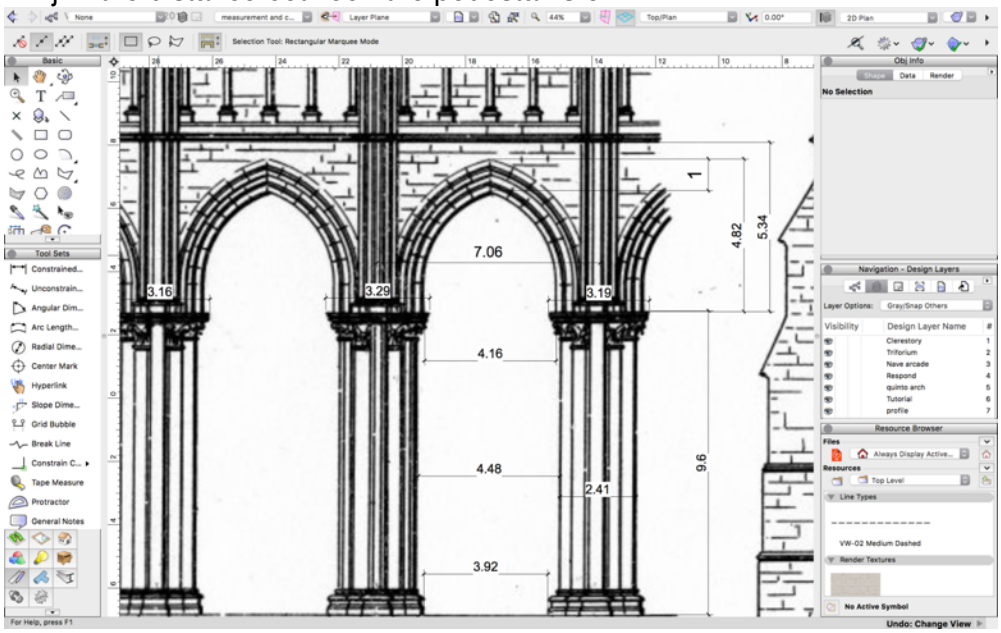
Learning Objectives for this tutorial:

1. Using the Basic Tool palette: Line, Circle, Rectangle, Trim, Move by Points, Mirror
2. Using Attributes palette
3. Changing settings in Object Info palette: coordinate, show direction
4. Extract Solid
5. Extract Line

Key dimensions for the nave piers at Chartres Cathedral:
Span of the inner arch: 4.16m
Height of the arch: 4.82m
Width of arch profile: 1m
Width of the arcade: 7.06m [Note: Take the measurement from the midpoint of one pier to the midpoint of the other, not from the edge of the arch]
Span of capital: 3.19m(left), 3.29m(middle), 3.16(right)
Diameter of the pier: 2.41m
Height of the pier: 9.6
Distance between two piers: 4.48m

Step 1: Determining and Drawing the Arch

1. Create a new design layer, called “Measurement”. Import the reference image (file name: elevation.jpg). Refer to the Floor Plan tutorial to review how to import an image.
2. Using **Unconstrained Linear Dimension** tool, take the following measurements:
    a. span of the inner arch: 4.16m
    b. height of the arch: 4.82m
    c. width of arch profile: 1m
    d. height of the arcade: 5.34m
    e. width of the arcade: 7.06m [Note: Take the measurement from the midpoint of one pier to the midpoint of the other]
    f. span of capital: 3.19m (left), 3.29m (middle), 3.16 (right)
    g. diameter of the pier: 2.41m
    h. height of the pier: 9.6
    i. distance between two piers: 4.48m
    j. the distance between the pedestal: 3.92m

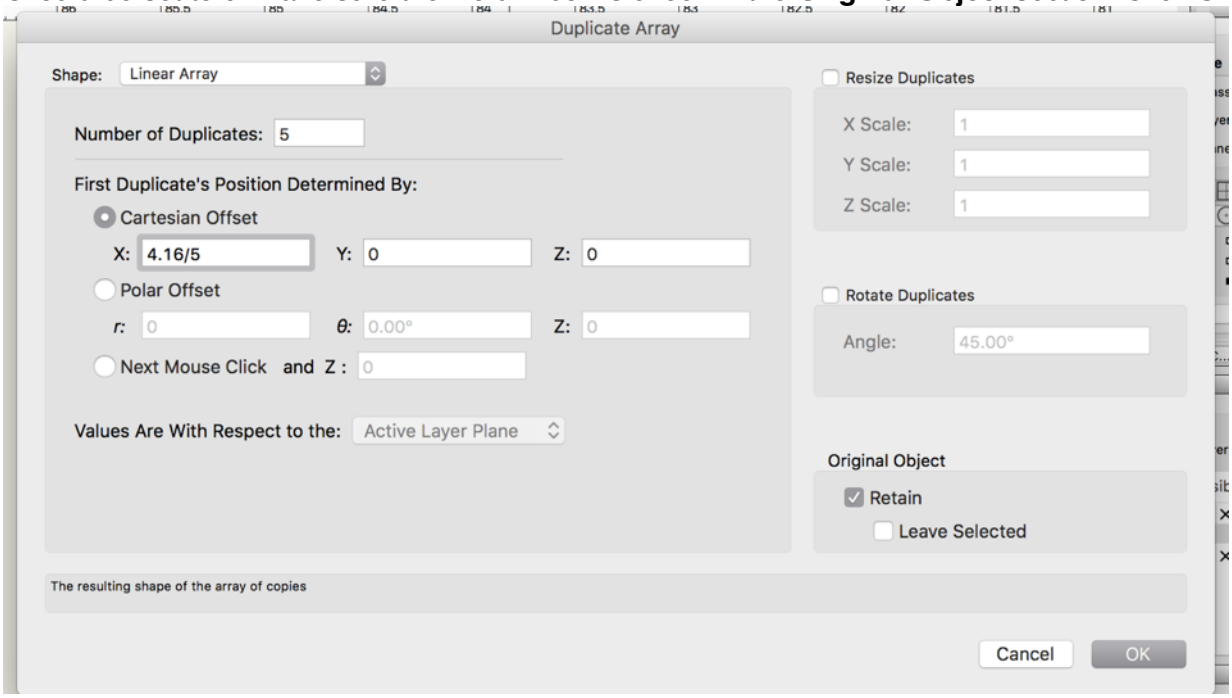


1. We will be creating a pointed arch with a height that is 4/5 of its width. This is commonly referred to as a Quinto Arch. Create a new design layer for the arch.
2. Using the **Line** tool, draw a line that measure 4.16m.

3. Divide this line into 5 equal segments. To do so, first create a short vertical line at the left endpoint.

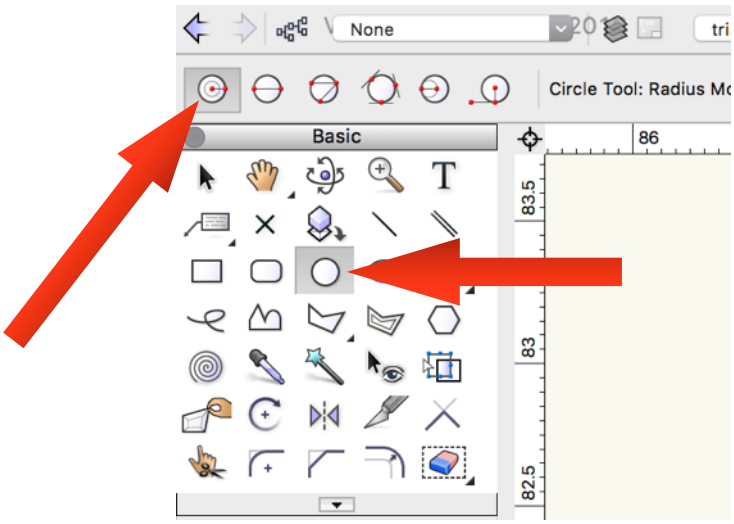
4. Go to **Edit > Duplicate Array** to create 5 duplicates that are evenly spaced horizontally. Input 5 into the **Number of Duplicate** field. Select **Cartesian Offset**, input the distance between each of

the line in the **X** field. Note that Vectorworks can do the calculation for you. Input **4.16/5** in **X** the field, and the result will be 5 short lines equally spaced along the 4.16m line. The **Y** and **Z** fields should be set to 0. Make sure the **Retain** box is check in the **Original Object** section. Click OK.

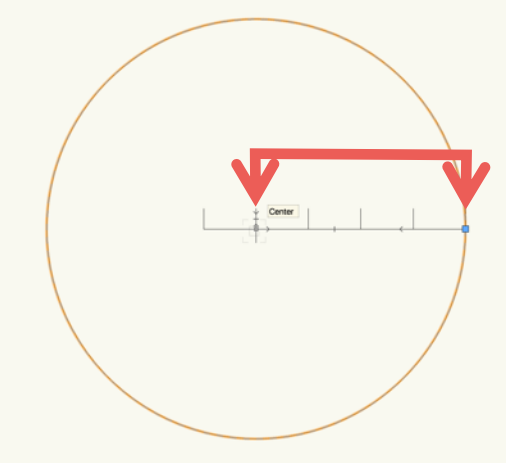


5. Your line should look like this: example below

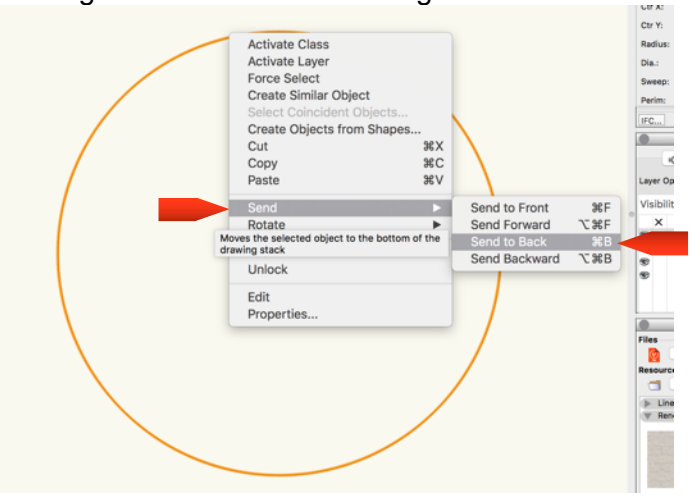
6. Select the **Circle** tool from the **Basic Tools** palette. Set to **Radius Mode** in the **Tool Preferences** menu.



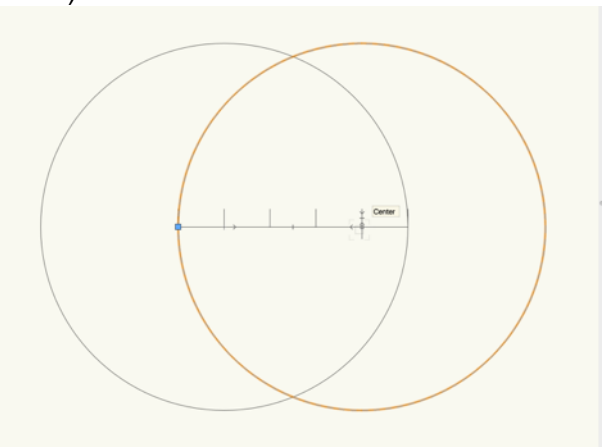
7. Click once at 4/5 point from one end of the line and click again at the end of the line.



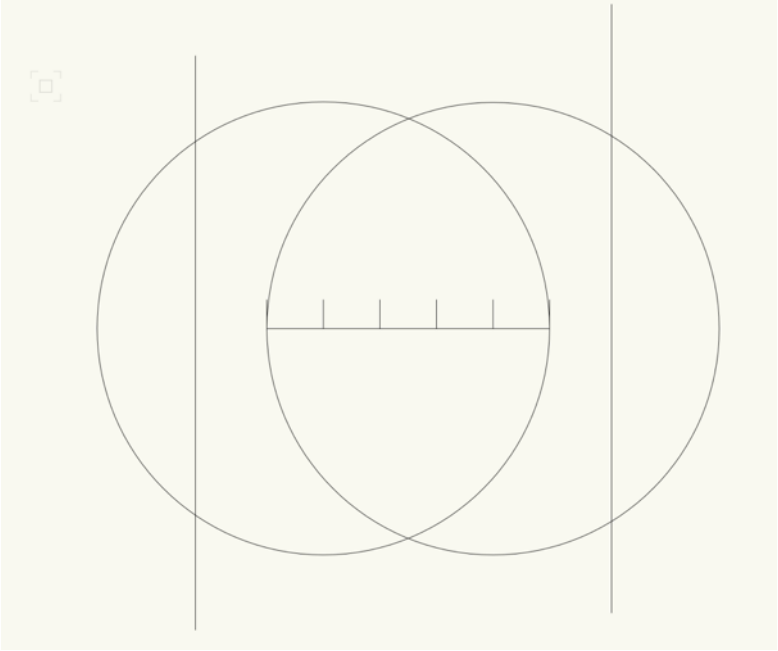
8. Right click on the circle and go to **Send > Send to Back**.



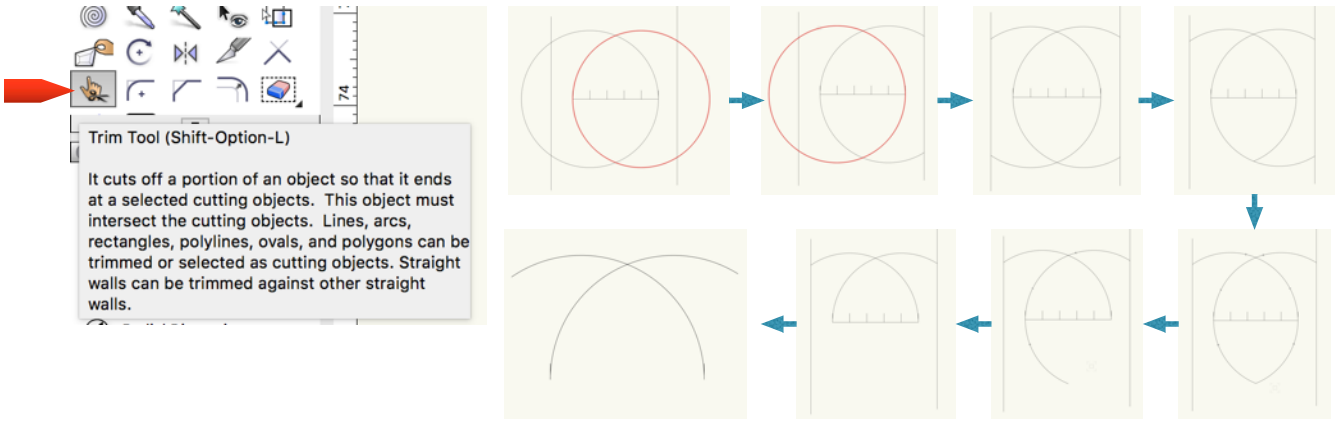
9. Select the **Circle** tool, and draw another circle from the 4/5 point on the other side (repeat step 6-8).



10. Create 2 vertical lines on either side of the intersecting circles (see illustration below).

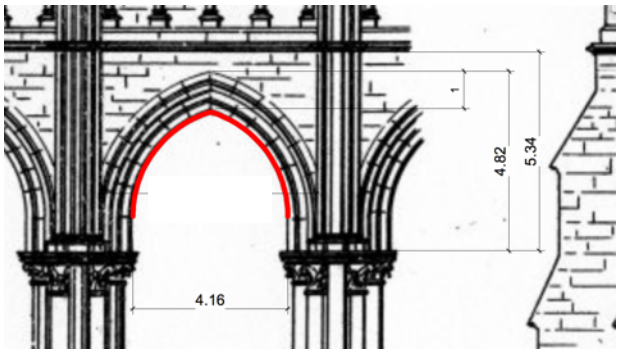


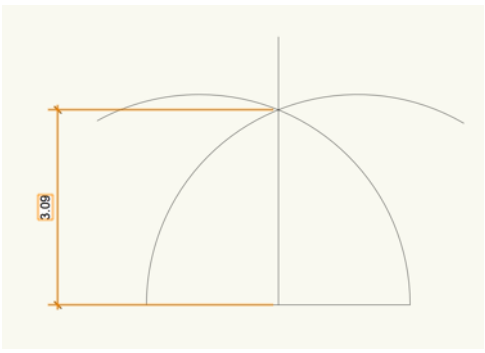
11. Select the **Trim** tool from the **Basic Tools** palette. Trim the areas where the circles DO NOT overlap by clicking on the segments you want to remove. If you trim too much, undo the action (Mac: command + z; PC: control + z) Be sure to leave a small segment on either side of the intersecting arcs (see illustration below). This will prevent intersecting geometry when extruding the molding the thick arcade profile along the arch paths.



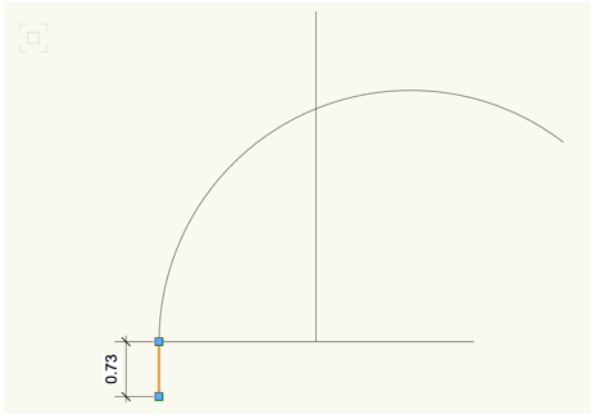
12. Delete the vertical lines you created in step 10. Create a new perpendicular line that runs through the midpoint of the intersecting arcs.

13. Measure the height of the arch using the **Unconstrained Linear Dimension** tool. It should measure 3.09m. Note that this arch is shorter than the height of arch in the reference image, which is 3.82m. We need to add “legs” to the bottom of each arch so that the height of our arch measures 3.82m. Each “leg” should measure 0.73m.

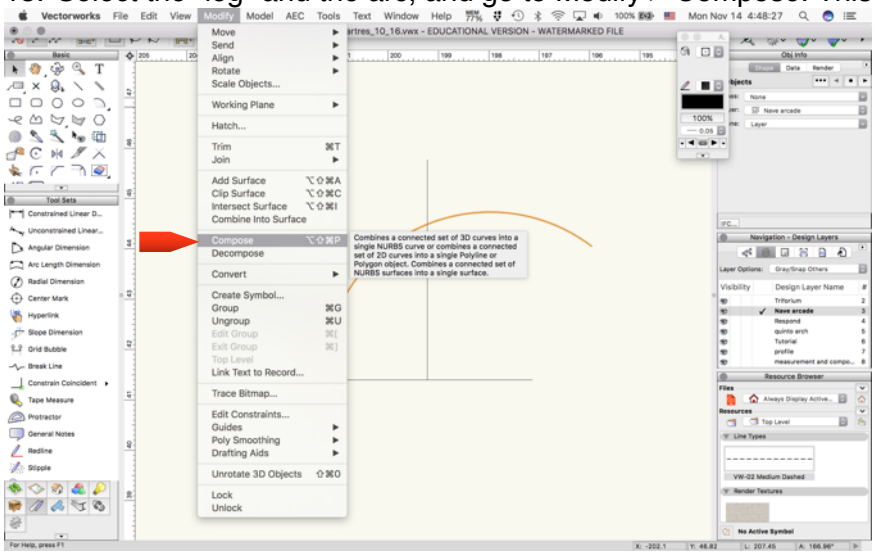




14. Using the Line tool, draw a vertical line measure 0.73m at the end of the arc. Because we are going to extrude the molding profile separately along each side of our arch, it is easier to do this once and then create a mirror copy. Delete one of the arcs and keep the vertical midpoint line for reference.

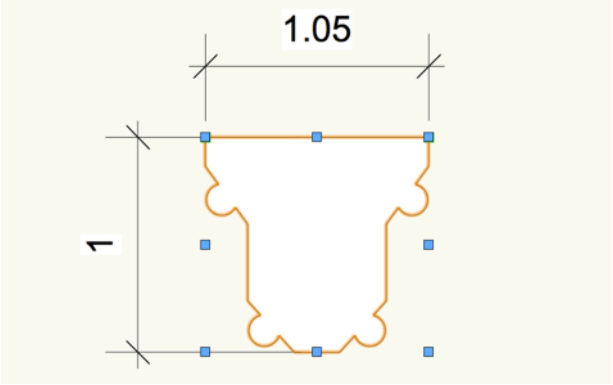


15. Select the “leg” and the arc, and go to Modify > Compose. This will join the two objects.

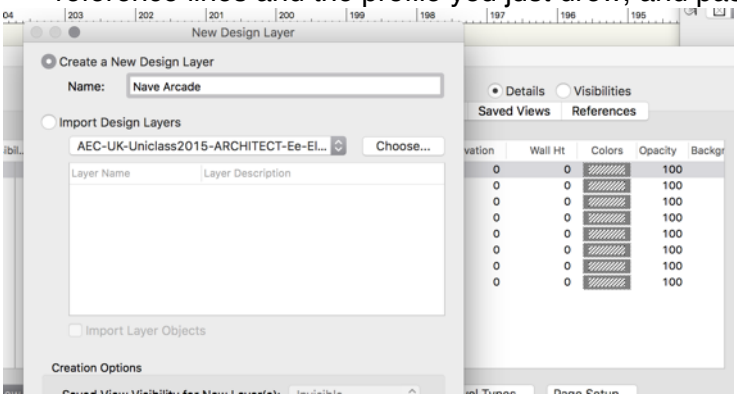


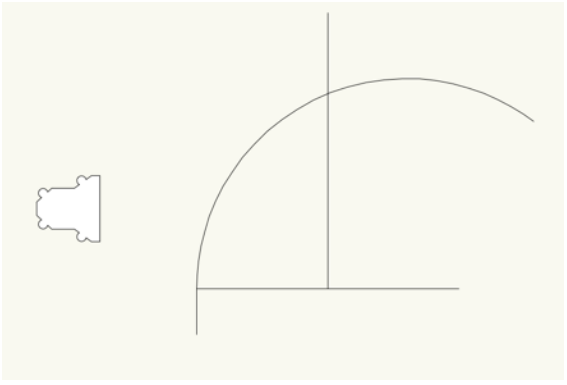
Step 2: Extrude Molding Profile

1. Refer to the molding profile reference image that you imported in the last exercise (file name: chartres pier profile.jpg). Draw the profile in the design layer named, “Measurement.” Refer to the **Creating a 2D Molding Profile** section in the nave pier tutorial.



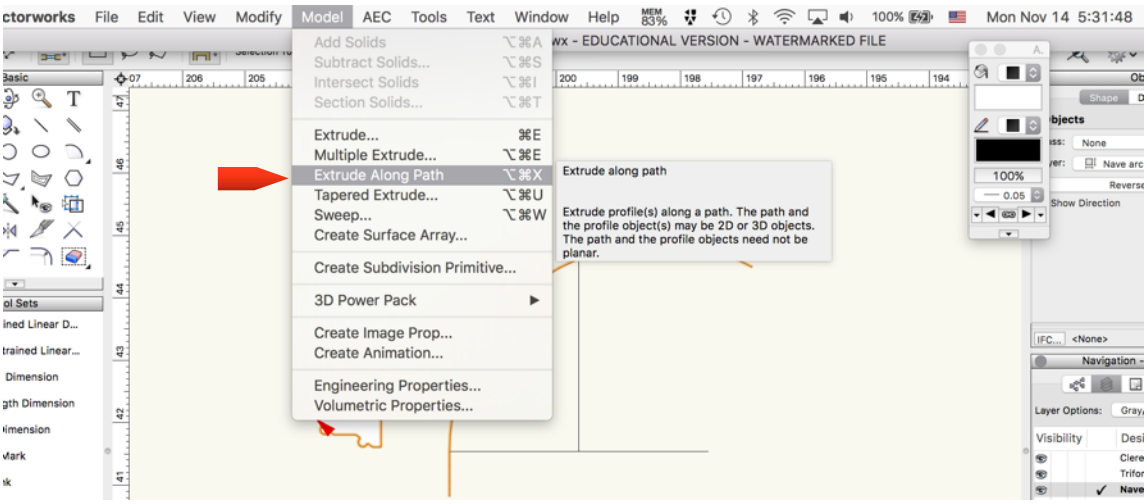
2. Create a new design layer to build your arcade. Name it “Nave Arcade”. Copy the arc with its reference lines and the profile you just drew, and paste into the new design layer.



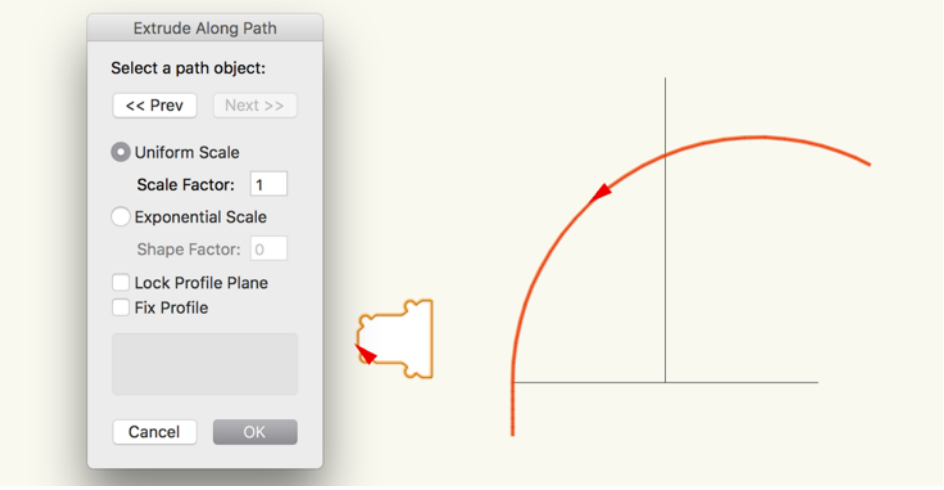


3. Make sure the side of the profile that is a straight line faces the outer edge of the arch. If necessary, rotate the profile by going to **Modify > Rotate**.

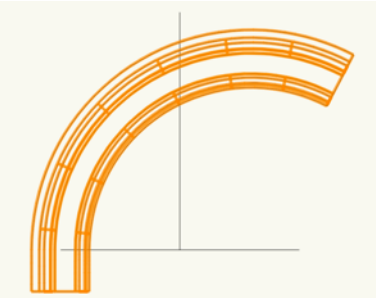
4. Select the molding profile and the arc. Go to **Model > Extrude Along Path**.

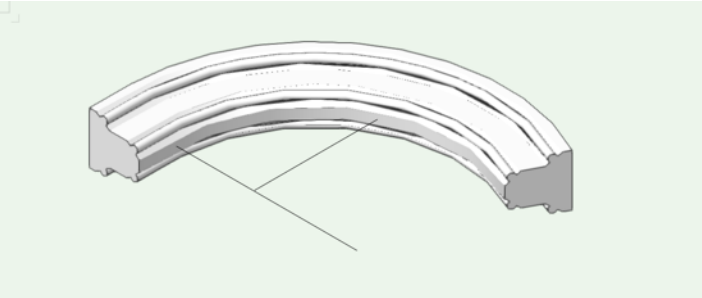


5. The arc should be outlined in red. If this is not the case, click **Previous** or **Next** to toggle between the selected objects. Click OK.

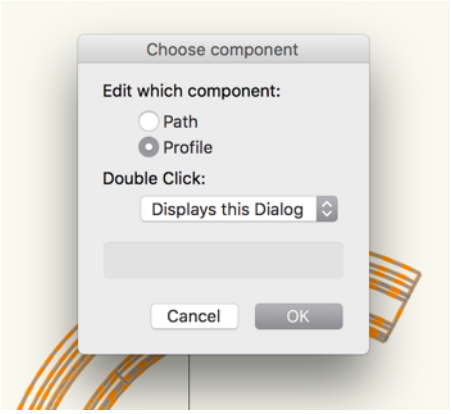


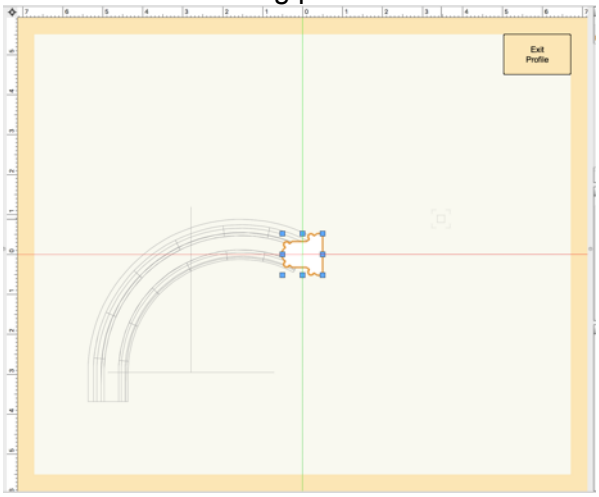
6. The extruded result should look like this (Left image is in **Wireframe** render mode, and the right image is in **OpenGL** render mode).



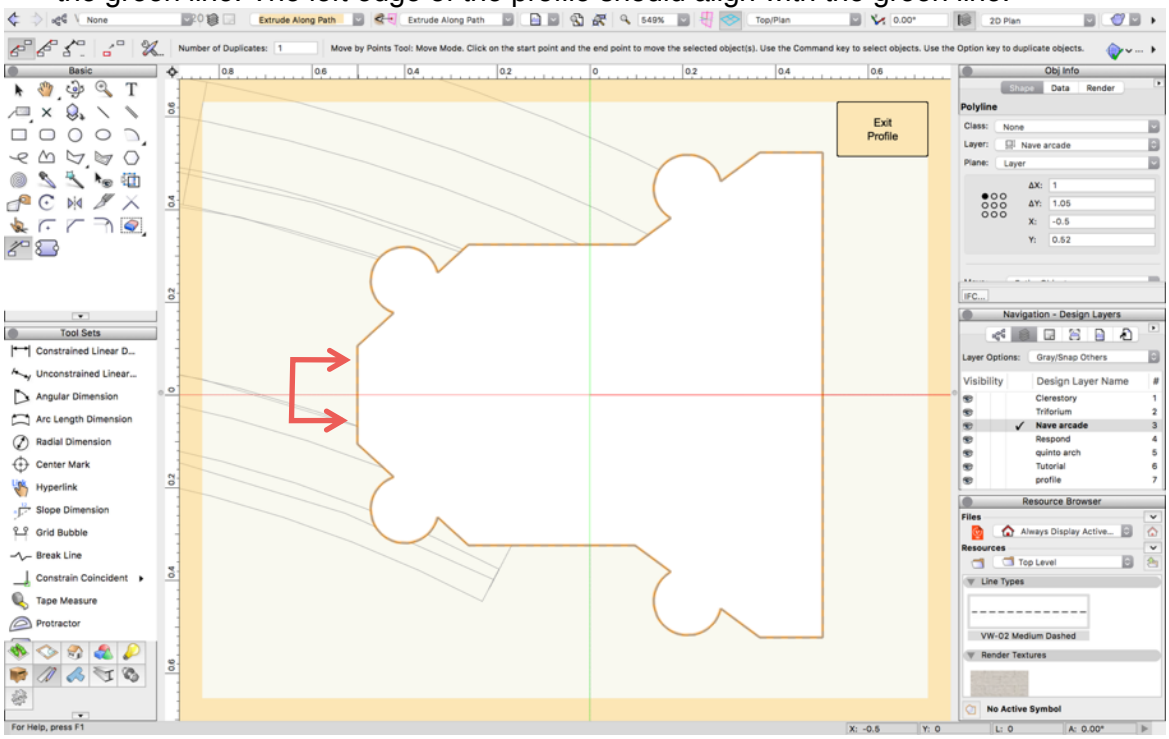


7. Vecterworks automatically extrudes the profile along its center point, and it is perpendicular to the axis of the path. Because we based the arch on its inner height, we would want the profile to be located outside the arc. To adjust the location of the profile, double click on the extruded arc, and select Profile from the pop-up window. Click OK. Your working plane will look like this.

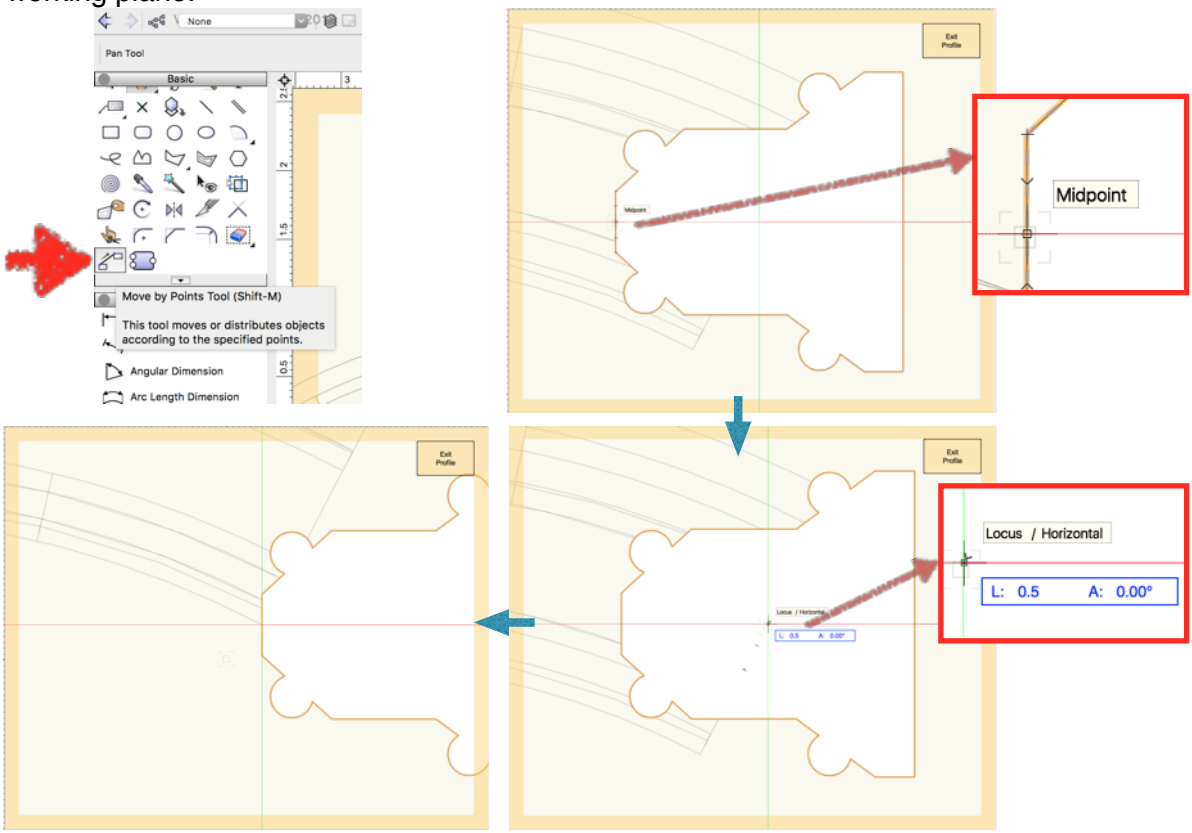


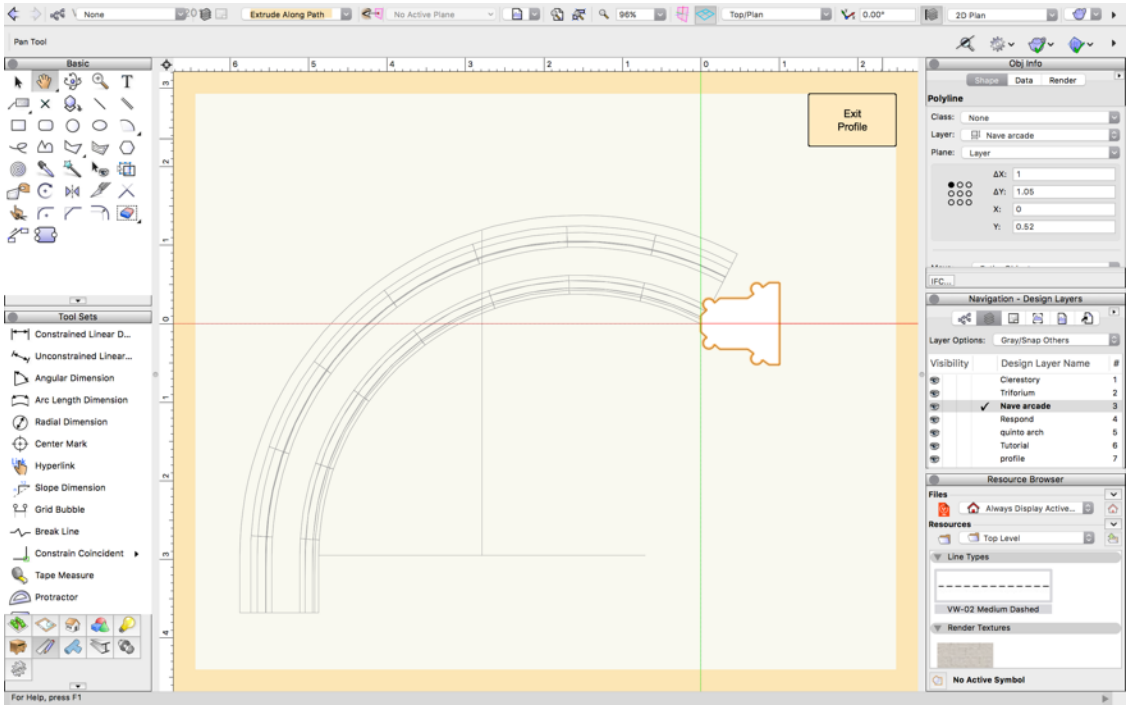


8. Zoom in on the profile. You will see a vertical green line and a horizontal red line intersecting at the center of the profile. These lines show the position of the profile relative to the path. Because we want the profile to run along the outside of the path, we need to move the profile to the right side of the green line. The left edge of the profile should align with the green line.

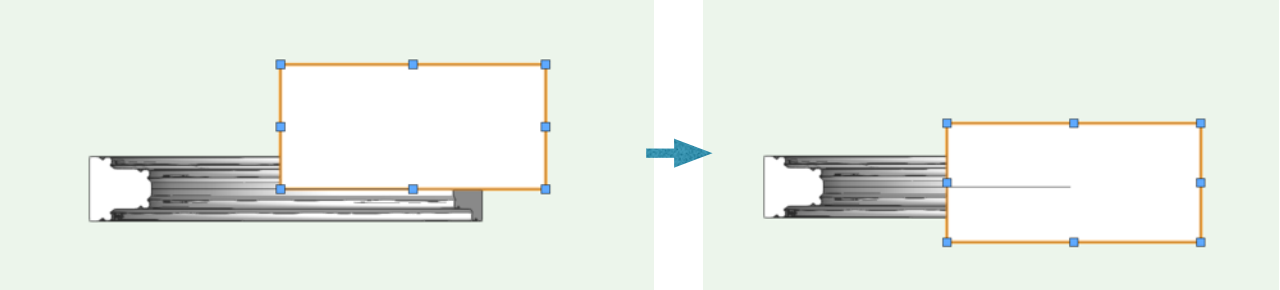


9. To move the profile, select the **Move by Points** tool from the **Basic Tools** palette. Click on the midpoint of the left edge, and then click on the intersection of the green line and red line (locus point). Your result should look like this. Then click **Exit Profile** in the upper right corner of the working plane.

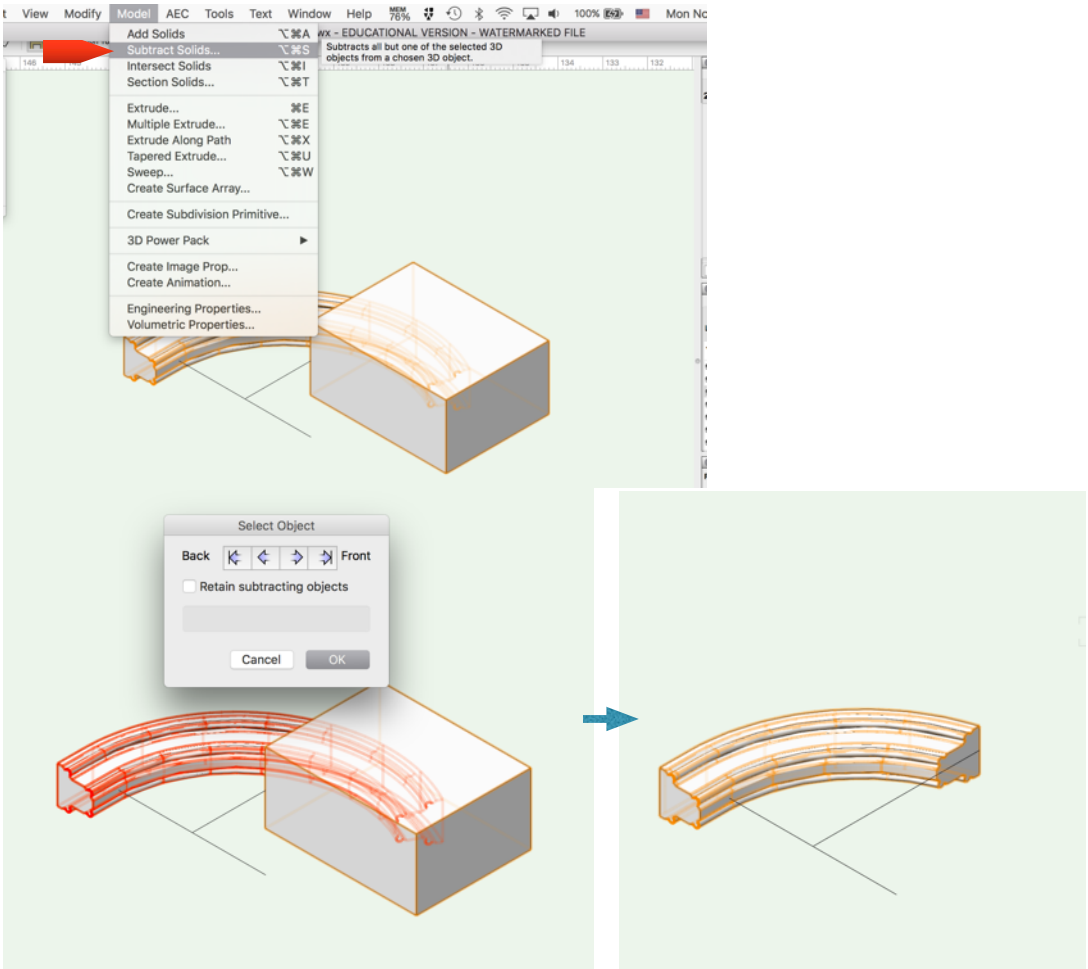




10. To remove the section of arc that extends beyond the vertical reference line, draw a rectangle that masks the section of arc to the right of the vertical reference line. If your rectangle has no fill, select a fill color from the Attributes palette.
11. Extrude the rectangle. Make sure that it is larger than the arc. Two meters should be sufficient. Go to the **Front** view, to make sure that the extruded rectangle covers the part of the arc you want to remove.

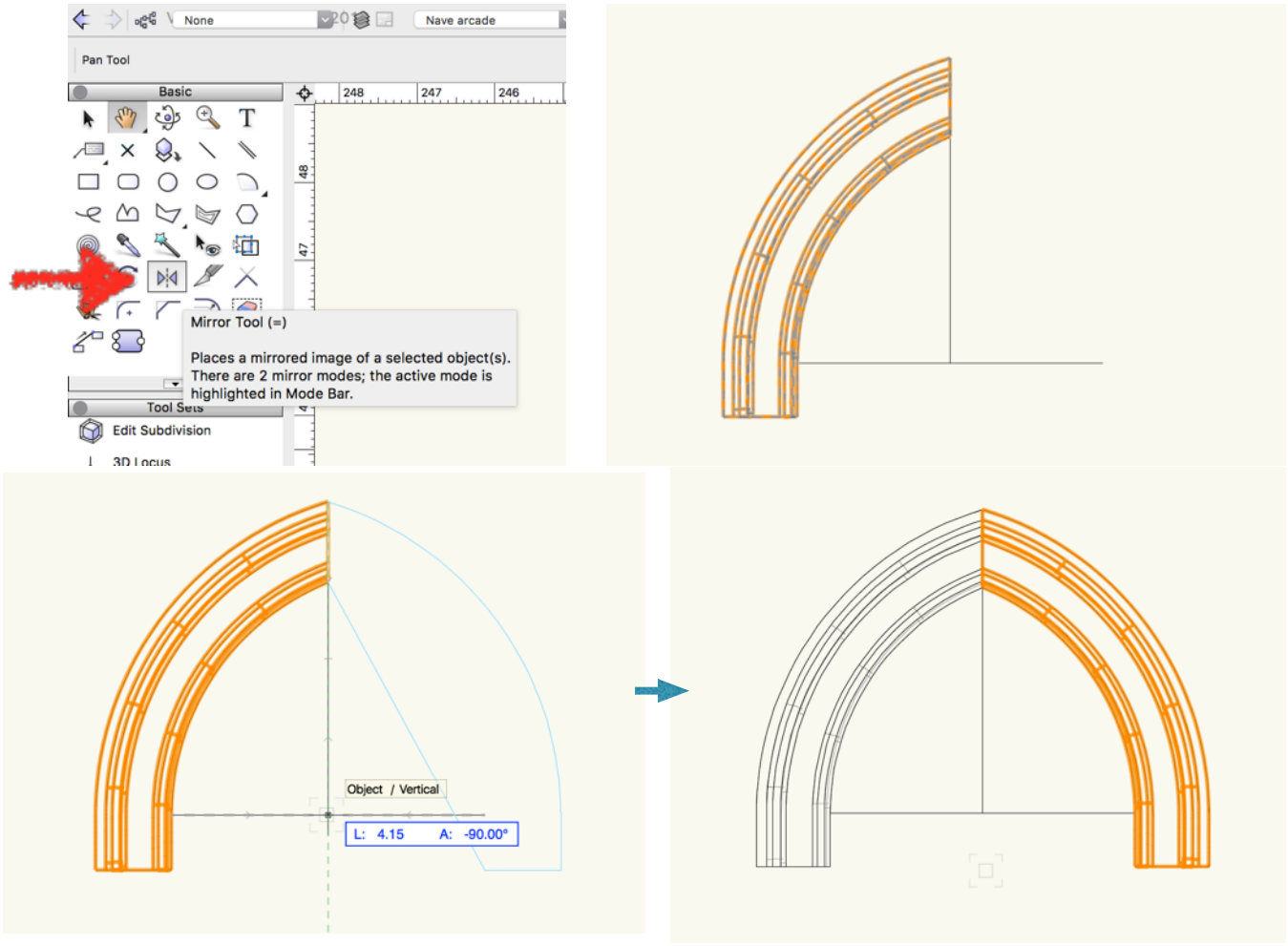


12. Go to **Right Isometric** view. Select both the extruded arc and the cube. Go to **Model > Subtract Solid**. The extruded arc should be outlined in red. If this is not the case, click the **Back** or **Front** arrows to toggle between the selected objects. Click OK.

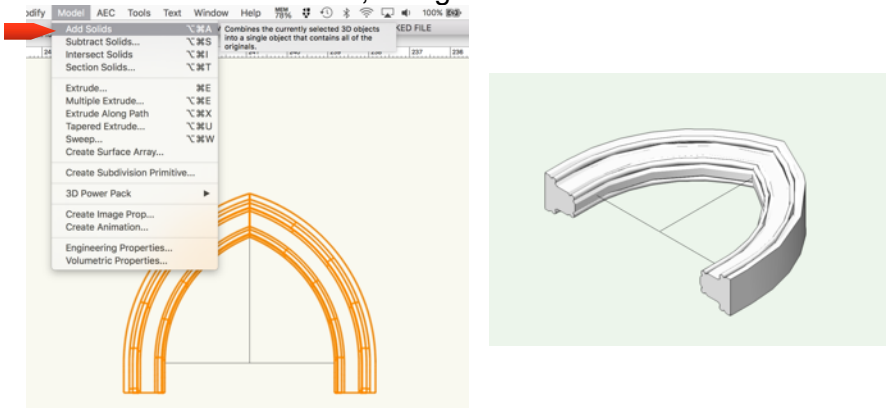


13. Go to **Top/Plan** view, to see the finished half of the pointed arch.

14. Select the **Mirror** tool in the **Basic Tools** palette to create the other half of the arch. Click once at the top of the arch, and click again at the base of the vertical reference line. You now have two halves of a pointed arch.



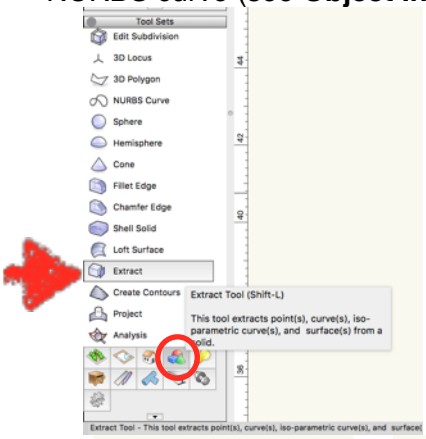
15. Select both arch halves, and go to **Model > Add Solids** to combine.

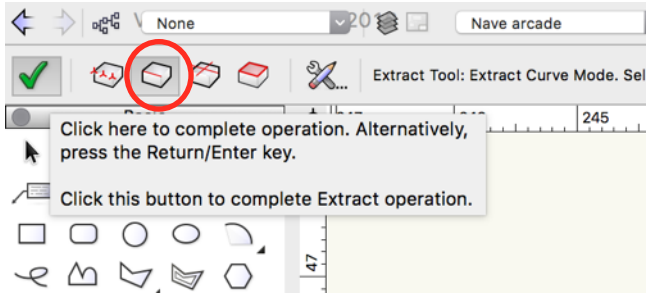


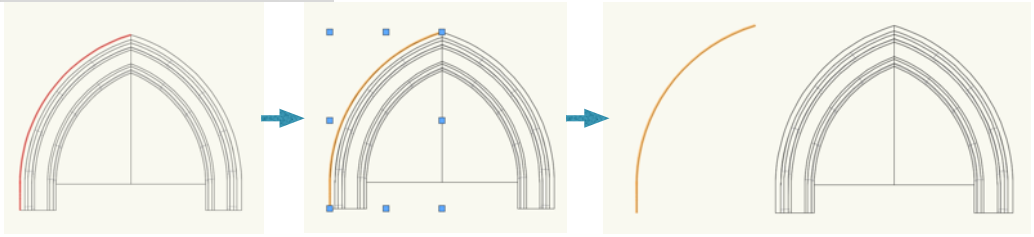
16. Select the arch, and go to **Modify > Create Symbol**. Name it “Nave Quinto Arch”. The symbol is stored in the Resource Browser palette. See Lynda.com for more on symbols.

Step 3: Adding Walls

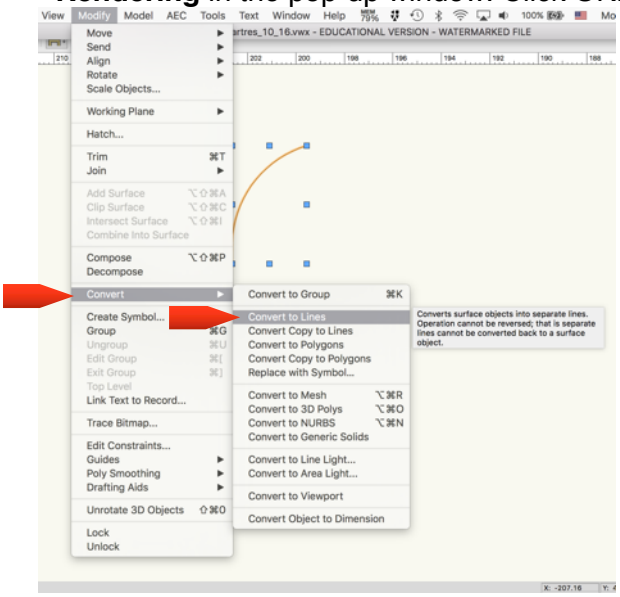
1. We will build a solid rectangular wall and then cut out space for the arches.
2. Select the **Extract** tool from the **3D Modeling** tool to extract the outer edge of the extruded arch. Because we want to extract a line, select the second Extract mode from the tools preference menu. Click on the left outer edge of the arch, which will be highlighted in red. Click on the green check mark above the Basic Tool palette. You will now have an extracted arc. This arc should be a NURBS curve (see **Object Info** palette).

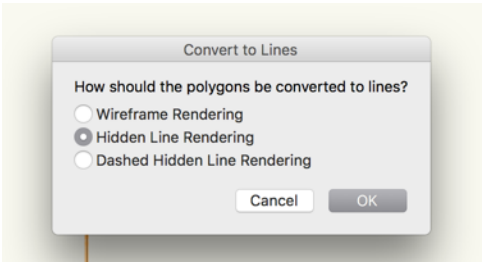


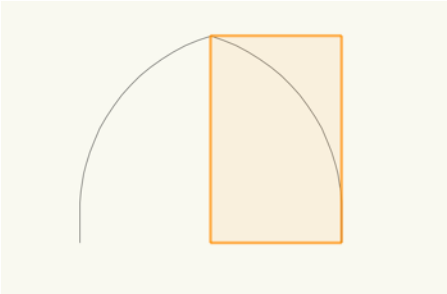




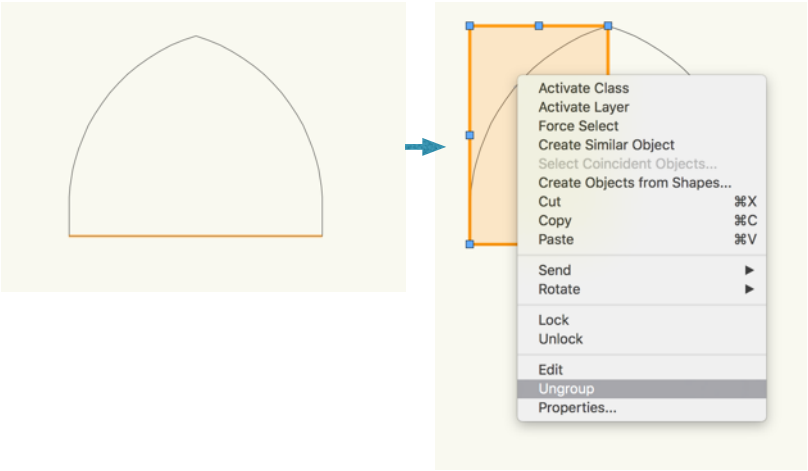
3. To convert the extracted line to a polyline, go to **Modify > Convert to Lines**. Select **Hidden Line Rendering** in the pop-up window. Click OK. Use the **Mirror** tool to create the other side of the arc.



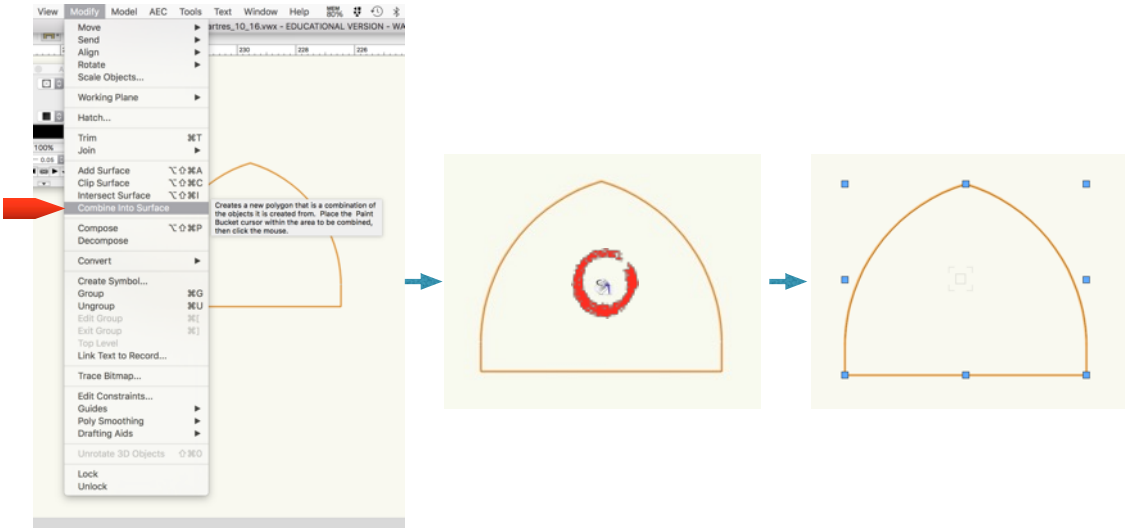


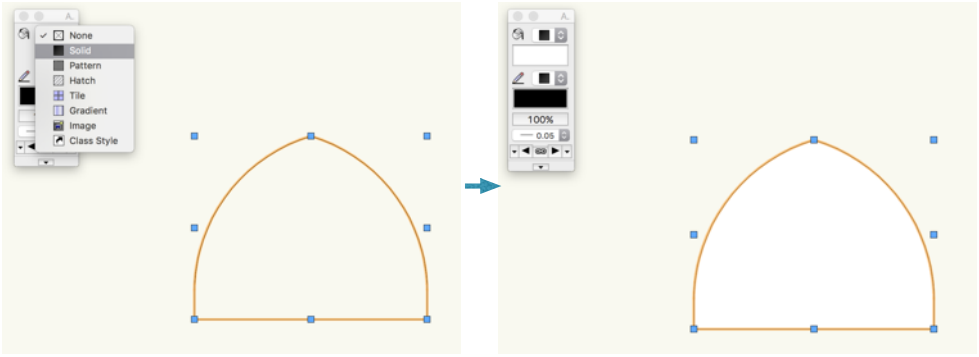


4. Select the Line tool from the Basic Tools palette, and draw a horizontal line to close the arch. Right click on one of the arcs and select **Modify > Ungroup**. Now select the other arc and ungroup it.

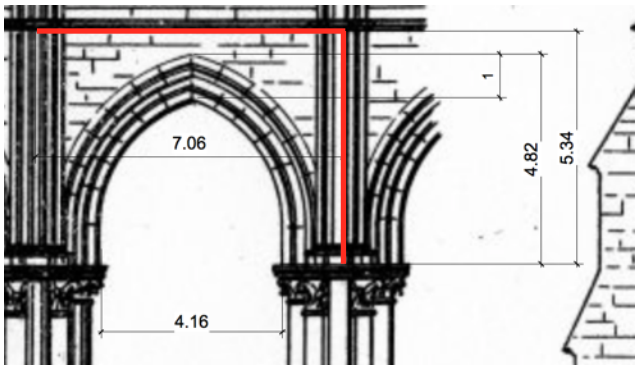


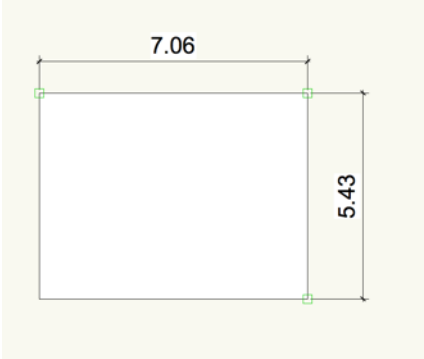
5. Select both arcs and the horizontal line. Go to **Modify > Combine into Surface**. The cursor will turn into a paint bucket. Click once inside the shape. The shape is now a surface. Go to the **Attributes** palettes if your surface comes out with no fill and change it to solid. Note that this step simply creates a surface. The lines you created are still there under the surface. Move the surface to delete these lines.



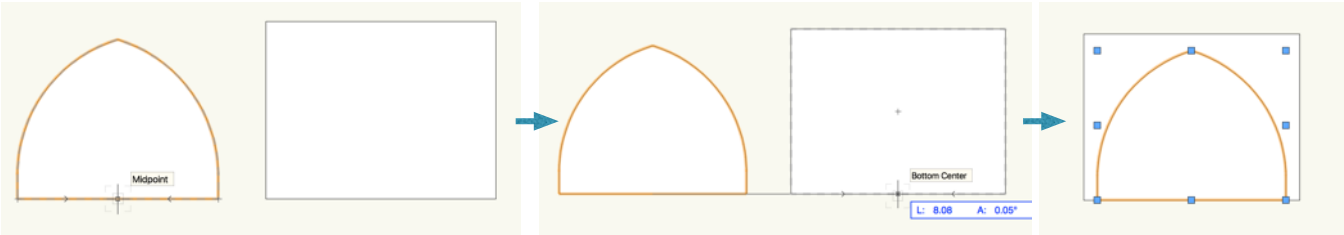


6. Check the wall dimensions on the reference image: width should be 7.06m and the height should be 5.34m. Use the **Rectangle** tool to create a 7.06 x 5.43 rectangle. Right click on the rectangle to send it to the back.

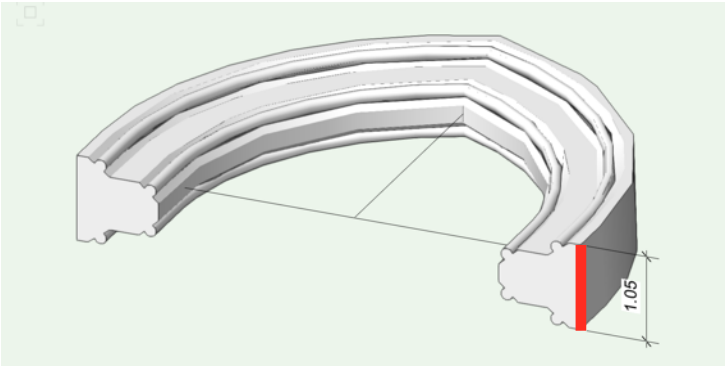




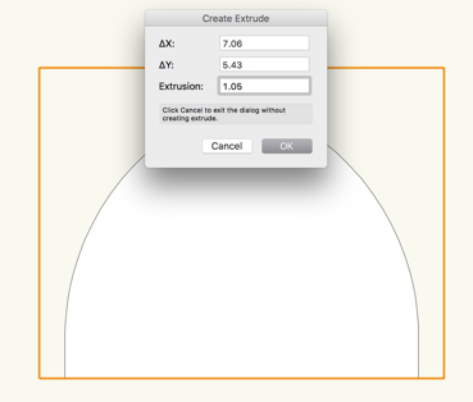
7. Use the **Move by Points** tool to align the two surfaces together. Click on the midpoint of arch bottom line and then click the bottom center of the rectangle.

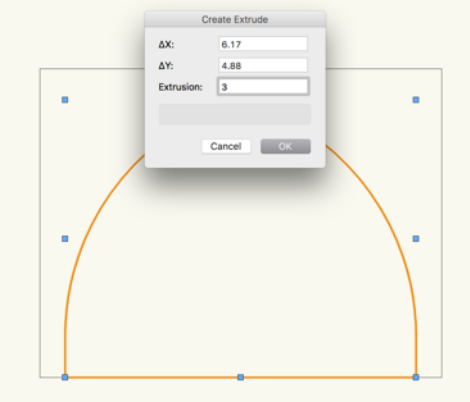


8. The thickness of the arch and the wall should be the same.

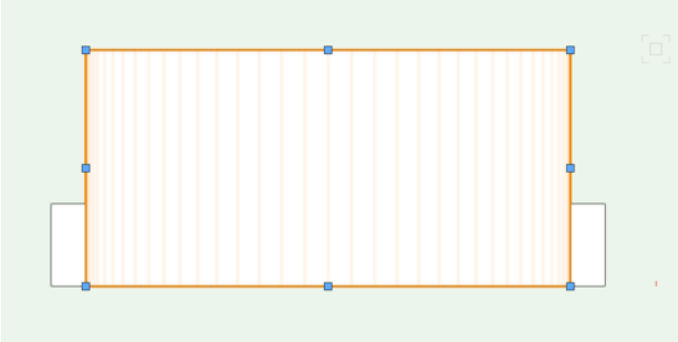


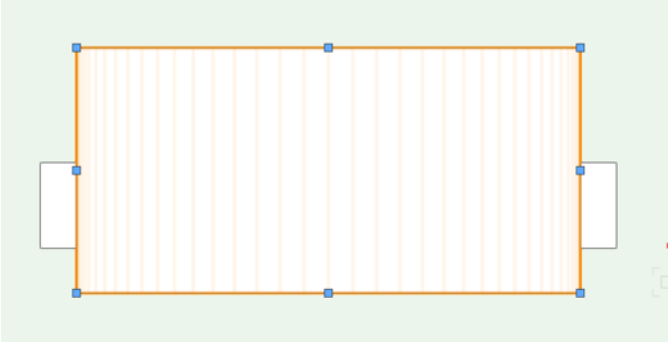
9. Extrude the rectangle by 1.05m. And then extrude the arch shape by whatever numbers that's larger than 1.05m. Here I'm extruding it by 3m.





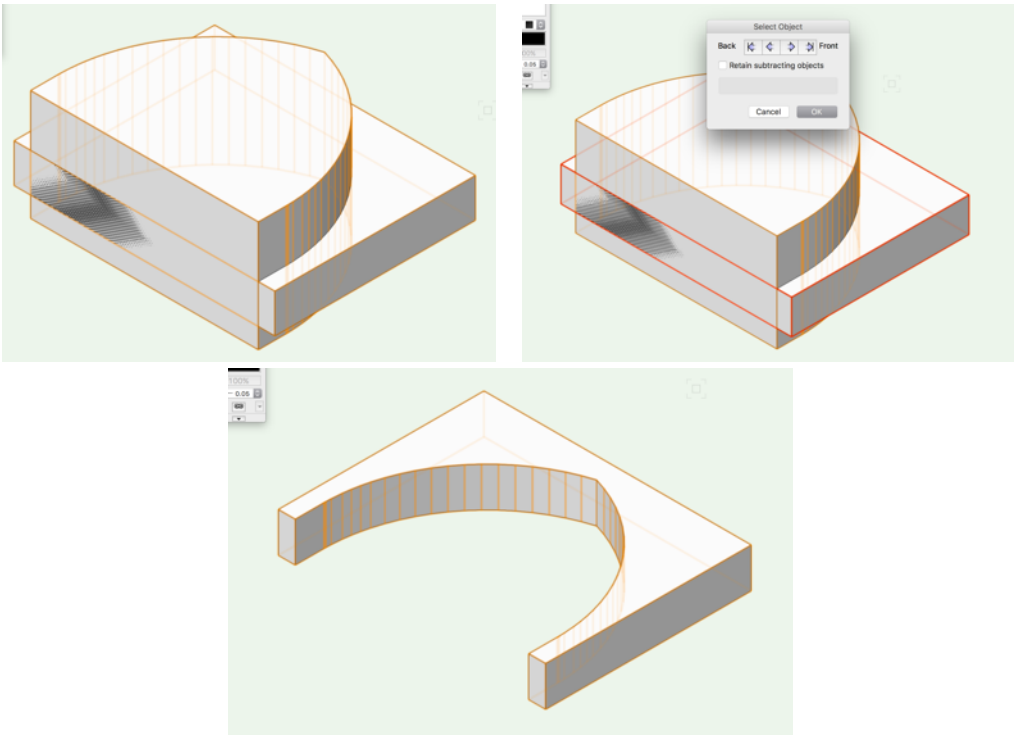
10. Go to the Front view. Like we did before when subtracting the arch, vertically move the arch-shape



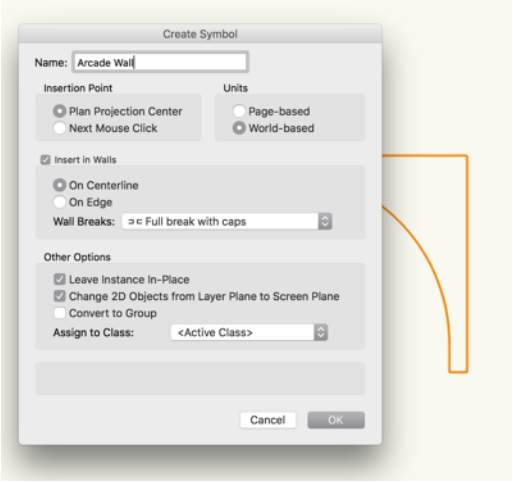


solid down to make sure that it completely contains the thickness of the wall.

11. Select both the solid. Go to “Model > Subtract Solid”. Make sure that the rectangle solid is outlined



in red and then click OK.

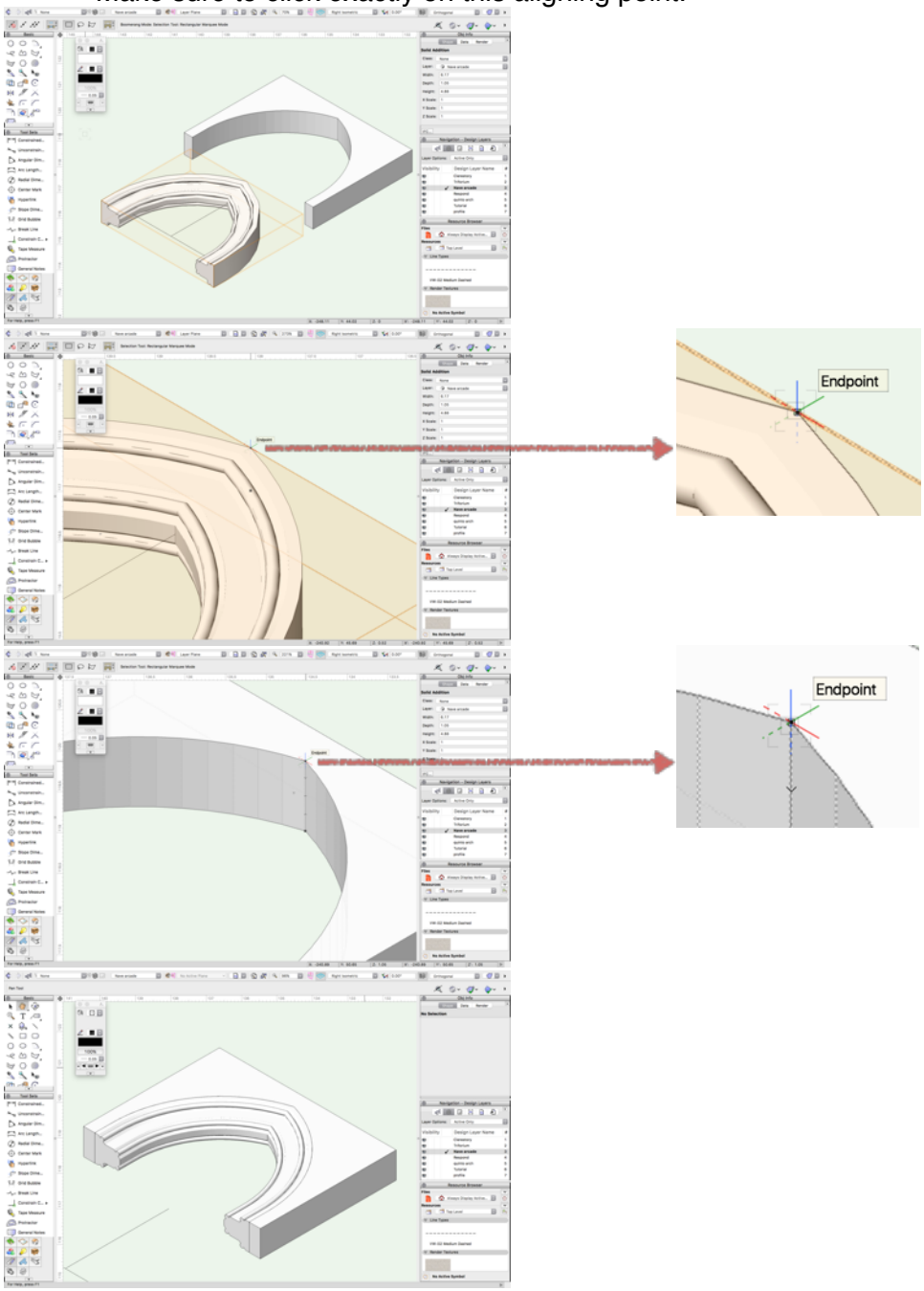


12. Add the wall to Symbol.

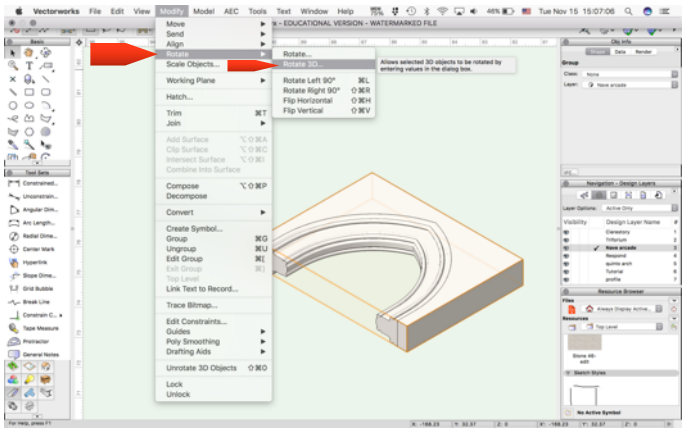
Step 4: Align The Arch, The Wall and The Pier

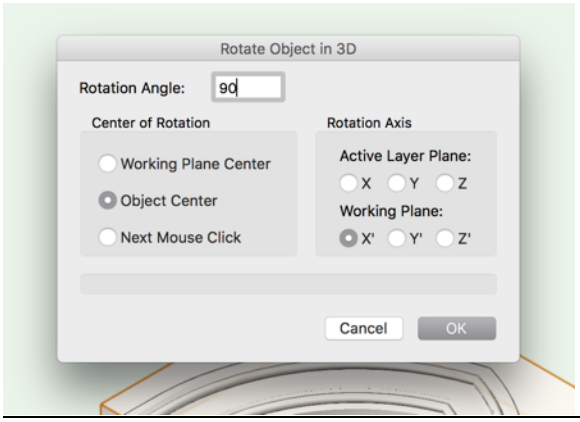
1. Align the wall with the arch.
   a) Select the arch, and use the **Move by Points** tool.
   b) Zoom in on the top of the arch, and click the top point.
   c) Then zoom in on the wall at the point where the top of the arch connects to the wall. Click again.
   d) After the two objects are perfectly aligned, go to **Modify > Group**.

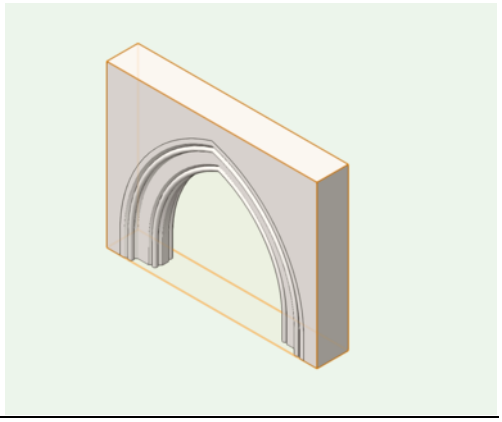
★ The key of aligning any two object is to be sure exactly at which point the two pieces connect. Make sure to click exactly on this aligning point.



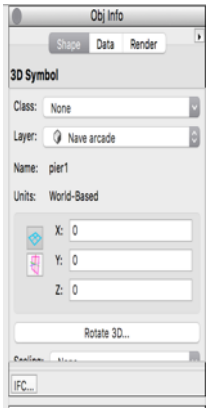
2. Rotate the arch and the wall.
   a) The wall is currently lying on the ground. We need to make it stand upright.
   b) Select Go to **Modify > Rotate > Rotate 3D**.
   c) Input 90° in the **Rotation Angle** field. In the **Center of Rotation section**, select **Object Center**, in the Rotation Axis section, select **X** for Working Plane.
   d) Click Ok.

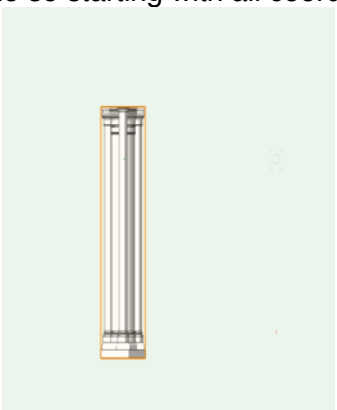




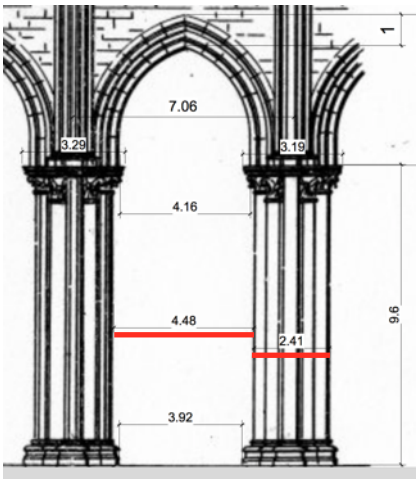


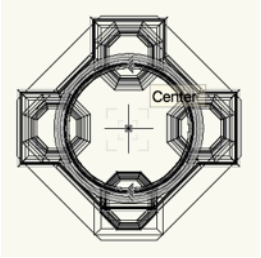
3. Placing the piers.
   a) Note that Chartres Cathedral has alternating piers at the nave arcade.
   b) From the **Resource Browser**, select “pier 1” from **Symbols**. In the **Object Info** palette, enter 0 for the X, Y, and Z coordinates. We are going to assemble the arcade based on this pier. It’s easier to do so starting with all coordinates set to 0.

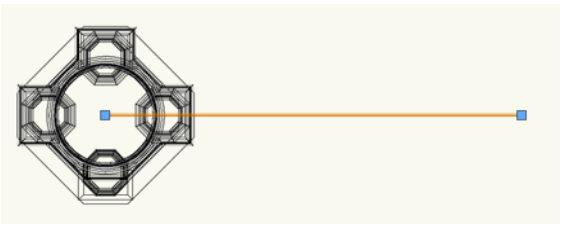




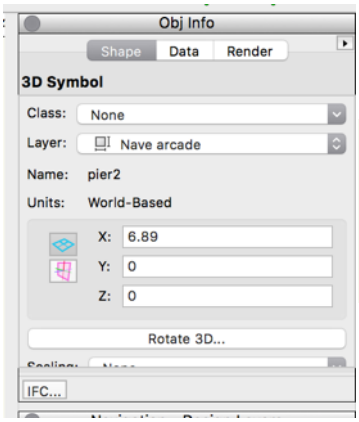
c) The distance between each pier is 4.48m and the diameters of each pier is 2.41m. Therefore, the distance between one pier center to the other should be 4.48m+2.41m=6.89m. Go to **Top/Plan** view, and draw a line measuring 6.89m from the center of the pier for reference.

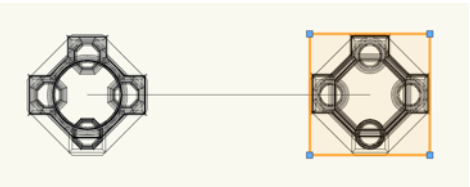


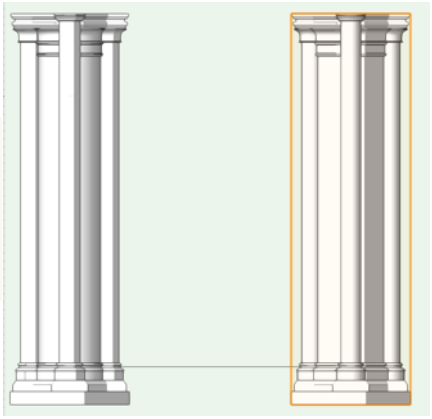




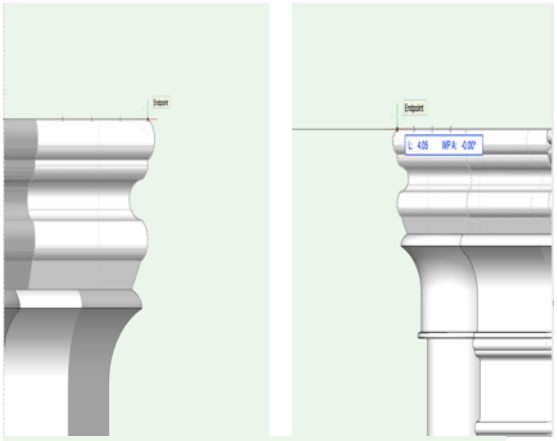
d) Select “pier 2” from **Symbols**. In the **Object Info** palette, change the X coordinate to 6.89, and set Y and Z to 0. Position “pier 2” so that it is centered at the end of the reference line. Go to the **Front** view to check that both piers are level.

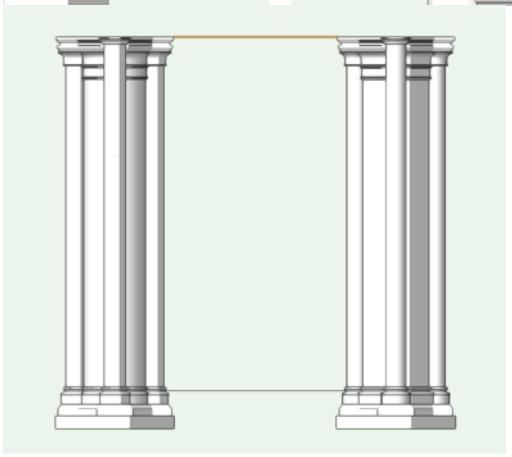


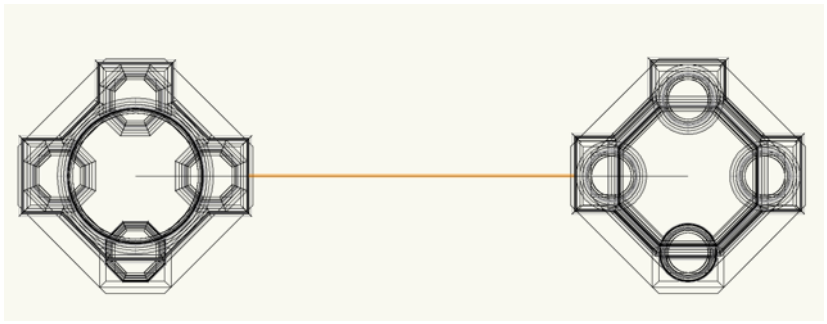




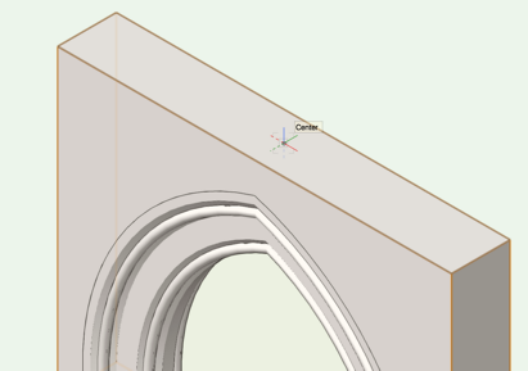
4. Align the wall and arch with the piers
   a) Go to **Top** view and create a reference line from the top right endpoint of one pier capital to the top left endpoint of the other pier capital. Go to **Front** view to check alignment.

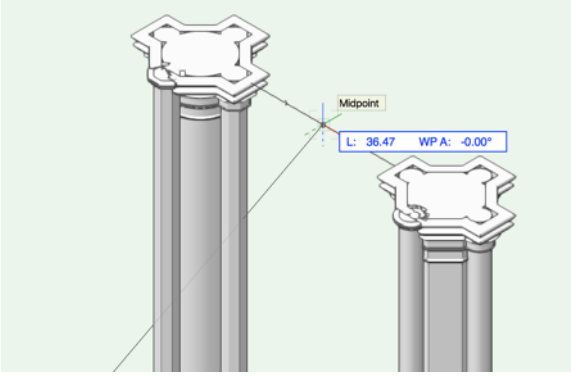


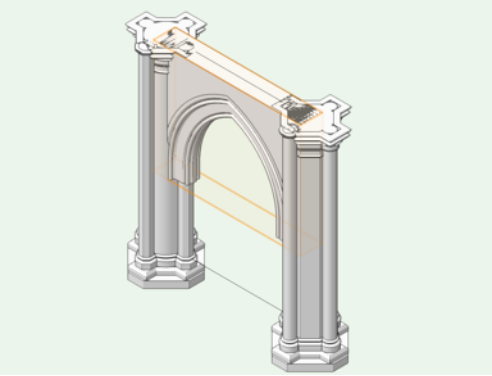


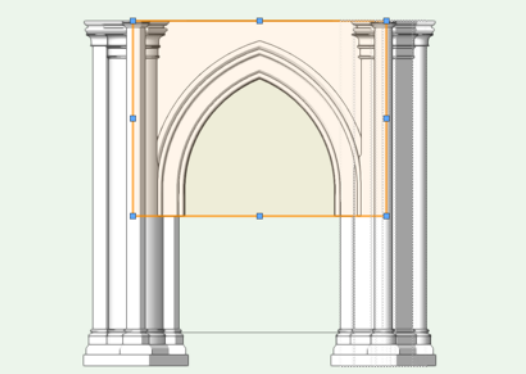


b) Go to **Right Isometric** view and select the grouped wall and arch. Use the **Move by Points** tool, click the center of the top surface of the wall, then click the midpoint of the reference line we just created.

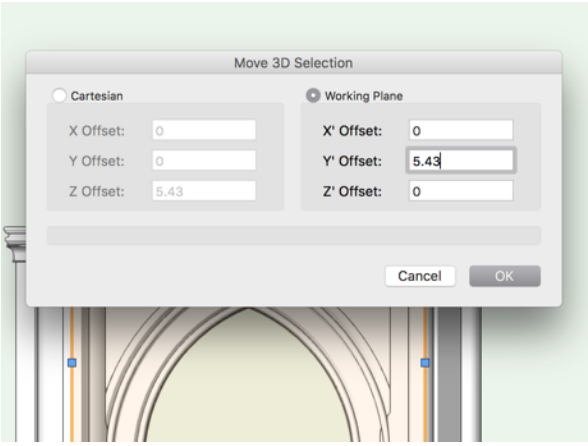


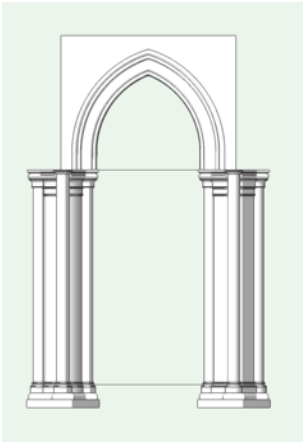


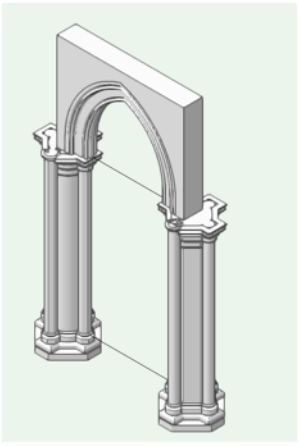




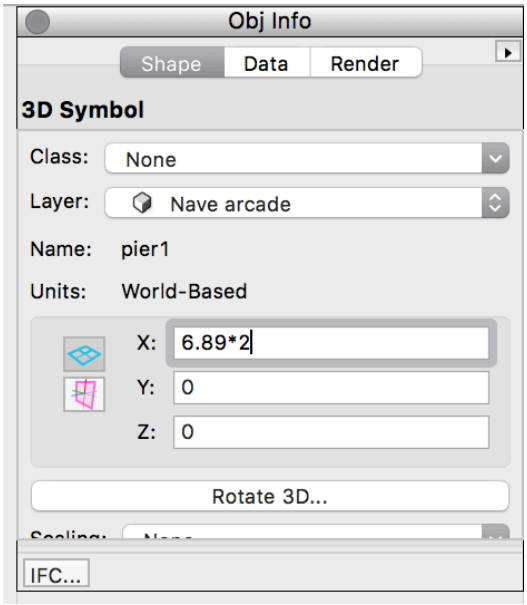
c) To position the wall and arch to the top of the piers, go to **Modify > Move > Move 3D**. Input 5.43m into the **Y Offset** box in the **Working Plane** section. Alternatively, you can enter 5.43m into the **Z Offset** field in the **Cartesian** section.

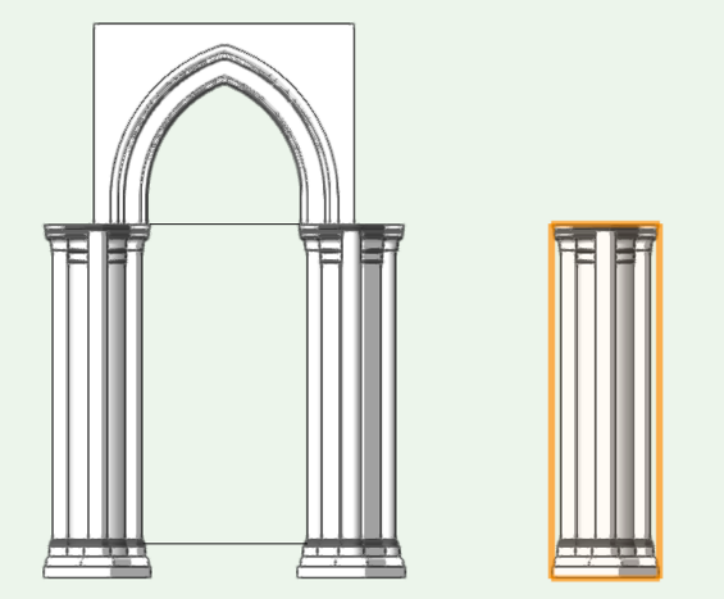




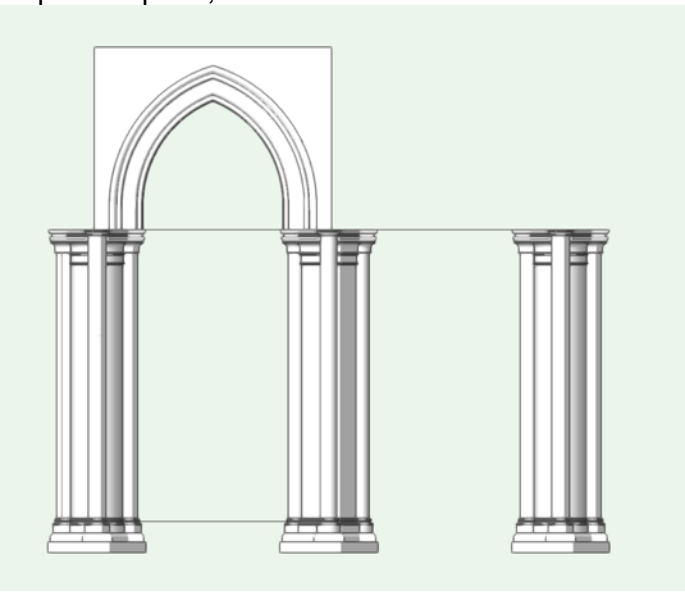


5. Complete the arcade.
   a) Drag another “pier 1” from **Symbols**. Go to the **Object Info** palette and change the X coordinate to 6.89*2. The Y and X coordinates should be set to 0.

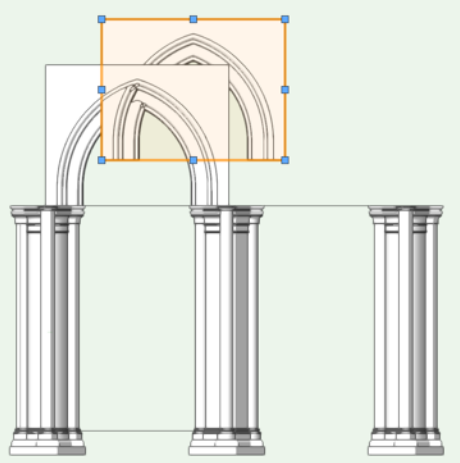
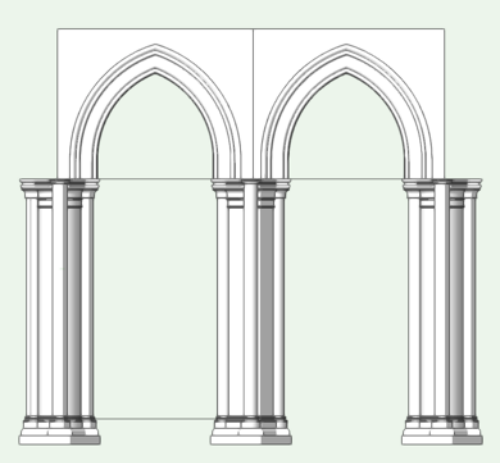
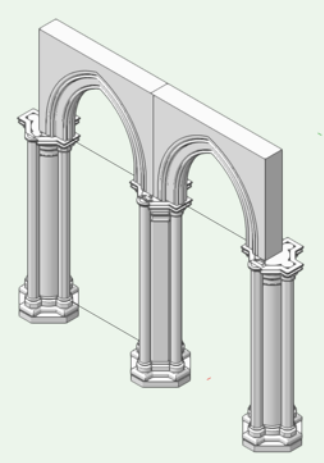




   b) Repeat step 4.a, and create another line between the top of the two piers.



   c) Duplicate the grouped wall and arch. And then repeat step 4.b to align them with the piers.

d) Continue to finish the arcade.