Build the clerestory of Chartres Cathedral
Overview:
Step 1. Create a new Design Layer
Step 2. Build the wall
Step 3. Build the lancets
Step 4. Build the rose window
Step 5. Build the rose window quatrefoils
Step 6. Assemble the clerestory
Learning Objectives for this tutorial:

1. Circular Array
2. Basic Tools palette: Rotate Tool

Key dimensions for the clerestory at Chartres Cathedral:
Clerestory width - 6.98
Clerestory square - 10.35
Wall thickness - 0.43
Lancet height - 7.78
Lancet width - 2.51
Distance between lancets -0.25 m
Lancet molding profile thickness- 28
Tapered base height - 0.86
Rose window diameter - 5.48
Rose window central window - 2.16
Small quatrefoil - 0.43
Large quatrefoil - 0.76
Rose window molding thickness - 0.22

## Step 1. Create a new design layer

1. Create a new design layer name it "clerestory."

## Step 2. Build the wall

1. Draw a circle with a diameter of 6.98 m , and a rectangle starting at the center edges of the circle with a height of 10.35 m .


## 2. Select shapes and got to Modify > Add Surface.


3. Extrude to the same thickness as the triforium wall, 0.43 m (Model $>$ Extrude).


Step 3. Build the lancets

1. Make a $3 / 5$ ths arch with a span of 2.51 m . Refer to the PDF on the different types of pointed arches in Gothic architecture (file name: Pointed Arches).


2. Close the arch with a horizontal line, select the shape, and use the Combine into Surface tool to create a polygon. Go to Modify > Combine into Surface. A paint bucket icon will appear. Click inside the polygon to create surface.

3. The overall height of the lancets is 7.78 m , and the height of the arch is 1.48 m . Draw a square and input 7.78-1.48 and Vectorworks will create a correctly-sized rectangle.

4. Add surface.

5. You will need this polyline shape as a path for the molding extrusion later. Move a copy of it to the side of the work area.

6. Mirror the lancet.

7. Draw a line 0.25 m long between the lancets and line them up so that they are 0.2 m apart.

8. Align the center of the 0.25 m long reference line with the center of the wall, and delete the reference line.

9. Extrude the lancets to any thickness greater than 0.43 m , then subtract solids.

10. The lancets that will fit into the pierced wall have a tapered profile. To create this tapered profile, use a simple triangle as a profile. Draw two perpendicular lines, the horizontal line should measure 0.43 m long and the vertical line should measure 0.28 m .

11. Connect the two lines to create a triangle. Delete the center line.

12. Select the lines and go to Modify > Combine into Surface.

13. Using the lancet polyline that you have saved on your workspace (see Step 3.5). Extrude the triangle profile along the lancet path (Model > Extrude Along Path). Make sure the triangle, and therefore the taper, is facing inward.

14. Make a copy and fit both lancets into the wall.


## Step 4. Build the rose window

1. Import the reference image (file name: elevation_buttress.jpg) and scale the image so that the diameter of the window measures 5.48 m .

2. Draw a circle with a diameter of 5.46 m .

3. Draw a circle outlining one of the petals.

4. Draw a circle outlining the central window, making sure the diameter is 2.16 m .

5. Select the petal and go to Edit > Duplicate Array. Select the Circular Array option and 7 into the "Number of Duplicate" field. The "Angle Between Duplicates" should be set to $45^{\circ}$. Finally, select "Next Mouse Click" under Circle Center Point. Click OK.

6. Click on the center of the central circle. The circle "petals" will duplicate around the central circle's center point.

7. Select all the petals and the center circle. Go to Modify > Add Surface.

8. Snap the central rose shape to the center of the larger circle of the rose window.

9. Select the large circle and make a copy.
10. Extrude the large circle to a thickness of 0.22 m . This measurement is an approximation based on how the wall tapers meet the rose window. Leave the central rose form as a two-dimensional polyline form for now. You will extrude it later.

11. Construct another triangle profile with a width of 0.43 m and a height of .22 m (refer to Step 3.10-13).

12. Extrude along the inner edge of the second large circle with the triangle facing inward. *Note: If the extrude tool gives an error, undo and check all your shapes are complete. You may also need to check the fix profile or lock profile plane box potentially.

13. Align with the rose window.


## Step 5. Build the rose window quatrefoils

1. Note that there are two sizes of quatrefoils radiating around the rose. Begin with the larger one. Draw a line measuring 0.76 m long and mirror it to create a cross.

2. Draw a circle from the center of the cross to each edge.

3. Select the circles. Go to Modify > Add Surface. If you leave the reference lines, it will be easier to align with the window later.

4. Repeat steps $1-3$ for the smaller quatrefoil. Begin by drawing a line measuring 0.43 m long.

5. Return to the rose window. Draw a line between the edge of the petal and inner edge of the tapered profile.

6. Snap the center of the small quatrefoil to the center of the reference line, then delete the lines.

7. Use the Circular Array tool with the same settings as before (refer to Step. 3.5-7), in addition to turning on Rotate Duplicates with "Use Duplication Angle" selected.

8. Draw another reference line between two of the small quatrefoils and snap center of the large quatrefoil to the center of the line.

9. Use the Rotate tool in the Basic Tools palette. First click on the center of the quatrefoil. Then drag a vertical line upward. Rotate until the angle is $30^{\circ}$ and click again.

10. Use the Circular Array tool with all the same settings as for the small quatrefoil.

11. Select the rose and all the quatrefoils, and extrude to any thickness greater than 0.22 m .

12. Select the design and the main circle (make sure you select the window, not the tracing). Go to Model > Subtract Solids.


Step 6. Assemble the clerestory

1. Draw a circle the same diameter as the rose window, 5.48 m . Extrude it to a thickness greater than 1 m to punch a hole in the clerestory wall for the rose window.

2. Align the center of the circle with the arc center of the wall.

3. Select the clerestory wall and the circle. Go to Model > Subtract Solids. Align the rose window with the clerestory. Remember to change views to make sure that all objects are aligned.

4. One last thing to finish the clerestory: the tapered base of the wall. To minimize the adjustments required to align the tapered based with the wall, construct the triangle in Right plan view. The triangle should measure 0.43 m by 0.86 m .

5. The wall only needs to be as wide as the lancets. Go to Model > Extrude and input: $2.51+2.51+.2 .5$. Click OK. Align with the wall.

6. Select all clerestory components and go to Modify > Create Symbol. Rotate the clerestory so that it stands upright when in Front view.

