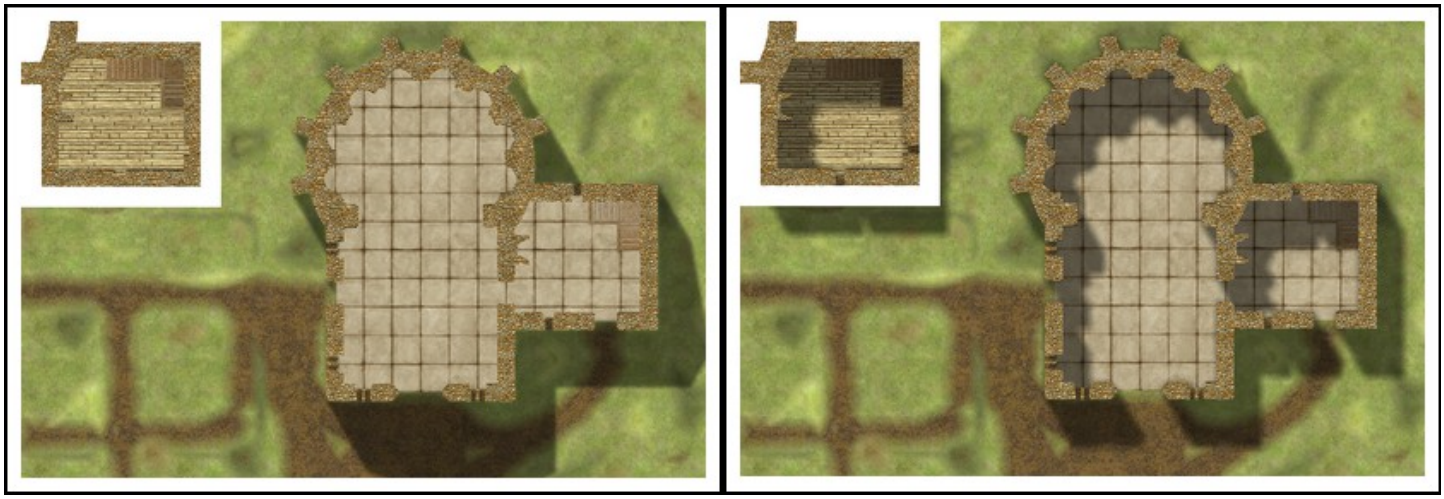
Part 9 – Shadows the Hard Way…

Introduction

Because of the earlier choice of using light effects inside the building, using the **WALL SHADOW, DIRECTIONNAL** effect from CC3 is not an option here. The effect “pulls” the walls on the opposite direction of the sun, regardless of inside/outside considerations.



Left: shadows made with the tutorial method; no effect inside the building. Right: shadows generated by the **WALL SHADOW, DIRECTIONNAL** effect included in CC3; nice outside, unrealistic inside.

The creation of realistic shadows implies:

- Understanding how real shadows are generated
- Drawing the shadows as CC3 polygons instead on relying on a cool, built in, effect

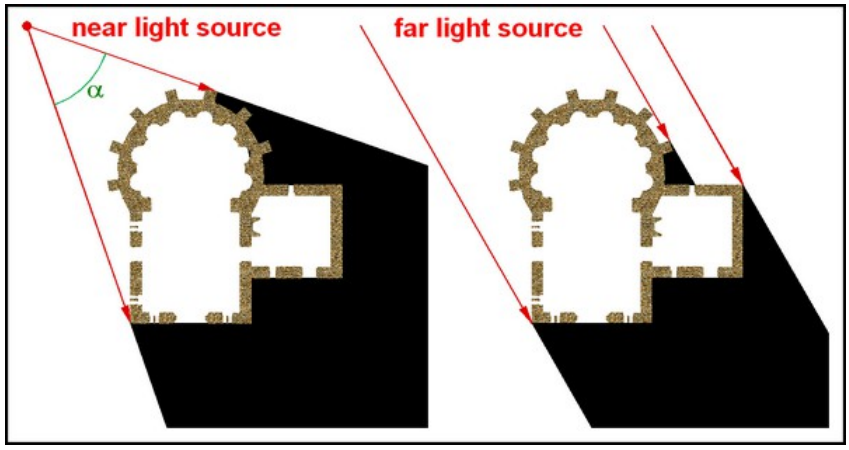
The physics of shadows

Shadows generate by a light source depend on the relative position of this source in regards to the objects blocking the light. Three parameters must be considered:

- The distance between the light source and the object
- The azimuth, an angle at ground level indicating the location of the light source
- The inclination, or how high the light source is in the sky, dictating the lengths of shadows.

Distance and parallelism

When the light source is near to the object, the light rays follow a radial distribution and the shadows are included in a wedge shape defined by an angle (denoted α in the left picture). The farthest the source moves away from the object, the sharper this angle. On real earth, the sun is so far away that the angle made by it's rays is smaller than a millionth degree, making the rays look parallel (picture right). In a fantasy world, the sun could be nearer but it should be only a dozen of miles away to make a difference, so it's fully acceptable to consider the sun rays parallel.



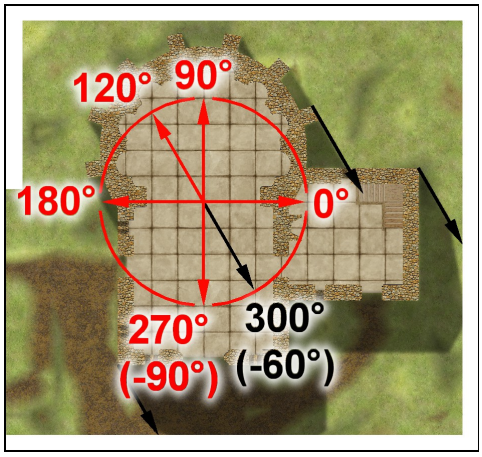
What is an azimuth?

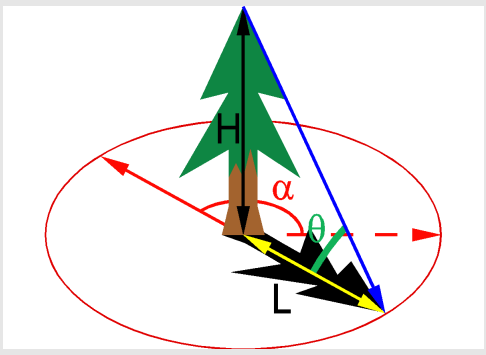
With the rays parallel, the azimuth is the angle they make with a reference direction. In CC3, the reference is 0° due right. 90° is up, 180° left and 270° (or -90°) down. The relation to the cardinal directions depends on the orientation of the map itself. If up is north, then the reference is 0° due east.

On real Earth, sun rays come from the east in the morning and from the west in the evening. During the day, they come from the south in the northern hemisphere, and from the north in the southern hemisphere. In a fantasy world, this can be different.

The shadows go in the opposite direction, calculated by adding or subtracting 180° to the azimuth.

The tutorial uses an azimuth of 120°.





The sun ray is in blue, the shadow length L in yellow and the object height H in black.

The azimuth is the red α angle and the inclination the green θ angle.

Trigonometry tells us: $L = H \times \frac{1}{\tan\theta}$

Which means that to calculate the length of a shadow you multiply the height of the object by the reciprocal of the tangent of the inclination angle, also called the cotangent.

The following table gives the shadow length coefficient C_s for usual angles:

θ (°)	15	30	45	60	75
C_s	3.73	1.73	1	0.58	0.27

What is the inclination?

Also called altitude or elevation, this is another angle, measuring how high the sun is in the sky. It ranges from 0° (sunrise or sundown) to a maximum of 90° if the sun happens to be just at the vertical of a location. This angle is related to the length of the shadows. The higher the inclination, the shorter the shadows.

The shadows length are proportional to the objects height so you just need to choose a coefficient number by which all heights will be multiplied.

At sundown or sunrise the shadows are theoretically infinite. At the zenith, there are no shadows in a top down view (unless under transparent objects).

Any number between 0 and the infinite is thus correct.

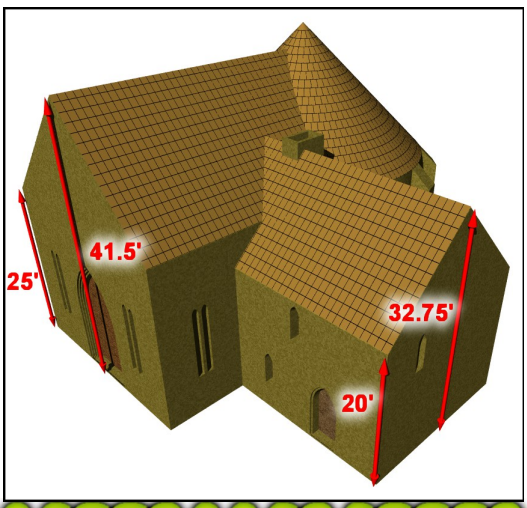
The tutorial uses a coefficient of 0.58 (corresponding to an inclination of 60°, see sidebar, but feel free to chose 0.5 or 0.6)

Choosing heights

A side or perspective view is a good help to set a building's heights. As a rule of thumb, a story height of 10' is a nice approximation and easy to calculate with. A great hall would be taller, two of three stories high. A modest house would probably have lower stories to spare fueling.

A 45° roof makes calculating the top height easy by adding half of the corresponding wall's length.

The picture shows the heights chosen for the chapel:



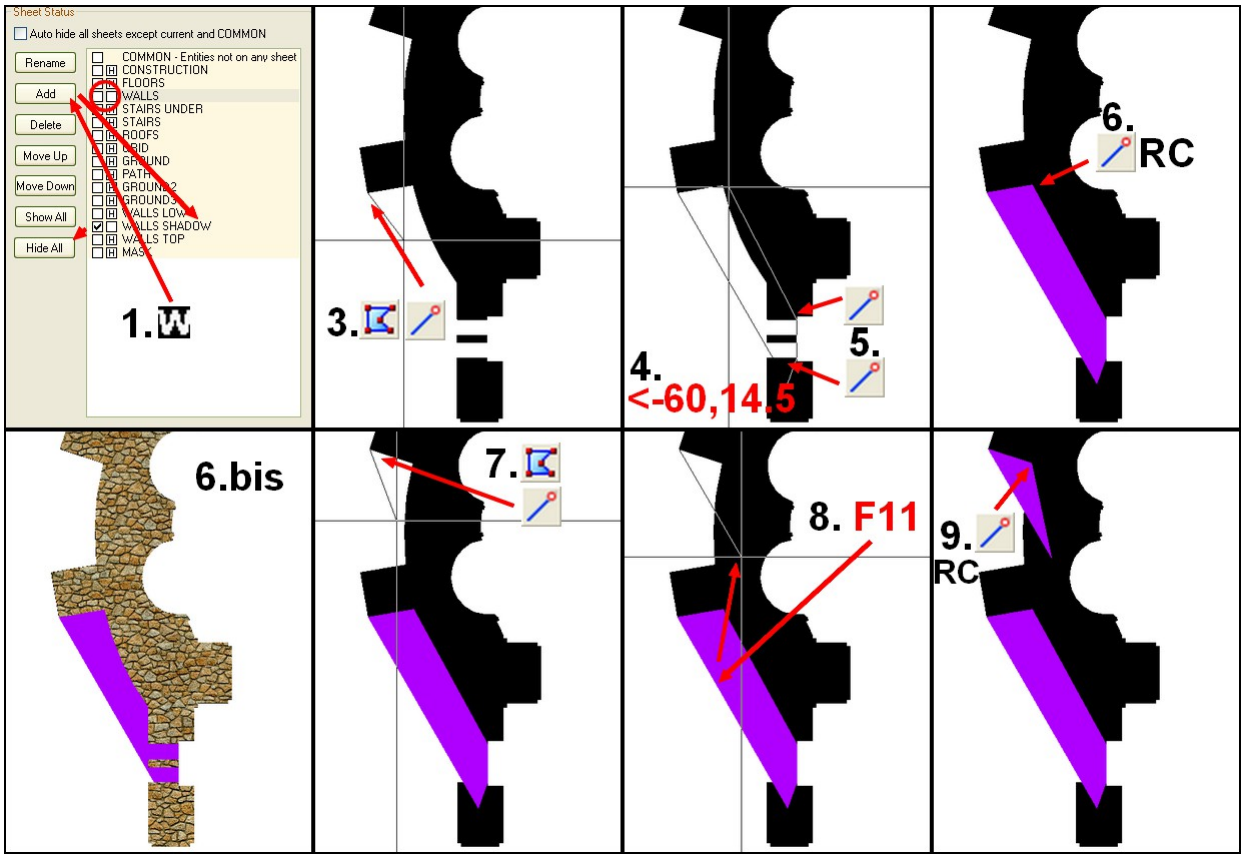
Now just multiply each height by 0.58 (or your chosen coefficient) to get the shadow lengths.

	Height	Shadow length
Nave roof, low	25'	14.5'
Nave roof, top	41.5'	24.07'
Lodging, low	20'	11.6'
Lodging, top	32.75'	18.995'

Creating the sanctuary shadows

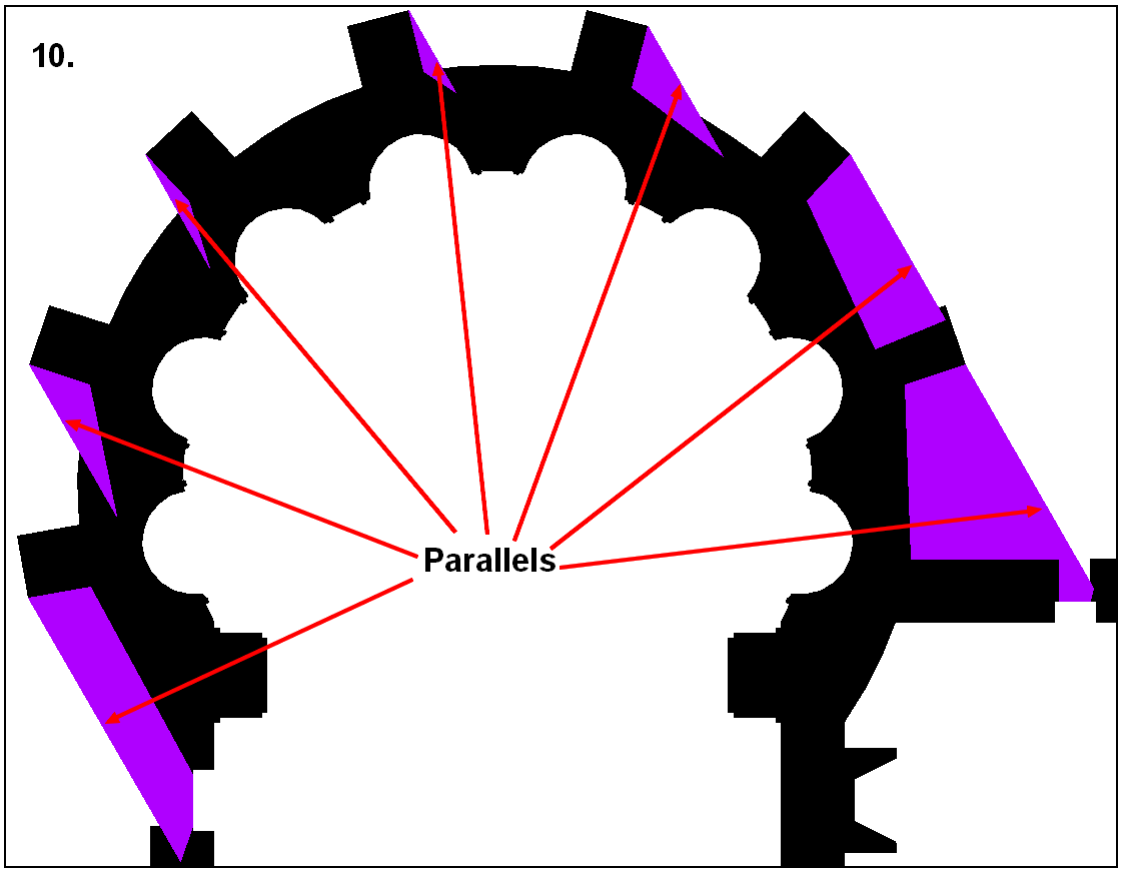
With an azimuth of 120° and an inclination of 60° the limit of the shadows will be lines starting at a wall corner, with an angle of -60° and a length of 14.5' (25×0.58):

1. Click on W. Click on the Sheet Indicator and **Add** a new sheet **WALLS SHADOW** between **WALLS LOW** and **WALLS TOP**[6]. Click **Hide All** then on the "H" box of the **WALLS** sheet to make it visible. Keep the left box of **WALLS SHADOW** checked. Click **OK**.
2. Click on the Color Indicator and choose color 7 (violet) or any other bright color: the idea is to clearly differentiate the new entities. Click on the Fill Style Indicator, the Brush Patterns tab and chose the **Solid** fill style. Click **OK**.
3. Click on the ***Polygon*** (**POLY**↵) tool then on the ***Endpoint*** (**F5**) modifier and select the bottom left corner of the bottom left buttress.
4. Type **<-60,14.5**↵. The "**<**" character means "at an angle of", followed, after the coma, by the length to draw along said angle, (0° right, 90° up...).
5. Use the ***Endpoint*** (**F5**) modifier to reach the lower, inner wall of the window and again to the upper part.
6. Continue with the ***Endpoint*** (**F5**) modifier to the lower intersection point of the buttress and the circular wall then right-click to finish the polygon. The part overlapping the wall will be hidden once the **WALLS TOP** sheet is visible again (see picture 6bis). Do not make this sheet visible now.
7. Repeat steps **3.** with the lower left corner of the next buttress.
8. The length of 14.5 is too long because the shadow from the buttress reaches the wall before its full length. The shadow needs just to be parallel to the previous one so hit **F11** to use the ***Parallel*** modifier (no icon). Click inside the walls to specify the length.
9. Use the ***Endpoint*** (**F5**) modifier to get the lower intersection point of the buttress and the circular wall then right-click to finish the polygon.



6 Refer to part 6 to get the detailed steps to add and order sheets.

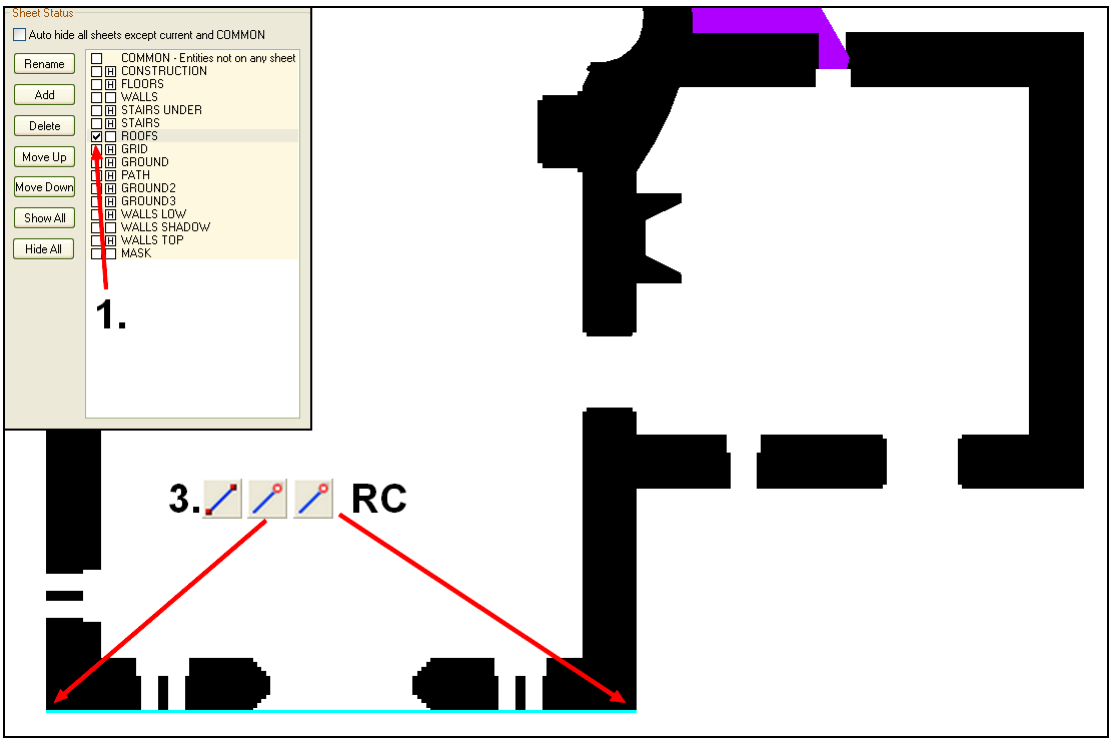
10. Repeat all around the nave.



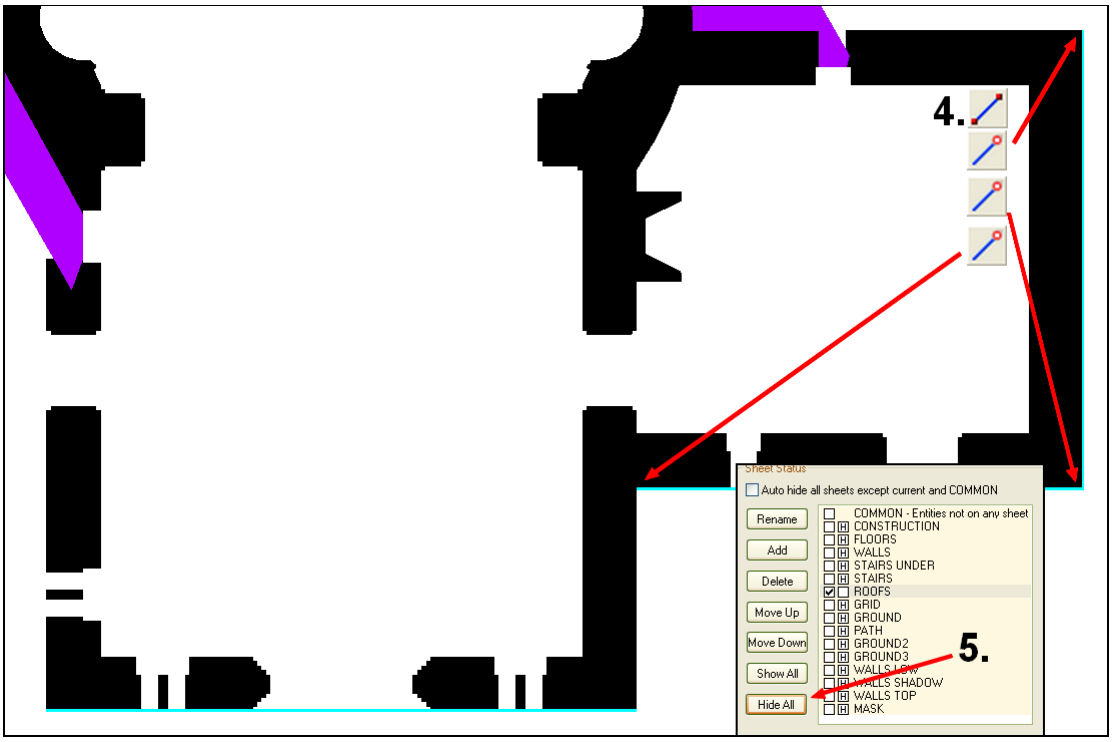
Creating the front right shadows

In order to draw the shadows generated by the sloped roofs, the front ridge lines must be designed:

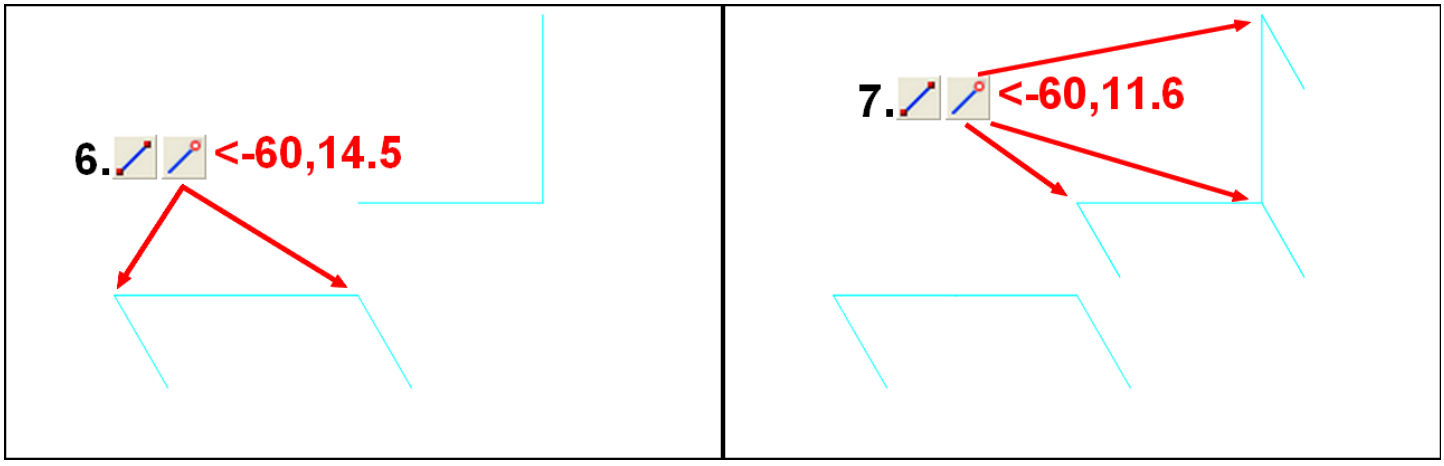
1. Click on the Sheet Indicator and check the left box of the **ROOF** sheet. Click **OK**.
2. Click on the Color Indicator and choose a new color (e.g. 5, bright cyan).
3. With the ***Line*** (**LINE**↵) tool combined with the ***Endpoint*** (**F5**) modifier draw a line joining the bottom corners of the nave. Right-click to end.



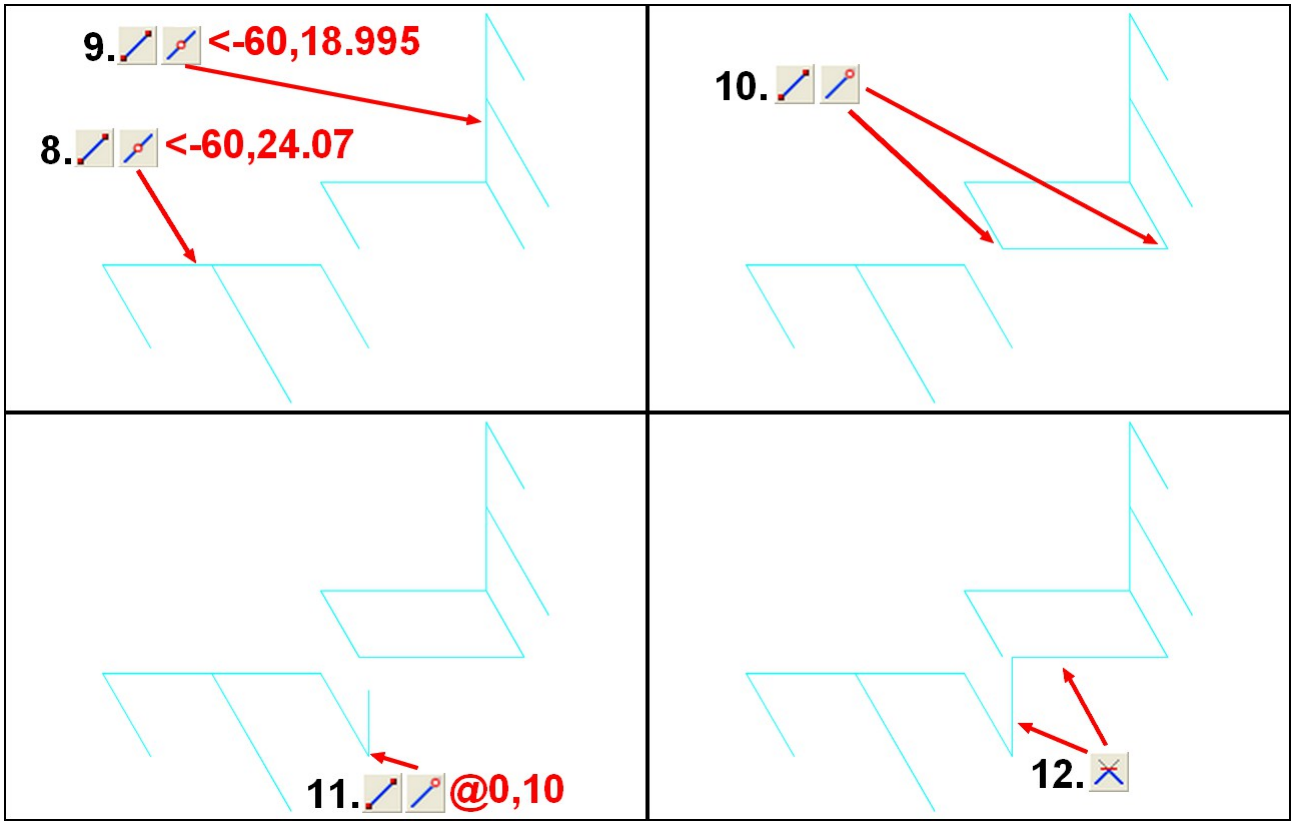
4. Use the *Line* (**LINE**↵) tool combined with the *Endpoint* (**F5**) modifier to draw two lines starting by the top right corner to the bottom right corner then to the bottom left corner. Right-click to end.
5. Click on the Sheet Indicator, on **Hide All** then on **OK**. This leaves just the three blue lines.



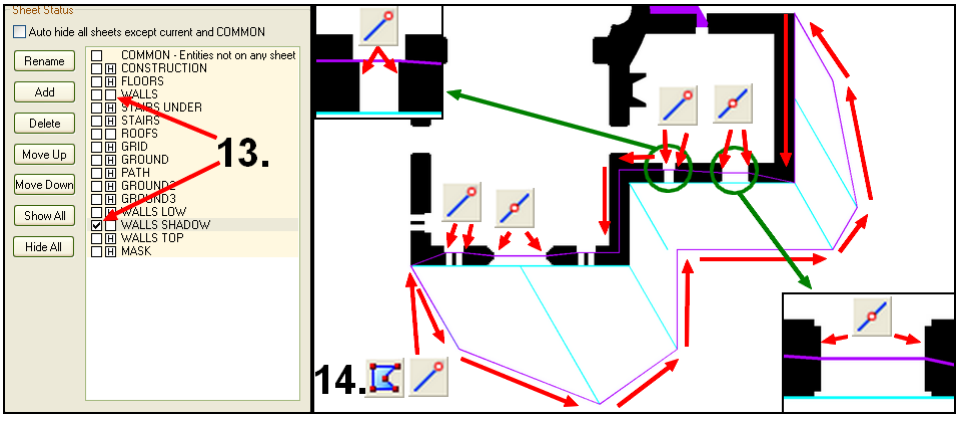
6. With the *Line* (**LINE**↵) tool combined with the *Endpoint* (**F5**) modifier draw a line **<-60,14.5**↵ from each endpoint of the horizontal front line (right-click to end each line).
7. Do the same for the lodging lines, but with **<-60,11.6**↵ (14.5' and 11.6' are the shadow lengths calculated page 64). Alternatively, you can draw the first line then use *Copy* (**COP**↵) combine with the *Endpoint* (**F5**) modifier to create the other one, especially if you have many more to draw on a complex shape.



8. On a standard building, the highest point of the roof is at the vertical of the midpoint of the line: use the ***Line*** (**LINE**↵) tool combined with the ***Midpoint*** (**F3**) to draw a line **<-60,24.07**↵ from the midpoint of the horizontal front line.
9. Do the same for the vertical line, but with **<-60,18.995**↵ (see page 64).
10. To prepare the merging of the nave's and the lodging's shadows, draw a ***Line*** (**LINE**↵) joining the lowest projections from the lodging.
11. Draw a ***Line*** (**LINE**↵) from the right projection of the nave, typing **@0,10**↵ to make it vertical (it should be parallel to the nave wall).
12. ***Trim to Intersection*** (**TRIMINT**↵) the lines from **10.** and **11.**

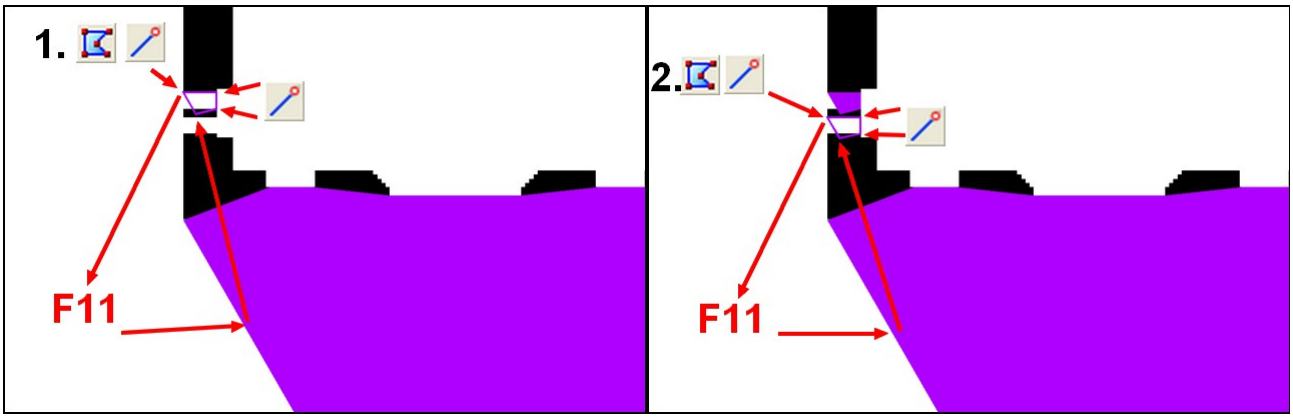


13. Click on the Sheet Indicator and on the "H" box of the **WALLS** sheet then on the left box of the **WALLS SHADOW** sheet. Click **OK**. Change the color to 7 or to the color you chose for the shadows page 65.
14. With the ***Polygon*** (**POLY**↵) tool combined with the ***Endpoint*** (**F5**) modifier draw the shadow polygon following the blue lines, the inside walls of the windows and the ***Midpoint***s (**F3**) of the doors sides. You can freely use ***Zoom In*** and ***Zoom Out*** through the process. Right-click to end. **Note**: the polygon is hollow on the example map for academic purpose.



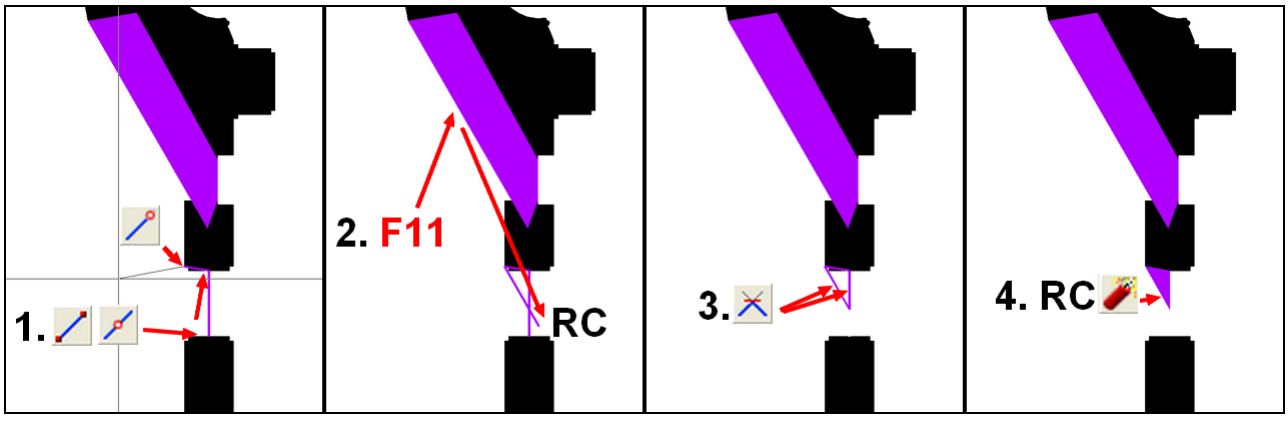
The last window
The upper side of the lower left window of the nave and its mullion (the center “pillar”) also cast shadows. It's a small detail but details bring the map alive.

1. Launch the ***Polygon*** (**POLY**↵) tool and use the ***Endpoint*** (**F5**) modifier to start on the left upper corner of the wall. With the **F11** ***Parallel*** modifier click on the left shadow projection line from the front shadow polygon. Click inside the mullion then use the ***Endpoint*** (**F5**) modifier to reach the inner nodes. Right-click to end.
2. Repeat **1.** starting from the lower left corner of the mullion.



The last door
On the doors, the shadow stops at a line joining the midpoints of the frame:

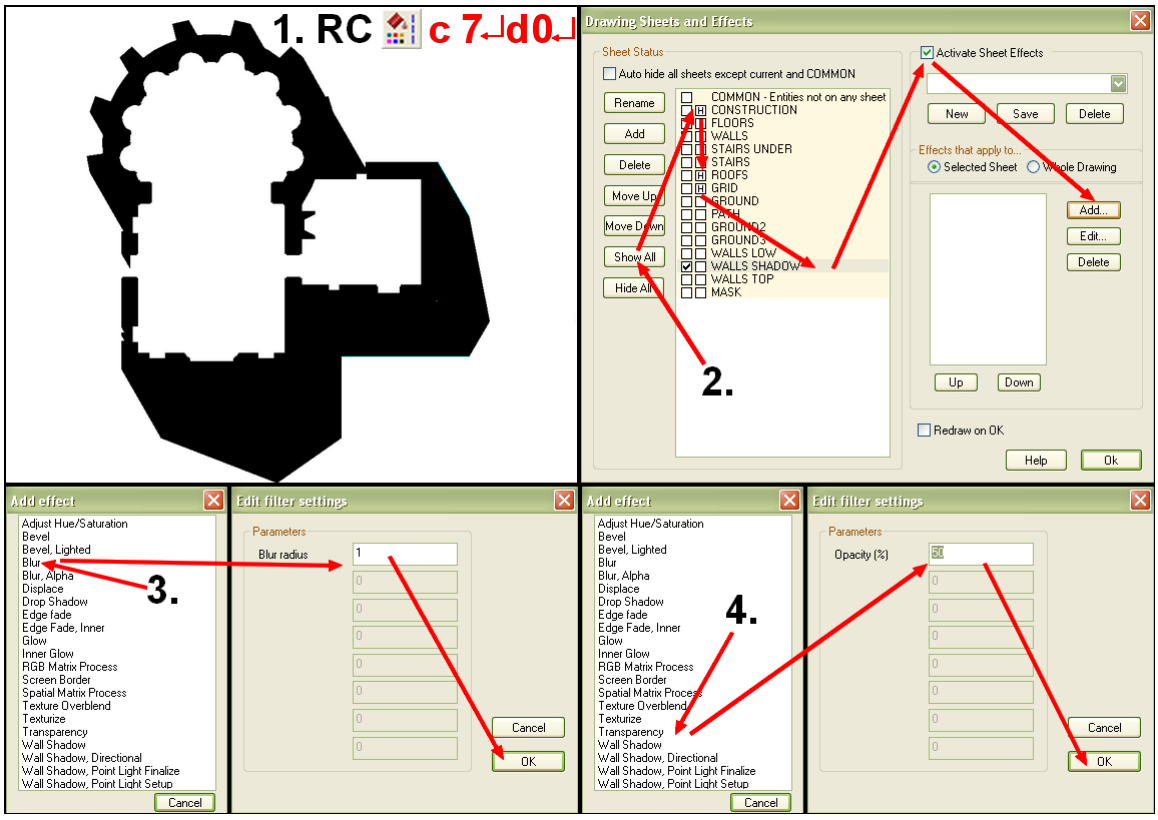
1. Use the ***Line*** (**LINE**↵) tool combined with the ***Midpoint*** (**F3**) to draw a line joining the midpoint of the lower side to the upper side's midpoint. With the ***Endpoint*** (**F5**) modifier reach the upper left corner of the outer frame.
2. With the **F11** ***Parallel*** modifier click on a shadow projection line at -60° then click to cross the first line.
3. ***Trim to Intersection*** (**TRIMINT**↵) the crossing lines.
4. Right-click ***Explode*** and chose ***Line to Path*** (**LTP2**↵). Select all the three new lines. If you also selected the black wall, hit **b** (or right-click and choose **both**) then **c** (or right-click and select **Color**) then **7**↵ (or the number of your temporary shadow color). This ensures that only color 7 entities are still selected.



Finishing the shadows

All the polygons have been created and only need a color change and some effects. If you chose a very specific color, only the shadow entities should have this color and you just select by this color. Otherwise, you must hide all other sheets to easily select all shadow polygons:

1. Right-click ***Change Properties*** and chose ***Change color*** (**CHANGEC↵**). Hit **c** (or right-click **Color**) then **7↵**. Right-click **do it** (**d**). Type **0↵** (black).
2. Click on the Sheet Indicator. Click **Show All** then on the right boxes of the **CONSTRUCTION**, **ROOFS** and **GRID** sheets to hide them ("H" in the boxes). If the **WALL SHADOW** line is not grayed click on its name to make this sheet selected. Check **Activate Sheet Effects** and click on the right **Add** button.
3. Chose **Blur** and set the Blur Radius to **1**. Click **OK** to close the pop-up.
4. Back to the sheets list, click again on the right **Add** button and chose **Transparency**. Leave the Opacity to 50% (or set it to it if for some reason it's not the displayed value). Click **OK** on the pop-up then on the sheets list to close it. Use ***Zoom Extents*** to see the whole map (next page).

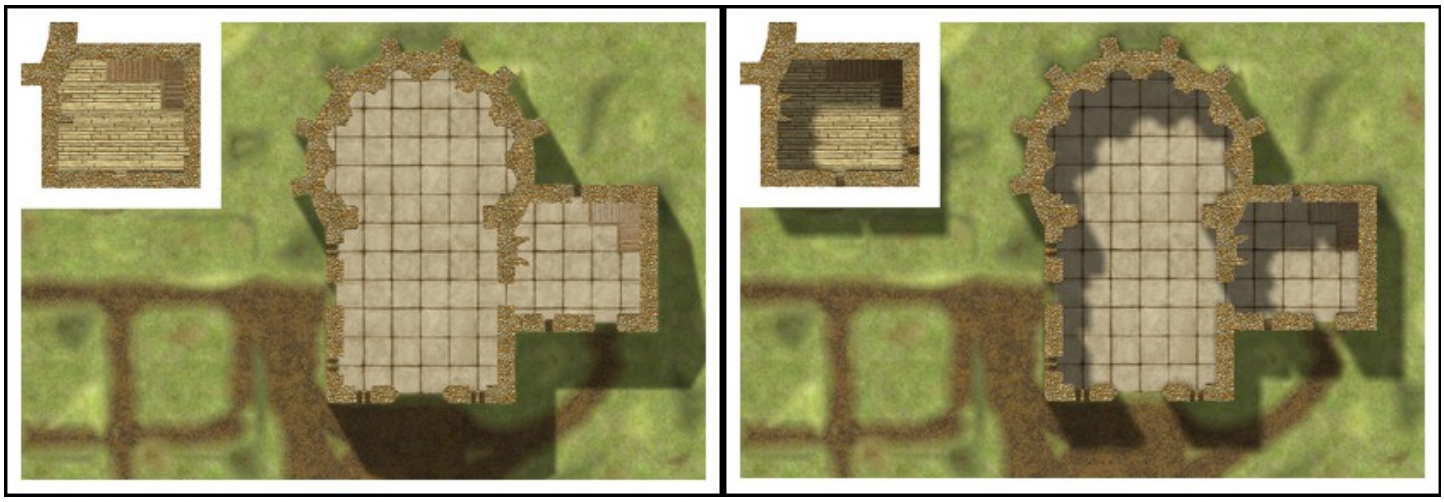


Conclusion

Drawing shadows manually requires:

- Choosing an azimuth, or, which amounts to the same, an angle for the shadow projection, in this tutorial, -60°.
- Choosing a sun inclination (here 60°) and calculate the coefficient to multiply the heights or use the table provided page 64. In this tutorial, 0.58 which is the rounding of the cotangent of 60°. Alternatively, just chose a coefficient.
- Multiply the heights of objects casting shadows by this coefficient.
- Drawing projection lines and shadow polygons.

It is a lengthy process however it also allows the creation of shadows from objects with diverse heights on a single sheet, which is not possible with the **WALLS SHADOW DIRECTIONAL** effect that requires another sheet for each additional height.



Left: the map with the effects on. The angle of the lodging's roof shows (the angle of the nave's roof is hidden by the map border mask), the shadows from the lodging are shorter than those from the nave, hinting at different heights and inside the building there are no shadows at all because the light effects will take care of them.

Right: the traditional **WALL SHADOW, DIRECTIONAL** effect. Around the sanctuary the result is quite similar to what the tutorial produced but note how the lodging and nave shadow differ (not to mention the doors and windows openings that should somehow be handled too). The greatest difference is the inside shadows that would add to the ones that will be created by the light effects.

In part 10, these light effects will be added, along with symbols inside the building.