

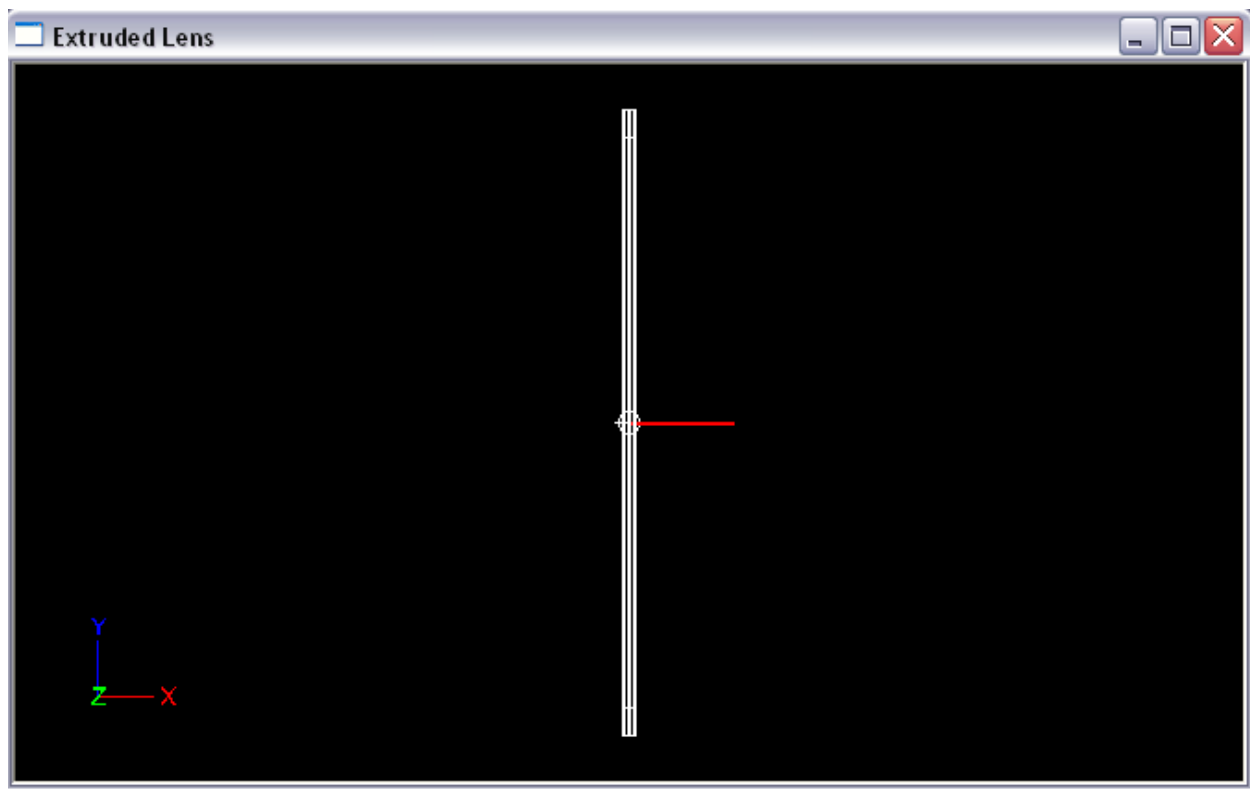
Advanced Tutorial – Designing an Extruded Lens

This tutorial demonstrates designing an extruded lens around a fluorescent source by utilizing Photopia's Parametric Lens Design Tool. It is a good idea to complete the beginner tutorials before attempting this advanced tutorial, since many of the more basic functions and concepts are not explained in this tutorial.

The lens design parameters for this tutorial will be the following: a 55° peak intensity (+/- 5°), an 8 inch maximum width, and a 3.5 inch maximum depth. We will use a 32W 4' T8 fluorescent as the source and acrylic as the lens material.

Import the Lamp

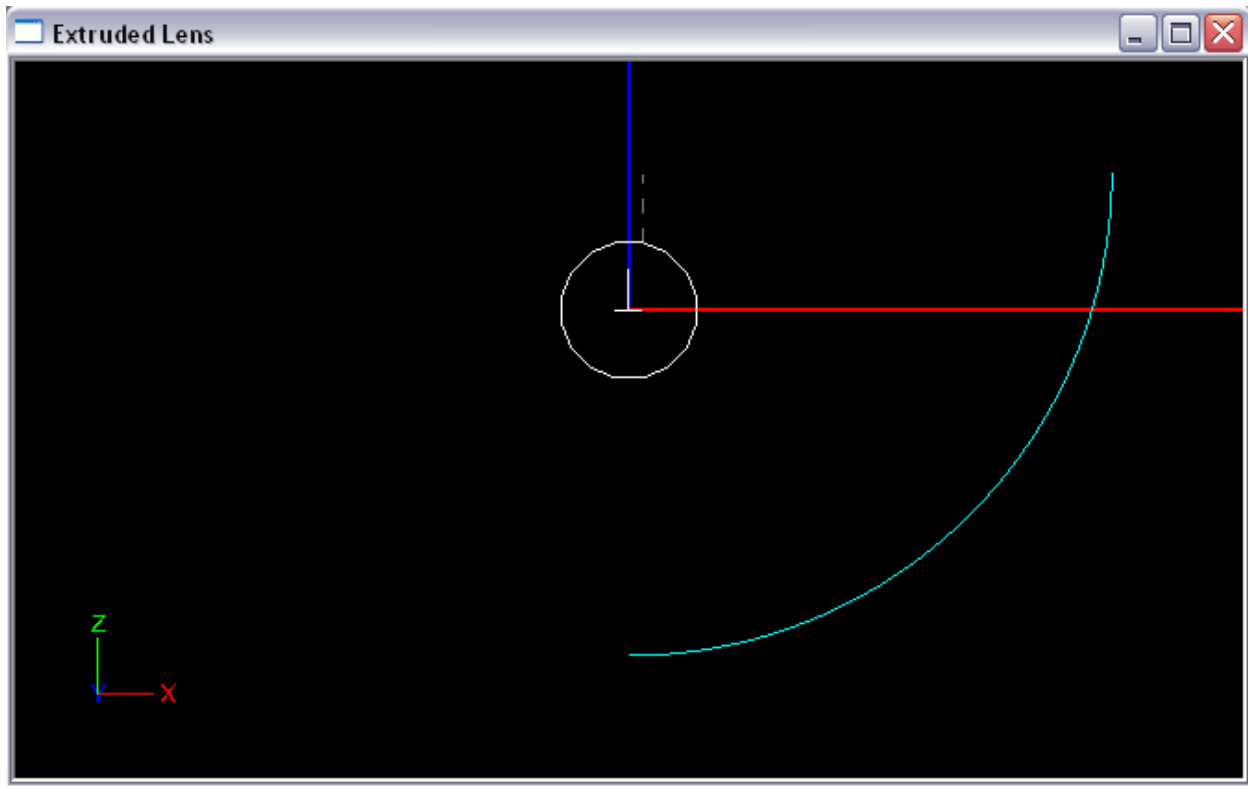
1. Start a new project and choose **File > Save As** and give it the name *Extruded Lens*.
2. Choose **File > Import Lamp** and then browse for the lamp file named *FO3231.LDF*, which is the 32W 4' T8. Insert the lamp at 0,0.



Construct the Extruded Lens

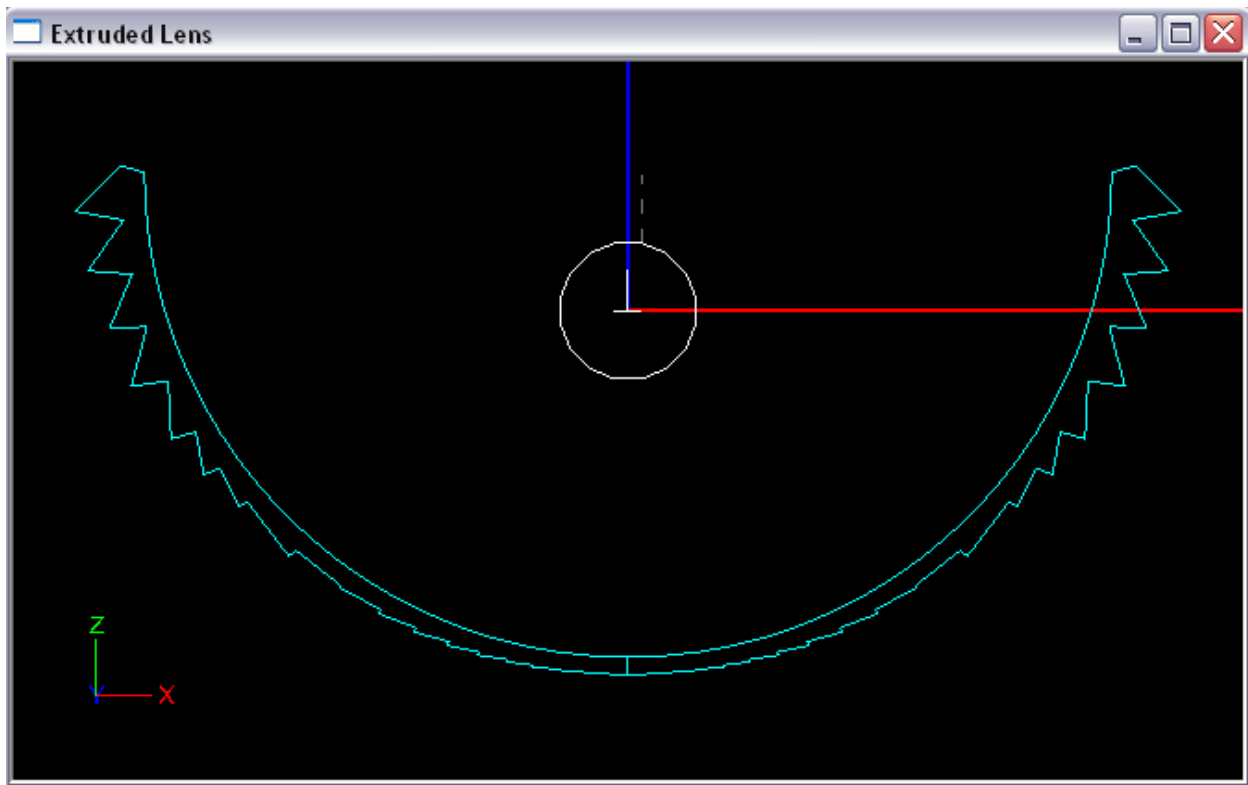
We will start by drawing an arc that will serve as the lens base profile, to which the prisms will be mapped.

3. Under **Settings > Layers**, create a new layer named *REFR-Lens* and change the color to cyan. Set this new lens layer to be the current layer and click OK.
4. From a front view, choose **Draw > Arc**
 - a. Enter a start point of 0,-2.5 in order to start the lens below of the fluorescent source.
 - b. Choose E for End Point
 - c. Enter 3.5,1 for the end profile point so that the lens extends above the lamp.
 - d. Choose 90 for the angular extent of arc in degrees.



To turn the curve into an extruded lens:

5. Select the base profile by clicking on it, and then choose **Design > Lens > Extruded Symmetric**.
 - a. Press Enter to use the default lamp center of 0,0.
 - b. Press Enter again to use the default (10) number of Refractor Prisms.
 - c. Press Enter again to use the default (1.491) index of refraction for acrylic.
 - d. Enter 0 for the aiming angle at the start of the profile to aim straight down.
 - e. Enter 70 for the aiming angle at the end of the profile to design towards our requirement.
 - f. Press Enter to use the default (5°) aiming angle increment.
 - g. Press Enter again to use the default (0.125") generated minimum thickness.
 - h. Enter 48 for the extrusion length so the lens fully covers the fluorescent source.

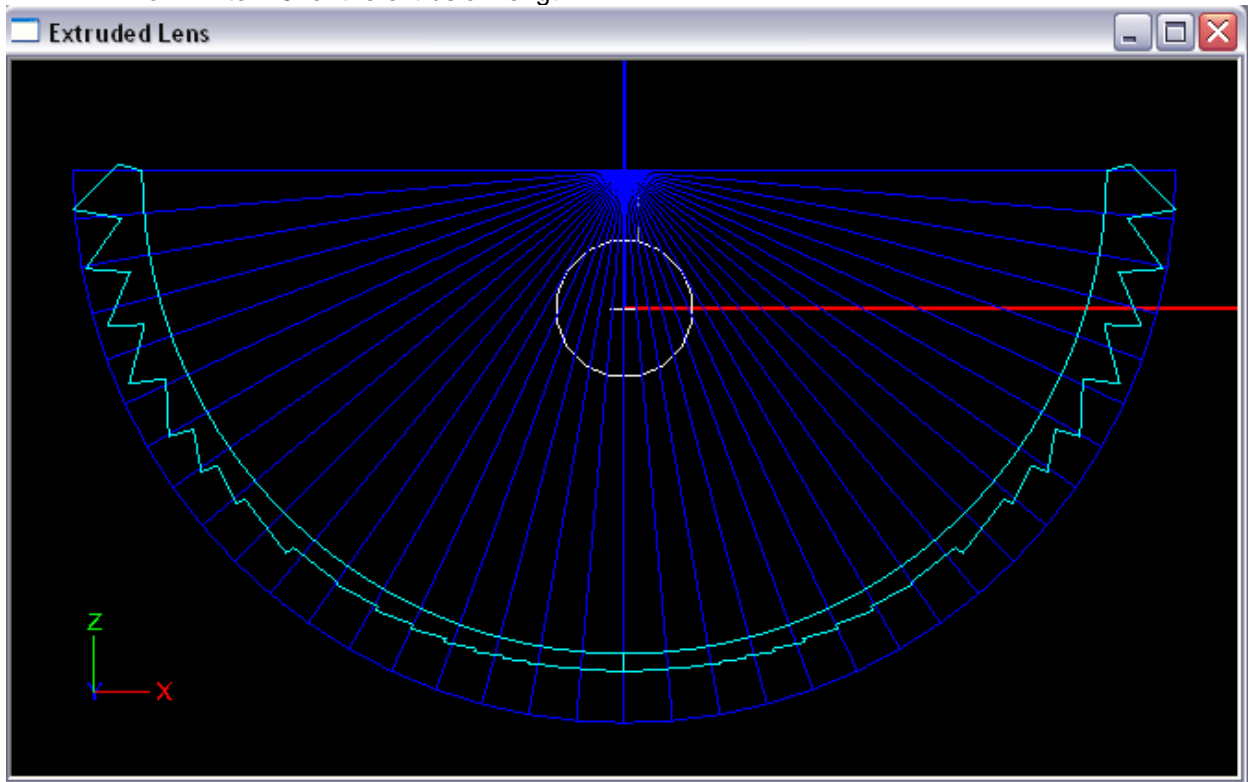


Construct the Housing

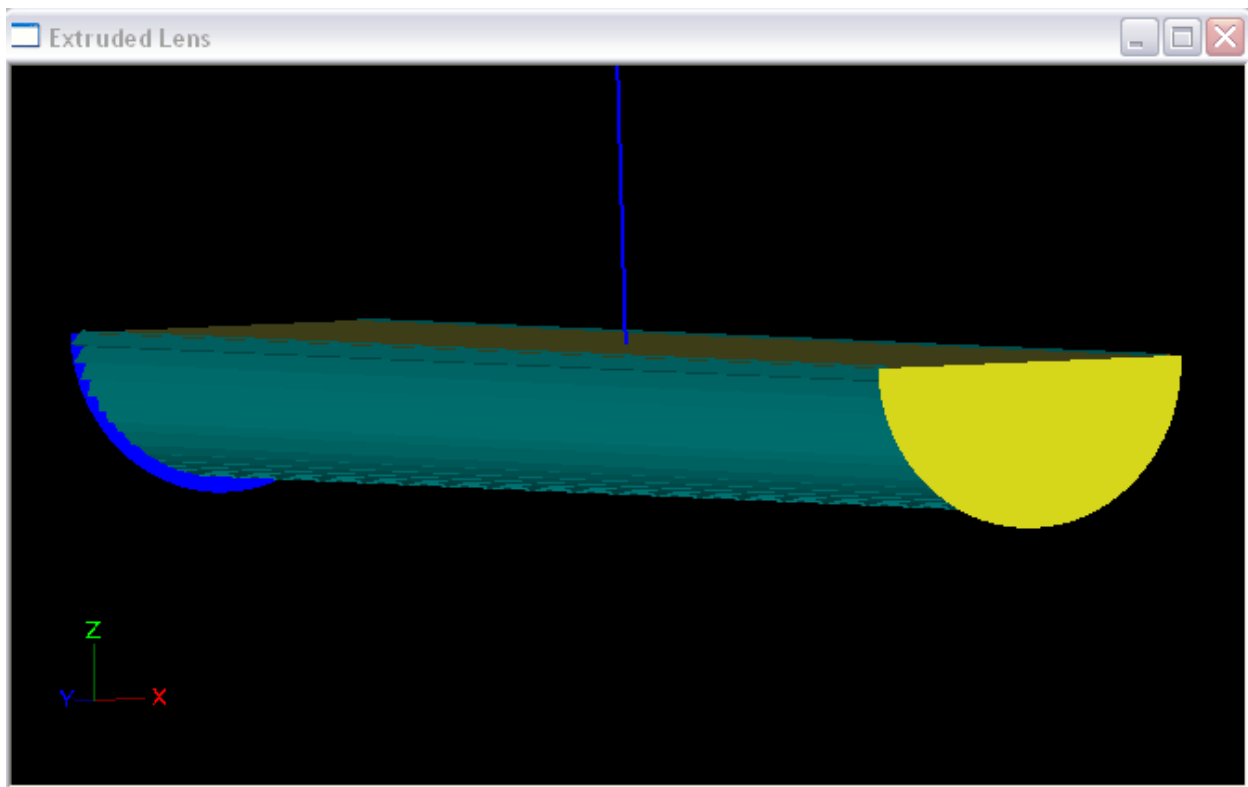
Next we will build a housing to enclose the optic we have created. We can start with the 8 inch maximum width, and a 3.5 inch maximum depth.

6. Under **Settings > Layers**, create a new layer named *REFL-Housing* and change to color to blue. Set this new reflective layer to be the current layer and click OK.
 - a. From a top view, choose **Design > Reflector: Polyline Based > Revolved**.
 - b. Press Enter to pick default (0,0,0) lamp center.
 - c. Enter a start point of -4,-24 so that the end caps begin below the bottom of the lens.
 - d. Enter 4,-24 for the next point to make an 8" width.
 - e. Press Enter to end reflector profile.
 - f. Press Enter to pick default number of revolved sections (36).
 - g. From front view, select the revolved reflector and move it up 1" so it aligns with the lens.
 - h. With the revolved reflector selected, change the Number of Mirrors from 0 to 1 under **Properties > Mirroring**. This will add an end cap at the other end of the lens.
 - i. With the revolved reflector selected, change the Rev Extent from 360 to 180 under **Properties > Extrude/Revolve** which will change the end caps to half circles.
 - j. From front view, choose **Design > Reflector: Polyline Based > Asymmetric Extruded**.
 - k. Press Enter to pick default (0,0,0) lamp center.
 - l. Enter a start point of -4,1 to begin the top of the housing.
 - m. Enter 4,1 for the next point to complete the top of the housing.
 - n. Press Enter to end reflector profile.

- o. Enter 48 for the extrusion length.



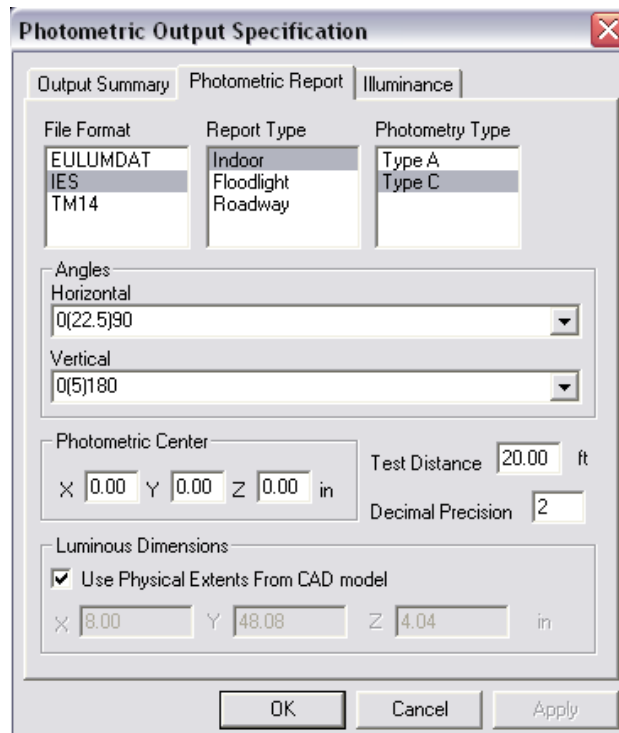
7. You can ensure that the surface is oriented correctly, as shown below, by right clicking in CAD view and choosing **View Style > Show Surface Orientation**, and then using Orbit. You can then return to the original view style by selecting **Wireframe**.



Setup the Output and Materials

We should add an illuminance plane to the project, and need to specify materials for the optical components of our project.

- Under **Analysis > Specify Photometric Output > Photometric Report**, ensure that your photometric output is set up for a linear downlight with quadrilateral symmetry.

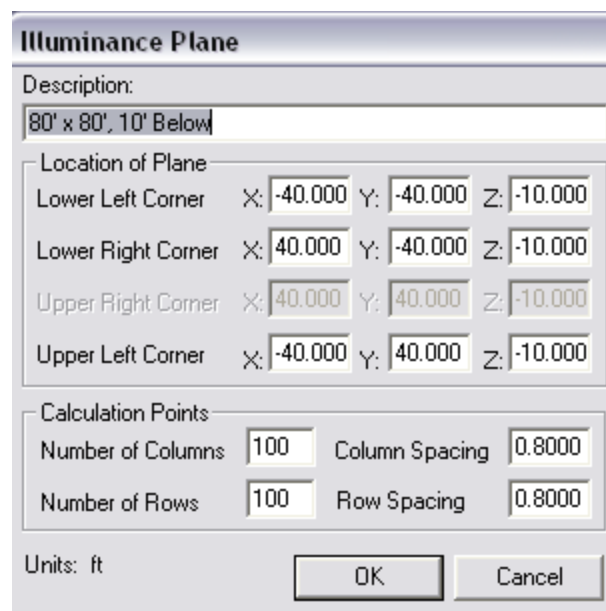


The **Photometric Output Specification** dialog box is shown with the **Photometric Report** tab selected. It contains the following settings:

- File Format:** EULUMDAT, IES, TM14
- Report Type:** Indoor, Floodlight, Roadway
- Photometry Type:** Type A, Type C
- Angles:**
 - Horizontal: 0(22.5)90
 - Vertical: 0(5)180
- Photometric Center:** X: 0.00, Y: 0.00, Z: 0.00 in
- Test Distance:** 20.00 ft
- Decimal Precision:** 2
- Luminous Dimensions:**
 - Use Physical Extents From CAD model
 - X: 8.00, Y: 48.08, Z: 4.04 in

Buttons: OK, Cancel, Apply

- Under **Analysis > Specify Photometric Output > Illuminance**, create an illuminance plane 80'x80' 10' below the fixture. Click OK in both the Illuminance Plane window and the Photometric Output Specification window.

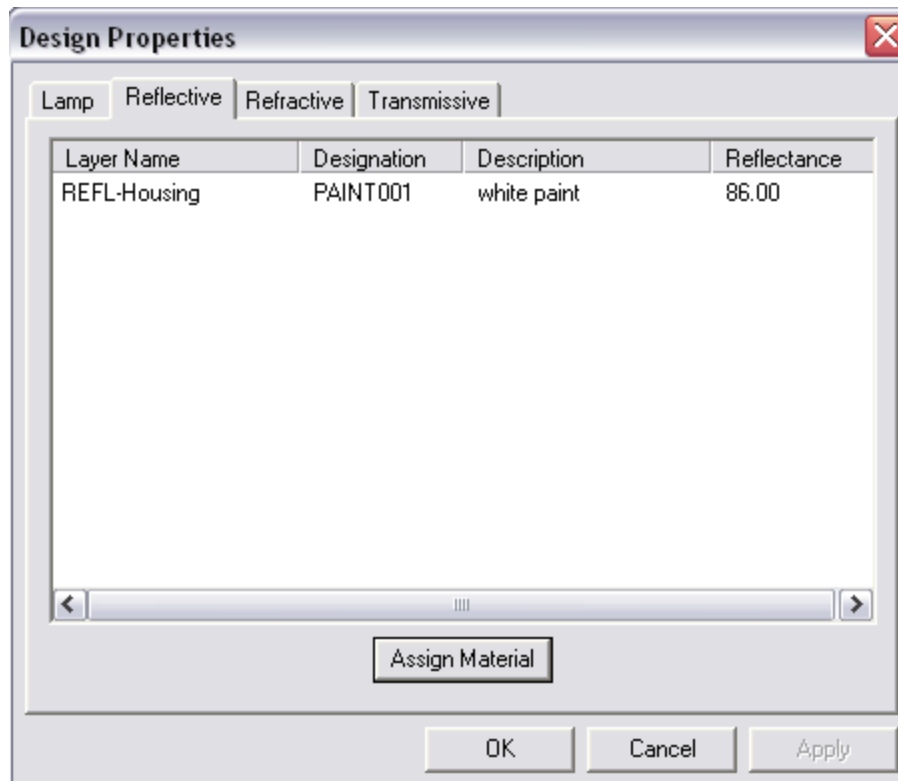


The **Illuminance Plane** dialog box is shown with the following settings:

- Description:** 80' x 80', 10' Below
- Location of Plane:**
 - Lower Left Corner: X: -40.000, Y: -40.000, Z: -10.000
 - Lower Right Corner: X: 40.000, Y: -40.000, Z: -10.000
 - Upper Right Corner: X: 40.000, Y: 40.000, Z: -10.000
 - Upper Left Corner: X: -40.000, Y: 40.000, Z: -10.000
- Calculation Points:**
 - Number of Columns: 100, Column Spacing: 0.8000
 - Number of Rows: 100, Row Spacing: 0.8000
- Units:** ft

Buttons: OK, Cancel

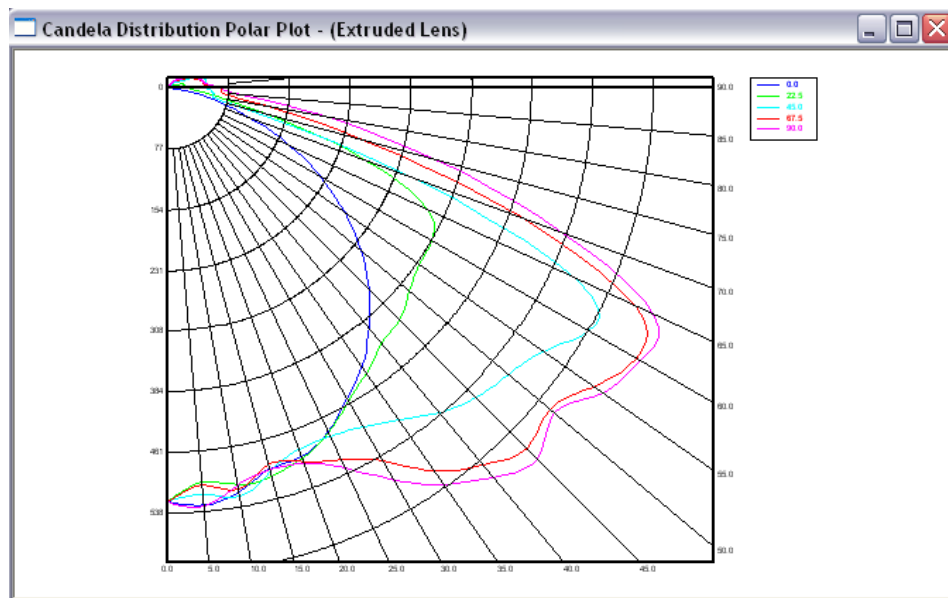
10. Under **Edit > Design Properties > Reflective**, select **PAINT001** for the housing.
11. Under **Edit > Design Properties > Refractive**, select **ACRYLIC1** for the lens.



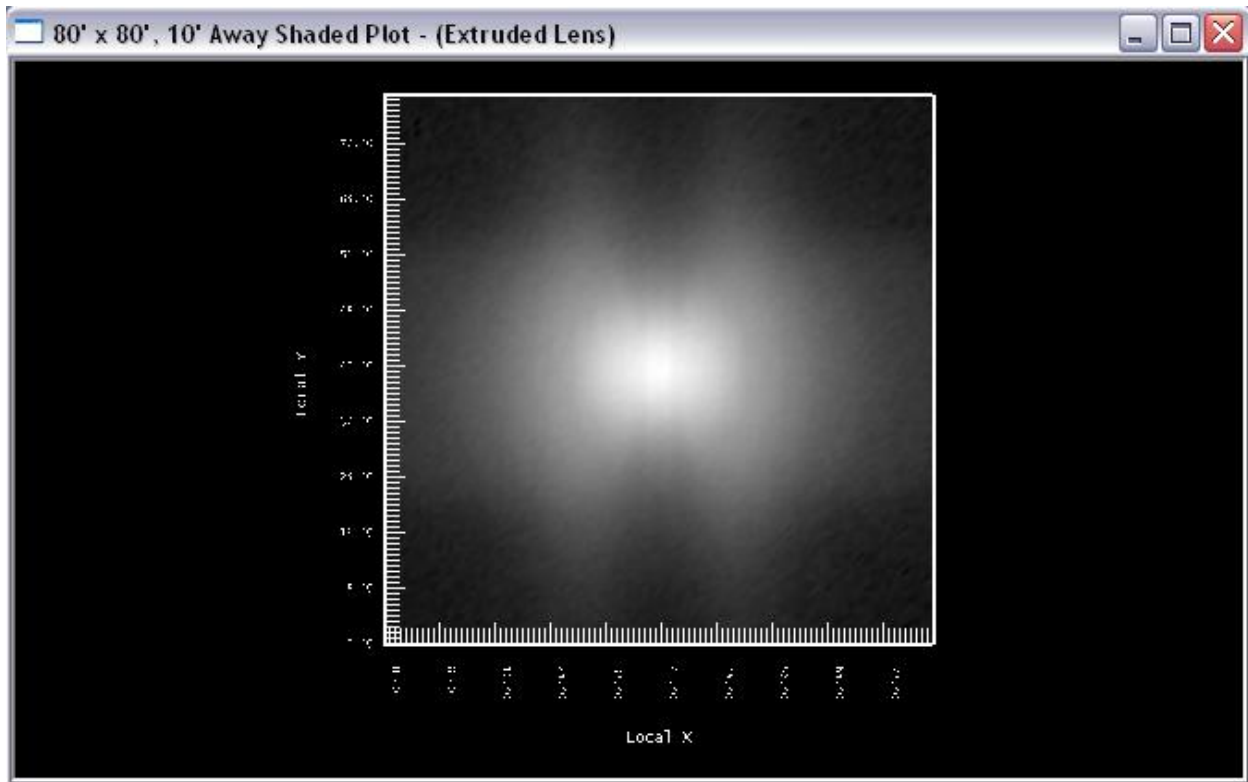
Simulate the Design Performance

Now we can run a raytrace and test the performance of our extruded lens design.

12. Save the project and choose **Analysis > Begin Analysis** to begin the raytrace.
13. To view the candela distribution, choose **View > Candela Distribution > Polar Plot**.

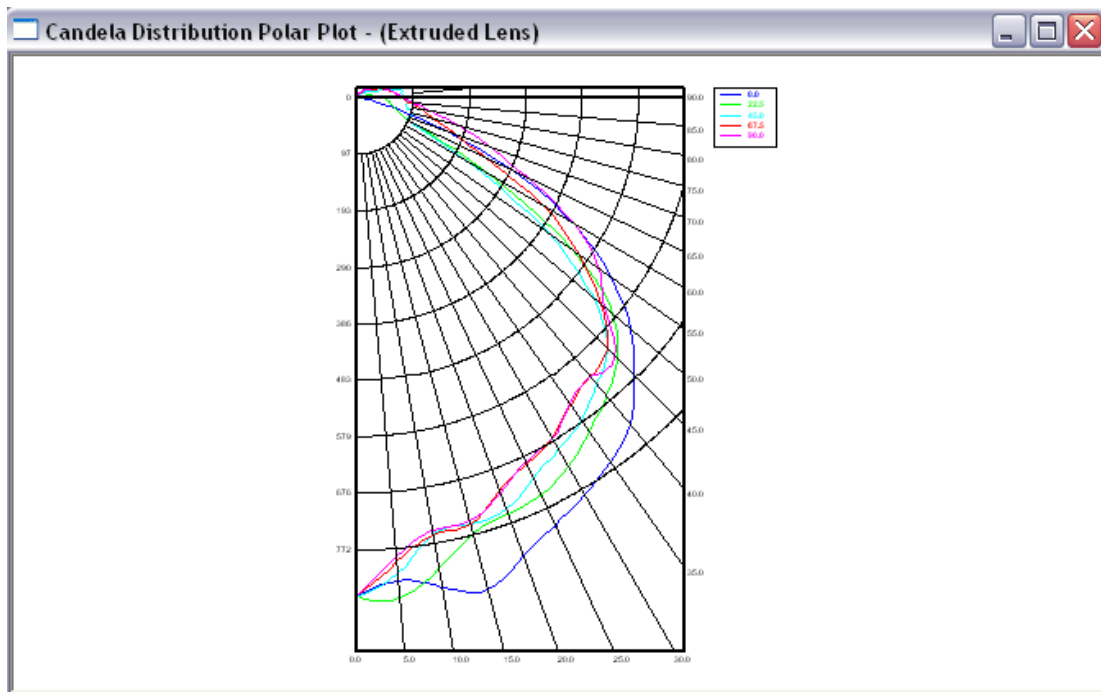


14. To view the illuminance plane, choose **View > Illuminance > Shaded Plot**.

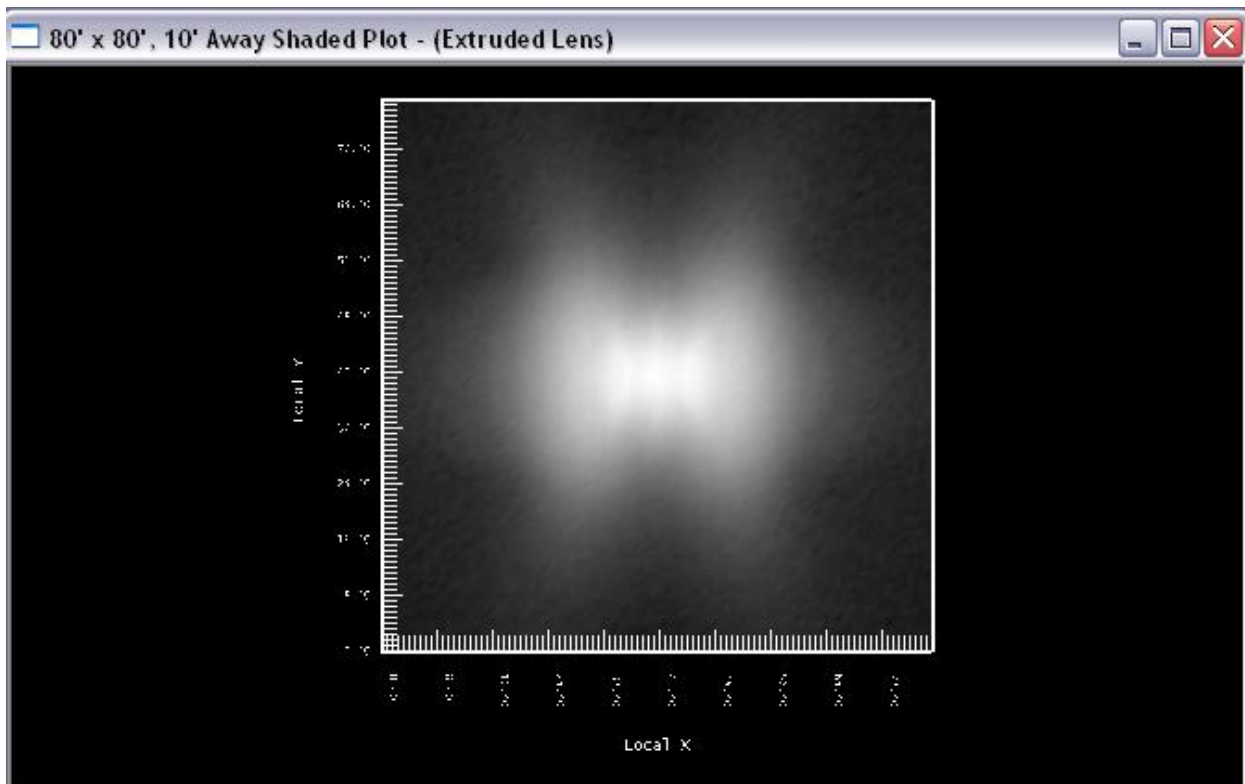
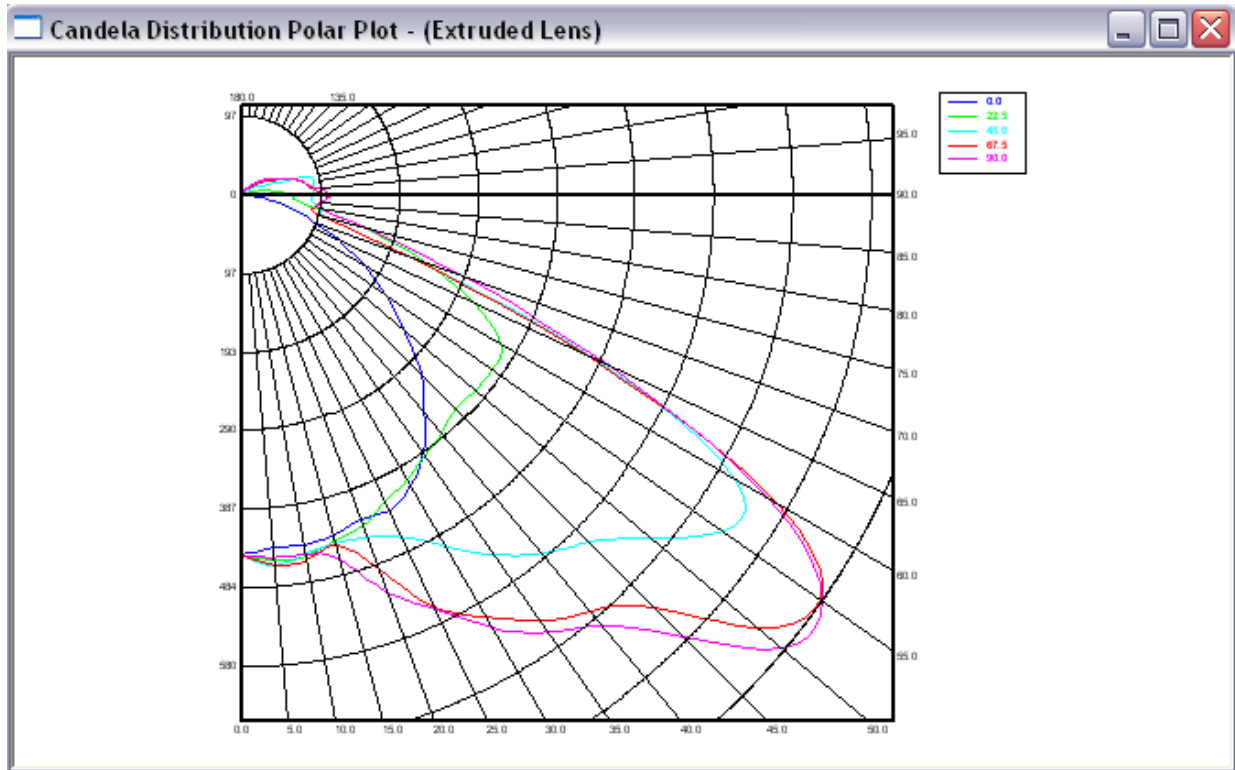


Both the candela plot and illuminance on the floor plane look alright, but we will make refinements.

15. With the lens selected, choose **View > Parametric Optical Design**, change the aiming from 0(5)70 to 0(5)60 and click **Update Aiming** so that the beam peaks closer to 55°.

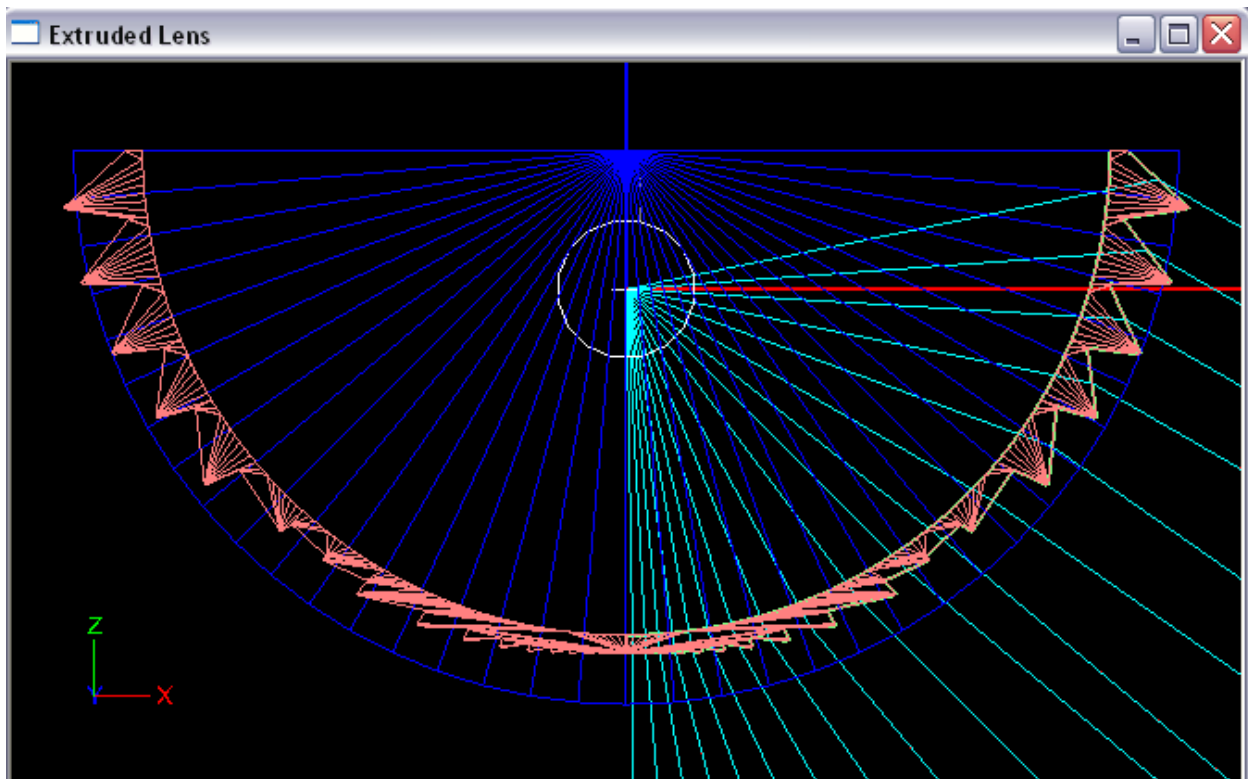


16. In the above distribution, we don't have enough light at 55°. With the lens selected, under property control change the **Weight Exponent** from 1 to 3 so more of the aiming is directed towards the higher angles.
17. With the lens selected, under property control, change **Number of Prism Steps** from 10 to 20 so the intensity distribution becomes smoother.



Now both the candela plot and illuminance on the floor plane look pretty good. We will make a few adjustments and run a final raytrace to confirm that none of these adjustments had undesired effects on our lens design.

18. With the lens selected, under the property control, change both the **Peak Fillet Radius** and **Valley Fillet Radius** to 0.01" to account for the limitation of manufacturing.
19. With the lens selected, under the property control, change the **Arc Resolution** from 4 to 1 so the lens profile is approximated at 1° increments rather than 4° increments.
20. With the lens selected, under the property control, change **Offset Style** from Radial from Lamp Center to Simple offset.
21. With the lens selected, under the property control, change **Close Start** from Yes to No so that the center of the extrusion doesn't have a vertical wall between the two halves.
22. With the lens selected, under the property control, change **Cap Ends** from No to Yes so that the ends of the refractor are enclosed by lens material.



It appears that the adjustments we made had no undesired effects on our lens design, and we met all our design requirements so we will stop our design here. We were also able to achieve an optical efficiency 86% which is decent considering an additional 6% of the lumens are above 90°.