

# LucidShape Lit Appearance

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## Abstract

In lighting applications, it is desirable to see the luminance distribution on the reflector or lens itself. *Lit Appearance* defines what the illumination system looks like in a dark environment and is critical for evaluating applications with a special function like an automobile's signal lamp. In that type of lamp's design process the check as to whether the reflector is completely illuminated is an important safety aspect that should not be overlooked.

## Introduction

Lit Appearance analysis within the LucidShape<sup>®</sup> software is supported by fast ray-tracing algorithms. Before running a simulation, one has to assign a light flow sensor and a material property (like specular or refractive) to the designated objects. To get satisfactory results, the simulations should be performed with a sufficiently high number (1000 m or greater) of rays. Two different simulation methods are available: Monte-Carlo ray trace and light mapping. In a forward Monte-Carlo ray trace, rays are traced from the light source to the optical surface. In light mapping, LucidShape starts the trace from the surface that collects rays to the light source. The latter method is faster by omitting the need to calculate surface intersections, but it cannot be applied to lens optics because refraction is not considered; only shading by other objects is considered.

This paper describes the steps needed to create a luminance image on a surface and how to best view the Lit Appearance under different observation angles and distances.

## General Procedure

LucidShape's simulation and analysis tools make it easy to detect and evaluate Lit Appearance. The basic procedure runs as follows:

- ▶ Create geometry
- ▶ Assign a material to the geometry
- ▶ Assign a light flow sensor to the geometry
- ▶ Create a light source
- ▶ Perform the ray tracing
- ▶ For the 3D view, turn on *Display Light* mode and *auto redraw*

LucidShape contains four predefined examples that demonstrate the Lit Appearance using signal beam, high beam, and low beam reflectors. They can be found under the menu entry *Test/Lit Appearance*. This simple example uses a rectangular paraboloid.

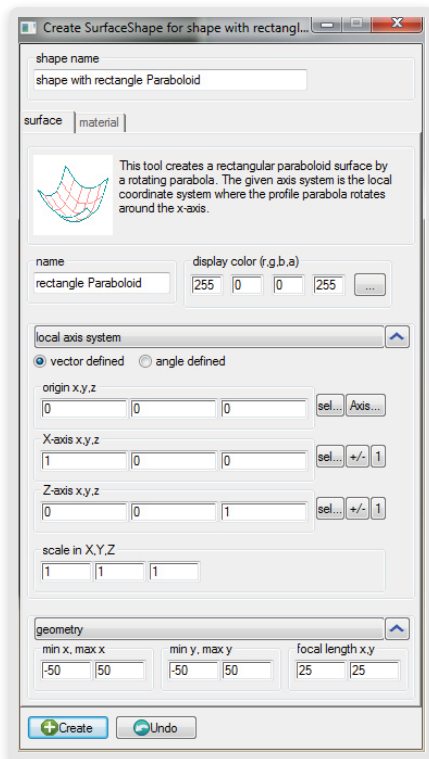


Figure 1. Rectangular Paraboloid dialog box

To create a reflector, we used the surface geometry in Figure 1. In Materials, we set the material to *specular reflective*. When the *exit flow sensor* radio button is checked, a light flow sensor is created on the paraboloid's surface. This sensor is needed to see the resulting Lit Appearance. A second dialog box shows the sensor's settings:

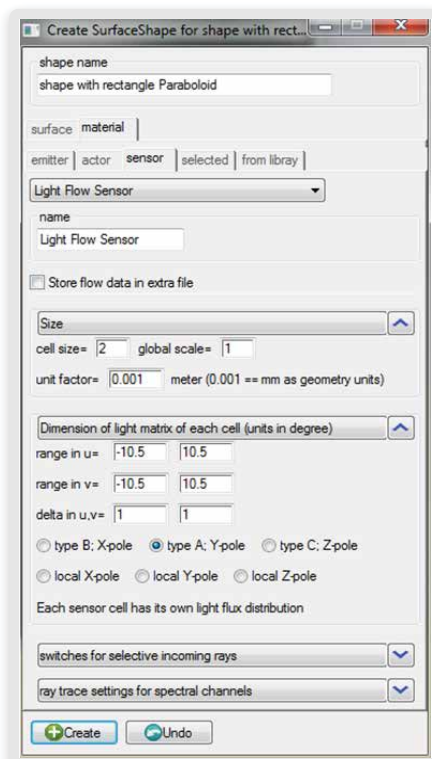


Figure 2. Dialog box for the flow sensor

In this dialog box, parameters like *cell size*, *range in u, v* or *pole type* can be set. The *range* in *u, v* defines the dimension of the light matrix in each cell (which contains its own light flux distribution). The values are in degrees and should not be set too large because high numbers are memory consuming. The default values are a good choice.

Finally, a light source has to be inserted. Since the reflector has a focal length of 25 mm in x and y direction, set a cylinder light source at the corresponding position on the z-axis:

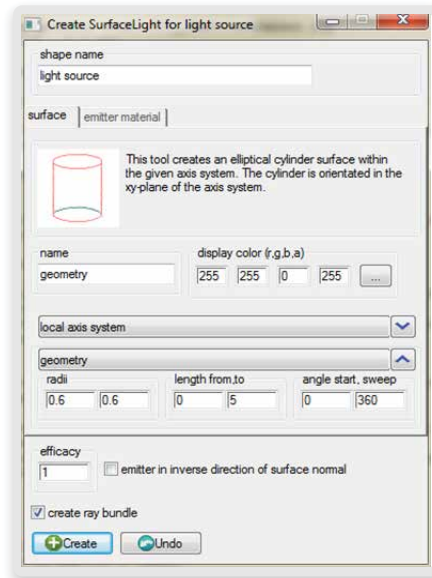


Figure 3. Cylinder light source settings dialog box

Figure 4 shows the created scene:

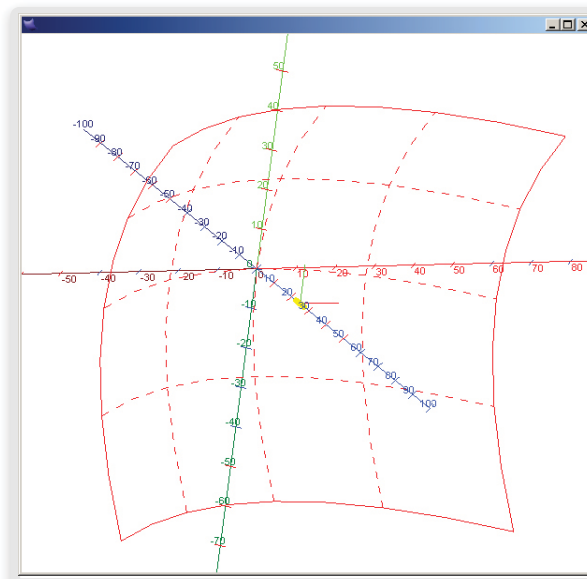


Figure 4. Rectangular reflector with cylinder light source

With the setup complete, you can now perform a simulation. Since there is no other geometry than light source and reflector, a light mapping simulation with 100,000,000 rays will show satisfactory results in a reasonable time.

After the simulation is complete, the result may be observed in the geometry view by setting the *Display Light* mode in the view's property menu. The reflector's luminance images may now be viewed under various angles by rotating the geometry with the mouse button. Figure 5 shows some slightly tilted reflector positions with variations of the Lit Appearance in a false color display:

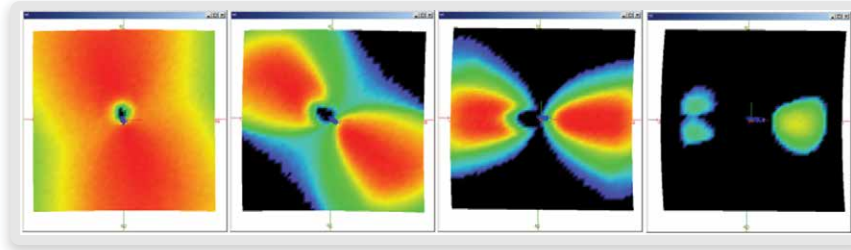


Figure 5. Variation of the LIT Appearance with slightly tilted reflector positions

The *Surface Display Properties* dialog box allows the setting of display parameters for the reflector's light distribution. In Figure 6, we have selected the unit  $\text{Cd}/\text{m}^2$  to be displayed on the surface.

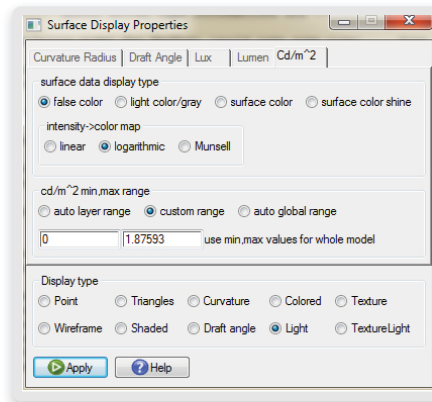


Figure 6. Surface Display Property dialog box

Another parameter is the *surface data display type*. For example, setting this value to *surface color* displays the Lit Appearance in the reflector's original color, whereas *surface color shine* creates an additional shining effect.

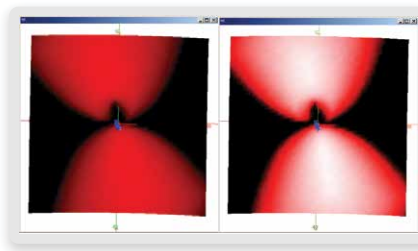


Figure 7. (Left) surface color, (right) surface color shine

As a further evaluation tool, a luminance image of the light distribution may be displayed. By using the *Luminance Image from Sensor Light* dialog box with the settings as in Figure 8, a luminance image of the reflector's light distribution (here seen from a front view position) can be displayed in the light data view.

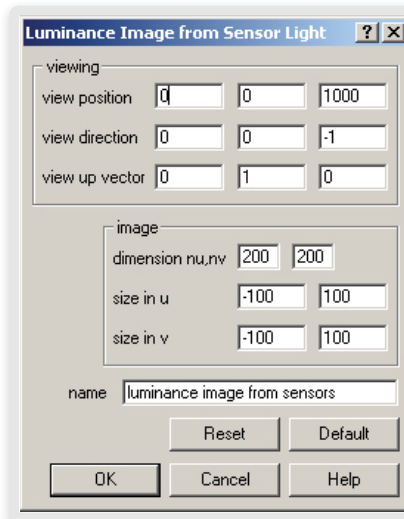


Figure 8. Luminance image from Sensor Light dialog box

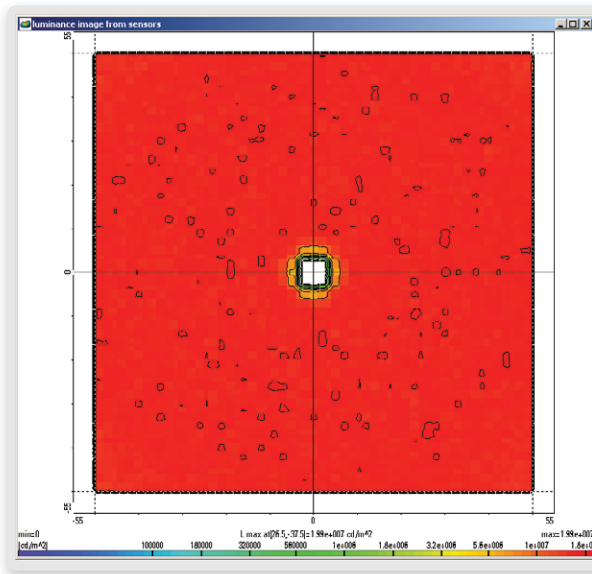
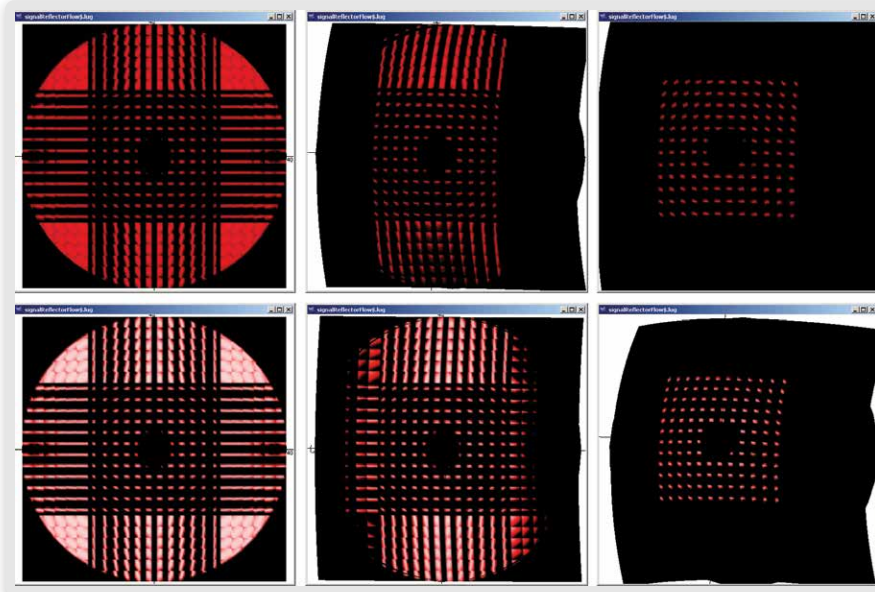


Figure 9. Luminance image of the reflector's light distribution (front view) in the UV data view

Because of the front view position, the plot shows a constant luminance over the whole reflector in red color. The view position may also be changed in the dialog box for geometry creation.

As another example, in Figure 10 we display LucidShape's predefined signal beam example using the modes *surface color* (upper row) and *surface color shine* (lower row). The cross beam pattern in this example's Lit Appearance is clearly noticeable.



**Figure 10. Luminance image of the reflector's light distribution (front view) in the UV Data View**

Store the result in a binary .lug file in order to keep loading times moderate. For a large number of pictures, however, the 3D-Snapshot dialog box is recommended. This tool creates a picture sequence that runs from beginning to end that shows the viewing angle from both the horizontal and vertical direction. The sequence can also be used to create a movie in a subsequent process.

## Conclusion

We have used LucidShape's simulation capabilities and sensor techniques to show the LIT Appearance on reflector surfaces. These techniques will help you to create a reflector that not only meets required regulations but also achieves a perfect illumination of the reflector surface.

## To Learn More

For more information on LucidShape and to request a demo, please contact Synopsys' Optical Solutions Group at (626) 795-9101 between 8:00am-5:00pm PST, visit <http://optics.synopsys.com>, or send an email to [lucidshapeinfo@synopsys.com](mailto:lucidshapeinfo@synopsys.com).