White Paper

# LucidShape FunGeo Neutralizing Surfaces for Ray Deviation Correction

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## Introduction

In modern headlamp lens design, the headlamp's outer lens surface may turn out to be extremely curved in some areas, causing ray deviation and possible unwanted disturbance of the cutoff line. This is also a well-known problem in other "vision" type applications, for instance in the design of motorcycle helmet visors.

The reason for the ray deviation is a difference between the orientations of the target planes of the incoming and the outgoing ray (Figure 1). LucidShape® software's functional geometry module (LucidShape FunGeo) provides a tool to analyze this effect and to compensate for ray deviation with a "neutralizing" lens surface.

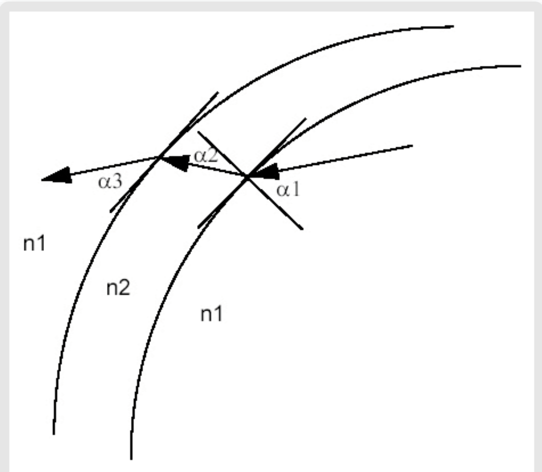


**Figure 1. Ray path with different tangent orientations**

## Neutralizing Lens Surface

The compensation for the ray deviation effect is in fact a special case of constructing a freeform lens. For a given fixed surface (inside or outside), the opposite surface is created with a variable wall thickness to compensate for the unwanted deviation.

The computation starts at a given surface point with an initial wall thickness. For the rest of the surface, the thickness varies around this initial value. Other key input parameters are the refraction index and the main ray direction.

To prove the quality of the result surface, LucidShape FunGeo can create several analysis pictures:

- Thickness maps display the wall thickness over the surface's parameter range
- Checkerboard images visualize the optical effect when looking through the lens onto a regular checkerboard pattern
- Deviation maps show the total, vertical, or horizontal deviation in degree or mm on 1 m distance

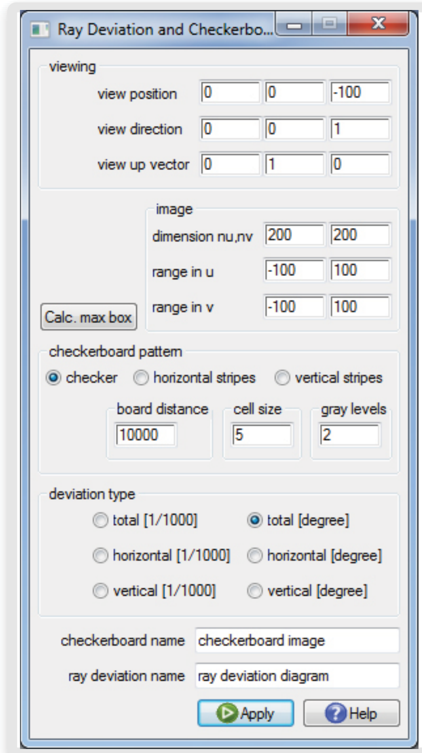


**Figure 2. Dialog box for analyzing ray deviations**

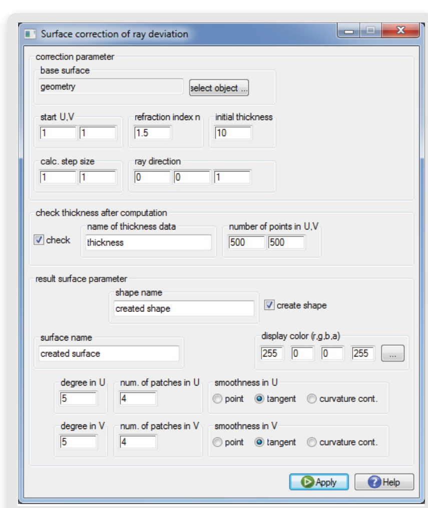


**Figure 3. Dialog box for creating the neutralizing surface**

## Application to a Typical “bad” Case

In order to study a typical “bad” case, we create two lens surfaces with a constant wall thickness. This implies a fixed offset in the normal direction.

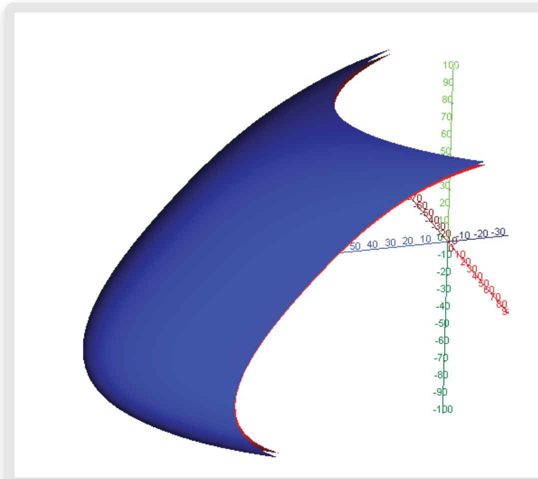

**Figure 4. Lens sample surfaces (inner: red, outer: blue)**

The result is then examined by the checkerboard tool and a ray deviation map. We see that the checkerboard image in Figure 5 shows a large deviation from the original undisturbed pattern. Figure 6 shows that the ray deviation becomes as large as 4.6 degrees.

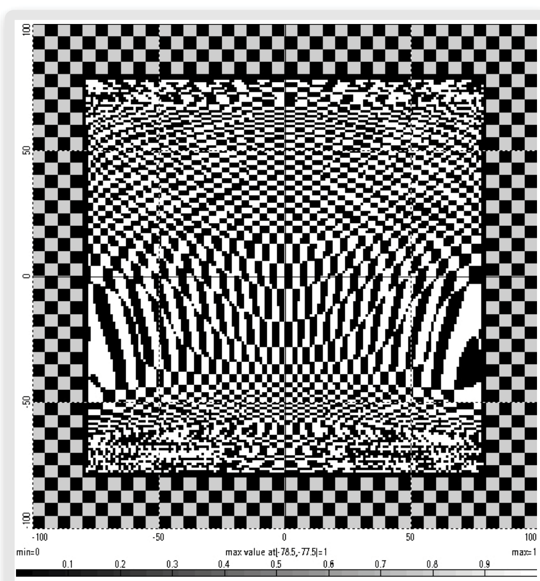

**Figure 5. Checkerboard image for a refractor with a constant wall thickness**

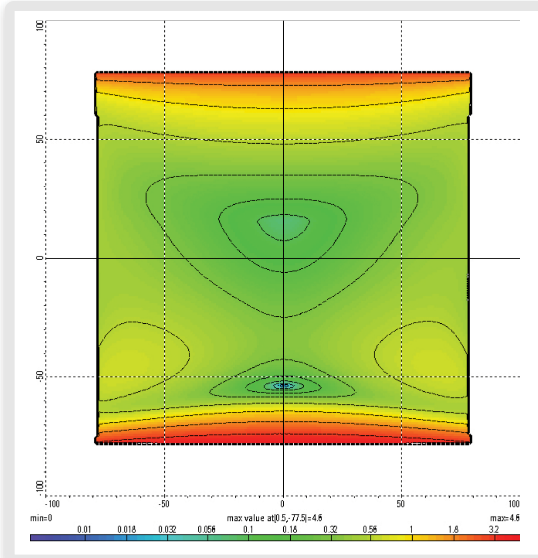

Figure 6. Deviation map for a refractor with a constant wall thickness

## The Corrected Surface

The lens with its constant offset surface being replaced by the calculated neutralizing surface is then also examined by our analysis tools. Unlike in the previous uncorrected case, we see in Figure 7 that the original checkerboard pattern now remains nearly undisturbed, and in Figure 8 that the angular ray deviation is considerably reduced.

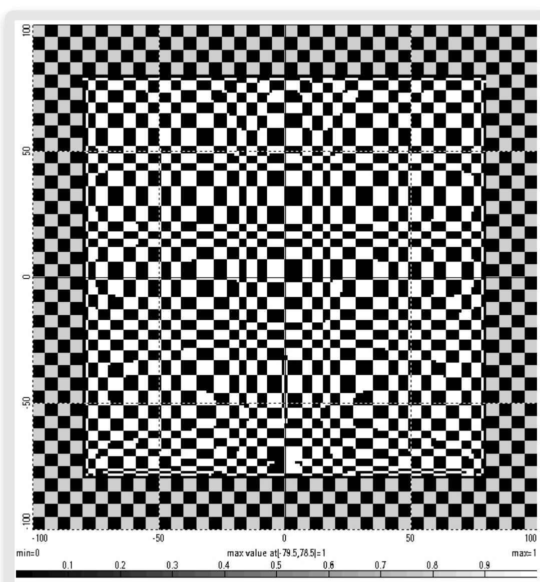

Figure 7. Checkerboard image for a refractor with a neutralizing offset surface

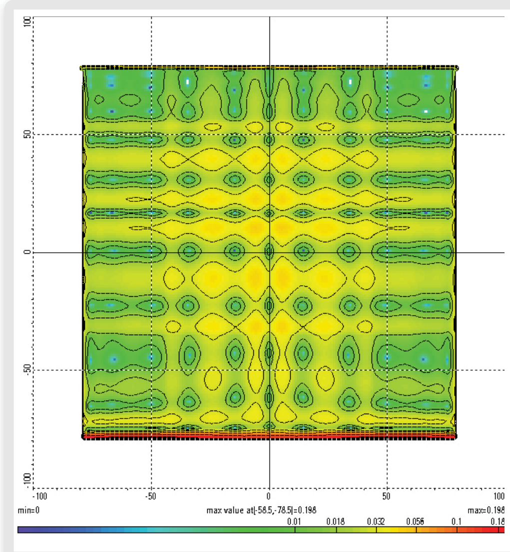

**Figure 8. Deviation map for a refractor with a neutralizing offset surface**

Figure 9 shows that the created correction surface's wall thickness varies around the initial 2.5 mm in a range from 1.7 mm to 3.0 mm.

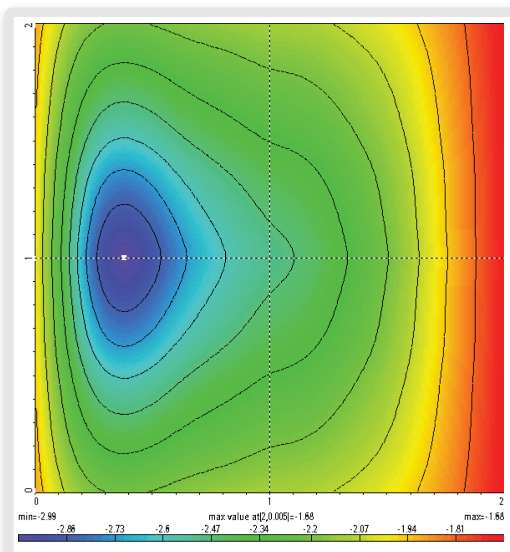

**Figure 9. Wall thickness diagram**

## Conclusion

Extreme styling in lens design may lead to serious optical defects. You can use LucidShape software's functional geometry module, LucidShape FunGeo, to identify and compensate for such defects. Fixing these defects early in the design process helps you to save money and development time.

## 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.

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