

# Using a Generic Genetic Optimization Algorithm for Optical Design

Ryan Kelley, Mark Jongewaard

LTI Optics, LLC: 10850 Dover St., Suite 300, Westminster, CO 80021, USA  
ryan@ltioptics.com, mark@ltioptics.com

**Abstract:** Applying a generic genetic optimization algorithm to optical design tasks allows for a wider range of applications and optimization targets than integrated optical design optimizers. © 2023 The Authors

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## 1. Introduction

Optimization routines are available in many commercial optical design software, however these are typically limited to a specific scope of design style or limited to a single type of optimization algorithm. For an optical engineer working outside of these limitations they are forced to manually iterate and optimize. Having a more open and flexible optimization algorithm can open up the range of design styles that can be optimized.

## 2. Generic Genetic Optimization

Within the Rhinoceros CAD system [1], users have access to Galapagos [2], as well as a range of other plugins that offer genetic optimization routines. These routines can be used within Python scripting and Rhino's own visual programming language, Grasshopper. Galapagos is a generic genetic optimization routine, which allows users to feed in control parameters and result parameters and it will determine the range of options to test and find the most optimal solution.

## 3. LED Downlight Reflector Optic

Figure 1 shows the application of the generic optimization algorithm to a revolved reflector designed for an LED downlight [3]. The optimization routine is designed to target a specific beam angle and progresses through thousands of iterations to achieve this. This was all done without the optimization routine knowing anything about optics or raytracing.

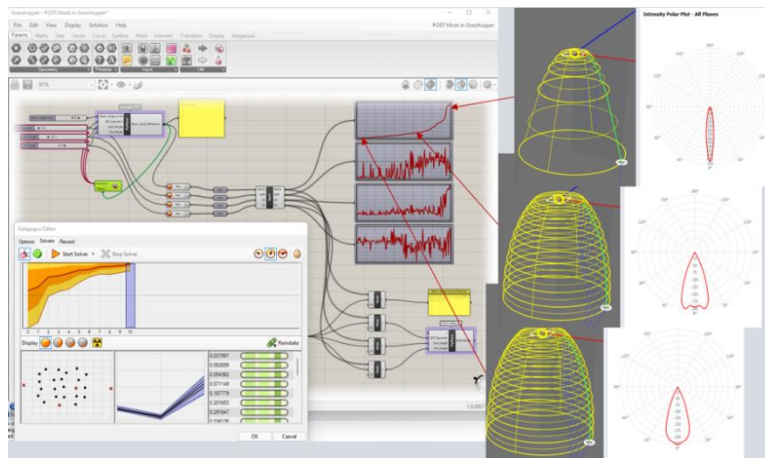
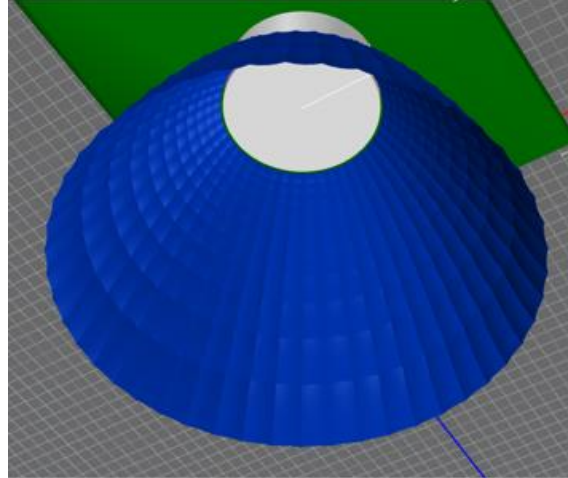


Figure 1: Revolved Downlight Reflector Optimization

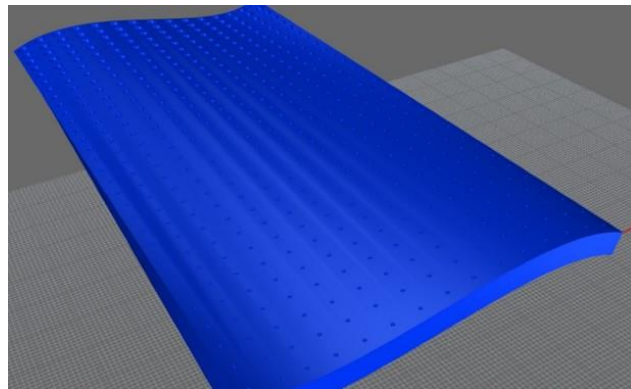
#### 4. Other Application Examples

Since the optimization routine is generic, it can be applied to a wide range of optical geometry. Figure 2 shows an example of a reflector with pillow shaped facets. The size and curvature of the facets can be optimized to satisfy specific end performance, like a beam angle, or a color uniformity metric.



*Figure 2: Pillows on a Faceted Reflector*

Light guide plates often make use of repeated patterns to extract light in a uniform way. The density, size or location of these features control the uniformity. An optimization routine can be adapted to test the uniformity of extraction and then optimize this by varying the parameters of the light guide extraction features.



*Figure 3: Light Guide Extraction Features*

#### 5. Conclusions

Having access to a generic genetic optimization algorithm allows an optical engineer to optimize any optical geometry towards any goal, surpassing limitations often seen in optical design software's internal optimizers.

[1] Rhinoceros CAD system. <https://www.rhino3d.com>

[2] Galapagos Optimization Algorithm. <https://www.grasshopper3d.com/group/galapagos>

[3] Photopia Optimization Tutorial. <https://www.ltioptics.com/en/support-tutorial-rhino-podt-galapagos.html>