

# LucidShape Version 2.0 Technical Description

## Author

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## Introduction

Synopsys' LucidShape® products are a powerful 3D system for the computer-aided design of automotive lighting and optical products. Its interactive tools support you through product design, simulation, analysis, and documentation.

You can use LucidShape to:

- Simulate all kind of light sources, surfaces, materials and sensors
- Perform efficient ray trace predictions to quickly evaluate whether your design meets your intended product function. The LucidShape ray trace algorithm makes it fastest software on the market for reflector design
- Analyze light in motion for your products, like automotive headlamps in driving scenes or reflector motion
- Customize the LucidShape user interface to fit your project and personal needs. For example, you can add your own defined dialog interfaces
- Import and export CAD and photometry data. LucidShape supports a wide range of data formats
- Support your development process with tools made to examine and document shapes and light data

## Components

LucidShape includes these powerful tools:

- LucidShell is a script interpreter that lets you write scripts in a C-like language to automate tasks like running simulations
- LucidObject is a rich tool box of library components that you can use to build complex lighting simulations
- LucidShape FunGeo is your ultimate feature to create reflector or lens geometry. You can use its collection of algorithms to calculate reflector and lens geometry for freeform objects under optical conditions. This allows you to design by lighting by function, rather than by shapes
- LucidDrive lets you run night drive simulations for automotive headlamps.
- Visualize Module delivers high-speed photorealistic visualizations of an automotive lighting system's lit and unlit appearance



Figure 1: Side mirror indicator; Left: Photograph, Right: Photorealistic simulation with LucidShape's visualize module

## Applications

- Automotive lighting (headlamps, tail lamps, interior lighting)
- Interior and external building lighting
- Signal lighting
- Fiber optics and pipe design
- Vision systems
- LED applications
- Dynamic adaptive light functions
- Instrument panels
- Slide and TV projectors
- Infrared alarm and imaging systems
- Optical scanner

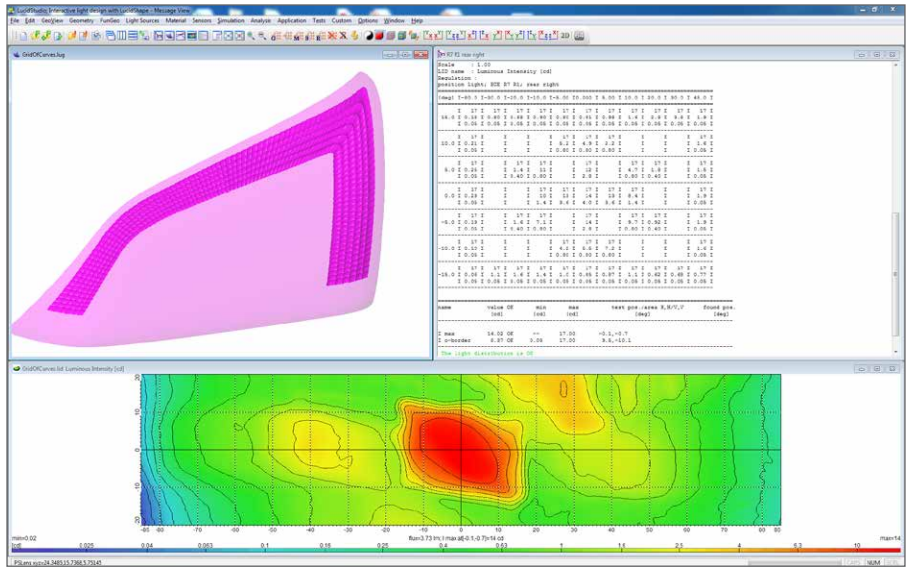


Figure 2: Unlimited freedom of lens and reflector styling

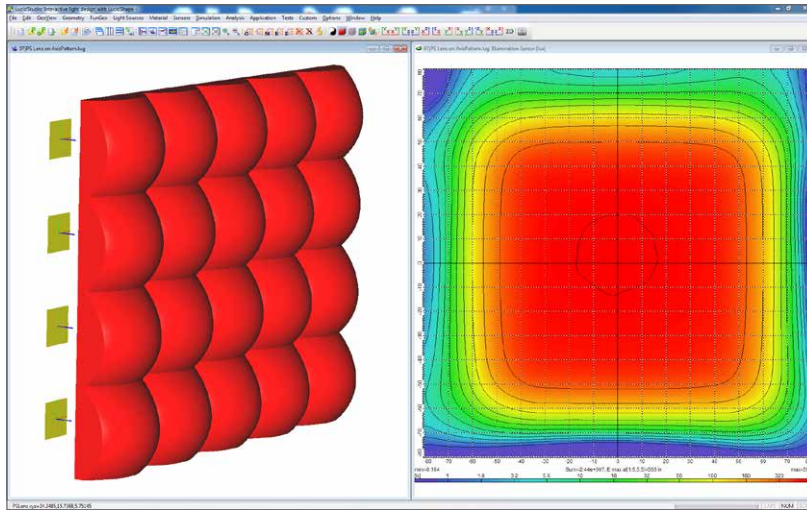


Figure 3: Homogeneous light distributions for a rectangular lens

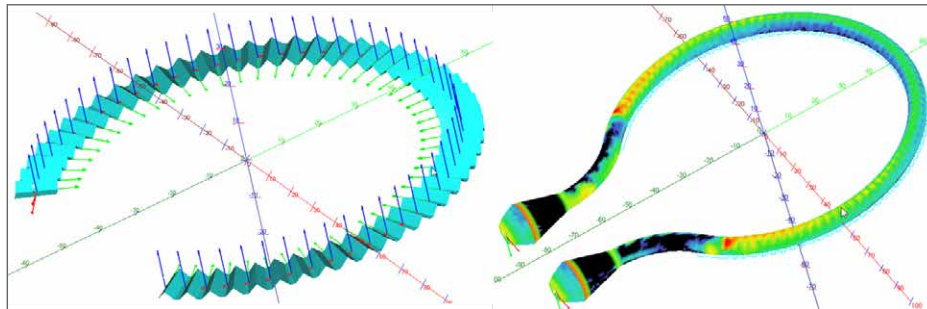


Figure 4: Prism band for light pipe design

## Digital Setup

You can interactively define geometry within LucidShape for components like reflectors, lenses, light pipes, collimators, and retro reflectors. You can also import and export geometry data from CAD files (e.g., .stp and .igs files). Using the LucidShape shell script, you can create automated workflows and modify the user interface in your own applications.

## Setup Building Parts

- Light sources (ray files, point, cylinder, and any shape light sources. Emitter types: Lambertian, Phong (cosn), and directional)
- LucidShape also offers a library of automotive lamps and lamps for general lighting
- Sensors (illumination (lx), light flux (lm), luminance (cd/m<sup>2</sup>), light flow, ray file and history sensors)
- Materials (specular, diffuse reflector/refractor, absorber, refractor)
- Curves (ellipse, parabola, hyperbola, polylines, NURBS, Bezier arcs, general curves from formula, interpolated and approximated curves)
- Surfaces (cylinder, plane, sphere, disk, cone, box, freeform surfaces, NURBS, interpolated and approximated surfaces)
- Procedural surfaces (rotational-paraboloid/hyperboloid/ellipsoid, rot surface, varirot surface, pipe surface, extruded surface, swept surface, swung surface, spread surface, prism surface, pillow optics on free surface)
- LID Data (light intensity distribution) several file formats, e.g., .ies, .ci

## Form Follows Function

To achieve a certain optical or lighting effect the shapes within a lighting fixture must be formed to enable such a behavior. The calculation for optical/lighting functionality is one of the main features in LucidShape. It contains a set of tools that allows the design of freeform shapes with lighting/optical behavior like reflectors and refractors, as shown in Figure 5.

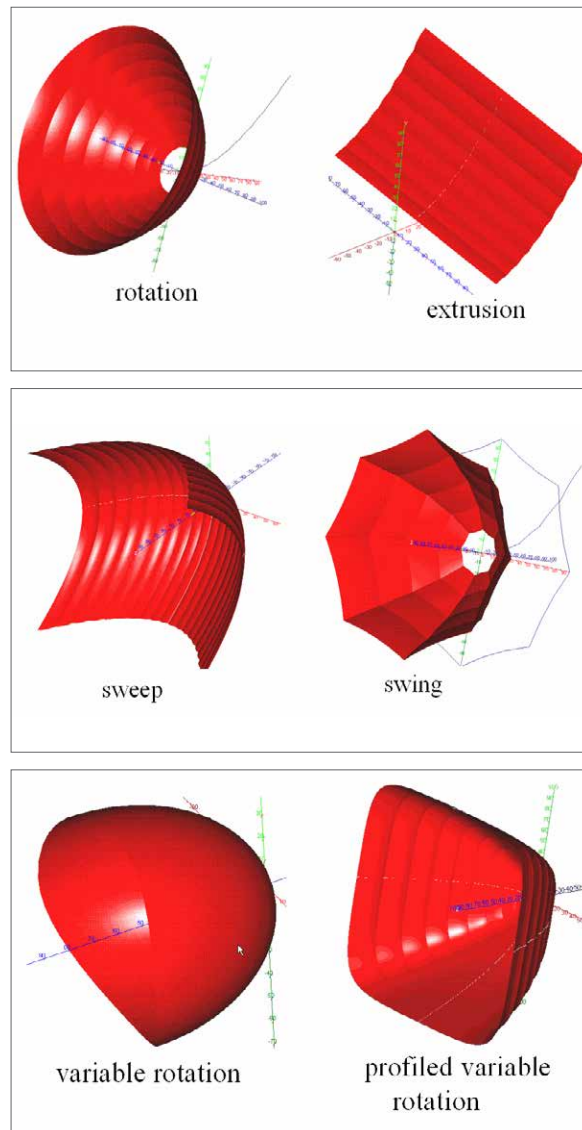


Figure 5: Freeform reflectors designed in LucidShape

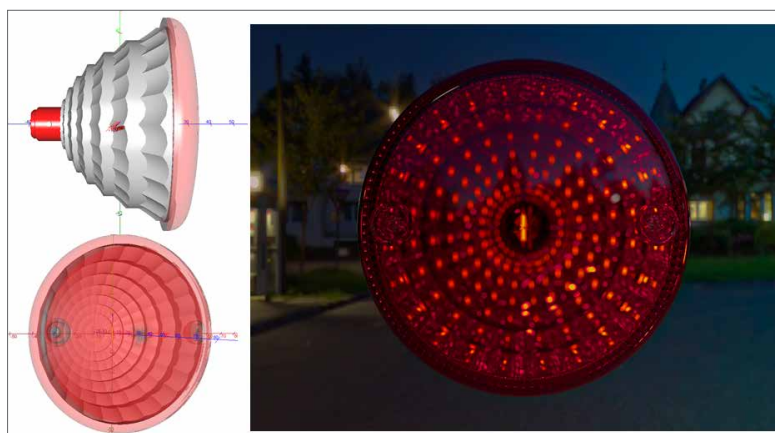


Figure 6: Tail lamp with photorealistic simulation

## MF Calculation

MF (MacroFocal) reflector and refractor calculation is the ideal software to model the perfect shape with LucidShape.

Samples within LucidShape are:

- Automotive signal lamp, fog lamp, low and high beam
- Automotive projector lamp
- Profiled reflectors and refractors
- Retro Reflector
- Freeform (FF) lens surfaces for either applications or for the compensation of ray deviation

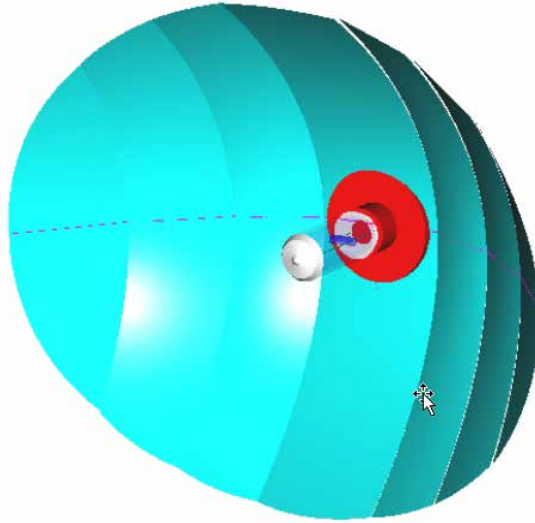


Figure 7: MacroFocal head lamp reflector. The user defines the spread angle of each facet; LucidShape calculates the curvature of the facets

## Simulation

Simulation is the process of computing a prediction for the light function of a given lighting fixture. It answers questions like: "What will be the light intensity distribution?" or "What will be the illumination distribution on the surface of interest?" Several simulation tools are available, which differ mainly in calculation time and precision of the calculated results.

You can simulate different types of ray tracing in LucidShape:

- Forward Monte Carlo ray trace
- Fast light mapping
- Luminance image from backward ray trace
- Gather sensor light (load sensors directly from light sources)
- Reverse sensor light (calculate light source distribution reverse from sensors)
- Random rays from light sources
- Interactive ray tracing

## Forward Monte Carlo Ray Trace

The general forward ray trace simulation based on the Monte Carlo principle gives the best and most precise results for intensity and illumination distributions but requires increased calculation time depending on the scene's complexity.

## Light Mapping

For the initial design of geometry, especially in reflector design, one needs a fast estimate to see the effects of geometry modification. For these tasks LucidShape provides the light mapping method for calculating light distributions within seconds. The whole setup should contain at least one source, one actor and one sensor.

## Ray Trace Analysis

Interactive ray trace is a powerful tool to investigate reflector and refractor design behavior; it allows special parts of the reflector to be examined in detail. In LucidShape one can interactively touch the shapes. Individual rays or ray bundles can be shown from origin to destination. Interactive ray trace also provides wavefront and filament images for every part of the reflector.

*"The interactive ray trace tool allow fast understanding and testing of complex lighting situations and problem solving."*

~Oliver Dross, LPI Spain

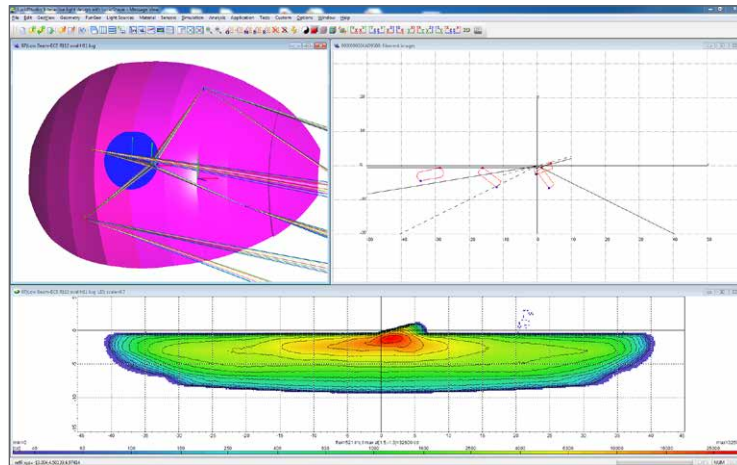


Figure 8: Real time ray tracing of ray bundles. Allows you to visualize the mirror images of a light source on a screen

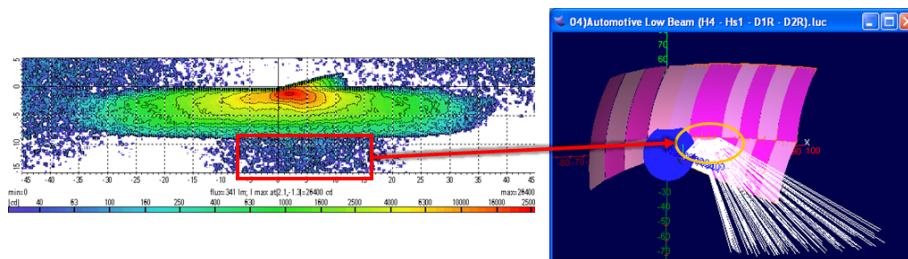


Figure 9: Ray history sensor trace back light from light distribution to reflector

## Geometry Analysis

LucidShape offers a variety of data analysis tools:

- Different data views
- Interactive ray path display
- Wave front and filament image display
- Curvature analysis for shapes
- Ray deviation analysis with checkerboard image
- Wall thickness diagram

## Light Data Analysis

- Light data analysis & operations (gradients, filter, addition, subtraction, scale, mirror, etc.)
- Control light data display properties like log/linear scale, color mode
- Measurement tables for automotive lighting for ECE, SAE/FMVSS & JIS regulations

LucidShape offers a wide range of possibilities for evaluating measurements. All data can be edited and modified for subsequent analysis.

New data analysis tools are added regularly.

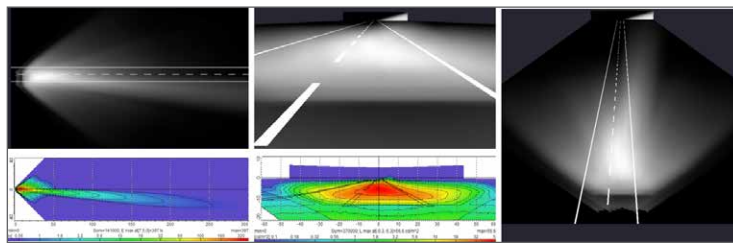


Figure 10: Low beam application in different view positions;  
Left: Bird's Eye View, Center: Driver View, Right: 20 m View

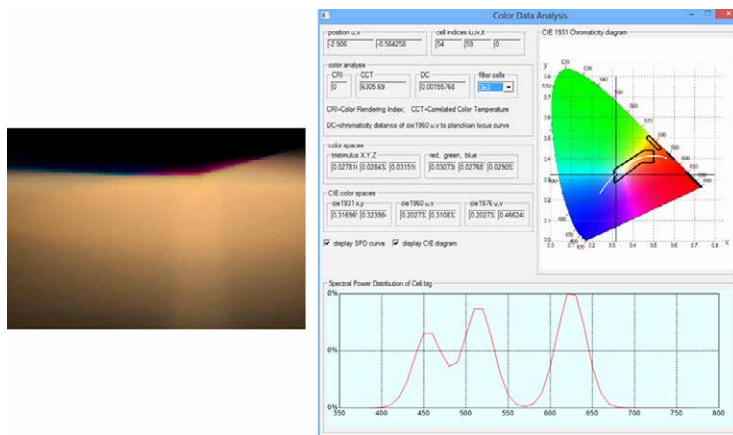


Figure 11: Color data analysis

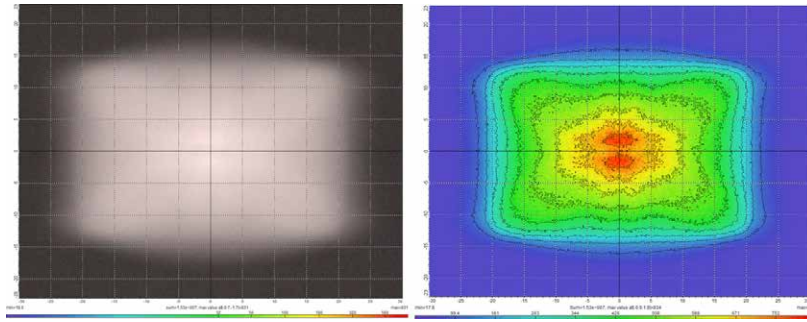


Figure 12: Converted light data; Left: Spectral simulation of a lens application, Right: Extracted luminance from the spectral simulation

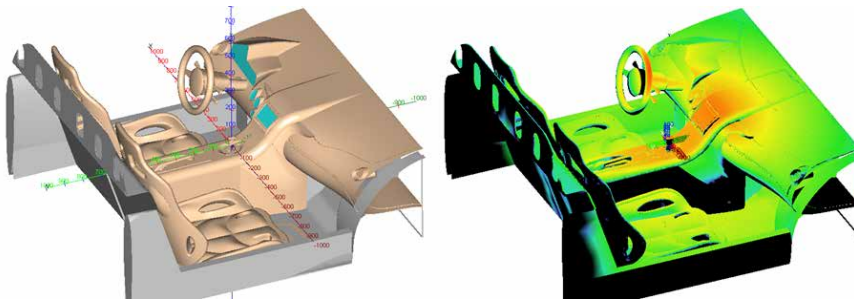


Figure 13: Mapping of light distribution on surfaces

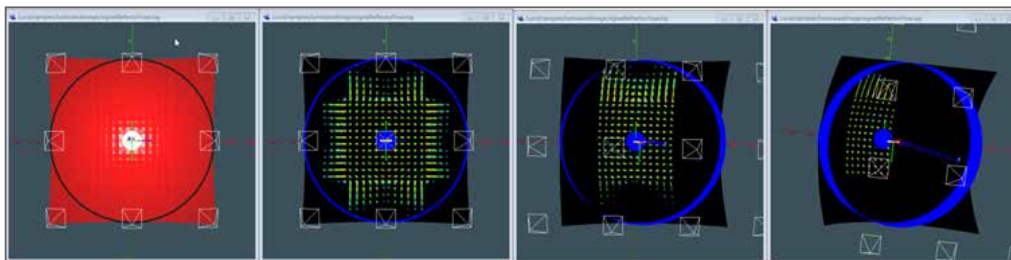


Figure 14: Flow Sensor Interactive luminance display mapped on the geometry

## User Interface

The user has complete control of every aspect of visualization of the model and analysis of the data. The model can be rotated, translated and zoomed via mouse and keyboard buttons.

Some visualization aspects are:

- Surface display type (points, triangles, curvature, light, wire frame, shaded, colored, texture)
- Light data display types (false color, gray, surface color, ISO lines)
- Multiple data views



## Customize Your User Interface

LucidShape is also an ideal framework for product function design in any technical and physical area. For your special needs we can tailor an individual design system for you. Please call us for more information.

You can easily customize your project work with LucidShape. You can set up your own:

- Individual pull down menus
- Experimental setups
- Dialog boxes
- Test tables

With our customized LucidShape applications for headlamp and tail lamp design we check the feasibility of a design concept in a very early stage. (Dr. Alexander von Hoffmann, Volkswagen)

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~ Dr. Alexander von Hoffmann, Volkswagen

## Animation

LucidDrive offers animation tools for light in motion analysis:

- Dynamic driving scene
- Road editor for road types and equipment, e.g., trees
- Reflector, lens, and bulb motion

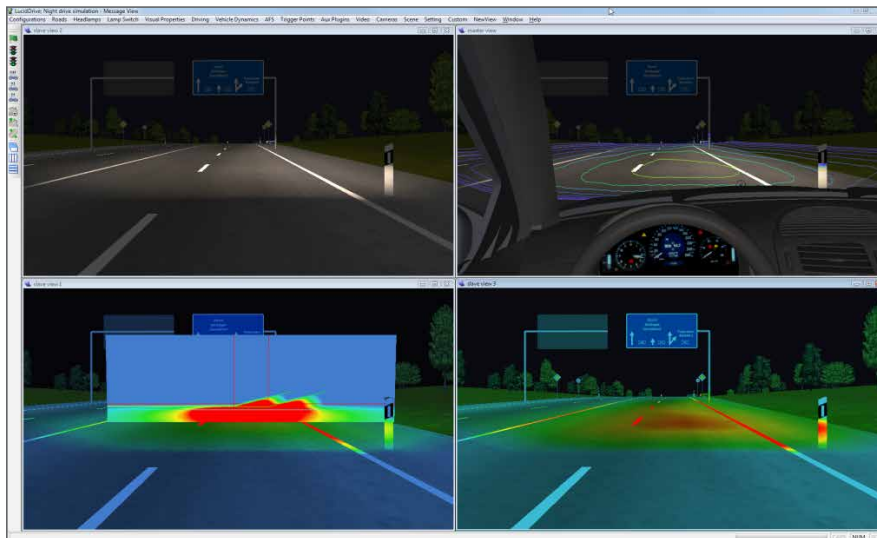


Figure 15: Different analysis options in LucidDrive

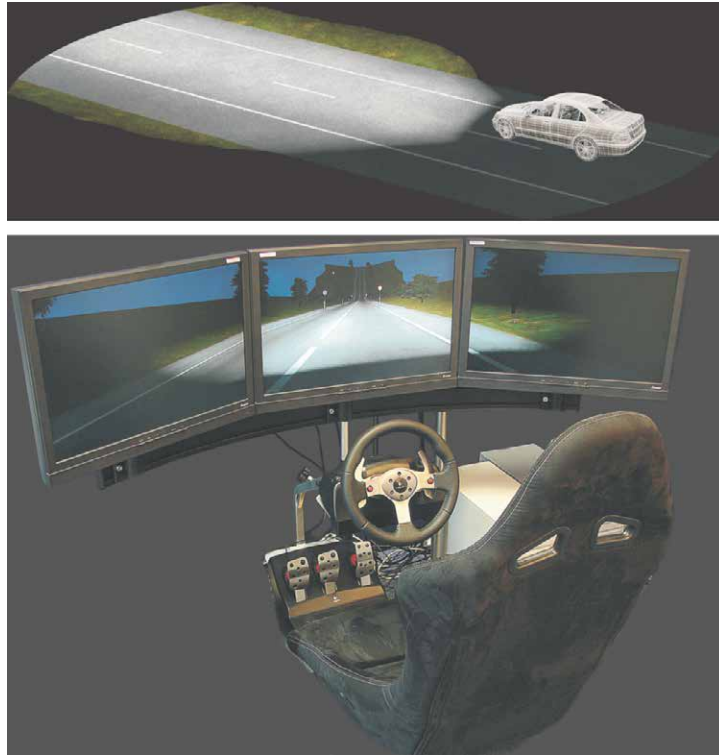


Figure 16: LucidDrive animation

## LucidShape Script Language

LucidShape has its own script language. The user can set up the experiment and run simulations with this C/C++-like language. The user-written programs can also be integrated into the LucidShape user interface as menu items. All tasks can be performed, there are no limits!

## Import/Export of Data

LucidShape can import and export data in different file formats.

### CAD Software

- .igs (multiple CAD software)
- .stp (multiple CAD software)
- .3dm (Rhinceros 3d geometry files)
- .stl (Stereo lithography format) (import only)
- .dat (simple point data file format) (import only)

### Ray Files

- .dis (ASAP ray files) (import only)

## Luminous Intensity Distributions

- .ies (IES light distribution)
- .cie (CIE light distribution)
- .ldt (EULUMDAT light distribution)
- .lmt (LMT goniometer format)
- .kzu (Kohzu Seiki Goniometer data)
- .dis (ASAP light intensity data)
- .din (ASAP light intensity data)
- .csv (LMT goniometer data in Excel text)
- .krs (Optronik goniometer format)

## Free LucidShape Demo

The LucidShape demo version is a time-limited and functionality-restricted version. Ray tracing and scripting are enabled but saving and printing are disabled.

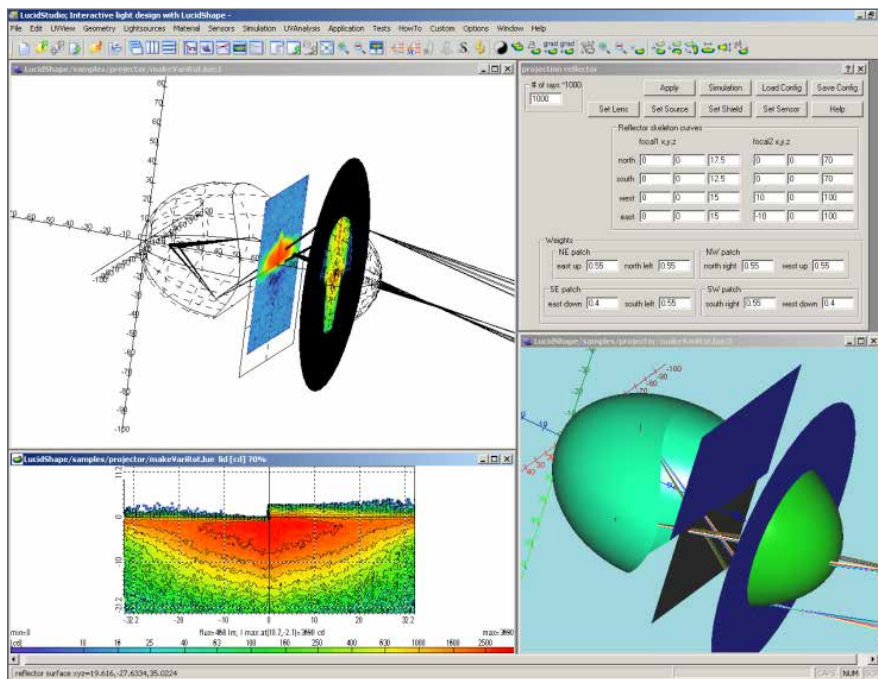


Figure 17: LucidShape demo version

## 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 [synopsys.com/optical-solutions/lucidshape](https://www.synopsys.com/optical-solutions/lucidshape) or send an email to [lucidshapeinfo@synopsys.com](mailto:lucidshapeinfo@synopsys.com).