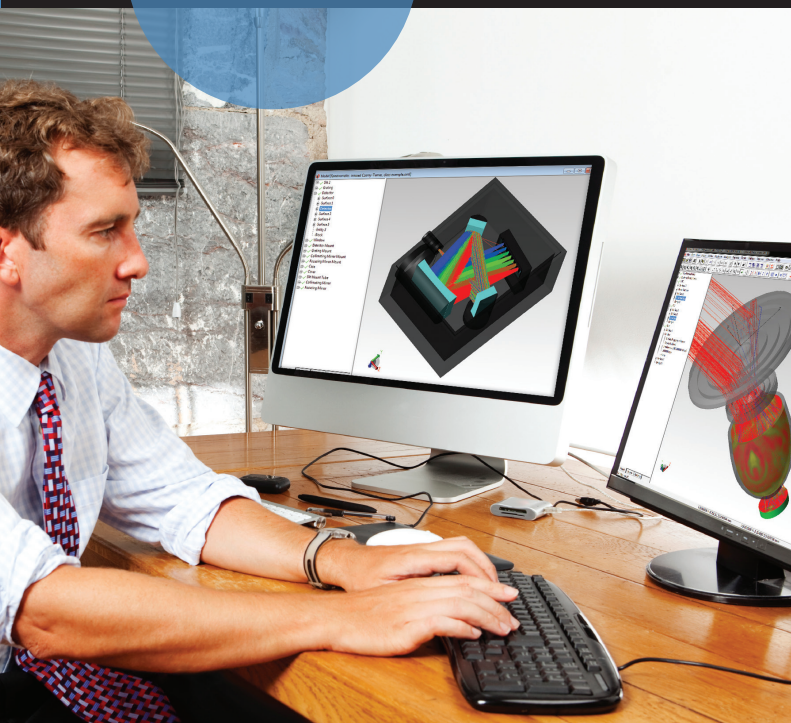
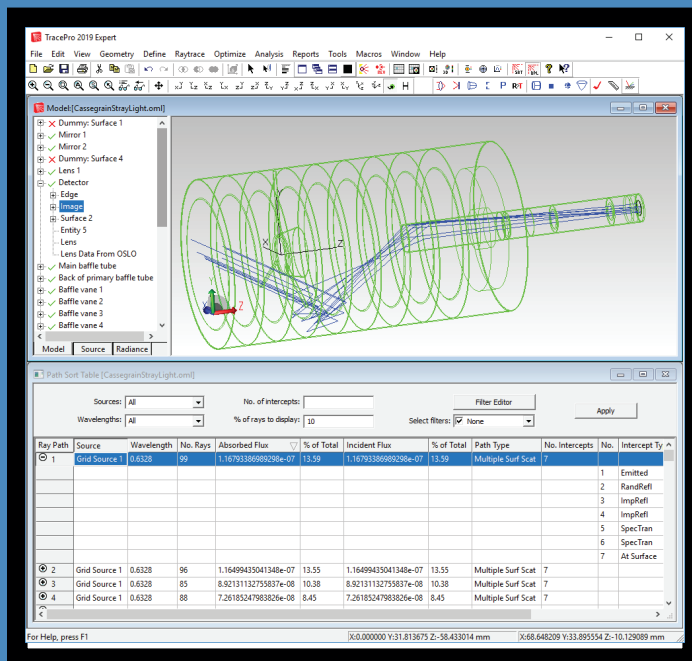


# Illumination Design, Analysis, and Optimization Software

TracePro® is award-winning opto-mechanical software used for design, analysis, and optimization of optical and illumination systems. With its intuitive CAD interface and powerful features like interactive optimizers, TracePro offers users a sophisticated and powerful optical design environment combined with a short learning curve to accelerate product time-to-market.



TracePro streamlines the prototype to manufacturing process for optical and illumination systems with a familiar CAD interface, interactive layout and optimization, and seamless interoperability with popular CAD software, such as SOLIDWORKS®.



Visualization of a Stray Light Path in Telescope

## Solid Modeling

TracePro models are created by importing lens design or CAD files, as well as by directly creating the solid geometry within TracePro. Models can be modified by using move, rotate, scale, sweep, and revolve object and surface operations via the user-friendly, 3D CAD interface. Primitive solids, such as tubes, blocks, cones, and spheres; and optical elements, including lens elements, reflectors, and Fresnel lenses, can also be inserted. TracePro utilities allow interactive sketching to quickly enter 2D and 3D profiles; and then extrude, revolve, and combine these surfaces to create sophisticated geometry, like lightpipes, reflectors, and free-form optics. Visualization options include: photorealistic rendering, solid rendering, silhouette, wireframe, and hidden line views. Users also have the ability to pan, rotate, zoom, and perform other standard geometry manipulation techniques. TracePro's multiple document, multiple view architecture allows you to have several views of the same model open at the same time, and several models open at the same time. Copying and pasting objects from one model to another requires just a couple of keystrokes or menu picks.

## Optical Properties

A wide range of material and surface properties can be applied to objects and surfaces in the model. Optical properties that can be specified include:

- Material properties – index of refraction, absorption coefficient, and birefringence
- Aperture diffraction
- Surface properties – reflectance and transmittance coefficients, surface absorption, surface scatter
- Bulk scatter
- Fluorescence
- Gradient index
- Mueller Matrix for polarization modeling
- Surface source
- Temperature distribution
- Thin film stacks for modeling multilayer optical coatings, including anti-reflection coatings, bandpass filters, and cutoff filters
- BSDF for versatile modeling of surface scatter

Surfaces with random or periodic arrays of repeated structures can be created using TracePro's RepTile™ feature.

Properties can be defined with customized parameters or applied from TracePro's catalog of commonly used, commercially-available materials and coatings. You can also add your own properties to the database to streamline the modeling process.

Polarization is modeled seamlessly, using the Mueller calculus, with Mueller Matrices applied to objects and rays defined by Stokes vectors.

## Performance and Accuracy

TracePro's ray tracing engine is fast and accurate, providing complete control of threshold parameters to achieve simulation results quickly with no compromise in accuracy. Analysis Mode ray tracing, unique to TracePro, is a very powerful capability that creates an interactive environment to analyze every surface and object both visually and quantitatively to gauge the feasibility of a design.

Ray tracing features include:

- Ray Splitting
- Exact Ray Tracing – no missed intersections or “leaky” rays
- Analysis Mode ray tracing for interactive viewing of any analysis result on any surface or object after the ray trace is completed
- Simulation Mode ray tracing for tracing very large numbers of rays with little or no memory consumption
- Multiple Exit Surfaces (Simulation Mode)
- Voxalization of Object Space for fast ray tracing using uniform or octree voxels
- Aperture Diffraction
- Stratified Importance Sampling
- Reverse ray tracing for designs in which sampling is improved by this method

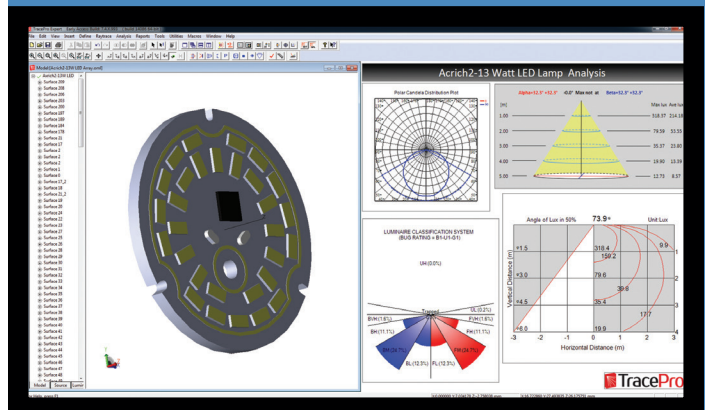
## Light Sources

TracePro simulates the distribution of luminous intensity, irradiance/illuminance, and flux throughout a model or at selected surfaces by tracing rays using the Monte Carlo method. Light sources are modeled by emitting rays. Additionally, TracePro's Surface Source Property Utility enables graphed surface source properties to be imported directly from a manufacturer's datasheet.

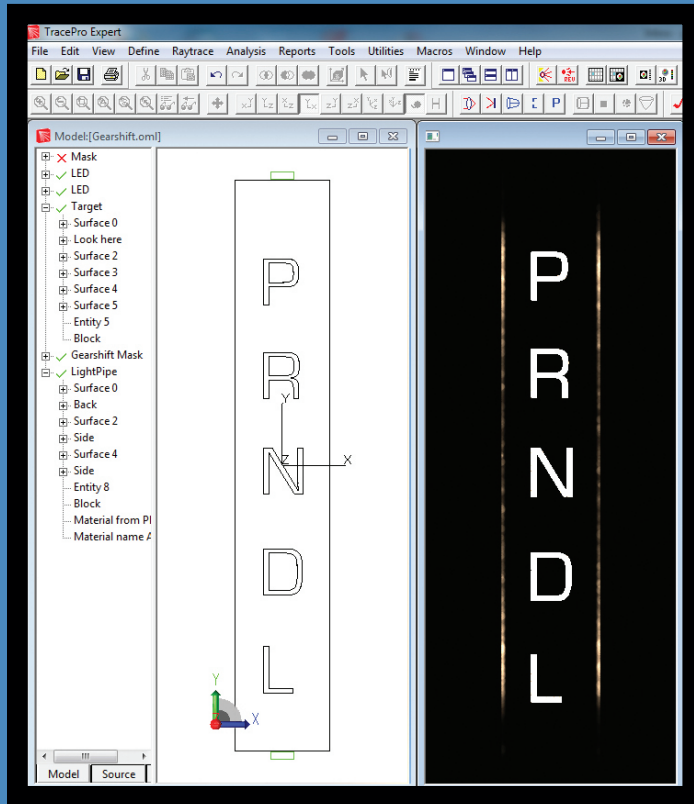
Ray sets are defined using any combination of three methods:

- **Grid** – specify spatial and angular beam profile, wavelengths, and dimensions along with beam orientation, polarization state, and degree of polarization.
- **Surface** – specify angular distribution and emission spectrum from one or more surfaces of any solid object using luminous flux or irradiance/illuminance. Surfaces can also be defined as blackbody or graybody radiators. Any combination of surfaces can be defined as sources.
- **Ray File** – predefined ray tables consisting of XYZ starting points and direction vectors, polarization states, wavelength data, and the initial flux value or Stokes vector for each ray. Ray files are typically created from source measurements or theoretical calculation and are often posted on source manufacturers' websites.

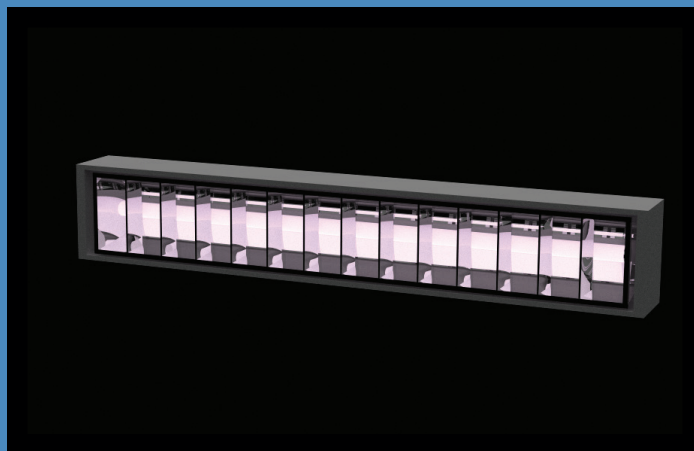
TracePro's RepTile (Repetitive Tile) is an on-the-fly surface creation utility that defines and creates repetitive microstructures on any planar surface. RepTile is a convenient, easy-to-use function that reduces the time it takes to build and modify a structure, as well as ray-trace millions of surface entities for lighting and display backlight analysis.



Acrich2-13W LED Array Report



**Photorealistic Rendering:  
Gearshift Lever**



**Photorealistic Rendering:  
Lighting Louver**

## Analysis

TracePro provides a comprehensive set of tools to view and analyze results of the ray trace, including:

- Irradiance/Illuminance Maps show irradiance or illuminance, CIE, and true color maps of light incident on, absorbed by, or exiting a selected surface. Multiple options are available to control resolution, profiles, relief plotting, linear and logarithmic output, gradient, color maps, and smoothing operations, as well as the capability to export results to a text file or an image file.
- Luminance/Radiance Maps can be displayed as true color based on the wavelengths traced. Luminance Maps can be used to make very accurate photorealistic renderings using the optical properties and sources applied to the model.
- 3D Irradiance Plots map irradiance, CIE, and true color plots of the incident, absorbed, or exiting flux onto the selected surfaces or objects in the system view. This mapping is achieved by layering the light map of the displayed flux or color output on top of the 3D CAD geometry. Multiple options are available for contour plotting, transparency, ambient lighting, linear and logarithmic output, gradient shading, color maps, and smoothing.
- Candela Plots show luminous or radiant intensity in candela or watts/steradian. There are four types of candela plots: Polar Candela, Iso-Candela, Rectangular Candela, and Iso-Candela.
- Polarization Maps chart the polarization ellipse for the incident flux onto the selected surface. Color levels and ellipses graphically display the degree of polarization and ellipticity at points on the surface.
- Incident Ray Tables provide tabular output of rays incident on a selected surface.
- Ray History Tables give a complete history of every ray incident on a selected surface.
- Path Sorting Tables give a sortable table of ray paths incident on a selected surface, with interactive viewing of rays and irradiance maps of paths you select.
- Optical Path Length (OPL) or Time-of-Flight plots present flux absorbed or incident on a selected surface versus OPL for specialized analyses.
- Volume Flux Maps allow visualization of the flux absorbed, incident, lost, or emitted throughout a rectangular volume.

Map and plot output can be further controlled with Ray Sorting and Path Sorting. For example, analysis results can be filtered to show only the rays intersecting a selected surface, rays following selected path(s), rays of a certain wavelength, interaction type, or flux range.

# Optimization

TracePro offers an optimizer that enables quick specification of a starting design and interactive control- and segment-point specification. The optimizer has interactive ray tracing tool to quickly lay out a starting-point design. Pulling on a control-point automatically updates the rays. TracePro's optimization process rapidly converges on the optimal design, while also allowing results to be continuously monitored and used for subsequent refinement of the model. Complex non-symmetric designs are supported with the optimizer, which is ideal for designing unusually shaped complex lightpipes and LED lenses.

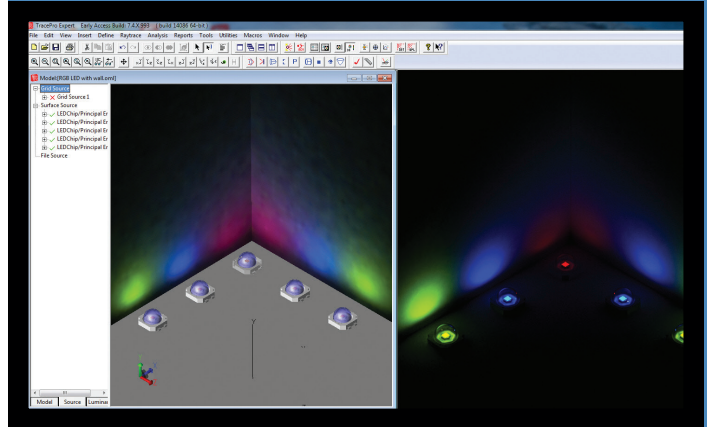
# Texture Optimization

TracePro offers the Texture Optimizer, which allows you to optimize the distribution or photorealistic rendering of scattering dots on a backlight diffuser. First define a target irradiance distribution, then define a starting point distribution of dots. The optimizer will adjust the density of the dots to achieve your target distributions.

# Visualization & Rendering

TracePro has several surface and ray display options that help identify problem areas and visualize energy propagation through any optical or illumination system. Irradiance/illuminance and candela plots with linear or log scales, several color palettes, profiles, and 3D viewing options enable understanding of the flux, angular intensity or irradiance on any surface.

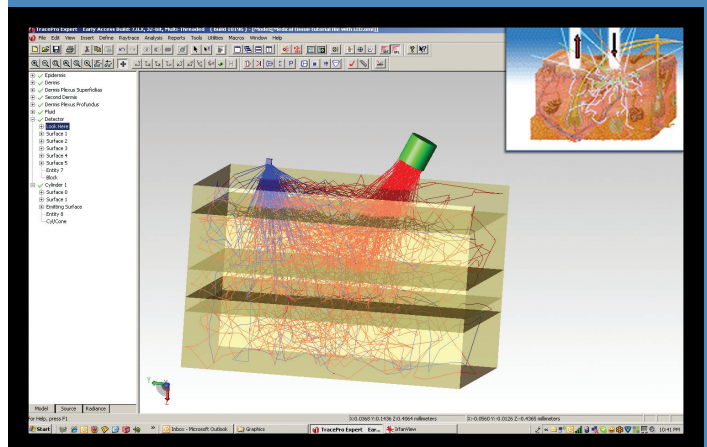
TracePro's Photorealistic Rendering feature uses source and optical properties of the model, real ray tracing, and photon mapping algorithms to enable you to visualize your design's lit appearance from any viewpoint.



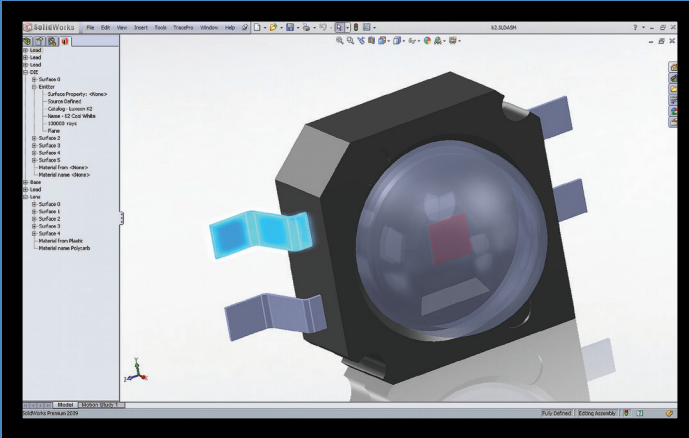
## 3D Illuminance True Color Plot Versus a Photorealistic Rendering

TracePro illumination design, analysis, and optimization software has enabled product innovation and research discovery across a breadth of applications:

- Luminaire Design
- LED Optical Integration
- Lightpipe Design
- Design Optimization
- Biomedical Optics
- Stray Light Analysis
- Display Illumination
- Solar Energy Collection
- Daylighting



## Biomedical Simulation



*RayViz for SOLIDWORKS*

## CAD Integration

TracePro offers seamless integration with SOLIDWORKS using RayViz™ for SOLIDWORKS, an add-in to SOLIDWORKS that allows optical properties to be added and saved directly to the SOLIDWORKS model, preserving mechanical and optical properties when models are exported from SOLIDWORKS to TracePro. As a result, design productivity is dramatically improved without sacrificing performance or functionality.

## Reporting

TracePro can generate a variety of ray trace and property reports. For example:

Flux Reports provide a summary of surface area, number of incident rays, incident and absorbed flux, and lost flux for all defined sources or as a function of the selected source or wavelength. Bulk absorption and incident flux are displayed for each object. Property Data Reports display the model's optical surface and object property definitions.

## Editions

Three editions of TracePro are available with increasing levels of functionality and sophistication suitable for all user levels and virtually any application. This provides a convenient and practical upgrade path as a user's needs and experience increase. The LC edition is targeted at standard lighting and lightpipe applications. The Standard edition is perfect for most optical and illumination design, analysis, and stray light tasks. When advanced capability is needed for textured backlight design or life science applications, the Expert edition has the superior capability to model millions of scattering dots, user-defined bulk scatter, and fluorescence modeling for simulating biological tissue.

See table on the next page for details or contact our sales team with any questions at [sales@lambdare.com](mailto:sales@lambdare.com).

## TracePro Editions Comparison

Three Editions of TracePro are available to cost-effectively fulfill your design and analysis needs

	LC	Standard	Expert
<b>FEATURES</b>			
User-Friendly CAD Interface, Interoperability with commercial CAD software and Lens Design Software	YES	YES	YES
Scheme Macro Language, Recorder, and Editor	NO	YES	YES
Material, Surface, Lens, Lamp, and LED catalogs of commercially available glass, plastics, metals, anodized surfaces, paints, lamps, and LEDs	YES	YES	YES
Interactive Optimization	NO	YES	YES
<b>SOLID MODELING</b>			
SAT Import and Export	YES	YES	YES
Lens Design Import for popular optical design programs	YES	YES	YES
RayViz for SOLIDWORKS Compatibility	YES	YES	YES
CAD features including solid modeling, Boolean Operations, 3D interactive view, 3D Rendered, transparent, wireframe, hidden view, and measurements	YES	YES	YES
Optional CAD translators for import/export of STEP and IGES	OPTIONAL	OPTIONAL	OPTIONAL
<b>PROPERTIES</b>			
Surface Property modeling includes absorption, reflection, refraction, scatter off any surface, and bulk absorption	YES	YES	YES
Diffraction, Bulk Scatter, Grin, Thin Film Stacks, Polarization, Diffraction Gratings, Temperature Dependent, Anisotropic Properties, and Tabular Scatter Models	NO	YES	YES
Repetitive Tile (RepTile) Surface, Temperature Distributions, Birefringence, Wire Grid Polarizers, and Fluorescence	NO	NO	YES
Scatter Models	SYMMETRIC	SYMMETRIC & ASYMMETRIC	SYMMETRIC & ASYMMETRIC
<b>SOURCES</b>			
Grid Sources	YES	YES	YES
Surface Sources	YES	YES	YES
Blackbody/Graybody Sources	YES	YES	YES
File sources using ray files	YES	YES	YES
<b>RAY TRACE</b>			
Monte Carlo with Ray Splitting	YES	YES	YES
Simulation Mode (single or multiple exit surfaces to see results) or Analysis Mode (interactive results)	YES	YES	YES
<b>ANALYSIS</b>			
Irradiance/Illuminance and Candela Maps (Intensity) for both Photometric and Radiometric output, CIE(x,y), CIE(u,v), and True Color plots	YES	YES	YES
3D Irradiance Maps, Photorealism, and Luminance/Radiance (Lit Appearance)	YES	YES	YES
Flux, Ray History, Ensquared Energy, and Path Sorting	YES	YES	YES
Polarization Maps, Volume Flux, OPL, and Time-of-Flight Reports	NO	YES	YES
<b>TOOLS</b>			
Interactive Optimizer	GEOMETRY MODELER ONLY NO OPTIMIZATION	FULL OPTIMIZATION	FULL OPTIMIZATION
Surface Property Generator	YES	YES	YES
Surface Source Property Generator	YES	YES	YES
IES/LDT Plots	YES	YES	YES
Texture Optimization	NO	NO	YES
Fluorescence Property Generator	NO	NO	YES
Solar Emulator	YES	YES	YES
Analysis Toolkit	YES	YES	YES
Lighting Toolkit	YES	YES	YES



*Lambda Research Corporation, a privately-held company founded in 1992, is an industry leader in optical analysis, illumination system design and analysis, and custom software development. Lambda Research Corporation publishes TracePro, an award-winning opto-mechanical design software used for designing and analyzing illumination and optical systems. TracePro streamlines the prototype to manufacturing process by combining an intuitive 3D CAD interface, advanced tools, and seamless interoperability with other mechanical design programs.*

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