

# LightTools Illumination Design Software

Design, Analyze, Optimize and  
Deliver Illumination Optics

# Design Highlights



## Design Highlights at a Glance

- ▶ Smart system modeling with full optical accuracy and precision
- ▶ Interactive point-and-shoot ray tracing for quick evaluation of optical behavior
- ▶ Fully integrated illumination optimization that automatically improves model performance
- ▶ Specialized, robust features for modeling complex optical surfaces and elements
- ▶ Efficient model parameter management to maintain design integrity
- ▶ Interactive, smart user interface
- ▶ Libraries of models, sources, surface finishes, coatings, filters and application-oriented utilities to speed design setup
- ▶ Custom solutions for design task automation
- ▶ CAD software interoperability for seamless information sharing

For more information, visit  
[www.opticalres.com/lt/features](http://www.opticalres.com/lt/features)

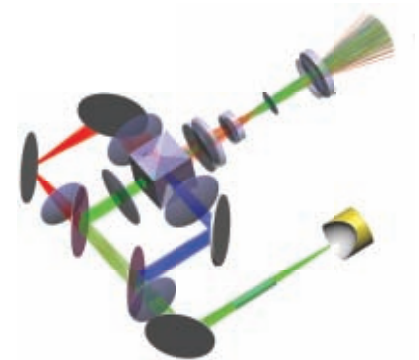
## The Complete Design Solution for Illumination Applications

Design accurate, cost-effective illumination optics with LightTools software. Its unique design and analysis capabilities, combined with ease of use, support for rapid design iterations and automatic system optimization help to ensure the delivery of illumination designs according to specifications and schedule.

**Smart system modeling with full optical accuracy and precision**—Create designs easily with 3D solids that can be inserted into the model at any size, in any location and at any orientation. Geometry is always editable using Boolean and trimming operations that retain the optical accuracy of surface shape, position and intersection for all calculations.

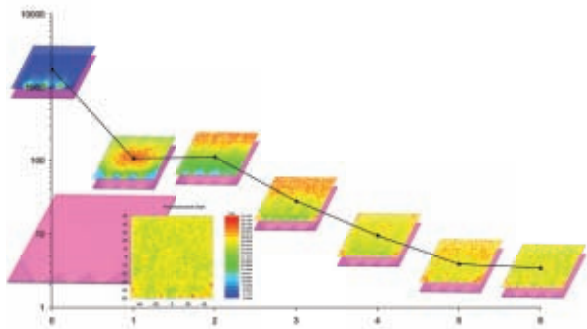
**Rapid evaluation of optical behavior during design iterations**—With point-and-shoot ray tracing, gain an instant understanding of the system's optical behavior by graphically starting and aiming rays from any point in the model. Rays are displayed visually and updated

automatically as the model is changed and they can be moved and rotated interactively to study the behavior of a model.



**Figure 1: LightTools' smart modeling capabilities make it easy to quickly build complex illumination systems. Point-and-shoot ray tracing provides instant feedback on system alignment.**

**Quick convergence on the design that best meets your goals**—Improve system performance automatically with the most effective illumination optimization algorithms available. LightTools' fully integrated optimization capabilities combine design and analysis features to allow you to optimize any aspect of your system to meet performance goals. For

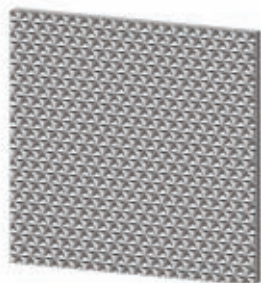


**Figure 2: LightTools' fully integrated illumination optimization capability greatly improved the illuminance uniformity of this edge-lit LED backlight system in six iterations, with minimal user input.**

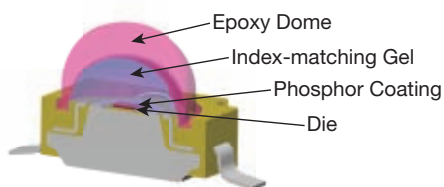
example, optimize a system to match a target illumination distribution while simultaneously maximizing total power.

### Robust modeling of complex surfaces

**surfaces**—Model complex optical surfaces with skinned solids, a highly versatile, fully optimizable class of geometrical objects whose size and shape are defined by multiple cross-sections along their length. Apply textures—2D, 3D and user defined—to any planar surface and vary the shape, size and spacing of texture elements as needed.



**Figure 3: LightTools' user-defined 3D textures enable you to design arrays of complex shapes on a surface for backlights and microlens arrays.**



**Figure 4: LightTools can easily handle complex LED packaging design requirements. You can immerse elements in one another, in multiple levels—ideal for modeling the embedded phosphor and epoxy covering in an encapsulated LED.**

### Efficient model parameter management

—Use parametric controls to establish links among optical system parameters so that changing one parameter automatically updates all associated parameters. Design modifications correctly propagate throughout the system, maintaining both the design intent and the physical realism of the model.

### Ease of use

—Work faster with LightTools' smart user interface. Hierarchical data structures, editable spreadsheets, tabbed dialog boxes, multiple design views and navigation windows support interactive geometry creation and modification. Windows® functions like point-and-click, copy-and-paste and moving and resizing windows are instantly familiar.

### Reduced design time with libraries, example models and utilities

—Jump start your design with LightTools' robust set of libraries, including sources, materials, lenses and surface treatments. Wizard-like utilities help you create, analyze and modify designs. Example models demonstrate key LightTools features, such as modeling sources and defining surface properties.

### Custom solutions to automate tasks and leverage other tools

—Have unlimited design flexibility with the LightTools COM interface. Automate repetitive design tasks using Visual Basic® macros. Incorporate LightTools functions into other COM-enabled applications such as Microsoft Excel® or MATLAB® to achieve an

## Exceptional Software Support

When you use LightTools, you can expect to receive the most comprehensive software support in the industry to ensure that you are productive throughout your illumination design projects.

- ▶ Expert technical support staff comprised of degreed optical engineering professionals
- ▶ Dedicated customer website includes FAQs, macros, example models, tips and more
- ▶ Comprehensive documentation
- ▶ Onsite and offsite software training
- ▶ Regular program updates with customer-requested enhancements

integrated, multi-application engineering environment.

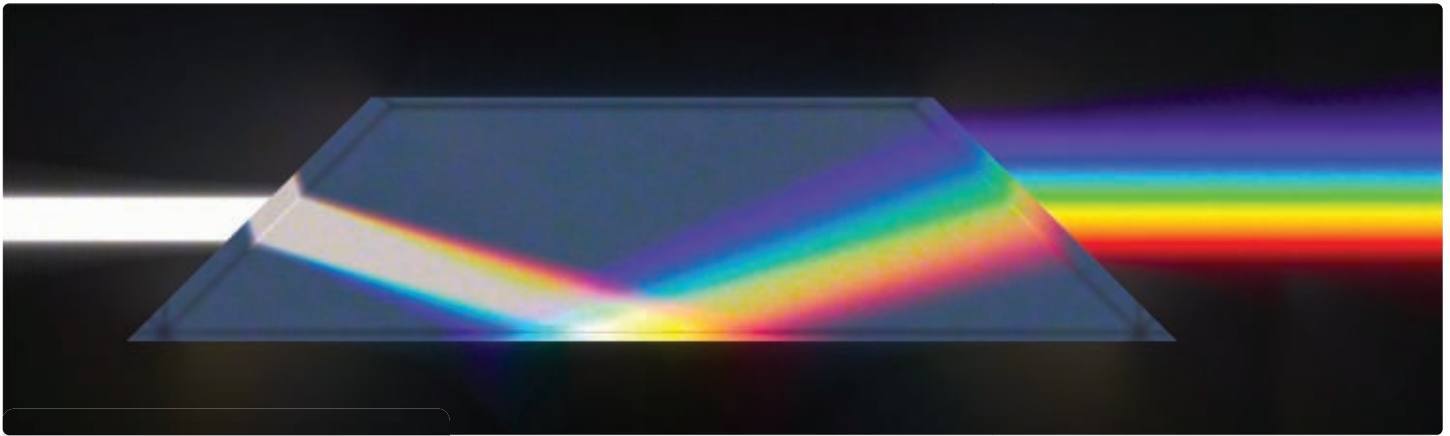
### Seamless information sharing with CAD programs

—Import and export CAD data using industry-standard formats. Associate LightTools entities with CAD files and update geometry with the click of a button, without losing optical properties and relations with other elements of the LightTools model. Link SolidWorks models to LightTools and optimize your design. Group and simplify imported geometry and perform repairs to maintain CAD model integrity and improve ray trace speed.



**Figure 5: LED taillamp linked from SolidWorks.**

# Analysis Highlights



## Analysis Highlights at a Glance

- ▶ Flexible angular and spatial luminance analysis
- ▶ Accurate predictions of colorimetric performance
- ▶ Simulations of real-world effects including polarization, scattering and reflection and refraction
- ▶ Rapid, robust Monte Carlo ray tracing and accelerated ray tracing
- ▶ Visual design evaluation and communication
- ▶ Customizable, interactive charting
- ▶ Multi-CPU support to speed complex analyses and system optimization

For more information, visit [www.opticalres.com/lt/features](http://www.opticalres.com/lt/features)

## Analysis Tools that Verify and Ensure Design Performance

With LightTools' virtual prototyping capabilities, you can quickly analyze your system and perform tradeoff studies. Explore design alternatives, study light behavior and improve product quality by identifying and fixing potential problem areas early in the product development process.

LightTools calculates all the photometric and radiometric quantities needed to perform a complete illumination analysis. Define any number of receivers on real or virtual surfaces in the model to collect ray trace results for illumination analysis. Calculate illuminance, luminance, luminous intensity (near and far field) and encircled energy (angular and spatial) at any receiver.

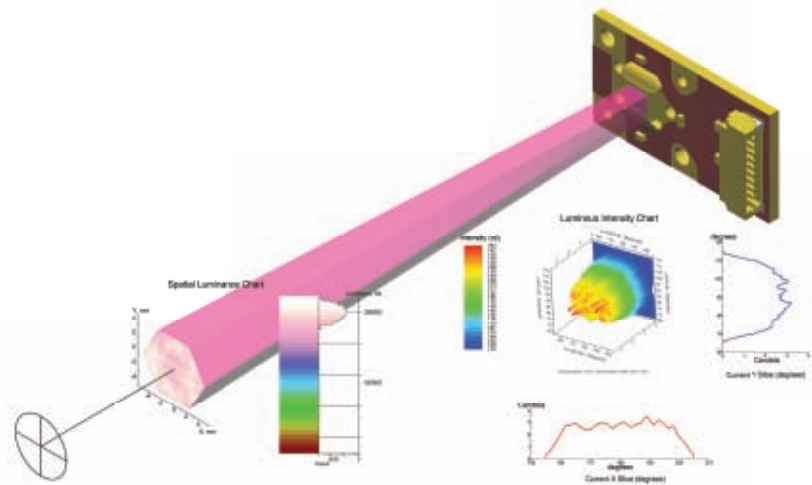


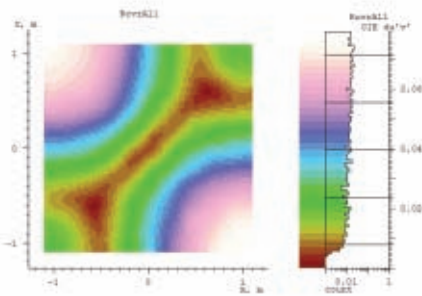
Figure 6: LightTools' full suite of analysis tools includes intensity, luminance and illuminance charts.

### Angular and spatial luminance analysis

**analysis**—Attach angular and spatial luminance meters to surface receivers to analyze and display luminance. Move the luminance meter angle to see what the fabricated system's performance will look like at any viewing angle, in real time.

### Accurate predictions of colorimetric performance

**performance**—Obtain calculations of CIE coordinates (1931 x-y or 1976 u'-v') for receivers as well as the Correlated Color Temperature (CCT) as a function of position or angle. Visualize true color appearance of an illuminated surface using the RGB plotting capability.



**Figure 7: CIE color difference analysis calculates and optimizes system color performance. This is useful for producing an even color distribution.**

### Simulation of real-world conditions

Include surface effects such as polarization, scattering, reflection and refraction (with Fresnel losses) and the performance of thin film coatings. Include material effects such as dispersion, volumetric absorption, volume scattering and color filtering.

### Flexible, efficient Monte Carlo ray tracing

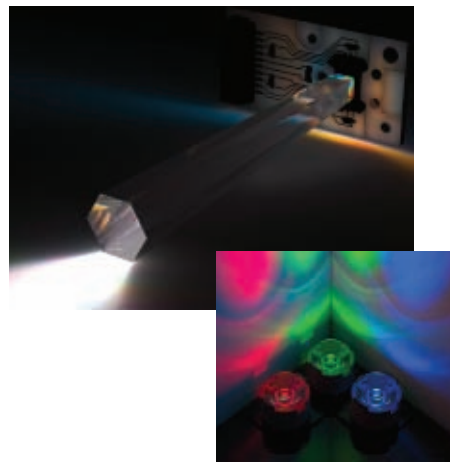
**tracing**—Perform an accurate illumination analysis with rapid and robust Monte Carlo simulations. Select forward or backward ray tracing to enhance simulation speed

and accuracy. Filter data according to a variety of criteria to improve your understanding of the results. Graphically display the paths of traced rays. Define aim regions for sources and surface scatterers to limit traced rays to important areas of the model.

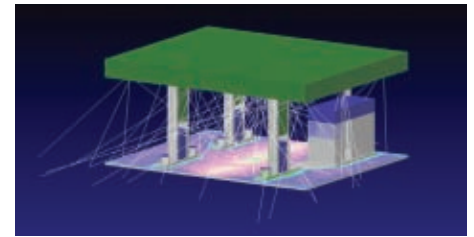
**Accelerated ray tracing**—Select ray tracing shortcuts to speed up simulations. With accelerated ray tracing, control the level of accuracy on selected surfaces to increase ray trace speed by 4x to 60x or more. Turn on probabilistic ray splitting to enable LightTools to intelligently choose which rays to trace and to ignore ray paths that carry little power.

### Visual design evaluation and communication

**communication**—Visualize illuminance in the 3D model to quickly understand the distribution relative to model geometry. Generate photorealistic renderings to assess and demonstrate how your illumination optics look and perform. Include lit appearance in photorealistic renderings to show the luminance effects of light sources contained in the model.



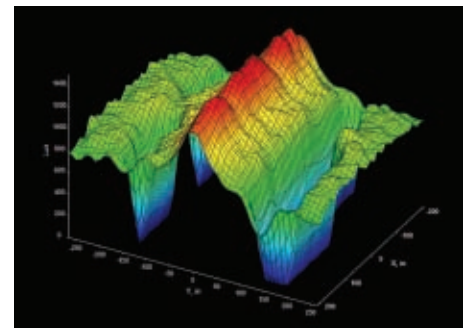
**Figure 8: LightTools' photorealistic renderings can demonstrate the appearance of your optical system during design evaluations and product presentations.**



**Figure 9: Visualize illuminance in the 3D model to quickly understand the shape and orientation of the distribution across a receiver relative to model geometry.**

### Customizable, interactive charting

Display the output of illumination calculations as line or raster plots, scatter plots, contour plots, 3D surface plots and many more formats. Interactively rotate and zoom charts to view a specific region of data. Customize charts to meet personal, company or industry standards.

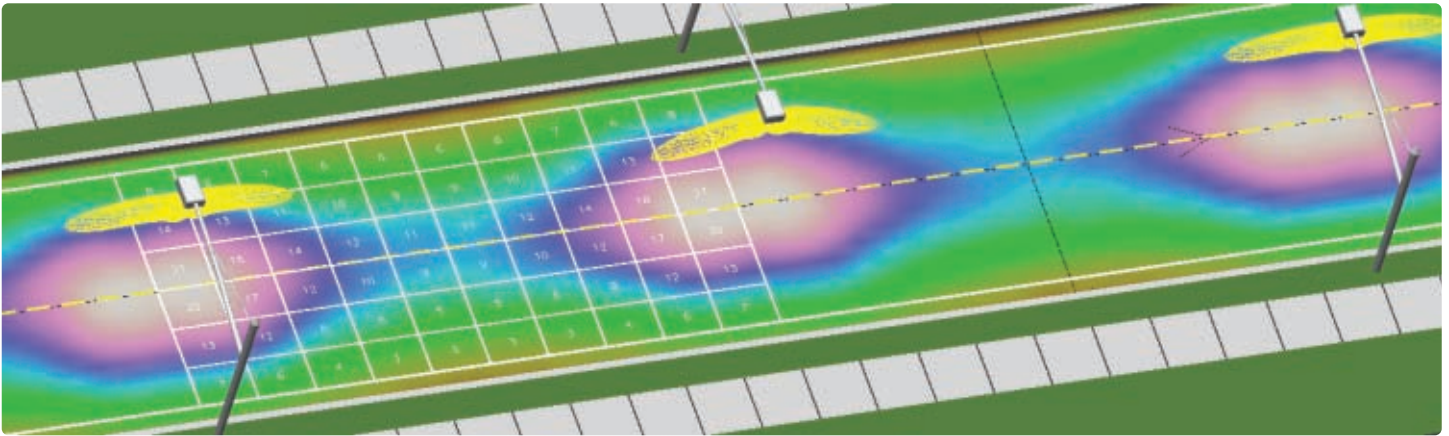


**Figure 10: LightTools charting provides many options to customize illumination simulation results to meet personal, company or industry standards.**

### Faster solutions with increased computer power

**computer power**—Speed up complex analysis and optimization processes with LightTools' multi-CPU support. LightTools makes full use of hardware configurations involving multiple CPUs or single CPUs with hyperthreading or multiple core architecture.

# Applications

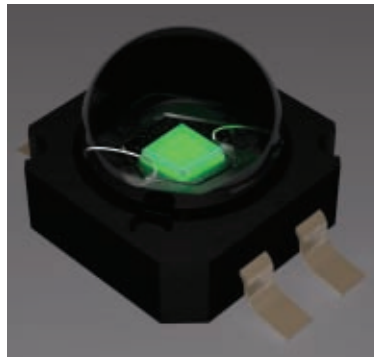


## Sample Applications and Key Features

Across a broad range of illumination applications, LightTools helps you get high-performance, cost-effective systems to market faster. Complete design and analysis features, combined with groundbreaking illumination optimization capabilities, allow you to achieve design solutions unachievable with any other software. View a gallery of LightTools applications at [www.opticalres.com/lt/applications](http://www.opticalres.com/lt/applications).

### LEDs, including LED dies, LED arrays and LED packaging

- ▶ LED utility to quickly build a complete model
- ▶ Library of pre-defined LEDs
- ▶ Multiple immersion for modeling the embedded phosphor and epoxy covering in an encapsulated LED
- ▶ Fully optimizable skinned solids for creating efficient LED couplers
- ▶ User-defined materials to model phosphor-based white LEDs



**Figure 11:** This photorealistic rendering of a lit LED shows a level of source model detail that can be easily achieved in LightTools.

### Backlit displays

- ▶ 2D and 3D textures, including multiple appliqués, dot patterns, fine groove structures and bump structures for solids and surfaces
- ▶ User-defined 3D texture shapes and patterns for designing and analyzing arrays of complex surface reliefs
- ▶ Backlight utility that automates system setup and facilitates rapid design studies
- ▶ Backlight Pattern Optimization utility that designs and optimizes backlight extraction patterns



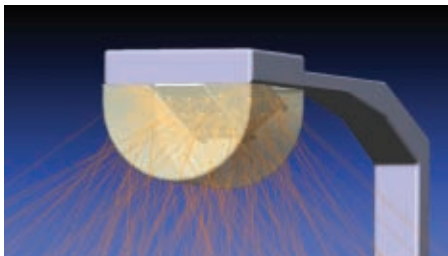
**Figure 12:** LightTools can be used to design and analyze a wide variety of consumer products, from LCD and keypad backlights on cellphones to household lighting fixtures.

### Digital and overhead projectors

- ▶ Library of pre-defined LCD, DMD and LCoS projector models
- ▶ Light source definition using existing ray data sources, including Radiant Source™ Models
- ▶ Built-in colorimetry analysis features to evaluate color quality and simulate display appearance
- ▶ Skinned solids to create complex mixing-rod shapes with minimal effort and optimization capabilities that automatically refine the design form
- ▶ Backward ray tracing for rapid, high-accuracy spatial luminance calculations

## Lighting/luminaires

- ▶ Photorealistic renderings to visualize both how a luminaire is lit and how it lights a room
- ▶ Reflector construction and automatic pattern-generation tools
- ▶ User-defined 3D textures that efficiently model a variety of complex components, from pillow optics to light diffusers for fluorescent troffers
- ▶ True-color RGB output
- ▶ Utility to read and convert IES-formatted angular intensity data files into LightTools angular apodization files



**Figure 13: LED street lamp modeled in LightTools.**

## Lightpipes

- ▶ Interactive construction, parametric editing and automatic optimization of complex shapes
- ▶ 2D and 3D texture capabilities, where each solid or surface can have multiple appliqué, dot patterns, fine groove structures or bump structures
- ▶ Probabilistic ray splitting, Fresnel loss and mixed scatter to improve speed and accuracy of light pipe simulations
- ▶ Volume scattering inside a material to simulate the diffusing characteristics of appliqué

## Stray light simulation

- ▶ Ray path analysis that visually identifies stray light issues and summarizes energy flux and total power
- ▶ Point-and-shoot rays that illustrate potential ray path problems
- ▶ Receiver data filtering for multiple analyses from a single simulation
- ▶ Importance sampling using aim areas for efficient analysis of stray light in systems
- ▶ Ghost image analyzer utility

## Vehicle interior lighting and displays

- ▶ Library of pre-defined LED and filament sources
- ▶ CAD import and export to leverage existing data
- ▶ Photorealistic renderings of an optical system's lit appearance
- ▶ Virtual luminance meters that can be graphically positioned at any location in the model space to measure spatial and angular luminance and evaluate display visibility and quality

## Vehicle exterior lighting

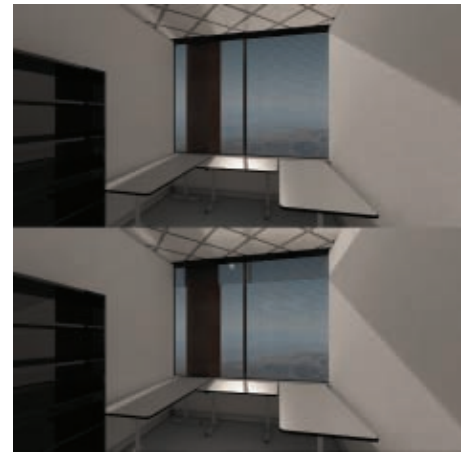
- ▶ Macro control of spline, sweep and patch surfaces
- ▶ SAE Test Point Analyzer utility that analyzes receiver data against most SAE standards, displays results and sets up type A and B photometers
- ▶ Far-field and surface receivers that collect light rays and successfully predict the luminous intensity output of lighting components
- ▶ Accelerated ray tracing of imported CAD geometry



**Figure 14: Automotive headlamp modeled in LightTools featuring filament sources for the high beam and LED sources for the low beam.**

## Solar collection and daylighting

- ▶ Skinned solids for classical and custom solar collection optics
- ▶ Solar utilities for modeling of solar collection systems
- ▶ 3D textures to model brightness-enhancing optics
- ▶ Fluorescence to enhance light capture in solar concentrators
- ▶ Photorealistic renderings to show the effect of daylighting enhancements



**Figure 15: LightTools is useful for modeling the effect of solar radiation for daylighting and architectural applications.**

## Medical devices

- ▶ Full suite of volumetric optical effects, including scatter, phosphorescence and absorption
- ▶ Ability to apply Henyey-Greenstein models to a material for tissue modeling
- ▶ Extensible BSDF surface scattering capabilities

## Machine vision and laser scanning components

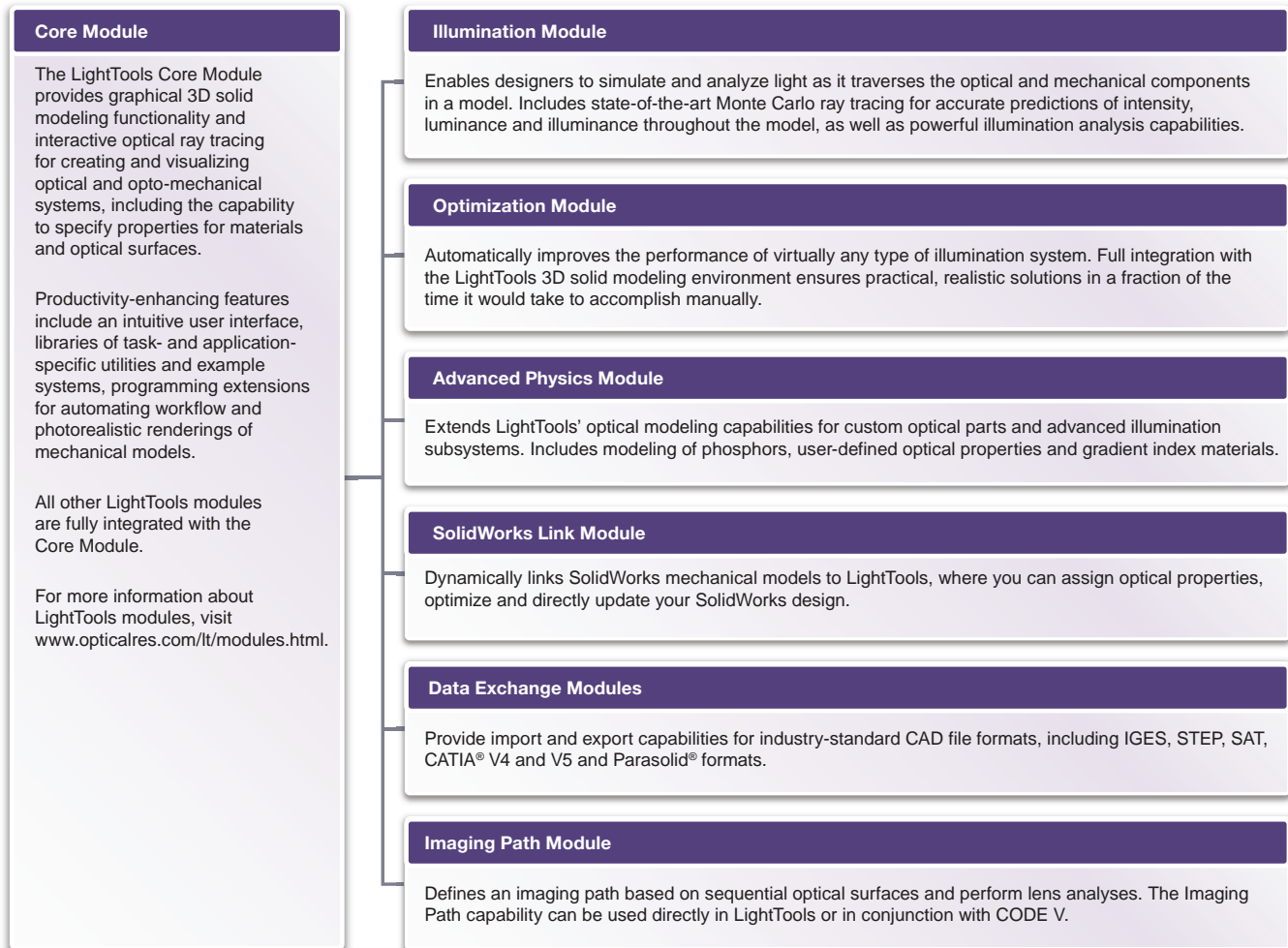
- ▶ GRIN material modeling and a full complement of geometric laser propagation capabilities
- ▶ Accurate geometric modeling of both illumination and detection optics across the electro-magnetic spectrum
- ▶ Photorealistic renderings to evaluate illuminator and detection optics from the detector's point of view

## Aerospace and defense/ spaceborne systems

- ▶ Stray light and off-axis rejection analysis, including aim areas and importance sampling
- ▶ Blackbody source spectrum
- ▶ CAD import for optical mounts and assemblies

## Configure LightTools to Meet Your Needs

LightTools has multiple modules that can be licensed in various configurations to meet your specific application needs. The Core Module is a prerequisite for all other modules, which include the Illumination Module, Optimization Module, Advanced Physics Module, SolidWorks Link Module, Data Exchange Modules and Imaging Path Module. These modules work together seamlessly to provide a complete design and analysis solution for illumination systems.



## To Learn More

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



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