

# Optical simulation software

The design of complex and high-performance optical assemblies is greatly simplified by the availability of a wide range of sophisticated software packages, reports **The Scott Partnership**.

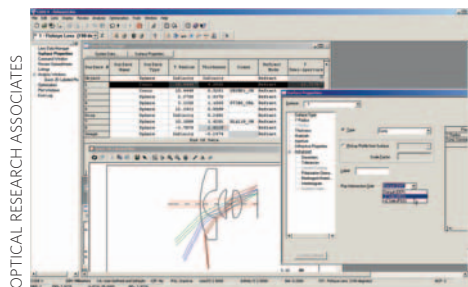
Optical design software is used by engineers and scientists to perform a variety of tasks, including illumination calculations, laser beam propagation, stray light analysis and freeform optical design. The software enables accurate and rapid virtual prototyping, allowing the performance of optical systems to be predicted and analysed prior to fabrication. It is routinely used to design a wide range of optical systems, such as lens and mirror assemblies, for a variety of products, including photographic equipment, medical instruments and aerospace systems.

“These are exciting times for optical designers,” says Kyle Ferrio, director of scientific software applications at Breault Research Organization. “As the capability [AU: OK?] of optics grows, the industry demands rigorous optical design software with virtual prototyping and manufacturing integration.”

Ferrio explains that optical designers have a long history of making important contributions to society and are now driving innovation in fields as diverse as security, medicine, entertainment and green energy generation.

Optical design software works by producing a mathematical description — known as a prescription — based on the shapes, locations and materials of all the optical elements used in a design. Typical optical design software involves three processes: data entry, evaluation and optimization. Data entry is the process of formally describing the design in question and usually involves the use of an online lens database. The evaluation stage is the point at which the performance level of the optical system is determined. Optimization — the main focus of optical design software — then takes a starting design and improves its construction to meet the desired specifications.

Methods involved in optical design software can be divided into three main categories: sequential ray-tracing, non-sequential ray-tracing and finite difference time-domain (FDTD) simulation. Sequential ray-tracing is used to model the geometrical components of optical systems, define the optical properties of objects, approximate



light sources with directional rays and then predict real-world system behaviour by observing the propagation of these rays through system models.

Unlike sequential ray-tracing, in which optical elements are intersected one at a time and light travels from surface to surface in a predefined order, non-sequential ray-tracing allows for random and multiple encounters between rays and surfaces by a process of automatic ray-splitting. Because non-sequential ray-tracing allows rays to scatter and interact with system components as they do naturally, this method enables scientists to predict the real-world behaviour of optical systems more accurately than in sequential ray-tracing [AU: Is this what you mean?].

The third method used in optical design software — FDTD simulation — offers the accuracy increase necessary when features in optical systems shrink to wavelength scales. FDTD simulation is used to predict the behaviour of micro-optical systems, and for the design and analysis of integrated optical devices, optical microcavities, plasmonic devices and scattering from wavelength-scale objects and structured surfaces. It works by propagating electromagnetic fields through micro- and nanoscale structures.

## SEQUENTIAL RAY-TRACING

Version 10.2 of the CODE V optical design software from **Optical Research Associates** (Pasadena, California, USA) features a number of enhancements that simplify its use and provide greater flexibility over previous versions. The latest version introduces improved ray-tracing algorithms that increase robustness when designing optical systems with extreme aspheres, hyper-hemispherical fields of view (fisheye lenses) and highly tilted

components. Furthermore, custom macro writing is simplified in CODE V 10.2, allowing users to now specify any appropriate external program as the default text editor. CODE V 10.2 also delivers expanded graphical output options, including the use of smarter defaults for producing optical system drawings with the ‘view lens’ feature. File conversion enhancements allow all CODE V plots to be directly saved in a number of common graphics file formats, including as BMP, GIF, JPEG, PNG and TIFF files. CODE V data display is improved with an updated status bar, which can show substantially more user-selected system parameters than in previous versions. CODE V 10.2 also makes solving tolerancing problems easier with an expanded range of built-in performance metrics. These metrics can be customized, providing users with flexibility for evaluating system performance and manufacturability.

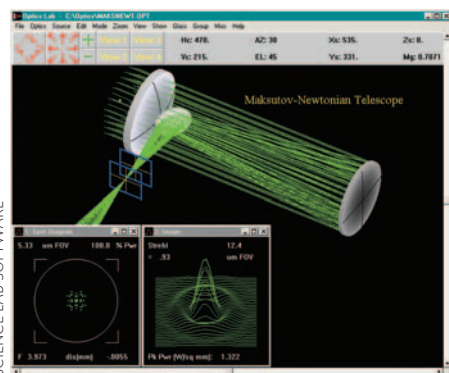
[www.opticalres.com](http://www.opticalres.com)

**Breault Research Organization** (Tucson, Arizona, USA) has made available a new version of the company’s Advanced Systems Analysis Program (ASAP). The ASAP 2009 V2R2 release adds significant capability to the program, which is a sophisticated tool for virtual prototyping of optical systems and devices. Industry applications for ASAP include automotive, architectural and speciality illumination design, simulation of laser systems and other coherent devices, stray light analysis of telescopes and space-based imaging systems, display modelling, complete biomedical system modelling and micro-optical device modelling. New features and enhancements in ASAP 2009 V2R2 include geometry shrinking, which allows users to remove unnecessary surface trimming information contained in imported CAD geometry files — a proprietary process that optimizes imported system geometries for ray-tracing — and ray export, which allows users to export rays in an IGES file format using the same tools for exporting optical system geometry already present in ASAP. Furthermore, over 30 new LED and xenon source models have been added to the Breault Research Organization light source

library, as well as other software repairs and enhancements.

[www.breault.com](http://www.breault.com)

## NON-SEQUENTIAL RAY-TRACING



SCIENCE LAB SOFTWARE

**Science Lab Software** (Carlsbad, California, USA) has developed Optics Lab, a non-sequential ray-tracing software package for optical design and analysis that allows its users to evaluate the performance of optical systems quickly and easily. The simple interface allows optics to be placed anywhere on the computer screen, with the software tracing rays through the optics automatically. Ray intercepts are computed automatically for each ray and total internal reflection is treated properly [AU: Please explain what you mean by 'treated properly']. Furthermore, optics may be placed anywhere, beam-splitters produce new rays automatically and the effects of surface scatter and ghost images may be evaluated. The software provides established [AU: OK?] models of optics, thus simplifying the optical design process as the user does not have to enter surface details individually. It also includes automatic optimization, which varies selected parameters of the optical system (such as lens radii, glass types and thicknesses) to produce the best possible image. Using Optics Lab, six colours of light may be simultaneously traced, 120 optical elements may be simultaneously used and optical elements may be offset and rotated in any direction.

[www.optics-lab.com](http://www.optics-lab.com)

**ZEMAX Development Corporation** (Bellevue, Washington, USA) has added colourimetry to its ZEMAX optical system design software tool. Colourimetry is the study of colour, which is the response of the human eye to light. It is important in many areas of lighting design — particularly in LED lighting, where a small number of narrow-wavelength bands must be made to appear white. The method works by

tracing sources using their real spectral data and then integrating over the eye's spectral response. ZEMAX's powerful optimizer allows each pixel's colour to be analysed and targeted such that a user can optimize for a desired colour. The colour of any non-sequential source object can be defined using the ZEMAX software. Many different methods of defining source colour are supported, including the CIE tristimulus, chromaticity, MacAdam [AU: OK?], blackbody and measured spectra standards. [AU: OK?]

[www.zemax.com](http://www.zemax.com)

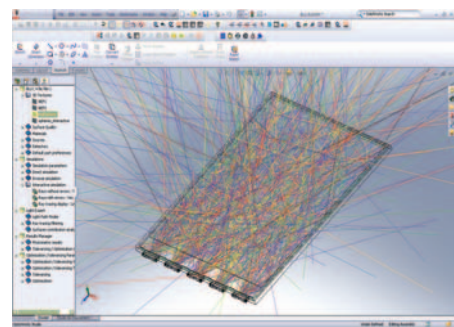
**LightTrans** (Jena, Germany) has developed VirtualLab 4.6 [AU: OK?] to provide simulation techniques covering everything from geometrical optics to electromagnetic methods in a single platform. The software exploits vectorial field-tracing for unified optical modelling, thereby offering improved flexibility and efficiency over previous versions. The toolboxes of VirtualLab 4.6 allow the investigation of nano- and micro-optics, diffractive optics, laser systems, ultrashort pulses, laser resonators, LEDs, excimer lasers, gratings, photonic crystals and artificial materials. All toolboxes — including the starter, diffractive optics, grating and laser resonator toolboxes — work together on the same platform.

[www.lighttrans.com](http://www.lighttrans.com)

**Optiwave Systems** (Ottawa, Canada), a provider of optical component and system design tools, has launched OptiBPM 10.0 — the latest version of its waveguide optics design suite. This new release includes the addition of OptiMODE, a robust application used to create complete mode-solving projects with the same level of design toolkits (layout designer, simulator, VB script and analyser) utilized in beam-propagation method and FDTD projects. The company has also announced the availability of OptiSPICE 1.0, the industry's first circuit design software for the analysis of integrated circuits, including for the interactions of optical and electronic components. OptiSPICE enables the design and simulation of optoelectronic circuits at the transistor level, from laser drivers to transimpedance amplifiers, optical interconnects and electronic equalizers. With the imminent coexistence of electrical and optical components at the chip and board level, it is important to provide designers with a reliable simulation framework that can accurately and efficiently predict signal behaviour in optoelectronic integrated circuits.

[www.optiwave.com](http://www.optiwave.com)

## SIMULATION



OPTIS

**OPTIS** (La Farlède, France) is expanding its optical design solutions with the launch of a 3D optical texture simulation solution based on its SPEOS optical design software. OPTIS solutions are based on a 3D human vision model, enabling them to take into account exactly how the eye perceives light, and thus how it images objects and true colour. OPTIS solutions are fully integrated in CAD software CATIA V5, Pro/ENGINEER and SolidWorks, making them an effective light propagation solution for manufacturers. This application allows engineering and designers to model complex, integrated mechanical and optical engineering tasks seamlessly within their existing CAD environment. Managing light and appearance is crucial for designing innovative lighting systems and optimizing human machine interfaces. The new texture simulation capability created by OPTIS makes it possible to model the optical performance of devices in conventional CAD packages, bringing significant time savings. As the use of LED sources (such as automotive tail lamps, luminaries, lit buttons and backlights in electronics devices such as PDAs and mobile phones) continues to grow, it is becoming necessary to model the optical effects of 3D textures on complex surfaces. OPTIS's 3D textures function brings both improved design functionality and valuable time savings for challenging lighting applications, from the modelling of backlit displays to the latest designs of automotive lights.

[www.optis-world.com](http://www.optis-world.com)

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