Optical design is facing an influx of new applications, new designers, and new approaches.

Optical engineering has a role at some level in any system that involves light, whether that is a lithographic stepper, a fiber-optic network, a fluorescence spectrometer, or a solid-state desk lamp. As new technologies emerge, optical design has to adjust to suit.

One area commonly considered promising is non-imaging optics, particularly solid-state lighting—using LEDs for illumination. According to Robert Steele of Strategies Unlimited (Mountain View, CA), the solid-state lighting market is small but growing fast. “It’s kind of a niche application,” he says. “If you’re thinking of LEDs replacing lightbulbs, that’s 10 years out, but that doesn’t mean there aren’t some interesting things going on.” And optical engineering is poised to play a major role. “[Optical design] is a key in enabling solid-state lighting,” adds Steele. “Almost everything you’re going to do with an LED is going to require some optical thing to shape the light and direct the light and spread it out.”

Solid-state lighting is all about non-imaging optical design—creating a desired photon flux. Non-imaging optics in general offer unique advantages. “If you’re willing to give up the ability to form an image of your object, then the field of non-imaging optics allows you to make lenses, mirrors, etc., that are typically 50% to 150% more effective than imaging optics,” says David Pelka, executive vice president of Lighting Elements (Manhattan Beach, CA). “Once you can gather up and collimate the light coming from an LED, you can use binary optical elements—holographic diffusers—to take that round, highly collimated beam and put it out into designer patterns.” He cites applications such as airfield illumination lights, picture illumination, or even illumination of the walls of glass buildings during washing. The size of the source is the key. “You get tremendously more optical control if your source is very small. You can control its radiation pattern almost completely, and you can specify far-field flux patterns that you would like. The field of non-imaging optics allows you to match them using the minimum number of LEDs possible.” Consequently, Pelka says, LED-based systems for certain high-performance applications can compete with classical systems, even though LEDs today are more expensive than incandescent or fluorescent sources.

Pelka sees other benefits to LEDs, namely the potential for color-controlled illumination. “People want to be able to take a red, green, and blue source and be able to control the color temperature to have mood lighting. LEDs’ ability to change the color content is simply something that other sources can’t offer.”

By Kristin Lewotsky