Light Matters

Designing illumination systems with high-brightness LEDs

"Today we have smart thinking about lighting, tomorrow we will have smart lighting that thinks" – Dr. Bob Karlicek, Director, Smart Lighting Engineering Research Center at Rensselaer Polytechnic Institute.

In short, Smart Lighting is a new way to envision light by leveraging one or more "seemingly unrelated" disciplines such as physics, physiology, embedded intelligence, sensors and communications. The concept is to create entirely new value propositions for light, beyond simple illumination.

Consider the humble street light. Many "traditional" streetlights today use HID (high-intensity discharge) arc lamps. These lamps are more efficient than incandescents and provide a large quantity of light. Unfortunately most magnetic induction and electric arc technology yields lamps which can only be "full on" or "full off"—thus there are times each day, (before dusk and after dawn) when potential savings are lost due to an excess of power and light.

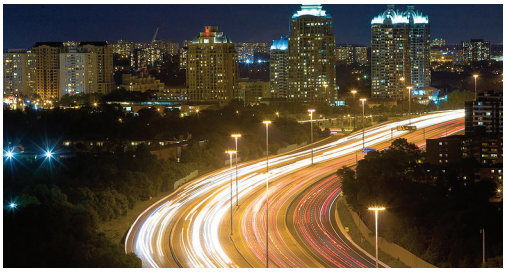

Figure 1 – High mast streetlights along a highway in Canada.

It would be more sensible to ramp a streetlight's illumination in consort with daylight- as light in the sky gradually fades, streetlights should get gradually brighter, and vice versa. High-brightness LEDs (HBLEDs) have several advantages in this application; they can be easily controlled using pulse-width modulation or other means, are more energy efficient at all brightness levels, and have much longer lifetimes.

But controlling the streetlight's output (and associated energy usage) based on ambient daylight is just a starting point. For example- it's 3 AM and traffic is minimal. Why not dim the lights, say to 75%, along selected roadways? Networked streetlights connected to inductive sensors embedded in the road can intelligently scale their energy and operating costs. During periods of infrequent use, they dim slightly. When approaching traffic is sensed a mile or two away, they return to normal illumination levels in advance of the vehicles. This is a simple example of Smart Lighting.

Let's take the idea a few steps further. Since the streetlights are networked (typically wirelessly) and their locations are known, police and emergency services can remotely increase the brightness of specific streetlights near an incident or in response to an emergency. Or flash the streetlight nearest a 911 call.

Why not monitor weather and air quality at intervals along the streetlight network? Because they are continuously-powered and out of harm's way, smart streetlight heads, streetlights can also serve as platforms for many types of sensors. The light output could be controlled locally or remotely for optimum safety under fog or storm conditions. If a streetlight fails, or is starting to fail (over-temperature, loss of one or more subsets of LEDs, etc.), the streetlight should "call home" and request a service call.

Smart LED streetlights might sound like a fantasy, but in fact Avnet, EBV and Silica have been working with customers designing systems like this for several years, both in the US and in Europe.

From an economic and safety standpoint, smart streetlights have obvious implications. But what about lighting inside your home or workplace? LEDs can be switched on and off at very high frequencies and with precise phase control. This opens the door to wireless optical communications. Since the human eye has a relatively slow response time, overhead room lighting can be transmitting high bandwidth digital information simultaneously and imperceptibly.

Researchers at the Smart Lighting Engineering Research Center are studying various solid state lighting modulation techniques including phase and polarization. Work at various institutions is also being conducted on exploiting potential health benefits of light—through selective introduction of physiologically-responsive wavelengths as well as circadian rhythm entrainment.

Today we are fortunate to have most of the critical elements for Smart Lighting at hand—HBLEDs, improved thermal management, many varieties of low-cost sensors and microcontrollers, advanced wireless protocols and modules, and institutions such as the RPI's Smart Lighting ERC. Smart Lighting will advance as fast as we can imagine new ways to use light for the benefit of mankind. If you have an application for Smart Lighting, maybe we help.

As always, feel free to send me your high-brightness LED questions, comments at **LightSpeed@Avnet.com**

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is Global Director of the Solid State Lighting and Advanced LED business unit of Avnet Electronics Marketing. An ardent advocate of energy efficient LED-based illumination, he has worked closely with LED manufacturers, advanced analog IC and secondary optics vendors since his first patent using LEDs was issued two decades ago. Avnet works with customers through their national team of illumination-focused sales engineers who are experienced in thermal, drive stage and optics design. Prior to his LED lighting focus, Cary was Avnet's technical director and managed Avnet's North American FAE team.

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To learn more about designing an LED-based illumination system, go to:

www.em.avnet.com/LightSpeed