

In predicting the future of lighting, there are myriad possibilities/directions the market might take. In the future home, for example, we might easily imagine a generation of more efficient devices that replace incandescent sources. We could imagine controls that help reduce the electrical load for lighting by 50 percent or more. We can imagine lots of whimsical, Jetsonian form factors and technological permutations such as luminous drapes, wallpaper and furniture.

Each of these respective possibilities is a one-way street, however—an individual piece in a larger potential puzzle. In order to see how these pieces may come together and precipitate a trend in commerce, we need to zoom up to 36,000 ft and try to encompass not just how the lighting industry may evolve but also how other industries may affect lighting.

One exciting possibility for the future of lighting is computing. It might sound outlandish, but—considering the puzzle pieces that are already in place—it is not hard to imagine a time in the not-so-distant future when the lighting and the information technology industries fit together in a much larger puzzle.

Our first puzzle piece is the computer science discipline of ubiquitous (or pervasive) computing, the main tenet of which is that computers demand too much of people's attention. Moore's law gives us regular, significant progression in chip speed

and storage capacity, but computers, it was felt, won't really evolve until they disappear into the environment where they can "calmly and quietly" assist people. For that to happen, we need to shrink computers and distribute them everywhere throughout the built space. These tiny computers would also need to sense their location and communicate with one another. They could then monitor, interact and assist building occupants. Most components in the workaday environment (switches, outlets, ovens, etc.) already contain

computer-rich environment, how do we get these computers to talk?

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That's where the puzzle piece of controls falls into place. Computers are dumb to location. Embedded GPS devices in PDAs can place us on a map, but on a room scale, a computer doesn't know its own location or its location relative to other computers. A few lighting controls companies have emerged recently, however, that offer the promise of dynamic controls through sensing

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a chip and can be considered de facto computers. Thus, the first criterion, shrinking the computer and distributing it throughout the environment, has already been met.

Where the architects of ubiquitous computing erred, however, was in thinking that the tiny, distributed computers should be stripped bare of most processing capacity. They become featureless drones that are controlled peripherally by a back-end server that carries the computing burden. Because appliance manufacturers rely on feature sets for competitive differentiation and back-end servers are impractical, the potential of ubiquitous computing was never realized. Questions remain like: Even if we have a lean,

and, as a result, escape from the issues of commissioning. Dimming algorithms are nuanced, and the effect is remarkably sophisticated compared to what we are used to.

It is the future of lighting controls, but it is much more than that. Each light acts as an individual computer, locating its neighbor and working in concert to tailor dimming based on environmental feedback. Voilà: a ubiquitous computing network is born. Instead of stripping down all the components in the environment, the architects of ubiquitous computing should have identified a potential super component, and they need look no further than lighting.

We need light everywhere, so it is laid out in a regular grid. Each

APPS + ANSWERS

power supply can hold a chip, and each fixture can contain a sensor array; luminaires can even be a Wi-Fi source. Lighting, then, becomes the perfect Trojan horse for distributing computing power throughout the built environment.

The future of lighting controls doesn't have to be limited to occupancy or daylight harvesting functions. The addition of RFID technology would allow for personalized lighting for each occupant. We could have undercabinet fixtures, for example, which would be a glare source to a person in a wheel chair, dim when that person enters the room. We can imagine a 100-sq ft illuminated area that envelops a worker as he cleans an open office at night without the need to light the entire floor.

With aging baby boomers reaching retirement age, smart homes become a necessity. Instead of imagining the built environment as a blank slate—a series of discreet spaces into which we introduce discreet sources—imagine a ubiquitous lighting scenario with pre-loaded sources. Through remote access to the smart home, the future designer could design the lighting specifically tuned to all the home occupant's needs. This dynamic commissioning also allows us to abandon the idea of lighting design as a one-size-fits-all, time zero snapshot. The lighting design can be created for each person and it can evolve over time. It can be tailored to individual spectral sensitivities, health needs and personal preference for light.

TOMORROW'S ALLIANCE

From a lighting perspective, the potential alliance of lighting and

computing is exciting, but the real question is how the information technology industry might harness the potential. The promise of open source programming and the range of applications built for devices like the iPhone, for example, point to infinite possibilities of what the future of computing looks like. Despite the prophecy of movies like *Avatar*, that future is not necessarily a virtual reality. The architect of ubiquitous computing imagined just the opposite: a crescendo away from our machines and back into the real world. The promise of ubiquitous computing is the ability to lead more sensory, human lives—the same brand of living as our ancestors.

Over the last 30 years, computers have evolved to become a societal need absorbing much of our working and personal lives. Ubiquitous computing doesn't propose to negate that need. If anything, computing will be even more prevalent; we just won't see it. Our days of staring at a box are numbered, and, when it is all said and done, we may have lighting to thank for it.



Don Peifer began his career designing the lighting for such famed photographers as Annie Leibovitz and Steven Klein. Architectural projects include the Flagship Nike Media Store in NYC. A graduate of the Lighting Research Center at RPI, Mr. Peifer is the founder and chief innovation officer for Lunera Lighting.