Ian ASHDOWN

Ian Ashdown is cofounder of the All Things Lighting Association (ATLA), a non-profit organization whose purpose is to advance, support, promote and contribute to innovation, science, and engineering in lighting, including lighting for health, horticulture, architecture and entertainment.

He is also President and Senior Scientist for SunTracker Technologies Ltd., where he develops lighting design and analysis software for horiculture, architecture, entertainment, and ultraviolet germicidal disinfection. He has been doing lighting research for thirty years, and currently holds 75 patents in many fields of lighting science and technology.

Lighting Design as a Cross-Disciplinary Science

What does the *metaverse*, the promised "next chapter for the Internet" (Mark Zuckerberg, 2021), have to do with architectural lighting? It will be after all an immersive virtual world where people will gather to socialize, play, and work.

The first and obvious answer is that the metaverse will be a reflection of our physical world, where companies will want their virtual storefronts and gathering spaces to be as engaging as their physical counterparts. This will give professional lighting designers the opportunity to design lighting for virtual spaces in much the same manner as we do now with lighting design software for physical spaces.

We can do better, however. The second and more subtle answer lies in what we already know about the psychophysics of spatial and temporal human vision. There is a much richer and more rewarding set of opportunities and challenges for start-up companies that may come from applying this knowledge.

Think about it: the metaverse will be nothing more than the projection of images onto the viewer's retinae. With eye tracking technology, we will know the viewer's gaze direction and hence the spatial distribution of cones, rods, and ipRGCs onto which the images are being projected. From vision and color science, we already know that our perception of reality can be influenced by what our retinae see and how our visual cortex processes the flow of information – we can manipulate this information frame-by-frame to our advantage.

The knowledge is there for all to see, published in peer-reviewed academic journals. What is often not there, however, is an understanding of how it can be applied to lighting design, or more specifically to how we perceive our environment through optical radiation. To apply this knowledge, we need to thoroughly understand the topic from our perspective.

Speaking more generally, lighting design is inherently a cross-disciplinary science. Think, for example, of circadian-based lighting, light pollution, light-based communications, Internet of Things, ultraviolet germicidal disinfection, and horticultural lighting. We invariably ask, "How can I apply existing products and technologies to these market opportunities?" This is, however, precisely the wrong question. We should instead ask, "What is missing here?" To answer this question, we ourselves need to become experts in the specific field, whether it is circadian rhythms, light pollution, virology, or botany. We do not need to understand every detail, but we do need to understand how the field relates to optical radiation. Only then will we see the true opportunities and challenges related to lighting, even though they may not be evident to acknowledged experts in the field.

Take, for example, horticultural lighting and its relation to botany. Should you as a lighting entrepreneur care about the spectral and temporal responsivity of the photopigment phytochrome in relation to the end-of-day responses of plants, and in particular diurnal and circannual changes in atmospheric sky color? If you want to be on the cutting edge of lighting technology, the answer is unequivocal: yes.

Horticultural lighting is not about using blue InGaN and red AlInGaP LEDs to maximize photosynthesis; it is about manipulating the spectral and temporal properties of light sources to optimize the multidimensional aspects of plant growth and development. From the molecular underpinnings of plant photomorphology and (in this case) atmospheric physics, we need to look well beyond lighting science.

The same principle applies everywhere that lighting of any sort has an impact: the opportunities and challenges come from fully understanding the potential scope of the application. It is not about how we illuminate something, but how that something responds to and utilizes light. ■

I.A.