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DETAILS

Designing the Lit Environment

Techniques and technologies to promote holistic lighting design

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Designing the Lit Environment

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There often is a tension between lighting designers who focus on daylighting design and those who concentrate on electric lighting design. In my experience, the tension arises out of a conversation such as this:

Daylighting Consultant: “Daylight is important for people’s health and productivity, is highly desirable, and can reduce lighting energy use. It is my goal to make sure that your electric lighting is never on. I will design the fenestration system to achieve the specified lighting criteria with daylight only.”

Electric Lighting Designer: “It is my goal to highlight the beauty of the architecture and achieve the specified lighting criteria during all

occupied hours of the year, not just those hours when the sun is out. Besides, daylighting can be glaring and I want to be sure the space is well lit even when the blinds are closed."

Too often, the daylighting consultant and the electric lighting consultant struggle to find a common language and fail to recognize that what is needed is holistic lighting design. The challenge of specialization is successful integration of that specific knowledge. Daylighting consultants and electric lighting designers, even those with a close working relationship, or those who have expertise in both areas, often find it challenging to navigate the two media. Who needs to be involved to promote successful holistic lighting design? What techniques and technologies are available to progress its evolution? What language barriers and technological shortfalls exist to complicate the issue? These questions will be pursued in this article.

UNDERSTANDING THE PROBLEM

The desire to include daylight and the need to reduce energy use in office buildings has led to the development of lighting control systems that attempt to integrate, or at least communicate between, the two lighting types. These systems hold tremendous potential to reduce energy use in buildings. The general premise is that if sufficient daylight is present, electric lights will respond and either dim or switch off. Unfortunately, in reality it is rare that spaces designed for inclusion of daylight produce the electric lighting energy savings purported during design stages. This is in large part due to dissatisfaction among building users who disable the lighting control systems or fail to operate their blinds in an optimal fashion, therefore reducing electric lighting energy savings. Too often, I walk into supposedly "daylit spaces" and the blinds are down. Research suggests that occupants rarely adjust blinds, and if they do, they are only positioned for short instances of glare. For example, in an informal walkthrough of two elementary schools in Idaho with a total of 156 south-facing windows with manual louver blinds, only 18 windows had blinds that were open. That represents only 10 percent of the potential daylight access. This phenomenon obviously plays an important role in the design of the lit environment and illustrates a lack of understanding of the complexity of design and occupancy issues related to the lit environment.

Daylight sensing lighting control technology has been available for a long time but the market has been slow to adopt these technologies, in part because of a shortfall of long-term research studies that support the technology's implementation. The rather small collection of research available primarily highlights the shortcomings of the control systems in areas of realized energy savings, installation and commissioning, and user satisfaction, and suggests that users go so far as to physically disable the systems. The most broad-sweeping multiple-site research effort in the area of integrated lighting controls, completed by Fair Oaks, California-based Heschong Mahone Group in 2005, suggests that spaces with daylight entering from the side, using a photocell-based electric lighting control system, achieve an average of only a 25 percent realized savings ratio. This is unacceptable and is part of the reason why some owners are hesitant to install integrated lighting controls. It also is a sign that there is miscommunication between daylighting designers, electric lighting designers, and the whole of the design team, as well as those living and working in these spaces.

When considering the holistic lit environment, many factors come into play including the dynamic typologies of daylight sources, electric light sources, view content outdoors, surface color and specularity both indoors and outdoors as viewed through windows, color temperature of various sources, color rendering of electric sources, blind type, control type, task type, as well as a multitude of individual user factors. How do holistic lighting designers make sense of and incorporate these factors? It is a challenge that will keep those in the lighting community employed for years to come. However, there are some recent evolutions that are beginning to progress holistic lighting design; both in design approach and technological innovations.

INTEGRATED DESIGN PROCESS

The Integrated Design Lab (IDL) in Boise, Idaho, a function of the University of Idaho College of Art and Architecture, is part of the Pacific Northwest University Design Lab Network that worked to develop the following definition of the integrated design process with the leadership of professor G.Z. Brown at the University of Oregon. “Integrated design synthesizes climate, use, loads and systems resulting in a more comfortable and productive environment, and a building that is more energy-efficient than current best practices.” The IDL believes this process will produce buildings that are more comfortable, require less energy to maintain and operate, and enhance the health and productivity of their inhabitants. The process, when employed aggressively, brings owners, users, and the entire design and construction team together for meaningful dialogue on a long list of topics, including the lit environment. Within the design team, this process provides a stage for important discussion between lighting designers with expertise in daylighting design and electric lighting design, architects, mechanical and electrical engineers, interior designers and space planners, and landscape architects. All of these disciplines need to be connected to promote holistic lighting design. The integrated design process has fostered new developments in control logics that wrap multiple building systems together that can result in additional benefits beyond the lit environment. This type of dialogue holds the potential to produce new knowledge of the interaction of building systems that also can lead to better understanding and progress of holistic lighting design. Additionally, it can provide a conduit for user input and education of lighting design intents that will result in improved system functionality.

HIGH DYNAMIC RANGE IMAGING

Mehlika Inanici, now at the University of Washington, validated high dynamic range (HDR) imaging as a digital photography technique with the use of Photosphere software and simple digital cameras. HDR imaging captures the spatial luminance from a particular point of view and produces a luminance value for each pixel captured by a digital camera. In 2006, researchers at the Lawrence Berkeley National Laboratory introduced elements of HDR imaging into the built environment at the New York Times Headquarters building in New York City. The building installed several horizontally directed illumination sensors at the perimeter of the building looking through the glass to the outside. These sensors were calibrated with HDR photographic luminance commissioning data in an effort to develop a blind control system that responded to minimize instances of glare. This approach has proved promising, although it is not surprising to note that occupant experiences are providing additional input for consideration in adjusting blind control algorithms. As published by Sarkar and Mistrick in the Illuminating Engineering

Society of North America's journal Leukos (2006), experiments with HDR also have been conducted to control electric lighting in response to daylight available.

COLOR TEMPERATURE

One of the challenges of integrated lighting controls is that even when there is substantial daylight in a space and the electric lighting either dims or switches off, occupants often perceive a change in color temperature. The overall change in light level may be irrelevant and virtually unnoticeable, but the occupant may still take note and possibly be disturbed by the shift in color temperature of the overall lit environment. Philips has developed what it calls "Dynamic Lighting." According to the product website, "with Dynamic Lighting, we can bring the dynamic character of light—with its seamless changes in brightness and warmth—indoors, allowing us to enjoy the beneficial effects of natural light on the human body." Essentially the system places a differentially dimmable cool lamp and warm lamp within the same fixture, thus allowing flexible combined color temperature and intensity. While some might read Philips' claim as a means of supplanting daylight, thus casting a myopic attitude toward holistic lighting, an interesting opportunity also emerges. This type of system might be used to better mesh with the variable color and intensity of daylight sources while still being tuned for energy savings. Could controlling color temperature through this type of electric lighting system help minimize the color shift often perceived in typical daylight sensing electric lighting control systems? If so, this may serve as an interesting area to pursue for those who want to progress the idea of holistic lighting design.

The integrated design process, integrated building control systems, HDR imaging, and manipulability of color temperature are a few areas the future of holistic lighting design may look toward to continue the evolution of designing the lit environment. These relatively new techniques and technologies provide additional layers to the field of lighting design and add to the tool belt of those interested in practicing holistic lighting design.

KEYWORDS

Subject
Lighting Design, Daylighting, Illumination, Control Systems

Organization
HDR

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