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THOUGHT LEADERSHIP

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Does Your Daylight Harvesting System Perform Brilliantly?

Assessing Energy Efficiency and Investigating Failures in Automated Lighting Controls

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Lighting currently accounts for approximately one-fifth of global electricity use. To comply with energy efficiency certifications (e.g., LEED and Green Star) and local codes (e.g., California Title 24-2008 and New York City Local Law 97), building owners are increasingly installing daylight harvesting systems that aim to conserve energy in new buildings and building retrofits. Also known as daylight-linked controls, these advanced lighting control systems involve a complex arrangement of photosensors, controllers, shades, and dimmers that can adjust the output of light fixtures and the positions of shades in response to light entering from windows and skylights. The overarching goal is to maximize daylight to offset the amount of electrical lighting needed to properly light a space.

While studies predict that daylight harvesting systems can provide up to 60% energy savings, effective system design, installation, and operation can be complicated and often involve more than one system and vendor. Nascent energy efficiency standards and complex daylight harvesting technologies can pose significant challenges for even the most experienced system designers and operators, sometimes resulting in performance gaps. When energy savings from daylight harvesting systems are less than building owners and operators expect, thorough investigations can help stakeholders across industries identify the root cause and support dispute resolution.

Interconnected Systems, Interconnected Problems

Because daylight-linked controls are complicated electronic systems that are relatively new to wide installation, multiple factors can affect their performance. Gaps in system design; malfunctioning of sensors, cables, and other system components; incorrect installation; and ineffective operation can all contribute to lower than expected system performance or cost savings. In more than one case, a daylight sensor for a system for controlling the interior lighting in a shopping mall or office has been installed on the exterior roof, causing the system to be unable to detect and respond to dim conditions inside the building. As a result, the interior light levels were often too dim, or the interior lights simply remained off during all daylight hours. Frequently an inadequate sensor calibration and system commissioning process fails to detect sensor failures or wiring errors. If these issues prevent the system from dimming interior lights as intended, the expected energy savings of the system will not be achieved.

Daylight harvesting goes well beyond lighting and photosensors. Wiring and equipment need to be interconnected, installed, and programmed throughout entire multi-story buildings. If systems will be connected to the Internet of Things or smart phones, cybersecurity

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should be considered as well, including how best to interface with legacy systems. Lighting control systems may also interact in complex "combined control" strategies with other building systems such as shading systems and HVAC systems. For instance, in sunny conditions an automated shade control system may lower shades to decrease the amount of exterior light entering a building to reduce glare and HVAC demand for cooling, triggering the daylight harvesting system to increase energy consumption on interior lighting and heat gain from light fixtures. Even human factors come into play—a daylight harvesting system that poorly accounts for occupant comfort and usability could lead to occupants inhibiting the system. Daylight in a room is great until it causes unbearable glare on a computer screen or makes a metal desk too hot to work on. Poorly placed or insufficient sensors could lead occupants to tape over all of them if the lighting controls become too unusable. Motion sensors that are often coupled into these systems that don't account for furniture placement could also lead to manual overrides of a system.

Because each of these considerations can fall into different practices across multiple vendors and contractors, daylight harvesting systems can understandably experience a lack of oversight during the design, construction, and installation processes.

Wider Use, More Disputes

As the technology becomes more ubiquitous, we are starting to see an increase in disputes involving construction delays and electrical claims related to daylight harvesting. Our team at Exponent can help resolve these disputes by evaluating daylight harvesting technology at both the system and component level alongside each of the above considerations. We recently analyzed a system to offer dispute resolution support for a landmark 39-story office building in New York City that recently underwent a gut renovation. In this case we found that an electrical contractor performed substantial work beyond their contracted scope to accommodate design issues and mid-project design changes to the daylight harvesting system. The electrical contractor proposed new wiring and equipment configurations and installed 4 times more of certain lighting control elements along with additional digital controllers and additional control wiring to dozens of lighting ballasts per floor. Our work included both the investigation of system design and installation, as well as the underlying functionality of electrical and optical technologies. Combined with our analysis of technical documents, design documents, and manufacturer specification sheets, we were able to determine the root cause of what went wrong and offer some lessons learned for future possible retrofits and new builds.

How Exponent Can Help

Exponent's multi-disciplinary team of electrical engineers, computer scientists, mechanical engineers, usability analysts, and construction consultants has real-world experience analyzing daylight harvesting for litigation and international arbitration. We can help stakeholders across industries investigate design and performance issues that can affect the ability of daylight harvesting systems to deliver expected energy savings.

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