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# Working with Daylight in the Museum Environment

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I have had the privilege of working with (and learning from) two of the premier conservation departments in the country. First, at the Metropolitan Museum during my tenure as resident lighting designer in the late 1980s, and also with the Winterthur Museum during the Period Room Relighting Project. Both experiences offered an incredible opportunity to shape the visual environment for an iconic institution. These assignments also introduced me to a culture where conservators were well integrated into the programming and design process and where discussions and negotiations concerning illuminance exposure and visibility concerns took place on a regular basis.

This is a sharp contrast with what I frequently encounter on projects around the country today. Unfortunately, conservators are often perceived as bearers of bad (and expensive) news. Their input, and that of other staff, is marginalized as mission-critical preservation and operational concerns take a back seat to the pressures of creating the next architectural destination. I have been the recipient of too many calls that start something like “We just moved into our new building and ...” to believe this is an isolated issue. Of course, at that point you truly are the bearer of bad and expensive news, as an architectural issue is rebranded as a conservation problem.

Why do we continue to build so many museums that are unsuitable, if not outright hostile to the comfortable viewing of artwork and artifacts at conservation light levels? From my perspective, there are many reasons, but a few stand out related to conservation concerns:

- The design team often underestimates the magnitude of the visual havoc daylight can cause in the gallery environment, while overestimating the ability of technical systems to mitigate the problems.
- Programming requirements related to conservation criteria are poorly defined, if provided to the design team at all.
- Even well defined maximum and/or illuminance-based criteria places the emphasis on what a meter reads and not what a patron perceives.

## **Illuminance, Luminance, and Brightness Perceptions**

The basic metrics related to light exposure and visual comfort are often misunderstood by a design team. The concept of illuminance, the physical quantity of light that strikes an object is widely understood as something that needs to be controlled, even if there is confusion about the relationship between the measurement units of foot-candles and lux. Luminance, the physical quantity of light reflected back to the viewer, is often confused with brightness – how a viewer perceives and experiences luminance.

I believe it is in every conservator’s interest to consider the light that is reflected back to the viewer, and this must include luminance from all sources. A favorable relationship between the luminance reflected back by the object and the luminances of other surfaces in the surrounding field of view creates pleasing brightness perceptions of displayed objects. This is true even at the lowest illuminance levels. In my

experience, overemphasizing the target illuminance value as the end goal reinforces the tendency to treat mitigation solutions as technical concerns, to be engineered into submission. Including the visitor experience in the equation broadens the scope of the discussion and aligns conservators with the goal of creating a compelling visual experience.

Sculpting a favorable brightness perception is primarily a function of controlling the relative luminance between the displayed objects and their surround. It has little to do with the actual illuminance exposure the object receives. A luminance ratio of 3:1 between the displayed object and the surround creates a pleasing sense of emphasis and favorable brightness perceptions. As with all perceptions, subjective aspects such as prior experience and expectation will also play a powerful roll in developing brightness judgments. (I am reminded of my only late-night conservation crisis emergency phone call. During the opening party for a Degas exhibition at the Met, one donor threatened to pull his print from the show unless the light levels were reduced to the 5 foot-candle limit stated in the loan agreement. It was obvious to him, having viewed the piece at conservation light levels for years at his residence, that the piece was over-lit in the exhibit because it had never looked so bright. To the astonishment of the lender, dueling lighting meters confirmed that, in fact, the print was a little under-lit.)

So, in many ways, the art of exhibit lighting design can be defined as making objects appear brighter than expected at very low light levels. This becomes much more difficult to achieve in a world of white gallery walls, window reflections, luminous ceilings, direct sunlight patches, and the glare from unshielded accent lights. Few artifacts can compete for visual emphasis when displayed against a white wall. An illuminance meter can register the prescribed target value without revealing that the reflection from the opposite window makes viewing impossible. In these cases, the displayed material may appear to be the darkest object in the gallery, with the consequence that excessive illumination will be used to compensate.

The accompanying bar graph illustrates, on a logarithmic scale, the broad range of naturally occurring luminances that humans have evolved to perceive. Through the mechanism of visual adaptation, we are able to navigate the twelve orders of magnitude between moonless nights and a painful glimpse of the noon sun. However, an observer can only comfortably view luminances within an adapted range of two to three orders of magnitude at any moment. Note the disparity between the cluster of luminances for objects illuminated at conservation lighting levels and the luminances likely to be encountered when controlled daylight is allowed into the gallery setting. The eye can adapt to either range, but not at the same time. The visual system will automatically shift to the adapted range of the higher luminances in the field of view. The result is that the objects of interest are usually relegated to a featureless gloom when competing against daylight-induced luminances. To make matters worse, the constant shifting of one’s visual adaptation range between light and dark, window to object, print gallery to

adjacent sculpture court, creates a distracting and sometimes painful visual fatigue. Surveys and visitor logs confirm that poor visibility of displayed objects and supporting graphics is the primary complaint of patrons.

With an understanding of the disparity between the two adaptation ranges, it becomes obvious how difficult it is to affect meaningful change with post-occupancy solutions, short of blackout. It might be fair to ask whether daylight should be included in the museum luminous environment at all. However, curators speak of how the shifting spectral qualities of natural light enhance the viewing experience. Architects consider exterior views and connections to the outside world essential elements of a successful design. Visitors can tire of the monotony of black (or white) box gallery environments, and anyone with a windowless office can confirm the basic human biological need for time of day and weather cues that natural light can provide. So it would seem that the answer to the previous question is not if, but how will natural light be used.

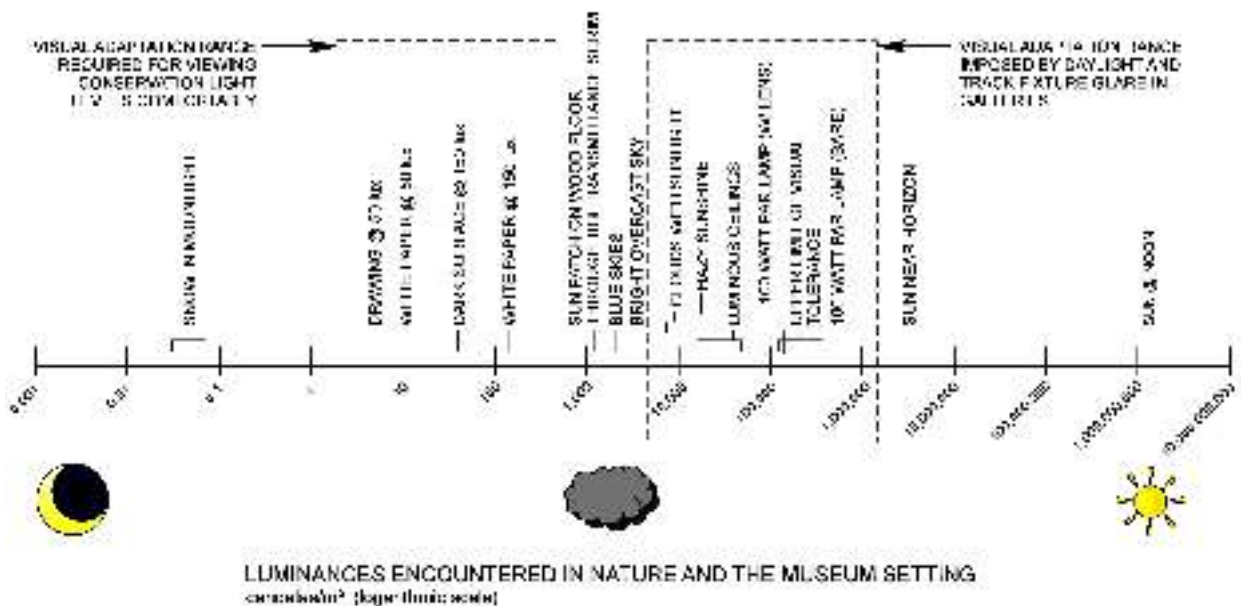
### Building Form and Daylight

Like most building types, the development of architectural forms for museums and art galleries was influenced by specific illumination criteria. The initial illumination criteria of these spaces, which were primarily developed in the overcast climates of northern Europe during the 18th and 19th centuries, were based on maximizing the collection of available daylight while minimizing the need for windows which reduced valuable display space and produced reflected glare. The resulting daylight delivery systems that were adopted to respond to these needs can be characterized by three solutions: clerestory windows, light wells, and skylights or luminous ceilings. Though every building and site location is different, the impacts of these building forms on illuminance distribution, luminance ratios, and brightness perceptions are fairly consistent and can be summarized as follows:

**Windows** - In many ways, windows are the most problematic daylight introducing building form. Illuminance exposure can spike to over 5000 fc when direct sun is allowed to enter a typical window and strike an object. Even if illuminance is controlled, the outside view will force the eye to adapt to luminances much higher than the displayed material. Finally, the reflections of the windows in display cases, works under glass, glazed objects, and paintings with varnish, can greatly reduce object perception and understanding. From my perspective there is no practical way to maintain favorable viewing conditions at conservation light levels in a gallery with windows. As noted earlier, shades and scrims are a last-ditch solution to an existing problem, and should not be considered as an acceptable solution for new construction.

**Skylights** (clear glazing at the ceiling) - Skylights can also introduce direct sun patches of extremely high illuminance into the museum environment. Rarely used in official 'gallery' areas, skylights are most often found in atriums and courtyards – areas that sooner or later will be used for the display of light sensitive materials. All of the visual concerns introduced by windows are present with unprotected skylights.

**Luminous Ceilings** (interior translucent glazing typically located under a skylight) - The traditional translucent laylight ceiling model is characterized by overpowering luminances at the ceiling. This approach can also allow large amounts of unwanted solar gain into a building envelope during the day in most seasons, and radiate heat loss at night causing a severe energy penalty. Reflections of the luminous ceiling plane can create reflected glare and difficult viewing conditions for large paintings with varnish and any glazed surface that reflects an image of the ceiling back to the viewer.



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## Working with Daylight in the Museum Environment, continued

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### **Lightwells, Lightscoops, and other Top Lighting Strategies**

- Typically, these various methods of introducing daylight from above have better visual characteristics than luminous ceilings. Top lighting strategies offer the possibility of controlling distracting luminances by blocking direct views of the sky and reflecting light into gallery. They can also be designed to distribute natural light to the display surfaces while maintaining the spectral and temporal qualities of daylight. Finally, compared to skylights and luminous ceilings, top lighting strategies can mitigate thermal concerns by minimizing glazing surface area to only let in the small percentage of the available daylight that is usable.

A well designed daylighting strategy can direct visual emphasis on the display surface without glare and reflection at modest illumination levels. In this environment, electric lighting loads can be offset and reduced by useful natural light, instead of increased to compete with excessive daylight.

### **Influence the Design Process**

The design team is working with many competing and conflicting interests as they develop the form and systems required for this most challenging of building types. Buildings that carefully introduce only the useable daylight into the building envelope, are typically less expensive to construct and maintain. The sustainability movement and stricter energy codes are prompting a rethinking of the way we design and build our museums. Having seen these issues play out on numerous projects over many years, I can offer the following recommendations on how to interact with the design team to better manage the outcome.

**1. Get involved as early as possible.** A conservator with a seat at the table during the design process is more likely to find an end result that meets their needs. Time and again, I see curatorial, conservation, and exhibit staff kept at arms length from meaningful interaction with the design team until it is too late to impact significantly the direction of the project. Enlightened leadership will understand the importance of including key owner representatives on the project team. If staff cannot be actively involved in the project, recommend that a conservation consultant be included on the design team as an owner representative. The opinions of the owner-hired consultants tend to carry more weight than when the same recommendations come from within the design team.

**2. Provide precise guidance with conservation-based lighting criteria.** The design team is often contractually obligated to provide a design that meets program requirements, and most will make a good faith effort to meet these needs if they are clearly defined. Specifically identify which collections or galleries should exclude daylight or require full blackout options. Very light sensitive object types that require 5 fc / 50 lux illumination levels cannot practically be displayed in galleries with natural light. Reiterate that lobbies, atriums, and corridors are display spaces. A not-to-exceed illuminance criteria is a start, but for galleries with daylight, annual cumulative illumination criteria will be needed. 5 fc / 50 lux of electric illumination equates to 15,000 annual fc-hours / 150,000 annual lux-hours. The

more typical 15 fc of electric accent lighting used in painting galleries approach 50,000 fc-hours / 500,000 lux-hours. A well-defined set of requirements can be your best chance to express your needs to the design team – especially if you are not actively involved during the design phase of the project.

**3. Review the architectural drawings.** Monitor the progress drawings that are typically available at milestones such as 100% schematic design, 100% design development, and 50% construction documents. Look for obvious architectural features such as windows or skylights in areas identified in the program as excluding daylight. Ask for information regarding proposed daylight control systems such as shades and blackout systems. What materials and transmittances are being considered? Do the proposed systems actually provide complete blackout without light leaks at edges? Are the proposed systems manual or motorized? How are they controlled? Finally, confirm that these devices remain in the project after the inevitable cost cutting takes place.

**4. Review studies and mock-ups.** Computer modeling of illuminance trends from daylighting systems is commonplace for most projects. The lack of a study should raise concerns. Confirm that proposed strategies will meet your illumination criteria and that a reasonable amount of electric accent lighting is included in the cumulative exposure assumptions. Also, if not clearly stated, request information about the primary assumptions used in the modeling to confirm they are realistic. (Ex. Default wall reflectance assumptions are typically 50% reflectance. Typical white gallery walls have a +/- 85% reflectance. The difference could significantly increase actual display surface exposure compared to the model predictions.)

**5. Go Green.** With the increased emphasis on the sustainability and energy conservation, the poor thermal properties of walls of glass combined with the cost of expensive windows and shading systems is becoming less defensible. Top lighting daylight architecture is notoriously expensive to construct, and every roof penetration increases the potential for leaks. Minimizing or eliminating daylighting systems will provide energy savings and lower building costs. Solid walls and roofs are less expensive than windows or glazing systems and the added shading systems that must be used to control the excessive light that these openings let into the building. When discussions about pleasing brightness perceptions and collection overexposure go nowhere, consider raising both 'green' arguments - environment and cost.

Consider these steps to help you get your needs expressed early on, when they are more likely to be integrated. Identify potential concerns before they become another "conservation problem." Perhaps it will not be long before responding to conservation criteria and visual concerns with appropriate building form is perceived as the low-cost, sustainable option.

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