

Improving the Management of Light in Museums

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Figure 1. Grand Rapids Art Museum, Michigan (USA)

In March of 2008, the Grand Rapids Art Museum became the first museum in the world to achieve the LEED Gold rating as a result of the \$60M expansion over 125,000 sq ft. of museum space.

This allows 70% of the museum to be lit by natural light and permits a greater connection with the reflecting pool and exterior green areas.

The US Green Building Council LEED 2009 ratings indicate 3 specific points to maximise usage of natural light within the building envelope.

In particular IEQ credit 2.4 requires a *"minimum daylight illumination level of 25 foot-candles (approx. 269 Lux)... in at least 50% of all regularly occupied areas"*.

The Market Need

When we interviewed several top museums and firms of museum architects in the UK and Spain during 2010/2011, we had to 'unlearn' what we thought we knew about the museum sector and this helped us to shape our understanding of the real business needs.

As can be seen in Fig.2, some museums need to place exhibitions in reduced natural light levels and then use directed artificial lighting which can lead to focussed deterioration on light-sensitive materials.



Figure 3. Ardabil Carpet, Persian carpet from 1539 AD, V&A Museum (London)

The museum sector also uses timer-controlled artificial lighting to protect priceless and irreplaceable works of art. One such example is the Ardabil carpet, shown in Fig.3, which is illuminated during only 10 minutes every half hour in order to limit light damage.

Curiously, this has the beneficial side-effect that museum visitors form queues to view the object, creating a heightened sense of expectation.

Figure 2. Chinese Vase with directed artificial lighting

Conservation

Exposition

Cultural institutions wishing to comply with Green Building Council requirements on greater usage of natural light then face a dilemma in balancing the **exhibition** of works of art with the **conservation** issue of reducing the resulting photo-chemical damage caused to light-sensitive materials, such as watercolours, textiles, photographs and manuscripts.

Current Solutions

Current solutions employed by the cultural sector include:

Current Solution	Analysis
Subdued natural light levels	This can impair vision and introduce safety concerns.
Directed artificial lighting	This does not offer the same colour quality as natural light and increases the energy footprint of the building, as well as causing localised deterioration.
UV filters and blinds on all windows	This measure can be expensive and cumbersome and needs to be applied to all windows in the exhibition, irrespective of how many objects are sensitive to light.
Rotating works of art periodically	This can increase the risk of accidents as objects are moved from one location to another.
Time or proximity driven lighting	This solution requires nevertheless subdued light levels in the off state.

If an object of type CIE-4 is illuminated at 50 Lux during 8 hours x 7 days x 52 weeks a year, it would receive a total exposure of 145,600 Lux Hours / Year, almost ten times above the recommended limit.

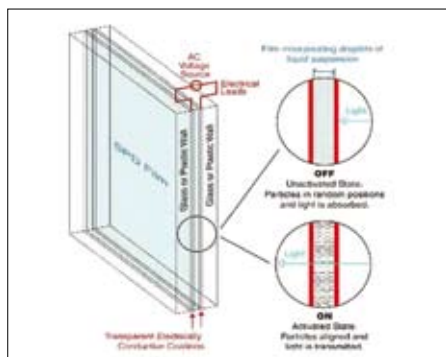
A sustainable Solution

So, instead of putting whole art exhibitions at reduced light levels, why not protect just the most light-sensitive objects in darkened display cases, only illuminating them when someone is present?

We propose using 'smart glass' (which incorporates a polymer-based light control film) to 'tune' the display cabinet to the needs of each work of art.

From the various light control films which alter their optical properties in response to an electrical signal, SPD films in particular provide special benefits to museums by allowing immediate switching, low power consumption (approx. 5W per sq. m) and less than 1% light transmission in their opaque state.

The SPD material is laminated by high-strength, high clarity glass and thus provides physical security as well as protection against the harmful effects of light.



At Domoticware, we have developed a smart display case that uses SPD smart glass to protect light-sensitive materials such as silk, manuscripts, ancient books and photographs, whereby the smart glass is controlled silently and intuitively with proximity sensors:-

- The display case switches into a semi-transparent state only when someone is present to view the work of art
- When no-one is present, the display case automatically becomes opaque, thus protecting the object from the harmful effects of UV, IR and visible light
- Thanks to the sensors positioned discretely on our display case, we can also measure light exposure (and thus estimate light damage) and transmit this information to a database which generates real-time management reports upon demand.

Benefits

Our solution gives a localised and configurable level of protection for light-sensitive works of art, allowing museums the following benefits:-

- Protects your investment in art by increasing the lifetime of each object
- Reduces restoration costs to the museum and also the environmental impact of chemical agents used therein
- Generates real-time on-demand reports to the museum management, showing profiles of temperature, humidity, light exposure and even visitor popularity

Light-Sensitive works of art

The International Commission on Illumination [CIE, from its French initials] defines categories of light-sensitive materials in its Technical Report CIE 157:2004.

CIE 157:2004 Material Light Response Classification				
CIE Category	Description	Example Materials	Limiting Illuminance (lx)	Limiting exposure (lx h / y)
4	Highly responsive	Silk, fugitive colourants, newspaper	50	15,000
3	Moderately responsive	Costumes, watercolours, pastels, tapestries, prints, drawings, manuscripts, miniatures, wallpaper, gouache, dyed leather, most natural history objects, botanical specimens, fur, feathers.	50	15,000
2	Slightly responsive	Oil, tempera painting, fresco, undyed leather and wood, horn, bone, ivory, lacquer, some plastics.	200	600,000
1	Non-responsive	Most metals, glass and minerals; stone, genuine ceramic, enamel.	no limit	no limit

- Allows the placement of very light-sensitive objects next to non-sensitive objects, allowing the museum to portray a coherent historical story
- Reduces the necessity for artificial lighting, thus allowing more natural light into the museum and reducing the energy footprint of the building
- Increased natural light improves the health and well-being of museum staff and visitors and improves the colour quality in which works of art are viewed
- Reduces the necessity for UV / IR filters and window shades which are not geared to seasonal sunlight distribution patterns or differing types of light-sensitive materials in the exhibition

Current Clients

We are now working with several cultural institutions worldwide to design solutions based on their concrete requirements, specific to each work of art. Please contact us for more information if you feel our products can help you to meet your objectives regarding the management of light.

About Us

Domoticware S.L.U. is a product design company dedicated to the smart building and sustainable construction sectors. We are corporate members of the UK Museums Association and the Green Building Council (Spain), through whom we promote the usage of smart materials to improve the management of light in buildings.