



Museum Lighting - A Lecture

This is a three part lecture on aspects of museum lighting originally given to a members of FORUM FOR EXHIBITORS in Norr Sweden.

The full lecture is available as a one day seminar by Kevan Shaw.

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Lecture 1: Museum Lighting Philosophy

Our approach to lighting museums is one of embracing light and moulding it to meet the apparently conflicting requirements in museum environment. Light is on one hand a destructive force and thus conflicts with the museums role in preserving our heritage other it is essential to vision, the principal means of communicating the information held within and around the objects in the collection, it is a key element in providing a context in time and space for the museum visitor, in an architectural sense as well relationship with the collection and it provides a key interpretive tool to extend the possibilities in communication.

All these elements are brought to a balance in the different projects I will be showing you. It is naturally difficult to isolate these they are so interrelated however I will try to describe how these different aspects come together in the results illustrated for each

St Mungo's Museum of Religious Life and Art, Glasgow. This project was developed as a change of use for an existing building originally designed as a visitor centre and meeting place for the adjacent Glasgow Cathedral. The building shell was completed by Architects Page + Park designed the fit out as a museum. The building included large areas of glazing to East and West in the space which were used to display part of the City's collection of stained glass. Generally the windows in the upper floors of the building had been designed to offer key views of the Cathedral and its surroundings which are relevant to the Museum's didactic role and therefore essential to retain. In this case much consideration was given to means of controlling the daylight while retaining the quality, views and opportunities for the display of glass.

Working closely with the architect, curator and conservators we developed an approach which allows daylight to retain a limited lighting but allow the views and display of glass. All the windows in the museum area are covered with neutral density window

providing an 80% reduction in light transmission. By treating all the windows and approaching the treated spaces through a stage is totally artificially lit visitors are unaware that the windows are anything other than clear. The next stage in the design was to direct sunlight could not fall on light sensitive objects. Working with the architects and curators displays were arranged with windows onto the windows providing large areas of shade within the galleries, The final piece of the jigsaw was the addition of controlled fluorescent light to the coffers adjacent to the windows allowing the surfaces here to appear to be lit by the windows completing that there is much more daylight in the space than is actually present.

Another challenge frequently presented is the display of small objects in desk cases. Here there are dual problems of shadowing viewer as they attempt to get as close as possible to the objects to see fine detail and veiling reflections of light fittings in the case. The solution here was again dependent on close cooperation with the architect and curator, we designed a coffer detail to provide a large area of light which provides extremely even lighting over the wall and case surface. As the area of light is so large there is no shadowing even when your face is almost touching the glass case and the even, relatively low intensity of the light does not create reflections in the case surface.

Finally in St. Mungo's, the curators were keen to create a contextually sensitive display for this large statue of Shiva, the Hindu deity. Traditionally this is displayed lit by multi flamed oil lamps which create advancing shadow making the statue appear to be alive. To create this effect we designed a simple effect light using two dichroic lamps a clock motor and a disk of obscuring glass two of which are mounted in the ceiling above the statue.

St Mungo's represents a traditional museum environment with a typical mixed collection. In recent years the growing interest in archaeology and social history has led to the development of industrial museums often within existing historic industrial buildings. Works in Dundee is a typical example of this type of project. The buildings are a typical jute mill of the late Victorian period and surviving Victorian office for which we reproduced simple lamp shades from an example found on site and use period carbon filament lamps to accurately reproduce the lighting as it was at the turn of the century. This research into lighting history is also a key task for a lighting designer. There is considerable recorded history for decorative lighting available however practical industrial and domestic lighting is generally poorly recorded but can produce some interesting discoveries in the way light has been used.

The remaining buildings are being developed to explore the industrial history of Dundee, the first phase exploring the Jute processing industry and second the social aspects of the early part of the 20th Century. Displays include thematic and interpretive elements and computer interactives. The museum also has a collection of working jute machinery which forms the key exhibit area within the building. This is housed in one of the best preserved areas of the old building with original roof and skylights. The objects here are not light sensitive and are working machinery so consideration of lighting is somewhat different from more conventional museums.

Our aims here were to express the strong sculptural forms of the machinery while highlighting the significant functional elements particularly where they are normally in shadow. The principal lights are set below the walkway and positioned specifically to create shadows. As there is a significant and changing level of daylight we developed a control strategy to maintain shadows basically by reversing the logic of a control system to increase the intensity of the display lighting as the daylight levels increase thereby retaining strength in the shadows. When the machines are operated it is necessary to switch off any of the low level lighting that causes shadows on particular machine for safety reasons, again this facility was incorporated within the control system. At night the extremely dramatic lighting state is used for storytelling events. The principal controlled lighting uses high efficiency Tungsten Halogen sources, the graphic banners are lit with Theatre profiles modified to take Metal Halide lamps for energy efficiency and long life.

The River and Rowing Museum in Henley of Thames is set in a modern award winning building by David Chipperfield. The building was completed before the exhibition philosophy was finalised and the collection brought together therefore the exhibition designers Design Studios devised interpretation and display strategies that related to the building. Our concerns included integrating lighting display elements rather than impose separate elements on the architecture. We also sought opportunities to use light to bring together architecture and exhibition together. In the rowing gallery, which explores the development of rowing as a sport, the principal exhibits are a collection of boats suspended in the space. The fins designed by Land provide suspension points independent of the building and use these fin elements to provide lighting positions for the boats which are used not only to light the boats but to create layers of light of the hulls on the opposite ceiling.

In the Thames gallery the river is explored from source to the sea. Each display unit carries integral lighting, including Fibre Optic cases and coloured fluorescent to animate the glass panel structure. Although not clear in the photograph each unit also carries effect light casting moving watery patterns on the ceiling. Both the galleries have a fixed louvre system controlling light from the glazing, here we allow the wall effects to be diminished by the daylight as the changing character of natural light is more relevant content of the museum.

In the Henley gallery the lighting is much more restrained partly because of the more sensitive nature of the exhibits but also to allow a large AV projection on the left wall to retain maximum impact. again Fibre Optics are used in the cases and low voltage spots to highlight objects and create pools of light along the walkways.

Finally I would like to show you some elements of the Museum of Scotland Project. This major new building was opened last November and houses a collection ranging from geological exhibits through to large scale industrial machinery and even sections of buildings are arranged in a chronological order from the basement to the roof to tell the story of Scotland. We were involved in the project at a late stage when the majority of architectural decisions had been made and the building was in an advanced stage of construction. We were somewhat constrained by existing decisions however were charged with producing a lighting scheme that provided consistent integration between the architecture and the exhibits. The client had major concerns over aspects of maintenance for the new building from their experiences in their existing buildings where lighting development has been piecemeal over many decades resulting in numerous different types of fitting and lamp.

We created a restricted palette of lamp and fitting types and employed these to create the lighting shown here. Throughout the project differing design approaches were applied. In the 'Beginnings' exhibit in the basement the lighting is relatively intimate to the exhibits and gobos are used to provide some graphic elements. There is also a large diorama with dramatic programmed lighting looking at the History of Scotland. Through out the Scotland in History section which studies the period spanning the middle ages to modern times a general approach is to wall wash the architecture and gently highlight objects. This approach creates a brighter more open feel which are still lit to relatively low light levels, The wall wash averages 45 to 50 lux depending on the space and most highlights are in the range 150 to 200 lux.

Even working within these restrictions it is possible to use light creatively to develop interpretation as can be seen here using the lighting of the beheading machine to link with the casket.

In the area dealing with the mediaeval church a different approach was used, thematically a smaller, darker space was appropriate to the architecture and the lighting was incorporated in the concrete slab ceiling. The solution here was to use fibre optics to deliver gentle lighting to the space using high wattage Tungsten Halogen light sources to preserve colour appearance and rendering in the space.

As you have seen from this selection of projects balance is required between differing aspects of lighting to achieve a scheme that meets the specific requirements of the project.

Lecture 2: Daylight In Museums

Since the late 19th Century the destructive effect of light on colours and materials has been studied specifically in relation to museums and museum exhibits. The full spectrum of daylight has been seen to be particularly damaging due to the Ultraviolet (UV) content and high levels of light normally experienced. The colour quality of daylight is however not satisfactorily reproducible and this quality is not desirable in the viewing of art and artifacts.

A perceptual contact with the sky is also a strong and desirable contact between the displays and artifacts and the real world within a museum building. these requirements of low level controlled lighting and the dynamic high level natural light are apparently in conflict. one of the principal challenges in designing the modern museum building is to develop a strategy to resolve these issues.

Categories

In respect of potential light damage museum objects can be considered in three broad categories:

1. Extremely susceptible to light damage

this category includes works on paper, textiles, naturally occurring dyes, Natural history exhibits including fur, feather, i plant material etc. This category of object requires strictly controlled lighting conditions.

2. Susceptible to light damage

This includes Oil paintings on canvas, most wood bone and Ivory and other materials painted or coloured.

3 Not susceptible to light damage

Metal most Stone , most ceramics and glass, wooden objects that have largely been used out doors or have otherwise natural colouring through design or use etc.

Traditionally maximum light levels are applied to these categories however this is a rather oversimplified approach when consi realities of light damage. The effects of light are cumulative and the true measure of the effect of light is that of total exposure c reality the commonly accepted measures of maximum light level are based on the exposure before which a detectable change observed over a ten year period on display. Given the relative ease with which it is now possible to measure and record data, e based conservation strategies are now possible and highly desirable.

At a practical level objects that fall in the first category above cannot be displayed under natural lighting. The levels for these n set to the narrow band before the eye loses the ability to fully appreciate colours. In nature this is the early morning when the s below the horizon or the evening as the sun has set, controlling natural light to these levels creates a perpetual gloom as if on winter's afternoon, conditions not conducive to feelings of comfort and well being that you wish to enjoy in a museum environm

The second category of exhibits can be lit to levels and with sufficient variation to accommodate changing natural light conditio much controlled way.

The third category of objects are easily displayed under natural lighting without substantial risk of damage.

Natural daylight potentially has a major role in museum and gallery lighting however consideration has to be given to display a conservation policy and exhibition design in relation to the architecture of the proposed gallery space.

Conservation Considerations:

From the discussion above it is essential to develop a lighting conservation strategy based on overall exposure values rather th maximum light levels. This provide a flexibility that is essential to allow experience of the variable nature of daylight. As discuss exhibits in the first category are generally unsuitable for lighting by natural light however as they are the most susceptible to da equally need the highest level of care. Despite the low light levels for exhibition of these materials the time of exposure must st controlled through programmed switching of lighting so they are not illuminated out with exhibition hours, Consideration can als to visitor controlled lighting to further reduce general exposure but allowing optimum viewing conditions. This can introduce a le visitor interaction with the displays. This is not a novel idea, examples of this date back to Victorian Natural History displays wh particularly Moths and Butterflies were displayed in desk cases with cloth or leather covers lifted by the visitor to see the displa

The second category of objects can be displayed under a varying but narrow range of light levels and these can and are frequently disallowed under controlled natural light. In general the amount of control required will normally require an active rather than passive control system and this can be operated by a system which reacts to changing light conditions in a suitably programmed way.

With the third category it is likely that lighting control measures will be considered for comfort reasons rather than conservation

The relationship between the different categories of objects is of key importance in determining exhibition layout. For comfort a visual response it is essential to keep lighting levels within the field of view reasonably similar to allow the eye to adjust to a certain visual range and to allow transition areas between areas of differing light level.

The major question is the appropriate level of control in largely daylighted spaces. It is clear that a level of daylight control is required for reasons of heat gain and visual comfort irrespective of conservation requirements.

In determining the parameters for the light control system we have looked at the principal aspects of lighting requirements. The variable nature of daylight and the wide range of levels experienced over the course of the year we need to set some parameters against. Looking at conservation requirements we can define an appropriate annual exposure level for the categories of object above.

1B/ Clearly category 1 objects are not going to be able to be displayed in daylighted areas, this notwithstanding an annual exposure level. For objects in this category a useful measure for occasions where these objects for one reason or another are required to be illuminated at higher light levels, these reasons are more likely to be for conservation condition reports and photography rather than display. For technical reasons, for example control system failure, lighting levels exceed those that are desirable this measure can be used to determine and compensate for these eventualities. Thompson proposes 200 KLux Hours

Category 2/ objects may be exhibited satisfactorily under controlled daylight conditions. From Thompson annual exposure for these objects should not exceed 650 KLux/Hours. Providing this with daylight alone is rarely possible as the opening hours of museums extend into hours of darkness in the winter necessitating some artificial lighting.

Category 3/ objects do not require exposure levels to be predetermined. In reality the light levels for these objects will be constant with the display conditions of other objects around them.

Now we have some parameters to use as goals for daylighting let us consider what we are controlling. Daylight varies enormously throughout the world. In Northern Europe and Scandinavia we see extreme variations in daylight availability throughout the year. At the equator there is little variation throughout the year in hours of daylight or solar angles, what variation there is tends to be climate dependent.

2/ It is extremely important to use daylight availability data for the location of the project. Obtaining this data can sometimes pose problems, we usually manage to obtain this from local meteorological offices or architecture and Building engineering schools.

The first table shows actual daylight recorded in Geneva averaged over a ten year period. As you can see the daily variation is large and the month to month variation is also dramatic.

The Second table shows similar data for London and the Third for Lerwick about as far North as you get in Scotland. As you travel North the Light levels may reduce however as hours increase the proportion of light available out with exhibition opening hours increases substantially. It is obvious that substantially different daylight control solutions will be appropriate at these different locations

3/ The following studies are work in progress on a project in Geneva. The architects have designed a building with a large area of glazing which has been tested in model form under a standard artificial sky. The results indicate that there are two conditions concerning

on proximity of internal partitions. The architect and client are keen to use passive methods of lighting control however retain area as possible for the exhibition of category 2 objects.

3A/ The following graph shows the effect of simple light reduction based on building daylight factors of 1 and 0.5%. These are low figures and reflect either small areas of glazing or a high density of filtration. In respect of light levels the following table shows relatively high levels that this approach delivers in high summer (over 700 Lux?) not that there is anything wrong with this provided annual exposure is considered.

4/ Looking in more detail at the daylight situation providing blinds that effectively black out the space out with opening hours has significant effect on total exposure (18%) but so does adding in artificial light to a level of, say, 150 Lux for winter evenings, in these simple methods of daylight control do not seem to be the optimal solution for this project

KS The next option to consider is dynamic passive control, for example a system of louvres at fixed angles and orientation to the type of system is most effective in a climate with a high proportion of sunlight however it can still provide a better solution than a passive system. The design of this type of system can be extremely simple, in the case of vertical glazing a fixed micro louvre such as Coopers Koolshade can be incorporated in the glazing system which can completely eliminate high angle sunlight which accounts for significant saving in light entry to a building. On horizontal glazing the system will require careful design.

SK These sketches show some possible design approaches. The first example would be suitable for a situation with a wide variation of solar angle over the year the intention being to gather low angle sunlight at the extremes of the day in winter and obscure high angle sunlight during the summer. The second example is a more suitable system for a narrower range of solar angles with a lower variation of summer to winter and will also provide significant reduction of diffuse skylight

5/ Active dynamic control is really the best solution to the wide variation of daylight. Here a louvre system that responds to the variation of daylight is used. To give an example these are light levels recorded over two years in two similar galleries at the National Gallery London. The first shows a dynamic passive control system the second shows a fully active louvre system, both these are worked in conjunction with photocell controlled electric light. In reality the light levels remain fairly constant in the passive control gallery. The exposure rise in the passive example comes from the much longer hours of daylight in the summer months that we saw earlier in daylight availability tables. When using this type of system it is still necessary to consider sun paths in the design and orientation of the louvre system particularly with the low angle winter condition where it is possible for louvres to act as light scoops rather than light blockers. It is possible for conditions to arise that actually increase light levels within the building by closing the louvres!

When considering dynamic control the method of operation is vital to an effective system. Remember that one of the reasons for daylight is to retain contact with the outside world so too tight a control of acceptable light level within the gallery space results in frequently operating louvre or blind systems with resulting distractions and excessive wear and tear, remember that you are controlling exposure levels not light levels. Using this approach light exposure can be aggregated over a time period say quarter to half an hour and the setting for the blinds decided for the following half an hour, this cycle repeating constantly over the exhibition opening hours the result is fewer blind movements, more variation of lighting according to sky conditions, but a satisfactory level of exposure is achieved. It may seem complex to arrange however it is well within the capabilities of most Building Management systems which have similar responses when controlling heating and air conditioning systems.

In conclusion daylight can provide a welcome and tractable source of lighting within museum environments providing consideration is given to light exposure criteria for conservation rather than light levels.

Lecture 3: Artificial Lighting in Museums

So far we have discussed some aspects of natural lighting in museums, I now wish to look at the contribution of artificial lighting in Museum environment. Even when we are using daylight as a significant contribution to lighting there remain times when there is insufficient light. In northern latitudes a considerable period through the winter season will leave us with little or no natural light. We have discussed the display of highly sensitive artifacts for which natural lighting is unsuitable. Given these situations an approach to lighting requires formulation.

The principal requirement is to create optimum conditions for viewing objects, this does not only include the lighting of the objects but also the general conditions of visual comfort, that is suitable light for orientation and movement, ease of visual adaptation to differing light levels required throughout the museum. Consideration of other lighting requirements for example emergency lighting, security and security lighting for cleaning are also important and require effective integration to a complete system.

The Human Visual System

An understanding of how we see things is essential to successful lighting. The human visual system consists of two elements working together, the eye and the brain. Although a complex and flexible optical system, the eye alone does not determine what or how things are seen, this is much more to do with the brain's interpretation of the information coming from the eyes. This visual system has evolved for the purpose of viewing museum objects, it has evolved to assist us in hunting, gathering food and evading predators. It is intended to work under a wide range of lighting conditions from full daylight to star lit night. This huge adaptive range is provided in the eye through different sets of receptors, Rods and Cones, under bright conditions the eye provides full colour information to the brain this is called Photopic Vision. Under lowest light conditions only shape and movement are communicated to the brain this is called Scotopic vision. The experience of this vision is where everything appears a blue grey. The transition between these two types of vision is called Mesopic vision. This is the range of light levels under which we are expected to view many fragile museum objects.

Experimentally colour vision is shown to be effective to illumination levels as low as 20 to 30 lux. These experiments, however, used flat colour charts not three dimensional objects of varying reflectance. Generally lighting is discussed in terms of illuminance which is the light striking the object however the eye responds to the luminance of an object being viewed, that is the light that is reflected. This is a very important point to note and remember in the following discussions.

Other aspects of the human visual system are also significant. Visual information is heavily processed by the brain which attempts to make sense of it in terms of the evolutionary model. These are subconscious processes which explain some rather strange effects. The brain assumes that light is white and applies a vast amount of colour correction to the visual scene. photographic systems lack this natural colour adaptation which is why photos taken under tungsten light often turn out yellow and under fluorescent light turn out pink when your memory of the scene would have been of fairly natural colours. In fact colour memory is actually very poor how well we are able to match and compare colours is very acute within the visible spectrum. This however forms a small section of the electromagnetic spectrum which extends upwards to the Ultra Violet (UV) and downwards through the Infra Red (IR). These continuations of the spectrum make no contribution to human vision however are inescapable additions to the creation of artificial light and care also potentially destructive to museum objects, particularly U.V.

The visual system's ability to deal with a huge range of light levels works through a comparative system which responds to similar variations in contrast in a scene independent of the actual light levels. The visual system takes its point of reference from the brightest point in the field of view rather than an average of light levels in the field of view, this creates problems when there are bright windows, glare from light fittings and views through to brightly lit areas within the field of view with objects lit at relatively lower levels.

So where does this place us when lighting in museums? The effects of the visual process must become primary considerations in the location of cases and objects within galleries as well as in the design of gallery spaces. This is not an argument for bland spaces or black boxes simply these considerations must take an important place in the design of exhibition spaces.

Light Sources

When considering artificial lighting, the light source should always be the first decision in the development of a lighting scheme

of light sources to render colours accurately is crucial in museums. The standard measure for this is the colour rendering index. Conventionally a CRI of 100 represents daylight. Comparison of the ability to distinguish colours under artificial light sources forms the basis of this measure. The best light source in this respect will be tungsten halogen (TH) with a CRI of 99. Now we are aware that TH is quite different from daylight in so far as it is much stronger in the red and yellow end of the spectrum however share with daylight a continuous spectrum which is a key factor in the human response to light. The only other light sources in CRI between 90 to 100 are some fluorescent lamps. These do not have continuous spectra however do get reasonably close to the response of the eye. Other light sources including the majority of fluorescent lamps, Metal Halide and White SON considered to be good colour rendering barely reach a CRI of 85 and cannot be considered acceptable for museum applications where any colour rendering and discrimination are important. These sources do have a role to play in providing energy efficient lighting in separate from the exhibition and for non colour critical tasks such as emergency lighting, service and security lighting etc.

The other factor in selecting light sources is colour appearance. This is frequently expressed in degrees Kelvin representing a colour temperature, that is the colour of a black body heated to the same temperature. This is a very poor indicator of the true appearance as lamps can have identical colour temperatures but, to the eye, vary very dramatically. From our discussion above we remembered that the human visual system has great powers of comparative discrimination so to maintain visual continuity the source should be used in all areas that may be viewed simultaneously unless a specific visual effect is required.

Different lamp types also produce varying amounts of UV. The risks of UV to human skin have produced legislation that has led to the manufacture of reduced UV output lamps. These provide a significant contribution to the reduction of UV in display lighting however these do not provide a total solution so additional filtration should be considered for highly fragile objects or those specifically at risk to UV damage.

Although there are major strides being made in lamp technology these are not aimed at creating perfect colour rendering and colour quality in this area are generally related to uses without the extremes of colour rendition we expect in a museum, these developments largely aim towards higher energy efficiency, a case of quantity rather than quality.

On balance at present Tungsten Halogen is the first choice for lighting in museums with high colour rendering fluorescent second choice.

Delivery Systems.

- Reflectors

How do we get light from the source to the object? In the majority of situations a lamp will sit within a reflector in a light fitting. This is usually the single most important optical component, shaping the beam and controlling, or not as the case may be, any stray light. Reflectors can form part of the fitting or part of the lamp, which is preferable is a consistent source of debate in Lighting Design. Reflectors are usually either metal, bright anodised aluminium for example, or coated glass. The argument for the reflector for the fitting is that when lamps are changed the optics remain constant, however in service setting a lamp accurately in the reflector is not always easy to achieve or is time consuming. Reflectors also need to be carefully cleaned at least as often as the lamp is changed otherwise the efficiency and even beam shape are affected by dulling or in extreme cases blackening of sections of the reflector.

Lamps with integral reflectors do not give problems with reflector cleaning and maintenance however there is the possibility of problems with lamps with ones of different wattage or beam angle and the necessity to keep a larger number of lamp types in stock for maintenance.

- Lenses

At its most complex Lens systems for exhibition range will be two or three elements arranged to provide simple pattern projection to a theatre profile spot, in fact there are some situations where suitable theatre equipment can prove a useful tool for museum designers. More common in the Museum environment are simpler lenses added to the front of display spotlights.

- Sculpture lenses or spread lenses.

These are usually pressed or ribbed cast glass which changes the shape of the light beam from the circular created by the reflector to an elongated oval or elliptical pattern which helps in lighting tall and thin or wide and long displays or creating lit bands on walls to encompass a range of objects.

- Diffusing lenses

are also useful to reduce light level and increase area covered by a particular fitting or to clean up striations in a beam caused by imaging from the reflector. These again come in a variety of types including cast glass or sand blasted glass

- Filters

like lenses these are placed at the front of the fitting and are sometimes referred to as lenses. These are intended to change the light from the lamp either by colouring it for effect or more importantly for museums applications to remove UV from the light

- Fibre Optics

In recent years manufacturers have heavily sold fibre optics as the solution to all museum lighting problems. Well, they are not. Fibre Optics are just another useful tool. What they are is a light delivery system, you can consider them as a very long and thin lens in front of a lamp. What they allow you to do is distribute the light from one lamp over a greater area. They allow you to subdivide the light from a single lamp and they allow you to locate the lamp at some distance away from where you want to have the light. These characteristics are extremely useful in lighting museum cases where low light levels are required along with flexibility and the ability to remove the lamp from the volume of the case for ease of maintenance. For most museum applications Glass fibre is preferable as it naturally reduces UV content of light but will pass IR. Considerations as to lamp type are the same as elsewhere, Fibre does not affect colour rendering, if anything it will impart a green cast, the longer the fibre the more apparent this becomes. Lighting large cases can be problematic and in using fibre you have a large number of small pools of light within a case these must be carefully focussed to avoid a very bitty appearance.

Maintenance

This may seem to be a boring topic however it is vital to maintain the museum environment to the very exacting levels to which it is designed. From a lighting point of view the museum environment is also unique in the expected life of lighting installations, whereas for example a lighting scheme is likely to be redesigned or replaced on not more than a five year cycle, commercial offices on the other hand many museum installations remain as installed for periods of 15 to 25 years without substantial changes. At the other end of the scale many museums have temporary exhibition spaces where lighting is changed with the exhibition often several times a year how ever the same equipment is used so it is subject to extremes of wear and tear.

At the design stage these factors must be given serious consideration primarily in selecting equipment and fittings suitable for use and also in design development to completion keeping accurate records of fitting location, lamping and focussing to enable maintenance to be facilitated, in this way the design can be maintained as intended for the likely life of the project.

Fitting design is a key consideration. The Museum market worldwide is a tiny fraction of the overall lighting market and few manufacturers produce fittings specifically for museum use that really address the full requirement, other manufacturers will produce variations to answer some issues. This fitting for example shows key features designed for museum use:

- Positive tool operated locking to maintain focus during re lamping
- Re lamp possible without moving fitting
- Lens facility that remains undisturbed during lamp change
- Self dim at the fitting to fine tune lighting levels

- Transformer and other key elements field repairable
- Track is also an almost essential component to allow flexibility. A single type of track with common wiring standards should this should be a type that can take more than one manufacturers fittings to promote flexibility.
- Control Systems

Lighting control systems are also an important tool in museum lighting. As we discussed earlier the primary consideration for c is that of overall light exposure over time. Centralised control of exhibit lighting is key to creating a rational and effective level o control. Organised switch on and switch off at opening and closing of the museum is an essential, whether this is accomplished an automatic system or by management this is facilitated by centralising the control to one location within the building. Outside hours security and cleaners lighting can be automatically controlled either by timing or occupancy sensors, the latter is more re lighting requirements and likely to reduce exposure in the long term.

Dimming control can be very complex to specify. Both TH and Fluorescent firings can be dimmed to set lighting levels and this done generally on a circuit by circuit basis or on a fitting by fitting basis as we saw earlier. Centralised dimming can provide for changes in light level or for gentle transitions between different lighting states , for example between daylight and artificial light. case consideration should be given to automating this with light sensing in the gallery spaces as from our discussion before , e attendants to react appropriately and accurately to changes in lighting level is neither realistic or desirable.

In the case of TH lamps even slight dimming can significantly extend lamp life however excessive dimming will create a strong of the light reducing its colour rendering and appearance qualities.

Applications:

Having talked at length on technicalities I intend to wrap up by looking at a number of different lighting applications from projec

- Black Box
- White Box
- Context
- Mood
- Location
- Time
- Colour & Effects

Conclusions:

In conclusion I hope you have found this talk informative and inspiring. Light is not only a functional requirement but also a cre: medium for use in museum exhibitions. Please do consider how best to use in in your museums in a positive way rather than t apparently easy option of excluding it.



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