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The Lighting of St Mel's Cathedral

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Abstract

The destruction of St Mel's Cathedral by fire brought the local community together to fund its restoration. Part of this initiative was the development of a lighting scheme using modern LEDs and intelligent lighting controls to recreate the atmosphere and reverence deserving of this historic house of worship. Problems encountered associated with the age and style of the building to be illuminated are discussed in the paper. A description of the design process and methodology is also included, along with the appropriate lighting conditions necessary to emphasize certain architectural points. The paper covers the illumination of the cathedral for the 21st century by discussion of the methods used and the development of the design.

Key Words:

Lighting, cathedrals, places of worship, LED, intelligent controls

1. Introduction

There has been considerable interest in the lighting of cathedrals and churches recently, largely due to the necessity of renewing installations which were made in the early years of the century and are by now unsafe electrically, as well as being inadequate by present-day lighting standards.

More recently, the advent of new and more efficient light sources has led to some radical rethinking of the design standards possible, and, in addition, the liturgical reforms of recent years have led to the rearrangement of many interiors, necessitating alterations to existing lighting schemes.

Furthermore, the publication by the Society of Light and Lightings (SLL) Lighting Guide 13 (LG13) provided guidance on methods and arrangements of applying lighting. The lighting design of St Mel's cathedral was already completed before the release of this guidance, therefore the design was scrutinised and evaluated against LG13[(1)]. Some key differences emerged, including the recommended uniform lighting levels for the different areas within the building and the methods of achieving and controlling the lighting scheme suitable for such a building.

A number of factors enter into the design which are commonly found in other fields of lighting. However, considerations of the age and architectural style of the building, the proper balance between lighting to display architectural or archaeological features and for use during church services, and the daylight appearance were all taken into account.

The lighting scheme for the St Mel's cathedral was sympathetic to the form, function and history of the building. The interior light scheme was designed for multiple light scenes according to the usage. Special attention was drawn to the method of installation of all new equipment and services routing.

The cathedral presented a number of challenging issues when developing the lighting design, some of them architectural in nature, others to do with how the building was to be used, and yet more focused on conservation, technology and cost.

High ceilings and obstructions, such as pillars and arches, all needed to be considered in terms of light distribution and liturgical items such as Stations of the Cross, statues and the baptismal font. Soft, lighting accents emphasised the three-dimensionality of these items. Thanks to high positioning of the luminaires and glare reduction, visitors' enjoyment of art pieces is aided by high levels of visual comfort.

It was also important to apply the correct source of lighting so that a specified illuminance was accurately achieved as well as meeting the budget for the project. The success of the installation was not to be judged by light meters but through the eyes of those who have to perform the ceremonies as well as those who watch them. Similarly, efficiency was not rated simply by the effectiveness of gathering all the lamp lumens and exclusively directing them onto

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Figure 1: The official reopening of St Mel's Cathedral, Midnight Mass 2014.

the task plane, but rather by the ease with which the task can be seen and by the contribution of the lighting installation to making the environment more agreeable. This was achieved by careful commissioning of the lighting and creation of the different lighting control "scenes" with the St Mel's Committee whose members included the local priests, key stakeholders and local engineers. This insured that the lighting was adequate and operated for the tasks planned. However, the design intent was for a robust scheme that would mitigate any contract variations. Ensuring that the requirements of the client had been met required the addition of a small number of luminaires where an increase in lighting was deemed beneficial.

The lighting scheme was installed and the building reopened to the public in December 2014.

2. Background

The cathedral is a neo-classical stone building, at the north east side of the town. Construction began in 1840 to the design of Joseph B. Keane and was finally consecrated on 19 May 1893. The cathedral is constructed like many churches in the shape of a cross.

Due to the cold, the heating ran at a high setting continuously for 17 hours on Christmas Eve 2009 to cater for the many visitors coming to say a prayer, light a candle or attend confession during the day and the for the large attendance at Mass that night. After Mass the temperature outside plummeted to -8°C. Sometime after 5am a local called the fire brigade and raised the alarm of a fire.

Despite efforts by the fire service, as Christmas morning dawned it was clear the interior of St Mel's Cathedral was lost.

Figure 2: Pre-fire condition of the cathedral.

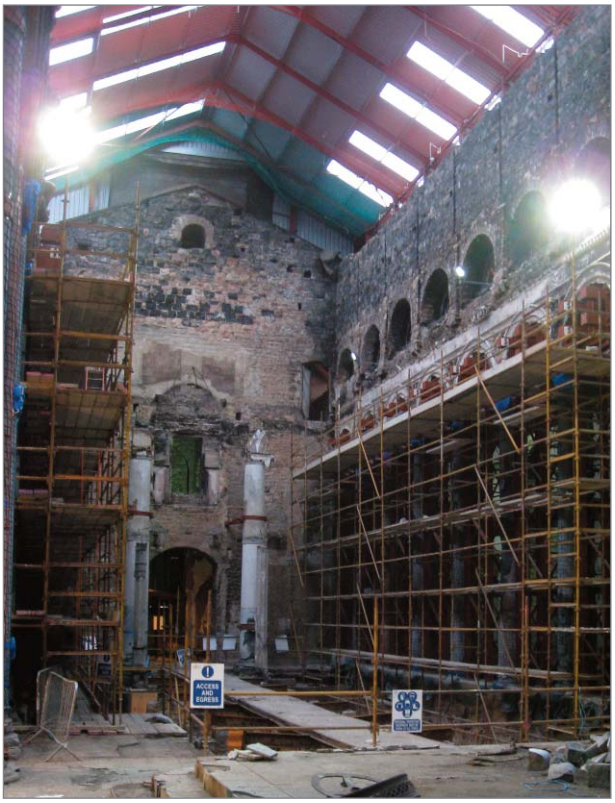

Figure 3: Post-fire condition of the cathedral.

The heating system consisted of an oil fired burner located in the crypt, with a flue connected to an original brick lined chimney. It is likely that combustible material may have accumulated in the chimney. Due to the prolonged running of the heating system, it is likely that this material became superheated.

When the burner was switched off, the natural draught allowed the ingress of oxygen causing the combustible material to ignite in what was, in effect, a chimney fire. Unfortunately, this chimney was fitted with inspection hatches. It is believed that burning embers from the chimney fire escaped via an inspection hatch door in the sacristy. There it ignited some further combustible material which then spread to destroy the entire interior of the Cathedral.

3. Methodology

The artificial lighting offered unique opportunities to integrate into its building fabric seldom possible in an existing place of worship structure. It cannot be emphasised too strongly how beneficial it was to discuss the lighting concepts with the architect at the earliest possible stage of the design of the building, and not leave it until detailed and finished drawings, which cannot be easily amended, were produced.

The advantages of designing the lighting at an early stage included simplicity in wiring and ease of maintenance, a point that is not always considered, but it is especially important in this situation where a regular maintenance staff are not employed[3].

The project was about marrying what was lost with what remained and putting in place something for the future. Historically, brass luminaires were mounted on walls and robust brass poles had been used to help illuminate the space. These were later refurbished with an LED source and reused as suspended chandeliers within the meeting rooms and the sacristy. Lighting of the cathedral space was a key area with modern technology used to visually enhance the cathedral.

Since St Mel's cathedral differs greatly from most secular buildings both in its use and architectural design, the lighting installation could not be designed on the conventional lines of a traditional workspace as it also had to be flexible to fulfil a number of purposes.

One aspect which was carefully considered was the balance of dramatic and utilitarian lighting. For cathedrals a "numinous" atmosphere which is conducive to worship is required[2]. This can often be achieved by dramatic lighting of the sanctuary, although it must always be remembered that the ambo and altar positions located within the sanctuary must have sufficient and suitable light for reading.

Regarding the visual task that would be undertaken by the congregation in the pews, they tend to sit in one particular area and this was to be a focus of the design brief. In addition to task lighting, this particular light is required to reveal texture and improve the appearance of the people within the space; thus good visual communication and recognition of objects within the space was essential. The average (mean) cylindrical illuminance was designed to be 50 lux, and uniformity (min/average) over 0.1, calculated 1.2m above the floor level. Each of the directional luminaires providing the functional lighting in the space was carefully angled towards the rear of the nave; this allowed the cylindrical illuminance required to be achieved.

Subtle emphasis of architectural features was also considered to help achieve the required atmosphere, but care was taken not to light a cathedral merely to show off its architecture. Indeed, the lighting design concentrated on creating contrasting effects since it is difficult to light a building by artificial means to give the same effect as is seen by daylight but to maintain the buildings functionality[4].

The lighting brief was to bring the 19th century building into the 21st Century. This included a lighting system that was to be energy efficient but would also capture the atmosphere essential to the cathedral. The level of control and scene-setting would also allow the priests to pre-set specific lighting scenes for specific liturgical occasions.

The lighting had four objectives:

- to enable participants in the religious activity or ceremony to see what they are doing;
- for the congregation to see what is happening around them by providing horizontal illuminance (maintained 100-150 lux) and cylindrical illuminance (50 lux) on the pews measured during commissioning using lux meters;
- to contribute to the safety of everyone within building;
- to create a good visual environment.

4. Spotlights or pendants

The use of pendant luminaires, either in the form of branched candelabra or of individual lamp housings mounted on a hoop or hoops, is often recommended, especially in the nave. The theory is that they more closely resemble the sort of lighting that may have been originally installed and that they have some decorative value in their own right. Such a system has the advantage of providing adequate illumination at "prayer-book level" economically, but it can give rise to considerable glare and also cause a 'tunnel effect' unless the fittings allow some upward light on the vaults. There is, however, considerable force in the objection that they are out of place in an environment that was never designed to take them, and that in daylight they 'pollute the space and spoil the appearance of the building[5].

The alternative of spotlighting using an LED source was used for St. Mel's cathedral but it was not without its disadvantages as it required careful consideration of their placement so they could be discreet. The lighting equipment is usually unobtrusive by day, but at night banks of spotlights can be remarkably glaring and seriously interrupt the soaring vertical lines of the architecture. The optimal position found was on the tops of the limestone columns for projection of light onto the side aisle and on the above-the-string cornice for the central aisle. From a lighting perspective this method is normally not to be encouraged in most other situations due to the glare caused by luminaires at lower mounting heights. However, as it was possible to keep the fixtures above 10m, the solution was both discreet and effective.

A recent departure used for the Cathedral, made possible by the high-efficiency LED lamps now available, is indirect lighting of the

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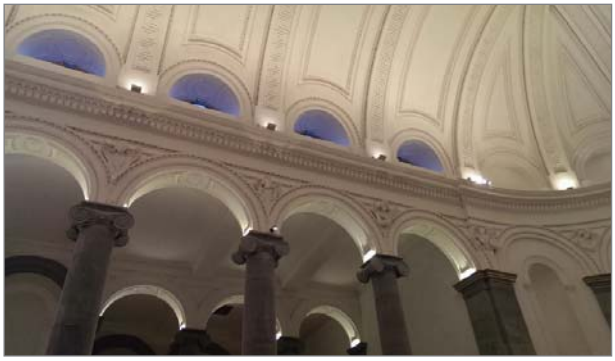

Figure 4: Discreet positioning of the luminaires was key.

main barrel ceiling from uplighting projectors mounted on the string cornice, but this necessitates supplementary direct lighting for the congregation to be able to see and read. As the aisles are also lit in this way, a fairly close approximation to the daylight distribution of light in the building was achieved.

5. Lamp source

With the reducing price and increasing availability of good quality LED spot and floodlights, they were considered as a first option. They provide a good low-energy solution with a very long life, thus reducing the need for maintenance access to what is a high location[6]. The wide availability of LEDs with different beam angles means that one family of fittings provided light for many different purposes. Wide beams were used for washes over vaulted ceilings, medium beams for lighting down over seating areas and narrow beams for picking out altars or features in the space. The LED spotlights came with integral dimming with DALI (digital addressable lighting interface).

6. Highlights and Shadows

It was important that glare was avoided wherever possible. A common fault is glare caused by an array of spotlights at low level or aimed without care from the cornice.

Glare was not simply a matter of the intensity of the light source; it is related to the contrast between a lighted object and its background. The illumination of the ceiling helped to counteract this issue.

This does not mean, of course, that a bland shadowless effect was the aspiration. The modelling of shafts and pillars, arches and sculpture was essential as their form was to be perceived. The

Figure 5: Vertical illuminance on the Stations of the Cross.

contrast between the illuminated and unlit parts of the cathedral produced dramatic effects without apparent effort.

Picking out salient features in daylight by means of carefully placed spotlights is equally permissible, and can give the effect of shafts of sunlight if carefully done. The concealment of the equipment has been made easier by the introduction of very compact narrow beam spotlights.

7. Design concepts

It was immediately apparent that the "lumen method" of lighting design, intended to produce an average maintained illuminance over an area, could not be applied to this building. Certainly, enough light to allow priests, choir and congregation to read easily is necessary, and the recommended illuminances in the LG13 code should be adhered to, but a flat, even distribution of light is neither necessary nor desirable.

It was equally obvious that with the exception of decorative chandeliers the lighting equipment should be as unobtrusive as

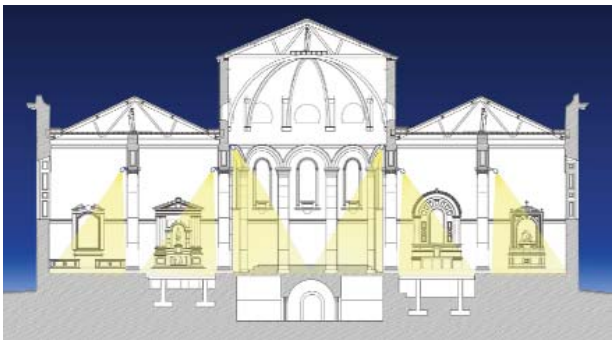

Figure 6: Functional lighting concept.

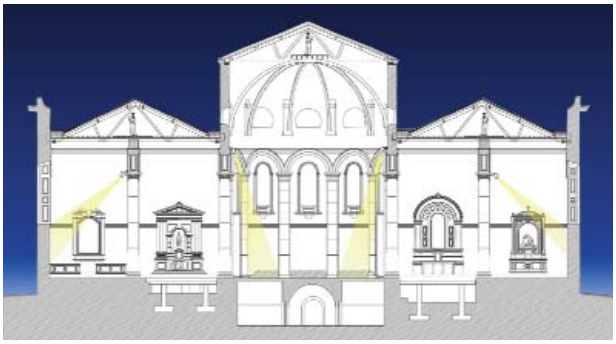

Figure 7: Accent lighting concept.

Figure 8: Uplighting concept.

possible. These buildings traditionally were not used after dark by the laity and, apart from the dim gleam of sanctuary lamps before the altars, the rest of the church would be in darkness. Even in parish churches the custom of a late evensong is comparatively recent, dating only from the 19th century, so that any form of artificial lighting is bound to be out of character with its surroundings. However, lighting essential to the present use of the building and the advent of first gas and then electric lighting in the l9th century has accustomed people to its use.

The lighting of some areas had been varied to suit their use; for example, as the nave was to be used for worship, lighting was concentrated on this area used by congregation and on the altar with the rest of the building left in comparative, although not absolute, darkness. In contrast, when used during the day for visitors or quiet reflection, less light is needed on the seating, and architectural features were emphasised, with indirect lighting of the ceiling vault, and some lighting in the organ and architectural elements.

Based on the objects, the lighting concepts focused on how and what elements required illumination. These main concepts included:

- the function lighting on the horizontal plane by wide beam projection LED luminaires at the tops of columns;
- accent lighting of the key architectural elements and art pieces by discreetly located LED projection lighting;
- uplighting of the barrel ceiling which would highlight the great craftsmanship put into the plastering detail.

8. Areas requiring special lighting

Organ and choir: Light for reading music was a vital element for the cathedral. A technical problem was that organ furniture was dark and absorbs light while choristers using sheet music look at music on a white background. To light the choir area, individual luminaires were recessed within the choir stall which provided functionality without taking away from the overall feel of the space.

Altar and ambo: The altar is the focal point of the cathedral; it is also a centre of worship, the table on which Holy Communion is celebrated. It must therefore be illuminated dramatically, but not in such a way as to make it difficult for the priest to see both his Bible and the congregation.

The readers at the ambo not only need to be able to see what they are reading, but must themselves be visible, for a great many elderly and deaf people rely on lip reading or on the facial expression as well as the sound of the readings.

The use of a strip light mounted at the top of the reading area also has serious disadvantages. Reversed shadows on the reader's face can have a negative effect on their appearance and a further disadvantage is that, if the strip light is mounted too close to the surface of the desk, it may cast shadows across the page making it difficult to read[7].

Figure 9: The Ambo during commissioning of the lighting.

The solution implemented was to provide dedicated spotlights with carefully shielded lamps to light the book or typescript. The spotlights were mounted 12m high and to the sides, so as to avoid glare and shadows to the reader, and to give natural modelling to the persons face.

9. Emergency lighting

The actual placing of luminaires presents the greatest difficulty rather than achieving the lighting requirements indicated in IS 3217 Code of Practice for Emergency Lighting with a recommended average maintained illuminance at floor level of at least 0.5 lux along the centre-line of the gangways. The main emergency lighting arrangement internally included recessed emergency lighting "nodes" in the side aisles and projector versions of these miniature nodes adjacent to the array of spotlights on the string cornice in the central nave[8].

The choice of system was mainly between a centrally controlled system, in which all the luminaires would be fed from a central point, using a large storage battery, and one of self-contained luminaires powered by nickel-cadmium cells actuated by mains failure. The former solution was implemented as it reduced the risk of battery failure at the lamp hence decreasing the amount of maintenance required at heights[9].

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10. Methods of calculating lighting values

The modelling and calculation used throughout was by the Relux Pro lighting software. Working with a 3D model enabled the discussions with the architect to be more productive and efficient, clearly indicating the intent and assisting with the design development.

The need for modelling and the provision of a "numinous" atmosphere governed the placing of the lighting equipment and the direction of the light. There is always a certain amount of "spill light" in the beam of a spotlight so that a certain amount of ambient light will be present on vertical surfaces, but it is important to provide variations of brightness. Therefore, carefully calculated positioning of the lighting equipment is recommended.

As a system of indirect lighting is used in the form of lighting the ceiling vaults, the reflectance of the vault or ceiling is of great importance. As it was a white plaster ceiling it reflects about 70%

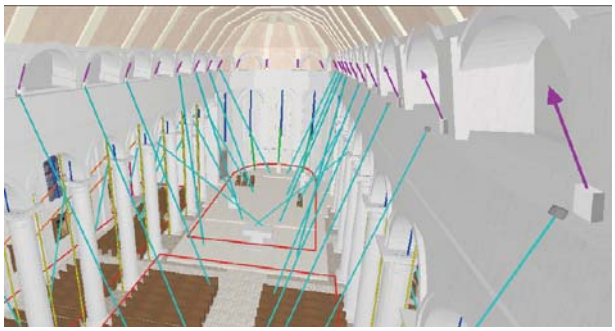

Figure 10: Modelling of thelLighting taken from the lighting software.

Figure 11: Rendered view taken from the lighting software.

Figure 12: Lighting installed and operating.

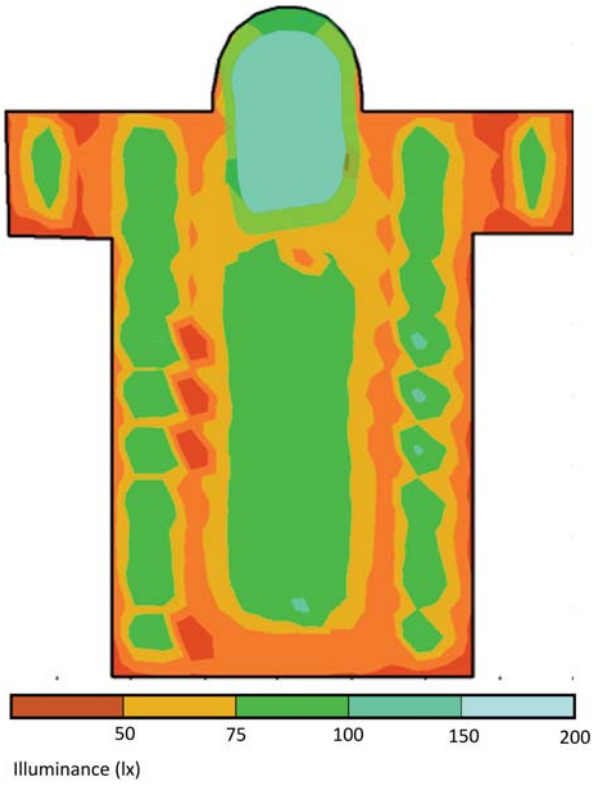

Figure 13: Design lighting levels taken from the lighting software.

of the light falling on it, but a stone vault as per the crypt would reflect no more than 50% at most[10]. As the ceiling is intersected by ribs, this figure would be still lower. Consequently, the indirect lighting of the vaults was not expected to provide a significant proportion of the light at 'prayer-book level', and the need to supplement it with direct spotlighting was imperative. The indirect lighting component was effectively no more than a decorative element especially when the number and power of direct lighting units was calculated but, nevertheless, uplighting of the vaults does produce ambient lighting needed for casual perambulation of the building.

If it was simply a matter of providing the recommended illuminance on the bible, choir or congregation, the reflectance of surfaces is of course irrelevant. However, it was important in calculating the size of the lamp and type of reflector to light vertical surfaces and the underside of the ceiling.

LG13 was not released during the design, therefore similar examples had been used as benchmarks as well as the illuminance recommendations for similar applications indicated in the SLL code for lighting 2012. The illumination on the horizontal plane in various parts of a church was designed to 100 lux in the "body" of the church, and 200 lux within the sanctuary with further accent lighting where required.

It transpired that the recommendations given with LG13 were consistent with the design approach[12]. However, the design did not include for the recommended maintained horizontal illuminance of 500lux for the altar area. The design approach was rather less uniform and focused more on making the altar the focus

of the building with lighting but by using accent and vertical lighting as well as a base line 200lux of horizontal illuminance. This was achieved by using different 'layers" of light which include uplighting of the alter back wall and dedicated accent lighting of task areas such as the ambo and the bishops chair so that reading can be achieved during services without issue.

11. Lighting controls

The key client aspirations for the lighting control system were flexibility, ease of use and energy efficiency.

In order to deliver on this ambition, an intelligent control system using DALI (Digital Addressable Lighting Interface) was installed to enable a variety of fittings and controllers to be integrated within a single control system. The dimming system allows simple changes in the feel of the space, from simple lighting for general use to higher levels for services, with special scenes reserved for weddings, High Mass or quiet reflection.

The scene settings activate and/or dim specific light fittings and harnesses natural light when available to reduce energy consumption. The system also provides status reports for the user and allows remote access to the lighting system.

The centralised lighting control system with pre-set scene control makes it easy to set and change the mood for any activity at the touch of a button. The touch screen panel allows for the priest to select up to 12 different lighting scenes within the main sacristy.

Figure 14: Commissioning of the lighting controls.

11. Discussion

For specialist designs such as this, it is imperative that early coordination and agreement of the lighting concepts are carried out with the architect and client. The levels of illuminance, lamp source and controls are important but the visual effect on the space was the most critical factor on this project.

Many of the design fundamentals have been highlighted with the SLL's Lighting Guide 13: Lighting of Places of Worship which provides up-to-date guidance where relevant and incorporates best practice principles throughout, including the introduction of a distinction between task area and surrounding areas, and the subsequent recommendation of uniformity for those areas. However, uniformity is an issue that requires careful consideration as a less utilitarian approach was achieved with St Mels Cathedral. The approach here provided a more dramatic result while keeping the building functional.

Further evaluation of how the lighting has been adapted and controlled by the sacristan and priests, particularly with regard to the scene setting and the relationship between energy consumption and providing a decorative scene suitable for the different situations would be desirable. However, that was not part of this paper and would be recommended for future research.

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