ADVANCES IN LED LIGHTING

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BEFORE WE consider how church lighting has been advanced by LED technology, it is worth considering the development of earlier light sources. Many of our historic places of worship pre-date almost all forms of 'artificial' lighting except perhaps the candle, and the buildings and the means by which they were lit have developed in tandem.

Our earliest churches and cathedrals began as dark, mysterious and solitary spaces lit only by daylight through narrow windows. Artificial light was provided by candles and flaming torches, while great fires were used as sources of both light and heat. As building methods developed and larger window openings became easier to build, architects learned more about how to use natural light to illuminate an interior, relying less on flame and extending the hours in which these magnificent buildings could be purposefully occupied.

In the 17th century Sir Christopher Wren significantly changed the way daylight was used. When building St Paul's Cathedral he seized almost every opportunity to harvest natural light to enrich the interior. The technology of artificial lighting began to develop about the same time, and the 17th and 18th centuries saw the increasing use of natural fuels for lighting including whale, nut and olive oils. Although gas lighting had developed in China several centuries earlier, it was not until 1792 that William Murdoch used coal gas to light his house in Cornwall. Gas lighting continued to develop throughout the 19th century and became widely used, particularly for street lighting and then increasingly in commercial and domestic properties. Gas lighting was introduced in churches during this period, giving rise to elaborate and extravagant gasolier designs. Figure 1, from the parish archives at St Mary's Church in Painswick, Gloucestershire, shows a set of three Arts and Crafts gasolier designs by Messrs Hart, Son, Peard & Co in 1879. Number 71 was the chosen design.

Davy invented the first electric light bulb in 1809 but it was not until some 80 years later, in the early 20th century, that they came into more common use when both Swan and Edison developed the filament lamp. The early 1900s saw the invention of the mercury vapour and sodium lamps, which by the 1930s had become the norm for industrial and street lighting applications. So the introduction of electric light in the early 20th century by architects and engineers was a revolutionary intervention in our historic buildings.

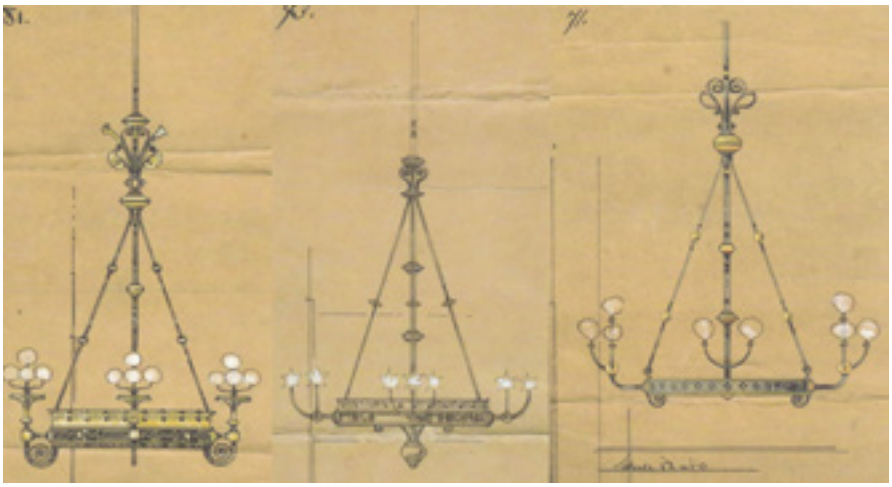

Figure 1 Set of three Arts and Crafts gasolier designs offered by Messrs Hart, Son, Peard & Co in 1879 for St Mary's Church in Painswick, Gloucestershire

When Coventry Cathedral was constructed in the late 1950s, Basil Spence was one of the first architects to be able to design a new cathedral with electric light in mind. By today's standards the development of electric lighting technology was then only in its infancy and the tools available were relatively rudimentary. Coventry underwent a major relighting project only a few years ago, and although this was before the onset of credible forms of LED lighting, the principles of luminaire positioning and their uses remain very much as Sir Basil originally intended.

Since the 1950s, lighting technology has developed enormously. Modern light sources are more efficient, longer-lasting and easier to control by electronic or other dimming methods. In the 1960s the first lighting track systems were invented. These became even more important in the 1980s when low voltage lighting came into more common use. Around 20 years ago, lighting professionals were excited by the improvements in the colour rendering characteristics of both fluorescent and metal halide light sources and the ability to dim fluorescent lighting with modern electronic control systems. These technologies, combined with high quality low voltage lighting, gave designers an excellent palette of tools to work with and lighting design began to blossom into a 'profession' in its own right.

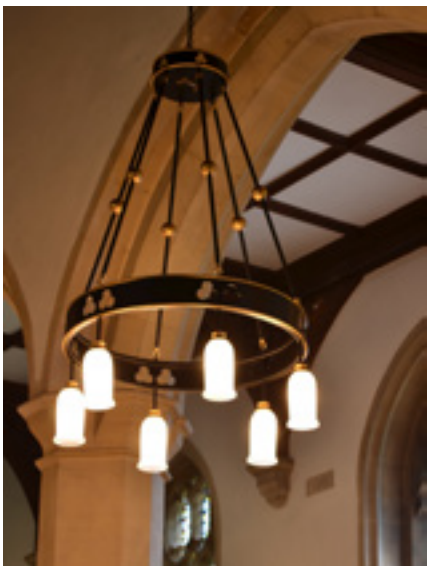

Figure 2 New electroliers at St Mary's, Painswick loosely based on the design of the earlier gasoliers and using LED lamps in frosted glass storm shades

However, it was back in 1952 in Cleveland, Ohio when a 33-year-old General Electric scientist called Dr Nick Holonyak Jr invented the first practical visible-spectrum light-emitting diode (LED). Diodes (small electronic components containing a semiconductor) had been known to turn electrical energy into light extremely efficiently, with far less heat

Figure 3 Wakefield Cathedral, West Yorkshire

Figure 5 St Mary the Virgin, Merton, London

Figure 4 Examples of clear LED lamps including candles

than incandescent filaments, and with far smaller components than a fluorescent tube. Furthermore, the diode was not degraded by the process, so LEDs offered a much longer potential lifespan than any previous light source. However, LEDs had previously only been able to produce infra-red light. Holonyak's refinement was to achieve light that was visible to the human eye, and this breakthrough was hailed by his colleagues as 'the magic one'. Nevertheless, it has taken over 50 years to develop and refine this technology to deliver what we have today, credible LED light sources that are replacing many types of fluorescent, metal halide and low voltage light sources. In doing so they are bringing much reduced energy and maintenance costs.

So this race through the recent history of lighting technology brings us to a point where we can start to look at the benefits of LED lighting and how they can be applied to lighting in our historic buildings.

LEDS IN ELECTROLIERS

The most traditional method of lighting large spaces in older buildings is of course the chandelier or 'electrolier', as its electrical equivalent is known. Large spaces can be illuminated evenly and effectively providing that the fittings are sufficiently powerful and positioned carefully in the space. However, when considering LED technology for electroliers we must immediately differentiate between bare or exposed lamps and those with shades. The larger LED lamps, capable of replacing the conventional GLS lamp (150W, 100W, 60W etc) are not necessarily things of beauty and work best if they are enclosed in frosted or non-translucent shades.

St Mary the Virgin at Painswick was recently re-lit with a set of new electroliers (see figure 2). The design is based loosely on the design of the earlier gasoliers. LED lamps are used within the frosted glass storm shades. Compared with halogen lamps the 14.5W LEDs offer an energy saving of up to 85 per cent and a ten-fold increase in lamp life. The LED lamps are a comfortable warm white at 2700K, they are dimmable and last for up to 40,000 hours. The shades make the LEDs almost indistinguishable from conventional lamps.

The recently completed scheme for the nave of Wakefield Cathedral, West Yorkshire (see figure 3) features pendants designed in the style of Sir Ninian Comper that are fitted with 7W 3000K LED lamps. Again these are warm white, fully dimmable and last for up to 25,000 hours. Here the LED lamps are fitted not with shades but an acrylic lens to make them look similar to a frosted (or 'pearl') GLS lamp.

For Flemish pendants or other fittings that use conventional candle lamps, exposed to view, there are also options for LED lamps. The LED chips (normally little orange squares) have to be carefully positioned to simulate the shape of the candle lamp filament. While many LED candle lamps are now available, care must be taken to note their appearance when turned off as well as when illuminated. A variety of LED lamps are illustrated opposite (figure 4) where the yellow/orange chips are clearly visible when the lamps are off. Illuminated they present a warm crisp light – almost identical in appearance to the filament lamps they replace.

LEDS IN SPOTLIGHTS

In traditional pendant schemes there is frequently an additional requirement for spotlighting. This may be for accent lighting for the high altar or in side chapels, or for general task lighting for the choir or musicians. Here LEDs provide excellent colour rendering and quality of light. At the Church of St Mary the Virgin, Merton, London (figure 5) LED spotlights are used throughout the chancel and sanctuary to provide highlighting for the altar, reading light for the choir and decorative lighting for the walls, ceiling and mullions of the east window.

Although pendants are common in traditional lighting schemes, they are not always required or appropriate, and spotlights are often employed on their own to provide

Figure 6 Carlisle Cathedral, Cumbria

Figure 8 St Michael at the Northgate, Oxford

general downlighting or uplighting to vaulted ceilings. At Carlisle Cathedral (figure 6), for example, the choir aisles are lit entirely with LEDs and almost all of the lighting is focused upwards to illuminate the vaults, providing only reflected light for reading. The LED spotlights, being significantly smaller than equivalent low voltage fittings, are discreetly located on the column capitals and are almost unseen.

LEDS IN FLOODLIGHTS

One of the areas where LED technology has been a little slower to mature is that of floodlighting. While we can already see a clear replacement strategy for the majority of GLS, low voltage and fluorescent light sources, the modern metal halide floodlight sources, which are typically higher in output, have held their own for a little longer. However, in a new scheme at All Hallows by the Tower in London (figure 7), 4,000 lumen LED chips drawing only 50W each have been used to provide both uplight and downlight from the lighting troughs in the nave and aisles. This has transformed the interior of this post-war reconstruction of one of London's best known churches.

LEDS FOR EFFECTS

The miniaturisation of light sources has been able to progress at a great rate with LED technology. This is mainly due to its energy efficiency and consequent lower heat output. In our historic churches it is now very easy to include decorative lighting elements in restricted locations such as small cornices

Figure 7 All Hallows by the Tower, London

and at the base of window ledges without substantial building works being required to hide them. At St Michael at the Northgate in Oxford (figure 8), LED strips, concealed behind the timber moulding, uplight the chancel ceiling. Miniature LED spotlights uplight the mullions of the east window.

ARE LEDS THE HOLY GRAIL OF LIGHTING?

The development of LED lighting technology has kept the lighting design community on its toes for the last few years. Ten years ago, LEDs were starting to become interesting alternatives to some lamp types. Typically, the life expectancy, performance expectations and colour stability were over-hyped by enthusiastic manufacturers. Early LED schemes had high capital costs and saw many problems which proved equally costly to resolve. In the last five years we have seen steady improvements in both reliability and colour stability. We also have the benefit of hindsight in understanding the problems of those early experimental schemes. Nonetheless there remain some areas for concern:

The capital cost of LED light sources, and the electronics required to drive them is considerably more than that of most other technologies. We are therefore heavily reliant on the 'total life cost' argument to justify the initial costs of some schemes.

Like all technical systems, the integrity of LED lighting is only as good as that of the weakest link in the chain. Great care has to be taken to ensure that light sources, luminaires, controllers, dimmers and accessories are all fully compatible.

It is also important to be wary of the many products that appear on the market that are produced to fulfil a specific need and are then promoted for wider uses. It is important that products can be replaced if they fail without having to redesign control systems or re-engineer luminaires.

So if we note the warnings above and carefully match light sources to each application, we can now, with confidence, specify LED light sources from established manufacturers in many lighting schemes in both historic and new build projects.

BRUCE KIRK leads Light Perceptions, a lighting design practice working almost exclusively with places of worship and other historic buildings. Early church work included the relighting of Holy Trinity, Brompton in 1993. Current work includes schemes for Sheffield, Hereford and Norwich Cathedrals and Tewkesbury Abbey.