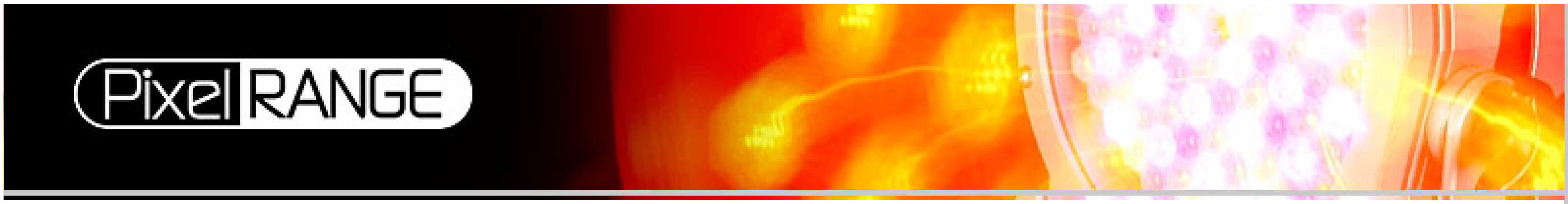


LED lighting

A brief history of LEDs

LED Lighting

Although we are used to seeing regular breakthroughs in technology, only very occasionally do those advances make a truly great impact on our everyday lives. Some come upon us quickly, others take a while. At roughly fifty years old, you could hardly accuse the Light Emitting Diode of being an overnight success. However, this technological 'slow burner' is beginning to cause a minor revolution in the way that we produce and use light.

Noted in theory as early as the mid-1920s, it wasn't until the late 1950s that the LED truly began life. The birth occurred relatively unceremoniously at research labs in the United States, where many innovations in semiconductor electronics were taking place in the wake of the Second World War. The most notable of these innovations was the transistor, a close and much more famous cousin of the Light Emitting Diode.

How do Light Emitting Diodes work?

Here comes the science: A 'conductor' is a material that allows electricity to pass through it (such as almost any metal). Conversely, an 'insulator' resists the flow of electricity (such as most plastics). However, a 'semiconductor' material can be made to do either, it can conduct or insulate according to how it is arranged. In a Light Emitting Diode, the arrangement consists of two small lumps of semiconducting material, one that is chemically altered to favour a positive (P) charge, while the other is persuaded to maintain a negative (N) charge.

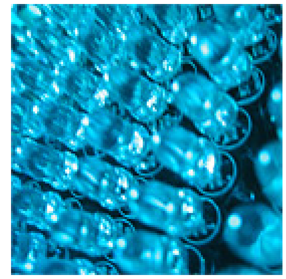
The interesting bit is the region where they meet, called the 'P-N junction'. When no outside voltage is applied to the LED, the positive and negative regions cancel each other out at the junction and this causes a barrier to form. However, when you apply a small voltage (in the right direction) across the two semiconductor lumps, it upsets the balance, depletes the barrier at the junction and allows electricity to flow from one side to the other. As this occurs, every electron that passes across the junction emits a tiny amount of light. By building clear plastic lenses into the body of the LED, the emitted light is encouraged to escape. The colour of the light that you see depends purely upon the material used to create the semiconductor lumps.

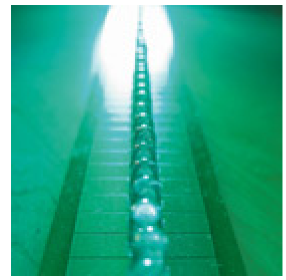
A gradual evolution

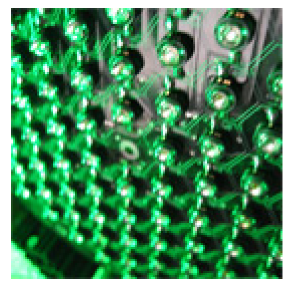
The first LEDs emitted only infrared light which is invisible to the naked eye. Not much use for lighting, but very handy for changing television channels – they've been doing that job for many years. The first visible LED colour was red, closely followed by orange, yellow and green. These early LEDs found numerous uses as indicators on all sorts of equipment and as the digits in bedside alarm clocks, however, they lacked the brightness for general illumination. Also, one colour in particular was proving elusive to researchers: Blue.

Blue was vitally important and was eventually cracked in the mid 1990s in Japan. This allowed two important things to happen. Firstly, a blue LED can be combined with a yellow phosphor lens coating to produce a light that appears to be white – useful for general lighting. Secondly, and most importantly for stage lighting and effects, when you have red, green and blue LED emitters located close to each other, you can adjust their individual intensities to create an almost unlimited palette of colours, rather like a television does – but with much greater brightness, flexibility and scalability.

The past decade has seen intense concentration and vast amounts of research spending by many companies worldwide to improve brightness levels and colour consistencies. The battle for supremacy is still raging and LED emitter quality continues to improve at an impressive rate.







James Thomas Engineering / PixelRange, an early innovator

JTE/PixelRange realised the potential of RGB mixing early on and set about solving the many technical challenges required to produce a useful stage fixture based upon Light Emitting Diodes. The result was the original PixelPar 90 which saw the latest high brightness LED emitters and control technology combined with 'tour-proof' mechanical construction. With the PixelPar 90, JTE/PixelRange succeeded in creating a resonant echo of their previous world class achievement – the original and vastly successful aluminium Par Can, first produced in 1977.

The PixelPar 90 has since earned an enviable reputation and remains a trusted mainstay for many lighting designers of stage and TV across the globe. The creation of the PixelLine 1044, a cyc light with attitude followed next. The PixelLine 1044 takes a wholly different approach and uses a multitude of smaller LED emitters (1044 to be exact) rather than the fewer but larger emitters of the PixelPar 90. The result is a finer granularity in a linear form which can be used to display patterns out at the audience, in addition to working well as a cyc light reflecting off a backdrop.

Both of these fixtures use solely red, green and blue emitters. Numerous other products from PixelRange add a fourth colour, amber, to provide even finer control over the mixed shades for those who need it.

Colour mixing – the old way and the future

The ability to call up almost any colour within a fraction of a second is one of the most compelling reasons to use LED fixtures for stage lighting. The way that they achieve this separates them from the more traditional forms of lighting. Within a standard stage fixture (including most sophisticated moving lights), you begin with a very large amount of white and then discard colours, using gels or filters, until you arrive at the required shade. This method of colour creation is ultimately wasteful in all but open white.

In comparison, when using an LED fixture, you work in the opposite direction. LED colour mixing is purely additive – you begin with black and increase colour intensities until you achieve the required shade – with no wasted light.

LED lighting in everyday life

It is the issue of waste that is another major factor in the race to improve and proliferate LED lighting as a whole, not just in niche markets, but into everyone's daily lives. It is here that LEDs will have a potentially massive overall impact. With increasing concern about the effects of global warming, the replacement of billions of tungsten incandescent bulbs with ultra efficient sources such as LEDs will play an important part in reducing overall power consumption.

The reason why LED fixtures will be able to make such a difference is thanks to the comparative efficiency of LED emitters. As light is produced, a much higher percentage of the applied electrical power is converted to light rather than heat. The light output efficiency levels (called 'Luminous Efficacy') of the most powerful LED emitters exceeded that of standard incandescent bulbs as early as 2002. LED emitters are now approaching the luminous efficacy of that previous champion of low energy lighting, the fluorescent strip light.

In large lighting installations, such as in TV studios, LED fixtures are already becoming prevalent and have resulted in a second energy saving opportunity – there's no longer a need for the powerful air conditioning that was required to remove the heat from the old inefficient spot lights. It is not true, however, that LEDs run completely cool. Although they emit a fraction of the heat output of a traditional lamp, high power LEDs do create heat from their PN-junctions (remember the two lumps of semiconductor material?) and it is vital that this heat is carefully managed to avoid damaging the junction itself. This is why you will see intricate cooling fins on most high power LED fixtures, such as the PixelPar 90.

Reliability is another major benefit that LED lighting brings to every situation. The average lifetime of standard incandescent bulbs is notoriously short, on average around one thousand hours before failure. LED emitters can exceed that figure by at least 20 times. Combine this long life with the proven energy savings and the cost argument for LED lighting becomes compelling.

This battle has already been won in the area of traffic signals. The vastly reduced maintenance requirements caused the US government to convert every traffic light from incandescent bulbs to LED emitter arrays. A similar conversion programme is being repeated across Europe right now. Street lighting is another major area of civil engineering where the combined reliability/energy saving advantage LEDs is being applied. This time the targets for replacement are the high pressure sodium and mercury vapour lights that have served as street lights for many years. This is proving to be a harder nut to crack than traffic signals, however, a number of towns and cities in various countries have already begun to trial lamp posts based solely upon LED emitters.

The revolution in domestic, civil and industrial LED lighting is just beginning. The revolution in stage lighting is already well established and is accelerating. The latest LED emitters are creating new opportunities for lighting and effects. As well as changing colour, fixtures are now also changing in shape and are being used in ever diversifying situations by an industry that craves and embraces innovation.

The future of LED lighting is very bright indeed.

Thomas
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