A brief history of LED lighting

The use of Light Emitting Diode (LED) technology in the lighting industry is a relatively new phenomenon. This is primarily because it is only in recent years that high intensity devices have become available.

There are two key areas where this technology will influence the lighting industries during the next decade: Illumination and Effects.

Illumination:

Illumination generally calls for the use of white light. LED's cannot produce white light; they can only produce a specific colour of the spectrum.

The LED is a semiconductor device made from a combination of chemically polarised semiconductors. The chemical composition is chosen to define the energy of the electrons that pass across the boundary between the two types of semiconductor. This electron energy is converted to light as electrons flow though the device. The electron energy defines the wavelength of the resultant coloured light.

So how can LED technology be used to produce white light? There are two possible approaches. The first was pioneered by Nichia in Japan in 1996:

A blue LED is coated with a white phosphor. When blue light hits the inner surface of the phosphor, it emits white light. This technology is now seen in commercial applications, but there are still some worries about the life cycle of the technology. It has been noted that the phosphor can degrade, reducing the light output, over a period of years. Current life estimates are of the order of 6 years.

The second method of producing white light is to use additive mixing of the three primary colours red, green and blue. This scheme is finding some applications, but by the nature of additive mixing, the white tends not to be very even in its spectrum.

Effects:

Effects lighting is an area where LED lighting has found an unassailable niche. Effects lighting invariably calls for colour, it is here that additive mixing of red, green and blue excel.

The concept of mixing the light output of LED's was probably first implemented in 1979 by Jerry Laidman at a company called Sound Chamber. The product named 'Saturn' involved a spinning propeller. Each of the three wings of the propeller was constructed of circuit boards fitted with red, green and yellow LED's. (Blue LED's had not yet been invented!)

Each of the LED's was controlled by pulse width modulation (PWM) allowing the intensity of each individual LED to be controlled. With the propeller spinning, the product could generate a huge number of colours. Jerry is now with Lighting & Electronic Design (L.E.D.) in Las Vegas.

The next technology jump occurred in 1993, with the invention of the blue LED by Nichia.

In early 1994, Artistic Licence prototyped what is believed to be the first full colour mixing design using red, green and blue LED's. The design used pulse width modulation of each colour channel, with a Zilog Z8 microprocessor receiving the colour request via the relatively new DMX512 protocol. The principal worked, but the LED brightness and cost was such that the design could not yet become a product.

By 1997, Nichia had very high brightness blue and green LED's and Hewlett Packard (Agilent) were producing very high brightness red LED's. This was the year that the brightness – cost ratio crossed the critical line on the graph. It was now possible to produce products using the concept.

It is expected that more companies will commence manufacturing LED solutions over the coming years. The initial cost per unit reductions have been fuelled primarily by the use of LED's in Traffic Lights and 'Third' Brake Lights. As the volume continues to increase, prices will drop further allowing more and more innovative lighting solutions to find applications.

<u>So where is the technology going?</u>

There are numerous promising area of development:

In Belgium, LumiLed, a joint venture between Philips and Agilent, are developing ultra high brightness LED's.

In Japan, Nichia continues to push the brightness – cost ratio.

In England, Cambridge Display Technology succeeded in producing the World's first blue light emitting polymer (LEP) and have now gone on to produce a white organic LED (OLED). Currently all development in this field is aimed at producing technology that can be used in colour display screens, but watch this space!

In the USA, The Massachusetts Institute of Technology (Nano Structures Lab) are working on a device called a Photonic Band Gap LED. Initially the research is aimed at improving the efficiency of single colour LED's. Extensions of this research could lead to a LED where both colour and intensity can be set electronically. The potential for effects lighting are staggering!

In England, Artistic Licence is pioneering new techniques for electronic control of LED intensity. Recent developments include a system called Frequency Modulation. Frequency Modulation provides a number of benefits compared to the older Pulse Width Modulation technique. The most notable of which is the ability to produce higher resolution control over the low intensity range. This is of particular interest in colour mixing applications.

What are the benefits of LED Lighting?

There are many:

1. Low power consumption compared to conventional lighting
2. No ultra-violet output. The UV component of conventional lighting can cause damage to fabric.
3. Very little heat is produced in the light output, reducing the cost of building air conditioning and allowing lighting to fit into positions too small for conventional lights.
4. Lamp life is very long; most LED manufacturers estimate 100,000 hours.
5. Ecologically friendly.
6. Light weight manufacture.
7. Coloured light can be produced by controlling the power to each primary colour, so no power is wasted.

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