

Report

HOW LED IS TRANSFORMING LIGHTING

By NDYLIGHT



NDYLIGHT
LIGHTING DESIGN

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1 INTRODUCTION

Whilst LED lighting is still regarded as an emerging technology in Australia, in Europe the technology has been embraced and widely accepted already. There is a high degree of confidence in the technology, provided basic technical considerations are addressed. Most reputable manufacturers provide a quality product that has been thoroughly tested, and we feel confident that the technology will prove reliable over the longer term.

There is no question that the use of LED lighting throughout office spaces will be main-stream within a few years. Indeed, many Clients are expressing the opinion that fluorescent solutions are rapidly being regarded as old technology. Some A Grade buildings due for completion in 2016 are now considering an LED solution.

The viability of LED's for commercial office buildings no longer appears to be in question. The number of leading manufacturers that are producing these types of luminaires are stating that the take up of the technology is changing their businesses, with sales increasing rapidly over last two years, currently LED products account for 20% of turnover with an expected rise of 50% by 2017.

The reasons for this change have been:

- The lumens/watt efficiency surpassed that of fluorescent technology in the past year. The cost of LED fittings has been steadily falling to the point where LEDs are considered to be a potentially cost viable solution once energy and maintenance is considered, thus increasing confidence in the technology by users and specifiers.
- European lighting designers also are seizing the opportunity to improve the lighting environment with new LED luminaires. The low brightness louvred solution is universally acknowledged as creating a poor quality lighting environment due to the harsh shadowing, dark ceilings, harsh wall scalloping and poor ambience.

2 LEDS IN GENERAL

- LED stands for **LIGHT EMITTING DIODE**. It is also sometimes referred to as Solid State Lighting, or SSL.
- **The first LED was created in 1907**. Yes, that long ago. However the first visible spectrum LED didn't come along until 1962, and usable LEDs for commercial lighting purposes were not a viable solution until the late 1990's.
- It is important to remember that **an LED is just another type of light source**. It should not be thought of in terms of a separate genre, or any kind of sub-set of existing lighting. We can specify fittings with many types of light sources, of which LED is just one type.
- **LED development is extremely rapid**. Specifying a luminaire with a unique type of LED is dangerous – it may no longer be available in two years, let alone ten. It is often (depending upon the project) a better option to use industry recognised interchangeable modules. Zhaga is the recognised international protocol in this regard. It is a conglomerate of leading industry manufacturers who have joined together in the interests of standardisation. See: <http://www.zhagastandard.org/> (*And as an aside, Zhaga is not an acronym; it is in fact a river in China*).
- **95% of all lighting R&D across the globe is on LEDs**. There are now some major manufacturers who no longer invest in or create anything other than LED luminaires.
- **LEDs are printed circuit board technology**. If they are going to fail, it is usually catastrophically in the first hundred hours or so due to a constructional defect. If they can survive that, then they can potentially operate for very long periods. However, unlike incandescent, halogen or fluorescent lamps, they do not typically 'fail' to zero. Rather, and like old mercury lamps, their output diminishes over time. Therefore the rated life is a nebulous concept rather than finite. Outrageous lamp life claims of 50,000, 75,000 or even 100,000 hours have been made, which prey on the consumers lack of understanding of the above concept.
- In reality, **LEDs reach a point at which the output drops below a usable level**. This has been defined by the industry as L70 or L90. The US EnergyStar Definition of Rated Lumen Maintenance Life (Lp) is the elapsed operating time over which the LED light source will maintain the percentage, p, of its initial light output. For example, L70 (hours) is time to 70% lumen maintenance. This usable lifetime figure is often somewhere in the range of 35,000 to 50,000 hours.
- **LED lamps will not eliminate maintenance**. A luminaire with an LED lamp would still need to be cleaned occasionally, and so could expect some losses due to depreciation over its lifetime.
- **LEDs are incredibly temperature sensitive**. An LED with a chip temperature 10 degrees above the rated value has about half the life expectancy. Heat sinking is necessary and essential. Incandescent lamps lost heat by radiation; whereas LED lamps lose heat by conduction.
- **LED lamp shapes are not necessarily bound by legacy thinking**. LED modules can be flat, round, large, small, even miniscule. They liberate luminaire design and allow design solutions unimagined even ten years ago.
- **Retrofit solutions are never as simple as they seem**. An LED module inserted into a luminaire designed for a different light source can operate quite differently, and often to the detriment of the LED. The temperature profile may be completely different, affecting the life of the LED; and a different bulb shape can drastically affect the lighting performance.

- **LEDs are not Plug & Play.** Unlike commodity items such as incandescent lamps or fluorescent tubes (put it in the fitting and away it goes), LEDs are system-based devices which need the right combination of LED, heat-sinking, control gear (driver) and optics to work efficiently and correctly. LEDs can be driven at different currents to provide different outputs (and usually the lower the current, the less the heat and the longer the life)
- **Not all LEDs are equal.** Colour variation between different batches of the same colour temperature LEDs can vary widely, even from the same manufacturer. These colour variances are significantly more pronounced than with fluorescent lamps. Careful selection of matching batches (called binning) is a critical part of the control of this process. Cheap and cheerful LED light sources do not go through a rigorous binning process (if at all). Quality light sources do.
- **Australia lags behind other countries with respect to LED standards.** Roadlighting standards are now starting to change, but interiors and manufacturing standards have a long way to travel to match other specifier markets. Relevant luminaire/chip testing should be done in accordance with international standards IESNA LM-79, LM-80, LM-82, & TM-21. The U.S. Department of Energy also provides numerous free papers and reports on LED technology for additional reading and reference.
- **Think Lumens, not Watts.** A LED that produces 1000 lumens this year will probably still be around next year, but the wattage may well have been reduced due to technical advances. Therefore it is old-fashioned and redundant to think of lamp sizes in terms of watts, and far more useful to consider lumen package sizes.
- **Be careful with dimming.** Dimming is possible, usually with PWM or 1-10V dimmers. However the dimming curve for LEDs can be somewhat unexpectedly non-linear. LED luminaires dimmed to 1% at a leading client's tenancy still produced 4-5% of light output, which was problematic in meeting rooms requiring very low levels for presentation modes.
- **Be wary of Alternatives.** A fluorescent alternative to a specified fitting stands a statistically far greater chance of being closer in performance to the specified article than an LED alternative. This is due to the diversity of LEDs on the market, as compared to the complete standardisation of fluorescent lamps. Always physically review, turn on and test an LED alternative before committing. **Do not rely on computer plots to equate performance.**
- **The Colour Rendering Index of an LED can worsen over life.** Although LED manufacturers are somewhat shy to reveal this, LEDs can in fact suffer a lessening in the CRI value as they age. There is no remedy for this at this time, however the specifier at least needs an awareness, and a long-term strategy in mind for the Client.
- **LEDs emit light very differently to previous light sources.** Fluorescent lamps emitted light through 360 degrees; incandescent and halogen lamps were effectively point sources. However each LED is effectively a miniature torch-head, with a cone of light having a relatively sharp cut-off. This cone (or group of cones) is modified by the optics on the front of the LED fitting. However if left unmodified, the light cut-off can be harsh.
- **Reflections!** LED strips are a collection of dots. Install them near glossy or metallic surfaces, and every dot will be reflected, usually in an undesired manner. Stainless steel is particularly vulnerable. Diffusion can assist but needs to be visually checked or tested by the specifier first.
- **Colour rendering is good generally, unless you are a Red.** A white LED is in fact a blue LED with an applied phosphor over it. As a result, they are strong in the blue/green region for colour rendering,

and for other saturated colours, but tend to be poor for saturated reds. There is a considerable body of evidence to suggest that the current Colour Rendering Index system used internationally needs an overhaul, since some LEDs have been shown to perform perceptibly better than their calculated CRI value would indicate. A new technology called GaN on GaN (available in some brands) has an improved red colour performance.

- **A lot of bright LEDs in a small area = Glare.** Yes they are small and compact, and yes they are efficient. But gather a lot of them into a compact luminaire and glare is a likely consequence. Well designed fittings, especially in outdoor and streetlighting applications, use carefully designed aiming and shielding patterns on individual LEDs to prevent this occurring.
- **The drivers can have shorter lifetimes than the LEDs.** Incredible but true; some LEDs actually have drivers with shorter rated life-times than the LEDs themselves. The master specification is up to date in this regard, however it is something that needs to be carefully assessed when viewing samples, and especially alternatives.
- **Many LED manufacturers offer five-year warranties.** We are therefore now producing specifications with this requirement as standard.
- **Many office lighting troffers on the Australian market are as designed for the European and North American markets.** That is to say, markets where the typical standard for office lighting levels is 500 lux (or even higher). Australian standards require 320 lux, so any of these used locally on standard set-out grids tends to over-light the space. Several local manufacturers are remedying this by producing locally modified luminaires.
- **LED can still meet Green Star requirements, if carefully designed.** The problem is typically meeting the IEQ-7 Electric Lighting Levels 400 lux point, for the reasons as noted above.
- **We are a long way off seeing the following applications for LEDs;**
 - Sportslighting. LEDs are years away from being able to produce the output of a 2kW sports luminaire, although fittings in the 1kW range have now emerged.
 - RGB (Red/Green/Blue) LEDs that can be colour-mixed to produce an acceptable white light. The white light produced by an RGB fitting tends to look anaemic and cold.

3 ADVANTAGES AND DISADVANTAGES

3.1.1 ADVANTAGES OF LEDs

- Efficiency is superior to most other light sources
- Minimal lamp changing makes their cost of ownership lower
- Small size creates new possibilities in luminaire design
- Greater variety of size and configuration as a light source
- Long lifetime under the right conditions
- Little forward heat emission
- Very little if any UV emission
- Instant turn-on at 100% brightness
- Functions well in low temperatures
- Resistant to vibration
- Less toxic in recycling compared with mercury-based lamps such as compact fluorescent, T5 and metal halide
- May provide a reduced luminaire height effectively minimizing the lighting zone within the ceiling
- LED technology provides the opportunity for both higher visual comfort and increased energy efficiencies not able to be achieved with the linear fluorescent louvred parabolic reflector
- Seen as leading technology in the market and can be used by clients as marketability.

3.1.2 KNOWN ISSUES

- Cost
- Variations in product quality are hard to detect from data or samples
- Rapid evolution makes future-proof specification difficult
- Poor quality LEDs/thermal design can lead to swift lumen depreciation
- Colour variations on LEDs between products can be unattractive
- Colour rendering can be poor on certain colours
- Glare control can be a problem with very bright light sources
- Dimming driver availability and compatibility can be a problem
- Product characteristics (colour/power/beam) can be inflexible
- Poor quality product/test data makes performance/life hard to assess
- Potential health concerns by photochemical risk to the eye from blue LEDs
- End of life may require a completely new luminaire.

4 WHERE TO USE AND WHERE NOT TO USE

Applications for which LED is an appropriate solution

APPLICATION	REASON
Luminaires with long burning hours	Long rated life of LEDs means reduced maintenance
Luminaires in difficult-to-reach locations	Long rated life of LEDs means reduced maintenance
Luminaires subject to vibration	LEDs are effectively impervious to vibration
Wherever saturated colour is required	Red/Green/Blue (RGB) LED luminaires with colour mixing capabilities are readily available
Wherever space requirements are limited	Small physical size of LEDs
Projects with dimming requirements	LEDs are easily dimmed
Projects requiring full light upon turn-on	LEDs do not require a warm-up period
Wherever radiant heat is a concern	Typical LED heat loss by radiation is less than 5% (c.f. incandescent at 95% and fluorescent 40%)

Projects and applications for which LED is not (or not yet) an appropriate solution

APPLICATION	REASON
Sportlighting for broadcasting purposes	Size of luminaires and required heat-sinking would be completely impractical
Wherever direct reflectances in glossy surfaces cannot be controlled	Each LED is a bright dot, and will be reflected as a series of dots rather than as a line of light
Mixing white LEDs from different manufacturers in close proximity	Theoretically 'identical' whites from different manufacturers never look the same when installed in close proximity – preferable to adhere to one manufacturer per area if possible
Wherever bare LEDs are in a direct line of view	The luminance of bare LEDs can be quite intense and uncomfortable – some form of shielding or diffusion is always preferred
Use mixing of RGB LEDs to achieve a white light	The quality of the white light is poor. If this must be done, use RGBW or RGBWA LED products.

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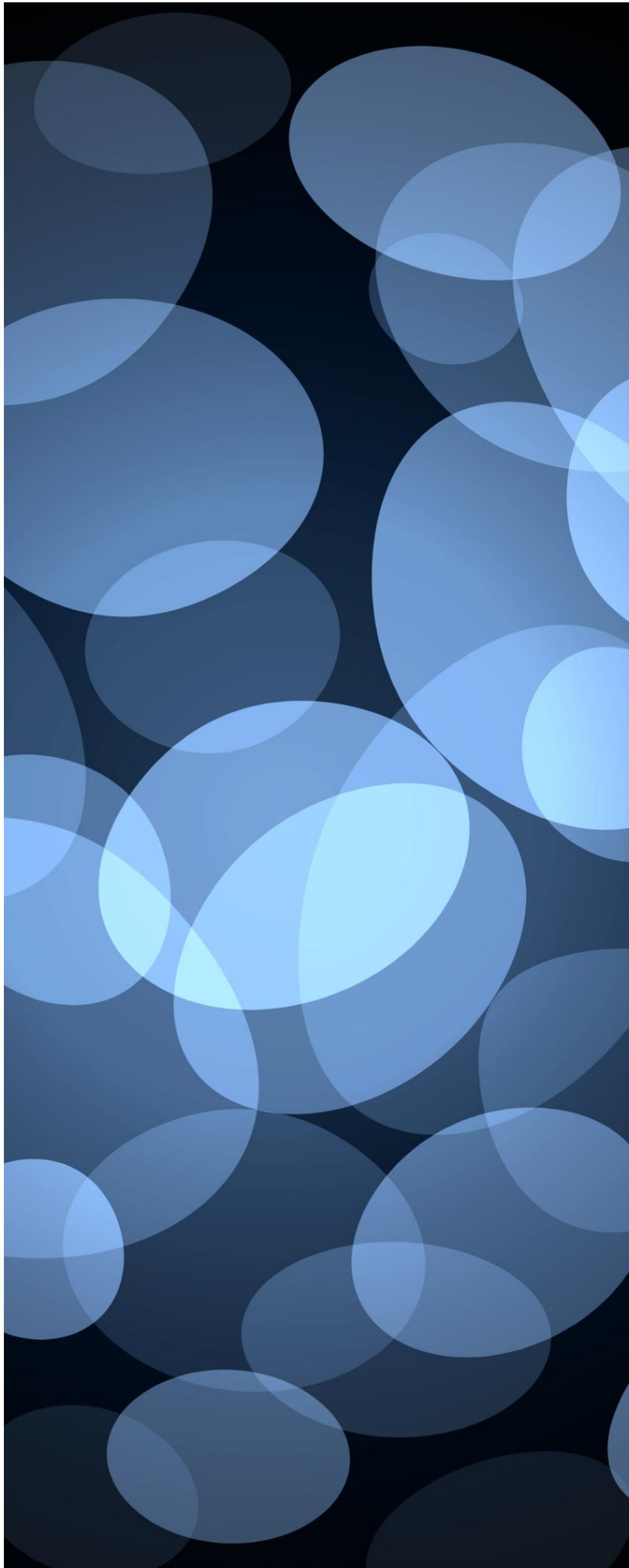
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Revision No: 1.0
Revision Date: 15 April 2015
Reason Description: FINAL
File Location: W:\M348xx\M34825\173\00\24_Reports
Filename: rp150415m0016
Client Name: By NDYLIGHT
Client Contact:
Project Coordinator: Steve Brown
Editor: Steve Brown



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