LED – the answer to everything?

Some critical observations.

Text. Susanne Brenninkmeijer

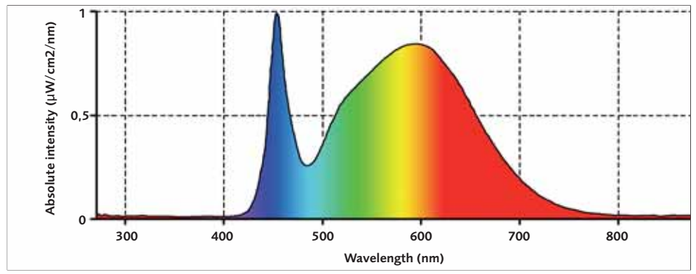
Since their invention white LEDs have developed rapidly in leaps and bounds. Efficiency is improving fast and every month we are witness to new developments and technologies. At the world's biggest light fairs in 2012, 90 per cent of the light sources used were LEDs and the majority of luminaire manufacturers only displayed their latest LED-adapted products. This state of affairs is more confusing than it is inspiring.

The time has come to verify the facts. We need to include social factors when we start the discussion on the real status quo of the market – designers need to understand what responsibility they bear towards the environment and the users of the spaces they design the lighting for. Let's forget the hype and focus our attention on reality!

Information published a couple of years ago on the potential serious health hazards caused by LED lighting, in particular in the case of children, gave rise to voiced concern – at least throughout Europe – which was soon swept away again by a further wave of enthusiasm, a wave of apparent advantages of light-emitting semiconductors, augmented by general despair at the phase-out of the incandescent lamp that left no real alternatives. Top of the list is energy efficiency, the prime reason quoted for phasing out the incandescent lamp, and in 90 per cent of all cases the reason for changing to LEDs. But to what extent do LEDs fulfil the promises made by the manufacturers when it comes to efficiency rates of up to 120lm/W and a service life of 50 000 hours?

Expectations as to energy saving as a consequence of switching from incandescent lamps to compact fluoresecent lamps were initially met with bitter disappointment.

The term "energy-saving" would appear to relate more to the concerns we should have regarding production and disposal costs for such lamps and the inherent problems arising from those processes. The question that springs to mind is whether the prognoses for efficient light-emitting diodes are not based on similar calculations. In November 2011, the German magazine "Öko-Test" published the results of tests on eleven LED retrofit lamps available on the market as replacements for a 60 watt incandescent lamp. The German construction biologist Wolfgang Maes discovered that of the eleven LED sources tested only three fulfilled the efficiency specifications quoted. Seven of the test sources did not produce the lumen output quoted on the packaging, and one did not even produce 16 per cent of the quoted amount. Two specimens failed to meet the rated service life of 50 000 hours by 47 000 hours (!), which is ridiculous to say the least. This all results in frustrated end-users, who feel they have wasted their money, and – in the design field – to frustrated clients, who feel cheated at having their expecta-tions raised by exquisitely worded advertising slogans and a list of advantages as long as your arm from the lighting industry, and thwarted as soon as the light sources are put to real use. It's about time we all got more realistic. What are the lasting benefits of light-emitting diodes when subjected to critical examination?



Typical spectral distribution of an LED showing the characteristic peak in the blue range. Measured by building biologist Joachim Gertenbach.

The initial rated service life of 100 000 hours has been reduced to the 50 000 hours generally accepted today. This claim only holds true when the LEDs operate in an (ideal) ambient temperature of 25°C. Any increase has a more or less serious negative effect on their performance and life. Apart from that, the inner temperature relies heavily on how they have been manufactured: remote phosphor configuration is thermally more efficient than chip-on-board assemblies. Current fluctuation, especially increases in current fluctuation, has a substantial impact on the service life of the light source. Can we always presume that tests are carried out under ideal conditions? High efficiency ratings of 120 lm/W are reduced by over a half when the colour rendering properties are enhanced. It quickly becomes apparent that this is not the only shortcoming in this area: the standard for measuring colour rendering is based on eight now "outworn" colours and a further four saturated colours plus skin tones and leaf green. The last six are not included in the calculations that give us the colour rendering indices. The ninth colour in particular, a saturated red, reveals this weakness in the colour rendering properties of the source. Not many on the market have succeeded in filling this gap to date. The best colour rendering, without any significant dip in the red range, is rated as Ra 98. This results in a lower efficiency rating of 40 to 55 lm/W maximum, far less than a compact fluorescent lamp. Well, you can't have everything, I suppose!

Compared with the spectral composition of the compact fluorescent lamp, that of the LED is essentially more uniform – except, of course, for the peak in the blue range at 450nm.

But all the panic about potential damage to the human eye because of these very wavelengths seems to have gone with the wind. We would probably do better to do some serious research on the matter rather than sweep it under the carpet. I don't know how you feel about it, but the prospect of serving as a guinea pig to test the long-term damage of specific LEDs does not appeal to me at all!

Let's take a closer look at further positive data supplied by the manufacturers: measurements – including studies made by construction biologists – have proven that the claim that LEDs emit no ultraviolet or infrared radiation holds no water. The true advantage of the tiny, versatile light sources is yet to be revealed. In most cases one small, easily focusable LED is not sufficient to achieve the desired – or required – quality and quantity of light, which is why LED sources comprise several LEDs in an array on a board. This obviously makes it difficult to control the light emitted pre-cisely using just one reflector.

If one reflector is used per LED, this takes up more space. Given that the diodes are extremely sensitive to changes in temperature, especially heat, well designed thermal management is an absolute must, which again requires additional space. About the same amount of space as the screw base on an A lamp, come to think of it…

In the case of remote phosphor technology, the tiny light sources become small Lambertian radiators, although the internal temperature is lower. New optical developments based on the above facts are a bold, but in my eyes sensible investment in the future, which will hopefully pay off.

We must not forget that when we talk about LEDs we are talking about light sources. This is often lost when parts of the luminaire, such as reflectors, have to be adjusted in order for the fixture to work at all. The luminaire has to respond to all these requirements. From the point of view of design, luminaire and light source have to be part and parcel of one idea, and one object. To be practical, only manufacturers can handle this kind of coordination. Given the wide inconsistency of the products currently on the market, lighting de-signers are only able to work on a one-off scale. Attempts to promote uniformity in a modular fashion, as Zhaga is trying to do, are unfortunate-ly doomed to failure if the manufacturers are not willing to accept the inherent restrictions. This is understandable, when you consider the pace at which innovative technology is currently developing and the pressure this puts on the market.

The Artist Series from Xicato is rated on the market as offering the best colour rendering, but consequently loses a little on efficiency.

The responsibility of the designer lies more than ever in understanding and coordinating technology, design, and aspects of human perception – and demanding the relevant developments from the market. Human perception and the biological effects of light are gaining more attention and thus significance. The lighting designer needs to use this to put pressure on the lighting industry – crucial human aspects are all too often ignored or glossed over in favour of the latest technological developments. It is imperative that the biological effects of light be included in all further developments. We will need new standards and guidelines to reinforce this. Some are already in the making. Experts in the field – doctors and therapists – must be consulted when compiling these documents. Specialists in the field of photobiology have been invited to contribute to the study and review of the existing colour rendering index, for example.

To date we have relied on our knowledge of human perception to measure our sensitivity to colour. Now we know that spectral radiation affects our minds and bodies and also impacts the way the lens in the human eye adjusts focus. Many designers are aware of these facts, which in turn must be taken into account in the further development of lighting technologies. The physiological effects of flicker from fluorescent lamps and the majority of LEDs are long known but frequently played down, usually with the argument that we do not perceive flicker visually. Our brains do register this disturbing phenomenon, however, and the effects of flicker have not been researched in depth. Before serious study has been done on this, we will remain ignorant. To carry on regardless is highly irresponsible. Designing for humans means accepting social responsibility. Never before has the designer incorporated such an important link between technology, design and the user. Lighting design has always been a complex topic, but now we are faced with channelling ground-breaking developments in the right direction. The responsibility is considerable and all-embracing.

Technical standards and regulations, including the above-mentioned factors are one thing, a realistic appraisal of the situation another. LED technology is a great development, but is not without drawbacks. Fantastic prospects for future developments, quoting utopian figures coupled with over-enthusiastic assessments and visions, do more damage than good. Designers and clients are uncertain as to what they should believe, because they get the impression that what is specified today may be out-of-date tomorrow.

It is time to be truly realistic. This could well help to clear up the market and do away with cheap, low-grade products, which would go a long way towards simplifying quality control. Don't get me wrong: I have nothing against designing with LEDs, and do not wish to encourage colleagues not to use them. But I don't want to have to use LED lighting only for my designs. LEDs are not (yet) the answer to everything. Maybe they will be – one day.

Collimators used with exchangeable Spherolit lenses in one newly developed optoelectronic system from Erco. Light is no longer controlled by reflectors but by lenses. A big step – and investment – in the future.