

ENLIGHTENED THINKING

LIGHTING, PRODUCTIVITY AND WELLBEING
IN THE WORKPLACE, AND THE CASE FOR HUMAN-CENTRIC LIGHTING

By Katy Lawn and Colin Stuart


**almost
70%**
of employees
complain about
the lighting in
their offices¹⁹

Six-hundred-thousand years ago, the discovery of fire provided a source of warmth, protection, and – for the first time in human history – an ‘artificial’ source of *light*. No longer did we need to depend solely on the light from the sun. Fast forward to twenty-first century, and artificial light is an absolute necessity in today’s 24/7 work culture. Every worker in every sector will likely be working with the help of artificial light for all or part of the day. It’s now common knowledge that the design of our workplaces can have a huge impact on our health, wellbeing, and even mood – but a recent study by the American Society of Interior Design showed that almost 7 in every 10 employees complain about the lighting in their offices.¹ This white paper considers the impacts of workplace lighting, and the case for human-centric circadian lighting.

LIGHTING: WHAT’S THE PROBLEM?

As designer Ralph Caplan wrote: “thinking about design is hard, but *not* thinking about it can be disastrous.” This holds especially true for workplace design, as workers who were rate themselves as satisfied with their work environments were also more satisfied with their jobs – meaning higher levels of commitment and less staff attrition.² Simply put, good workplace design can boost happiness, productivity, innovation, motivation, commitment and – ultimately – profit.

Thoughtful design is especially essential with lighting because beyond the common ocular complaints – eye strain, headaches, blurred vision and dry eyes – lighting has a vast range of other health impacts. These include musculoskeletal complaints due to awkward postures (often in order to see under inadequate lighting conditions), but also stretch into the domain of sleep disorders and contributing to serious life-limiting illnesses; and these problems are ever-more acute with a progressively ageing workforce.

Research also shows that people who perceive their lighting as being of higher quality tend to rate their workspace as more attractive, report improved moods, and exhibit better well-being at the end of the day.³ So why are we designing lights and lighting schemes that aren’t working for so many of us?

Globally, buildings
use about



40%
of all primary
energy²⁰

Until relatively recently, the concern with lighting in the workplace didn't go far beyond making sure there was bright enough light for workers to complete tasks safely. But over the last four decades, medical science has consistently shown the crucial role of light in wellbeing, as well as task performance. In short, we've moved from thinking about lighting as a health and safety issue, to treating it as a tool we can use to boost productivity and health.



People receive about 85% of their information through their sense of sight²¹

COMMON MISTAKES

It's no secret that lights that are too dim can cause eye-strain and headaches, but equally frequent problems in workplace lighting are glare (too much direct or reflected light) or flicker.⁴ Problems can also occur when light is poorly distributed in the space, causing eye strain where different parts of the office have substantially different light levels and the eyes are constantly having to readjust.

Light is in fact one of the eight categories considered in the International WELL Building Institute WELL certification, and includes detailed assessment of thirteen different categories.⁵ This shows the level of thought that should be given to lighting in healthy, well-designed workspaces; but what are the absolute basics of lighting design? What – legally – are we working with in the UK?

The Health & Safety at Work Act of 1974 sets out an employers' duty provide suitable lighting to ensure that work can be undertaken safely' and that employee's eyesight and overall health must not be jeopardised. This is obviously quite vague – and the Workplace Regulations Act 1992 adds little additional detail, adding that: lighting must be suitable and sufficient; that this should be natural light, so far as is reasonably practicable; and that suitable and sufficient emergency lighting shall be provided where needed.⁶

Guidance from the Health and Safety Executive's guide to Lighting at Work provides advice on what constitutes good practice and sets out the *minimum* recommended levels of light. A corridor or walkway, for example, would need a minimum of 20 lux, whereas office spaces need 100 lux minimum.⁷ However, guidance from CIBSE suggests that the *actual* recommended lighting for office spaces is five times this minimum, at 500 lux; and for computer workstations, between 300 and 500 lux is preferable. It's clear that whilst we do have best practice guidelines, workplace lighting has limited legislation and the advice varies.⁸

NHS LIGHTING IMPROVEMENTS

Researchers studying ways to improve NHS facilities found evidence of lighting alterations having positive impacts for staff, patients and visitors. They recommended that certain rooms should have different lighting colour and lux levels - staff break rooms, recovery rooms or rooms for patients awaiting surgery should have warmer, softer light, whereas surgery rooms should have bright white light. They found that whilst changing the lighting may not *cure* health problems, unsuitable environmental conditions had a clear negative effect on patient recovery rates, stress and staff morale.*

Dalke et al (2006) '[Colour and Lighting in Hospital Design](#)', *Optics and Laser Technology*



In industrial settings, good lighting can be expected to increase productivity by **about 8%**²²

This is all made more problematic by the fact that lighting a workplace is a complex task which is usually planned during the design stage of the building, rather than when a company's employees move in. The challenge of tailoring your lighting design to an already-built office space post fit-out can be difficult; but this is where task lighting becomes so important, particularly because the *right* lighting depends entirely on the needs of the workers in the space and the way the space is used.

LIGHTING AND PRODUCTIVITY

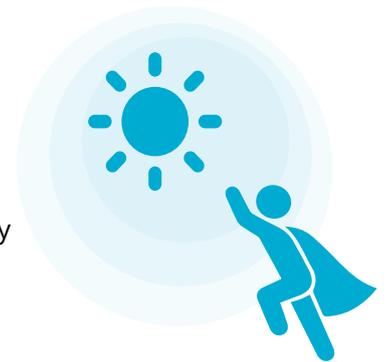
So what's the link between lighting, productivity and wellbeing? A recent paper from CASS Business School explains: "existing research documents good evidence of an association between lighting and work performance, mediated by employee well-being".⁹

A classic lighting case study is the Reno Post Office sorting room. In 1986, the Post Office was a warehouse with very high ceilings and direct downlights. The directors decided to lower the ceilings and replace the direct downlighting with soft, indirect lighting. The complete renovation cost \$ 300,000; but the productivity gains from these changes were worth \$ 400,000 to \$ 500,000 *a year*. In other words, the adjustments more than paid for themselves before a year was up.¹⁰

What is perhaps most fascinating is that the increase in productivity that the researchers saw was completely unexpected. They assumed that the adjustments might be a bit better for the staff, but the objective was actually just to lower energy costs. The lowered ceiling made the room easier to heat and cool; the lighting was chosen because the bulbs were more energy efficient. But we can safely assume that better, less echoey acoustics helped mental focus, and that the diffuse lighting led to less eyestrain and therefore less sick days and higher task accuracy (after the changes, only 1 in 1000 letters were being sorted incorrectly).

The Reno post office study represented a landmark moment in looking at the impacts of lighting on productivity. It's other major contribution was to demonstrate the ROI for sensible, cost-effective lighting changes. Given that 19% of electricity consumption worldwide is devoted to producing light, there is ever-growing demand for more efficient and sustainable lighting systems.¹¹ We've come a long way since the 1980s, but with lighting still being such a major contributor to the energy demands of a building, it's a crucial area where we can look to reduce costs, as well as considering the environment by being efficient with our energy use.¹² It also reinforces what we all already know: that wellbeing is crucial for a productive workforce. Happier, healthier employees work better, faster, and are less error-prone.

But beyond minimising eye strain, what light is it, exactly, that we need in order to boost wellbeing in other ways? As the Workplace Regulations Act 1992 mentioned, lighting 'should be natural light, so far as is reasonably practicable'. The second part of this paper considers the benefits of natural light, and how this relates to circadian, or biologically-effective light.



Workers exposed to daylight are **18%** more productive²³

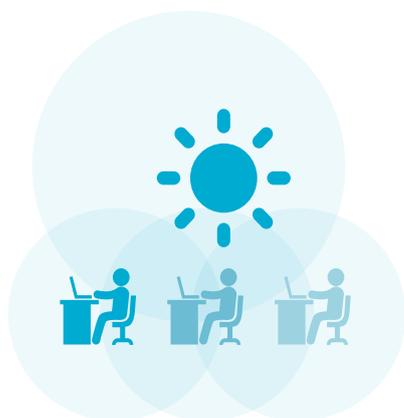
NATURAL LIGHT: WHAT'S THE FUSS?

Research shows that workers who have a window in their office tend to have a much better sense of health (rated as overall wellbeing and sleep quality) than those in windowless environments.¹³ This is especially important, because office workers are a risk group as they are typically indoors often without access to natural – or even artificial bright light – for the entire day.

Researchers found that in comparative experiments between nurses who worked mostly in environments with artificial light vs nurses who had access to natural light, there were hugely significant differences. The nurses with access to daylight communicated better with their colleagues. They also laughed more at work, were nicer to their patients, and even their own physical health was improved. Nurses who saw daylight had significantly lower blood pressure than those that didn't.¹⁴ It's clear that we ideally need access to daylight in order to function at optimal levels, but what's the next best alternative?



10%
of UK workers
work with no
natural light
at ALL²⁴



// We suggest that architectural design of office environments should place more emphasis on sufficient daylight exposure of the workers in order to promote office workers' health and well-being

Journal of Clinical Sleep Medicine²⁵

HUMAN-CENTRIC LIGHTING AT CBRE

A comprehensive 2017 study at the Amsterdam office of the global property company CBRE has yielded promising evidence in a trial of human-centric lighting systems. In what became known 'The Healthy Offices project', researchers installed time-controlled lighting featuring a circadian-friendly lighting sequence which simulated the natural cycles of daylight using varied light intensities and colours throughout the day. The survey included biological data, questionnaires, and daily movement evaluations and interviews – creating more than 100,000 data records for the 124 employees involved.*

The results were staggering. Employees perceived their work performance as 18 % better. Work accuracy rose by 12%, and, a startling 76% of employees reported feeling happier. 71 % of them felt more energized, and 50% felt healthier.**

Interestingly, the existing lighting levels at the CBRE office *before* the experiment met the norms for most workspaces and therefore might not have even been considered problematic, which shows how unaware we might actually be of how *much* we could improve our workspaces.

Memoori (2017) '[The Growing Case For Human-Centric Lighting](#)'
LuxReview.com (2017) '[10 Things You Need to Know About Workplace Lighting](#)'

LIGHTING: CIRCADIAN RHYTHMS AND SLEEP HYGIENE

Thomas Edison famously proclaimed that using an electric light “is in no way harmful to health, nor does it affect the soundness of sleep”. We now know that this is untrue – though not for the reasons that he might have expected. There are many reasons why people get insufficient or low-quality sleep in our 24/7 society, from long morning commutes to caffeine-rich food and drink. But a crucial factor is often to do with Edison’s famed invention: the electric light.¹⁵

Unknown to him, light is one of the crucial factors that regulates the body’s circadian rhythm; essentially the body’s own internal 24 hour clock, which runs in the background and cycles between alertness and sleepiness at regular intervals (also known as your sleep/wake cycle or your ‘body clock’). In fact, as the director of the Division of Sleep Medicine at Harvard Medical School states: “light impacts on our circadian rhythms more powerfully than any drug”.¹⁶ Severe disruption of circadian rhythms has been linked to breast [cancer](#), and could also play a key role in the development of ovarian, prostate, endometrial, colon and skin cancers; diabetes, [cardiovascular diseases](#), endometriosis, gastrointestinal and digestive problems, obesity, and depression.¹⁷

Light regulates this system because special cells in the eye process information on light, and send signals directly to the hypothalamus; a part of the brain which is responsible for the production of melatonin, a powerful hormone often known as the ‘sleep hormone’. Melatonin is responsible for telling the rest of the body whether it is night or day, for regulating our energy levels and alertness, and for regulating our sleep. This is why it has such a significant biological and physiological impact.

Whilst the presence (or absence) of any type of light from any type of lamp has an effect on alertness, mood, and sleep, our photoreceptor cells do have markedly different responses to different colours of light. They are most sensitive to blue wavelength light, meaning that blue light is the most effective at suppressing melatonin; i. e. keeping us feeling more alert and awake. This is why cold-white, blue-enriched light is great for waking us up in the morning, whereas warm-white, red-enriched light in the evening is better for relaxation. And the same logic explains why we are always told not to go on our phones (which emit a concentrated blue-white light)

for an hour before bed – it suppresses melatonin, which in turn stops us from feeling sleepy.

The key is that in addition to these immediate effects, the right lighting at the right time can stabilise your circadian rhythm in the long-term. Keeping our circadian rhythm stable leads to greater well-being; and this is what drives improved performance.

CIRCADIAN LIGHTING: IS IT ALL IT’S CRACKED UP TO BE?

Circadian lighting systems represent a rapidly growing market, with a steadily growing evidence base; and not just in the workplace. We are being bombarded with light-based alarm clocks that simulate sunrise and sunset... but at the time that we want it to happen. This seems somehow dystopian: synthetic sunrises to replace the real thing. Nevertheless, it seems to make some scientific sense. In a 24/7 economy it’s almost impossible to live in sync with the natural cycles of sunrise and sunset. Instead, the best we can do is to get as much real daylight as we can, and to simulate the cues that our bodies need for balanced energy levels and circadian rhythms. But we do still need more evidence.

The biggest reservation that many companies are likely to have is the cost – comprehensive circadian lighting systems don’t come cheap. And whilst the promised payoffs of these systems accrue (with less sick days, lower attrition rates, higher task performance, better wellbeing, lower energy use) a strengthened evidence base will make the financial outlay easier to swallow. What is certain is that ignoring the potential benefits of well-considered lighting will likely mean compromising on productivity due to poorer working conditions.

If you’re not ready to take the plunge just yet, the basic steps to take are to check your lighting scheme at regular intervals. Are you using the most energy efficient bulbs? What simple upgrades could be made at low cost? How are your employees feeling about the lighting? Are there any recurrent complaints? Just keeping a finger on the pulse of how your employees are doing will tell you what immediate adjustments need to be made, and it doesn’t necessarily need to be high tech or costly.

UNDER THE SPOTLIGHT: LUCTRA®



One product line we have recently been interested in is Luctra's range of human-centric lighting, in the form of sleek, functional and stylish table, floor and mobile lamps. The thinking behind these circadian-friendly products is founded on the same principles that NASA used on the International Space Station to improve the performance and sleep quality of astronauts by mimicking a normal day/night cycle.

BIOLOGICALLY EFFECTIVE

Luctra's 'biologically effective' range of lights have been proven to affect the level of melatonin released by the body dependent on different colours of light. In line with what previous research has told us, Luctra LED lights were found to suppress melatonin production when set to bright white or blue-white light (meaning higher levels of wakefulness), whereas both dim light and warm-white light saw the highest levels of the 'sleep hormone' in the body.*

INDIVIDUALLY TAILORED TECHNOLOGY

Natural circadian rhythms vary from person to person – which is why some of us are night owls, and some of us are 'more of a morning person'. But for most adults, the biggest dip in energy happens when they're fast asleep in the middle of the night (somewhere between 2am and 4am); and just after lunchtime, between 1pm and 3pm. So, as it turns out, there is a biological reason for the mid-afternoon doldrums in the office. Given that circadian rhythms determine our energy levels, mood, and sense of wakefulness/sleepiness, we obviously (at best) would prefer lighting tailored to our individual needs.

Luctra's free app, Vitacore® calculates the optimum lighting sequence for the user, based on their responses to a couple of simple questions about their daily habits. The app then transmits these settings directly to the lamp via Bluetooth and automatically varies the intensity and colour of the light to simulate the natural course of the day.

FLEXIBLE LIGHTING

It goes without saying that flexible workspaces need flexible lighting. Increasingly, organisations are having to be adaptable and to pro-actively change to meet rapidly changing market conditions which is fuelling the demand for adaptable lighting schemes; ones that can play a part in creating working environments which are flexible, innovative and able to meet the *changing* needs of an organisation. Further, numerous independent studies have also shown that giving workers in open plan offices local control of lighting can increase job satisfaction as well as decreasing the experience of stress, regardless of what lighting you provide; but the *complete* personalisation of light is in fact the feature that won Luctra's FLEX lamp an AIT Innovation Award.**

*Luctra (2014) '[Final Project Report: biological effects of the Luctra LED desk lamp](#)'

**HSE (2018) '[Human factors: Lighting, thermal comfort, working space, noise and vibration](#)'

CONCLUSIONS

Offices are complex ecosystems involving many hundreds (or even thousands) of components. With each of these components comes the opportunity to make a choice between a healthy or an unhealthy approach; and lighting is a crucial part of that puzzle. Investing in lighting is likely to represent a smart business investment in the long run, as losses associated with burn-out, sickness and high staff turnover rates are significant expenses that can be drastically reduced or eliminated by introducing healthier working environments.

Human-centric lighting systems, built around the principles of circadian rhythms and natural daylight cycles, are the latest way that innovative technologies are helping to take our workplaces to the next level. This goes hand-in-hand with a move towards human-centric design more generally; and what are workplaces really for? Humans. As the evidence base builds, more and more employers, workplace consultants and real estate managers and builders are starting to take note.

It's clear that changing our working environment could lead to a brighter future for people at work. It's also clear that healthier offices create a ripple effect which generates wider benefits outside the workplace. Whilst recent evidence shows exciting potential for the use of light as a tool for wellness and productivity in the workplace, further studies are needed in order to strengthen the business case.¹⁸ Nevertheless, the evidence we're starting to see is cause for excitement – so it's certainly time for some seriously enlightened thinking.

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We have an award-winning track record and have helped businesses in both the public and private sectors - from SMEs to large multinationals, from local councils and NHS trusts to central government departments-to use the working environment as a catalyst to drive positive behavioural change, promote staff wellbeing and improve business performance. Our client-focused, tailored approach means we can support you throughout the lifecycle of your property

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