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BIOPHILIC DESIGN
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SELLING POINTS

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Editorial copy deadline: First day of the month preceding the publication month

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Switched on

Many of us will be sharpening our elbows in preparation for that stressful, last-minute Christmas shopping dash. Of course, many more of us will be scouring the web instead, searching for seasonal bargains from the comfort of our own homes. Both methods will produce similar results, but the user experience will be completely different.

As the Society of Light and Lighting's new retail lighting guide, LG17, affirms on page 4, good lighting design is critical to promoting the real shopping experience as an exciting, engaging alternative to the sedentary and sterile online transaction. The guide offers an insight into what a lighting designer will need to consider to create a great retail destination for customers and staff.

Visual comfort was an important element of the lighting design for Europe's largest infrastructure project, the Elizabeth line. Good vertical illuminance has been prioritised to enhance legibility of signs, while indirect lighting – and use of luminaires with large, diffuse, luminous surfaces – has helped create fewer shadows and veiling reflections on materials and finishes (page 10).

On page 14, we report on a study that will test an office and its staff before and after a refurbishment based on biophilic principles.

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Lighting for wellbeing

Studies drawing specific connections between workplace conditions and their long-term impact on personnel are mobilising a tangible movement around the idea of wellness at work – in particular, the importance of making improvements at every stage of a building's life-cycle.

It is in this new landscape that Tamlite Lighting, the UK's second-largest privately owned lighting manufacturer, is championing the benefits of human-centric lighting as part of workplace wellbeing strategies.

Launching this month, Tamlite's Lighting for Wellbeing campaign is borne from a response to hard-hitting studies, such as the recent review of workplace health published by the British Council for Offices (BCO).

The BCO report underlines the urgency of the current situation, with less than half of respondents feeling that their workplace is having a positive impact on their health. Understanding the business case for wellbeing is essential across the sector.

To support this, Tamlite is taking an industry lead and has produced a range of resources explaining the long-term commercial and people

benefits of creating a perfect balance between natural and artificial light.

The message is simple – and the business case is compelling: the right light, correctly tuned to the needs of building users, can result in step-change improvements. These include reduced stress and absenteeism, as well as a boost to employees' cognition and mental and physical health.

Commenting on its wellbeing campaign, Tamlite's Debbie-Sue Farrell, said: 'The workplace wellbeing agenda is driving the business programme. We believe in rebalancing the investment equation in favour of wellbeing.'

'By inviting every part of the built environment supply chain to take an active part in the wellness conversation, it will be far easier to deliver buildings that are authentically conducive to employee health and productivity.'

tamlite.co.uk/wellbeing



High streetwise

The SLL has published its first guide to retail lighting. **Jill Entwistle** talks to author Simon Robinson about why it was needed and what it covers

The retail sector is in a state of flux. The high street is hollowed out, traditional supermarket behemoths are looking less invincible under the assault of cost-slashing competitors.

A key factor, of course, is shifting consumer buying patterns, with online shopping offering convenient and irresistible options for the customer. An upshot of these disruptive developments has been the growing emphasis on 'retailainment'.

The retail experience must offer what

the online process cannot – a tactile, sensory, stimulating and three-dimensional encounter. This has repercussions for design, which is crucial to creating an appealing ambience. Lighting, one of the key components in conjuring up atmosphere and delineating the merchandise, is now even more vital for setting the scene and providing dynamism.

Retail interiors have moved way beyond a bit of spot lighting from a ceiling track. As elsewhere, LEDs have opened up the creative gates at just the right

moment, allowing a multiplicity of techniques – from discreet, integrated shelf lighting through to increasingly prevalent giant video walls.

Given the growing complexities in this sector, it is a timely moment for the Society of Light and Lighting (SLL)



The quasi-temple feel of a recently opened Sanctuary store in Boston, Massachusetts, devoted to Adidas and designed by Montreal-based SLA; and (inset, left) an example of signage illumination at London's Greenwich Market, with lighting by Hoare Lea





Licht Kunst Licht's scheme for the Balenciaga flagship store in Paris reflects an industrial aesthetic



to introduce its first lighting guide in this area – LG17 *Lighting for Retail Premises*.

It has taken three years to put together, and the society recognises that it fills an important gap in its guidance documents.

'We wanted to help designers who have little or no experience with retail lighting, and to provide an insight – for shop owners, architects and interior designers – into what a lighting designer will need to consider during the design process,' says lead author Simon Robinson, of WSP. 'The guide is not aimed at those who are either experienced retail designers or owners/managers of large retail chains with easy access to those skills.'

As authors of guidance publications are only too aware, readers cherry pick the sections relevant to their situation, rather than the whole document. To help this type of reader, LG17 opens with a chapter on the approach to designing retail lighting.

'This sets the scene and covers topics that are expanded on later in the guide,' says Robinson, who is chair of the SLL technical and publications committee. 'It can be thought of as a foundation for the book and includes useful tips on issues, such as making sure you have the right information about how the owner intends to operate the shop before the design process starts.'

A suggested list of questions (see panel, 'Questions example') will help inform the whole design process and may lead the reader to consider something that had not occurred to them before, says Robinson.

'The creative elements of a design will need to draw heavily on the intended use of the retail space and the owners' aspirations for their business. Trends in shopping habits and interior design can be strong influences and lead to customers expecting a particular "look" to a space, even though the shop owner may prefer something else.'

'A good example is the trend in fashion stores towards high contrast lighting, which uses display lighting almost exclusively,' adds Robinson. 'The popularity of this approach with customers means an expectation develops, and similar shops may need to follow the design ideas, even if the shop owner is not a fan of the "look".'

Displaying the merchandise to best advantage is an important focus, but – as with all SLL guides – the approach is more holistic, considering the store, shop or supermarket as a workplace, as well as somewhere that sells things.

'Retail spaces are places of work for millions of people around the world and their occupational health and safety have been addressed in the new guide,' says Robinson. 'Traditionally, the sales or checkout positions, as well as back-of-house locations, have been easily identified as areas where staff will spend time, making it relatively easy to provide appropriate lighting for their tasks.'

The use of smart devices, however, has complicated matters. 'Increasingly common is the flexible approach that tablets and other touchscreen devices have brought to retail,' says Robinson. 'Staff can now spend long periods of time with ➤

SLL GUIDES UPDATE

SLL Lighting Handbook (2018)

The new handbook has just been published. All existing chapters have been updated and an additional 13 have been included – along with four appendices – making the 2018 version one of the most comprehensive guides to interior and exterior lighting in the world.

LG1: The Industrial Environment (updated 2018)

Updated by addenda after a review in October 2018.

LG13: Lighting for Places of Worship (updated 2018)

Also reviewed in October 2018 and now featuring an addendum.

LG17: Lighting for Retail Premises (2018)

The SLL's first guide to lighting for retail premises was published in October.

LG18: Lighting for Licensed Premises (2018)

With a slight change of title, this publication has been updated and expanded for its second edition.

» customers in any part of the space, making it more difficult to provide a lighting design that addresses their needs.'

The guide recognises that energy reduction is a fundamental part of any design project – though retail lighting, like other leisure areas, has always been recognised as having rather different needs than, say, an office environment.

'There will always need to be a balance between appropriate use of energy, the use of lighting to highlight merchandise or sales banners, and the need to offer an inviting environment for customers,' says Robinson. 'Hopefully, LG17 addresses these issues while recognising the need to allow designers to be creative in the use of lighting in retail spaces.'

LG7, on office lighting, was the first lighting guide to introduce examples of how various spaces could be illuminated. This approach has been carried through to the retail guide, which includes 10 examples of retail spaces, ranging from a small to medium-sized, general-purpose retail space to a fully glazed car showroom.

Robinson draws an analogy with office spaces, in that retail tends to be associated with large shopping complexes, supermarkets or department stores. In reality, however, the vast majority of retail outlets are small, general-use spaces, often repurposed or occupying space not suitable for any other use – which is why the practical examples begin with a general-purpose shop.

'Such spaces make up the majority of retail establishments, so the uses to which they can be put is extensive and the example discusses two approaches,' says Robinson.

'The first acknowledges that many shop owners simply want a flexible, general-purpose space that can maximise their opportunity to sell merchandise. The second considers the use of display

QUESTIONS EXAMPLE

Pre-design stage questions to ask the client:

- Is daylight to be optimised or excluded?
- What tasks are to be performed by staff?
- Will staff be located in set positions or mobile?
- How critical is good colour representation of merchandise?
- Will merchandise have small text that needs to be read by customers?
- How important is the vertical surface? It is key in a bookstore, for example, but perhaps not so much in a bakery



The flagship Dolce & Gabbana in Aoyama, Tokyo, with interior lighting by Curiosity, is designed around the themes of light and shadow

"Good lighting design is critical in differentiating the real shopping experience from the sedentary and sterile online transaction"

lighting for sales promotions, or to highlight particular parts of the space or merchandise on sale.'

Internet-based retail is also considered in LG17, with an example examining the lighting approach for a collection point in a store front.

For many segments of the retail sector, there is no doubt that business now is literally a hard sell. However, as LG17 affirms, good design – specifically good lighting design – is critical in differentiating the real shopping experience from the sedentary and sterile online transaction. □

■ *LG17 Lighting for Retail Premises* is available through the CIBSE Knowledge Portal. Members of the SLL receive unlimited online access to all SLL publications. For information about becoming a member, email sll@cibse.org



'Unsung hero' Paul Ruffles is Lux Person of the Year

Ruffles recognised for outstanding contribution to the lighting industry

Lighting design engineer Paul Ruffles was named Lux Person of the Year at the 2018 Lux Awards in London last month.

Ruffles dedicated a major part of his career to the industry and, according to the judges, is an 'unsung hero' of the sector.

As editor-in-chief of the *SLL Lighting Handbook*, he has helped revise it for 2018, adding 13 new chapters.

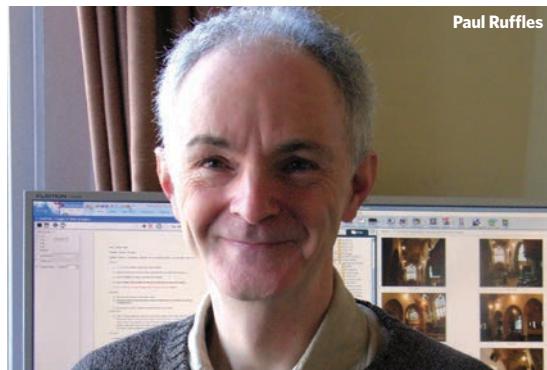
Ruffles has been the principal of Lighting Design & Technology since founding the practice in 1992.

He has helped in the organisation and administration of his profession through his work with engineering institutions, as well as bodies such as the National Illumination Committee, the International Standards Organisation, Lux Europa and the British Standards Organisation. He is also a past

president of the Society of Light and Lighting, previously known as the CIBSE Lighting Division.

Ruffles' projects include The Holiday Inn in Kensington and a new visitors' centre for Kew Gardens. He also offered lighting support to BuroHappold's offices in London, Leeds and Saudi Arabia.

Also at the awards, WSP's Emma Beadle picked up the Young Lighter of the Year Award.



Yangpu Bridge,
Shanghai

Signify shines light on Shanghai's buildings and bridges

China's financial and economic centre Shanghai has been given a lighting facelift, with the aim of saving up to 70% of its annual lighting costs.

Signify, formerly Philips Lighting, has completed a connected architectural lighting project at the Shanghai Municipality, which involved dynamically lighting the waterfront, the Yangpu, Nanpu and Xupu bridges, and more than 40 buildings in the financial and tourist districts.

'Our connected lighting can give municipalities control and real-time information on the performance of individual light points. This information could be input into smart city dashboards to give planners a 360-degree view of their assets as China transforms its cities to be more efficient and liveable,' said John Wang, president at Greater China, SVP, Signify.

The firm is helping Chinese cities to develop eco-friendly business and tourist landmarks through connected LED lighting, to lower energy use and reduce operating costs. The luminaires are expected to save the city 50-70% of its annual lighting costs, compared with conventional lighting. More than 50,000 have been installed to light up the buildings and bridges.

New SLL Lighting Handbook published

The *SLL Lighting Handbook* has been updated and published, after a major drive by the lighting profession – with 30 chapter editors and more than 50 reviewers and technical auditors, drawn from 40 UK organisations, including manufacturers, consultants and universities.

Chapters on vision and light have been removed and will be included in the updated *SLL Code for Lighting*, due to be published in 2019. The 13 new chapters summarise specific applications of light detailed in individual SLL lighting guides – such as *LG13 Places of Worship* – as well as areas not yet covered, such as event lighting, exterior architectural, and lighting for extreme environments. Chapters on integration with other building services and commissioning of lighting systems in line with Commissioning Code L: Lighting (2018) are also included. The chapter on general building areas now covers common spaces, such as corridors, toilets, entrance halls, locker rooms and storage areas.

For details, read Paul Ruffles' overview of the guide at bit.ly/CJDec18SLL

Born to create natural light

Waldmann Lighting is a core partner with the BRE on their *Biophilic Office* research project; a long-term study into the beneficial effects of a naturally considered and holistically designed approach to office interiors.

In the biophilic office we will be using our Lavigo free-standing luminaire, the world's first office luminaire to achieve Cradle-to-Cradle™ certification for sustainability and circular recycling.



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ENGINEERS OF LIGHT



Let's talk Wellbeing

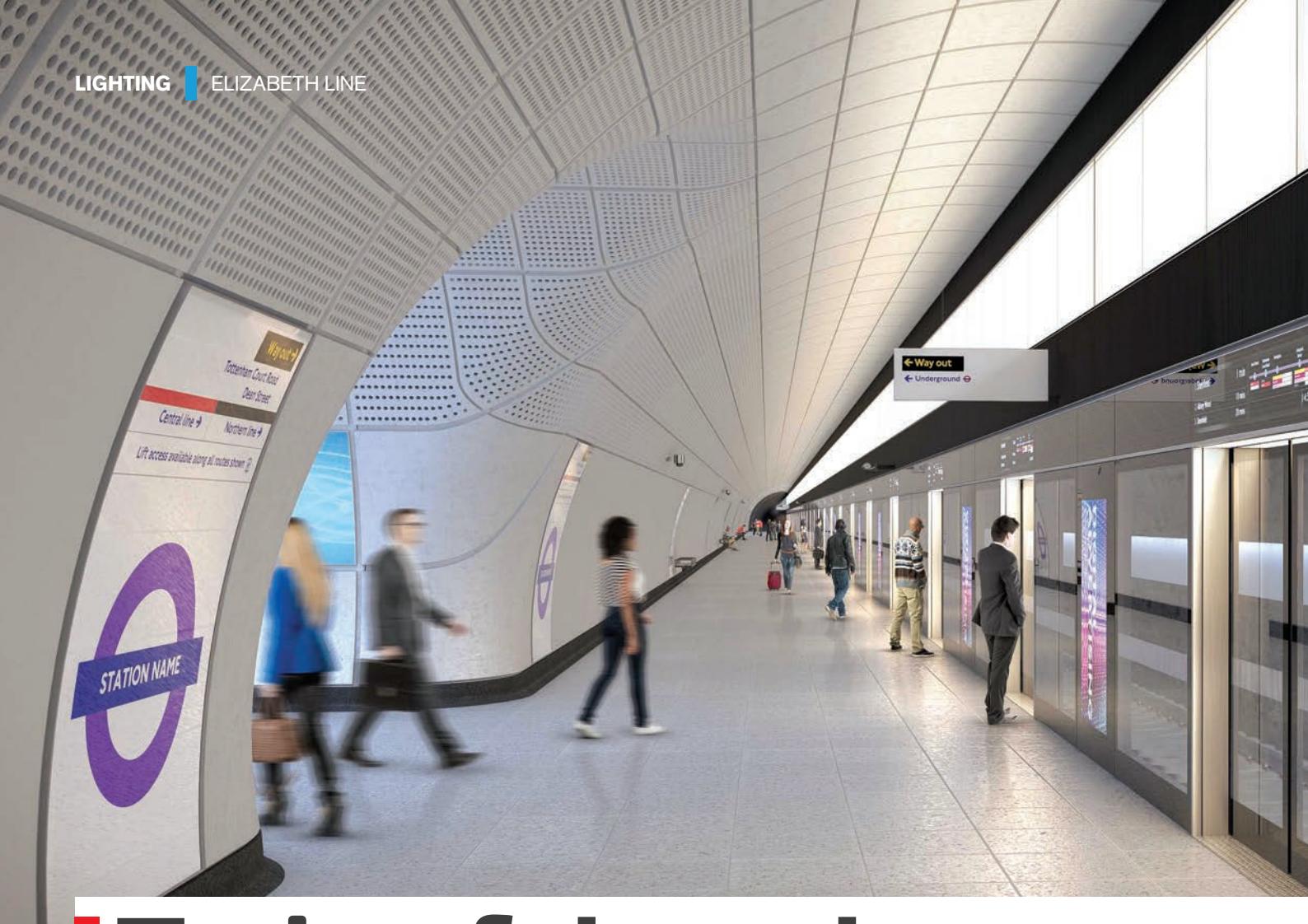
There is a powerful connection between sustainable buildings and the improved health, productivity and performance of those who occupy them. Regardless of building type, size or age, we will help you create a human-centric environment that strikes a perfect balance between natural and artificial light. At Tamlite, our lighting technologies and strategies are always designed with people in mind.

Explore the power of lighting for wellbeing.
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Lighting for
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Train of thought

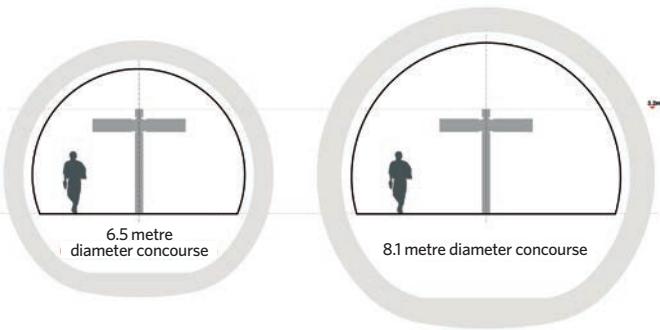
GIA Equation's **Keith Miller** explains the overarching principles behind the lighting concept for the Elizabeth line, Europe's largest infrastructure project

Crossrail, the new railway for London and the South East, runs from Reading and Heathrow to the west of the capital, through 42km of tunnels beneath London, to Shenfield and Abbey Wood in the east. It will be known as the Elizabeth line when it opens to the public in autumn 2019, and will carry an estimated 200m passengers a year, increasing central London's rail capacity by 10%. Integrating new and existing infrastructure, the project has included the construction of 10 new stations and the upgrade of 31 existing ones.

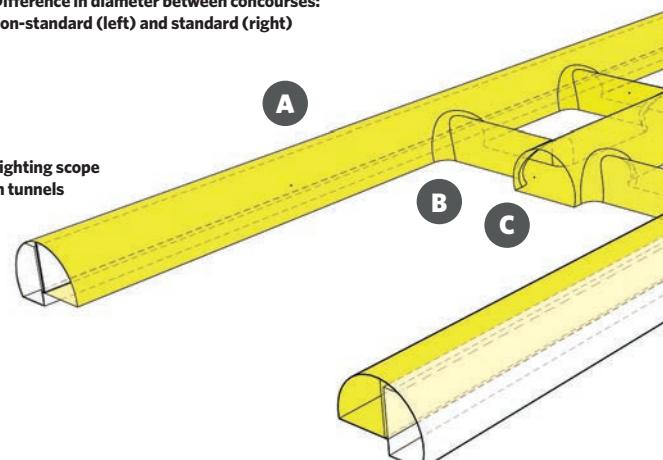
Within central London, there are eight new underground and two new above-ground stations, which are linked by a common identity created using standardised components. This unified set of architectural components and products form part of a line-wide design package for the public areas.

In 2009, a multidisciplinary design team developed the design strategy and, since then, has been working in partnership to integrate these essential components. The team comprises engineers and package leaders from SNC-Lavalin's Atkins business, architects from Grimshaw, product designers and wayfinding experts from Maynard, and lighting designers from GIA Equation.

Spatially, the line-wide design encompasses aspects of the ticket hall, escalator, concourse and platform areas, and offers passengers an easy-to-navigate environment that is unique to the Elizabeth line. The consistent design language is strongest within the below-ground spaces of the five new tunnelled stations – at Bond Street, Tottenham Court Road, Farringdon, Liverpool Street and Whitechapel – because of their similar functional requirements.



Difference in diameter between concourses:
non-standard (left) and standard (right)



Many of the features synonymous with an underground railway – such as tunnel linings, platform-edge screens, lighting and signage – are designed as a set of standardised parts that employ a coherent visual language, functional performance and geometry, to create a familiar feel for the Elizabeth line.

Passenger comfort and experience has been at the forefront of key decisions and innovations, and it is hoped the resulting design creates a quality experience for those moving through the stations.

Line-wide lighting concept

When appointed by the client 10 years ago, the Crossrail line-wide design team faced several challenges in creating forward-thinking lighting solutions for the central London stations. LED technology in the rail industry was not widespread at that time, and was not sufficiently well developed in 2009 to satisfactorily implement some of the principal lighting concepts for the sub-surface station spaces.

Nevertheless, by engaging with LED and luminaire manufacturers and OEM suppliers early in the design process, the design team was able to accurately predict how the LED lighting products and solutions were likely to develop and evolve over the subsequent five to 10 years. This gave the client team confidence to proceed with the completely LED-based lighting installations throughout the Elizabeth line.

Between 2009 and 2011, the GIA Equation design team – in partnership with Atkins, Grimshaw and Maynard – developed bespoke lighting solutions to a RIBA Stage F1 level of resolution for the sub-surface public

PLATFORMS

The platform environment is characterised by the language of the calm, uncluttered GFRC cladding of the ‘arrivals wall’. The solidity of this element contrasts with the glazed, high-technology platform-edge screen (PES) of the ‘departures wall’ (see image below).

The PES has been developed as a services wall, with fully integrated ventilation, lighting, signage, customer information systems, cable management systems, speakers and line maps.

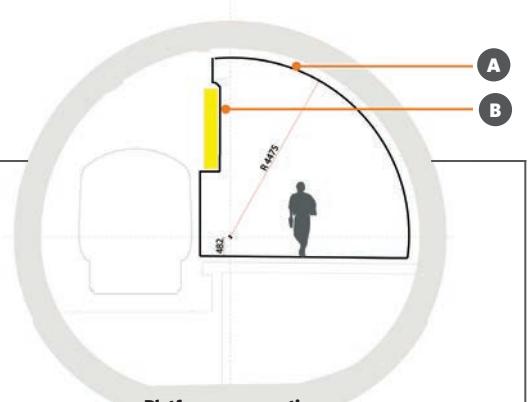
The platform lighting comprises a visually continuous series of evenly diffuse modular luminaires mounted on the PES. The height of the luminous section of the diffuser is 1.1m. Each module is 1.5m long and the array of PES luminaires should cover the entire length of each platform. The luminaire module is uniformly diffuse (a perfect Lambertian surface), reflecting primarily on the upper section of the vaulted ceiling and providing direct illumination on to the platform surface.

Secondary accent light is provided at help-point locations. In addition, train arrival – and passengers boarding and alighting – are assisted by tuneable, white colour-changing linear LED luminaires recessed into each door head within the PES structure. The light fittings change colour – from warm white when the PES doors are closed, to cool white when a train has arrived at the station – synchronised with the opening of the platform screen doors.

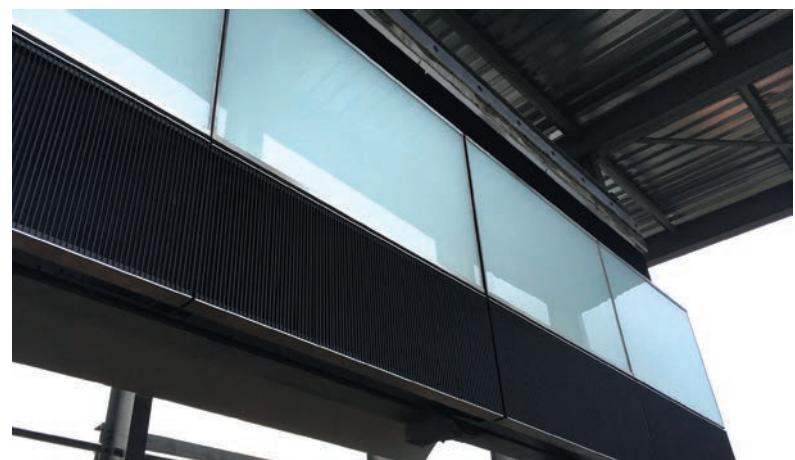
The detailed design involved developing full-scale working prototypes for all principal luminaire types, which were procured from several lighting manufacturers. The prototyping phase also included a full-scale mock-up of the platform space, including lighting.

This process allowed the assumptions made during the design stages of the project to be tested, photometric performance evaluated and product detailing to be refined. This avoided potential risks to project delivery, ensuring buy-in from stakeholders and enabling the proper testing of installation and maintenance procedures.

These initial prototype fittings became the client’s reference luminaires for several years, and served as an example to the design and build contractors of how to manage the luminaire design and fabrication for the final installation.



Platform cross-section
A GFRC cladding B Departures wall

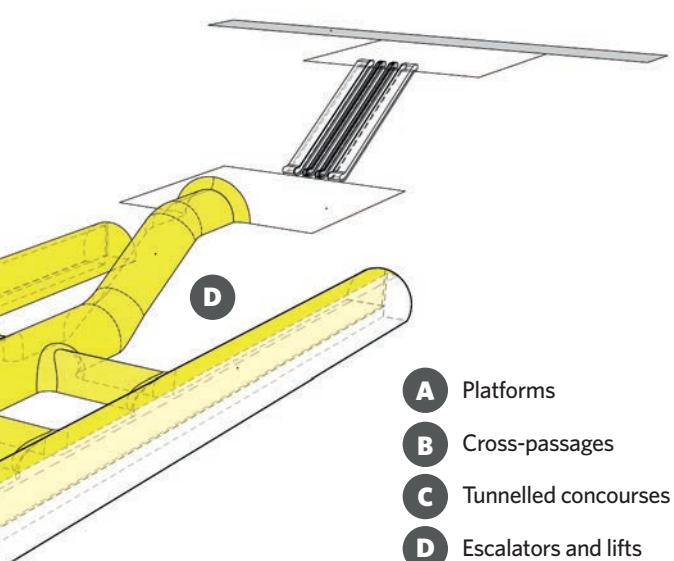


areas of the central London mined (tunneled) stations. These were successfully implemented by each station contractor.

The lighting scheme for the sub-surface stations is designed to respond to and enhance the architecture of escalator barrels, the lower concourse, cross-passages and platforms. The lighting concept forms part of the client’s requirements for all central London stations, with particular focus on the five deep-mined stations.

The sub-surface stations have created unique interior spaces, with tunnel diameters 75% larger than the London Underground standard, and twice as long. These very long platforms, with possible exits in different areas from each station location, presented particular wayfinding challenges for the design team.

From an early stage in the project, the over-riding strategy was to group technology elements – such as services and lighting – into highly coordinated areas, such as freestanding ‘totems’, platform screen doors and ceiling-mounted



➤ service channels. The aim was to facilitate ease of installation and future maintenance over the design life of the equipment.

Indirect lighting within the concourses, escalator tunnels and platforms emphasises the interior public areas rather than drawing attention to the luminaires themselves. The light grey, matt-textured, glass-fibre reinforced concrete (GFRC) cladding of the sub-surface environment is illuminated with indirect light, which creates a sense of space and an elevated ceiling for passengers, staff and other users.

There is a clear distinction between the use of ambient and accent lighting. The former provides general illumination and the overall uniformity required for safe passage without creating harsh shadows. The accent lighting draws attention to specific areas and task surfaces, such as help points, signage, escalator landings and other identified visual tasks.

Accent- and task-lighting elements offer enhanced levels of local illuminance in accordance with London Underground standards, and the perceptual difference in illuminance values according to BS EN 12665:2018 *Light and lighting. Basic terms and criteria for specifying lighting requirements*.

Assisting wayfinding

The lighting design was used to influence intuitive wayfinding by the passengers and to assist their decision-making, whether when moving from concourse to platform or disembarking from a train and seeking an exit from the station. Thresholds, entrances and exits were clearly identified, and signage elements and passenger information highlighted.

Conceptually, the different public spaces in sub-surface stations were classified as either 'wayfinding' or 'transit' spaces with the following characteristics.

Wayfinding spaces:

- Multiple activities, such as reading signage, customer information displays, and identifying entrances and exits
- Multiple routes and decision-making required
- Gathering space
- Larger architectural volume.

Transit areas:

- Single-activity space
- Direct movement along a fixed route defined by architecture
- Transitory space
- Smaller, linear architectural volume.



ESCALATOR TUNNELS

The lighting scheme for the escalator tunnel was developed as two discrete elements. Functional lighting for the escalator steps was initially provided by the uniformly illuminated side panels. During the design and build phase of the project – once the concept design stage and the client's requirements had been set – this was replaced by visually continuous escalator skirting lighting, which gives the required levels of task illuminance on the escalator itself. This task lighting is coupled with indirect lighting of the vaulted escalator tunnel, using deck-recessed linear LED uplights.

The escalator soffit is a key surface because it is directly in the sightline of passengers approaching the top of the escalators from each station ticket hall. The design intent was to create a welcoming introduction to the sub-surface environment by illuminating the vault overhead with a soft-edged wash of cool white light.

The escalator deck uplights will create a broad upward light distribution to the vaulted escalator tunnel, a soft-edged light distribution with graduated coverage across the vault, and a 'darklight' appearance to the luminaire itself. This is created by the black cross-blade louvre design, which ensures the luminaire does not create discomfort glare to passengers approaching and using the escalators.

A suspended illuminated sign at the top and bottom of the escalator gives additional task lighting at the locations where passengers step onto and alight from the escalators.

The low-brightness appearance of the luminaires will ensure a balanced lit environment, with the focus on the illuminated cladding surfaces and wayfinding elements of the design.

Intuitive wayfinding is promoted by using visibly different colour temperatures for the lighting within adjacent spaces. Cool white (5,000K) is used for transition spaces, while warm white (3,000K) is applied within the wayfinding areas.

Vertical illuminance and visual comfort

Illuminance measurements are normally taken on the horizontal plane at ground level or on a specified task surface. Relevant standards and guidelines are primarily based on these criteria. However, humans process vertical surfaces within the visual field more easily and more often than horizontal ones. So, good vertical illuminance has been prioritised to improve facial recognition of fellow passengers, enhance the legibility of signs and information displays, and allow for the better detection of potential obstacles and hazards. The use of indirect lighting and of luminaires with large, diffuse, luminous surfaces creates a visually comfortable environment with fewer shadows and veiling reflections on materials and finishes.



LOWER CONCOURSE

Within the lower concourse, all technology elements are integrated into freestanding totems. These stand around 3.2m tall and incorporate lighting, loudspeakers and signage elements. The luminaires are located at the intersections with cross-passages and at intermediate points along the concourse.

Designated as a wayfinding space, the lower concourse is illuminated by warm white indirect light (3,000K) provided by the totem-mounted uplighters, which wash light up on to the vaulted concourse soffit to give ambient light.

The totems were designed to be spaced at 6-10m centres within standard 8.1m-diameter concourses and smaller 6.5m-diameter concourses. Both sizes required the same general light distribution and quality to be achieved (see sketches on page 10).

Providing sufficient lumen output from the uplights to achieve the required levels of illuminance within the concourse was a significant challenge. Luminaire manufacturers were engaged by the client to develop early prototypes, built for fine-tuning lighting requirements, sharing designs with the contractor's specialist designers, setting quality and material coordination standards, and facilitating early buy-in from project stakeholders and progressive assurance in advance of the final contractor design. (Read 'Alight here for Crossrail', September 2018 CIBSE Journal).

To avoid potential discomfort glare to passengers travelling down the escalators, an integrated louvre system was proposed for the uplights, to be installed within the totem uplights located nearest to the base of the escalators.

"Light grey cladding of the sub-surface environment is illuminated with indirect light, which creates a sense of space and an elevated ceiling"

This also improves the lit environment for visually impaired passengers by minimising glare and improving the legibility of the space.

Architectural integration

The various luminaire components are carefully integrated into the architectural design. Services, lighting and other technology elements are grouped together and separated from other fixed elements, such as cladding systems.

The luminaire types specified have a similar aesthetic and visual appearance, to create a coherent narrative, in harmony with the architecture. They are integrated into other components, such as the totems in the lower concourses, or mounted

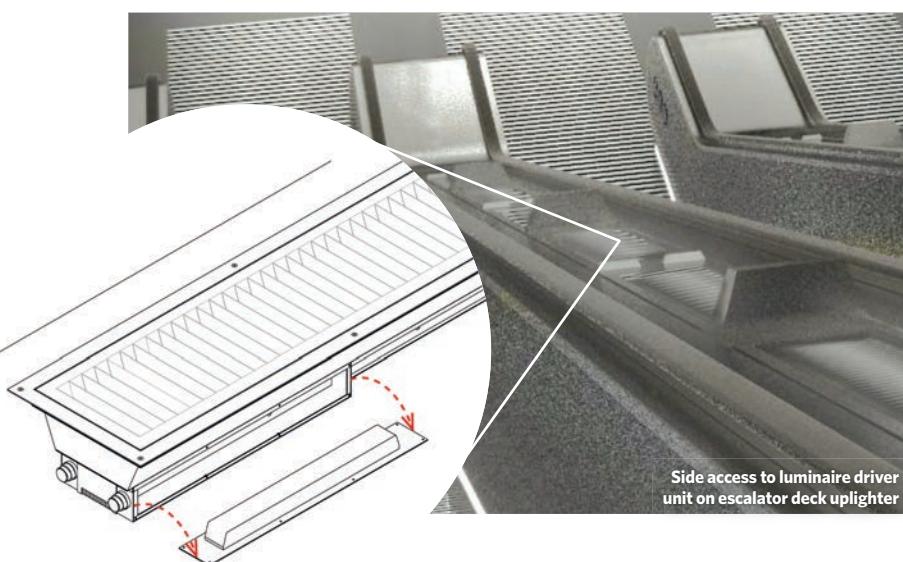
flush within cladding elements, such as the cross-passage service boom.

Visible luminaires are typically conceived as a visually continuous, linear arrangement of luminous panels, which contributes to a consistent visual language across the Elizabeth line sub-surface environment.

This highly integrated application of linear lighting elements helps fulfil the architectural intent of creating an environment that is simple to interpret and free from visual clutter. It facilitates ease of maintenance and replacement, as luminaires and other lighting equipment have a shorter design life than the surrounding fixed architectural components, such as GFRC cladding. Emergency lighting has been designed to be fully integrated within the standard luminaire types.

The lighting design of the Elizabeth line sub-surface stations has created visually comfortable spaces with fewer shadows and veiling reflections. This enhances the legibility of the space and promotes intuitive wayfinding for all customers. □

KEITH MILLER is director of lighting consultancy GIA Equation



CROSS-PASSESSAGES

There are five standard cross-passage types, all illuminated by a flush recessed, overhead service boom. The system comprises a visually continuous service channel with integral linear diffuse LED luminaires mounted flush at the apex of each cross-passage. These are mounted end to end and periodically interrupted by speakers and CCTV cameras. They are accessible from below for maintenance via a hinged mechanism giving access to the cable management system.

Office space by Oliver Heath Design, which is collaborating with BRE on the biophilic study



Natural selection

A BRE study into biophilic design will focus on daylighting and electric lighting among other elements, explains BRE's **Flavie Lowres**

In an exercise that may be the first of its kind in the world, an entire floor of a working office building – and the 40 people employed there – are the focus of a wide-ranging study. The workplace and its occupants will be tested and monitored for a year before – and a year after – the office space is refurbished.

This is no ordinary refurbishment. It is part of the two-and-a-half-year Biophilic Office project, and will follow the principles of biophilic design. These focus on the needs of the people in buildings and their inherent connection to nature.

The research is being carried out by building science centre BRE in conjunction with Oliver Heath Design and a range of industry partners.

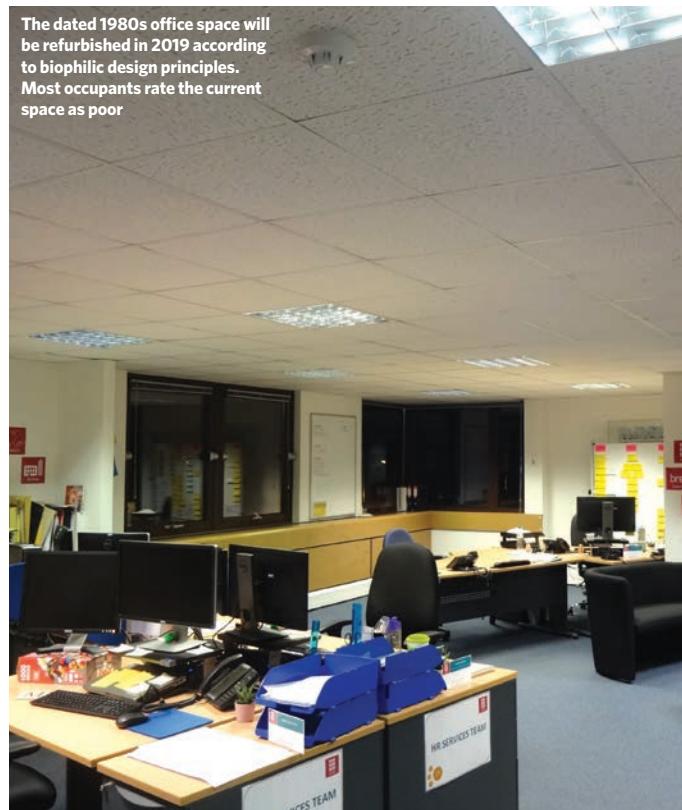
The impact of nature

Previous research has shown that being in natural environments, or even viewing depictions of nature, can have a positive impact on people's wellbeing.

Such environments can alleviate negative emotions such as anger, anxiety, depression and stress, while helping people feel calm and be inspired. But, the fact is, we spend the majority of our lives in buildings that usually isolate us from nature.

Biophilic design helps bring us back into contact with the natural world in the built environment. This is not just about incorporating plants – although they are often an important element – but also making use of natural materials and textures, colour variations, personalised workspaces, views, refuge spaces and much besides. Integral to biophilic design is the provision and quality of natural and artificial lighting, including the impact that lighting has on circadian rhythms.

The dated 1980s office space will be refurbished in 2019 according to biophilic design principles. Most occupants rate the current space as poor



The rhythm of life

Circadian rhythms refer to our mental, physical and behavioural changes and patterns across a day, as we – and other living things – respond to external factors. Exposure to light, particularly blue light, has been shown to maintain – or potentially alter – the body's circadian clock.

This has prompted the development and testing of circadian lighting, with the aim of maintaining the correct timing of people's natural biorhythms in a working environment. Most commonly, the idea is to improve alertness during daylight and working hours – so delivering better performance – before changing to lower brightness, warmer-coloured lighting when it is time to relax.

During design, more focus is often put on factors such as energy use rather than the fact that buildings are for people. Although important, energy accounts for just 1% of typical office business running costs, while staff costs amount to 90%, according to the World Green Building Council's *Wellbeing and Productivity in Offices* report.

Often, however, little attention is paid to the wellbeing of occupants in the layout of buildings; potential impacts on their mental, social and physical health are ignored, so opportunities to lever better business outcomes are missed.

Hard evidence needed

While a number of innovative new office buildings are being designed around their occupants' health needs – maximising natural light and clean air for example – this is not the reality for the great majority of office workers.

They work in existing buildings, the owners and managers of which have limited budgets and a need to ensure a return on investment. Hard evidence of the benefits of biophilic design is needed if they are to be convinced that investing in refurbishments that prioritise the wellbeing of building users will enhance their business.

Located just off the M25 on BRE's Watford campus, the building at the centre of the Biophilic Office project was built in the 1980s. It has a mainly cellular layout with some open-plan space, and is typical of office buildings in the UK and worldwide. This office space will be refurbished using biophilic design principles in 2019. Before that – throughout 2018 – the office conditions have been extensively monitored and the occupants' wellbeing investigated. This will continue for a year after refurbishment, giving comparable before-and-after data.

Initial investigations of the quality of the indoor environment – factors such as

lighting, temperature, CO₂ and volatile organic compound (VOC) levels, relative humidity and acoustics – found that, while lighting was poor in some areas of the building, in general, these issues were within prescribed levels.

But when asked about office conditions, most occupants rated the look and feel of their office as 'poor', and 67% said they would not want to show clients or colleagues around.

This feedback was part of a questionnaire survey conducted quarterly throughout the project, examining how the occupants felt about their offices and issues such as lighting, glare, noise and other comfort factors.

BRE research shows it is unusual for organisations to ask their staff about the buildings in which they work, although doing so can generate valuable information on improving staff comfort and wellbeing.

Other aspects of staff wellbeing that are being monitored include fitness, ability to concentrate and stress levels. They have been given wearable technology to monitor their heart rate, activity levels and sleep patterns, and the project is gathering business and HR data, including the number of days taken as sick leave. Stress levels will be monitored by testing saliva samples.

Lighting conditions

The test building's current lighting is entirely T8 fluorescent – ceiling-mounted fittings with prismatic diffusers in most spaces, and ceiling-recessed reflector fittings in the open-plan area. As part of the pre-refurbishment monitoring, illuminance and spectral power distribution from the existing lighting, as well as surface reflectance, have been surveyed. This included measuring horizontal desk illuminance, and vertical illuminance at eye level, which particularly affects circadian rhythms.

Researchers have also recorded in-situ measurements of surface visible light reflectance on walls, ceilings, floors, doors, window frames and desks.

»

"It is unusual for organisations to ask their staff about the buildings in which they work, although doing so can generate valuable information on improving staff wellbeing"

REFURBISHMENT PLANS

The current cellular offices are occupied by teams performing varying tasks with different requirements. The new layout will have three zones, presenting three different biophilic design refurbishment strategies.

Oliver Heath Design – the project's design partner – has consulted the occupants about their current working conditions, comfort needs and business requirements. Based on this, and findings in the lighting and other reports on the building's working conditions, it is designing areas with different biophilic design approaches, so a wide range of features can be investigated.

The office design is now in the final stages of checking and approval. Project partners are Ahrend, AkzoNobel, Ambius, Biotecture, CoeLux, Ecophon, Interface, Plantronics and Waldmann Lighting.



A floor-standing luminaire by Waldmann Lighting

» In addition, internal light levels are continually monitored using ceiling-mounted light sensors in representative office locations, and external light levels using roof-mounted daylight sensors.

The BRE lighting team is currently conducting computer modelling of the existing electric lighting and daylight distribution in the offices, using the monitoring data to calibrate the model.

By modelling annual profiles of daylight illuminance at eye level, and of total eye-level illuminance, they are estimating the levels of circadian stimulation for each person working in the offices. All findings will be included in a pre-refurbishment lighting report.

In conjunction with the BRE social research team, the BRE lighting team is setting up a protocol to monitor occupants' continuous exposure to light, which will be implemented in the post-refurbishment phase.

Lighting

Cosmin Ticleanu, BRE's electric lighting expert on the project, says that although lighting plans are still to be finalised, in the office areas they are likely to make use of floor-standing luminaires, placed close to each desk to give upward and downward light distribution.

'The upward lighting will make the ceiling more brightly and uniformly lit, reducing the existing contrasts in the visual field that can cause discomfort – especially for those spending long periods of time in the office,' he says.

'We are considering using automatic controls for the upward lighting and, potentially, providing light levels that follow the natural pattern of light throughout the day – starting low and rising to a high point around noon before reducing again as the day progresses to evening.'

'But control of the downward component, which will light the desk and task areas, is likely to be given to the building occupants so that people's varying lighting preferences can be fully accommodated.'

While the predominant lighting will be from floor-standing luminaires, there will also be suspended and recessed fittings. Colour temperature, both static and changing, will form an important part of the study.

'Half the project is biodynamic, the other half is split into 4,000K and 3,000K zones,' says Jim Ashley-Down, managing director at Waldmann Lighting. 'All of it is designed to comply with [workplace lighting guide] LG7 even though there are various biophilic and biodynamic elements to the overall design that make this difficult to achieve.'

He says there is the conflict between the



Artificial skylight mimics sunlight and the Rayleigh scattering process that creates the blue colour of the sky



"Monitoring of the offices and occupants will be widely publicised to help ensure health and wellbeing become routine elements of office refurbishment"

light levels required by LG7 for a workspace – for example, 500 lux on a desk – and the requirement for biodynamic lighting to be at a lower intensity at the end of the day.

Also, an important design element of a biophilic space is the colour, texture, and visual interest of the walls. In LG7, reflectance values and neutral surface colours must be allowed for to fully comply but, when walls have colours and/or patterns or are obscured by plants or green walls, it can directly impact the lighting in a way that contradicts LG7. He says: 'To overcome this, there needs to be far greater communication within the design team than usual to make sure the lighting, surfaces, and objects placed within the space work in a holistic way, rather than the usual engineering approach of the lighting calculations largely being done in isolation of the interior design.'

Another partner will supply ceiling light fittings to act as artificial rooflights, creating the appearance of sky and sunlight. 'The light fittings project light through a mini "atmosphere" of nanoparticles to create a scattering of light,' says Ticleanu. 'This mimics the scattering of the sun's light by the Earth's atmosphere, giving an attractively realistic rooflight effect.'

The evidence from pre- and post-monitoring of the offices and occupants will be widely publicised to help ensure health and wellbeing become routine elements of office refurbishment through biophilic design.

The aim is that future workplaces will enhance the mental, social and physical health and wellbeing of their occupants and, in turn, enable better business outcomes for office-based companies. **CJ**

■ For details, visit www.bregroup.com/biophilic

■ **Flavie Lowres** is associate director at the BRE Research and Strategic Advisory Group

PRODUCTS & SERVICES

Luceco and Ensigna Construction shine at Harris Academy Merton



LED lighting technology has enabled Harris Academy Merton to be optimised to accommodate assembly areas and a range of indoor sports activities.

The cost-effective and energy-saving lighting solution was supplied to the school by Luceco and Ensigna Construction, and involved the installation of LED LuxPanels in a double-height, multifunctional hall with high ceilings. Glare control and adequate illuminance on the vertical, combined with good uniformity, are necessities in this application. A 4,200-lumen variant of LuxPanel was used to ensure lighting levels are suitable for many functions, including assemblies, exams and sports.

Luceco's LuxPanels are quick and easy to install into exposed grid ceilings, with remote 'plug and play' drivers. Available in standard fixed output, dimmable and emergency options - with no maintenance or re-lamping required over its lifetime - LuxPanel eliminates the need for high-access equipment. The high-efficiency backlit panels have a completely frameless appearance in the ceiling plane and boast an efficacy of 152Llm/cW.

■ Call 01952 238100, email uk_sales@luceco.com or visit www.luceco.com

Highbay helps Luceco light up the Middle East

Luceco has relit two large manufacturing plants in the Middle East for Oman Cables Industry, using its Eris Highbay.

Established in 1984, Oman Cables Industry is one of the oldest and most trusted cable manufacturers in the Middle East, and has operations throughout the region and in parts of Asia and Europe. It required an improved lit environment, keeping energy efficiency and cost-effectiveness in mind.

Luceco developed an LED lighting solution using the Eris Highbay, a modern, slim IP65-rated luminaire, with a die-cast aluminium body and polycarbonate lens optic for optimum performance. It offers 50,000 hours of operational life and comes with a five-year warranty. High-efficiency LED lighting met the required lux levels, and overall light distribution throughout the plant has been improved. Supplied as digital dimmable or standard, Eris comes with a stirrup bracket and hook for surface or suspension mounting. There are 20,250lm and 32,400lm variants, with an efficacy of 135Llm/cW, and it comes in two sizes: Maxi Highbay 150W or 240W and Mini Highbay 100W or 120W.

■ Call 01952 238100, email uk_sales@luceco.com or visit www.luceco.com



Concord delivers new stylish and efficient smart-controlled office lighting

Concord Pixer is a high-specification architectural solution that can be laid out in square or rectangular 'pods' in a fully recessed or dropped setting. It features glare control to UGR<19, in line with office lighting guidelines, and has an output of up to 4,700 lumens, as well as versions achieving up to 150lm/W.

Pixer is a highly efficient and aesthetic solution, which creates an ideal ambience for generating increased productivity through a sense of wellbeing, and provides a platform for the SylSmart wireless, energy-saving office control system. Richard Turner, general manager of the

EMEA specification business unit for Sylvania, said: 'The modern office is a valuable asset, and it is important that business owners take advantage of every square metre of floor space to get the best return. By improving user comfort through better lighting, employee wellbeing and productivity levels will benefit, too.'

'Lighting, cooling and ventilation are responsible for more than 60% of electricity use in office buildings, so energy efficient, smart-controlled lighting solutions are a must.'

'Our new range of office lighting is DALI dimmable compatible for better ambience, and offers SylSmart Connected Building functionality - an intelligent, decentralised lighting control system.'

'This enables businesses to easily manage their lighting to make significant energy savings through granular control of each luminaire, based on usage, presence and natural daylight. Our efficient lighting, combined with smart features, will deliver greater energy savings, which can help to achieve <4W/m² building-energy consumption.'

Pixer is designed with a modular architecture, allowing for quick customisation and available in either recessed or dropped configurations. It gives business owners greater flexibility in design and control, in varying lumen output levels, and comes with three-hour emergency options.

It also comes with the SylSmart Standalone Office solution, so business owners and occupants can control the lighting through an easy-to-use app. Automatic on/off functionality is made possible through the use of sensors, while scene setting can also be managed via the app, to create the optimum ambient working environment.

Pixer has been shortlisted for a prestigious Lux Award this year, being nominated in the Interior Luminaire of the Year category.

■ Visit www.sylvania-lighting.com/en-gb/applications/office





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This Journal CPD programme can be used to meet your CPD requirements. Study the module and answer the questions on the final page. Each successfully completed module is equivalent to 1.5 hours of CPD.

Modules are also available at www.cibsejournal.com/cpd

Human-centric lighting

This module explores how the case is being made for assessment of the benefits of human-centric lighting principles in design standards

Human-centric, or biodynamic, lighting describes the use of artificial lighting sources to create visual environments that mimic the natural daylight that drives – and can interfere with – the human body's daily cycle. Where daylight is not a practical option, the technique promises to benefit occupant performance, comfort, health and wellbeing but – despite intensive research over many years – there is still much to discover. This CPD will explore some of the factors that are combining to build a compelling case for the assessment of the benefits of human-centric lighting principles in design standards.

Humans are attuned to the variation in the natural outdoor daylight that has normalised the circadian rhythm (see 'The circadian rhythm' panel), which is influenced by the integration of light intensity, colour, position, direction and texture. Altering the patterns of people's exposure to light has been shown² to contribute to the alleviation – or prevention – of health problems such as chronic sleep phase disorder (a potentially genetic disorder that shifts the length and phases of sleep) and sleep maintenance insomnia (difficulty staying asleep, or waking too early). In the workplace, sleep deprivation in night workers is associated with an increased number of accidents and reduced productivity. Applying a programme of light exposure (phototherapy) has been shown³ to phase-shift body clocks of night workers, enabling them to perform more effectively. The Alzheimer's Society⁴ reports that bright-light therapy may benefit people with dementia, reducing restlessness and disturbed sleep for people with the condition, but it notes that further research is needed. Recent reports⁵ of a study⁶ undertaken in Denmark suggested that people being treated for severe depression were discharged in almost half the time if their rooms faced south-east rather than north-west – with the intensity of daylight in south-east rooms 17- to 20-times greater than north-west-facing ones. In the past year, Joel Soler, from Michigan State University, reported⁷ outcomes from research indicating that light intensity can change the structure of the brain and impair a person's ability to learn and remember. In his

recent presentation,⁸ Russell Foster, of the Sleep and Circadian Neuroscience Institute at the University of Oxford, presents findings suggesting that as the length increases of 'social jet lag' – the time difference between when a person naturally wakes compared with when they need to wake – so does the risk of poor health (for example, obesity and diabetes), bad moods, increased fatigue

»

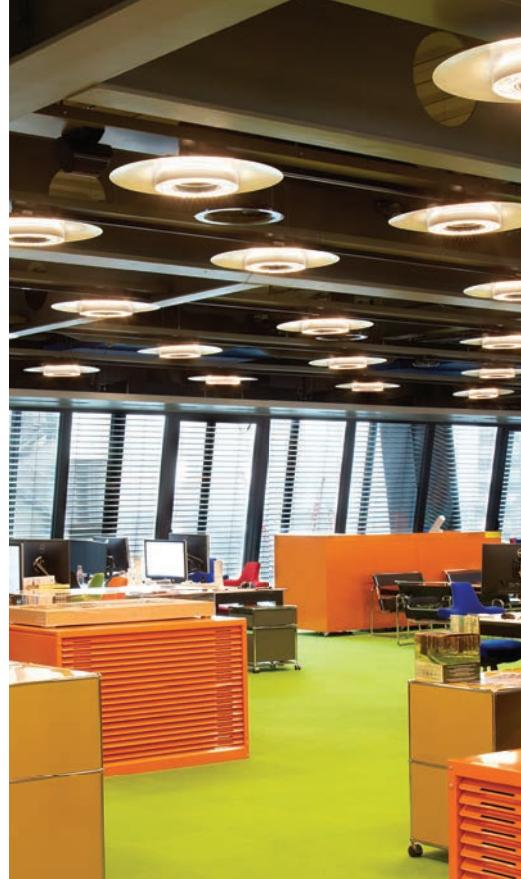
THE CIRCADIAN RHYTHM

The term is derived from the Latin phrase 'circa diem', meaning 'about a day', and refers to variations or rhythms with a cycle period of approximately 24 hours. The circadian system is a basic part of life and can be found in virtually all plants and animals, including humans. This regulates a wide range of physiological and behavioural systems, from digestion and the release of hormones to controlling core body temperature and when a person feels alert or sleepy.¹

The circadian rhythm can be disrupted with changes in lifestyle and ambient lighting, and in the absence of light its period will usually lengthen. As discussed in the Society of Light and Lighting's (SLL's) *Code for lighting*,² the organ that controls these cycles in humans is the suprachiasmatic nuclei (SCN) set deep in the brain. The SCN is linked directly to the retina, receiving signals from a recently discovered photoreceptor – the intrinsically photosensitive retinal ganglion cell (ipRGC).



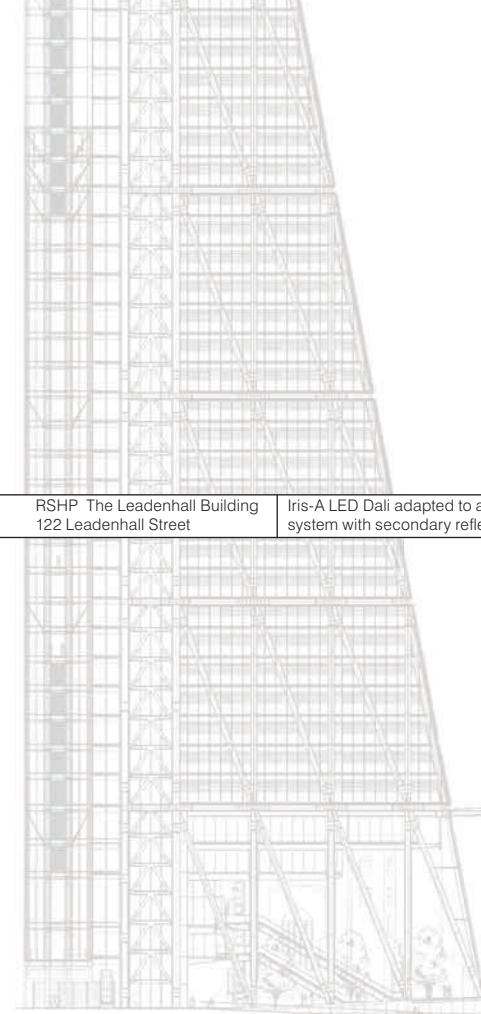
Daylight 6500°K



Warm 3000°K



Neutral 4000°K



RSHP The Leadenhall Building
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Iris-A LED Dali adapted to a tracked
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» and heart disease. As the population ages, an increasing number of elderly people suffer with conditions related to a failing circadian system and their consequent sleep problems.

Light, therefore, not only affects what is consciously visible, but also alertness, wellbeing and performance. Although the human circadian rhythm and seasonal variation are genetically fixed, they will be affected by the human condition, and are likely to be influenced by the surroundings – including the visual environment.

As the sun rises in the morning and descends at night, there is a continuous progressive variation in colour range and intensity. Daylight, with a high proportion of blue light – particularly in the morning – contributes to the suppression of the hormone melatonin (which promotes sleep), reducing the prospect for deep sleep. The hormone cortisol is produced in the body in the morning, stimulating the metabolism, programming the body for the day's activity. The first morning light helps suppress the production of melatonin, while the levels of cortisol decrease over the course of the day. For daytime workers, it can be desirable to support the activity of the cortisol at the beginning of the working day by stimulating cold-tone light and high illuminance values. In the afternoon, the production of cortisol in the body has already decreased significantly. The production of the sleep hormone is not yet required as the evening approaches, and practice has shown that, in this transitional period, alertness levels can be enhanced by means of a neutral mixed light and reducing the illuminance level. In the evening, as people tire, the melatonin levels in their blood increases. Then, as they sleep, melatonin levels drop in readiness for morning awakening. A lack of light during the day and too much in the evening has been shown to adversely affect sleeping patterns.

As discussed in the SLL's *Code for lighting*, in recent years evidence has accumulated for the presence of a non-visual photoreceptor in the human eye, the primary purpose of which is to regulate the body's internal clock. This has begun to reveal the importance of exposure to adequate daylight levels for the health and wellbeing of humans, many of whom now spend most of their lives inside buildings. Light sensitivity is controlled by rods and cones in the eye. Rods deal with low sensitivity and cones deal with colour and higher sensitivity. The recently recognised third receptor – the intrinsically photosensitive retinal ganglion cell – may provide an important means of linking health and wellbeing to light.

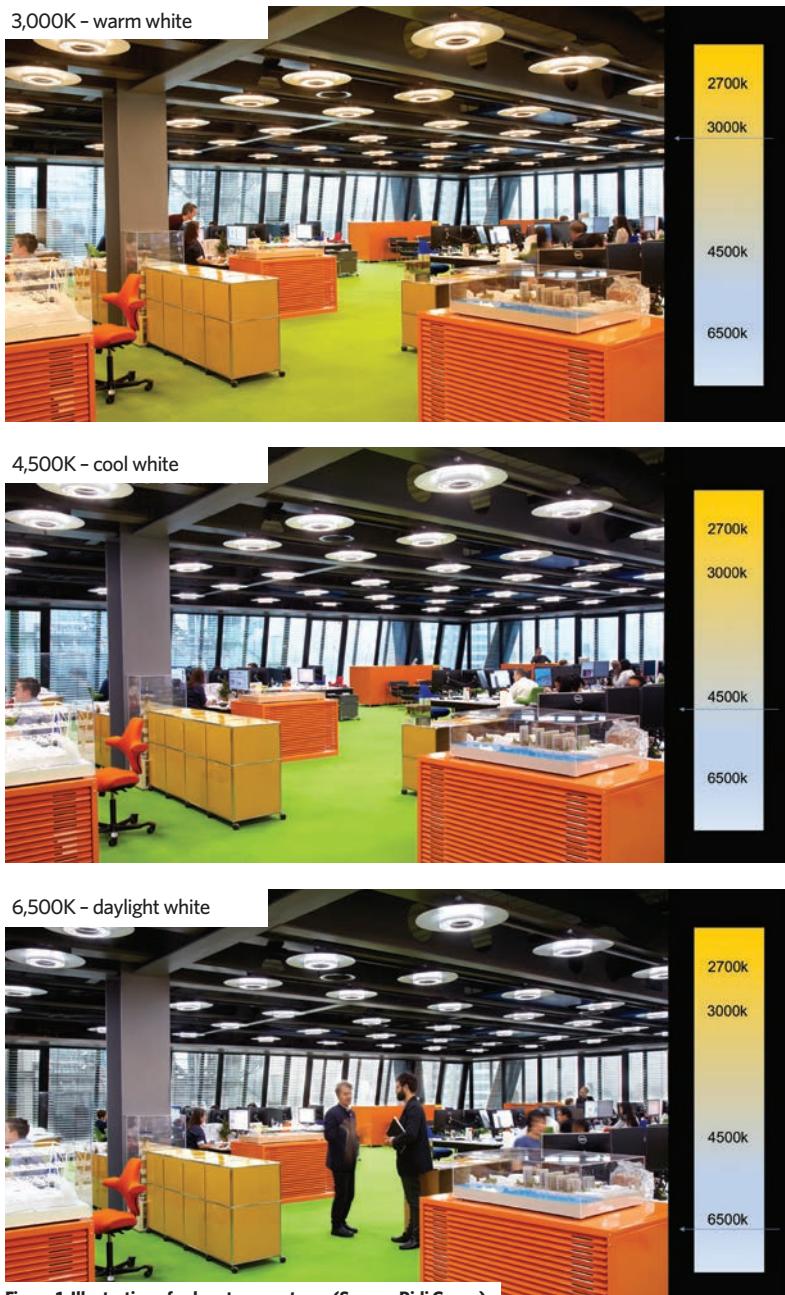


Figure 1: Illustration of colour temperatures (Source: Ridi Group)

The benefits of different hues of 'white' light have been well documented – for example, the blue end of the spectrum is linked with alertness. However, it is still not clearly understood what other factors in the lighting scene are significant. Studies indicate that higher lighting levels at the beginning of the morning that slowly decrease, together with a gradual increase in colour temperature, may be beneficial. However, the physiological effects of tuneable white light need careful

HUMAN-CENTRIC LIGHTING IN PRACTICE

At the Amsterdam office of the property company CBRE (Figure 2), a time-controlled lighting system features a 'circadian-friendly' lighting sequence, which varies the colour temperature and intensity during the course of the day. Employees are stimulated during the morning and early afternoon with high illuminance levels and cool indirect white light. At midday and late afternoon, the light levels fall and become warmer.

It was reported that researchers found an accuracy improvement of 12% in an objective experiment. Additionally, the participants working in the office with the human-centric lighting (and other novel design features) found their total work performance to be 18% better, 71% found they had more energy, 76% thought they were happier, and 50 per cent said they were healthier.



Figure 2: CBRE office
Amsterdam (Source: CBRE)

consideration, as long-term consequences have not yet been determined.

The evolution of efficient light sources has made deep open-plan office buildings cost effective, where lighting levels, energy efficiency and glare control have provided the key design parameters. These parameters have been optimised and harmonised to evolve towards the perfect office luminaire, which is often installed in a standard grid to provide illumination of the open-plan office where glare is controlled and the space is softly lit.

However, this can create a flat, visually undefined and unstimulating office that may not fit well with the shifting philosophy of 'agile' working. Although the open-plan workspace filled with desks is still the most common, another series of spaces has emerged to accommodate different tasks and the varying needs of workers.

The workplace is evolving further, to become not just one space, but a collection of spaces designed for different purposes – such as meeting rooms, breakout spaces, video-conferencing booths and concentration areas – that present a complex pattern of visual environments.

Considering a general office workspace, most guidelines will typically require illuminance levels of between 300 lux (for screen-based tasks) and 500 lux (for paper-based tasks). High contrast in luminous intensities between the screen and overhead luminaires will make the human eye adjust continuously, which not only causes tiredness but can also result in eye fatigue and headaches, as well as contributing to eye strain. As screens have become more portable, the challenge presented by this has increased. The colour temperature of an environment can also contribute to eye fatigue, as the colour temperature of on-screen 'white' matches cool daylight (6,500K), yet many offices are illuminated in neutral white light (4,000K) (examples of colour temperature are illustrated in Figure 1). CIBSE/SLL LG7⁹ sets out extensive guidance on suitable lighting design for offices.

This difference in colour also makes the eye continuously work to balance the white tones, which could also contribute to eye strain and tiredness. Computer screens have recently been introduced that adjust colour temperature throughout the day, with the aim of supporting 'natural circadian rhythms' and so improve wellbeing. To impact the circadian rhythm, it is likely that every light source in a

space should have a coordinated change in colour temperature.

However, the dynamic screen technology provides an opportunity to explore a full dynamic lighting scheme that may support circadian rhythms better – although, with the modern workforce so mobile, it is difficult to imagine the possibility of being able to manage all the sources of light they are exposed to over the course of a day.

While building standards are becoming increasingly environmentally aware, the quantification of the 'wellness' of the building from the point of view of its occupants is a relatively new pursuit. The Well Building Standard¹⁰ includes illumination guidelines that are explicitly 'aimed to minimise disruption to the body's circadian system, enhance productivity, support good sleep quality and provide appropriate visual acuity where needed'. The upcoming revised edition of CIBSE TM40 *Health Issues in Building Services* is likely to include reference to the complex mechanisms of human responses to light, as well as highlighting that there is still a need for further research to establish metrics for lighting design that take circadian effects into consideration. As highlighted in the SLL *Code for lighting* 'both the visual system and the circadian system have evolved under a natural regime of daylight days and dark nights. The alternative electric light sources have only been available for use by day and night for about a hundred years, a very short time in evolutionary terms'.

Human-centric lighting aims to deliver a type of 'daylight progression' using different sources, colour temperatures and illuminances to provide a form of compensation for humans where they suffer from lack of access to daylight. But this is early days in establishing the full potential of such techniques. In his recent editorial¹¹ for CIBSE's *Lighting Research and Technology Journal*, Peter Boyce provides an experienced take on the current situation: 'In many ways, human-centric lighting is new land waiting to be explored. [This...] requires knowledge and this can only be gained by careful research into the importance, magnitude and reliability of the effects. It is only in this way that successful exploration can be ensured.'

Activist-researcher Russell Foster appears to concur on the magnitude of effort required to generate the rigorous research needed in this area. He has been quoted as saying: 'Perhaps the time is now right for biologists, lighting engineers and architects to work together to generate these data for the development of truly human-centric lighting.'

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► Turn to page 22 for references.



Module 139

December 2018

» **1. In the Danish research, what was the discharge period for patients from south-east-facing rooms compared with those in north-west-facing rooms?**

- A Those in south-east-facing rooms were discharged in twice the time
- B Those in south-east-facing rooms were discharged in around a 50% longer period
- C Those in south-east-facing rooms were discharged in around the same period
- D Those in south-east-facing rooms were discharged in around half the time period
- E Those in south-east-facing rooms were discharged in around 10% of the time period

2. Which of these is least likely to help a person to remain actively awake?

- A Blue light
- B Daylight
- C Higher body cortisol levels
- D Higher lighting levels
- E Increased melatonin levels

3. What is the approximate colour temperature of cool daylight?

- A 2,700K
- B 3,000K
- C 4,500K
- D 6,500K
- E 8,000K

4. Which publication is noted in the article as being particularly suitable for guidance on office lighting design?

- A SLL Code for lighting
- B LG7
- C SLL Guide for lighting
- D TM40
- E Well Building Standard

5. What is the name of the recently discovered third receptor in the eye?

- A ipRAC
- B ipRGC
- C ipTGC
- D irRGC
- E isRAC

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