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OMS® RIGHTLIGHT RETAIL&PRESENTATION

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It is well to compare a retail environment with a forest path. During the daytime hours an abundance of sunlight filters through the rich foliage of the trees, creating narrow shafts of light to which we are instantly attracted. When this happens the atmosphere of the place is lifted and our mood changes, we automatically have a smile on our face, a feeling of calm and happiness in our bones and a breath of fresh air in our lungs.

The same we want to achieve in the stores from which almost all goods worldwide are bought. However, they cannot fulfil one of the most basic needs of us as humans, the need for an emotional connection to the items and activities that fill our lives. Such a connection can only be facilitated in a physical store, whether it be on a city square, a high street or in a shopping mall. Here customers buy based on their dominant emotional needs, where the decision to buy is 80 % emotive and only 20 % objective. In such spaces, where a theatre of stimuli takes place, lighting plays a central role. It enables the creation of a space that is not only to fulfil needs but that can take customers to a new world, a place of wonder and delight. The task set before lighting professionals demands the highest levels of expertise, combined with practical experience and a strong knowledge of the theory behind it. This brochure aims to explain the basics of retail lighting design across many settings, from fashion to dairy, and to help you understand how it can make all the difference, not only to the customer, but also to the retailer.

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CONTENT


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RETAIL PSYCHOLOGY

Light is a cornerstone in retail, a key tool to influence and guide customer reaction to and engagement in the shopping experience

Value is not a static concept. In some ways it develops slowly over time, and in other ways it changes drastically. Customer needs and market demands are constantly moving, therefore it is important that retailers identify any new theory or trend that can influence the positive purchasing behaviour of customers.

Light influences our emotions, cognition and spatial perception. In fact, it is argued that there is a direct correlation between the use of light and resultant behaviours. However, when we delve into the research surrounding this complex topic it is difficult to come away with clear conclusions about how best to use light to enable and guide perception and communicate a message. There are several factors to consider when designing a store and its lighting. Factors representative of the modern world of retail.

1. The face of retail has changed, with customer buying behaviour being led more by desire than need. Therefore it is necessary to change the way we see customers, to understand that each has their own feelings, perceptions and longings. In order for a retail environment to be successful more attention must be paid to spatial and lighting design, to making a predominantly emotional rather than objective impression.

2. Shopping is not only a practical pursuit; it is something customers do for pleasure. Consequently, it is important for lighting to stimulate and entertain and not only illuminate.

3. A store must create its own unique atmosphere in order to differentiate itself from the competition, especially when the merchandise offered is similar. A store's atmosphere becomes a central part of its personality, on which basis customers form brand loyalty.

4. Stores need to be inclusive for all types of customers, with design elements and communication tailored to many groups from various social, economic, ethnic and cultural backgrounds. Interior and lighting design are fundamental aspects of a store's ability to do this.

5. Money. Ultimately retail is business, and stores want to have the highest turnover for the lowest costs. Lighting design can play a crucial role in both parts of the equation, helping to define the perfect balance.

The role of contemporary retail design is to link instinct with art and commerce, to communicate a brand and meet the ever-more demanding needs of customers. It must incorporate the management of people and space in such a way as to support the dominant characteristic of retail: change. This requires complex and holistic partnership between architects and designers, between psychology, technology and ergonomics. Each element does not exist in isolation from the others, and a clever balance of all will create a holistic and successful retail experience.

WHY DO WE SHOP

Price perception is key to the success of a store. This involves matching customers' perceptions to the cost of goods. Key to exploiting this is the understanding of what motivates people to shop.

Purchasing behaviour can be categorised into hedonic or utilitarian, to shopping for pleasure or to fulfil a need. Nowadays most purchases fall into the first category and are driven by desire, emotion and sensation, thus, it is increasingly important that stores make the correct impression on and connection with customers. This very much depends on factors such as the store's spatial design, its location, the merchandise on offer, and the knowledge and attitude of sales personnel. All of these aspects combined represent the store's image, the function of which can be separated into five key concepts: the implementation of a retail strategy, the provision of a rewarding shopping experience which helps to build brand loyalty, the increasing of sales and turnover, the effective management of costs, and finally the ensuring that all legal requirements are fulfilled.

When customers are satisfied with their shopping experience they are more likely to make a positive connection with the store, to spend and be happy with their purchases, and will ultimately return again. Two key factors in customer perception are environmental and social responsibility, both adding emotive and therefore hedonic value to a brand's identity.

SETTING THE SCENE

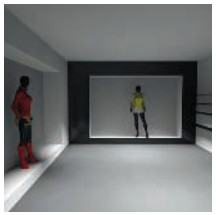
Communication of a store's image is not only about the brand, but about the entire sensory experience. This needs to be thought through and managed down to the smallest detail in order to reap the largest rewards. Lighting is crucial here and should be tailored to product types, classes and relationships. Here the creation of an appropriate ambience can make all the difference, encouraging customers to take more time browsing, make more purchases and feel satisfied with their choices.

A higher proportion of indirect to direct illumination gives the store a more passive and relaxing feeling, evoking dominance and control in a customer, especially when the majority of the illumination is of vertical rather than horizontal surfaces. Whereas consistent levels of brightness make a store feel open and vast, giving the impression of choice and opportunity but negating any intimacy. Glare and sparkle enliven a space, energising, stimulating, and appealing to a sense of detail and theatre. In all cases, it is important to avoid the extremes of under- or over-illumination, both of which can have a very negative impact on the psychological comfort of browsing customers. It is better to use rather varied lighting, with comfortable levels of general lighting combined with accent lighting to attract and guide attention. Here are a few examples of how light can directly affect customer behaviour.

A

B

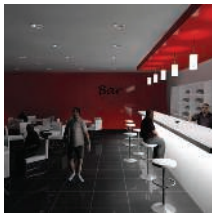
At points where customers can choose to go in various directions through a space, brightness is a key tool. The results of one study show that when routes to left and right are equally illuminated, 69% of people will automatically go to the right (A). However, if the route to the left is more brightly illuminated 75% will go to the left despite the natural tendency to go to the right (B). This suggests that a simple elevation of brightness at a particular point can determine the route people take within a space.



A

B

Brightness draws attention. When creating a focal point it is possible to increase the attracting effect simply by increasing its brightness in relation to the surroundings (B).



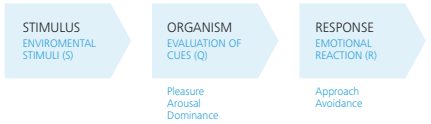
A

B

Another study showed that people entering a bar are more likely to select seats facing a brightly illuminated vertical surface (A) rather than directly under bright and monotonous light (B).

A SENSORY EXPERIENCE

The dominant method of studying customer behaviour is the 'Stimulus > Organism > Response' (SOR) model developed by Mehrabian and Russell. This model enables the understanding and assessment of reactions to environmental stimuli.



Originally intended for general psychological study, it has been adapted to fit use in retail psychology. Here, environmental stimuli (S) are said to evoke positive or negative reactions (R). These reactions are based on people's internal evaluation (O) of different environmental cues. The reaction of a person is characterised by three dimensions, known by the acronym PAD: Pleasure – displeasure, Arousal – avoidance, and Dominance – submissiveness. It is important to note that sensory stimuli should complement and not compete, or else the experience could become overbearing.

The importance of this model for retail is that it presents the relationship between environmental stimuli and people's emotional reaction, alongside quantifying the behaviours that result from their interaction. Since a store where a customer has a stimulating experience is likely to be one where they spend their time and money, retailers want to increase approach behaviours. It is, therefore, important to understand what environmental stimuli evoke positive reactions. It is imperative to take advantage of the estimated 100 million neurons in the human brain distributed across customers' five senses, which combined are the most powerful trigger of the decision to purchase.

ELEMENTS OF A STORE'S ENVIRONMENT

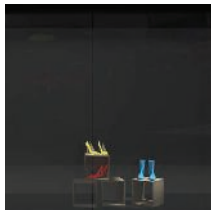
To identify what environmental stimuli evoke an approach response it is beneficial to classify the store design into three parts: ambient, design and social factors.

Ambient factors

Ambient factors can be described as background conditions, such as music, scents, temperature and lighting. Lighting has time and again proven itself to be an indispensable tool for influencing customer behaviour, greatly impacting on their decision to enter a space, and whether to stay or leave. Here are eight ways in which light can stimulates positive or negative reactions. It is vital that each individual aspect of the lighting design be complementary to the others, ensuring a holistic pleasurable experience.

Design factors

The functional aspects of store design can be categorised into two main areas: display and layout. Display includes everything from shop windows to purchase counter displays as well as signage and other informative mediums. Layout influences both the customer experience as well as the speed at which they shop and leave. The three most commonly used layouts are the grid, racetrack and freeform. The gird is most commonly used for supermarkets where products must be organised in an easy to understand and navigate way, allowing for both comfortable browsing and fast shopping. Ideal for utilitarian shopping although hedonic customers can also enjoy the structured space. The racetrack is typically used in department stores to guide customers on a predetermined route through all areas and past all product groups, encouraging purchasing behaviour. This is an ideal layout for hedonic customers who are in the store to experience the space and product variety, not only to make objective purchases. The freeform is used mainly in stores selling highly hedonic products such as clothes. It allows customers to go where they like within the space, although certain visual cues can be used to ensure they see all offered merchandise. This is the most costly layout type, but highly effective in stores where customers need time to browse and enjoy the available items.

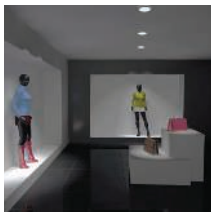


Approach

Avoidance

It is vital to minimise glare, especially in shop window areas where disturbing reflections can have a negative visual and psychological effect. However, this must be balanced with excellent colour rendition and the saturation and vividness provided by light sources with a light colour below the Planck curve. The main focus is on ensuring that colours are stimulating but never unnatural.

Approach



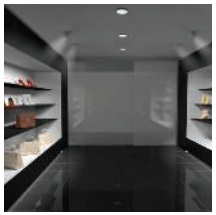
Avoidance

Dynamic lighting can be used in two ways: to enable fast and easy adapting to changes in display, or as a visually stimulating tool that changes over a period of time according to lighting scenes. In both cases it is crucial to find the perfect balance between light colour temperature, contrast and brightness.

Approach

Avoidance

Another useful idea for shop window lighting is to adjust it according to the amount of daylight available In order that optimal contrast ratios are maintained it is necessary to use accent lighting to highlight displayed objects. When the daylight is bright, the accent lighting must be brighter, and when the daylight is gone the accent lighting can be dimmed so as to highlight but not over-illuminate the objects and space.



Approach

Avoidance

A common lighting mistake is to increase overall brightness levels to attract, which is both visually and psychologically unpleasant as well as energy inefficient. It is better to use a comfortable level of ambient general lighting in combination with eye-catching high-contrast accent lighting, which is visually stimulating and more comfortable, and provides energy savings.

Approach

Avoidance

Studies have shown that people react positively to the use various light colours within a lighting concept. This can include the use of various colour temperatures for both horizontal and vertical illumination. TunableWhite LED technology makes this incredibly simple to incorporate into any retail space.

Approach

Avoidance

Perception differs according to age, gender and customer profile. For example, men take an overall view of a space whereas women tend to focus on details. Therefore, it is important to adapt the lighting to those to whom you wish to sell products, which depends on not only the brand and type of merchandise, but even the time of day.

Social factors

Social factors are concerning the people within the store, covering the number, profile and behaviour of customers along with sales personnel. This area is focused on crowd management, staffing issues and waiting times for service, and plays a crucial role in a customer's perception of the quality of a store and its products. The number of sales personnel available is one key element, along with the quality of customer service. Other important elements that are becoming increasingly important are the concepts of social and environmental responsibility, which help to ensure the customer feels a moral as well as emotional and material connection with the brand.

Approach

Avoidance

Wide-area backlighting of shelves is a visually stimulating and highly effective way of ensuring that shelves are suitably illuminated, in combination with contrast-providing accent lighting. This is a clever way of ensuring sufficient levels of overall general illumination in smaller spaces also, which makes for a dramatic and captivating atmosphere.

Cool colour temperature

Warm colour temperature

Colours are connected to emotions and influence whether a space is considered acceptable, pleasurable or unpleasant. Cool colour temperatures of 5000 K or more make a space feel larger whilst warmer colour temperatures of 2700 K and 3000 K make a space feel cosy and intimate, and neutral colour temperatures have been show to extend the amount of time customers stay in a store. The choice of colour temperature can have a significant impact on a customer's perception of the store, with warmer colour temperatures preferable in terms of evoking feelings of comfort and security.

COLOUR THEORY

Everyone knows that colours effect mental and psychological perception, far more so than mere aesthetic devices. Consequently, colour is one of the most powerful tools of retail to make an environment communicate a specific message, be that one of being intimate, vibrant, exciting or high-tech. Each colour has its own particular effect, and depending on the hue, can evoke specific feelings.

Red
Red is a very physical colour that creates a powerful impression and always elicits a response, although depending on its use that response can be either positive or negative. It is perceived as warm and positive, energetic, passionate and active, stimulating customers and encouraging them to make a decision to buy. For this reason it is perfect for use at points-of-sale. It also stimulate the appetite, making it ideal for use in gastronomic premises and signage. Red even has a physical effect, influencing blood circulation and the nervous system, raising blood pressure and heart rate. As red is so dynamic, it is recommended to use it as an accent colour only, as large amounts can be overwhelming and very negatively perceived.

Orange
Orange is a very psychological colour, seen as vibrant, extravert, optimistic, confident and fun. It has a vitalising and energising effect on the psyche, and an especially stimulating effect on the appetite.

Perfect for use in all types of restaurant or cafe, it is however important to use the right tone for the particular establishment as some shades can feel cheap. Also great for use in spaces for children and teens as it suggests adventure and excitement, and also affordability.

Yellow
Yellow is a powerful colour. One of the first colours to be registered by the human eye it is highly attracting, but not comfortable to be in the presence of for too long. Brighter, more saturated shades are perfect for use in areas where customers need to keep moving. Softer hues are considered warm and comfortable, creating a sunny and pleasant ambience for brief and energising stops, such as in a cafe. As a colour associated with signage, it is ideal for use in promotional displays.

Green
Green is very calming for the psyche, providing the psychological conditions conducive to clear and objective decision-making. Strongly associated with environmentally friendly products, it is perfect to highlight any ecological benefits or themes. It is also the colour of newness, of growth and energy, encouraging a feeling of potential and optimism. Great for use in areas where customers need to think about what they are buying, rather than making spontaneous decisions.

LIGHT AND US

BRINGING ORDER TO THE LIGHTING WORLD

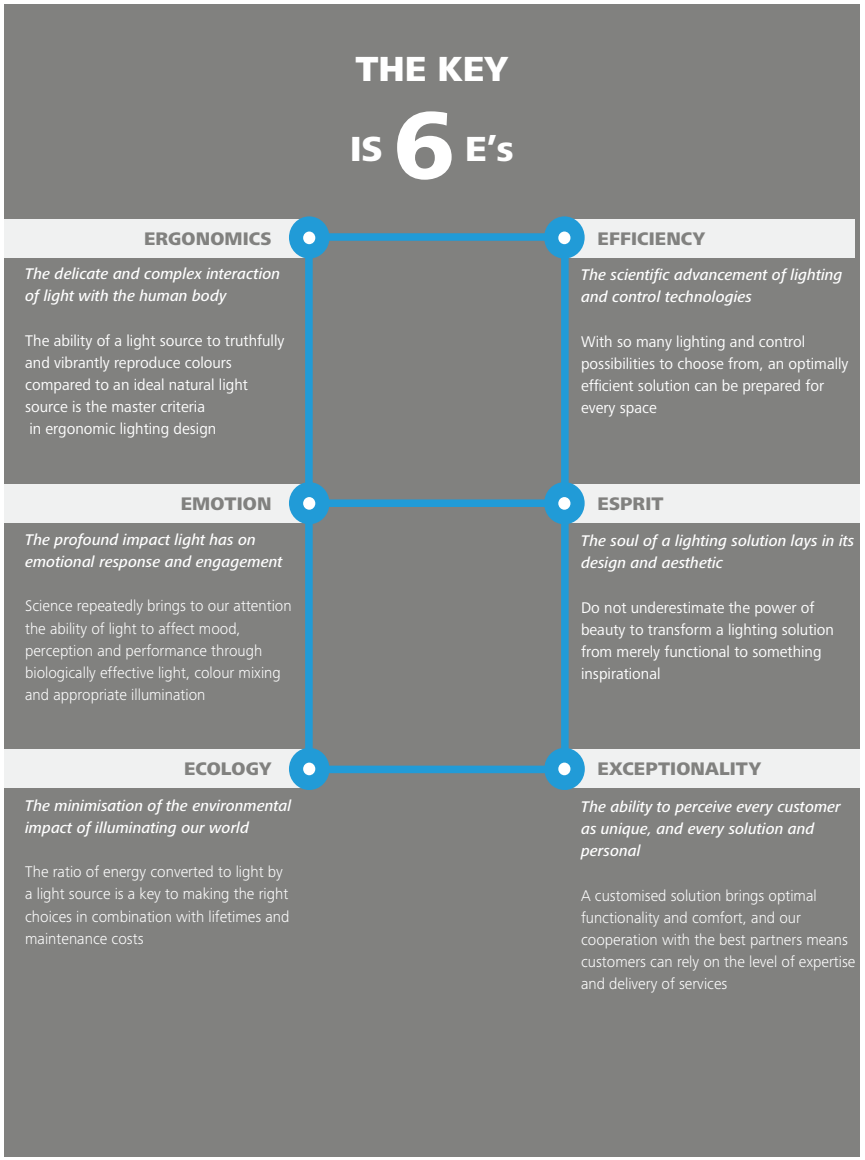
Light is one of the most important aspects of the retail environment. It is a vast and open area for expression and emotional effect. Lighting designers must use their experience, creativity and talent to navigate the complex array of technologies and their uses. This is in part aided by standards and requirements, and in part informed by the results of research and time-tested theories. Until recently, the combination of these many factors was chaotic, and criteria incomprehensible. At SLE we realised that the lighting industry needed a regulated and systemised lighting assessment tool that would enable simple, fast and effective evaluation of lighting solutions. A system that would help not only the designers, but also the customers, supporting them to work together in choosing the best options to meet their needs. That system is the **Lighting Quality Standard.**

In life, rules are important. When it comes to creating an effective, efficient and safe lighting solution, one that enables visual comfort and acuity as well as performing a stimulating and emotionally engaging role, there are defined guidelines and parameters to follow. These things do not act to limit, but to lead and inform the creative and technical processes behind the conception of a perfect lighting solution. The Lighting Quality Standard (LQS) forms a logical framework within which both the objective and subjective aspects of a solution can be judged, helping everyone involved in the realisation process stay on track and achieve the best results.

It was not so long ago that every producer of light sources and luminaires had their own system of assessment. It was impossible for customers to judge the quality and suitability of different products, and therefore compare and assess complex solutions. We offer LQS to the lighting world as a tool for all to use and benefit from. It is not merely an aid, it is a significant step forwards for the lighting industry.

LQS is comprised of twenty objectively quantifiable criteria that enable the intuitive assessment and evaluation of everything from individual lighting fixtures to complex lighting solutions. Each criteria is scored on a scale between 0 and 5, with five representing the highest and most beneficial result. An overall rating is given once the process is complete, allowing for the simple comparison of one solution with another.

The whole assessment is categorised into six areas, the 6 E's: ERGONOMICS, EMOTION, ECOLOGY, EFFICIENCY, ESPRIT and EXCEPTIONALITY. The first four are objectively assessable, forming the so-called walls of an ideal structure. The last two are subjective, providing the roof of the structure, completing it and perfecting it. Each category cannot be effectively assessed separate from the others. The fullest and most advantageous result can only be achieve when all elements are viewed as a holistic whole. That is the philosophy of LQS, where the structure of the world we live in is crystal clear.



ERGONOMICS

By designing a lighting system to provide the perfect light only where needed, we minimise losses and ensure ideal illumination

The right light in the right place. That is the ergonomics of light. But what defines the right light? To answer this question we must understand how light affects the human eye. Only by doing so can we respect the principles that govern our visual world and consequently create a visual harmony that ensures comfort and acuity.

The majority of our understanding of these principles is laid down in the European standard EN 12464-1 for interior workspaces.

By following these standards, and where appropriate surpassing them, lighting designers can choose exactly the right light source, optical system and light distribution for each individual space. In retail applications, this covers all lighting parameters: colour rendering index, glare prevention, illumination level, lighting uniformity and harmonious distribution of brightness. Each individual parameter must be viewed as part of a holistic whole, ensuring the perfect light for both customers and employees.

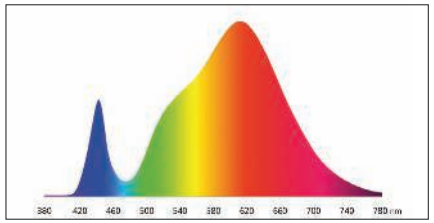
Excellent colour rendition is the most important lighting parameter in the retail environment

COLOUR RENDERING INDEX

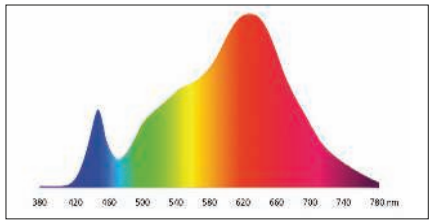
Colour is possibly the most important visual parameter in retail environments. It determines our perception of goods, informs our decisions to buy and defines the identity of a store. Colour, however, does not exist without light, thus what light we use in retail environments in absolutely key.

Each light source displays colours differently, be it daylight or the light emitted from a fluorescent lamp. Colour rendition refers to how colours are displayed under different light sources, with the Colour Rendering Index (CRI) acting as the quantifiable measure of colour rendition.

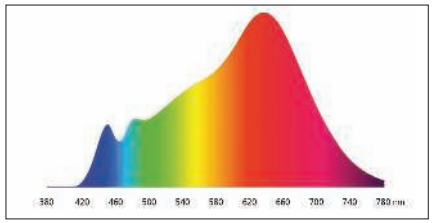
In order to define the CRI of a given light source it must be compared to a neutral control light source, most commonly daylight. Both the control and test light source must have the same CCT properties for the comparison to be accurate, as CCT is one of the key determiners of CRI. The more accurate the colour rendition of a light source, the higher its CRI value, with daylight having CRI = 100. To assess colour rendition, fifteen test colours are compared, each receiving an individual rating with the average of the first eight referred to as the Ra value, the standard expression of CRI used throughout the industry.



Standard LED light source with CRI = 80



Standard LED light source with CRI = 95



Standard LED light source CRI = 98


CRI comparison: on the left illustrates CRI = 70, on the right CRI = 93

LQS VALUE

Colour rendering index (CRI)

CRI	LQS Value
> 90	5
80–90	4
70–80	3
60–70	2
40–60	1
20–40	0

For all sales areas a minimum of CRI = 80 should be used, although for certain shops, such as those selling food products or fashion items, we recommend a minimum of CRI = 90 in order that colours appear natural and appealing as opposed to the dull and lifeless colours displayed under light sources with lower CRI values.

Glare is both visually and psychologically disturbing to employees and customers and must be minimised by the correct design of the lighting system

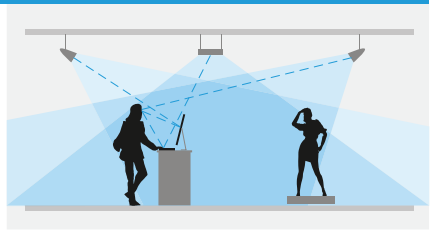
GLARE PREVENTION

Nobody is a fan of glare, it hurts our eyes and gives us headaches. It is not only uncomfortable but also potentially dangerous as it restricts and distorts visual perception. In retail environments light should be comfortable so as to not disturb customers, deterring them from entering or lingering in a space, but most importantly it must enable sales personnel and other employees to fulfil their tasks effectively and safely.

Glare is caused by the presence of areas within our field of vision that have significantly higher luminance than the background luminance or luminance of the task being undertaken. This causes excessive contrast that ultimately results in reduced visual acuity, sometime to an extreme extent. The quantification of glare is calculated according to the Unified Glare Rating (UGR) system developed by the Commission Internationale de l'Éclairage, with lower values representing lower levels of glare. In basic terms, it divides the glare of visible light sources by the general level of background luminance.

$$UGR = 8\log\left[\frac{0.25}{L_b}\sum\frac{L^2\,\Omega}{p^2}\right]$$

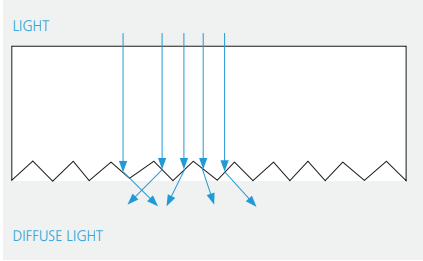
Where:
log = logarithm
L = luminance of light source in the direction of the eye of the observer in cd/m²
Ω = cut off angle of the luminaire relative to the eye of the observer in steradians
p = Guth position index representing the location of the observer relative to the light source
L_b *= background illuminance in cd/m²*



Glare can be both direct, such as when the light from a light source shines directly in the eye, and indirect, such as the reflections from a monitor, table or magazine. Indirect glare in the most harmful as it enters the eye from below, at an angle to which our eye is most sensitive.

Lighting requirements	High luminance screen L > 200 cd/m²	Medium luminance screen L ≤ 200 cd/m²
Case A *For spaces with common CRI and visual acuity demands.*	≤ 3000 cd/m²	≤ 1500 cd/m²
Case B *For spaces with above-standard CRI and visual acuity demands.*	≤ 1500 cd/m²	≤ 1000 cd/m²

Maximum luminance values of used lighting fixtures at an angle of 65°



Microprisma is the most effective optical material for minimising glare as the light 'breaks' on the external edge of the material, on the so-called optical prisms. This ensures that the light is uniformly distributed and soft, which is visually comfortable and pleasing, and has a suitably low UGR rating.

In retail environments, a general rating of UGR ≤ 22 is recommended in order that customers can comfortable and effectively view the goods on offer. Whereas at payment counters and packing areas UGR ≤ 19 is recommended, as excessive glare in such places will negatively affect performance and concentration, and cause fatigue and possibly health problems such as eye strain and headaches. For areas where VDUs are used, which is the case at almost all payment counters, ISO 9241-307 must be followed, which defines the maximum luminance values of the used lighting fixtures at an angle of 65° up to a maximum of 90°.

One special area for consideration is accent lighting as spotlights focus their light very strongly on a small area. To avoid light being directed directly into the eyes of both customers and employees the fixtures must be directed at an angle of no more than 30° from horizontal. Here it is especially important to utilise the knowledge and experience of lighting design experts.

LQS VALUE

Glare prevention

Glare prevention	LQS Value
UGR ≤ 16	5
UGR ≤ 19	4
UGR ≤ 22	3
UGR ≤ 25	2
UGR ≤ 28	1
UGR > 28	0

The perfect combination of lighting and technical parameters can only be ensured by experienced lighting designers

ILLUMINATION LEVEL

LIGHTING UNIFORMITY

HARMONIOUS DISTRIBUTION OF BRIGHTNESS

These lighting parameters are clearly defined for most types of space, such as interior workplaces like offices and production halls. However, for retail application the recommendations are few, and are not fixed. Rather it is appropriate to design the lighting based on experience and research into the various contributing factors to the retail experience.

Retail is about emotion and cannot be defined by numbers. There are certain recommendations for retail environments, but they are open to interpretation and not rigid requirements but act more as guidance. In many cases the lighting design of a retail space depends on the brand and may well not fulfil recommendations. In some stores you may find very high levels of illumination at floor level, whilst in others you may find very low levels and a stronger focus on the illumination of vertical surfaces. We recommend higher levels of vertical illumination for retail spaces due to its ability to suitably highlight shelves and racks, the most common display methods used. **One basic rule we strongly advise is to ensure a minimum ratio of vertical to horizontal illumination of 2:1, a minimum lighting uniformity of 0.4 and maximum UGR of 22.**

Type of area, task or activity	$\bar{E}_m$ lux	UGR_L	U_o	R_a
Sales area	300	22	0,40	80
Till area	500	19	0,60	80
Wrapper table	500	19	0,60	80

EN 12464-1 normative requirements for retail spaces

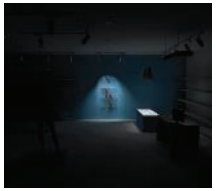
	Retail (lux)	Supermarket (lux)	Special requirements (lux)
General and sales floor lighting	750	500	
Accent lighting	1000	1000	meat and fish 800
Promotion displays	1500	1500	
Cabinet displays	1000	1000	
Shelf displays	1000	750	
Storerooms	300	300	
Counters and points-of-sale	500	500	

SLE recommendations for retail and supermarket spaces

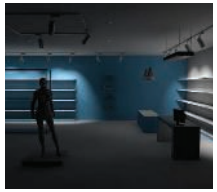
General and sales floor lighting – 750 lux

Payment counter – 500 lux

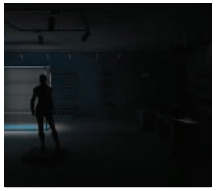
Promotion displays – 1500 lux



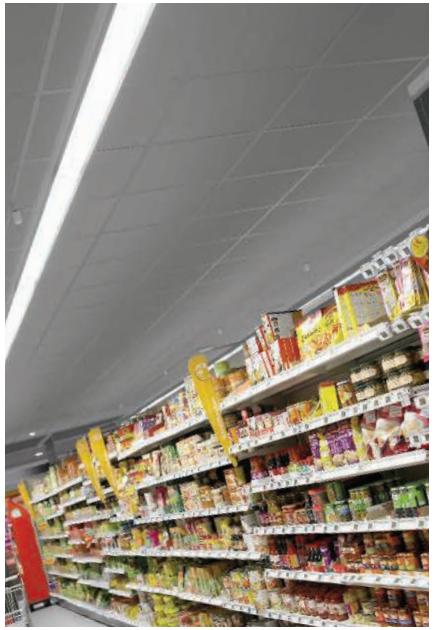
Accent lighting – 1000 lux



Shelf displays – 1000 lux



Cabinet displays – 1000 lux



Here at SLE we believe that the retail environment has the greatest potential for creative expression, where architectural, spatial, interior and lighting design elements are combined from the very beginning and work in perfect harmony. Based on our extensive experience we have defined our own lighting recommendations for this exceptional kind of interior space.

LQS VALUE

Illumination level (task area)

Illumination level (task area)	LQS Value
Yes	5
No	0

LQS VALUE

Illumination level (surrounding area)

Illumination level (surrounding area)	LQS Value
Yes	5
No	0

LQS VALUE

Lighting uniformity

Lighting uniformity	LQS Value
Yes	5
No	0

LQS VALUE

Harmonious distribution of brightness

Harmonious distribution of brightnees (contrast)	LQS Value
Em(wall) > 150 lux with U_o > 0,3 Em(ceiling > 75 lux with U_o > 0,3	5
Em(wall) > 75 lux with U_o > 0,3 Em(ceiling > 50 lux with U_o > 0,3	4
Em(wall) >75 lux with U_o > 0,1 Em(ceiling > 50 lux with U_o > 0,1	3
Em(wall) > 50 lux with U_o > 0,1 Em(ceiling > 30 lux with U_o > 0,1	2
Em(wall) > 30 lux with U_o > 0,1 Em(ceiling > 10 lux with U_o > 0,1	1
Em(wall) < 30 lux with U_o > 0,1 Em(ceiling < 10 lux with U_o > 0,1	0

EMOTION

Shopping is an emotional activity so emotive lighting is key to retail success

Emotion is the most important aspect of our relationship with retail. The decision to buy is 80 % emotional and 20 % objective, therefore, it is of vital importance to fully understand and exploit the ability to influence, inspire and guide customers by stimulating sensory reactions, appealing to instincts and entertaining.

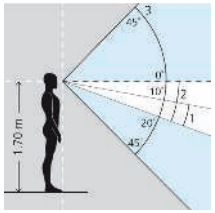
Light is one of the most powerful tools for influencing and creating emotional responses and connections. Many call it the fourth element of architecture.

The first element of lighting to consider is the relationship of vertical to horizontal illumination, after which we can think about brightness, contrast, light's biological effects, colour and ambience.

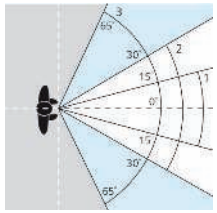
VERTICAL ILLUMINATION

We are more or less sensitive to light depending on the angle at which it enters the eye. This fact defines our understanding of how vertical illumination relates to horizontal illumination, and informs the way in which we can use luminaires to create optimal optical conditions, including the vital visual component of contrast.

Our sensitivity to light depends on the angle at which it enters the eye, knowledge that guides and defines many aspects of lighting design. Our visual field extends upwards and downwards 45° from our line of sight and 65° to each side. However, some parts of that visual field are more sensitive than others as shown in the diagrams below.



1 the most sensitive area of our visual field
2 the most effective part of our visual field
3 the general visual field



LQS VALUE

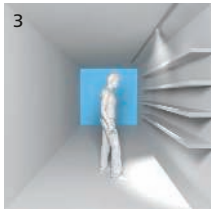
Vertical illumination

Vertical illumination	LQS Value
$Ev_{avg} > 0.5\ Eh_{avg}$ (Wall LG7) $Ev_{avg} > 150$ lux	5
$Ev_{avg} > 0.5\ Eh_{avg}$ (Wall LG7)	4
$Ev_{avg} > 0.4\ Eh_{avg}$	3
$Ev_{avg} > 0.3\ Eh_{avg}$	2
$Ev_{avg} > 0.1\ Eh_{avg}$	1
$Ev_{avg} < 0.1\ Eh_{avg}$	0

Based upon the determined areas of sensitivity it is possible to plan the layout of items, especially in supermarket shelving displays, according to which products are of the highest importance. Items placed within area one will be the first to catch our eye so the space could be reserved for special offers or new items, whilst area two could be for general products and area three for less important products such as low profit items. However, it is necessary to also bear in mind that areas one and two are also where our eyes are most sensitive to glare, a factor that must be taken into account during the design of the lighting system. Spotlights are often used for shelving displays, and it is important that they be directed appropriately to not cause glare, only illuminating products and never shining directly at the customer. For high-end lighting design, such as in boutiques, it is advantageous and very dramatic to use floor mounted spotlights that direct their light upwards as this is far less likely to cause any visual disturbance or discomfort.

In years past lighting systems were designed to provide horizontal illumination only, with much higher levels of brightness than what we now consider necessary. This was done to ensure sufficient vertical illumination was delivered and ultimately provided very monotonous, overbearing light that consumed huge amounts of energy. By designing a lighting system according to our knowledge of the eyes' special sensitivity to vertical illumination, customers are able to clearly see and identify vertical surfaces, whilst horizontal illumination takes a secondary role to aid navigation only. This simple change of understanding, leading to the directing of light only onto relevant surfaces, can bring energy savings of up to 40%.

Vertical illumination
To ensure the effective vertical illumination of shelves we use the same rule as with accent lighting, that the lighting fixture is positioned one third of the room height away from the display (H/3), and vertically rotated by 30° towards it (1). If lighting fixtures are too far from the shelf display the illumination will be partially blocked by the browsing customer causing shadows (2). On the other hand, if the fixtures are located too close to the shelf display the top shelf will be illuminated and all shelves below in shadow (3).



How to create the perfect vertical illumination

There is one simple equation to remember, which acts as the base for all vertical illumination design. The vertically illuminating lighting fixture, most commonly a spotlight or asymmetric linear fixture, should be positioned one third of the room height (H) from the surface to be illuminated, or simply put H/3, and rotated 30° towards the object.

What this means in practice is that the lighting fixture is ideally positioned to illuminate all vertical surfaces, of a shelving display for example, without being blocked by the browsing customer or causing too many shadows.

CONTRAST

Contrast is one of the most important factors of vision. It enables spatial perception and the modelling of objects. Without it our world would look rather boring and visually flat. Therefore, optimal ratios of contrast play a key part in retail lighting design.

The recommended ratio of vertical (wall, shelf, display) to horizontal (floor) illumination is 2:1, which provides ample light for easy and safe navigation whilst very clearly drawing attention to vertical surfaces. In this respect, higher contrasts are not ideal as they could become visually disturbing due to the vertical surfaces being too bright compared to the floor, resulting in glare.

For the accentuation and modelling of objects, we recommend a minimum ratio of object (mannequin, display) to background (wall) illumination of 3:1, creating light areas and shadows to aid our visual perception and creating interest. This ratio can be increased up to a maximum of 15:1, at which point the brightness 'swallows' the object being illuminated. Higher ratios create a more dramatic impression and seem to bring objects to life, with the play of light and shadow changing as the customer moves.

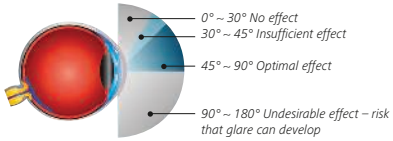
THE BIOLOGICAL FACTOR OF ILLUMINATION

Light has a greater impact on us that we may think. It is one of the most powerful tools to evoke emotional reactions and influence behaviour, making it a core concern in any retail space.

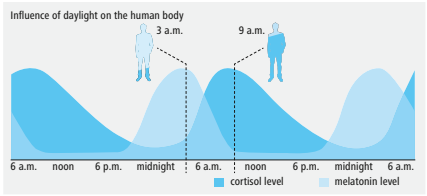
Light can affect our energy levels, concentration, mood and motivation. It goes without saying that daylight is the most favourable and beneficial light for our bodies and psyche, and should be used to illuminate interior spaces to the greatest extent possible in combination with suitable measures to minimise possible glare. However, in many interior spaces daylight availability is very limited or even non-existent. Unfortunately, in retail spaces it is often the latter. However, many advancements in both understanding and technology have been made in recent years, leading to artificial light being able to simulate many of the natural properties of daylight. This is something any store can benefit from, be it with or without access to natural light.

Blue light content

In the early 2000's scientists made a remarkable discovery that changed the face of lighting, adding a new and fundamental dimension to our understanding of light and its capabilities. This discovery was the detection of a third photoreceptor in the human eye, one that directly influences the body's production of the hormones melatonin, cortisol and serotonin. All of which, especially melatonin, have a governing effect on our circadian rhythm, acting as the cue to our bodies that it is day or night. The photoreceptor was found to be particularly sensitive to the blue part of the light spectrum with a wavelength of around 464 nm. Instigating a flurry of new research and development within the lighting industry, luminaires and light sources are now available that can provide the right light at the right angle to positively affect human behaviour.



The third photoreceptor is particularly receptive to light with a wavelength of 464 nm, the blue part of the spectrum. This function acts to stimulate and regulate the production of certain hormones and the circadian rhythm.



During the morning hours the body produces the hormone cortisol which increases concentration and performance. The amount of the hormone in the blood peaks at around 9am and gradually decreases through the day. Melatonin, often referred to as the sleep hormone, has an opposing effect, being produced during the night with quantities peaking at around 3am.

Conventionally used fluorescent light sources do not have a biologically stimulating effect on the human body.

However, LED luminaire with a CCT of 4000 K is able to positively influence the human body.

LQS VALUE

Biological factor of illumination	LQS Value
availability of daylight	0/1 (No/Yes)
blue light content	0/1 (No/Yes)
daylight simulation	0/1 (No/Yes)
dynamic lighting	0/1 (No/Yes)
tunable white	0/1 (No/Yes)

The retail environment most benefitted by biologically effective light is supermarkets, where hormonal stimulation increases alertness and activity. Supermarket shopping is not always the most riveting experience and purchasing behaviour is quite objective. Biologically effective light is the perfect solution to help customers feel more emotionally engaged in the experience, to minimise their forgetting of important items, and to encourage them to stay and browse longer. **Research into which lighting is most beneficial in this demanding area of application has proven that the use of LED lighting with a CCT of 4000 K is more activating that than similar fluorescent lighting.** SLE have developed a special range of lighting fixtures, especially for retail spaces such as supermarkets, with a newly updated, highly efficient and effective LED version available with a CCT of 4000 K. The use of this perfectly tailored luminaire will surely bring great benefits to the customer experience and therefore increase sales.

Melatonin
Melatonin makes us feel drowsy, slows down bodily functions and lowers activity levels to facilitate a good night's sleep. It also ensures that a large number of metabolic processes are wound down. Body temperature falls; the organism, as it were, is put on the back burner. In this phase, the body secretes growth hormones that repair cells at night.

Cortisol
Cortisol is a stress hormone, produced from around 3 a.m. onwards in the adrenal cortex. It stimulates metabolism again and programmes the body for day-time operation. The first light of the day then stimulates the third receptor in the eye and suppresses the production of melatonin in the pineal gland. At the same time, the pituitary gland makes sure the body secretes more serotonin.

Serotonin
Serotonin acts as a mood-enhancing, motivating messenger. While the level of cortisol in the blood falls during the day in a counter-cycle to melatonin, serotonin helps us achieve a number of performance peaks. When daylight fades, the internal clock switches to night.

However, if our body does not get enough light during the day, it produces only a low level of melatonin. As a result, we sleep badly, we wake feeling unrested, we are tired during the day and lack energy and motivation. Insufficient exposure to stimulating light during autumn and winter can turn the process into a downward spiral. At that time of year, some people develop seasonal affective disorder (SAD). Their internal clock misses its cues because the hormonal balance in the brain is upset.

DYNAMIC LIGHTING

DAYLIGHT SIMULATION

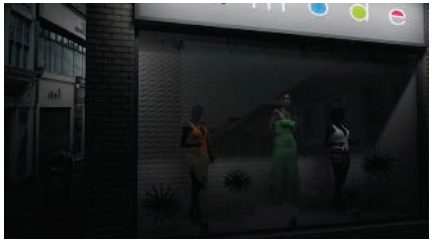
TUNABLE WHITE

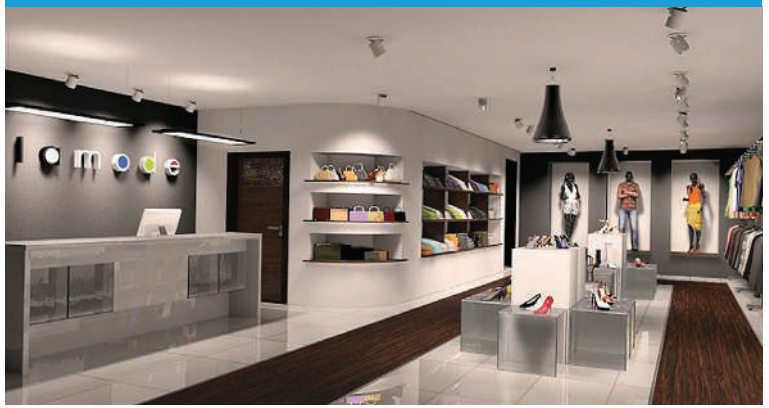
As we have already mentioned several times, it has time and again been shown that daylight is by far the most beneficial light for the body and mental state of humans. Technological advancements in lighting mean that now we can more closely than ever simulate many of the properties of natural light.

Dynamic lighting is the term used to describe lighting where the properties change over time according to lighting scenes. This can include changes in brightness, colour temperature and colour. Dynamic lighting is highly effective in drawing the attention of customers and stimulating their imagination, hence encouraging purchasing behaviour. Daylight simulation is one particular kind of dynamic lighting where brightness and colour temperature change in such a way as to mimic the natural changes of daylight. TunableWhite is a modern and versatile development in lighting, enabling the adjustment of CCTs between warm and cool white, which when used in connection with dimming enables daylight simulation.

The use of dynamic lighting can have a tangibly positive effect on customer perception. One of most advantageous ways to use it is in shop windows, which act as important cues to potential customers to enter a store, browse and purchase. Lighting can be changed according to the seasons, for example by using cooler light for winter items and warmer white for summer items, or according to the feeling the store wants to portray in the display. Lighting can also be changed through the day, simulating clouds passing, the changes in light according to the time of day from sunrise to sunset, or to have a biologically effective impact on customer behaviour.

However, this functionality need not be confined to shop windows, as it is also beneficial to use in interior spaces. This allows for the light to adapt to the merchandise displayed, for example using warm white light for leather and wood goods, and cool white light for metallic items. It can also encourage a particular impression of a space, with warm white promoting feelings of intimacy, relaxation and safety, whilst cooler white gives the impression of spaciousness and modernity. Daylight simulation can also adapt to the natural properties of the light outside at any given time, providing a stimulating experience for customers as they enter, energising and activating them. A perfect example of this is the use of warm and bright 'sunny' light inside a store when outside it is grey and raining. This encouraging impression lifts the mood of customers and prompts them to react positively to the store and stay longer to enjoy the ambience before returning to the gloom outdoors.





Warm white creates a relaxing atmosphere. It is useful in stores where we want to make customers feel comfortable and safe. It can be used as part of daylight simulation.

Neutral white can be used as a serve-all option where neither warm nor cool white light are acceptable or practical. It is used in daylight simulation as the meeting point between warm and cool white light, maybe over lunch time for example.

Cool white light creates a modern and fresh atmosphere and is ideal for presenting state-of-the-art products. During the morning hours it can be used to activate customers, making them more alert and motivated.

LQS VALUE

Biological factor of illumination	LQS Value
Biological factor of illumination	
availability of daylight	0/1 (No/Yes)
blue light content	0/1 (No/Yes)
daylight simulation	0/1 (No/Yes)
dynamic lighting	0/1 (No/Yes)
Tunable White	0/1 (No/Yes)

ACCENT LIGHTING

Monotonous light creates a monotonous space, which has a negative impact on customer perception and mood, decreasing their activity, engagement with the environment and purchasing behaviour.

In modern lighting design, accent lighting is key. It plays the central role in the creation of visual comfort, wellbeing and interest. By accentuating shelves, promotion displays and even individual items it is possible to decisively guide customer attention and create a dramatic and emotionally stimulating atmosphere.

Light direction

Light can be directed at an object from any number of angles, with each angle having a slightly different effect on the overall impression the object makes. Light direction can be classified simply into five areas: light from above, from below, from the side, from the front and from the back. Light from above, below and the sides creates strong shadows, light directed at the front of an object enables effective modelling, whilst light from behind the object creates a dramatic silhouette. By carefully combining these effects it is possible to illuminate an object in such a way as to almost bring it to life, giving it great visual depth and detail.

LQS VALUE

Accent lighting

Accent lighting	LQS Value
Yes	5
No	0

Colour is a highly flexible and powerful tool to create the emotional atmosphere of a store

RGB COLOUR MIXING

Our world is not merely black and white, and cannot be experienced to its fullest extent based on changes in brightness and the play of light and shadow.

Colour is a fundamental element of our visual lives, informing, influencing and defining everything we experience by sight. By using coloured lighting in the retail environment we can exploit every possible aspect of light available to us and reap the rewards both as sensory driven customers and as a sales driven retailers.

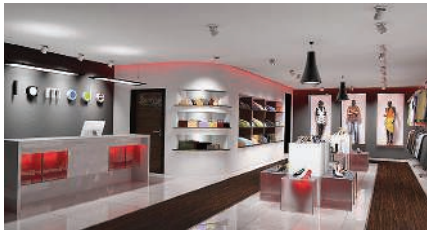
The mood and atmosphere of a store can be radically changed by colour, with different colours having a strong impact on customer reaction to a space. For example red is very stimulating, blue is cool and fresh and pink is positive and encourages customers to linger. Instead of making frequent and expensive modifications to a store's interior, it is possible to change everything simply using light, changing colours at the touch of a button. RGB colour mixing puts at our fingertips 16 million colours, a variety we can never exhaust and that is fully adaptable to any interior design vision with subtle shades just as accessible as dramatic ones. By using white in combination with RGB LED light sources it is possible to achieve better colour saturation and definition and improve the efficiency of the lighting solution.

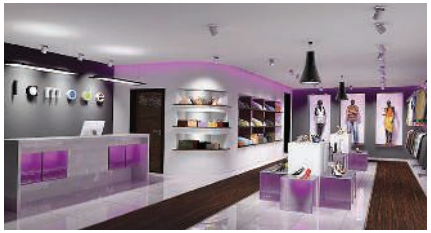
AMBIENT LIGHTING

Ambient lighting is achieved by using hidden lighting fixtures, for example in a cove, giving the effect of the ceiling or wall glowing from within. Such lighting visually expands a space, providing an airy and soft atmosphere, a highly effective way to promote visual and psychological wellbeing and encourage customers to spend time in the space. RGB combined with ambient lighting is greatly influential on customer emotional engagement with a store and its merchandise.

LED strip lighting fixtures and fluorescent tubes are concealed along the edges of ceilings and vertical surfaces, providing indirect illumination. Indirect lighting is psychologically and visually comfortable and therefore improves feelings of wellbeing in customers.

It can be used as both the main source of illumination or as an atmospheric addition to general and/or accent lighting. Cove lighting is perfect for highlighting architecturally interesting or ornate ceilings, really adding a finishing touch to the interior design of a space.



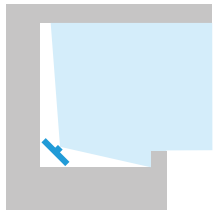


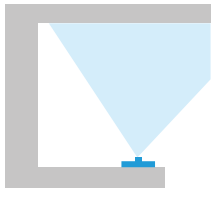
Perimeter cove lighting to illuminate the ceiling

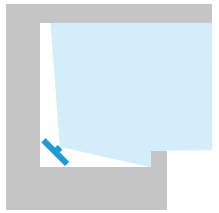
Central cove lighting to illuminate the ceiling (Corona effect)

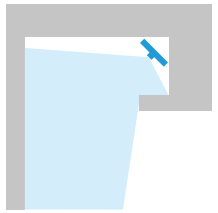
Radius cove lighting to illuminate the ceiling

Perimeter cove lighting to illuminate the walls









LQS VALUE

Ambient lighting

Ambient lighting	LQS Value
Yes	5
No	0

LQS VALUE

RGB colour mixing

RGB colour mixing	LQS Value
Yes	5
No	0

ECOLOGY

Ecologically sound lighting solutions are changing the face of modern retail, bringing environmental responsibility to the fore in this fast changing and demanding area

ECO FRIENDLY

Respect for the fragile equilibrium of the environment has been core to innovation and growth in many industries over the past few decades. The lighting industry is no exception, having great ecological potential and consistently pushing to the forefront the values of environmental responsibility and understanding.

Gone are the days when the provision of light is enough. Now light source and lighting technologies are required to be energy efficient, recyclable and have a long lifetime, additional to being effective and having a low environmental impact during production, use and disposal.

All of these factors combined make for an ecologically sound solution, as well as a cost effective one, both advantages being strong driving forces behind technological development and customer uptake. This is as much so in the 'energy-hungry' retail sector as any other.

LEDs have proven to be the most suitable and effective light source for retail application

LATEST LAMP TECHNOLOGY

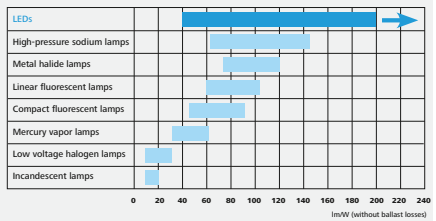
The time when people applauded Swan and Edison are long gone. Although history will forever remember them as the fathers of artificial light, science is rapidly and consistently driving advancement in this area.

Energy sources are limited and prices are constantly rising. Awareness of this makes it more and more important to attain greater light source efficiency and lower energy consumption. A few years ago, metal-halide lamps were the light source of choice but are now rapidly losing ground against LED technology. Compared to conventional light source technologies LED has many advantages including being more effective, consuming less energy, emitting negligible amounts of heat and containing very low levels of hazardous materials. In terms of light source development, more than 90 % of innovation is taking place in the field of LED, with innovation in conventional technologies occurring at a much-reduced rate. However, we must remember that the driving force behind both LED and conventional light source development is their efficiency, with conventional lamps being replaced by eco and longlife versions, and even standard metal-halide lamps by second generation ceramic filament ones.

The key indicator of the efficiency of a light source is its efficacy, how much light is emitted in lumens in relation to the power consumed in watts, resulting in an easily quantifiable lm/W value. This is a core parameter for any lighting designer when designing a lighting system, especially in retail where lighting traditionally consumes very large amounts of energy. In this respect, LED proves its worth by offering efficacies far higher than those of conventional light sources.

Currently, despite being far more efficient and providing very high quality light, LED technology has not yet replaced conventional technology, mainly due to the higher initial price. However, to gain a clear view of the situation we must look at the wider context as lower power consumption, reduced maintenance and long lifetimes make this new technology very appealing by providing excellent return of investment. Nevertheless, it is not merely a case of using LED light sources, but also of using lighting fixtures specifically designed for use with this very different technology. There is now an influx of retrofit LED light sources available, which although suitable for domestic application are not a reasonable option for larger scale use as their efficiency is greatly marred by the fact the lighting fixtures used are not suited. Lighting fixtures designed for LED are able to capture and direct the light very effectively, exploiting the power saving potential of the technology to its fullest extent, wholly justifying the investment.

EFFICACY OF LIGHT SOURCES



LQS VALUE

Latest lamp technology

Latest lamp technology	LQS Value
η > 100 lm/W	5
η > 90 lm/W	4
η > 80 lm/W	3
η > 70 lm/W	2
η > 60 lm/W	1
η > 50 lm/W	0

Modern luminaire optical system design exploits the latest materials and construction methods to minimise losses

SYSTEM EFFICACY OF A LUMINAIRE

Light source efficacy is only one part of the equation. The use of inappropriate and ineffective lighting fixtures negates the positive effects of the light source, therefore it is vital to ensure that effective lighting fixtures are also part of the plan.

System efficacy refers to the effectiveness of the lighting fixture itself, how well it can direct the light whilst reducing losses on the surfaces of the optical system to a minimum. This is measured in much the same way as light source efficacy, with the light output of the luminaire in lumens divided by its overall power consumption resulting in a lm/W value. Another important value with regard to lighting fixtures in the Light Output Ratio (LOR) that expresses the ratio of the light source output to the lighting fixture output. This ratio can be applied to both the illumination directed upward and downward, expressing how much of the light output is directed above or below the lighting fixture. This is important for those spaces that place high demands on ceiling illumination.

$$\text{LOR} = \frac{\text{Lumen output of luminaire}}{\text{Lumen output of light source(s)}} \times 100\ \%$$

$$\text{System efficacy of luminaire} = \frac{\text{Lumen output of luminaire}}{\text{Installed power of luminaire}} \left[\frac{\text{lm}}{\text{W}}\right]$$

LQS VALUE

System efficacy of luminaire

System efficacy of luminaire	LQS Value
η > 80 lm/W	5
η > 70 lm/W	4
η > 65 lm/W	3
η > 55 lm/W	2
η > 40 lm/W	1
η > 30 lm/W	0

How to make an effective luminaire

The materials used in the construction of a lighting fixture have the greatest influence on its effectiveness. Optical materials are used to diffuse the light, modify its distribution and change its spectral composition. They are divided into two types, those that reflect and those that transmit. Aluminium, with various surfaces finishes, is the most common material used for reflectors, whilst glass and plastics are used for transmitting parts. Every material has different reflectance and absorption properties, but generally the more effective the materials used the lower the amount of light lost on the surfaces and the higher the efficacy of the luminaire.

However, the effectiveness of a lighting fixture is also dependent on the shape and design of the optical system. Well-designed optics ensure that the greatest amount of light is directed as desired with minimal losses. Modern computer applications are able to calculate the optimal mathematical and geometric properties for the individual parts of a given optical system.

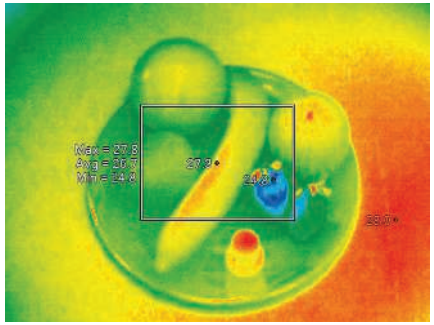
designed especially for use in areas such as supermarkets. The optical system, designed specifically for use with LED light sources, provides a system efficacy of 108 lm/W. This is greatly beneficial for customers using the conventional version of PRESTIGE as they can simply replace the old with the new without any issues associated with different dimensions, light distributions or shapes, and reap great savings in energy consumption.

THE THERMAL OUTPUT OF LAMP

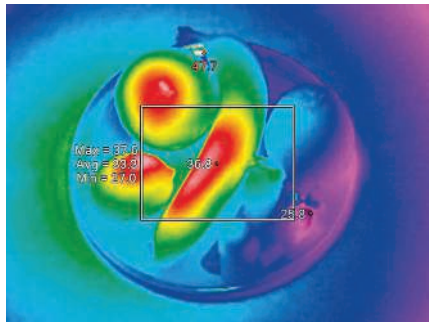
The part of the light spectrum visible to human eyes ranges between infrared (IR) and ultraviolet (UV). Even though we cannot see IR radiation we can still sense it, as heat.

All light sources emit a certain amount of IR radiation, energy that is lost as heat rather than being useful as light, therefore, the lower the amount of IR radiation a light source emits the more effective it is. From this point of view, the incandescent bulb is the least effective as 95 % of the energy they consume is emitted as heat, and only 5 % as light.

In retail applications, this factor is of vital importance. A light source that emits a high proportion of heat will consume a lot of energy to provide very little light, meaning more light sources will need to be used and a great deal of heat will be radiated into the space. A comfortable temperature is important in any kind of store, as a comfortable customer is more likely to stay, browse and purchase. Air conditioning is a vital component of almost every retail space, one that consumes a lot of energy, with a direct correlation existing between increased lighting energy consumption and air conditioning energy consumption. As a result, the use of light sources that emit low levels of heat not only provide energy savings within the lighting system, but also reduce the cooling load placed on the air conditioning system, which in turn results in energy savings. When we look at IR radiation in this way, it is clear to see that what may at first seem like a trivial factor is in truth of great importance. LED is the technology of choice here as they emit negligible amounts of IR radiation, making them not only highly effective as light sources, but also greatly reducing the work required of air conditioning systems.



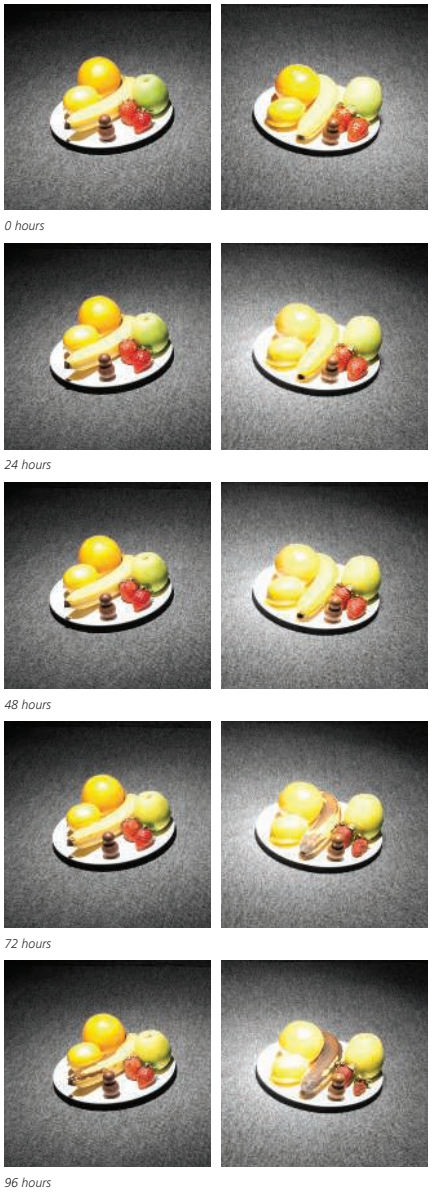
LED
Temperature of objects 26.7°C, Temperature of air 25°C



Metal-halide
Temperature of objects 37.8°C, Temperature of air 25°C

LQS VALUE

Thermal output of lamp	LQS Value
Thermal output of lamp	
< 15 % proportion of IR radiation	5
< 26 % proportion of IR radiation	4
< 28 % proportion of IR radiation	3
< 31 % proportion of IR radiation	2
< 60 % proportion of IR radiation	1
≥ 60 % proportion of IR radiation	0



0 hours

24 hours

48 hours

72 hours

96 hours

These images illustrate the affects of IR radiation on food items, mainly fruit, over a period of four days. On the left we see the items displayed under LED, and on the right under metal-halide, the most commonly used light source type for food displays. The conclusion is that foods displayed under metal-halide deteriorate much faster than those displayed under LED.

ECO
FRIENDLY

DANGEROUS MATERIAL CONTENT

When people think of the dangers associated with broken lamps it is usually of being cut. In fact, the risks connected with most types of light source are far greater and have a serious impact on our health as well as on the environment.

The main reason why we say this is that most types of light source contain mercury, a highly toxic heavy metal and vital component especially of fluorescent and metal-halide lamps. Despite a great deal of research being done into finding a substitute for mercury in light sources, none has yet been found. Alternative light sources that are not dangerous to people and the environment are so costly that they are not financially viable for mass use.

The risks associated with these light sources are not present during general use. It is only when a lamp is broken during handling, or disposed of inappropriately, that it poses a threat by releasing vapours into the air or material into the soil. If damaged during handling, depending on the number of lamps damaged, the size of the room and its ventilation, short-term health effects such as nausea and mental distress can be felt. If disposed of inappropriately the contamination can spread into the soil and possibly water as heavy metals do not decompose and become a permanent element of the environment.

Lighting designers must therefore consider the ecological impact of the light sources they use. Newer 'eco' fluorescent lamps do contain less mercury, but in this respect LED comes to the fore as the safest and most responsible option as they contain no mercury at all.

PRODUCT LIFETIME AND MAINTENANCE COSTS

It is no issue to change a lamp at home, it's not even such an problem in an office, but in retail applications light source maintenance can be highly inconvenient and costly, disrupting customers and negatively affecting their perception of the store and ultimately decreasing sales. As a result, from the very beginning of the design process, lighting designers should consider the lifetime of the chosen light sources and their maintenance needs.

The main reason why people switched from using incandescent bulbs to fluorescent lamps is their lifetime, with some fluorescent tubes capable of lifetimes twenty four times longer than the average incandescent bulb. However, for the same reason incandescent lost favour, so now fluorescent is. LED light sources have a lifetime double that of fluorescent, greatly reducing the need for maintenance. This is beneficial as lamp replacement is costly in terms of the material, personnel, time and equipment needed, additional to costs associated with access to more difficult to reach places.

LEDs standardly have a lifetime of 50,000 hours, meaning that if a lighting fixture is used 12 hours per day, seven days per week, as is many retail spaces, the light source will function for more than 11 years. Another advantage is that LEDs do not just stop working but reach the end of their life when their output falls below 70 % of that when new. So even if the light source is old, it will still illuminate, giving retailers time to plan for and carry out maintenance in the most cost effective way. Also, LED light sources have a very low failure rate compared to conventional lamps, with only two LED dies per one million failing, meaning you can rely on the ones you have to function throughout their entire lifetime. By using LED in combination with a Lighting Management System, it is possible to reap vast benefits in terms of energy savings, controllability and ease of use, all of which make this light source technology perfect for retail application.

LQS VALUE

Dangerous material content

Dangerous material content	LQS Value
mercury content 0 mg	5
mercury content < 0.5 mg	4
mercury content < 1.5 mg	3
mercury content < 2.4 mg	2
mercury content < 5 mg	1
mercury content ≥ 5 mg	0

LQS VALUE

Product lifetime & maintenance costs

Product lifetime & maintenance costs	LQS Value
≥ 50,000	5
> 24,000	4
> 19,000	3
> 12,000	2
> 10,000	1
≥ 2000	0

EFFICIENCY

Lighting control not only brings energy savings, but also allows for the simple and effective changing of a store's atmosphere

Light is a fundamental tool in the creation of a unique atmosphere in each store, whether it be an independent boutique or a large chain supermarket. It affects mood, creates visual and psychological comfort, stimulates activity, and enables employees to work effectively and productively. In an ideal case, the lighting should be a perfect balance of biologically effective daylight and artificial light, with optimal functionality achieved by using a Lighting Management System.

We live in a world defined by technology, resource consumption and ever-increasing energy prices. The decision of retailers to incorporate Lighting Management Systems (LMS) into their stores is most often motivated by the potential to reduce energy consumption and associated costs. However, at the centre of any retail lighting design is the need to find a balance between emotional impact and energy savings, with each store having its own distinctive needs and desires.

Energy savings is, however, only one aspect of an efficient and effectively designed and controlled lighting system. By implementing suitable control tools retailers can rest assured that they have reduced their CO_2 emissions and impact on the environment, whilst also benefitting from the comfort of simple, autonomous and flexible control of their extensive lighting systems. Two things determine the comfort offered by a lighting system: the functional parameters defined for the given space, and the control tools used to regulate the system. As a rule, the more sophisticated the control tools used, the more comfortable and user-friendly the system is, with high-tech methods such as smart device, computer and remote control reducing and even removing the need for user intervention. Extensive control systems are ideal for spaces that have large and complex lighting systems that cannot be simply and effectively controlled by employees, such as larger stores, supermarkets, storehouses, indoor parking areas and even entire shopping malls.

SLE have produced a comprehensive and simple to understand overview of control methods, tools and ideas, 'Lighting Management Systems', where you can find all you need to understand the full potential provided by using lighting management.

Finding the right balance

As we know, emotional engagement in the shopping experience is central to retail success. Finding the perfect balance between emotional impact and energy saving is a complex task, with each store having different needs. Experienced lighting designers know how to define the many details, and determine which tools and methods are most suitable for each application.

Lighting consists of four parts: general lighting, accent lighting, RGB colour mixing and ambient lighting. All have their own inimitable role to play, some more than others depending on the store itself. The autonomous control of these, and the resulting energy savings, can be achieved using four basic control tools: presence detectors, constant illuminance sensors, daylight sensors and lighting scenes using protocols such as DALI, along with additional tools such as remote system monitoring and RFID control.

Applicability of sensors	Presence detector	Daylight and constant illuminance sensors	Lighting scenes	RGB colour mixing
Shop windows	X	X	X	X
Fashion stores	X	X	–	–
Shelf displays	X	X	–	–
Fitting rooms	X	–	–	–
Storerooms	X	–	–	–
Shopping malls	–	X	X	X
Facades	–	–	X	X
Parking areas	X	X	–	–

PRESENCE DETECTOR

The most commonly used control tool, presence detectors can provide great user comfort, and savings potential of up to 50 % in certain types of space. It is possible to use them independently or as part of a complex control system, all depending on the needs of the particular store or area. Functioning based on movement within the scanned area, the lighting is turned on, off or dimmed to pre-set levels.

There are three ways in which presence detectors can be used in retail: detecting presence, tracking customer movement and attracting attention. Basic presence detection switches or dims the lighting according to the presence of people in spaces such as fitting rooms, storerooms and indoor parking areas. Tracking is suitable for use on shop floors where the general lighting adjusts according to customer movement with no effect on accent lighting, a feature with practical value and which can arouse curiosity in customers and act as entertainment as is it still quite uncommon. A new trend in retail lighting is to use presence detectors to trigger flashes of light and colour as potential customers pass a shop window, drawing their attention and luring them inside the store, a feature most beneficial when people are unaware of its intention.

Passive Infrared (PIR)

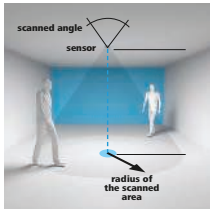
These sensors respond to the heat of passing people, which causes the sensor to communicate with the lighting to turn it on or increase the brightness. The scanning element of the sensor emits no radiation, which is why it is called a passive sensor. Suitable for use in both interior and exterior spaces, these sensors can be set with various levels of sensitivity according to their positioning, with mounting heights of up to 12 m.

In order that the sensors are not compromised is it important that they be installed at an adequate distance from heat sources, including the lighting fixtures they control, as well as air conditioning or heating systems. It is also important that the ambient temperature of the space is not too high so that there is an adequate difference between it and the temperature of passing people. Sensitivity is at its greatest if a person passes in front of the sensor, with reduced sensitivity if the person is walking directly towards it. Sensitivity is also impaired if people are wearing many clothes, reducing the amount of body heat emitted, and by large obstacles which again block or limit the sensing of heat.

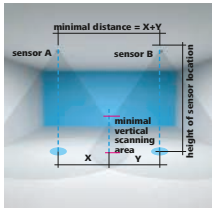
High Frequency (HF)

This type of sensor emits and receives a signal, based upon which it switches or dims the controlled lighting. Suitable also for use in interior and exterior spaces with large obstacles as the signal can pass through them, HF sensors are ideal for use in stores and spaces with complex interiors, and for storerooms and indoor parking areas. Not affected by ambient temperatures, and sensitive to even the smallest movements, these sensors are very effective. They do have the disadvantage of sometimes detecting irrelevant movement, so must be positioned and set very carefully by an experienced technician.

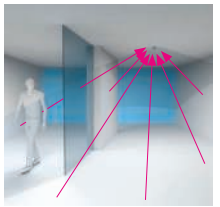
Both types of presence detection function most effectively when the scanning areas of individual sensors slightly overlap, ensuring there are no 'blind spots'.

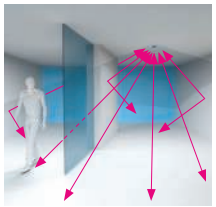


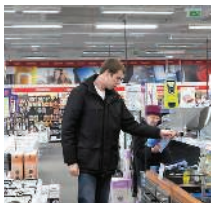
Depiction of the detection area

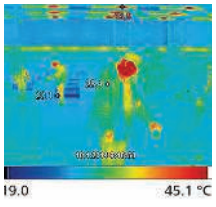


Suitable presence detectors movement sensors with partially overlapped scanning areas

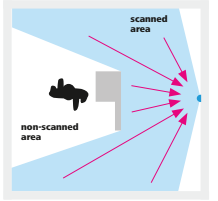




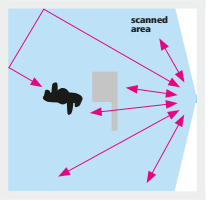

The scanned space



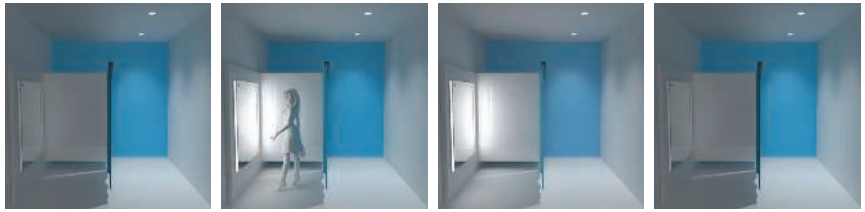
Infrared image of the scanned space

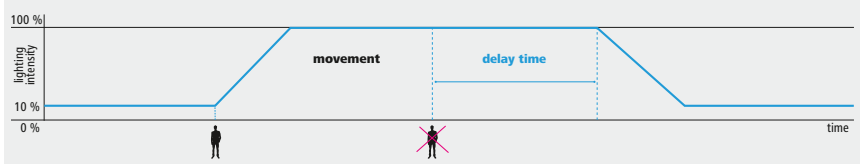


Scanning area of the passive infrared sensor (PIR)



Scanning area of the high-frequency movement sensor (HF)





Time procedure of presence detector - with delay

Switching and dimming

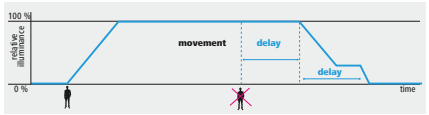
The simplest method of control is the switching of lighting within the space. However, 0 % and 100 % are not always the best options, and immediate switching is not recommended in many areas of application as it is visually disturbing as well as possibly impairing safety.

In many areas, it is necessary to maintain a safety level of illumination even when people are not present. This is certainly the case within retail environments where total darkness is practically and psychologically deterring to customers. Sensors can be set in such a way as to dim the lighting to, for example 10 %, rather than switching it off completely.

It is also appropriate in some cases to delay the switching off or dimming of the lighting so that people are not disturbed by darkness seemingly following them. This is also a safety feature as people can rapidly return to an area after leaving, in which case the lighting will still be as full illuminance.

Time procedure of presence detector - without delay

Time procedure of presence detector - without delay



Time procedure of presence detector - with double delay

LQS VALUE

Presence detector

Presence detector	LQS Value
Yes	1
No	0

When a space needs to evoke an emotional reaction, the used luminaires take on a new and unique architectural role

DAYLIGHT SENSOR

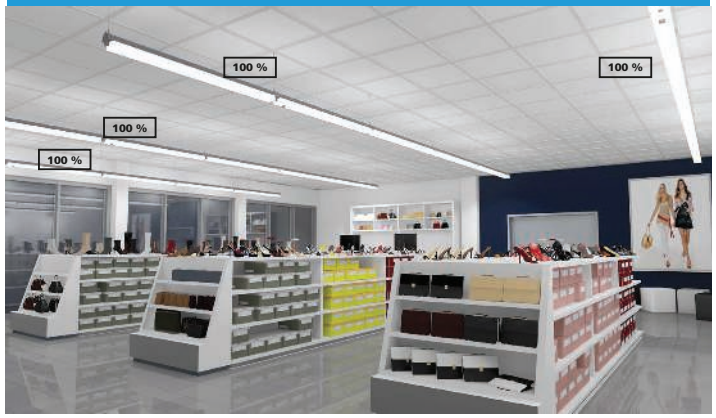
The basic functionality of these two sensors is to ensure a determined level of illumination, although both operate on very different principles. Daylight sensors adjust the level of illumination according to the amount of daylight available within a space, whereas constant illuminance sensors ensure that a set level of illumination is delivered throughout the entire lifetime of a lighting system.

Similarly to presence detectors, these sensors can be used independently or as part of a complex control system. The advantage of these sensors is that they make sure light is only provided where and in the quantity needed, never more, never less. This opens up a huge potential for energy savings, especially in stores with access to a large amount of daylight.

Daylight

There are two ways in which daylight sensors can be used: on the shop floor and in the shop window. Both uses guarantee energy savings as well as making the lighting far more visually comfortable for customers.

On the shop floor, daylight sensors are used to regulate the general lighting by reducing the amount of artificial light according to the daylight available. This is done by the system being set to provide a certain level of illumination, and if that is provided in part of in full by daylight, the artificial lighting can be dimmed or switched off. In many stores, there is in fact a great amount of daylight available, meaning that energy consumption can be reduced and significant savings made. However, no matter what changes occur, accent lighting must remain at full illuminance to ensure that the attracting, contrasting and modelling effect is maintained at all times.



If there is not sufficient daylight available (such as during evening hours) all luminaires automatically work at full luminous flux.

If the room has large windows and during the day there is sufficient daylight it is suitable to use cascade scanning to dim the luminaires. For maintaining a uniformity of lighting throughout the whole space the luminaires are automatically dimmed more at the windows.

In larger stores and supermarkets, where daylight cannot penetrate the full depth of the space, it is appropriate to use a cascade system. There are ways to calculate the general amounts of daylight to reach each point of a store from its source, be it a window or skylight, according to which particular dimmed levels of illumination can be set in each group of luminaires. Alternatively, more sensors can be used to control each group precisely.

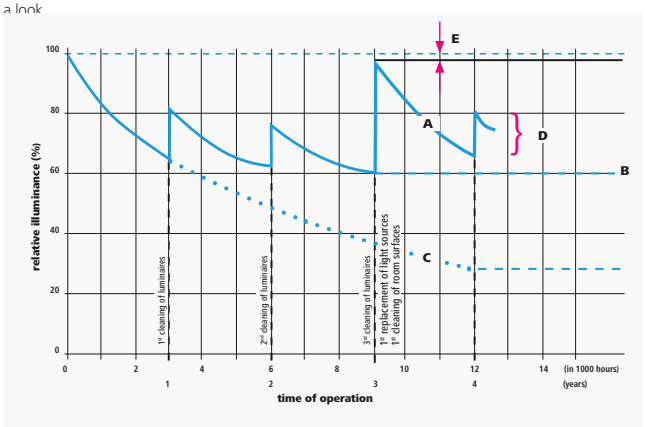
An added advantage of this type of control is that at no point will there be an excessive amount of light, which can be unpleasant for customers and employees alike, and increase the incidence of glare.

In shop windows, the same sensors have an opposite function. Here it is important to ensure that the window illumination is always brighter than outside. In the daytime this means that the lighting must be set at a high level, and at night it means that the lighting level can be reduced quite significantly whilst still guaranteeing the same effect. The function of the sensors is to measure the amount of daylight available and increase the illumination when there is bright sunlight, and reduce it when it is darker. This does not provide energy savings during the day when high brightness levels are needed, but the savings made by reduced energy consumption during the night are a strong motivating factor for retailers.

This also ensures that people passing the shop are never glared by overly bright shop windows, as is often the case at night. The level of illumination during the darker hours is attracting, provocative and interesting without being too intense and visually disturbing. This visual comfort means that passers-by will not turn away from glaring window displays but rather move closer to take a look.

CONSTANT ILLUMINANCE SENSOR

During the lifetime of a lighting system, it is natural that the level of illumination provided decreases. This is the case regardless of the type of light source used and due to the ageing and dirtying of optical parts and lamps. However, it is possible to incorporate into an LMS the constant illuminance function, which maintains a defined level of illumination throughout the entire lifetime of the system. This is achieved by over-dimensioning the system at the design stage, deliberately choosing luminaires that can provide higher than required levels of light. The sensors act to regulate the illumination, at the beginning of the system's life by reducing the amount of light emitted, and towards the end of the system's life by increasing the illumination. The sensors constantly monitor the system and make minute changes according to need, meaning that retailers can rely on their lighting system to provide the required light at all times without need for intervention. At first sight the idea of over-dimensioning a system would suggest increased energy consumption, but this is not the case as the system will not provide 100 % output for most of its life. Constant illuminance sensors work perfectly with daylight sensors, together providing considerable savings in energy.



Illumination changes during the life of the lighting system
A – maintained lighting system curve
B – maintained value – maintenance factor
C – unmaintained lighting system curve
D – benefits of cleaning luminaires at regular intervals
E – irreversible loss caused by ageing of luminaire materials

LQS VALUE

Daylight sensor

Daylight sensor	LQS Value
Yes	2
No	0

LQS VALUE

Constant illuminance sensor

Constance illuminance sensor	LQS Value
Yes	1
No	0

CALLING OF LIGHTING SCENES

One of the most useful methods of complex control is to use pre-defined 'lighting scenes'. Each scene has its own unique combination of lighting parameters such as brightness, colour temperature, RGB colour and ambient lighting, which can be activated across one luminaire group, several groups at once, or a whole system. Scenes can be selected manually via computer, smart device, touch panel or switch, or implemented automatically based on time and date settings.

This type of control is perfectly suited to retail application as it allows for easy and fast changing of lighting parameters, from the simple adjustment of brightness levels to the complex setting of individual groups of luminaires and colours. Lighting scenes can also be used for dynamic lighting, allowing for the autonomous changing between various parameters over a period of time. This means that the lighting can be adapted precisely to the needs of any given time, to influence the mood and behaviour of customers.

Control devices such as wall switches, touch panels and computer-based applications mean that store, supermarket and shopping mall employees can very easily change settings at the touch of a button. For example, employees can select the lighting scene defined for a specific type of food presentation. They do not need to understand the lighting needs and be able to set the parameters, they only need to push the correct button. This removes the possibility of human error based on lack of lighting knowledge.

Lighting scene control is just as beneficial in a dynamic boutique as in a multi-storey shopping mall, as the LMS can be designed in such a way as to regulate even the most complex and sizable lighting system.
There are various protocols used to control lighting scenes. The protocol and control devices chosen depend entirely on the type of lighting, the needs of retailers and users, and the type of space. Lighting designers fully understand the advantages of each protocol and can advise you as to which will suit your needs best. The two most commonly used protocols are DALI and DMX.

Morning lighting scene: Payment counter 100 %, promotion display lighting 100 %, accent lighting 100 %, general lighting 100 %. All lighting elements function at 100 % luminous output. The brightness is activating and stimulating to customers who are only just starting their day.

Lunchtime lighting scene: Payment counter 100 %, promotion display lighting 100 %, accent lighting 100 %, general lighting 100 %. Again, all elements of the lighting design function at 100 % luminous output. This motivates and energises customers after a long morning and stimulates purchasing behaviour.

Nightime lighting scene: Payment counter 0 %, promotion display lighting 20 %, accent lighting 50 %, general lighting 0 %. Here some elements are totally switched off and others function at a reduced luminous output. This attracts attention to important areas within the store for passers-by who look in through the window, but does not over-illuminate or waste energy by illuminating unnecessary areas.

DALI

DALI (Digital Addressable Lighting Interface) enables the control of complex lighting systems using two-way communication between the controlling and controlled devices, in most cases a touch panel or computer and DALI compatible luminaires. Various control devices can be used, from simple wall push buttons, through customised touch panels, to complex computer based applications. Additionally, various peripheral devices can be controlled, including blinds and air conditioning units.
Each DALI bus enables the control of 64 devices, dividable into 16 groups. It is possible to combine several DALI buses to create a large system. Each device can be controlled independently as each has its own address. Furthermore, the fact that DALI uses two-way communication means that each component of the lighting system can be monitored, with statuses, faults and failures immediately reported to the user.

DMX

DMX (Digital Multiplex Transmission Standard for Dimmers and Controllers) allows for multi-channel digital control along one control phase. Communication to all controlled devices happens simultaneously meaning that the requested changes in lighting parameters are almost immediate. This makes DMX perfect for RGB and dynamic lighting.
All controlling and controlled devices are individually addressable allowing for the independent control of each simultaneously, although several components can be addressed in the same way allowing them to act as one group. DMX communication is only one way, so although fast, information can only be sent or received at any one time making this protocol less suitable for lighting systems that require monitoring.

Remote control

In this case remote control does not refer to a handheld radio control device, but rather the control of a complex lighting system via the internet, allowing retailers and users to control and monitor their lighting systems from anywhere in a building, and even anywhere in the world. This type of control is not dependent on the protocol used, but rather on the computer software used and its programming.

Additional features

Remote system monitoring
As already mentioned, remote control allows for the monitoring of a lighting system from anywhere with an internet connection. This may initially seem like an excessive and unnecessary solution; however, it can be very useful, informing retailers and users of the real-time energy consumption and state of their lighting system. The ability to modify lighting scenes, predefined parameters and settings also means that the moderator of a lighting system can be in full control at all times.

RFID control
This is an old technology with a new application. RFID tags are commonly used as theft-deterrents in retail, raising an alarm if goods are removed from the store premises without being paid for. However, a great deal of research and development is happening in this area. It is possible to use the anti-theft tags attached to items of clothing to also activate the lighting in fitting rooms. Another new lighting trend is to programme the tags on each type of clothing with specific information, meaning that each item of clothing will set the fitting room lighting to its needs. For example, an evening gown will have a tag that tells the light to have a warm colour temperature and a lower brightness level, and a swimsuit will communicate that it wants cool bright light. The potential is immense as RFID tags can be fully programmed and are very small making them extremely versatile. We anticipate that the application of this technology will only grow in future.

LQS VALUE

Calling of lighting scenes	
Calling of lighting scenes	LQS Value
Yes	1
No	0

ESPRIT

Esprit is about making the ordinary into something extraordinary, about a sense of grace, humour and the ability to surprise, enriching our lives by bringing an element of the unfamiliar to our everyday environments. This is something our designers know very well. They consciously push the boundaries of design when creating new luminaires, scorning stereotypes in favour of pure imagination. The result is a range of luminaires perfect for use in a wide range of spaces.

When a space needs to evoke an emotional reaction, the used luminaires take on a new and unique architectural role, sometimes by their extravagance and other times by their restraint. No other area of application provides the same possibilities for expression as retail. Functionality ceases to be the sole criteria as it is joined in equal part by originality and innovation.

LSE has responded to the diversity of customer and solution requirements by establishing an in-house design department within Research and Development, where experienced and talented product designers work in collaboration with technical specialist to put new luminaires and technologies into the hands of customers. The result is a collection of unique and highly effective luminaires with a futuristic soul, fixtures with the ability to infuse a space with a breath of fresh air. Our use of various high quality materials, combined with wide-ranging technical experience, allows us to develop truly special products, all of which can be tailored specifically to any customer need.

There are no quantifiable criteria within the LQS for evaluating esprit as it is a highly subjective topic, however, there are several important elements we urge customers to consider in order that they make the most informed, and ultimately satisfying choice, about which luminaires to use. Firstly, consider the overall impression the luminaire and its intricacies make, what is the immediate and longer-term emotional response; like a fine perfume, there are the details that attract immediately, and the subtleties that linger. Secondly, how does the luminaire fit into the space, both in terms of presence and how it ties in with or complements the interior design; it can be a refined addition to the space, or a statement piece. Thirdly, the surface finish, which is a fundamental part of our reaction to its presence; does it evoke the desired feelings and communicate the right qualities. Fourthly, consider the materials used and the luminaire's functionality, as these aspects determine not only the practicality of the item, but also its value to the customer; everyone wants something that perfectly fits their needs without compromise on quality.

ZOOM TRACK

by Anton Zetocha

Perfect accent lighting is a tricky business, as each item requires illumination that little bit different. ZOOM TRACK is truly innovative in terms of both concept and technological innovation. Besides the attractive and modern shape, the star element is that the beam angle can be very simply tuned between 12° and 40° by twisting an adjustment ring. This unique feature is possible thanks to a cleverly designed liquid filled 'pocket' that forms into a spherical shaped lens under pressure. Twisting the adjustment ring changes the amount of pressure on the pocket and therefore the beam angle. Now you really can create the perfect light, not limited by set beam angles and fixed reflectors.

EXCEPTIONALITY

SLE's ambition is to create smart lighting solutions that bring added value and wellbeing to our lives in addition to showing respect for the environment. To this end we act as a lighting solutions project platform, focused on connecting everyone involved in lighting in mutually beneficial collaboration under the umbrella of SLEs knowledge, tools and services. In this way, each participant can contribute their unique skill set towards a cooperative final solution of higher value and quality than could be achieved alone.

This chain of value is what sets SLE projects apart, acting as a simple and reliable framework upon which our partners can stand with confidence. Furthermore, we understand that a successful business strategy must be customer focused, and SLE's support enables partners to be just that, because we have the rest covered.

WHAT SETS IS APART

Our partners can come to us for exclusive products, full solution packages, comprehensive yet simple sales support and cutting-edge information, which together help us achieve the collective goal of putting the future of lighting into practice now to provide a better future and achieve business success.

Exclusive products

Our distinctive product portfolio offers cutting-edge products that cannot be found anywhere else and which are guaranteed to perfectly integrate with every solution we provide. And as each product it designed for specific applications, our partners can rely on finding the best fit for every lighting design and project. Furthermore, with the possibility of product customisation, both partners and customers are assured that every solution is truly specialised and therefore unique and worry-free.

Complete solution packages

Lighting can be complicated, especially considering the influx of new technologies, terminology and possibilities. This creates stress for both customers, who do not understand their possibilities, and lighting professionals who must navigate a myriad of options to find the best solution. With this in mind, we offer a range of complete 'ready-made' solutions for every application, to keep things simple for everyone but never at the expense of quality or suitability. Each solution includes everything needed for the implementation and completion of each project and even comes with added benefits.

Moreover, as each solution is provided as a whole, full compatibility of all components is guaranteed, and the entire system falls under one straightforward warranty. To help partners communicate these solutions, we provide understandable and transparent information that makes it very easy for customers to grasp the options and make an informed choice. In this way, lighting suddenly becomes very simple.

Each complete solution package contains:

- Lighting services
  - Lighting audit
  - Luminaire selection
  - Definition of illumination
  - Lighting calculation
  - TCO calculation
  - Standard wiring design
  - Lighting measurement
  - Energy measurement
  - Customer presentation
- Luminaires
  - Dimmable LED luminaires
  - Luminaire package and transport
- Support
  - Transport
  - Lighting installation
  - LMS adjustment
  - LMS training
  - Electrical installation approval
  - Recycling of old lighting installation materials

We tailor our services and support to current and future market needs, thereby increasing the effectiveness of every link in the value chain, from supply to end use.

LIGHTING SOLUTION

PROJECT PLANNING	GLOBAL PROJECT REALISATION	AFTER SALES SUPPORT

GLOBAL PROJECT NETWORK

SUPPLIERS	ARCHITECTS	LIGHTING DESIGNERS	PROJECT COMPANIES	BRANDS

EXCLUSIVE PRODUCT PORTFOLIO	OFFER & DELVERY OF COMPLETE LIGHTING SOLUTIONS	TECHNICAL SUPPORT	SALES SUPPORT	PROMOTION
Best fit according to application & lighting design	Excellent cost overview & control	Lighting services	Flexibility & time to market	Professional marketing materials
Customisations	Less beaurocracy	Lighting tools	Complete business package	Significant brand awareness of project participants
Project protection	Simplicity of sale, installation & use	Education & training in solution & trends	Acquisition support	
	Compatibility guaranteed			
	System warranty			

Sales support

Our partners' realisation is at the heart of our interests, which is why almost everything in the SLE value chain is useful for those on the front line. From technical support tools through product information to marketing materials and project promotion, we provide everything needed to achieve sales success. And once a sale has been made, we will also help with acquisition and financing, giving customers a name they can trust in and taking the extra load off our partners. With such a complete business package, our partners will never be short of help in attracting and building a firm and long-term relationship with customers.

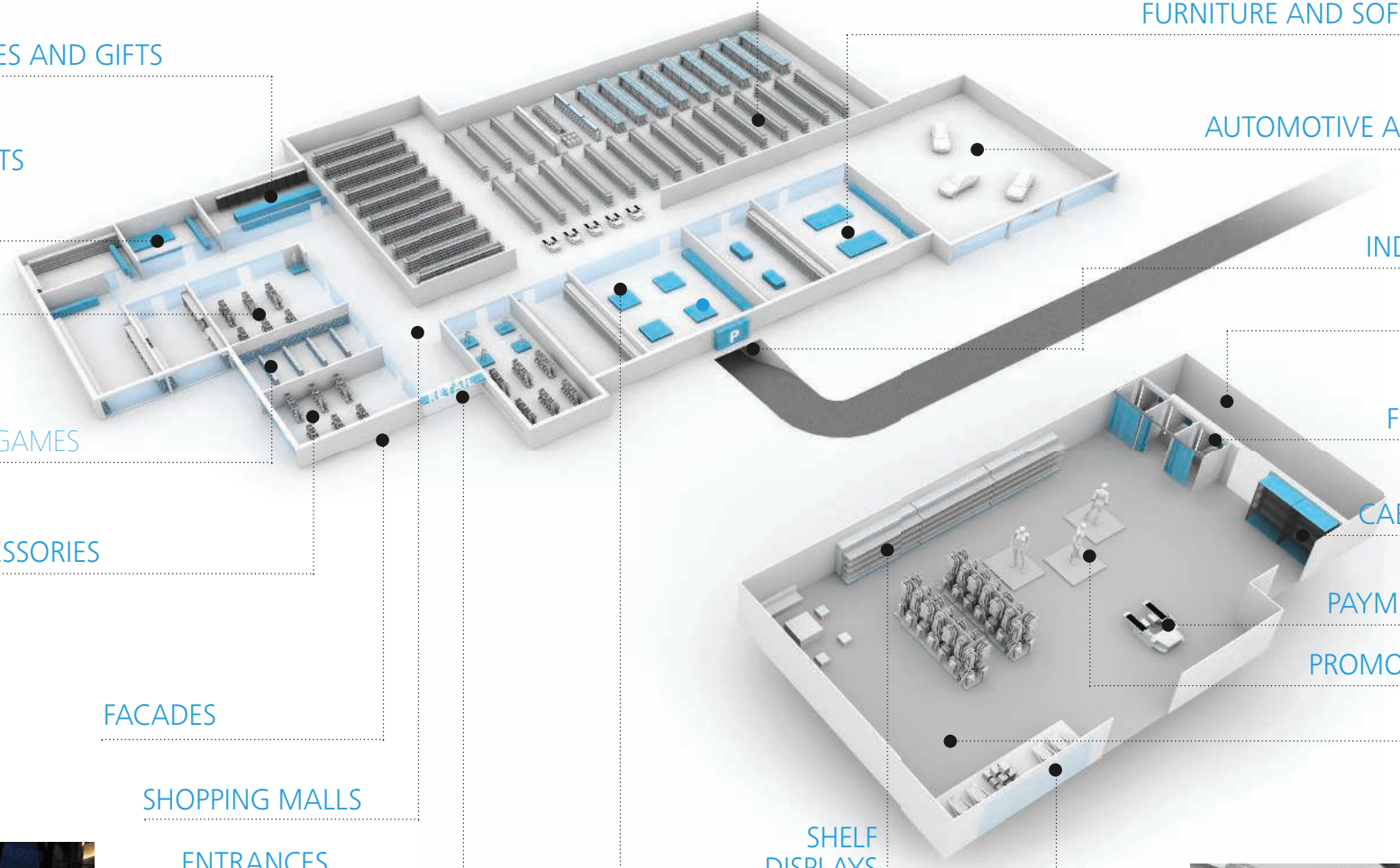
Technical support

We have created a framework of clear and accessible knowledge, practical and theory-based support, and insights into the development of lighting through research. To achieve this, we eagerly follow the trends that are driving technological and ecological development in the global market and apply them to lighting and its influence on both humans and the environment. This knowledge is implemented both through our own lighting services and in the development of a number of specialised proprietary supportive tools for all involved in sales, project planning and implementation. These tools include the Lighting Quality Standard, described earlier in this publication, and its associated software tools LQS Composer and LQS Composer PRO, in addition to LIACS, Saving in 5 and the Right Light books, one of which you are reading right now. For more information about these tools and how they can help you, visit the SLE website.

Promotion

It is no fun doing the work and never getting any credit, which is often the case for the individuals and small companies involved in the provision of lighting solutions. We believe that everyone involved in a project should be given due recognition. All partners involved in our projects are included in related promotion. This strengthens both the presence of truly skilled professionals on the global lighting scene and the network of support and collaboration that will drive the success of all.

LIGHTING
IN THE RETAIL & PRESENTATION



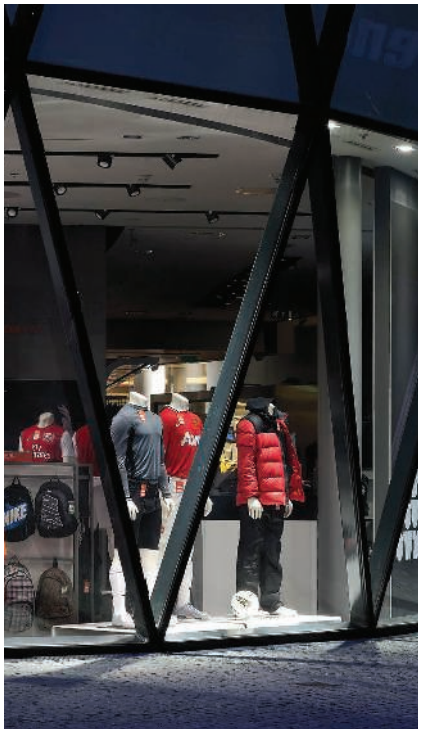
OMS

Shop windows are the most important tool to attract customers and entice them to enter the store

SHOP WINDOWS

A visually inspiring shop window display is one of the most powerful tools by which to make your store stand out from the many other elements in the environment fighting for attention. It must capture the curiosity and interest of those passing by. Lighting has a direct influence over the behavior and perception of potential customers and is used to evoke an emotional response, inciting them to imagine themselves with the displayed merchandise, and enticing them to enter the store and explore further.

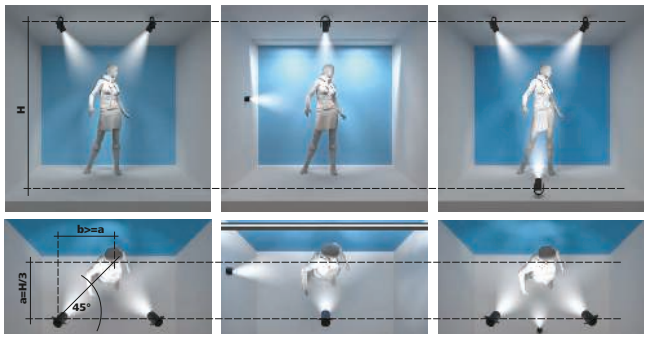
Contrast is vital for object modelling and the perception of depth. A minimal contrast ratio of 3:1 between displayed objects and the background is necessary (the illumination of the displayed object is three times brighter than that of the background). Higher contrasts are acceptable with a maximum advisable ratio of 15:1, at which level the object is 'swallowed' by the light and the form lost. To achieve optimal contrast accent lighting must be provided in narrow beam angles of 8°, 24°, 40° and 60°, with the chosen angle depending very much on the distance of the lighting fixture from the object to be illuminated, and the kind of accentuation needed. The modelling of objects is based on the varying sensitivity of the human eye to light at different angles so it is important to use a combination of upward, downward and side illumination.



Imaginative lighting design undoubtedly attracts, with research into the use of dynamic lighting showing it to be far more effective at catching the eye than static lighting. Dynamic lighting covers several effects, and the unlimited variability means that each lighting solution can be perfectly tailored to each application. The first step is to create continuous changes in light distribution, for example by moving the light from left to right within the display space, thereby creating a feeling of movement. Additional effects include the use of varying levels of brightness to visually stimulate, the use of RGBW to bring colours to life, and various white light colour temperatures to create atmosphere. All of these effects can be used to guide the customer's perception, allowing you to present a story. Such dynamic lighting solutions are now very easy to control using devices ranging from touch panels to smart phones, all of which can be programmed with lighting scenes according to each customer's ideas. However, care must be taken as often what instantly attracts can just as quickly deter, it is therefore vital to find a balance between stimulation and distraction.

Stores continually update merchandise and displays, meaning that shop window lighting must be highly flexible and adaptable. For this purpose, adjustable track lighting fixtures are ideal, allowing individual fixtures to be tilted and rotated to precisely illuminate regardless of changes in requirements. In addition, many track lighting fixtures have exchangeable reflectors enabling the very simple changing of beam angles according to need. It is also highly beneficial to be able to change the colour temperature of the light used depending on the kind of display and the season.

Shop window lighting uses a lot of energy; however, the incorporation of a Lighting Management System into the solution can significantly decrease consumption. The use of daylight sensors alone can decrease consumption by up to 30 %. The functionality of daylight sensors is opposite to what is commonly expected: in order to maintain optimal contrast it is necessary to account for changes in exterior lighting levels, with bright sunlight demanding higher levels of accent illumination rather than a generally lower level of illumination. However, during times with lower light levels all display lighting can be dimmed, which not only limits the unpleasant glare of over-illuminated windows, but also provides a reduction in energy consumption. This functionality we recommend only for stores with street-facing shop windows, not for stores within shopping centres that are not affected by changes in natural lighting.



Basic shop window lighting design
Two spotlights are positioned above the object, one on the left and one on the right, rotated inwards 45°.

Advanced shop window lighting design
One spotlight is positioned above the object with an additional spotlight positioned on the left side of the object (if the object is a figure the side spotlight will be positioned at two thirds of the height of the figure). An RGBW wall washer is located above the object and used to illuminate the back surface of the display space.

Dramatic shop window lighting
Two spotlights are positioned above the object, one on the left and one on the right. An additional spotlight is placed below the figure (at floor level).

Dynamic lighting scene
Based on the Dramatic shop window lighting design. The dynamic effect will continuously simulate the movement of the sun. The spotlight positioned above the object to the left will have a cyclical change of brightness level 10–100–10 %. This creates a very theatrical effect.

SLE offers an additional way in which to simplify the installation and control of a shop window lighting solution, and to reduce energy consumption. The CPS system centralises safe 48 V DC power supply for all track lighting fixtures, providing the option for system-, DALI- or 1–10 V-based control of brightness levels. Levels are stored, recalled and set with the simple touch of a button (depending on the specific type of control used), enabling pre-defined brightness parameters to be easily followed by all staff, and ensuring easy adaptation to any necessary changes. Another advantage of using the CPS system is that initial installation costs are reduced as the light fixtures do not require individual LED drivers and the wiring infrastructure is very simple.

ENTRANCES

It is good to think of a store's entrance as its business card. The shop window is there to attract potential customers, but the entrance is the first step of the journey into the store. It is vital that the entrance design is closely related to the facade design, and also the design and style of shop window displays. By having unity (not uniformity) across all exterior design elements a store can project a strong and convincing image, enhancing the brand and, if appropriate, the architectural features of the building. However, care must be taken that the entrance does not disturb a customer's behaviour and movement into the store.

The primary goal of entrance lighting is to provide a welcoming impression and influence the decision to enter. Studies have shown that brightness automatically attracts and that differences in illumination levels can be used to guide the movement of customers. The lighting must stand out from that of the surrounding area, with increased brightness at both the opening of the store and extending in front, acting as a beacon towards which people are automatically drawn. Entrance lighting must also enable safe orientation. A high level of vertical illumination provided by asymmetric lighting fixtures ensures comfortable and easy navigation of the entrance space.

The entrance acts as a gateway to another world, the retail world

Another way by which to catch the attention of potential customers is to use dynamic lighting, for example by using an RGB projector to highlight part of the entrance, or the area in front (1). This added visual stimulus will pull the eye towards the store and its displays. Lastly, but no less important, is the illumination of the store logo. Customers remember stores by their brand identity, a large part of which is the name and logo. There are two main ways in which to effectively illuminate a logo so that it cannot be overlooked. Firstly, by using special projectors that brightly illuminate the logo, making it stand out from the background and catch the eye (2). This illumination can be both white or coloured. The second way is with backlighting, making the logo look like it is glowing, floating away from the surface (3). Which option is chosen depends very much on the kind of store, and the logo itself.

Using wide beam angle luminaires ensures safe and attracting illumination of vertical surfaces.

By creating high contrast between the brightly illuminated logo and the background, passers-by are sure to see and be drawn to the store entrance

Back-lit logos are stylish and seem to float in space, creating a visually interesting focal point to which potential customers are attracted.

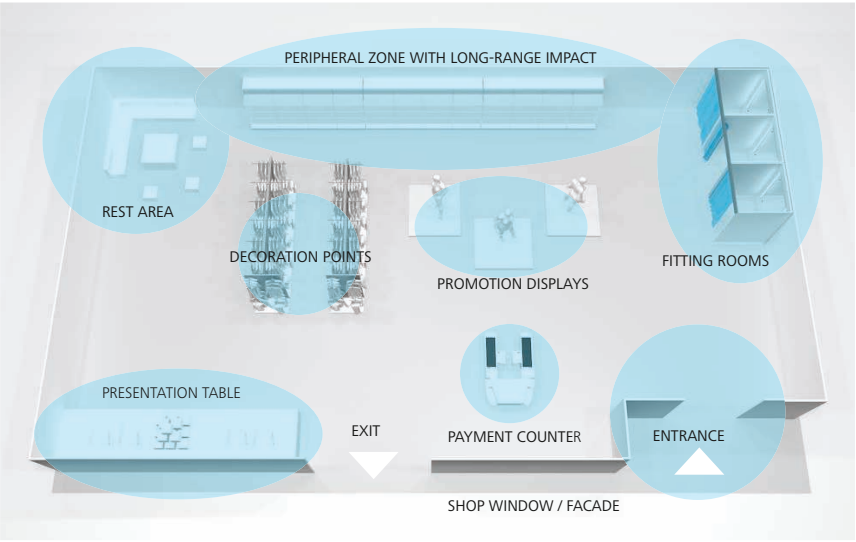
SALES FLOORS

Once a customer passes through the entrance to a store, they are entering a different world. Sales floor lighting, the general lighting of a store, should be tailored to the identity and style of the brand to reinforce its image, as well as serving to aid navigation. A clever lighting design can also positively influence mood, thereby increasing sales.

There are three rules to follow when it comes to this important but often underestimated aspect of a store's lighting design. The first rule is directly connected to the primary function of navigation. Studies prove that light can be used to guide people around a space, as we automatically move towards brightness, in particular to brightly illuminated vertical surfaces. By harnessing the power of this behavioural characteristic, the lighting design of a store can literally direct customers, taking them on a predefined journey through the entire space and ensuring that they see all displayed merchandise. This maximises the chances of a customer making a purchase.

Secondly, all elements of a store's lighting design must be flexible. Merchandise changes continuously, sometimes leading also to changes in layout. It is vital that the general lighting be fully adaptable to these changes in the simplest way possible. For this reason, we recommend the use of fully adjustable lighting fixtures such as track mounted, ceiling surfaced and recessed spotlights. Such lighting fixtures can be used for both accent and general illumination, which further broadens the possibilities.

The third rule is to be ready for changing seasons and themes, for example the change from summer to autumn merchandise. This demands the use of varied lighting parameters, especially colour temperature. The easiest way to be prepared for such changes is to use TunableWhite fixtures, which are fully adaptable as they provide white light that ranges from cool through neutral to warm, meaning that the light can be adapted precisely to the merchandise on display, showing each item to its highest advantage. In some circumstances, it is beneficial to combine cooler and warmer light at the same time, for example, displaying wooden furniture under warm glowing light, and glass under cool crisp light. Another use of varied light colour temperatures is to simulate daylight within a store that has no access to natural light. This solution uses large ceiling mounted LED lighting fixtures which allow for TunableWhite functionality and changes in lighting intensity, using LEDs with colour temperatures of 2700 K and 6500 K combined with highly diffusing optical materials. Such fixtures provide similar properties to daylight and positively affect mood and perception.



General lighting ensures the safe and comfortable navigation of the space

General lighting is the biggest consumer of energy within a store's lighting system, therefore providing the greatest potential for saving. Stores are often over-illuminated, with levels ranging from 300 lux up to 5000 lux. If a store has access to daylight, it is highly beneficial to incorporate daylight sensors which can provide savings of up to 40% by dimming general lighting according to the amount of daylight entering the store through windows, while the accent lighting remains at the same level, ensuring that optimal levels of contrast are always maintained.


MaxMara

SHELF DISPLAYS

In all types of store the majority of products are displayed on shelves or in ways that require similar lighting properties, such as clothes hung on rails. Therefore, shelf lighting is a vital component of a store's illumination, something which cannot be provided exclusively by general lighting, so specialist lighting fixtures are needed to prevent visual monotony and the associated loss of acuity, and to draw customer attention exactly where needed.

When designing this crucial aspect of the lighting system it is important to understand that everything centres on the perception of the human eye, which is most sensitive to vertical illumination, especially in the area directly in front and down to an angle of about 45°. Illumination that takes advantage of this inherent visual characteristic will positively affect customer behaviour. It is also important to use an ideal ratio between vertical and horizontal illumination, generally accepted to be a minimum of 2:1. What this means in practice is that if a floor is illuminated with 500 lux the shelves and vertical displays must be illuminated with at least 1000 lux. It is also recommended that similar lighting properties be used for similar products to facilitate easier comparison.

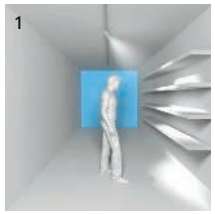
Higher levels of vertical illumination make sure that customers look exactly where you want them to

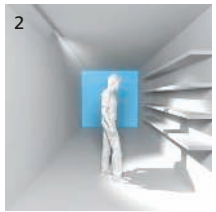
When designing the lighting system it is essential to identify what exactly must be illuminated at each location and tailor the light specifically. Shelf lighting can be broadly categorised into three types: general, accent and wallwasher. General lighting is most often provided by continuous line mounted linear fixtures positioned centrally over aisles to illuminate shelves on either side. Here it is necessary to direct the light to minimise shadows. It is also beneficial at times to use track systems as they allow for the combination of general lighting linear and accent lighting spotlight fixtures. Wallwashers provide something between general and accent lighting, suitable for spaces where more focused general illumination is needed.

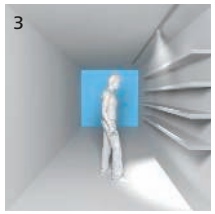
There are also various light source parameters that can significantly impact on the display of goods. Good colour rendition is important to highlight colours and make objects and displays attractive to browsing customers. Light colour temperature is also a vital consideration, with TunableWhite lighting fixtures being fully adaptable to changes in display. And lastly, but no less important, attention must be paid to the amount of IR and UV radiation produced by light sources, both of which can have damaging effects on many products, from food to delicate textiles. This is especially important where lighting fixtures are directly incorporated into the shelving or display units, as they are in very close proximity to goods.

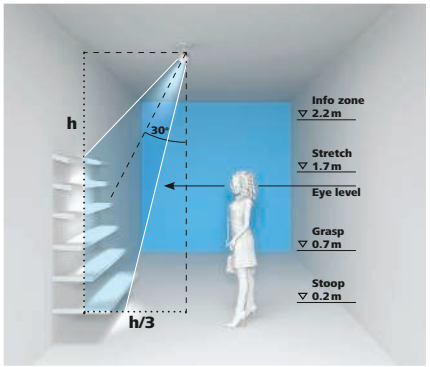
Accent lighting
Accent lighting is best provided by narrow beam angle adjustable downlights and spotlights that highlight specific objects.

Vertical illumination
To ensure the effective vertical illumination of shelves we use the same rule as with accent lighting, that the lighting fixture is positioned one third of the room height away from the display (H/3), and vertically rotated by 30° towards it (1). If lighting fixtures are too far from the shelf display the illumination will be partially blocked by the browsing customer (2), causing shadows. On the other hand, if the fixtures are located too close the shelf display the top shelf will be illuminated, but all shelves below will be in shadow (3).





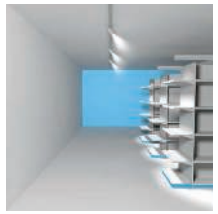




Track mounted spotlights
Track mounted spotlights are incredibly flexible, allowing for the simple and quick adaptation of the lighting to changes in display. Various additional features include exchangeable reflectors so that beam angles can be easily modified, the use of coloured filters for dramatic lighting, and TunableWhite functionality, which means one lighting fixture can adapt to changes in season, product and theme.

Recessed spotlights
Recessed spotlights have the advantage of being hidden away in the ceiling, for a clearer interior design. They can be extended, retracted and rotated meaning they can adapt to changes in display with ease. Some versions have exchangeable reflectors and the option to use coloured filters also.

Wallwashers
Wallwashers have much broader beam angles than spotlights, yet have the same flexibility. This allows for simple adaptation to changes in display, whilst providing a large enough asymmetric light distribution to illuminate a whole wall, shelf display or rail. Recessed and track versions are available, fitting in with the kind of solution design that best suits the store's needs.



End-of-shelf displays
End-of-shelf displays, sometimes referred to as gondola heads, are the ideal place to position particularly noteworthy goods such as those on special offer. For these areas, it is important to use additional accent lighting and to increase general illumination to a higher level than used for aisle displays, which guides customers up and down aisles towards the brightness, past all displayed merchandise and boosting sales.

LED light sources are so small that they can be hidden within a cabinet display, providing perfect illumination and minimising glare

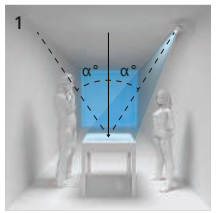
CABINET DISPLAYS

Cabinet lighting is the illumination of any kind of display cabinet, from the locked and secure glass cabinets used to display jewellery and gifts in a department store, to the open fronted refrigeration cabinets used to display chilled items in a supermarket. The clever lighting of items in cabinets brings out their detail and character, highlighting the sparkle of gems and metals, or giving the colours of chilled vegetables a freshness that is hard to resist.

The first type of solution for such lighting involves the use of a ceiling mounted spotlights to accent light the display (1). However, it has many drawbacks, the main one being the undesirable glare created by the light being reflected off the glass surface. For example, if a spotlight fixture shines onto a horizontal glass shelf at an angle of 30°, the reflection will shine up at the same angle into the eyes of any customer looking at the display from the opposite side. This is not only unpleasant, but also hazardous for the eyes as the glare is at a very high level.

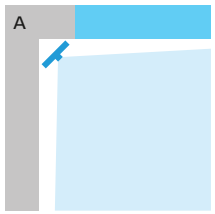
The use of low-glare LED lighting fixtures provides the perfect resolution of this issue (2). Due to their small dimensions, LED strip luminaires can be installed directly at the upper edge of display cabinets (A) or under the edge of shelves to illuminate items on the shelf below (B), making the light source and its reflections almost invisible to customers and providing uniform illumination. Another advantage, besides the light source being positioned in such a way as to practically eliminate glare, is their close proximity to the displayed items. This allows lower power fixtures to be used, which saves a lot of energy when compared to the traditionally used illumination methods. In the past, this was not possible as light sources emitted a lot of heat, which could damage products, but LED light sources emit negligible amounts of heat and can be positioned close to even sensitive items such as foodstuffs.

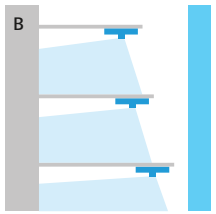
Such illumination is also perfect for providing optimal contrast ratios, making the cabinet display stand out from the background, and highlighting items. One common issue with cabinet lighting is over-illumination, which must be avoided as it is disturbing rather than attractive for customers.



A lighting design that uses a narrow beam angle spotlight for accent lighting. Glaring reflections are a big problem with this solution, and must be taken into account in the design and layout of the display and its illumination.

A lighting design that uses low-glare LED strip luminaires that are hidden around the edge of the display cabinet, making them and their reflections almost invisible to customers. This also provides a much better uniformity of illumination.





By positioning LED strip luminaires on the lower edge of shelves, all shelves are optimally illuminated. LED light sources are perfect for this because they emit negligible amounts of heat, allowing them to be positioned very close to even fragile items.

Payment counters are workspaces, therefore the lighting must be designed to provide perfect working conditions

PAYMENT COUNTERS

The payment counter is the last step in any shopping experience and therefore also the last opportunity a store has to make a lasting impression on a customer. This final impression is vital and can be influenced in several ways. The first and most obvious factor is that the payment counter must be easily recognisable so that customers can navigate to it effortlessly from anywhere within the store. The simplest way to do this is to play with visual perception by using increased levels of brightness, to make the area around the counter stand out. This brightness could be created using unique or statement luminaires that also add a memorable aesthetic element to the area.

However, the payment counter is also a workplace, and as such the visual and psychological needs of sales personnel must be of primary focus. People work at payment counters for many hours and they handle a lot of money where there is no room for mistakes. Such work demands much of the lighting. **Standards require a minimum illumination of 500 lux** for task areas, and a **lighting uniformity of 0.6.** It is also crucial in these areas to minimise glare and its associated visual discomfort and loss of acuity, with a maximum acceptable **UGR of 19**.

A boutique style payment counter using statement suspended luminaires to highlight and illuminate the counter, and accent lighting spotlights to provide suitable vertical illumination of the display behind.

In larger stores such as supermarkets where check-outs are located next to each other, it is beneficial to use continuous line lighting to ensure sufficient levels of illumination with minimal glare.

Payment counters are also places where small 'final' products can be displayed, from the tasty treats offered at a supermarket check-out to the accessories displayed behind a payment counter in a boutique. Such displays require vertical illumination similar to that used elsewhere is the store and should not distract from the sales point, something achieved very simply by ensuring that the illumination of the payment counter is higher than the vertical illumination of the nearby display.

FITTING ROOMS

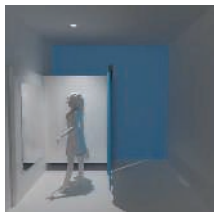
Fitting rooms are key spaces within a store, where customers makes the decision to buy or not. As a result it is crucial that the best lighting be provided that ensures the customer looks at their best when trying products.

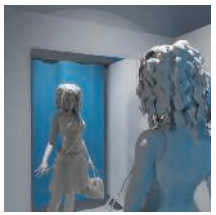
The most effective way to show a customer at their best is by using linear lighting fixtures down the length of both sides of the mirror. The illumination must be soft and diffused to avoid any glaring or harsh shadows and must flatter the skin. This kind of solution illuminates the front of the customer so that their reflection is representative of how they would look in their normal environment. It is not advisable to use lighting fixtures positioned above the customer as it creates a hard contrast between light and shadow, highlighting wrinkles, skin impurities and the undesirable 'lumps and bumps' we all have. Such illumination also makes vertical surfaces negatively contrast with the surroundings in the fitting room, distorting how the customer looks and having a profoundly negative impact on their impression of the goods, and themselves.

Fitting rooms are the spaces where purchasing decisions are made, so we must make sure everyone looks at their best

Here the lighting design uses linear lighting fixtures to provide soft diffused light down both sides of the mirrors, ensuring that the customer looks natural in an outfit.

This image shows why it is beneficial to use soft diffusing linear lighting fixtures down either side of the mirror, which minimises harsh shadows and provides more realistic modelling of the customer.





This image shows the negative effects caused by using lighting from above in a fitting room. Notice the harsh shadows and unrealistic modelling of the customer.

A vital aspect of fitting room lighting is colour rendition. In order to give customers the truest and best view of the goods they are trying, the colours must be rendered as close to perfect as possible. **For this it is recommended to use light sources with at least CRI ≥ 90, which to the human eye is very near the colour rendering of daylight.**

Fitting rooms are a perfect place for using energy saving features such a presence detection, so that lighting is only used when customers are in the spaces. This can provide quite considerable savings potential in combination with the obvious saving potential of using LED lighting fixtures.

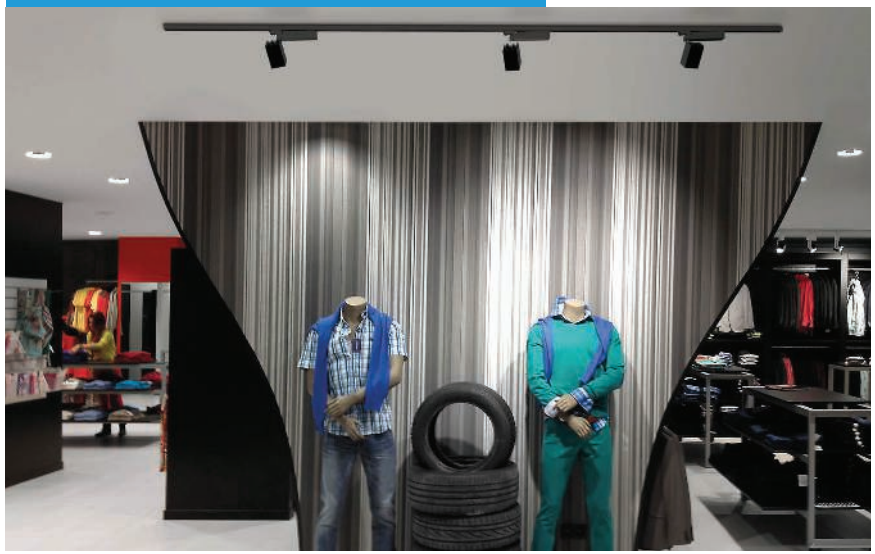
PROMOTION DISPLAYS

Promotion displays are objects such as mannequins, sculptures and statues that are used to highlight certain products, for example the items that make up an outfit. These objects demand special attention and are a fundamental tool for emphasising key pieces, trends and new merchandise. It is important to use the perfect lighting for promotion displays, to create interest and drama which inspires the imagination of customers and positively effects their perception of the store and its products.

Typically such displays are illuminated using accent lighting which is ideal for creating vivid contrasts between light and shadow and for the modelling of objects and highlighting of textures, and also to make the display stand out from its surroundings with higher levels of brightness. **Here it is appropriate to use the same rule as for any accent lighting, that the lighting fixtures are positioned at one third of the room height from the object being illuminated (H/3). It is necessary to use at least two accent lighting fixtures in order to create contrast, with a minimum ratio between the vertical illumination of the object and the vertical background illumination of 3:1.** This kind of lighting is suitable for display objects that are viewed from one side only. **However if the object is to be viewed from all sides at least four accent lighting fixtures are required to model the object, with a minimum ratio of cylindrical to horizontal illumination of 2:1.** In both cases these ratios are often exceeded, creating a highly dramatic and eye catching effect, and if the lighting is set carefully, as the customer passes the object the accents and shadows will change creating the feeling that the object itself moving.

Track lighting fixtures are most often used for accent lighting as it allows for easy combination with general lighting, and provides great layout flexibility. However, it is good to pay attention to the desires of architects and spatial designers as they may wish for the lighting system to be more discreet, hidden. This can be easily and effectively accommodated using recessed adjustable spotlights, downlights and daylight simulating large diffusing luminaires, all of which have their own unique benefits and features. It is also fully appropriate for such displays to be illuminated using dynamic lighting, differing colour temperatures and RGBW colour mixing, because they are the heart of the visual presentation of the store, and just as a human heart has a pulse, so must this visual heart.

A key tool to guide the attention of customers, promotion displays should be illuminated to captivate the imagination



A lighting design focused on cylindrical illumination using several track mounted spotlights with narrow beam angles (from 8° to 40°) to provide modelling and increased contrast between the object and the horizontal surface. This kind of solution is highly variable and adjustable.

The accent lighting needed for the object can be incorporated into the general lighting when continuous line installations are used. It is easy to include accent lighting fixtures alongside linear and linear asymmetric lighting fixtures. This kind of combined system allows for great flexibility and adaptability.

A solution that maintains a clear architectural design by using ceiling recessed lighting fixtures that do not disturb or clutter the space. It is also possible that in some cases track lighting systems are not suitable due to the construction of the ceiling. Recessed spotlights can be ejected, rotated and pivoted, although their flexibility cannot be compared to that of track lighting fixtures.

A design that uses a large area diffusing lighting fixture with TunableWhite which can simulate daylight. This creates a focal point for customers and provides natural looking light to provide a pleasant and psychologically comfortable perception. It is beneficial to use an additional spotlight recessed into the platform in order to achieve optimal contrast between vertical and horizontal illumination.

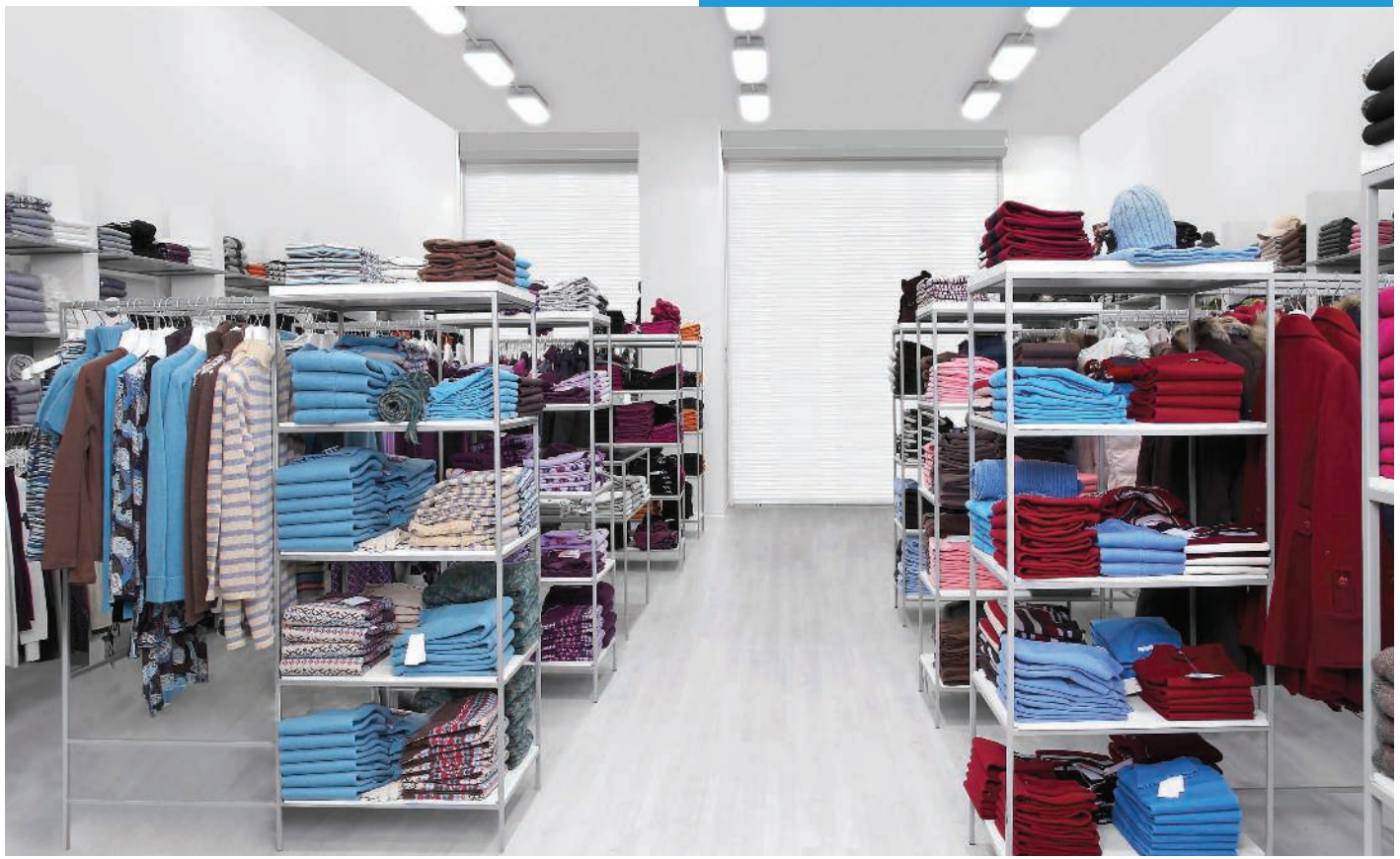
As a workplace, the illumination of storerooms must meet normative requirements and ensure safety

STOREROOMS

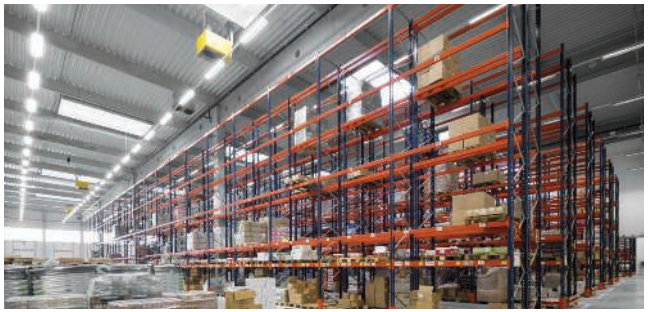
Storerooms are spaces where merchandise is stored and are usually separated from the main store area by doors. These spaces are workspaces only, occasionally visited by employees through the day and for such events as stock audits. The main focus of the lighting here is to fulfil the requirements defined by standards for workspaces, with a minimum average illumination level of 100 lux, a uniformity of 0.4 and UGR no more than 25.

In storerooms merchandise is often arranged in racks, and as such the recommended lighting solution is to use linear lighting fixtures located directly over the centre of aisles in order to maximise the illumination of vertical surfaces. It is beneficial is such spaces to use lighting fixtures with a higher IP rating as they generally require less maintenance and are of course more resistant to damage.

Storerooms are the perfect place to implement energy saving measures. Although the energy consumption is less than for shop floor lighting there is a still a significant potential. Simply by using LED rather than fluorescent lighting fixtures savings of up to 30 % can be achieved. This can be further enhanced by using presence sensors that ensure the lighting is only switched on when needed, and removes the possibility of luminaires being unnecessarily left on for extended periods of time by accident. Another possibility for larger storerooms is to use a Lighting Management System that allows for lighting fixtures to be grouped, enabling each group to be controlled separately, meaning that even when someone is present only the luminaires needed are turned on rather than all of them. Frequent switching is not beneficial in fluorescent lighting systems as it drastically reduced the lifetime of the light sources, this however in not an issue with LED.



Linear lighting fixtures are positioned centrally above the aisles to ensure optimal illumination of vertical surfaces. This minimises shadows at the front of the shelves and makes it easy to see stored items.



Shopping malls are a place of wonder, where customers demand pleasurable and entertaining experiences, so the lighting must not only fulfil needs but also provide stimulation

SHOPPING MALLS

Shopping malls are unique spaces that present customers with a symphony of details designed to elicit an emotional reaction, a perfect combination of architecture and light. Effective lighting is not merely a matter of navigation, but about the creation of a shopping and purchase conducive atmosphere.

It is estimated that up to 60% of the energy consumed in shopping malls used by the lighting, meaning that smart lighting design provides huge potential for savings. To achieve maximum savings it is necessary to plan how to reduce the general use of lighting. It is essential that architects, spatial designers and lighting experts work in unison from the very first moment to ensure the optimised design of each element, and that light is used only as needed, where needed, and no more. One way in which this is achieved is by daylighting. Modern shopping malls are designed to allow as much daylight as possible into interior spaces, which can in part substitute general lighting, and has a motivating effect on customers. However it is important to ensure that the overall illumination remains homogenous, meaning that daylight sensor controlled artificial lighting must be used to balance the available natural light by compensating in areas with reduced access, as dark corners and shadows have a negative impact of customer

wellbeing and subsequently sales. Reduced use of lighting also impacts on the air conditioning and ventilation needed, especially if LEDs are used, as the amount of IR radiation emitted is minimal.

Daylight however is not enough, with artificial light still playing a key role, and as such must be tailored to retailing and customer needs. Biologically effective and theatrically attention grabbing lighting will take the mall from being nothing more than a practical space with much variety and where everything can be purchased under one roof, to being a space where people want to go regardless of their purchasing needs. The use of different colour temperatures can be used to simulate natural light in areas with little or no daylight availability, corresponding to the colour temperatures outside, cooler during the day, and warmer at night. This matches the human biological rhythm, and therefore makes customers feel more comfortable and encourages them to stay longer. Coloured light can also be used to create interest and draw attention to architectural features and the mall identity, preventing the space from being dominated by individual storefronts.

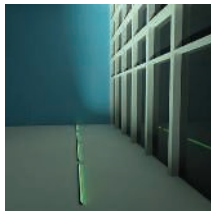
The facade of a store is its face, the thing with which we connect and that remains in the memory

FACADES

Stores need to attract and be easily identifiable from a distance, abilities that largely depend on the lighting cues communicated by the facade. Facade lighting is visible at all times of day and year, illuminating and defining city streets and squares. It must both complement the building's architecture as well as underscoring corporate identity, using an emotive scheme that enables it to compete against other engaging sights. This unique lightng design element of a store's is composed of three parts: logo, entrance and shop window lighting, all elements being as applicable to small specialist store as to multiple storey malls.

Logos must be brightly illuminated, whether it be by projectors or using integrated lighting or backlighting. However, the light should not glare and will ideally adapt to the time of day, for example, at night lighting levels can be reduced without compromising on contrast with the immediate environment.

Effective entrance lighting is a perfect tool for attracting passers-by, using high levels of brightness to usher customers into the store. This illumination can even extend in front of the entrance space, illuminating the pavement and further drawing attention, and can be white, coloured or dynamic. Tunable-White can be used to match the light colour temperature to that outdoors and RGBW lighting with brand associations can be used to reinforce corporate identity and attract, both having a positive impact. Although care must be taken that the entrance does not become a mere spectacle that attracts but then deters.



Shop windows can function in several ways. Firstly by acting as a display area where products are highlighted using dramatic accent lighting. Secondly, they can allow an unobstructed and intimate view of the inside of the store, giving the impression to passers-by that they are already part of the interior environment, and diminishing the divide between in and out. Thirdly, it is possible to use a combination of display areas and clear areas, allowing for some of the advantages of both methods.

Practical considerations include the need to minimise glare, so that passers-by are not visually compromised by the brightness or direction of the illumination, and in order to minimise any reflections on windows which are an obstacle to viewing the window displays or interior spaces. And of course, exterior lighting fixtures must have a suitable IP rating, of 65 or more, in order to safely withstand the weather and accidental damage.

Safety first, car park lighting must ensure psychological comfort and meet normative requirements

INDOOR PARKING

The lighting of indoor parking areas focuses on practicality and safety. However it can also have a psychologically positive effect, leaving a good impression on customers. Such lighting can be broadly categorised into three elements: entrance and exit area lighting, traffic route and parking space lighting, and peripheral area lighting. In all cases good colour rendition is beneficial to aid visual acuity. Standards require a minimum of CRI ≥ 40, however we recommend CRI ≥ 80.

Entrance and exit areas have one additional requirement which must be fulfilled. The human eye takes time to adapt to significant changes in brightness, like going from a brightly sunlit access road into indoor parking zone, and vice versa. This adaptation period is characterised by reduced visual acuity, something that must be compensated for. Here it is necessary to use increased levels of illumination in order to provide a transition brightness level, aiding the eye to adapt to the change as quickly as possible.

Routes and parking spaces must be clearly illuminated in order that drivers can safely manoeuvre and park in the confined dimension of the parking zone without incident. Drivers also need to see any pedestrians that may be in dangerous proximity, as well as any obstacles. This is best achieved using higher levels of vertical illumination to highlight vertical surfaces such a person, wall, support pillar or car. A minimum level of 75 lux at floor level is required along with a uniformity of 0.4.

Such parking areas often have areas determined for pedestrians, which allow for safe passage through the parking zone without getting to close to traffic routes. These areas are usually peripheral and require good levels of illumination, again especially vertical, which illuminates walls, obstacles and other people who may be approaching. This ensures suitable visual acuity and promotes a sense of wellbeing and safety as any unknown person or danger can be assessed from a distance.

In such spaces there is little or no daylight available, so artificial lighting must be provided at all times. This leads to high energy consumption, although this can be minimised by the use of a Lighting Management System and efficient light sources. A safety level of illumination is required at all times, but full illumination is only needed when there is activity in any given area. Here it is good to use presence detectors which increase and reduce lighting levels according to need. LED again proves its worth in such a lighting solution as it is a highly efficient technology, with a long and maintenance-free lifetime, and can be switched and dimmed as needed without detriment. The combination of using LED technology and presence detectors can provide energy savings of up to 80 % compared to conventional

When disaster strikes, effective emergency lighting lights the way to safety

EMERGENCY AND SAFETY LIGHTING

Emergency and safety lighting is required to illuminate spaces in the event of failure of the general artificial lighting system. It is a legal necessity, defined by European EN 01838 standards, to provide such lighting in corridors and routes that people will need to use in the case that they must escape a building, in areas with no access to daylight, and generally in areas where there are many people. All retail environments fall into at least one of these three categories.

The purpose of this lighting is to provide sufficient levels of illumination in emergencies. It must ensure that people can easily navigate and find escape routes based on back-lit escape and direction signs, and to the extent possible avoid any additional danger associated with large numbers of people in a space under heightened levels of stress, along with being able to find necessary firefighting and safety equipment.

A correctly planned and carefully maintained emergency lighting system can make the difference between the safe evacuation of people from a space and mass panic, injury and possibly death. For that reason, the selection of emergency lighting fixtures is vital. Guaranteed sufficient illumination and simple maintenance are important factors, as well as energy savings, as emergency lighting must be ready for use at any moment and therefore permanently powered. Based on these criteria LED battery pack emergency lighting fixtures are the optimal solution. Their long lifetime of 50,000 hours ensures low maintenance and associated costs, and their efficiency means that you can save up to 70 % in power consumption, with further saving potential if lighting fixtures are fitted with additional optics and reflectors that allow the overall number of fixtures to be reduced without detriment to the illumination provided.

1 Safety lighting of escape routes

Enables the easy identification and following of escape routes using back-lit escape and direction safety signs.

Escape routes up to 2 m wide:	
Illumination	a minimum of 1 lux along the central axis of the route and 0.5 lux over at least half of the route width
Uniformity	Emax:Emin = ≤ 40:1 lux
Colour rendition	CRI ≥ 40
Rated service time for escape routes	1 hour
Switch on delay	50 % of the required illumination within 5 seconds and 100 % within 60 seconds

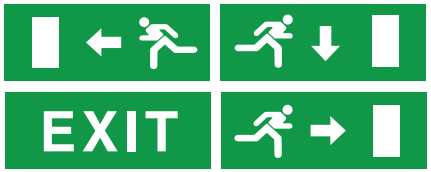
(Routes wider than 2 m can be classified either as a group of 2 m wide routes or as an open space that requires anti-panic lighting)

2 Anti-panic lighting

Provides sufficient illumination to minimise panic and enable people to find an escape route.

Escape routes more than 2 m wide and open spaces:	
Illumination	E ≥ 5 lux (horizontal illumination at floor level)
Uniformity	Emax:Emin = ≤ 40:1 lux
Colour rendition	CRI ≥ 40
Rated service time for escape routes	1 hour
Switch on delay	50 % of the require illumination within 5 seconds and 100 % within 60 seconds

(Peripheral areas with a width of less than 0.5 m are not taken into consideration.)



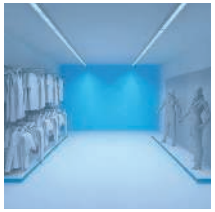
In order to achieve the best illumination, the lighting must be designed according to the specific needs of each space and the type of merchandise

FASHION AND ACCESSORIES

One of the key ways that customers as individuals realise and project their unique character is through their fashion and accessory choices, each possessing their own cocktail of sensitivities to different feelings, thoughts and ideas. Light plays an irreplaceable role in the perception of a store's philosophy and how customers connect their personal identity with that of the brand, it can be the 'make or break' element of a store's design. For large brands with many stores it is often the case that the same design rules are followed in every establishment, with the chosen corporate lighting design being one of the easiest and most powerful ways by which to distinctly communicate the unique brand style across many geographically disconnected locations.

In smaller stores accent lighting alone can provide high enough levels of illumination for easy navigation, **however in larger stores it is necessary to also use general lighting to ensure the required level of 300 lux** (horizontally at 0.75 m above the floor). But it must be noted that general illumination plays a secondary role only, whilst vertical illumination fulfils the task of illuminating and modelling merchandise in a dramatic and captivating way. A minimum ratio of 2:1 vertical to horizontal illumination must be maintained. It is also key in these larger spaces, where the combination of open space and darker areas can make customers feel insecure, that the general and accent lighting have an overall high enough level to make sure that customers feel comfortable.

Warm 2700 K light is perfect for displaying evening wear in the kind of light it will be worn in, providing an atmospheric and realistic impression of the products.



Cool 5000 K light is ideal for displaying summer daytime clothing such as t-shirts and swimwear, giving the feel of being outdoors.

In order to draw attention to strategic areas such as counters and promotion displays it is useful to use higher levels of horizontal illumination, supplied by accent lighting, supplementary to any present general illumination, along with increased levels of vertical or cylindrical illumination. **Another way to emphasise key points within the store is to use coloured light, whether it be the colour temperature or the use of RGBW lighting.** The colour temperature used for each product can have an impact on how it is perceived, with warm light bringing out the natural hues of leather, or cool light making bright coloured garments look vibrant. In a store where many varied goods are displayed it is best to use one neutral colour temperature, or if possible to separate the store into zones according to the type of merchandise with each area illuminated with a different colour temperature. It is also possible that colour temperatures can be adapted to the time of day or season so that the light inside reflects the natural and pleasant ambience of daylight, which has a positive effect on customer wellbeing and therefore perception. By using RGBW lighting it is possible to create dynamic scenes to entertain as well as attract customers. Coloured lighting can underscore trends and seasons and show certain

products in the light they are likely to be used under, such an evening gown under the glow of dimmed and atmospheric illumination or a winter coat under colours that simulate an Autumnal day. However, it is always important to have areas where customers can see products under light with a neutral colour and with good colour rendition of CRI ≥ 90 so that they can objectively assess materials, textures and colours and make realistic comparisons.

LED technology is ideal for illuminating fashion and accessories due to its incredible flexibility. **With LED it is possible to have within one lighting fixture variable colour temperatures that can be easily adapted to individual products and displays, with all colour temperatures achieving CRI ≥ 90.** It is also easy to incorporate RGBW lighting that can be used to create any colour within RGB colour space, and can be used for dynamic and scenic lighting. Additional advantages of LED technology are the low levels of heat radiated, which protects products and reduces the amount of cooling required to keep a store at a comfortable temperature, and the negligible amounts of UV radiation emitted, protecting products from fading and becoming fragile. Furthermore, besides the energy saved by having a reduced cooling load, the long lifetime, low maintenance requirements and energy savings they provide because of their great efficacy mean that the environment and budget are taken care of, and maybe more can be invested in the perfect lighting solution rather than the running of a less-than-ideal one.

Bu using RGBW lighting it is possible to create various fun, dramatic, entertaining and distinctive atmospheres within the same space.

Difference of CCT 2700 K *4000 K* *6500 K*

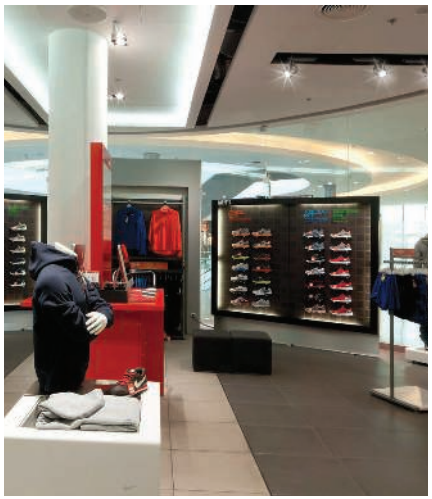
Illumination of sports goods should be representative of the kind of activiity being portrayed, with high contrast ratios and dynamic lighting being key tools

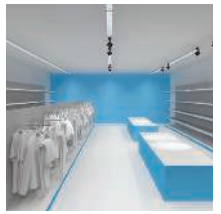
SPORTS

Sport is about movement, dynamism and being outdoors. Sports stores are often large and offer a wide variety of products, from clothing and accessories, through small exercise items, to larger pieces of equipment. Each kind of product requires something different from the lighting, but there is one strong theme running through it all, the lighting must be stimulating and create an atmosphere of energy.

In such spaces it is highly beneficial to use lighting with a cooler tone, of at least 4000 K, to give the feeling of daylight and freshness, and the impression of quality and luxury. Accent lighting is vital, and should be used in various beam angles to bring out the textures and colours of high-tech and vibrant fabrics, and to provide optimal levels of contrast for promotion displays and vertically arrange goods. It is also beneficial to use dynamic lighting, either by playing with colour temperatures to evoke the relaxing feeling of being outside, or with RGBW to create theatrical and energising lighting that can tell a story or emphasise a theme.

Sports stores have the same general lighting requirements as a fashion store, with a minimum ratio of vertical accent illumination to general horizontal illumination of 2:1, meaning that promotion displays and vertically presented products and shelves are given the dynamism they deserve, whilst maintaining a safe and comfortable level of navigational lighting. Key areas and items can be highlighted using increased levels of brightness and deeper contrasts between light and shadow. Another shared characteristic of both types of store is the need for flexibility, with adjustable recessed, surface mounted or track spotlights and adjustable downlights being ideal due to their ability to be directed as needed throughout changing seasons, trends, displays and layouts. Good colour rendering is important, with CRI ≥ 90 enabling the truthful reproduction of colours.





Such large stores, when dependent on a great number of lighting fixtures that use conventional light sources, must contend with a significant amount of IR radiation which is demanding of the air conditioning if the space is to be maintained at an acceptable temperature. Conventional light sources also emit UV radiation which can have a damaging effect on fabrics and certain materials, fading colours and making leather and soft plastics brittle. All of these negative effects can easily be avoided with the use of LED technology, which emits negligible amounts of IR and UV radiation, reducing cooling loads and minimising any damage caused to products. LED is also highly beneficial as it is incredibly flexible, allowing for simple and varied control of brightness, colour temperature, colour and dynamic lighting. Lighting systems that incorporate a Lighting Management System can benefit from reduced energy consumption, especially in areas with access to daylight, and user friendly control of a wide range of functions.

The perfect combination of general and accent lighting creates zones and attracts attention to products

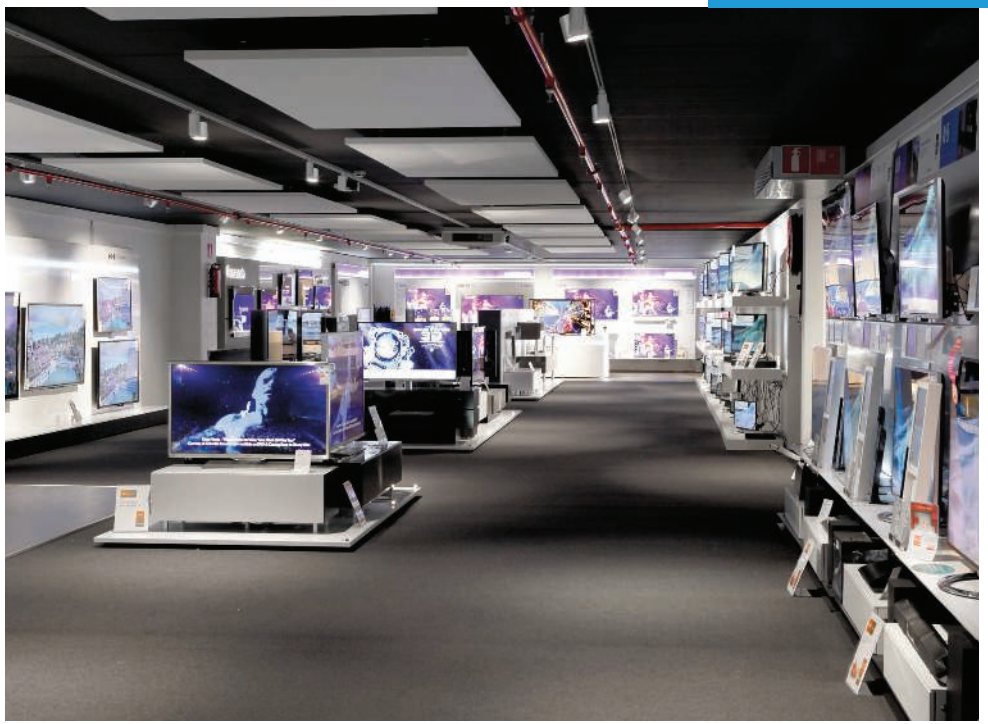
ELECTRONICS

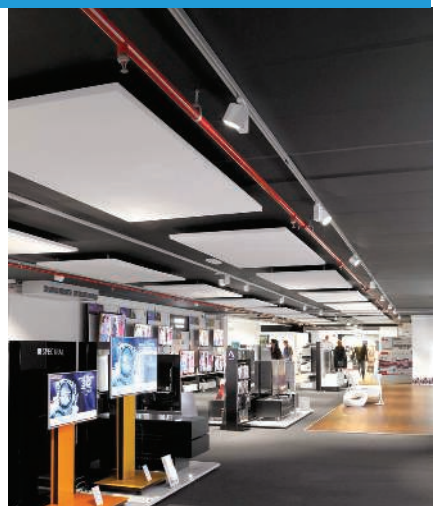
High-tech products demand high-tech lighting. From stores than sell refrigerators to those that sell state-of-the-art sound equipment, the interior and lighting design are vital components in a customer's perception of the quality and standard of technology offered. And just as electronic products follow rapidly moving trends, so must the lighting, with the use of the latest technologies and styles having a direct impact on the atmosphere in the store.

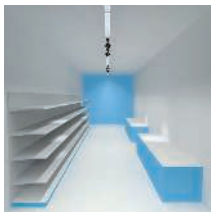
Often electronics and technology stores have a strong identity which is retained across many establishments. The lighting design is a fundamental element of this unified corporate identity, and whilst maintaining the core design and aesthetic properties can be tailored to each individual store's architecture, location and customer base. Such a corporate lighting design can be a complex combination of certain lighting fixtures, particular types of fixture layout, the use of coloured light and dynamic lighting. Such dominant yet subliminal elements of a store's 'personality' allows customers to easily identify with the brand regardless of the town, city and even country they are in.

For smaller stores that sell a specific type of product, the lighting design must be tailored directly to the perceptions associated with that products use. For example, TVs can be presented in a living room setting with soft and warm or coloured light, whilst a washing machine can be presented in a crisply illuminated kitchen setting that evokes cleanliness and comfort. Larger stores that offer a wide range of products require a combination of general and accent ligthing, best provided by continuous line linear systems that can incorporate accent lighting spotlights. In these cases the accent lighting can be tailored to the type of product displayed, providing various colour temperatures, beam angles and light directions.

It is vital to minimise glare, especially in areas where items such as TVs, computers, tablets and phones are displayed. It is also important to minimise IR and UV radiation in order to ensure customer comfort and minimise damage to products. LED technology is perfect for application in electronics and technology settings, itself a relatively new, modern and trend-setting technology. LEDs emit negligible amounts of IR and UV radiation, reducing the cooling load of air conditioning systems, providing great savings potential, and minimising system maintenance. Their extreme flexibility and controllability make them perfect for stores that integrate dynamic lighting and Lighting Management Systems.







The combination of continuous line linear lighting fixtures and accent lighting spotlights means that both general and accent lighting are simply and effectively provided in a low maintenance, flexible and practical way.

In smaller stores it is not always necessary to use general lighting, as accent lighting alone provides a high enough level of illumination for safe navigation of the space. Track mounted, recessed or surfaced adjustable spotlights are ideal as they can be positioned to perfectly illuminate detailed displays and highlight promotional areas.


PRADA
CHANEL
David Clulow
opticians

Small, detailed items require specialist illumination, with LED cabinet lighting being the ideal solution

JEWELLERY

WATCHES

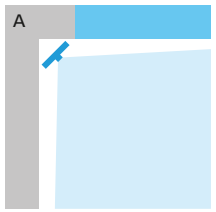
GLASSES

GIFTS

For such items as jewellery, watches, spectacles and gifts the success of the store is very much dependent on the wow factor as these special items are an expression of a customer's personality. The shop window must attract, but it is the way in which items are displayed on the sales floor that must dazzle, demonstrating the exclusivity and value of the products offered.

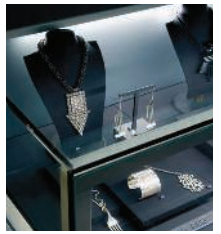
Jewellery, watches and gifts are often displayed in glass cabinets. In this context the use of LED has a decisive advantage over conventional light sources, as gemstones and fragile materials are easily damaged by IR and UV radiation. For example rubies fade and leather discolours and becomes brittle. LEDs emit negligible amounts of this radiation meaning that they are ideal for use in close proximity to products, widening the lighting possibilities available. Traditionally display cabinets are accent illuminated by ceiling mounted spotlights, however this kind of solution has the significant drawback of causing high glare when not very carefully designed. For that reason we recommend to use LED strip luminaires mounted around the upper edge of the cabinet frame (1A), and lower edges of shelves(2B), a lighting solution which both hides light sources from view and minimises glare. Based on these and other well-known advantages, LED is the most suitable type of lighting to use when design lighting for such purposes.

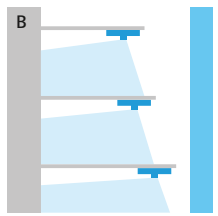
For other types of display, accent lighting is used to model and pinpoint the details of intricate workmanship. As the products displayed are often very small the lighting must be designed in such a way to be able to illuminate groups of objects, therefore it is ideal to use a combination of several accent lighting fixtures from various angles to create optimal contrasts. For special items set apart from the rest individual accent lighting provides them with their own 'centre stage', allowing customers to assess items independently rather than as one of a many.

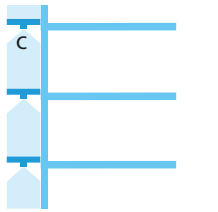


Spectacles especially benefit from being arranged on backlit displays as the light from behind gives the impression that the items are floating (3C). Using opal diffusing materials between the light sources and displayed items produces a soft and diffused light which attracts customers and ensures visual comfort. Additional accent lighting can also be used to add some drama to the displays by creating contrasts or modelling items.

The choice of colour temperature is key for the illumination of exclusive items, with each material type having its own 'best light'. Cooler colour temperatures are ideal for highlighting the brilliance of metals, whilst warmer colour temperatures make colours look richer and more exquisite. It can also be good to incorporate RGBW lighting into the design, as coloured light can create a dramatic backdrop for key items, or tell a theatrical story. Also, small items can easily get 'lost' in their surroundings so it is crucial to combine contrasting accent lighting with suitable backing materials. If a white backdrop is used, it is often the case that the luminance of that surface becomes greater than that of the object, therefore darker colours such as black, grey and dark blue are ideal as they help products take centre stage.







Sensitive products needs careful lighting, with a focus on low levels of IR and UV radiation

PHARMACIES

PERSONAL PRODUCTS

COSMETICS

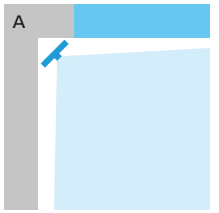
PERFUMES

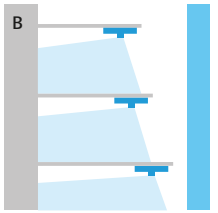
Pharmacies and stores that sell personal products, cosmetics and perfumes have very specific lighting needs. Items are especially small, with packaging designed for visual impact and not only for the practical containing of various substances. Almost all items are displayed on shelves with varying heights and depths, and whilst shelf lighting has its own set of lighting rules, for such spaces as a pharmacies these rules must be adapted and added to in order the ensure that sufficient attention is drawn to special, colourful, and often beautiful objects.

Such stores are spaces where customers want to feel comfortable and to be stimulated to appreciate aesthetics and details, and to value themselves. It is vital that the lighting is bright enough, without being overly dominating, that customers can clearly see and assess cosmetics and other coloured items when trying them. For this reason it is also key that the lighting fixtures used provide excellent colour rendition of at least CRI ≥ 90. A friendly and homely atmosphere, supported by indirect lighting from alcove lighting fixtures or a combination of direct and indirect lighting from statement suspended lighting fixtures, provides softly diffused illumination that flatters the skin and creates a feeling of wellbeing. Bright ambient illumination provided by adjustable downlights and recessed spotlights not only provides a general glow but can be adapted to changing displays and layouts, whilst ceiling surfaced and track spotlights can provide additional accent lighting for shelves and promotion displays, to draw attention to special offers and new products. Accent lighting will also best capture the details of small or intricate objects.

Shelves used to present small, detailed products can benefit especially from built-in lighting. There are two ways in which to best achieve comfortable and effective illumination of these difficult areas. Firstly, LED strip luminaires can be installed on the lower edge of each shelf to provide distinct lighting for the shelf beneath, eliminating shadows and ensuring that customers can clearly see displayed merchandise. Secondly, shelves can be backlit using hidden LEDs or alcove lighting fixtures, providing a warm glow behind items and acting as a bright point towards customers will automatically be attracted. Backlighting offers the perfect opportunity for the use of TuneableWhite or RGBW lighting, with the colour used being appropriate to the kind or brand or product being displayed, or allowing for dynamic lighting which can totally change the atmosphere of the store by adapting to the time of day, the season and the weather.

LED is perfect for such lighting needs as they are very adaptable, and small enough to be hidden away under and behind shelves and in alcoves. Another considerable advantage of LED is the negligible amount of IR and UV radiation they emit, which from conventional light sources can be quite significant and may cause damage to delicate cosmetic and pharmaceutical products and lead to their not functioning as intended or even causing problems to customers when used.





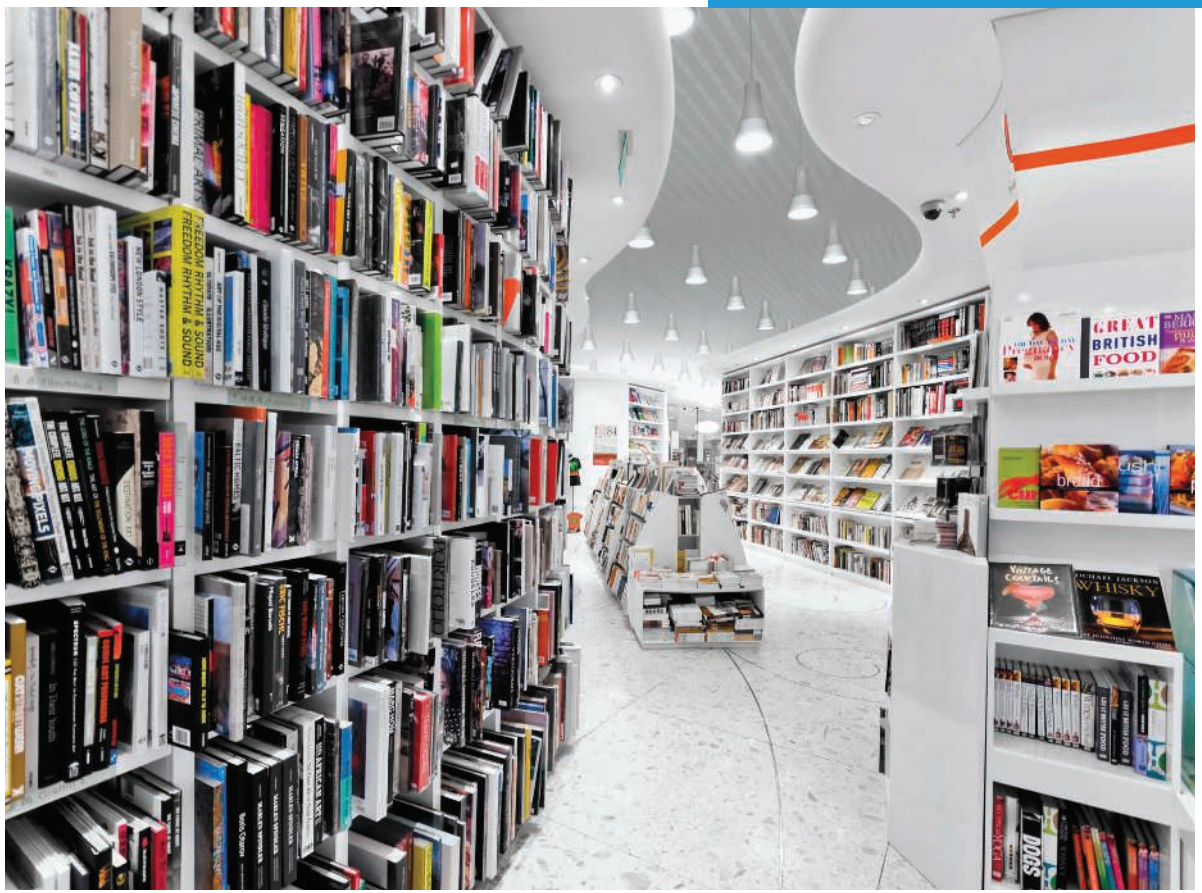
With light we can create different zones with different atmospheres, providing a relaxing yet visually suitable environment

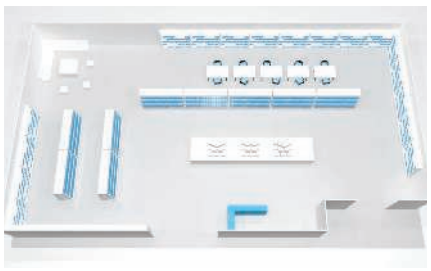
BOOKS

DVDS

GAMES

Stores that sell books, DVDs, music and games all have the same basic technical requirements as any store that displays its merchandise on shelves. However, these stores need a very different kind of lighting in terms of atmosphere creation and visual comfort in order to stimulate customers in a way reminiscent of the environment where such products will be used, i.e. home. The correct ambience is vital, as buying a book, CD, DVD or game is not the same as buying other kinds of merchandise where the first impression counts, but rather that the product is looked at, thought about, and after a time the decision is made whether to buy or not. It is also vital that the brand of the store be reinforced by the lighting design as customers are often attracted to 'big-brand' bookstores, not only because of their extensive range of products but because of their atmosphere, which must be there to welcome customers no matter which branch they visit.





Shelf displays demand a higher level of vertical illumination in relation to horizontal illumination, at a minimum ratio of 2:1. What this achieves is that vertically displayed items, of which books are a perfect example, are not only illuminated to a sufficient level in terms of visual acuity, but also highlighted to catch attention by being illuminated with a brighter light than less important surfaces. Accent lighting fixtures ideally fulfil this need, and in larger stores where general lighting is required, linear asymmetric luminaires placed over aisles provide both navigational and vertical illumination. Alternatively, in areas where products are displayed on a horizontal surface, such as tables with new releases, or 'bargain bins', accent lighting must also provide a higher level of illumination to catch the eye. Additionally, accent lighting creates contrast between light and shadow, with a minimum ratio of 3:1, although many stores use lighting that provides higher contrast accenting of products on shelves, a visual characteristic commonly seen in the home environment.

Another unique attribute of such stores is that they are often separated into distinct areas: the shelved spaces where products are displayed, and the intimate and comfortable spaces where customers are invited to take a seat and think about their purchase. It is important that the level of illumination is sufficient that no matter where a customer stops to read a page or two, they can comfortably read without strain. Soft, diffused light with a warmer colour temperature of 2700 K helps to create the feeling of home, whilst accent lighting from homely lighting fixtures in quiet corners entices customers to take time out for themselves to share with their new 'friend'. Many bookstores also have coffee shops, now a standard in both the larger and smaller branded stores as well as amongst the lower-profile unique stores where old and loved books can be bought alongside new and specialist items. These quiet zones and coffee shop areas provide customers with the perfect space to make a connection with their new book, encouraging sales.

Finally, for any book lover, the condition of their books is of high importance. Here LED technology really proves itself as the light sources emit negligible amounts of material damaging IR and colour fading UV radiation, ensuring that displayed items continue to appear at their best.

Lighting can be used to simulate the atmosphere of the space where goods will be used, showing products in the right light

FURNITURE AND SOFT FURNISHINGS

The most effective lighting for furniture stores is that which creates a comfortable atmosphere that encourages customers to browse longer, increasing the possibility of a sale. It is also beneficial to incorporate navigational lighting, increasing brightness in certain areas to guide customers around the store in a defined way past all merchandise.

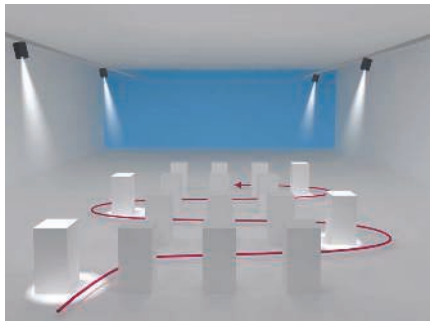
A key component of the lighting is its ability to perfectly set the scene. General lighting is needed, which should be warm and inviting with indirect and ambient elements, with suitable brightness levels to make comfortable and without being excessive which could evoke an impersonal feeling. Accent lighting should be used in addition to highlight textures and surfaces, model products and play theatrical games with light and shadow to stimulate and draw attention. The use of wallwashers can also help to brighten dark corners or highlight products located in peripheral areas, ensuring that no item is overlooked.

Furniture and household items are often displayed in settings, such as a living room or kitchen, and the lighting must be tailored to the specific space. For the living room warm pleasant light from statement lighting fixtures will inspire and stimulate the imagination, and for the kitchen warm brighter light that gives the impression of cleanliness and relaxation.

Customers are attracted to brightness, which in larger stores can be used to guide them in a defined way around the space.

Another display method is the grouping similar products, in which case the lighting must again be tailored, with warm white for leather and wood and cool white for glass and metallic surfaces. And for soft furnishings and textiles, it is best to use a neutral white which best allows for comparison. In all cases, good colour rendition is key, giving customers an honest view of the products and minimising returns due to the product not looking the same in the customers home.

Energy saving, a key factor in any lighting solution, is dependent on the use of efficient light sources, such as LED, and effective lighting fixtures in combination with a Lighting Management System. In entrance areas where there is daylight it is suitable to reduce the general lighting when sufficient daylight is entering the space. Another practical way to save energy is to use presence detectors based upon which brightness levels increase from a minimum safety level when customers enter an area and reduce again once the customer has left. Sometimes stores have few customers, in which case it is not necessary, and incredibly wasteful, for the entire space to be fully illuminated. If choosing to use LED light sources savings can also be made in air conditioning costs as LEDs emit very low levels of IR radiation in comparison to the significant amounts emitted by conventional light sources. One final consideration, and by no means less important, is the effect the light has on products. IR and UV radiation are very damaging to products, fading colours and deteriorating certain materials. Again LEDs are the star here, as they also emit negligible amounts of UV radiation.



Dynamic lighting brings products to life, inspiring and motivating customers

AUTOMOTIVE AND TECHNICAL

Lighting for automotive and technical areas is a crucial factor. Cars are expensive and intrinsically connected to the expression of our personality and identity, therefore their presentation must communicate just the right mix of messages. A single showroom can host a cost conscious city car, a safe family car and a powerful sports car side by side, so the lighting needs to be fully adaptable and flexible enough to suit each perfectly. Due attention must also be paid to colour rendition, as colour can be the 'make or break' factor in a sale.

Most car showrooms have high ceilings and large glass windows along at least one side. This allows natural daylight to flood in. However, it is important to minimise reflections caused by strong sunlight on windows, and to maintain high enough levels of illumination indoors that even in the brightest sunlight the showroom looks well illuminated and products are clearly seen from outside. This also provides the potential to save energy as general illumination can be in part or in full substituted by daylight, although accent lighting must be maintained at all times. And at night, the vital impression that a car makes on its potential new owner can be ensured by using suitable levels of theatrical accent illumination that plays with light and shadow and gives the product a whole new personality.

2700 K

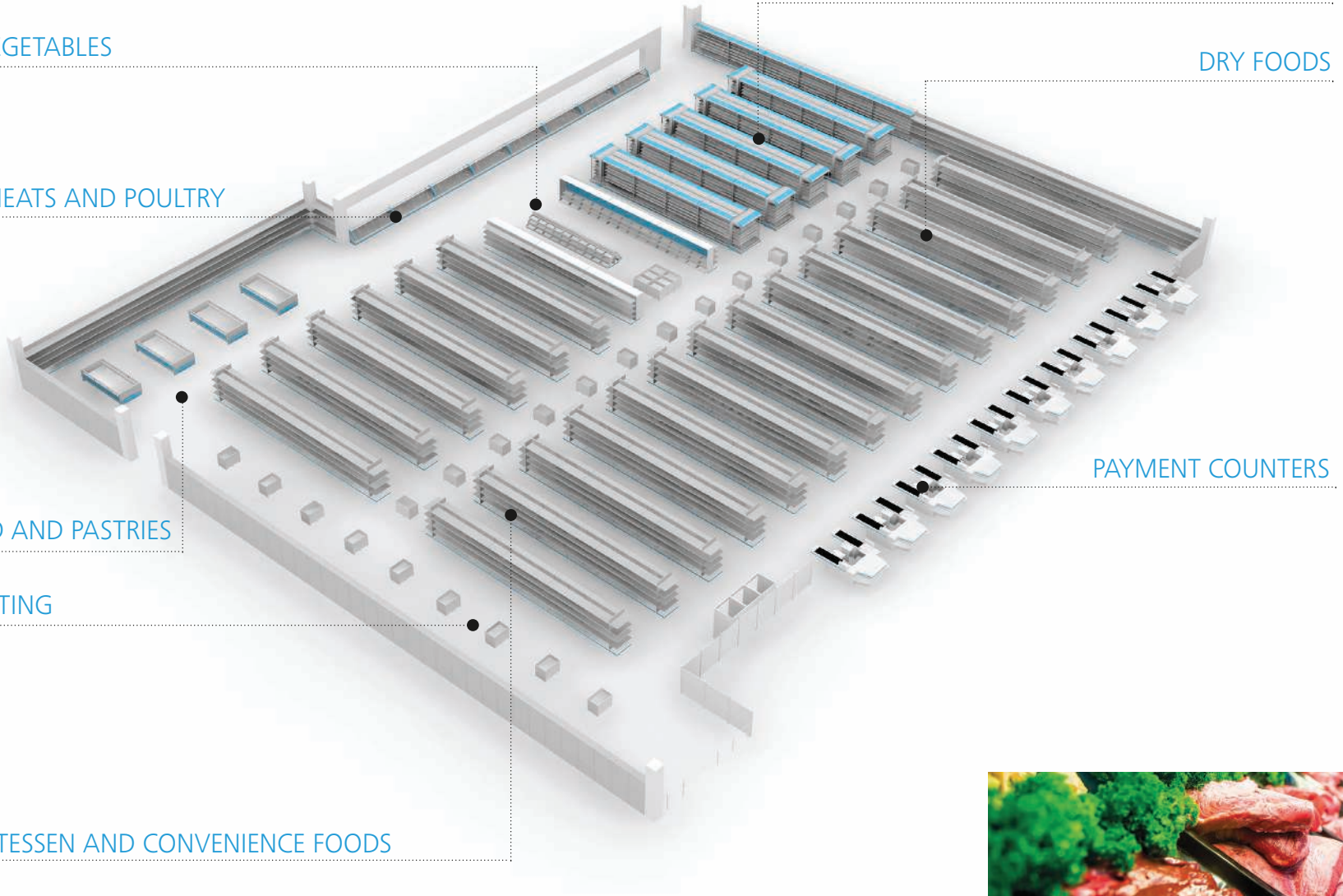
4000 K

6500 K

Brand loyalty is also a strong pull for many customers, and even for the less loyal customers brand is everything, maybe more so than for any other kind of product. For that reason, it is essential that the lighting not only fulfils visual and highlighting needs, but also supports a strong brand image. This can be based upon the use of appropriate colours in certain areas, or the use of specially design lighting fixtures, or simply by using lighting that has strong brand associations. However, whilst RGBW lighting may be applicable in certain places it should not be used too much as it can be distracting.

Another factor is that the automotive industry pushes its products based on technical innovation and the use of modern lighting fixtures and techniques is a subtle reinforcement of that element whilst simultaneously providing a suitability of light that was not possible in the past. **As cars have high-shine paintwork it is advisable to avoid the over-use of ceiling mounted downlights and accent lighting that can cause a myriad of annoying reflections**. Rather it is beneficial to use large area diffusing luminaires that evenly distribute 300 lux of soft, clear light to perfectly illuminate without glare, and are suitable for TunableWhite daylight simulation or RGBW dynamic lightin. Alongside this general illumination it is advised to use projector or wallwasher lighting at a level of 1000 lux that gives large area rather than pinpoint accentuation to define the contours and details of the bodywork and accessories. A practical, versatile and effective option is to use a combined lighting system whith various types of luminaire together, such as in a continuous line installation.

SUPERMARKET



SUPERMARKET

Supermarkets are a relatively recent development in the retail world, and have become a indispensable part of our modern lives. Spread over a very large area, often more than 2000 m², customers can find almost any product type under one roof. Generally set-out in several zones – entrance, toilets and amenities, fresh food, dry food, toiletries, homeware, electronics, pets, clothing and cash desks – thousands of different products are available at any one time. This places many complex demands on the lighting system.

Customers can find everything under one roof, with lighting playing a key role in the naviation and differentiation of product groups

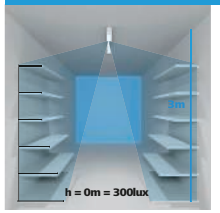
Shopping is an emotionally-led and sensory activity, of which light plays a key part, so it is essential that it be designed with the utmost care and consideration. The lighting must fulfil several basic functions: to ensure sufficient illumination for easy and safe navigation, to segment the space into different areas according to product category, to provide visual stimulation and promote sales, and of course certain areas are ultimately for work and so need to be properly illuminated to enable the effective and comfortable performance of tasks.

SUPERMARKETS – GENERAL LIGHTING

There are no standards for the general lighting of supermarkets although some larger chains have defined their own brand specific regulations. It does not, however, mean that this aspect of the lighting is unimportant. On the contrary it is fundamental and must be designed with great care. Supermarkets are spread over a very large area and as such require a certain level of homogenous and uniform lighting to enable navigation and the sufficient illumination of all products.

We recommend a minimum horizontal illumination level of 300 lux at floor level, which provides a comfortable and effective amount of illumination for navigation and visual perception whilst not being so bright as to overpower or negate the effects of accent lighting. The ratio of vertical to horizontal illumination should be a minimum of 2:1, meaning in practice a minimum level of 600 lux on vertical surfaces. We suggest using a higher ratio in order that shelves and displays draw the full attention of customers.

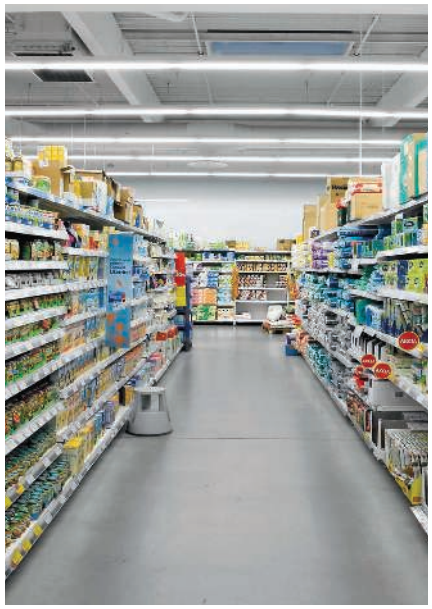
Ev = h 2.2 m = 1000 lux
Ev = h 1.7 m = 800 lux
Ev = h 1.2 m = 600 lux
Ev = h 0.7 m = 400 lux
Ev = h 0.2 m = 300 lux

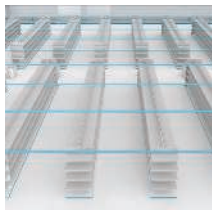


In order to maintain or exceed the minimum ratio between vertical and horizontal illumination of 2:1 we recommend that the floor be illuminated with 300 lux, the mid-level shelves with 600 lux.

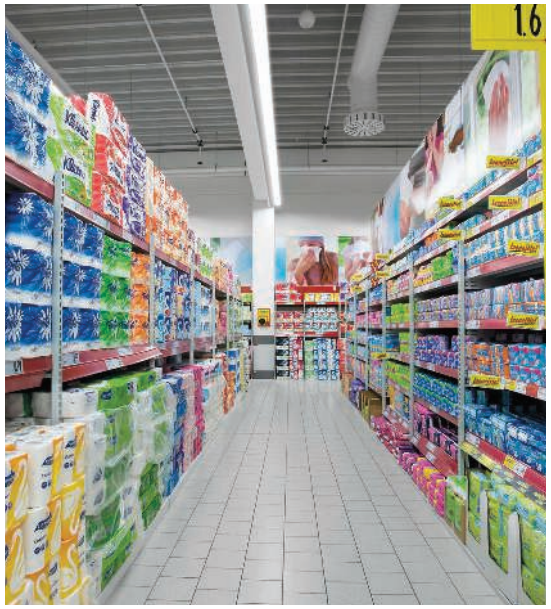
Although general lighting serves the purpose of providing appropriate illumination for visual perception, over the large areas of supermarkets such lighting can seem monotonous. The decision to purchase an item in a supermarket is approximately 80 % emotional and 20 % objective, with light playing a key role in evoking the impetus to buy. Therefore it is beneficial to use additional accent lighting to provide points of brightness to highlight product groups, special offers, or areas of interest. This prevents monotony by providing visual stimulation, which has been time and again shown to increase the length of time customers spend in store and subsequently improving sales.

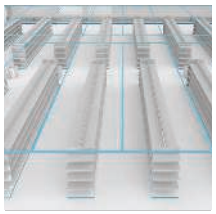
General lighting accounts for around 60 % of the energy consumed by a supermarket, so it is important that the lighting be designed to reduce the amount of light going to waste. This can be achieved primarily in two ways. Firstly, the layout of the luminaires is important, with continuous linear installations positioned parallel to and centrally over aisles, equipped by double asymmetric reflectors to direct the light on the shelves to either side. This prevents the unnecessary illumination of shelf tops where the light is of no value but continues to consume energy. Such ineffective illumination demands that the entire system be over-dimensioned in order to provide sufficient illumination where needed, increasing both initial investment costs and the energy consumption and maintenance costs during its lifetime. Secondly, if stores have access to daylight, sensors can be used to dim the general illumination proportionally to the amount of daylight falling into the space. Sensors positioned throughout the entire space ensure that a uniform level of illumination is provided everywhere. It is also important that accent lighting not be dimmed in such cases, so that the emotionally activating function is not lost. The use of daylight sensors can provide energy savings of up to 30 %. Another way to save energy is of course to use energy efficient light sources, with LED being the most efficient, requiring the least maintenance, and emitting the least heat and therefore reducing the cooling load on air conditioning systems.





Incorrect
The continuous line lighting is arranged perpendicular to the aisles resulting in a large proportion of the illumination being wasted in illuminating the tops of shelves. This kind of design requires many light sources and consumes a lot of energy in order to provide sufficient illumination.





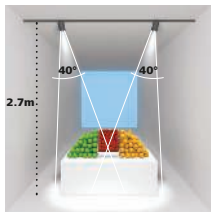
Correct
The continuous line lighting is arranged parallel to the shelving, and positioned centrally over the aisles. The fixtures use double asymmetric reflectors to direct the light onto the shelves and floor, providing an ideal amount of vertical illumination. No light is wasted. This means that fewer light sources are needed to provide sufficient levels of illumination, bringing savings of up to 40 %.

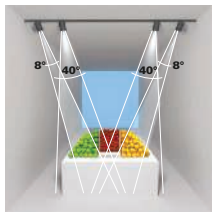
Fresh foods are highly sensitive and need to look at their best, so excellent colour rendition and low levels of IR and UV radiation are crucial

FRUITS AND VEGETABLES

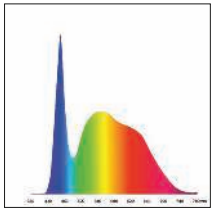
In many supermarkets the fruit and vegetable section takes centre stage, displaying fresh, healthy and appetising produce to focus the customer's mind on the task of buying food. It is therefore one of the most important areas in the supermarket, one where important customer impressions are made about the quality of all available merchandise and the overall standard of the store. This is as applicable to small-brand as to big-brand stores, and as applicable to discount as to luxury supermarkets.

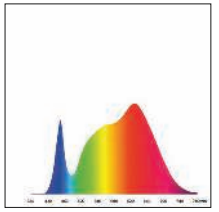
Most stores display produce in crates stacked at an angle, ideally matching the natural line of sight of customers, whilst the use of crates suggests that the produce is freshly picked and has only just been delivered. Accent lighting with a beam angle of 40° is perfect to highlight individual crates or product groups, creating suitable levels of contrasting light and shadow to give individual items shape and capture textures and colours. By using supplementary narrower beam angle accent lighting to create additional focal points, attention is automatically guided to each different mouth-watering product group, encouraging customers to buy items they maybe did not intend to when they entered the store. Excellent colour rendition of CRI ≥ 90 is a decisive element in the lighting design, truthfully depicting colours so that customers can choose with confidence. Warm light colour temperatures, ideally of 3500 K, are also beneficial as they maximise the attraction of rich natural shades.





Fresh foods are of course very fragile, and just as the lighting used can create an appetising impression, it can easily have the opposite effect by causing foods to dry and discolour, and even start to decay. It is therefore crucial that IR and UV radiation is kept to an absolute minimum. Filters can be added to conventional light source luminaires to help, but LED is recommended as they emit negligible amounts of both types of radiation, with no heat in the actual light beam. It is also important not to over-illuminate as this too can negatively affect the produce by promoting various chemical reactions. 1000 lux for accenting lighting is absolutely sufficient to visually stimulate without negatively influencing produce. Even lower levels are acceptable depending on the overall ambience of the store lighting.





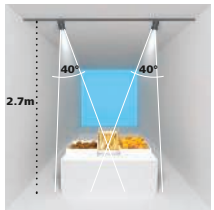
6500 K *3500 K*

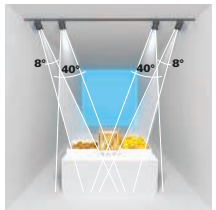
The right light can make goods appear fresh from the bakery, stimulating the appetite and therefore purchasing behaviour

CHEESE, BREAD AND PASTRIES

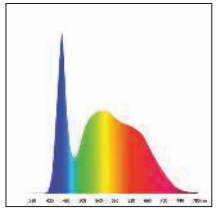
Few things are more tempting than the look and aroma of freshly baked bread and pastries. It is key to perfectly illuminate such produce as they are often bought on impulse and stimulate the appetite, having a greatly positive effect on a supermarket's turnover. Cheeses likewise require careful lighting to accentuate their unique properties, driving the buying of these costly and specialist items.

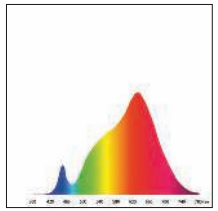
Similarly to fruit and vegetables, such items are often displayed at an angle, in boxes made of natural materials which emphasise the homely origin and colours of products. Cheeses must be refrigerated, and can also be displayed in open-fronted cabinet displays. Accent lighting with a beam angle of 40° differentiates product groups and highlights the crusty texture of baked goods and the soft, smooth or crumbly texture of cheese, visual factors very important in the choice of such items. It is also appropriate to use narrower beam angle accent lighting to create additional areas of brightness to guide the eye of customers around displays, encouraging impulse purchases. It is vital to use light sources with excellent colour rendition of CRI≥90 to ensure that customers are satisfied with the freshness and quality of their choices. For baked items it is best to use warmer light colour temperatures of 2700–3000 K that have Ra10 of at least 90, which really brings out the special golden colour we all love in our fresh bread and pastries. On the other hand, cheeses need to be illuminated with the appropriate light colour temperature for their type, with warm white light sources that provide good colour rendition of the yellow part of the spectrum for yellow cheeses, and light sources that highlight whiteness for white cheeses.





Baked goods and cheeses are susceptible to IR and UV radiation, which can cause breads to dry and cheeses to sweat and discolour. It is important that conventional light sources be equipped with the appropriate protective filters. LED however is simple and practical to use, as they emit almost no IR and UV radiation so your products are protected without the need for additional apparatus. An optimal accent illumination level of 1000 lux will ensure customers are visually stimulated and can closely inspect products prior to purchase. Lower levels can be appropriate for baked goods within the context of the overall lighting design, although cheeses are best displayed in bright light as their perfection is central to purchasing decisions.





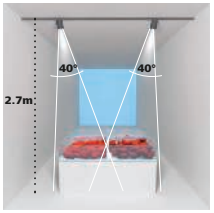
6500 K *2700 K*

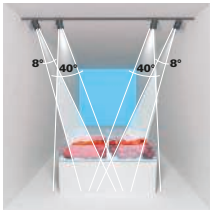
The most sensitive product group, fresh meats must not be over-illuminated in order to minimise deterioration

MEAT, COLD MEATS AND POULTRY

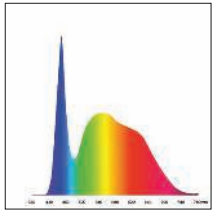
The correct illumination of meat products is a complex combination of many factors. Meats need to look fresh and appealing, whilst legally they must be displayed in a way that cannot mislead customers as to their condition. The freshness and quality of meat products are central to customer perception of a store, having a considerable impact on which supermarket they choose.

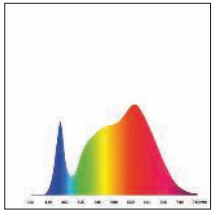
Broad angle homogenous and glare-free light minimises glare and reflections on server-over counters and glass open-fronted display cabinets so that customers can clearly see and evaluate freshness and quality, and staff are not unduly visually fatigued. What is most complex about the illumination of meat products is the selection of the perfect light source. It is recommended to user warm colour temperatures, to emphasise the natural colour of the produce, combined with excellent general colour rendition of CRI ≥ 90. It especially important that red and pink colours are shown precisely, with an Ra9 of least 80. Many light sources lack strength in rendering this part of the light spectrum, which leads to the required use of additional filters. However, it is also necessary to display the whiteness of meats accurately, without the pink hue from red filters. LED is suited to this application as there are now available variants with excellent red and white colour rendition that can highlight all visual aspects of the meats perfectly. Accent lighting can be used to highlight design elements behind serve-over counters, emphasising notices about special offers and new or key products.





Another important aspect of meat display is that light levels above 800 lux cause chemical reactions that give meat a greyish appearance making it look less appetising and even as if decaying. It is also necessary to protect produce from the visually and biologically negative effects of IR and UV radiation, a particularly difficult task as meats are often displayed in enclosed areas. Again, LED comes to the fore here as they emit little such radiation and can be safely used in close proximity to products.





6000 K *3000K*

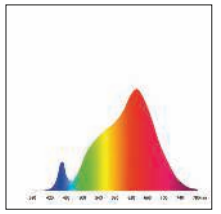
Cool light simulates the natural environment of the goods, making them look attractive and appetising

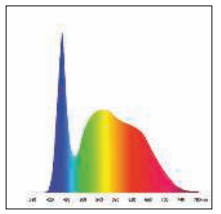
FISH, FROZEN PRODUCTS AND DAIRY

For certain types of product, it is important to communicate coldness with the light and not only by means of the actual temperature. This is the case for frozen items, fresh fish and dairy. The perceived low temperaure promotes a sense of freshness, assuring customers that the products displayed are of the highest quality. It is vital to use light with excellent colour rendition of CRI ≥ 90 in order that goods are truthfully and temptingly presented.

Cool white light immediately changes the perception of a space and has an emotionally activating effect. For freezer cabinets it is ideal to use bright white light with a cool colour temperature of 6000 K. For the display of fresh fish, light sources with excellent colour rendition of red and white are necessary, with an Ra9 of CRI ≥ 90, to bring out the inherent appetising redness of the flesh, and the cool sheen of the skin. However, it is best to display such items separately depending on if the products are whole or cut. Whole fish, especially if presented on ice, look ocean fresh when displayed under cold white light with a colour temperature of at least 5500 K, whereas fillets and seafood look tantalising under warmer light with a colour temperature of 2700–3500 K. Dairy, displayed in cooler cabinets, looks fresh and creamy under light with a colour temperature of 6500K.

All such products look flawless in bright, uniform light without distracting and deterring shadows. The brightness is perceived as being crisp, like outside on a fresh winter day. This can be easily and effectively achieved by using discreetly mounted strip lighting luminaires directly in the display cabinets, which do not causes any glare on glass surfaces and are not visible to customers, but provide unobstructed illumination of products. Here LED light sources are ideal as they are not negatively affected by low temperatures, in fact their performance improves. Also, they emit hardly any heat and so do not add to the cooling load of the refrigeration equipment. LEDs are also standardly available in many colour temperatures, opening up the lighting options available without the need to use additional filters.





3000 K

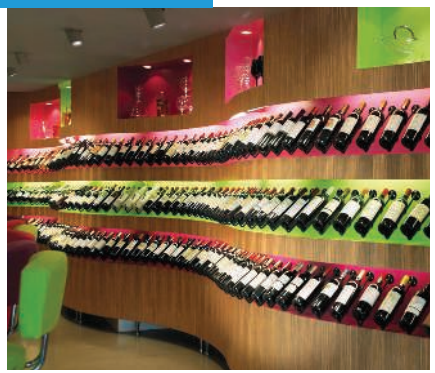
6000 K

Exclusive items demand mood lighting, with warm light creating a relaxing and appealing atmosphere

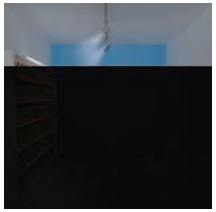
WINES, DELICATESSEN AND CONVENIENCE FOODS

Some product types require special attention as they are perceived as having a higher value and come with a correspondingly higher price. Wines, delicatessen items and convenience foods are products that customers take the time to browse and assess, products that very much appeal to the appetite rather than an objective need. Therefore, it is important to display such items in a visually stimulating and emotionally activating way, using more differentiated interior design and atmospheric lighting.

The commonly used minimum 2:1 horizontal to vertical illumination ratio applies for these items also as they are almost always displayed on shelves. Accent lighting, rather than uniform general lighting, should be used to create contrasts between light and shadow and give a more dramatic and stimulating atmosphere to the space. In this way, bottles stand out, delicatessen items look more appetising, and convenience foods more visually attractive. It is beneficial in such areas to use natural materials, such as wood, to reinforce the impression of authentic quality and taste. Such materials, along with their tasty display items, will look best under a warm colour temperature of 3000 K, which creates a homely and intimate atmosphere more akin to a specialist store rather than a supermarket, and brings out the tempting glow of the colours. This will encourage customers to take more time to find the perfect item.



Ceiling mounted spotlights and shelf mounted strip lighting luminaires are perfect for this kind of application, but care must be taken that they do not overheat the products, which can be sensitive and spoil. LED comes to the fore here as their very low emittance of IR radiation means that they can be used in very close, and dramatically creative, proximity to the goods. They are also ideal for use in refrigerated cabinets as they do not represent any extra cooling load. Their flexibility in terms of colour temperatures is also an advantage as it is possible to perfectly tailor the individual lighting fixtures to the items they illuminate.



Accent lighting

Accent lighting in combination with backlighting

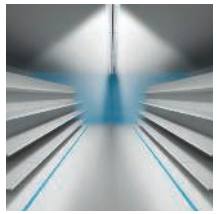
Most foods are displayed on shelves and require higher levels of vertical illumination to attract and guide attention

DRY FOODS

A large proportion of the goods displayed in a supermarket are dry foods, items packed in boxes, jars, bottles, bags, etc., located on shelves in long aisles. Here the classic ratio of vertical to horizontal illumination of 2:1 is perfectly demonstrated, as the light is effectively used to clearly and brightly highlight product packaging.

Aisles with shelves are best illuminated using continuous line linear fixtures positioned parallel to and above, ensuring that all the emitted light is provided where it is needed. The use of double asymmetric reflectors directs the light to the left and right onto the vertical shelf fronts, perfectly illuminating all products. This kind of general lighting provides clear and uniform illumination along the full length of the aisle, ensuring visual comfort and acuity. It is also possible to substitute or supplement such general lighting with accent lighting to create more a more dramatic atmosphere. Here each product group can be highlighted independently, acting as a stimulating visual cue to customers. Light colour temperatures of 3000 K or 4000 K provide a soft and neutral atmosphere which is psychologically comfortable for customers, encouraging them to take their time browsing and to buy more.

Dry foods are often sensitive to UV and IR radiation, so it is beneficial to use LED lighting fixtures as they emit negligible amounts of both. This ensures that products not only last a long time, but look perfect too. LEDs are also highly efficient and can provide savings in energy consumption, something worth considering as supermarket general lighting accounts for a large proportion of the overall energy consumed.



SELECTION OF THE RIGHT LIGHT SOURCE

Every space has different illumination requirements. The first and most basic task for lighting designers is the selection of the most appropriate light source or combination of light sources for each area, ones that provide the desired lighting characteristics. This selection is based on various factors, such as power consumption, luminous efficacy, colour temperature, colour rendition and RGB. Besides these lighting parameters designers must also consider the cost of procurement, maintenance and the lifetime of the light source.

Lamp type	Power rating from - to (W)	Luminous flux from - to (lm)	Efficacy from - to (lm/W)	Light colour	Colour rendering index (CRI) from-to	Lifespan from-to	Socket
Incandescent	30 - 100	300 - 1000	10 - 12	ww	> 90	1000	E27, E14
Tungsten halogen	5 - 250	60 - 5500	12 - 22	ww	> 90	2000	E27, E14, G9, GU10, GZ10
Linear fluorescent FD (T8) Ø 26mm	18 - 70	860 - 6200	61 - 93	ww/nw/dw	80 - 96	16,000 - 80,000	G13
Linear fluorescent FDH (T5) Ø 16mm	14 - 80	1100 - 6150	67 - 104	ww/nw/dw	80 - 93	24,000 - 45,000	G5
Compact fluorescent lamp 2 or 4 tube	5 - 57	250 - 4300	46 - 90	ww/nw/dw	80 - 90	5000 - 32,000	2G11, 2G7
Compact fluorescent lamp 3 or 4 tube	60 - 120	4000 - 9000	67 - 75	ww/nw	80 - 85	5000 - 32,000	2G8-1
High pressure metalhalide lamp single-end	20 - 150	1700 - 15,000	80 - 100	ww/nw	80 - 95	6000 - 15,000	G12
High pressure metalhalide lamp - single-end mounting with ceramic technology	70 - 150	5100 - 15,000	73 - 100	ww/nw	80 - 95	6000 - 15,000	PGJ5
High pressure metalhalide lamp - double-end mountings	70 - 150	6800 - 14,500	86 - 115	nw/dw	88 - 95	4500 - 15,000	RX7s
High pressure metalhalide lamp with ceramic technology and with reflector	20 - 70	1500 - 6900	73 - 98	nw/dw	82 - 90	10,000 - 12,000	GX8,5
High-pressure sodium sodium lamp - ellipsoidal shape	35 - 150	2200 - 20,900	63 - 139	ww	25, 65	12,000 - 32,000	PG12-1
High-pressure sodium - tubular shape	50 - 150	4400 - 22,500	70 - 150	ww	25, 65	12,000 - 32,000	GX12-1
LED retrofit	3 - 7	90 - 806	37 - 70	ww/nw/dw	80 - 90	5,000 - 20,000	GU10, E27
LED tubes Ø 26mm	24 - 30	700 - 1900	51 - 66	ww/nw/dw	70 - 80	10,000 - 35,000	G13
LED module	1 - 140	100 - 17,200	90 - 200	ww/nw/dw	80 - 98	50,000 - 100,000	-

ww = warm white correlated colour temperature (CCT) below 3300 K
nw = neutral white correlated colour temperature (CCT) 3300 K to 5300 K
dw = daylight white correlated colour temperature (CCT) over 5300 K

LED FOR RETAIL

When in 1962 the American professor Nick Holonyak created a prototype of the first 'Light Emitting Diode' (LED), it went almost unnoticed. The only one who anticipated its revolutionising future in the pages of Reader's Digest magazine was the inventor himself. It was almost 40 years before the industry began to realise the exceptional properties of LEDs and start learning how to harness them. Now LED is the most dynamic field of advancement in the entire lighting industry.

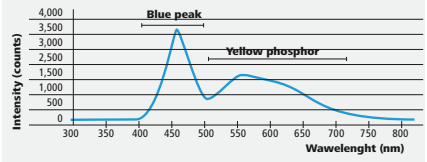
So, what is it exactly that makes LEDs so special, and how is it that their properties and parameters surpass those of conventional light sources? Why do architects, retail developers and spatial designers increasingly concentrate on the use of LEDs in the design of their lighting systems? Like any answer to any question, there is a short version and a long version. The short version is that LEDs are highly effective, have long lifetimes, excellent colour rendering properties and varied colour temperatures, and are cost-effective and environmentally friendly. However, to truly understand we must look at each property in detail starting with what LEDs actually are.

LEDs are semiconductor diodes that emit light by a process called electroluminescence. Each diode consists of two types of semiconductor, an N-type with surplus electrons and a P-type with a deficiency of electrons (called holes). When a current is passed through the semi-conductors the surplus electrons from N and the holes from P recombine to produce photons, commonly known as electromagnetic radiation, some of which we perceive as light. Most LEDs produce photons in the blue part of the visible spectrum, which need to be transformed into 'white' light using modifying phosphor layers. The light emitting part of the LED, the die, is in fact no bigger than the dot made by a pencil. It is enclosed within a 'package', most of which is a lens used to direct the light and at the same time protect the tiny die.

So, how are LEDs effective? Basically, they emit a lot of light in a very direct way, and use little electrical energy to do so. The beam angle of an LED rages between 15° and 180°, which allows the light to be harnessed and directed very precisely and minimises the amount lost within the optics of the luminaire. This is something very different to conventional light sources, which usually emit light in a very wide beam angle, much of which is not directed to where it is needed. This means less light needs to be emitted to achieve the same level of illumination when using LEDs, which reduces energy consumption. Additional aspects of the energy consumption argument include the fact that LEDs are more effective at making light. Incandescent bulbs transform a mere 5 % of the consumed electrical energy into light, fluorescent lamps 30 %, and LEDs 40 %. Another value to this is the luminous efficacy of a light source, which is the calculation of how many lumens you get from one watt, or lm/W. The first white LEDs in the mid-90's has an efficacy of 0.1 lm/W, however there are now commercially available LEDs, those with cool CCTs, that offer an efficacy of more than 160 lm/W. In laboratory trials efficacies of more than 250 lm/W have been achieved, illustrating great potential.

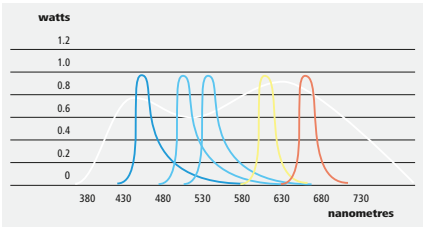
Colour rendition and temperatures? Both are crucial aspects of retail lighting design, and strong advantages of LED that make them suitable for this complex area of application. LEDs can emit light with CCTs anywhere between 2500 K and 10,000 K. Which CCT is emitted depends on the phosphor layer used in the LED. No other light source type has the variability and range of CCTs that LEDs do. It is even possible to use LED technologies that allow for adjustable CCTs within one luminaire, a very flexible and practical option for fast-changing retail environments. White light can also be created by combining the light emitted by red, green and blue LEDs, or RGB. In terms of producing white light, this is not an ideal solution as achieving just the right combination is a difficult process and colour rendition is reduced. However, the combination of RGB with white LEDs brings many new lighting opportunities to retail spaces, as RGB can be used to create millions of colours additional to the clear white light from the white LEDs. As for colour rendition, LEDs are available with CRIs between 70 and 98, with CRI ≥ 90 recommended for retail application as it is close enough to perfect rendition that the human eye does not register the difference. The smart combination of various CCTs and high CRIs ensures that all merchandise is displayed at its best, and truthfully, with RGB used create interest and drama.

Most LED light sources have a lifetime of 50,000 hours, which in a retail application where lighting is required 12 hours per day, 7 days per week, represents 11 years of reliable and maintenance-free operation.



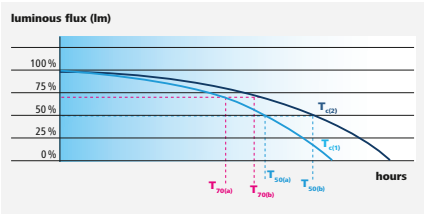
White light can be produced by combining blue and yellow light only. Sir Isaac Newton discovered this effect when performing colour-matching experiments in early 1700s.

SPECTRA OF WHITE AND COLOURED LEDS



LEDs do not require colour filters. The colour tone of the light is determined by the semiconductor material used and the dominant wavelength.

DEFINITION OF LIFESPAN



LEDs do not fail but the intensity of the light they produce diminishes over time. The lifespan (L) of an LED thus needs to be defined for different applications. For emergency lighting, for example, rating up to L80 are more are required, this means that the LED reaches the end of its service life when the luminous flux falls to 80 percent of the original flux measured. For general lighting, values of L50 or L70 are defined. The lifespan of an LED depends to a large extent on ambient and operating temperature. Where an LED is operated at a high temperature (Tc1) or with poor thermal management, its life is shortened.

What about lifetimes? The types of LED used in retail settings have a lifetime of around 50,000 hours and very low failure rates. In practice, this means that a light source in operation 12 hours per day, 7 days per week will last for 11 years, something not attainable with conventional light sources. Reductions in performance are inevitable, but happens towards the end of the LED's life and can be compensated for during the design of the lighting system. However, it is important that LEDs are effectively cooled as their lifetime is reduced and they operate less effectively under high temperatures. That is why it is vital to use quality luminaires where this factor is fully accounted for.

But LEDs are more expensive, so how can they be cost-effective? Yes, LEDs are more expensive, but that is merely one factor in the equation. In order to fully appreciate the cost-effectiveness of LEDs you need to think long term and not only about the initial investment. LEDs, as previously mentioned, use a lot less energy than conventional light sources. It is estimated that if all light sources were replaced with LEDs it would provide 30 % savings in energy, and if we think that artificial lighting accounts for 20 % of the overall consumption of electrical energy, that is no small difference. Even higher savings can be provided when LEDs are used to replace older and less efficient light source types, such as discharge lamps. Here savings of up to 70 % can be made simply by changing the light source. But wait, there is more. The lifetime of LEDs is longer, so savings can be made on the replacement of light sources over time, and all costs associated with maintenance. LEDs emit negligible amounts of IR radiation, or heat, and so demand far less of air conditioning systems than conventional light sources, some of which emit incredible amounts of heat. LEDs are also infinitely controllable by Lighting Management Systems, including switching and dimming according to presence and daylight availability amongst others, further expanding the savings potential available. And lastly, LEDs are safe and easy to dispose of. Most conventional light sources contain hazardous materials and are costly to dispose of as it must be done in specialist facilities and using complex processes.

How environmentally friendly? Well, LEDs consume less energy, therefore less resources, and they contain almost not hazardous content. Reduced energy consumption of course means fewer resources are used to produce the energy, and less waste is created as a by-product of that process. Moreover, the hazardous material content of LEDs is very low compared to conventional light sources, most of which contain significant quantities of toxic heavy metals in a gaseous state, making them dangerous when damaged and harmful when disposed of. LEDs do contain a very small amount, but in a solid state which means that even if damaged they pose no threat to us, and those small amounts of material are simple to separate and dispose of once the time comes.

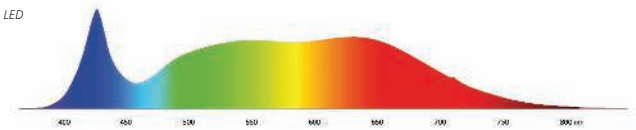
THE SPECTRAL DISTRIBUTION OF LIGHT

Light colour is defined using the CIE 1931 chromacity system. The Planck curve represents the ideal combination of all primary colours for human visual perception, against which can be mapped the whole range of Correlated Colour Temperatures (CCT) from very warm (2500 K) to very cold (10,000 K). Each type of light source has its own specific chromacity coordinates, most of which lay somewhere along the Planck curve, and its own spectral distribution, which is the amount of photons emitted at each wavelength, or the ratio of colours within the light. The spectral distribution of every light source can be mapped, from which we can learn much about the nature of the light emitted.

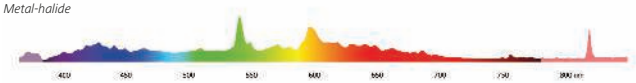
If we study the spectral distributions of LED light sources we see that they emit very little energy at UV and IR wavelengths when compared to conventional light sources. The advantages of this have been clearly and repeatedly explained throughout this publication with regard to every area of retail lighting. Both UV and IR radiation have distinctly negative effects on all kinds of merchandise, from UV fading the colours of fabrics, to IR spoiling foods. IR is experienced as heat, meaning that light sources that emit large amounts of invisible IR radiation are emitting heat that must be removed using costly air conditioning systems.

Another interesting feature of the different spectral distributions is that LEDs emit generally more photons at all visible wavelengths. This is perceived by the human eye as good colour rendition. However, not all CRI values are equal. Metal-halide displays all colours in a reasonably balanced way, and therefore have good colour rendition. LED on the other hand displays all colours, especially blue, with much higher definition, which means that CRI ≥ 90 in LED has more depth than CRI ≥ 90 in metal-halide. The colours are truthful, but have a more lifelike and saturated colour under LED light sources, more like under natural daylight.

LED



Metal-halide



Ri		Colours under natural daylight
R1		Light grayish red
R2		Dark grayish yellow
R3		Strong yellow green
R4		Moderate yellowish green
R5		Light bluish green
R6		Light blue
R7		Light violet
R8		Light reddish purple
R9		Strong red
R10		Strong yellow
R11		Strong green
R12		Strong blue
R13		Light yellowish pink (human complexion)
R14		Moderate olive green
R15		Japanese complexion (available in JIS only)

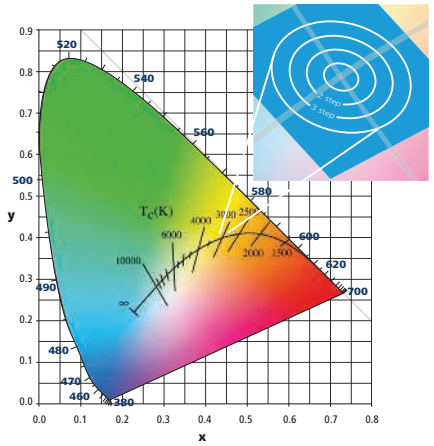
	LED	Metal-halide
CCT	4306 K	4241 K
CRI Ra	94.6	90.5
CRI R1	97.2	96.0
CRI R2	96.6	94.6
CRI R3	90.1	84.2
CRI R4	92.5	91.9
CRI R5	98.4	93.8
CRI R6	92.7	92.3
CRI R7	94.1	90.7
CRI R8	95.6	80.5
CRI R9	95.5	43.9
CRI R10	91.2	79.2
CRI R11	91.7	93.2
CRI R12	81.3	84.7
CRI R13	97.2	96.4
CRI R14	93.5	89.9
CRI R15	94.4	89.6

COLOUR CONSISTENCY

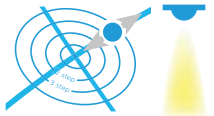
During the production of LEDs, deviations occur between individual batches with regard to various lighting parameters such as light colour. Within one batch the parameters are almost identical, but between two batches the differences can be very apparent. To ensure consistent light quality it is necessary to sort every batch according to their individual lighting parameters, a process called 'binning'. The main criteria considered during binning are the luminous flux (lm), the CCT (K) and the forward voltage (V).

The most important parameter to consider concerning the retail environment is light colour consistency. The use of low-quality LEDs can mean that within an installation potentially every luminaire will emit light with a perceptibly different colour. This is highly undesirable in retail settings where consistent light is vital for accurate perception of goods, and where the impression of quality gained from the environment can greatly effect sales.

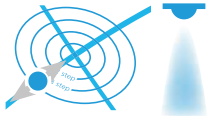
Colour consistency needs to be thought about in two ways. Firstly, it is important to choose a luminaire manufacturer that uses high quality LEDs, in this way you are assured that when installing a new lighting system all the luminaires will emit a perceptibly consistent light colour. Secondly, you need to think about what happens next, as all light sources emit light of a different colour after time, and LEDs are no exception. Your new installation can look perfect when new, but after five years the light colour of the luminaires can vary greatly. This is accounted for during the binning process. Nowadays LEDs are classified according to ANSI standard that defines colour consistency on the basis of the MacAdam ellipses, which quantify colour deviation along an X-Y axis: along the Planck curve between warm and cold, or above and below the Planck curve to green or pink. ANSI recommends that LEDs be within three threshold values of each other to be acceptable in use together. To put that in context, a difference of three steps is barely noticeable.



Starting point of 3000 K

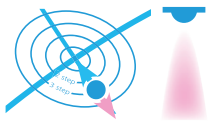


Warmer colour temperature on the Planck curve



Cooler colour temperature on the Planck curve

Above the Planck curve (green)



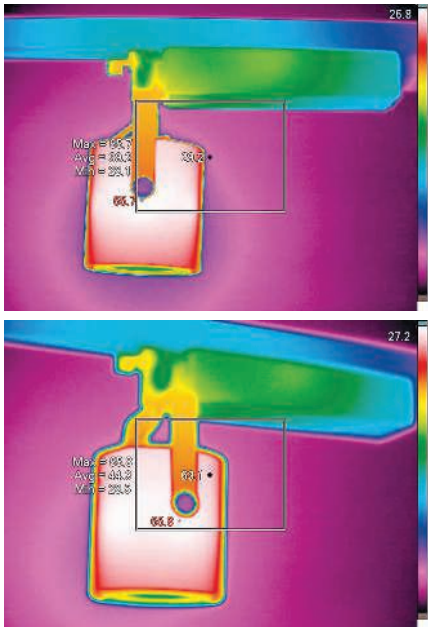
Below the Planck curve

What this means in practice is that, if all installed light sources begin with a CCT of 3000 K, they cannot change colour by more than three steps. This refers not only to the difference of one light source, but to the difference between all light sources in an installation. For example, one could move more towards a cooler colour temperature and another towards a warmer colour temperature, but the difference between them should be no more than three steps or else the deviation will be clearly apparent. Very high quality LEDs have a difference of only two steps over their lifetime, however a difference of three or four steps is standard. Some LED manufacturers have developed complex processes by which they can sort LEDs also according to the direction of deviation, so even though the light colour changes of all LEDs change, it will be in the same way, keeping any visual discrepancy to a minimum.

The experts estimate that if we replaced all existing light sources for the LED ones today, the energy savings worldwide could reach the amount of 30 %. If we realise that the artificial lighting consumes up to one fifth of the energy produced, this amount is not negligible at all.

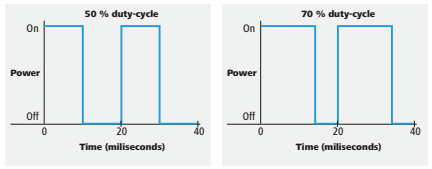
THERMAL MANAGEMENT

LEDs are as affected by operating temperatures as any other type of light source. However, LEDs are special in that they function better at lower temperatures, whereas other light sources tend to function better at higher temperatures. It is crucial that appropriate thermal management be used in LED luminaires to ensure that the LEDs do not overheat, which reduces their lifetime and efficiency and increases the risk of damage or failure. With this in mind, it is fair to say that thermal management is the most critical factor in the design of LED luminaires.

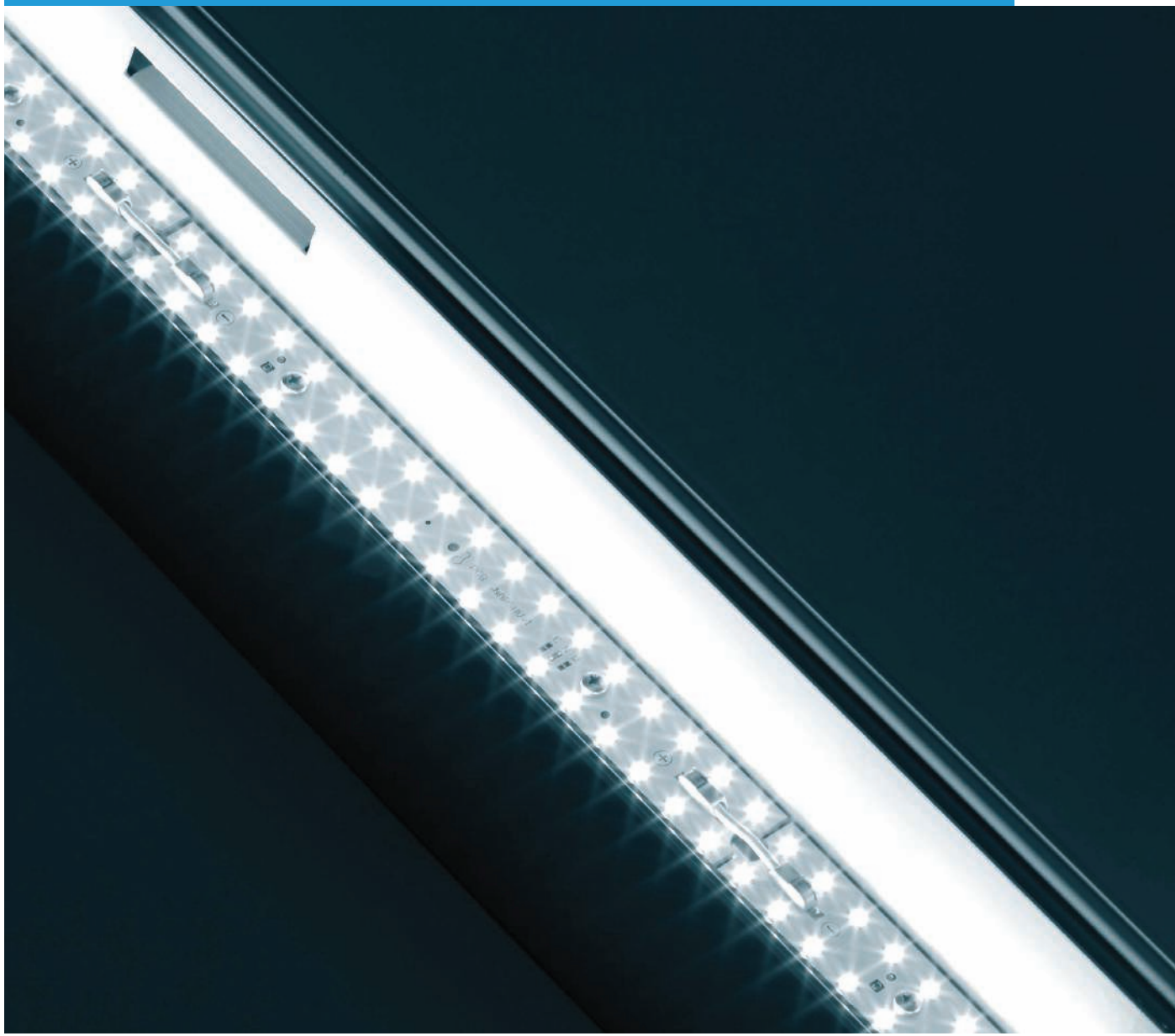


PULSE WIDTH MODULATION CONTROL

Pulse Width Modulation (PWM) is the method used to control the brightness of the light emitted by an LED and functions on the principle of switching on and off the current supplied to the LED die. Brightness levels are determined by the proportion of on and off time, also referred to as the duty-cycle. Switching frequency must be such that the light is perceived as constant by the human eye.



LEDs reach full illuminance immediately, something impossible with conventional light sources. This is beneficial in terms of safety and comfort. Another benefit of LEDs is that they are not negatively affected by frequent switching or dimming, allowing them to be effectively controlled without reducing their lifetime.



BASIC TERMS

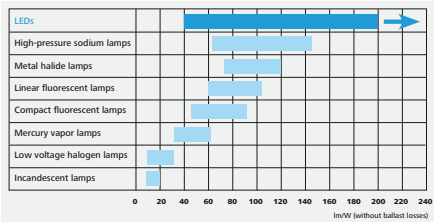
LUMINOUS FLUX (Φ)

Luminous flux is a physical quantity that tells us how much light is radiated in all directions in relation to the human eye, causing visual perception. The unit is lumen (lm).

EFFICACY (η)

Luminous efficacy tells us how effectively electrical energy (W) is transformed into light (lm). The unit is lumens per watt (lm/W).

EFFICACY OF LIGHT SOURCES

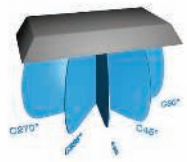


LUMINANCE (L)

Luminance is the light we perceive as it is reflected into our eye in relation to a specific surface. The unit is candela per square metre (cd/m²).

LUMINOUS INTENSITY (I)

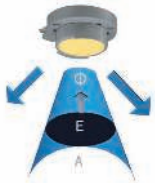
Luminous intensity is what we would commonly call brightness. It is the amount of luminous flux given by a light source or luminaire. The unit is candela (cd). Illuminance is a vector quantity which states what amount of the luminous flux falls to the illuminated surface. The unit of the illuminance is lux (lux).



intensity distribution curve

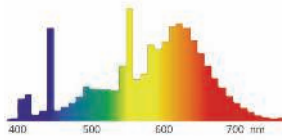
ILLUMINANCE (E)

Illuminance is the amount of light falling onto a surface. The unit is lux (lux).



GLARE (UGR)

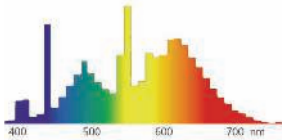
Glare is a condition caused by areas within our field of vision being brighter than the task or space we are focussing on. The excessive contrast reduces visual acuity and can cause headaches and fatigue.



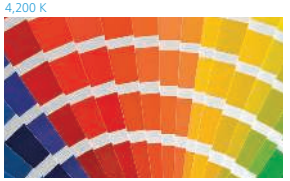
2,700 K

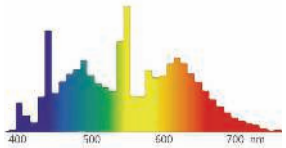
Corrolated Colour Temperature determines the atmosphere created by light. Low temperatures create warm light and cool temperatures create cold light. Warmer colours highlight red, yellow and orange and cooler colours highlight blue and green. The unit is kelvins (K).

CORRELATED COLOUR TEMPERATURE (CCT)

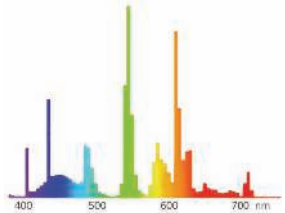


4,200 K





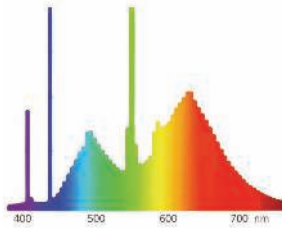
6,500 K



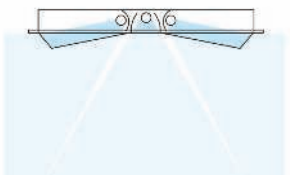
CRI 70

The Colour Rendering Index expresses how truthfully the light from a light source displays the colours shown under it. The higher the CRI value the closer to perfect colours are shown. Sunlight is classed as the perfect light against which all others are measured.

COLOUR RENDERING INDEX (CRI)



CRI 95



Light Ouput Ratio tells us the ratio of light emitted from a light source or sources and the amount provided by the luminaire. It shows us how effective a luminaire is and the amount of light lost in the optical system.

LIGHT OUTPUT RATIO (LOR)


BOWLING