
DESIGNING DAYLIGHT SOLUTIONS FOR COMMERCIAL BUILDINGS

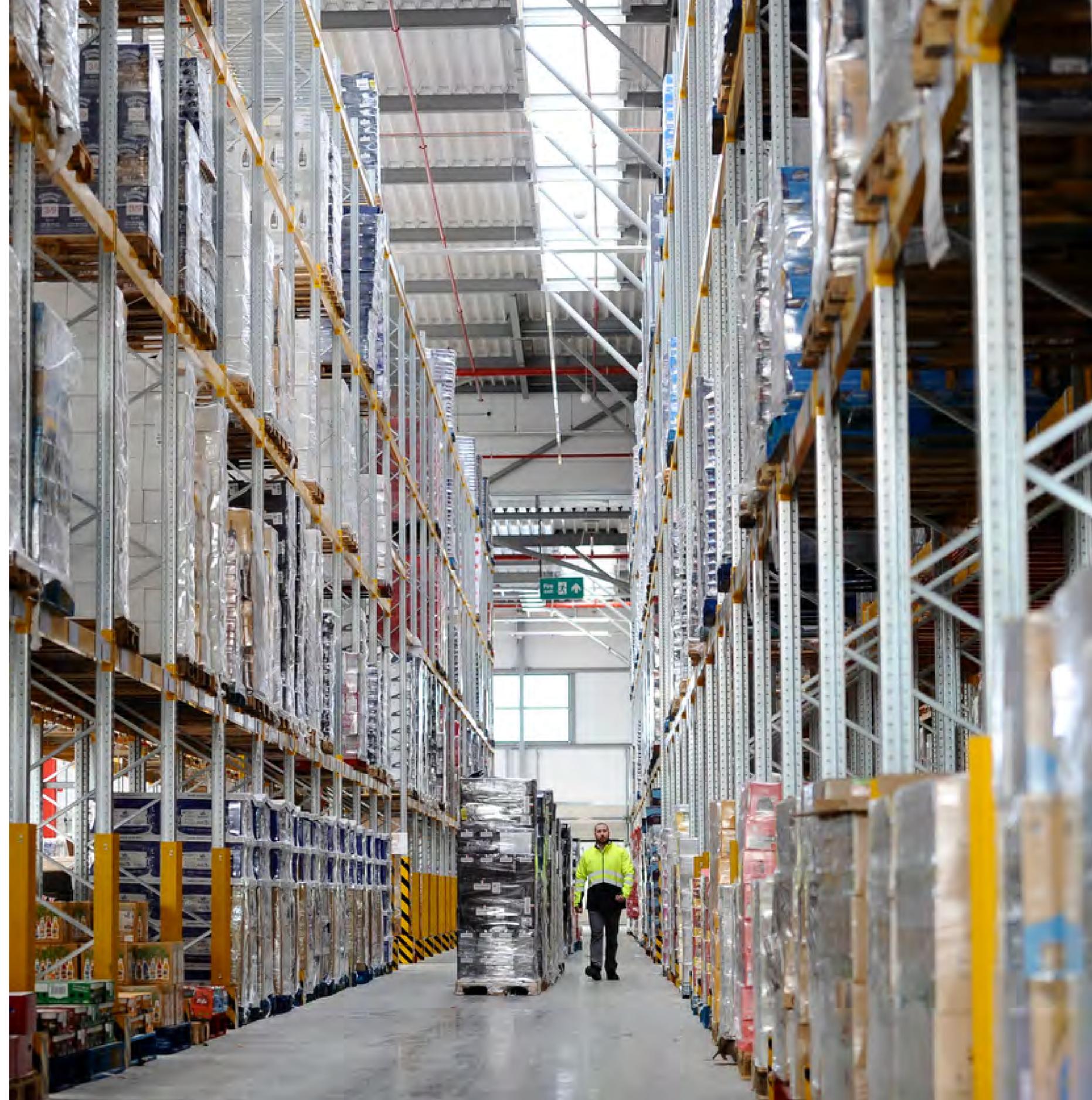
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Commercial

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EXECUTIVE SUMMARY

”

From the year 1800 to 2000, we've gone from 90% of people working outside to less than 20%. In a very short space of time we've gone from being an outdoor species to spending most of our time in dim, dark caves.

”

Dr Russell Foster

Head of the Nuffield Laboratory of Ophthalmology and the Sleep and Circadian Neuroscience Institute, University of Oxford.

The availability of artificial light over the last two centuries and the re-structuring of our working day have seemingly freed us from the constraints of the diurnal cycles of light and dark that nature places upon us. However, there is now a huge body of research that shows that this “divorce” from nature comes at a considerable cost to our individual health and well-being, indeed even to society at large. Even before the Covid-19 pandemic restricted us to essential journeys and limited exercise we were fast becoming an “indoor generation”. For many of us, our experience of daylight and fresh air

was often restricted to the morning commute to work or school, a quick lunch break or a stop at the supermarket on the way home.

Nonetheless, studies have shown that people still strongly prefer daylit spaces to those lacking natural light, even where there is sufficient artificial light to be able to see and have a primal need to be connected to nature. Spaces that have plentiful daylight are generally perceived by occupants to be “better” than dim gloomy ones (source: Mardaljevic et al, 2012), and lead to them experiencing a greater sense of job satisfaction.

The influence that architecture has on our lives cannot be understated, and the need to create healthier, brighter indoor spaces with greater access to daylight and to the outdoors is a pressing one. Roof glazing can contribute to making our work environments lighter and more connected to nature by offering unobstructed sky and sunlight, often bringing daylight into the heart of a building. There are a wide variety of roof glazing solutions that can provide commercial buildings with more natural light, help to achieve higher rates of ventilation, and contribute to saving energy. Solutions include modular skylights, glass rooflight systems, polycarbonate dome rooflights, and continuous barrel vault rooflights.



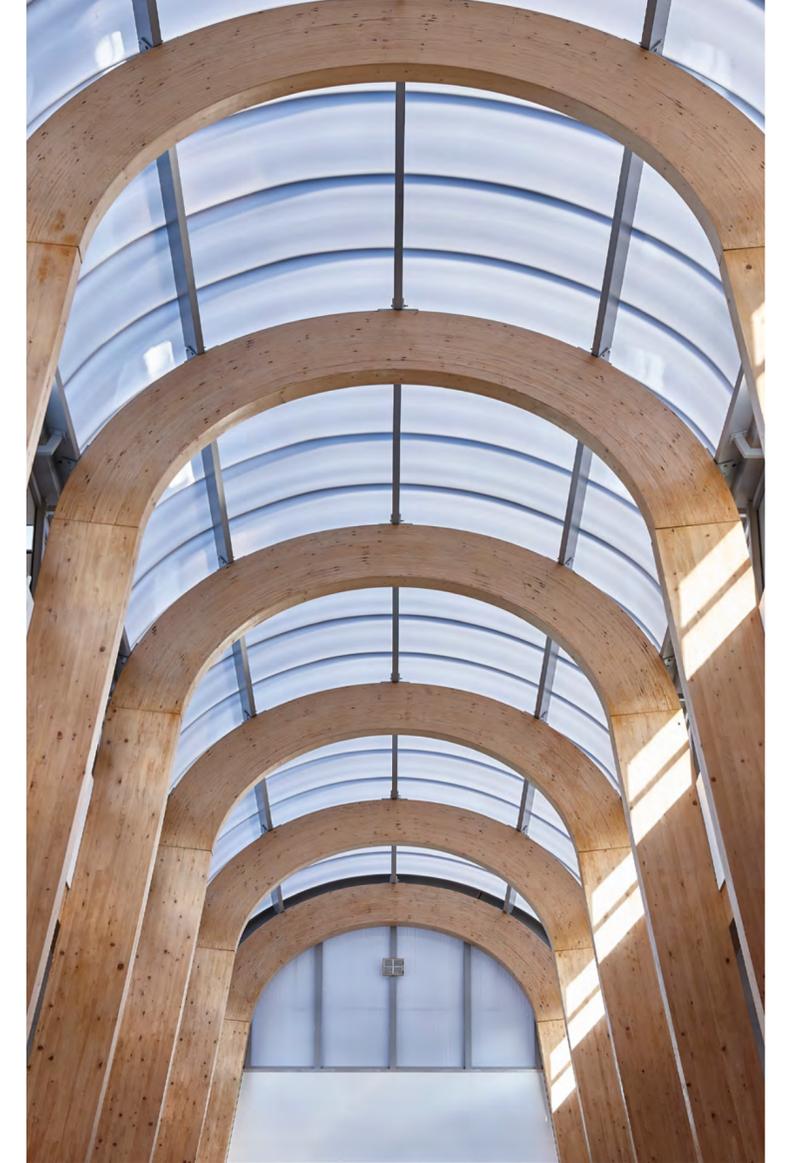
THE EMERGENCE OF THE INDOOR GENERATION

The rapid change in our lifestyle from spending large amounts of time outdoors for work or relaxation to becoming an Indoor Generation carries with it several risks...

Dr Hilary Jones
GP & Health Broadcaster

The 'Indoor Generation' refers to a growing number of people who spend the vast majority of their time indoors, currently 90% of their lives, living, working, learning and playing, and often in dark, poorly ventilated and unhealthy buildings.

Many of us do not realise that the lack of light can affect our sleep patterns and increase the risk of serious health problems such as diabetes, heart disease and depression. Indeed, only about half of the 16,000 respondents, who were questioned about their perceptions of indoor living as part of the 2018 YouGov survey which was commissioned by VELUX across 14 countries, were aware that daylight has a significant impact on sleep! Sleep loss and circadian rhythm disruption are most obvious in night-shift workers – more than 20% of the population of employment age work at least some of the time outside the 07:00-19:00 day. Josephine Arendt at the University of Surrey highlights this: "Because of their rapidly changing and conflicting light-dark exposure and activity-rest behaviour, shift workers can have symptoms similar to those of jet lag... and usually live out of phase with local time cues".



DAYLIGHTING NEEDS - HOW OUR CIRCADIAN RHYTHMS ARE IMPACTED BY DAYLIGHT

Whilst we have adapted to living indoors, we are essentially still outdoor animals, and our gene code is designed for us to live in a natural environment. Prior to the arrival of buildings our daily lives were determined by the availability of daylight hours, and the qualities of light that signalled changes in weather and in time. Our physiological systems, especially our circadian cycles were in harmony with these diurnal rhythms of daylight, as were our emotional responses to light and darkness (source: Herrwagen, 2011)

Light is "an acute stimulant that directly alerts the brain" and thus can affect energy levels as well as alertness and productivity. A properly functioning circadian cycle also determines patterns of coordination, blood pressure and cardiovascular activity. It affects mood and influences social behaviours and cognitive performance. Brain imaging following light exposure shows increased activity in many areas of the brain that are involved in alertness, cognition and memory (thalamus, hippocampus, brainstem) and mood (amydala).

HOW OUR CIRCADIAN CLOCK IS BEING DISRUPTED THROUGH SHIFT WORK AND OUR 24/7 SOCIETY

Increasingly our circadian cycles are being disturbed – advanced or delayed – by exposure to light at different times, and our metabolism and behaviour patterns are changing as a consequence. Peter Foldbjerg, Head of Daylight, Energy & Indoor Climate, laments that we now live in a "social clock society", a 24/7 society, that has become disconnected from the light and dark in nature. We are living and working in buildings where we are removed from natural daylight, where artificial light is often around 200 lux and rarely exceeds 500 lux, levels which are insufficient to regulate our biological rhythms, which require 1,000 lux. Hence the analogy to the "dim cave". The inability to provide the occupants of buildings with a well-illuminated environment can result in a detrimental impact on health and productivity, and a "substantial burden on the individual, society and the broader economy".

The benefits of working in bright and well-ventilated commercial spaces to our overall well-being and performance cannot be understated.



THE IMPACT OF DAYLIGHT ON OCCUPANTS IN COMMERCIAL BUILDINGS

The Covid-19 pandemic meant many of us had to adapt to working from home, whether temporarily or on a more permanent basis. For some, that meant turning a spare room into a useful 'office' space. For others, it meant trying to work at kitchen tables with frequent distractions. These enforced changes have shifted our views on what makes a comfortable working environment and perhaps reassess the good and bad of our office buildings.



In the YouGov survey, 39% of respondents said that daylight significantly impacts on their mood.

THE IMPACT OF DAYLIGHT ON OCCUPANTS IN COMMERCIAL BUILDINGS

Research on office buildings has shown that office workers highly value access to a window and to varying degrees of daylight – in a study of 7 office buildings in the Pacific Northwest (source: Heerwagen et al, 1992) more than 83% of the occupants said they “very much” liked daylight and sunlight in their workspace and valued the seasonal changes in daylight. Even in darker locations within a building, the occupants still expressed satisfaction with the daylight level, as long as they could look into a daylight space.

In a study of office workers in a Seattle high-rise building which compared the merits of natural daylight against electric light on the grounds of psychological comfort, general health, visual health, work performance, jobs requiring fine observation and office aesthetics (source: Heerwagen & Heerwagen, 1986), respondents rated daylight better than electric light on grounds of health, comfort and aesthetics, and rated daylight and electric light equally good for visual tasks.

In another study of office worker exposure to light during the winter in Sweden results showed that mood and vitality were enhanced in healthy people with higher levels of exposure to bright daylight (source: Partonen & Loengvist, 2000). Kaida et al (2006) reported in another study that just half an hour's exposure to bright daylight by sitting adjacent to windows reduced afternoon drowsiness in healthy adults and increased their alertness in almost the same way as a short nap would do.

CAN WE BE EXPOSED TO TOO MUCH DAYLIGHT IN OUR WORK ENVIRONMENTS?

However, it has been shown in surveys that people strongly value daylight even when it may actually be to the detriment of their vision! Only 20% of the Pacific Northwest survey respondents said that daylight was sufficient for work. The majority stated they used electric ceiling light “usually” or “always” to supplement daylight. Visual discomfort is reported even when there is plentiful daylight in the building – indeed in the post-occupancy evaluation of the first LEED Platinum building in the US, the Philip Merrill Environmental Centre, people were happy with daylight levels despite concerns with eye strain and associated issues (source: Heerwagen & Zagreus, 2005). This suggests that people may value the psychological benefits of daylight even when it creates difficulties for work due to glare and uneven light distribution.

“What is the necessary light dose?” This is as yet not quantified, although there are clear indications that the light dose needed is higher than interior light levels prescribed by electric lighting in standards and regulations. There have been studies to suggest that higher doses of daylight would leave people with a feeling of being more positive (source: Espiritu et al, 1994) and people behaved and interacted with others much better immediately following exposure to over 1000 lux (source: Aan het Rot et al, 2008).



INCORPORATING DAYLIGHT INTO BUILDING DESIGN TO ENHANCE WELLBEING AND PERFORMANCE

A study from the Technical University of Denmark revealed that the indoor environment can influence work productivity by up to 10% (source: Wargocki & Wyon 2013). Many studies show that the performance and productivity of workers in industrial, office and retail environments can be positively enhanced with the quality of light. Companies have recorded an increase in productivity of its staff of around 15% after moving to a new building with better daylight conditions, which in turn resulted in considerable financial gains (source: Edwards & Torcellini, 2002).

“
As designers we should focus on creating positive mental well-being for people in buildings rather than the absence of ill health. In this, daylight plays a crucial role.
”

Prof Koen Steemers - 2015

In the UK the publication of reports by the Royal Institute of British Architects (RIBA) and the Commission for Architecture and the Built Environment have also established a more holistic awareness of the role of architecture in health. Designing sustainable buildings, making use of abundant natural daylight, we can decrease our dependency on artificial light, resulting in greater energy savings and reduced impact on the environment, as well as simultaneously improving workers' physical and mental health, and their productivity.

Staff are the most valuable resource in most organisations, typically accounting for 90% of business operating costs, so even a 1% increase in productivity can have a major impact on the bottom line and competitiveness of any business. Employers, building owners, developers, investors and designers are learning in response to an increasing body of evidence, that office design affects the health and wellbeing of occupants in many ways and so it is prudent business practice to create green buildings that are healthy (source: World Green Building Council's "Health, Wellbeing & Productivity in Offices: The next chapter for green building" 2014).

Indeed, it is increasingly recognised that a successful building design is one that provides a connection with the outdoors whilst maintaining comfort. Incorporating 'natural' elements such as daylight and good ventilation can help to mitigate the negative effects of hours spent

indoors. However, Covid-19 showed that many buildings are not adaptable and not fit for purpose, especially in terms of providing fresh air. Windows had to be opened to increase ventilation rates, making occupants cold and uncomfortable, and increased the energy demand for space heating.

“
A reconnection to the rhythms of nature is ..needed – and this will also have a profound influence on architecture.
”

Russell G Foster

Prof Circadian Neuroscience and the head of dept of Ophthalmology at Oxford Univ.

Good building design should facilitate our reconnection to the rhythms of nature, and not just be focused on quantifiable parameters such as levels of humidity and temperature. And yet defining a suitable daylighting scheme for any building can be a challenge as there are many factors to consider.



DAYLIGHTING IN BUILDINGS AND THE IMPORTANCE OF EN 17037

European Standard EN 17037 was published in 2018 with the aim of helping building designers achieve appropriate levels of daylight in any type of building. Its intent is to change the focus of building design and the role of glazing in those designs to improve occupant comfort and overall energy efficiency. The need to provide glazed openings and well-distributed daylight to interior spaces, while reducing artificial lighting in use, must be considered with the balance between heat loss and solar gains.

WHAT ASPECTS OF DAYLIGHT DESIGN DOES THE STANDARD COVER?

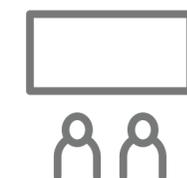
EN 17037 addresses four areas of daylighting: daylight provision, assessment of the view out of windows, access to sunlight, and the prevention of glare. Although written for new buildings, its provisions can be applied also to works undertaken on existing buildings.

Some designers may have familiarity with designing to provide daylight, but the other three aspects of design significantly extend the scope of the standard compared to existing best practice.



DAYLIGHT PROVISION

Daylight provision, or illuminance levels, allow users to carry out tasks and play a part in determining the likelihood of artificial lighting being switched on. Assessment can be via either climate-based modelling or daylight factor calculations.



ASSESSMENT OF THE VIEW OUT OF WINDOWS

Building users should have a large, clear view of the outside. EN 17037 considers the width and outside distance of the view, as well as landscape 'layers' (sky, landscape and ground). The view should be perceived to be clear, undistorted and neutrally coloured. Width of view can be established via a detailed or simplified approach. Outside distance and number of layers are each measured by a single approach.



ACCESS TO SUNLIGHT

Calculating access – or exposure – to sunlight is a comfort and health factor for users of dwellings, nurseries and hospital wards. Daily sunlight exposure can be established through detailed calculation or table values.



PREVENTION OF GLARE

As the name suggests, prevention of glare is concerned with removing the probability of glare for building users, especially those who do not choose where they sit. It uses detailed calculations of daylight glare (DGP), or a standard table of values for sun-screening materials.



BUILDING DESIGN – HOW DAYLIGHTING NEEDS CHANGE BY BUILDING TYPES



01

DESIGNING FOR DAYLIGHT IN OFFICES

Pre-2020 an increasing proportion of global GDP was produced in office environments (Source: VELUX/2016/productivity at work). Whether our offices are in our homes, commercial buildings or both, they are indoors and they are places where we spend a significant portion of our day.



Currently, an average of 36% of the European workforce (approx. 81.4m people) work in an office environment, rising to 40% in some countries.

Office employees spend roughly 30% of their waking hours each year in offices. Creating comfortable and healthy offices has been proven to have a significantly positive effect on workers' productivity and efficiency, so investing in good office design is sound business sense and is likely to repay the additional investment many times over. Addressing indoor air quality, thermal comfort, noise pollution as well as lighting are key considerations if 'Sick Building Syndrome' is also to be avoided.



More than 80% of European workers in office-based sectors stated that they are exposed to excessively high or low temperatures close to 25% of the time

(source: VELUX healthy workplaces article)

Good ventilation, including the use of openable rooflights, can increase comfort and productivity levels of the office occupants.



In a recent global survey a third of respondents stated that the design of an office would affect their decision to work for a company

(source: Human Spaces, 2015)

The survey also highlighted just how much they valued having natural light in the workplace. In 1997 the Danish Building Research Institute conducted a survey of over 1800 people working in office buildings and asked them questions such as how they valued windows and a view out to nature in the workplace. The ability to "see out" and to "see the weather" were considered top priorities. Having a view allows one to tolerate a lot more discomfort in the internal environment than if you do not have a view (source: NARM tech doc NTD12 2015). In the 2018 YouGov Study 63% of respondents stated that they think daylight has a significant effect on productivity. In other studies most surveyed believed daylight was good for their general health, their visual capability and productivity.

Another study examined workers in a call centre and in other office environments (source: Heschong Mahone Group, 2003).

Better access to views, along with improved daylight conditions, were found to significantly improve performance: workers in the call centre processed calls 6-12% faster when they had the best possible view versus those with no view.

Other office workers performed better in tests of mental function and memory when they had the best possible view. Neuroscientists in another study suggest that office workers with windows received 173% more daylight exposure during work hours and slept an average of 46 minutes more per night (source: Cheung I., 2013), whilst another study found that daylight coupled with the quality of views out of windows explained 6.5% of the variation in employees' sick leave. (Elzeyadi I. 2011)



DSV HEADQUARTERS

Leading international transport company DSV wanted to create an open and productive work environment when they planned the company's new headquarters in Denmark. Built around a large atrium covered with 900m² of VELUX Modular Skylights, the new office building brings daylight and fresh air into every corner. The light spacious headquarters underpin the position of DSV as a leading, global transport company.

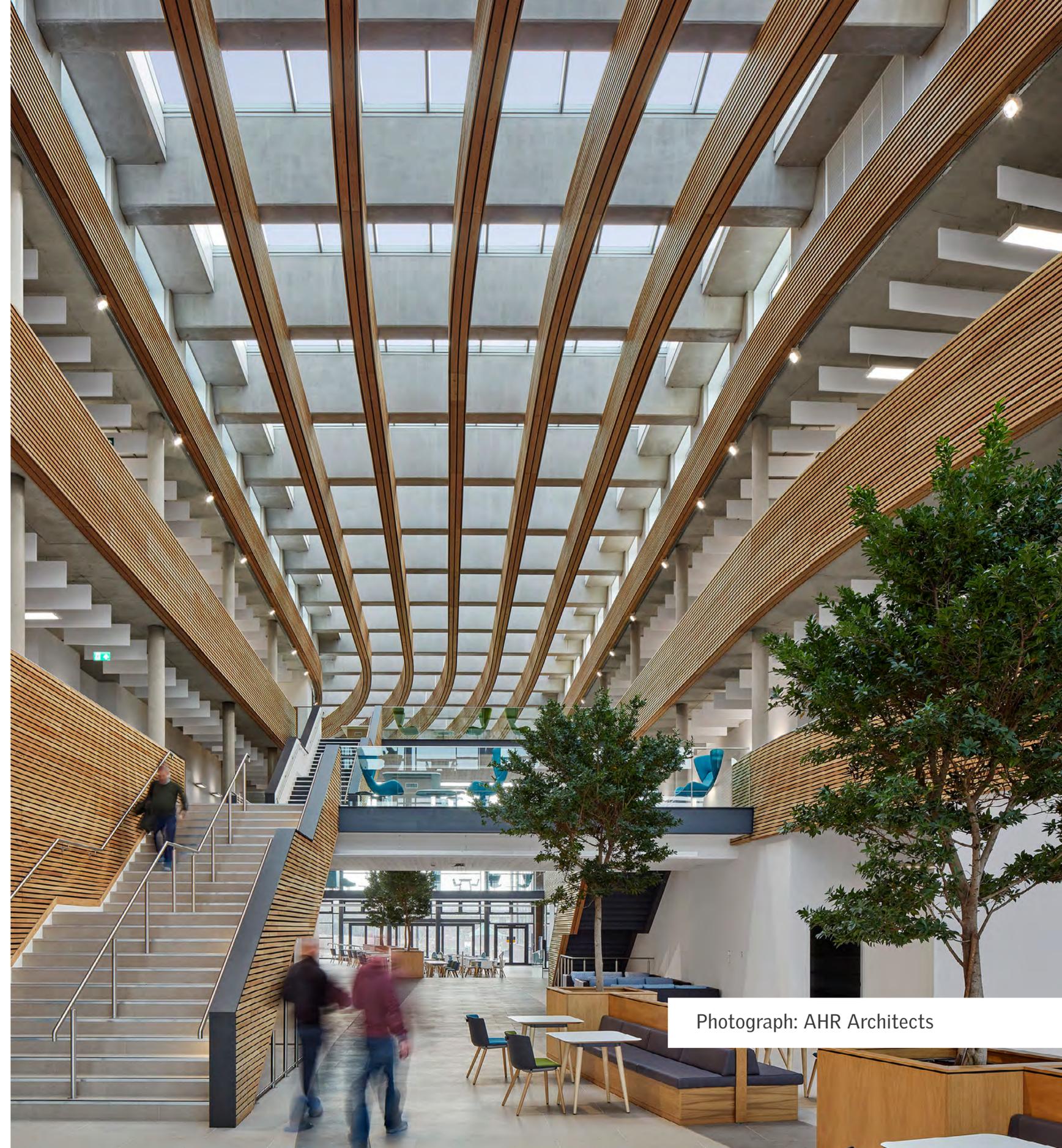
For further information on this project, please refer to the [CASE STUDY](#).



UK HYDROGRAPHIC OFFICE

Two hundred modules of the VELUX Modular Skylight system were installed as part of an innovative lighting and ventilation strategy for the Ministry of Defence's new UK Hydrographic Office. Modularised and prefabricated, the modular skylights simplified a complex specification for natural daylight, first-class ventilation, and modern aesthetics in a central atrium area at the heart of the new development. The UKHO has also been awarded the BREEAM Excellent rating.

For further information on this project, please refer to the [CASE STUDY](#).



Photograph: AHR Architects

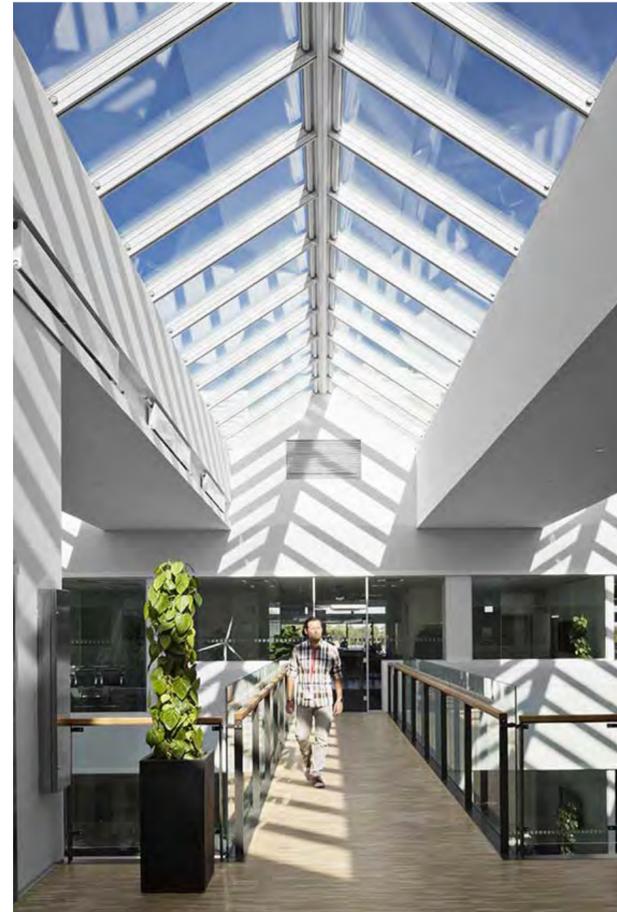
SIEMENS HEAD OFFICE

When building their new head office in Denmark, Siemens wanted to take advantage of the latest technologies to create a bright and productive office environment.

One of the central elements of the building design was a full-height atrium, which provides daylight to the interior of the impressive building. The large skylight solution consisting of 228 modular skylights was completed in just 15 days.

The display of sustainable solutions has made the Danish Siemens head office a beacon within the Siemens Group

For further information on this project, please refer to the [CASE STUDY](#).



The modular skylight solution consists of six rows of VELUX Ridgelights spanning 17 metres and comprising 228 fixed skylight modules.



Shading in the atrium is provided by factory-fitted roller blinds that are automatically controlled according to for instance the position of the sun and the lux levels in the atrium.



The building earned LEED Gold certification, the second highest ranking of the LEED rating system.

02

DESIGNING FOR DAYLIGHT IN HOTELS AND CONFERENCE VENUES

Modern hotel buildings now comprise quite disparate, and multi-functional areas, for which the management of natural and artificial light can be quite a challenge.



good daylighting design could save from 15-75% of the energy used for electric lighting in a hotel building

“
Light is a multitalented performer: it can follow moods or create moods, it can lift us and immerse us in different rooms, feelings or realms.
”

Petra Maluck

Project Director Marriott International | Eschborn,
D former Project Manager ROBINSON

The lobby and reception areas, restaurants, spa and wellness zones, corridors and hallways, guest rooms, and meeting spaces as well as service areas and recreation areas all require different levels of lighting, ventilation and thermal comfort. It is critical to be able to adjust lighting levels, to change the colour of a space and its ambience from bright and lively, to warm and inviting right through to calm and relaxing. Typically, lighting accounts for 15 – 45 percent of electricity consumption in small hotels and restaurants. In regions where there are no large heating or cooling costs, it can be the greatest use of electricity in a hotel. Most lighting energy is used in the 24-hour communal areas of a hotel – the corridors and lobby. In a typical 65-room hotel using traditional lighting, this can add up to almost 1000 kWh per day in corridors and 370 kWh per day in the lobby. Bedrooms come next, using about 350 kWh per day. (source: ec.europa.eu)

In the lobby and reception area it is essential to create a specific atmosphere in order to express the brand image and its uniqueness, whilst at the same time it is important for the operation of these areas that there is no glare which might impact on computer screens and work stations. In the restaurants and café areas the lighting concept must enhance the dining experience, in hallways and corridors daylight on the other hand can work in combination with artificial lighting to prevent a “tunnel effect” and make the routes more inviting as well as safe for guests.



“
Light is a fundamental component, it is the element which creates space. I prefer working with natural light because it creates a sense of direction in a building. In my view, artificial lighting should support and supplement daylight.
”

Mario Botta

Architect | Lugano, CH | www.botta.ch

However, the biggest single complaint registered by hotel visitors is the lack of sufficient lighting in guestrooms. Such spaces are multi-functional – it is where guests eat, work, relax as well as sleep. Today’s hotel guests are also seeking to be connected to nature and are prepared to pay premium rates for rooms with views out to nature.

But why would a hotel owner want to take on the challenge of using daylight to illuminate his hotel? To create beautiful spaces, save energy and operating costs, and reduce the impact on the environment, but money is still the overriding concern. Reduce costs, increase profits! According to the Hotel News Resource’s article, Daylighting: energy saving and productivity boosting benefits, published Oct 2010: “good daylighting design could save from 15-75% of the energy used for electric lighting in a hotel building”. However, this statement needs to be caveated: the amount of energy savings can also be significantly influenced by occupancy levels, design, energy usage, and the amount of daylight.

Natural daylight is a free resource, it costs nothing to the environment and yet it delivers big benefits to

both hotel guests and employees. It is a significant energy efficient lighting solution for hotels, thereby reducing the reliance on fossil fuels, and reducing carbon dioxide emissions. Daylighting also enhances the well-being of guests, and the change in daylight during the day can have a positive impact on bio-rhythms, thus helping their bodies to regenerate and recover. And it enhances the productivity and mood of the hotel’s employees too. The Hotel News Resource article also addresses the eco-aspect of using natural daylight in hotels: as today’s hotel guests look for more socially and environmentally responsible hotel brands, daylighting can help promote the green credentials of the hotel by reducing lighting and operating costs, reduce cooling costs (in almost all climates all year round), and this can be accomplished without a significant increase in construction costs in a new build. “It is the orientation of the building, glazing, energy-efficient light fixtures, mechanical systems and how all of these components are impacted by natural lighting” states Abby Vogen, project director at the Energy Center of Wisconsin, when calculating the actual effectiveness of natural daylighting in hotels. The architecture and layout of the hotel or conference centre can substantially impact the amount of natural light than can enter through windows or skylights. The location of these glazed elements can be key to providing an even, natural light with little glare, as well as to managing solar heat.

The Energy Center conducted an experiment at the Energy Resource Station in Iowa to see if cooling energy could be saved using daylighting design, and the results were considerable. Comparison of 2 rooms (one standard, one high-performance) yielded 32% savings on annual lighting costs and total overall annual energy savings of 22%.



THE GREEN SOLUTION HOUSE

At the Green Solution House every component in the building contributes to circular sustainability. Daylight plays an important role in the ambitious sustainability strategy of the hotel and conference centre. In order to maximize daylight, 196 VELUX Ridgelight modules were installed in the large, inner courtyard and atrium.

For further information on this project, please refer to the [CASE STUDY](#).



JAMMERTAL HOTEL RESORT COMPLEX

Offering the highest level of comfort and service, the hotel and spa complex provides a connection to nature while also featuring the latest technology.

The complex was extended in 2016 to include a themed restaurant. Steinberg & Koeppen Architects decided to bring daylight through the roof and specified VELUX Modular Skylights. Four Ridgelights, with a total area of almost 77 m², helped create a relaxing, light-filled space with sky views for guests.

The impressive skylight design reduces the use of artificial lighting and warms the restaurant passively during winter months to minimise heating demand.

For further information on this project, please refer to the [CASE STUDY](#).



03

DESIGNING FOR DAYLIGHT IN HIGH-TRAFFIC AIR AND RAIL CONCOURSES



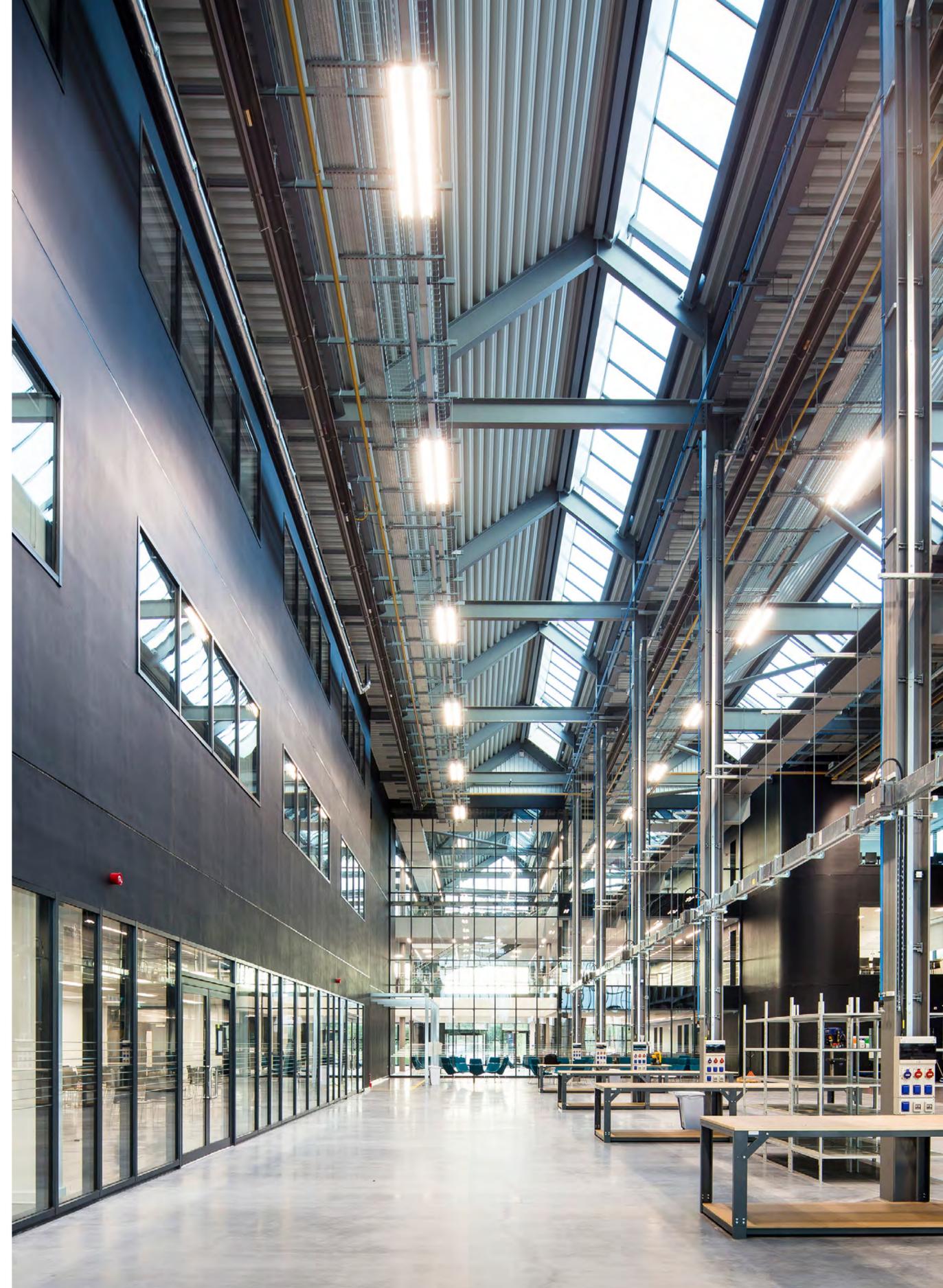
High-traffic public spaces, such as airports, are “complexsensory visual environments” (source: Horton Lees Brogden) and people’s experiences of them can often be negative – overwhelming, frustrating, tiring. There are signs that feelings towards air travel are shifting as a result of climate change. Nevertheless, aviation will continue to be a feature of our lives, so when we do travel, we want terminals to be interesting and, most importantly, comfortable places to spend time. Over recent years airport authorities have responded to these demands and focused on creating terminals that are more welcoming, more relaxed and that offer a variety of activities such as children’s play areas. They also recognise that air retail spaces in departure lounges and entrance halls filled with lots of natural light also encourage passengers to spend more time in these spaces, thereby increasing their revenue potential.

“ *New airport terminal design is improving the passenger experience by welcoming people into light-filled spaces designed to make a positive impression upon them.* ”

Source: AECOM.com

Mark Molen, aviation architecture specialist

The well-being of both passengers and staff has become central to airport design. View enhancement (providing awareness of the environment beyond the building – a view satisfies the physiological need of the eye to change focus -BREEAM), visual comfort, and knowledge of solar motion can shape architectural forms. The need to take advantage of free source of



light, namely daylight – optimising natural light for illumination can direct the location and shape of holding rooms and circulation spaces. “It can impact how we perceive a space, the way we walk through it, and how we remember it”. “New terminals are designed to take healthy advantage of natural light, benefitting passengers and workers alike.” Source: AECOM.com Mark Molen, aviation architecture specialist.

Factors such as site, climate etc can have huge relevance in the formulation of daylighting concepts at airports, and can determine where the addition of artificial lighting may be necessary to provide appropriate levels of illumination, balance brightness and shadow etc. With security of paramount importance staff need to have optimal visual conditions to do their job properly. The correct level of daylighting is necessary for facial recognition to avoid glare occurring, whilst still maintaining visual comfort for staff. Glare causes undue visual fatigue and headaches. As the use of information technology and digital media at airports has significantly increased – display screens for flights, advertising screens – so have the number of challenges to address, such as the requirement to ensure that these screens remain legible at all times, and that the contrast ratios are maintained. Daylighting has an impact on the choice of location for such display screens, for the control of possible reflections, and in the choice of materials used which can help to reduce glare.

There are guidelines that help designers to achieve the recommended lighting in public areas in the transport sector and their related access environments such as airport terminal forecourts and railway station platforms. They also include operation areas where a particular lighting concept is required for

staff to perform specific tasks such as:

- Terminal check-in and security areas
- Customs and baggage reclaim
- Movement routes and signage (arrival/departure information screens)
- Gate areas including automated transit systems

The Society for Light and Lighting, part of the Chartered Institution of Building Services Engineers (CIBSE), has produced a series of guidelines to help in the formulation of daylighting strategies. For example, SLL: LG15 Lighting Guide 15: Transport building. This guide was produced by the Society of Light and Lighting (associated to CIBSE) to assist designers working within transport environments to create effective lighting strategies that are energy efficient and enhance the passenger experience. It covers buildings for rail and air modes of transport as well as road and water.

A combination of facade glazing and roof glazing solutions provides high levels of natural light in airport buildings. Passengers benefit from external views and improved wayfinding.

“ Natural daylighting not only brightens airport terminals... but it can also reduce stress by making it easier to find and reach the departure gates. ”

Source: AECOM.com

Mark Molen, aviation architecture specialist



However, this must be balanced with the challenge of maintaining thermal comfort. Daylighting strategies that increase the amount of natural light and reduce reliance on electric lighting also create a more welcoming environment. The drop in electric lighting dependence lowers electricity usage but also cuts down on the build-up of heat caused by light fixtures. Diffuse daylighting can also allow facilities to operate during daylight hours without artificial lighting, leading to greater energy savings

Furthermore, solar studies are usually done to understand how the sun's rays will fall on a building during the course of the day and throughout the seasons and then the results are used to determine how to keep the direct sun off the exterior glazing to reduce heat gain and glare. Glazing specification is also critical to airport daylighting strategies – high-performance qualities are paramount. A balance needs to be struck between solar heat gain and visible light transmission (Source: Airport world magazine Sept2013 Wilson Rayfield)

Sir Norman Foster is one of the leading international architects to have recognised the importance of daylight in large public buildings to create both enjoyable as well as energy efficient spaces. He regards daylight from above as indispensable when developing such "megastructures" as airports or rail stations. But daylight from above is much more than an aesthetic dimension, remarks Foster: "Quite apart from the humanistic and poetic qualities of natural light there are also energy implications."

In designing Stansted Airport in the UK, Foster turned the conventional terminal model upside down, placing all the heavy equipment such as roof ductwork, air-conditioning units etc underneath

the main concourse, so that the roof became quite unique. "Its design is dedicated to natural light," explains Foster "with a proportion of the surface glazed to let sunlight in, and 'daylight reflectors' inside that bounce the light back up on to the sculptural shape of the ceiling. At night, artificial light achieves the same effect. We were able to open up the roof to sunshine and light. The results were not just great savings in energy, but also a far more poetic spatial experience."

In the rail sector Foster has been just as pioneering, seeking ways to bring underground as much daylight as possible to enhance orientation and to create a natural atmosphere. At the Canary Wharf underground station, for example, the glass-covered entrance ensures that as much daylight as possible is drawn deep into the concourse. Even from the street level glass escalators guide downwards. The pools of daylight guide the commuters to the exit after leaving the train and reduce the need for orientation signage.

The shift from viewing light as a qualitative asset to a quantifiable resource has dramatically shifted the way the architect's firm practices. As Foster remarks: "That humanistic, that poetic and spiritual dimension is for me completely wrapped up with the technology of how the building eventually 'breathes' and communes with nature." (Source: Why Norman Foster Scoops Daylight into his Buildings, Archdaily.com, 4.2.19 by Thomas Schielke)



THE OLD ROYAL STATION

VELUX Modular Skylights were chosen for the Old Royal Station at Ballater for their sustainability credentials and exceptional energy performance as well as their slim profiles, which enabled the rooflights to sit as flush as possible with the roof.

As a local landmark responsible for bringing tourism into the area, Aberdeenshire Council committed to a £3m restoration of the station. As part of the rebuild, the team had to re-install rooflights that were as similar to the originals as possible, but to meet modern building regulations, they also required a system that was more energy efficient.

For further information on this project, please refer to the [CASE STUDY](#).



04

DESIGNING FOR DAYLIGHT IN INDUSTRIAL AND WAREHOUSING BUILDINGS

Whilst in offices, concerns about lighting are focused on health, comfort and productivity. In industrial settings, which are classed as higher-risk, safety is the overriding priority. Poor quality lighting, provided either by natural daylight or artificial light, or a combination of both, can contribute to a higher incidence of accidents, especially in areas where heavy machinery is used, such as forklift trucks. Not only are such accidents very serious, resulting in employee injuries or even in fatalities, but the financial consequences for the company can be enormous (liability claims, repair costs, loss of earnings).

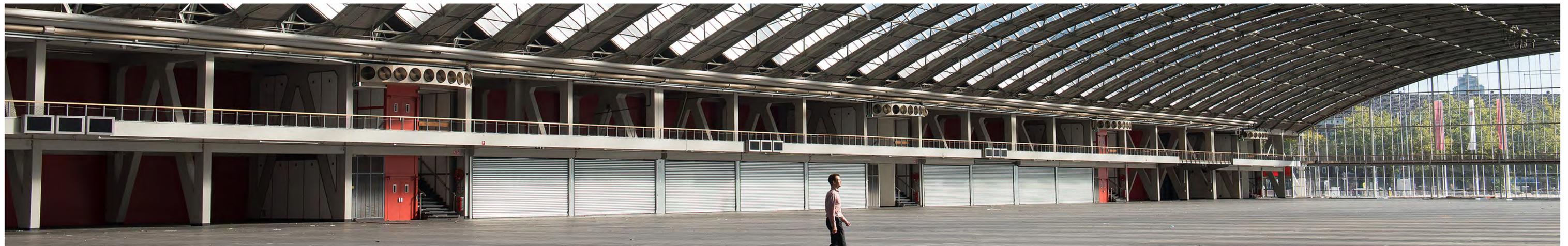
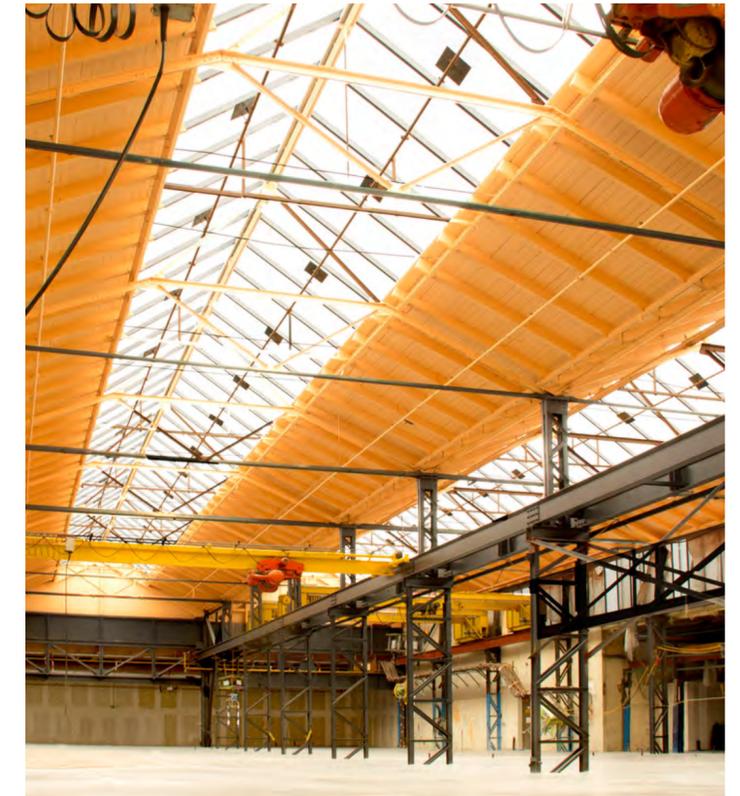
Furthermore, in those industrial environments, which are largely illuminated by artificial lighting, and where the working day/night is becoming every longer, too little natural light may be having negative effects on employees, reducing their alertness, and contributing to conditions such as seasonal affective disorder (SAD).

Whilst there are guides available to architects which recommend lighting levels for the industrial sector,

quite often the provision of the correct illuminance levels is simply a matter of judgement. In loading bays, classed as hazardous areas, the recommended level is 150 lux. In warehouses or storage areas the recommended level is 100 lux. In engineering environments, such as tool shops or assembly lines, the levels can vary between 300-750 lux. (source: aecom.com)

Yet even despite the emphasis on using natural daylight where feasible, this may not provide sufficient illuminance throughout a working area, or even throughout the working day, depending on the length and quality of daylight hours during the winter.

Ventilation in industrial environments is another a key priority in such buildings, to ensure that there is a flow of fresh air, and to allow pollutants to escape.

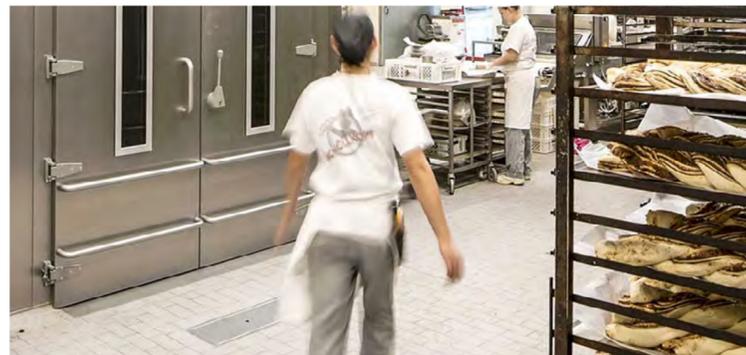


SCHÖLLKOPF BACKWAREN

As a successful, growing business, German bakery Schöllkopf Backwaren wanted to expand their bakery facilities. As well as increasing the size of the workspace, Schöllkopf also wanted to optimise its production processes and the working environment.

In order to ensure good working conditions, the bakery opted for a large skylight solution that would bring daylight into the work spaces and allow efficient ventilation through venting skylight modules. The shed roof construction - with 54 VELUX Northlights - lets in soft northern lighting and prevents direct sunlight and glare. 27 out of the 54 modules are venting modules that allow fresh and cool air into the bakery. Crucially, the extension of the bakery and installation of the skylights took place without disturbing the daily production.

For further information on this project, please refer to the [CASE STUDY](#).



05

DESIGNING FOR DAYLIGHT IN MULTI-USE COMMERCIAL SPACES

As the layout of industrial buildings becomes more sophisticated, where the demarcation lines between office and warehouse become less pronounced, it is critical to design daylighting and ventilation strategies that can accommodate and reflect the diverse requirements of these innovative multi-use commercial spaces of the future.

Logistics properties typically comprised only warehousing and distribution space, but designs have changed to include office space too. It is often necessary to have office employees working on site and so these warehousing spaces need to provide a safe working environment for all, with many of the same benefits as traditional offices such as promoting employee wellbeing.

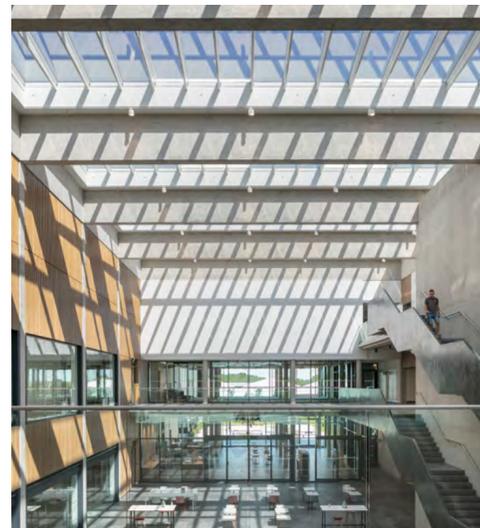


ROMO FABRICS HQ

Nowhere was the changing definition of a logistics property better illustrated than at ROMO Fabrics' new 33,000m² HQ, which combined not only office and warehousing spaces but also incorporated a large atrium. Central to the project was the need to utilise daylight and natural ventilation to create an inviting workspace for its employees to work in. Both those working in the office spaces and the adjacent warehousing areas would need to have access to ample amounts of daylight as well as smoke ventilation and blinds for solar glare. These were integral factors to ensure that a more positive and engaging workspace would be created across the organisation, which would also lead to greater productivity and performance. An atrium within the warehouse would draw in plenty of natural light.

Around 348 modules of the VELUX Modular Skylight system were installed across this project, making this the largest installation in the UK to date. VELUX Ridgelights were used to accentuate the entrances of the atrium and a view into the internal space, whilst VELUX Northlights were installed with the office and design studios to provide soft, natural lighting and a natural feel to the workspace. Pre-tested smoke venting modules and blinds were configured to ROMO's unique requirements to provide an adaptable system for managing ventilation and glare.

For further information on this project, please refer to the [CASE STUDY](#).



VITSOE HEAD OFFICE

When Vitsoe, makers of iconic minimal-modernist furniture, decided to build a new multi-use commercial space comprising both factory and office space, it was always going to be something special.

The client's brief was to create a new HQ in Royal Leamington Spa, UK, that would be a physical projection of its 'system-thinking' approach. This focuses on products that are flexible, modular and can be combined to form larger systems, which is one of the founding principles of Vitsoe.

The result was an economical, strong, yet elegant sawtooth roof-form that maximised indirect light, using banks of VELUX Northlights.

For further information on this project, please refer to the [CASE STUDY](#).

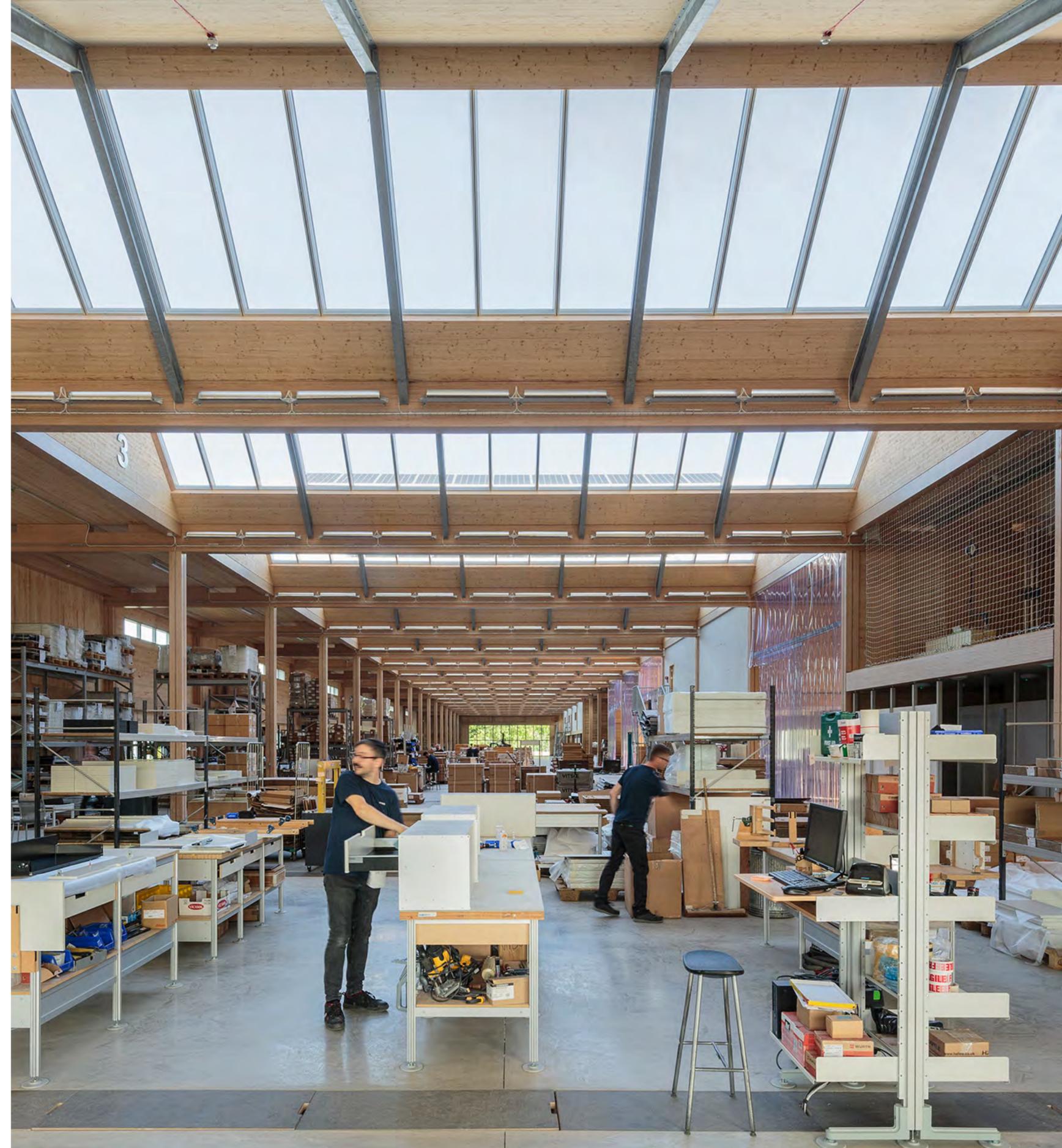
“

Natural lighting and natural ventilation from the VELUX Modular Skylights were critical to restoring a connection between the building's users and the world around them.

”

Mark Adams

Vitsoe Managing Director



VELUX COMMERCIAL DAYLIGHT SOLUTIONS

VELUX Commercial's daylight solutions offer complete flexibility for daylight and natural ventilation, smoke and heat exhaust ventilation (SHEV), as well as maintenance access. Our wide range of systems provide new-build and refurbishment solutions for every type of commercial building.



GLOBAL PRODUCT PLATFORM



CONTINUOUS ROOFLIGHTS

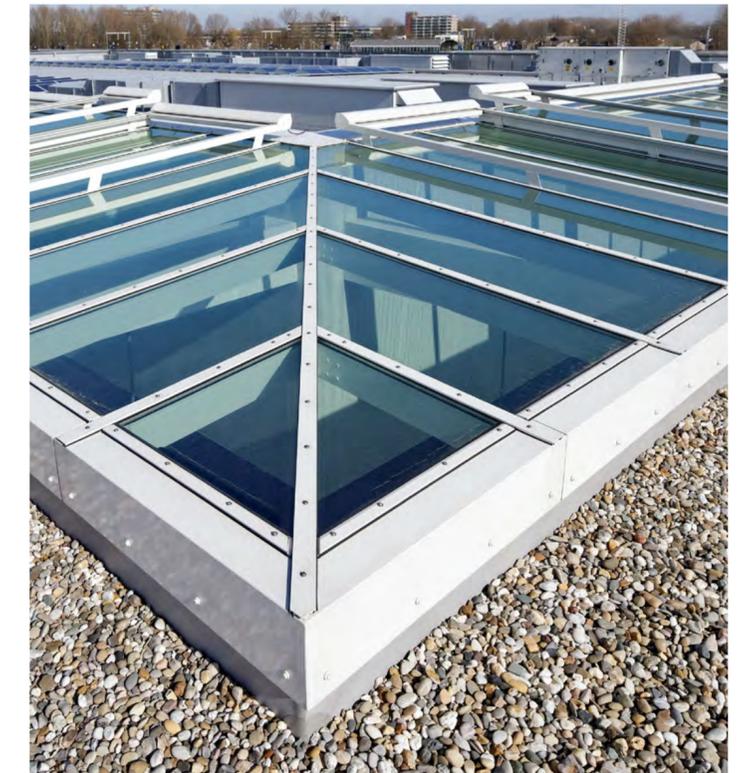
Continuous rooflight solutions can meet the demands of commercial or industrial buildings, including warehouses, logistics centres, production facilities and sports and leisure facilities. Suitable for flat and sloping roofs, they are available in polycarbonate plastic, fibreglass and acrylic for a durable, lightweight and cost-effective alternative to glass.



DOME AND FLAT GLASS ROOFLIGHTS

Dome and flat glass rooflights combine quality, performance and aesthetics, with solutions also available for maintenance access and ventilation. Designed for both function and appearance, they provide single sources of daylight and are available in a wide range of shapes and sizes to suit a variety of applications.

Polycarbonate domes are strong, easy to install and have a long service life. Flat glass rooflights can be specified as single unit rooflights or as connected rows for larger areas. Access hatches enable safe access to the roof for inspection or maintenance.



GLASS ROOF SYSTEMS

Glass roof systems can be used to create attractive rooflights in an array of shapes and sizes. They are the ideal choice for high specification roof glazing that looks beautiful and provides natural daylighting, fresh air and smoke and heat ventilation. Glass roof systems offer complete flexibility, and options can be configured to meet the most demanding design requirements.

GLOBAL PRODUCT PLATFORM

SMOKE AND NATURAL VENTILATION

Comfort and smoke ventilation solutions can be integrated across the majority of the VELUX Commercial range of products. A design-led approach creates maximum specification flexibility to help meet the requirements of any building project using either natural ventilation or smoke and heat exhaust ventilation (SHEV).



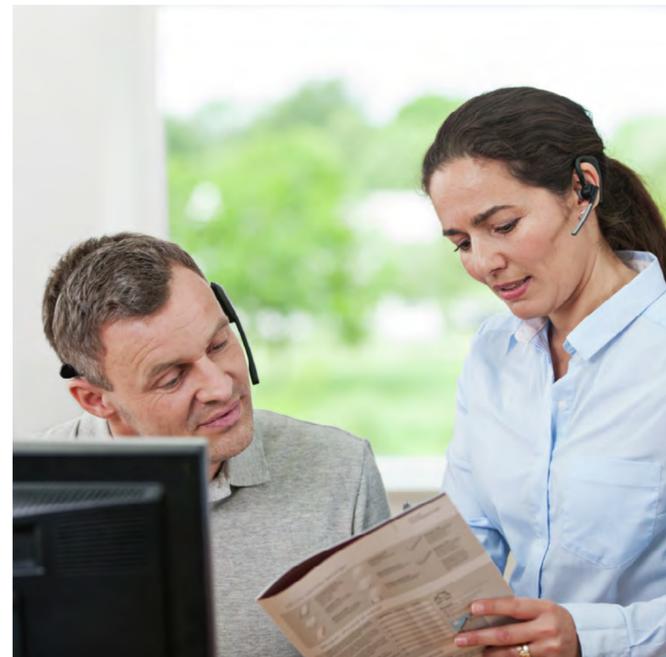
SERVICE AND MAINTENANCE

Ongoing servicing of roof glazing systems includes 24-hour availability of SHEV system maintenance to meet legal requirements, and service contracts for glass construction maintenance and care.

SUPPORT

At VELUX Commercial we understand the importance of supporting you throughout a commercial project programme - from product selection and technical support, through to installation and aftersales services.

Our expertise, knowledge and support offering makes VELUX Commercial your preferred partner in providing the right rooflight and smoke exhaust solution to meet your specific needs, whether in an industrial, commercial or public setting.



CONCLUSION

As we spend more time indoors, both at home and in work, and have less exposure to natural daylight and fresh air, the impact upon our personal well-being and quality of life is considerable. In the short-term this manifests itself in reduced alertness, and disturbed sleep patterns, in the long-term it can lead to much more serious diseases and mental health issues. But the ramifications of this "divorce" from nature go further – productivity levels and the development in commercial businesses are being undermined by low employee morale, greater levels of absenteeism and impaired performance.

We are witnessing a deepening consensus amongst building owners, employers and investors that they have a moral responsibility, as well as a financial incentive, to create vibrant, healthy spaces for occupants, which provide greater access to natural daylight and fresh air. Architects and designers are now rising to this challenge and are delivering buildings across a wide range of commercial sectors that achieve genuine occupant comfort. Awareness of glazing performance and, in particular, its contribution to daylighting is only going to increase.

Rooflight solutions offer greater access to unobstructed sky and sunlight, and are the perfect complement to vertical windows in external walls that might be faced with significant constraints from adjacent buildings or other obstructions.

VELUX Commercial's expertise in providing daylight solutions for commercial spaces, industrial and warehouse

buildings, hotels and conference facilities as well as high-traffic public concourses means we can assist designers and specifiers from an early stage on how roof glazing can help achieve the right performance levels across the four areas of daylighting covered by EN 17037.

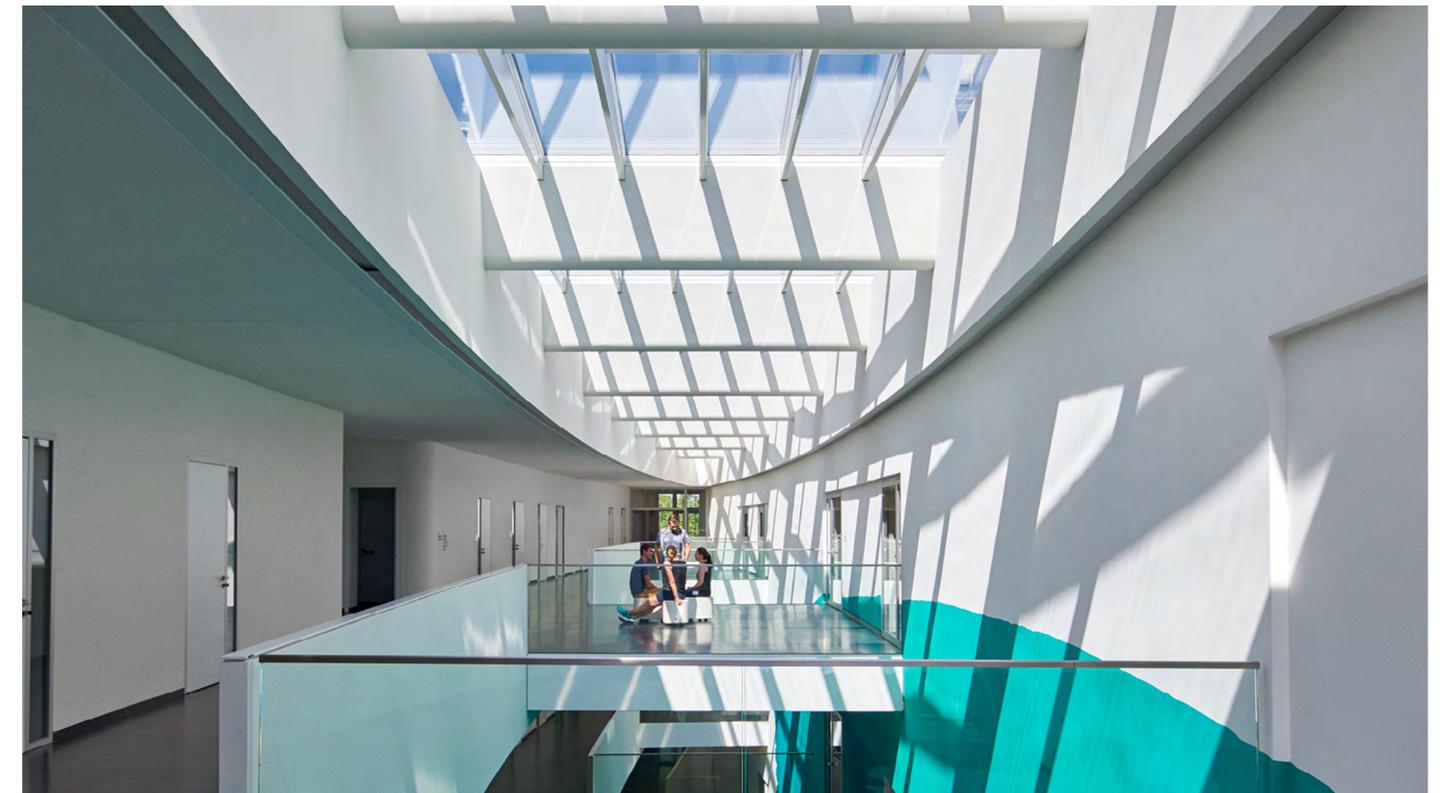
For project and technical support, or price estimates for commercial roof glazing solutions, contact us to discuss your requirements. ***Brochures and guides*** are available from our website, as are ***CAD and BIM object downloads***.



SOURCES AND FURTHER READING

For a more in-depth exploration of the topics covered in this white paper - including a wider discussion of the studies referenced in the section on 'The impact of daylight on occupants in commercial buildings' - VELUX's Daylight, Energy and Indoor Climate book (DEIC) is a comprehensive and readable guide, intended for architects, engineers, students and researchers alike.

THE VELUX DEIC BOOK IS AVAILABLE ONLINE AT:
www.velux.com/deic



Email: salg@veluxcommercial.dk

Find out more at
veluxcommercial.dk

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