

## *Diversity demands versatility*

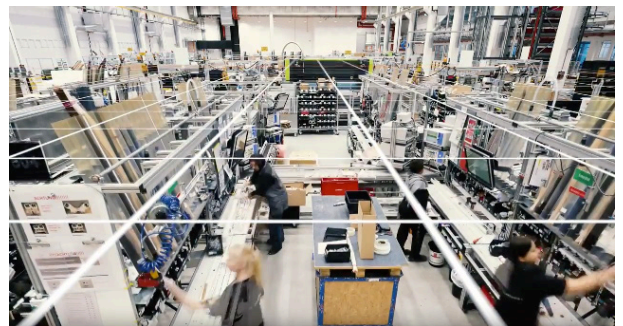
**Industry comprises diverse segments and different applications, for example higher logistic warehouses to compound automotive industry to hygienic food industry. There is no uniform solution to meet all demands of various industrial applications. It need to be tailored according to the different industrial setup and requirements.**

The demands on lighting in individual applications are equally diverse. This needs an Activity based lighting<sup>1</sup> solution, which is unique and dynamic as the processes and layout of different production halls. Employees safety and well-being are very important, particularly when considering the different work shift and timings. Due to precision, processes and diverse tasks, lighting plays an important role in the life of industry employees. So whether its day or night, the visual, emotional and biological aspects should be supported by blending Active Light<sup>2</sup> with a human centric lighting solution. This hybrid approach combined with smart connected solution facilitates accurate working, improves quality and supports well-being of employees.

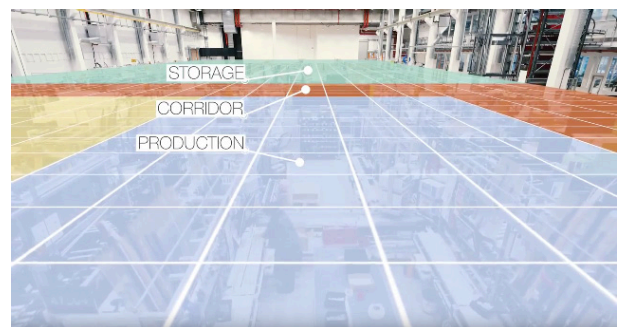
Thus, it's important to understand the requirements and the real industry needs and challenges, in order to offer the right lighting solution for every requirement covering all industrial applications.

Below, there are different examples of varying needs for the Industry.<sup>3</sup>

- 1 Logistics: Large halls and long operating hours require energy efficient lighting solutions with minimal maintenance costs.
- 2 Metal working: Shiny surfaces, varied visual tasks and oily atmospheres characterise the metal industry.
- 3 Automotive: Optimised solution in complicated assembly and body work. Silicon free environment.
- 4 Food: Hygiene standards place high demands on the quality. Tough and regular cleaning cycles.
- 5 Chemicals and pharmaceuticals: Clean rooms in particular require special constructive and material product features.
- 6 Car parks: Providing Safety, effective use of space and energy.
- 7 Quality checks: Optimal solution for supporting employees in inspecting complex visual tasks.
- 8 Wood, paper, textiles: High degrees of protection are essential in atmospheres with increased dust and/or fibre accumulation.
- 9 Agriculture: Higher degree of protection against stubborn dirt, ammonia and other aggressive gases.



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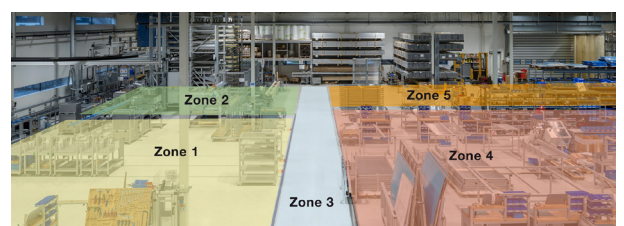
## ADAPTABILITY-LIGHT CONNECTS

Manufacturing optimisation and increasing the capacity by making the best use of their resources is the need of every industry. Driven by information and communication technologies, manufacturers increasingly are convinced that networked production devices can not only improve the traditional design of production plants, but also unleash a whole new dimension of industrial productivity. Moreover, bringing new technologies makes it a more efficient use of materials and energy, thus contributing to mitigation of environmental impact of manufacturers; catalyst to propel the innovativeness, efficiency and optimisation of factories.

By 2025, 80-100% of manufacturing could be using Internet of Things applications<sup>4</sup>, by the meaning that machines, sensors and other equipment mutually connects and communicates through the internet. This concept of the so called “Industry 4.0”, where man and machine communicate directly with one another using digitally connected, intelligent systems, is within reach. As an active part of the overall system, light will act as a connecting element – for example to collect data or for navigation which helps in optimum designing of factory floors or planning of production routes. Industry 4.0 has the potential to optimise industrial processes with regard to adaptability and productivity even further in the future. In this context, lighting can play a significant role. For example, the level of illuminance automatically adapts to the task at hand and therefore always provides the perfect lighting conditions. Furthermore, connecting communication and machines, systems and products can further increase productivity in the form of reduced production times, data analysis or decreased error rates.

The 2014 Digital IQ Survey of PricewaterhouseCoopers (PwC) showed that 54% of top performing businesses are adding sensors to people, places, processes and products to gather and analyse information that allows them to make better decisions and increase transparency.<sup>5</sup> Thus, the Internet of Things can help businesses achieve enhanced process optimisation and increased efficiencies by collecting and reporting on data collected from the production environment. In times of increasing digitalisation more and more work processes run completely automatically.

Production processes at industrial companies change at increasingly shorter intervals. One and the same room regularly has to satisfy different utilisation scenarios and visual requirements. Lighting systems should have a high degree of flexibility so that they can be quickly adapted to layout changes and reduce production downtime to a minimum. Industrial areas have an different production process and occupancy rate. Illumination level varies as per the task for example: Metal



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working and processing average maintained illuminance varies from: 200 lx to 1000 lx. Production Zone 1 needs 500 lx; Zone 2 and 4 needs 750 lx, while zone 3 being a corridor needs 300 lx. Zone 1 and 5 are less occupied and thus do not need continuous lighting. Active light based on sensor technology can solve all the needs for the different zones or processes in Industry. Being simpler and flexible it can be programmed for future layout changes, without changing in the physical layout. Time consuming sensor repositioning is therefore a thing of the past.

## PRODUCTIVITY – LIGHT FOCUSES ON PEOPLE

The job market is influenced by high education standards and qualifications. With growth in Industry sector the demands on workers will noticeably increase in the future. Routine tasks will be increasingly automated, whereas increasingly complex, non-automatable tasks will require appropriately trained employees.

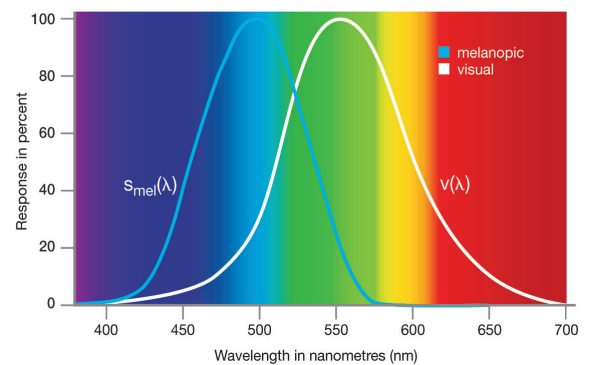
Beyond that, there is a demographic change: changing age patterns in the workforce bring about new workplace requirements. Companies are required to respond to these changes and adapt lighting to increasingly complex work processes, diverse visual tasks and the individual needs of employees. Good light quality is the basic requirement for the employees' wellbeing so that they are motivated and can concentrate sufficiently to deal with such highly complex tasks. This increases performance and demonstrably decreases error rates.

In addition to its visual and emotional effects, light at the workplace is also important in terms of biology: Light with shortwave, blue spectral components has an activating effect, whereas warm white light has a relaxing impact. Biologically effective lighting can provide long-term support in terms of employees' health, particularly in production areas without natural daylight or in night shift operations.<sup>6</sup>

The natural sleepwake rhythm is enhanced through targeted use of illuminance and light colours that imitate natural daylight. There are three known types of photoreceptor cells in mammalian eyes:

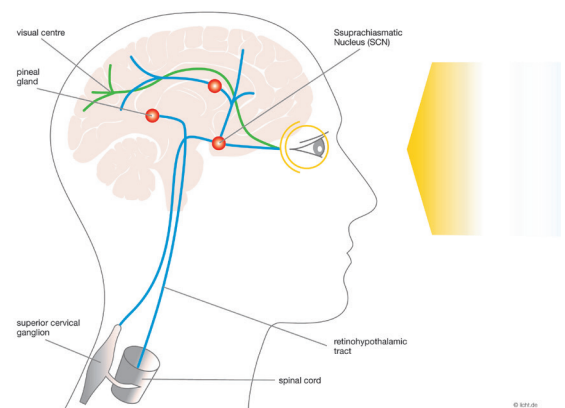
- 1 Rods: Use for Peripheral vision, functions in less intense light
- 2 Cones: They are responsible for colour vision and function best in relatively bright light
- 3 ipRGC (intrinsically photosensitive retinal ganglion cells) or third receptor is working at shorter wavelength and is sensitive to higher colour temperature of more than 6500 K.

## Spectral response functions



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### Visual (green) and biological (blue) path



In addition to its visual and emotional effects (both green path), light at the workplace is also important in terms of biological effect (blue path).

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## VISUAL AND NON-VISUAL EFFECTS: FLEXTRONICS

Dynamic lighting with non-visual effects has an energising impact in the morning and at mid-day and help in better sleep. Many people in industry work shifts have to get up, for example, very early in the morning. They often complain of sleeping badly and being tired during the day. The result is lower productivity, because workers who cannot regenerate overnight are not very efficient during the day. The study conducted by Zumtobel with Bartenbach shows three psychophysiological and productivity-related effects of changing room lighting conditions for workers at the Althofen plant of Flextronics during the morning shift.<sup>7</sup>

Scientists agree that light has a decisive influence on the visual performance and the well-being of working people. Indirectly, therefore, good lighting quality has an influence on productivity. If illuminance levels are too low, the error rate is considerably higher. For simple manual tasks, error rates will only decrease from illuminance levels of approx. 500 lx onwards.<sup>8</sup>

## BIOLOGICAL EFFECTS: IWL LANDSBERG

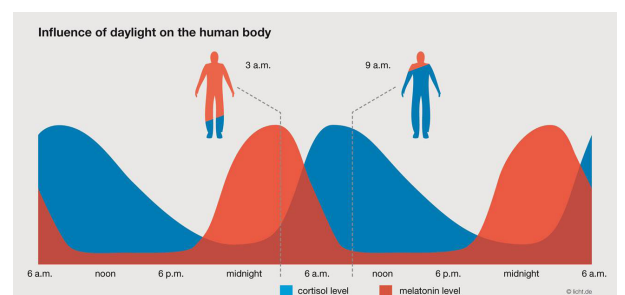
Recent study conducted at IWL Landsberg, Zumtobel in collaboration with the Munich University of Applied Sciences and lighting planner 3ipi have been evaluating the artificial light system<sup>9</sup>. It started in 2014 with the construction of a 2500m<sup>2</sup> production facility for people with disabilities. Light planning has to be done by combining daylight and artificial light concept, taking into account current knowledge about the non-visual effect of light. For a maximum of daylight, not only the roof construction was examined, but also the interior spatial geometry and reflective surfaces were optimised in parts. Thus, the transparency of the laminated roof glazing was increased by 40% by the use of ceiling beam plates. The melanopic efficacy could also be increased by 14% by selecting a glazing which had a higher light transmittance in the 490 nm spectrum. Due to the high blue content the luminaire used are melanopically effective.

At fixed times of the day, the light offer is changed. The biological effect is ensured and the circadian rhythm of the users is supported. Melanopically effective lighting can also support human circadian rhythms at industrial work premises. Which means, blue light is important – however the right amount, at the right time, such as lighting solutions with cool white and higher lux at midmorning and early afternoon, while warm white and lower illuminances in the evening.

Biologically effective lighting can provide long-term support in terms of employees' health, particularly in production areas without natural



**IWL workshops for people with disabilities, Landsberg | DE**  
Field study on biologically effective lighting. © Zumtobel



Melatonin produced during evening and early night is also called the sleep hormone. Light in the blue range suppressing the melatonin is characterised as the melanopic effects of light. © Licht.de

daylight or in night shift operations. The natural sleep wake rhythm is enhanced through targeted use of illuminance and light colours that imitate natural daylight. Activity based lighting with dynamic features of varying intensity, tunable colour corresponding to the natural sunlight, with the right amount on the right time, controls the circadian rhythm. Optimal lighting level together with a melanopic lighting are good for employees overall well-being and help maintain their productivity.

#### **RELIABILITY – LIGHT IS RESISTANT**

Due to the diverse environmental conditions in industrial and craft businesses, lighting systems need to be reliable and application-specific. As an alternative to uniform solutions, durable, reliable products are required that are optimally attuned towards individual application requirements and customer needs.

Industrial and craft businesses are very diverse and characterised by very different environmental conditions. Detecting the prevailing environmental influences therefore plays a significant role when selecting the right lighting. A luminaire's technical components should be protected against overheating in the case of very high temperatures. No liquids or foreign objects should enter the housing in areas with increased moisture and dirt accumulation. In intensive cleaning processes and chemically polluted ambient atmospheres, particular attention must be paid to the right choice of material in order to provide resistance against the substances present in the application. Application-specific standards and guidelines often contain lighting-related specifications that must be met. Checklists give an overview and record the existing general conditions in an industrial project as completely as possible:

##### **MECHANICAL RESISTANCE**

The mechanical resistance of luminaires is a high priority in many industry applications because very often pieces of equipment might come in direct contact with the lighting fixtures. Luminaire protection against impact is necessary to sustain in these environment.

##### **ENVIRONMENTAL RESISTANCE**

Due to different production and processes, the environment keeps on changing in the industry. Factors such as dust, humidity and temperature, impacts the life and quality of the luminaire. Factors such as very high or low temperature may influence not only the materials, but also the lifetime and the proper functioning of the electronic components of the lighting solutions. Furthermore, temperature and moisture are enablers of additional reactions with the chemicals in the surrounding atmosphere. Resulting in short lifetimes and early failure of the luminaires.

## CHEMICAL RESISTANCE

It's very important to consider the chemical influences in the industry before selecting the right materials. It's classified in two ways, chemicals substances in the surrounding atmosphere and chemicals in cleaning agents. Chemicals in surroundings can be caused due to different process in industry for example presence of ammonia in agriculture livestock. While chemicals such as alkaline, acid detergents, disinfectants, solvents are used for cleaning in various industries. For example food, metal, pharmaceutical or chemical industries can have a negative impact on the electrical equipment, including luminaires. Plastics and metal components can react differently to corrosive substances in cleaning agents.

To understand more, we take three concrete industry examples:

### FOOD INDUSTRY

Essential requirements in food industry includes mechanical protection like material should be shatterproof, temperature resistance due to cold storage and hot processing areas. Chemical protection against acid and alkaline cleaning agents. Plastics such as Polymethylmethacrylate (PMMA) material offers maximum resistance.

### PHARMA INDUSTRY

Cleaning agents used in pharma industry consist of alcohol or ethanol as disinfectant. Also, the product needs high environment protection against dust and humidity. Plastics such as Polycarbonate (PC) material offers maximum resistance.

### METAL INDUSTRY

In metal industry, there is a risk that foreign bodies like drilling coolants, grinding dust, grease & oil vapours and flying sparks could penetrate and damage the luminaire from outside and inside. Strong mechanical and temperature resistance is needed to sustain in the harsh environment. Plastics such as CHEMO material offers maximum resistance.

However, since the resistance of metals, plastics and elastomers can be affected by concentration, temperature, presence of other chemicals and other factors, this information should be considered as a general guide rather than an unqualified guarantee.

## **LUMINAIRES OFFERS MORE THAN JUST EFFICIENCY**

Resources are becoming increasingly exhausted. A consequence of this are steadily rising energy costs. This calls for a rethink – particularly in environments in which luminaires are almost constantly in use. The combination of LED luminaires and lighting control systems results in an energy efficient solution that saves both energy and maintenance costs.

Energy requirements at industrial enterprises are especially high due to long operating and production times. This has a negative impact on the carbon footprint and can increase energy costs. Selecting the right lighting and control system therefore contributes significantly to an optimised use of energy resources: Energy efficient, dimmable LED luminaires can cut power consumption by up to 25% in comparison to conventional lighting solutions. Centrally controlled time management systems and accurately positioned presence detectors ensure that lighting is only switched on when it is really needed. Daylight sensors dim luminaires depending on the incident daylight, thus guaranteeing a constant level of lighting.



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