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# LIGHT 2021

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## BOOK OF ABSTRACTS

*Luc Schlangen, Eindhoven University of Technology, Netherlands*



### **INTEGRATIVE LIGHTING, RECENT ADVANCES AND INSIGHTS**

Light can powerfully impact sleep, circadian rhythms, alertness, mood and hormone secretion. In integrative lighting solutions these so-called non-visual effects of light are combined with light's visual effects to maximize human comfort, health and well-being. In 2018 the International Commission on Illumination (CIE) has defined a new metrology to describe light for its ability to stimulate the five photoreceptor classes (rods, S/M/L-cones, ipRGCs) that can contribute to the eye-mediated non-visual effects of light. In this presentation some application examples of the new metrology will be given. Next to this the new metrology will be adopted in a discussion of the recommendations of the 2nd international workshop on circadian and neurophysiological photometry (2019) and some initial guidance on healthy daytime, evening and night-time light exposures in day active people will be given.

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*Annika Jägerbrand, Halmstad University, Sweden*

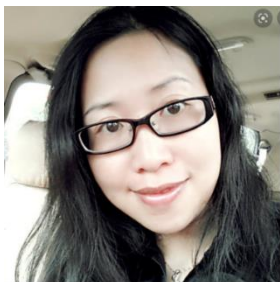


**EFFECTS OF OBTRUSIVE LIGHT ON THE NATURAL ENVIRONMENT AND RECOMMENDATIONS TO MINIMIZE THE IMPACT**

The presentation will start with explaining why outdoor lighting is becoming an environmental problem and how the environment and organisms are affected by light at night. An overview of the recommendations to minimize the ecological impacts will be given. The recommendations can be divided into three areas; legislation and/or guidelines, technical and practical recommendations, and how to deal with sensitive species and habitats. Suggestions of priorities for sensitive species and environments will be presented. Examples of effective precautionary measures will be shown.

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*Yandan Lin, Fudan University, Shanghai, China*



**LIGHTING SCHEME RECOMMENDATION FOR INTERIOR WORKPLACE TO ADJUST THE PHASE-ADVANCE JET LAG**

Light has been found to affect the circadian clock of the human body. This study aims at exploring the proper light scheme for improving performance and alleviating the negative effects of phase-advance jet lag. Experiments have been done under lighting conditions: (1) control lighting group (CLG), (2) low-intervention group (LIG), and (3) high-intervention group (HIG). The alertness, sleep quality, and circadian phases of the participants are measured during the closed circadian conversion stage. Statistical analysis results show that, compared to CLG, HIG can effectively reduce the effect of the phase-advance jet lag syndrome on alertness during daytime ( $p = .028$ ), improve short-term memory task performance ( $p < .001$ ), and reduce visual fatigue ( $p = .016$ ); besides, the 8-h light intervention during daytime assists in improving sleep quality. Finally, a model between light stimulus intensity and the circadian phase shift is introduced.

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*Jeff Kong, Shanghai Academy of Fine Arts, Shanghai University, China*

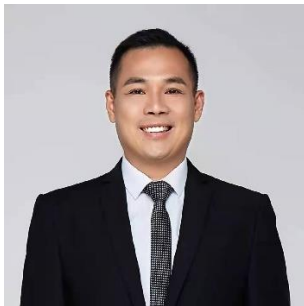


**PRACTICAL AND IMPLEMENTATION JOURNEY OF LIGHTING ARTS AND LIGHT FLASH**

Architectural lighting has grown in a fast and rapid pace and it helps to stimulate economic development and enhance the image of the city. From the perspective of a lighting designer and academist, I would like to share my real experience on lighting design and planning (Shanghai Huangpu District light design and planning, Xinjiang Urqumqi) to everyone from the perspective of lighting design. I will share my latest art works: "light art + flash" creative mode framework to explore another possibility of light art and urban space reshaping,

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*Steve Lau, YD Illumination, Hangzhou, China*



**MEASURES FOR REDUCING THE ADVERSE EFFECTS OF ARTIFICIAL LIGHT FROM LED ADVERTISING SCREEN OR LED MEDIA FACADE**

More and more LED flood lighting and landscape functional lighting are used/applied outdoor either in the downtown city center or even in the urban area all over the world in order to attract more tourists or to serve for illumination purpose or for advertisement purposes. The correct usage and proper installation of LED luminaires could bring positive effects and result, however, if they are used in the excessive and improper way, they may possibly bring a new source of light pollution that may affect astronomy observation, ecological system, floras and faunas, wildlife mating and birds migrating. This presentation will give insights on how these effects happen and provide measures on how to reduce the adverse effects of the obtrusive light from colorful and dynamic lightings.

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*Georges Zissis<sup>1</sup>, K. Bertin<sup>1</sup>, MA. Mequignon<sup>2</sup>, E. Fortrye<sup>1</sup>*

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### **EVALUATING THE IMPACTS OF ARTIFICIAL LIGHTING SYSTEMS TO ABIOTIC RESOURCES AND BIOSPHERE**

The need to reduce human environmental footprint has encouraged the development and use of innovative lighting systems that are becoming “smart” and more efficient in terms of energy use and/or service life. These novel systems are based on Solid State Lighting devices and more especially on light-emitting diodes (LEDs) technologies. However, beyond energy consumption or carbon footprint, there are many other criteria that must be taken into account when evaluating which light systems should be preferred depending on the situation. First of all, the potential environmental impacts generated by the manufacture, use and end of life of a system can be determined through Life Cycle Analysis. This standardized method provides an overview of the impacts of each phase of the life cycle and thus makes it possible to evaluate the performance of different lighting systems. LCA also helps to evaluate the relative effects of each phase of the life cycle on the impacts. These effects depend mainly on how the electricity consumed during use is generated but not only. To fully understand and quantify the impacts in our planet’s “abiotic resources” (energy, materials...) and on our biosphere (biotope and human being) we need define new metrics for quantifying an “appliance efficacy” of a lighting system for a given application. In this context, multi-criteria analysis has proved its worth in facilitating decision-making around complex problems containing many criteria that sometimes contradict. This talk, will stress all these aspects in order to draft the characteristics of what should be the most efficient light system for a given application.

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### **STANDARDIZATION ON OBTRUSIVE LIGHT AND SKY GLOW MEASUREMENTS**

The use of artificial light at night in the outdoor environment (ALAN) may introduce negative and unwanted side-effects such as light pollution and unwanted impacts on humans, ecosystems and biodiversity. It is therefore a complex and multi-discipline global issued that needs to be assessed in a holistic way. It is of high priority to develop frameworks and specify the methods for the monitoring of ALAN and the adverse effects of ALAN at the local and regional levels. Verification of lighting installations is necessary to avoid over-illumination and to ensure light inflation is not taking place.

This presentation deals with the current issues around the measurement techniques and instrumentation used in practice and the fragmented knowledge across different disciplines. The instrumentation and methods for the measurement, assessment and monitoring of the sky-glow and the sources of obtrusive light should be aligned and standardized. This includes measurements of outdoor lighting installations during the construction, operation and maintenance periods as well as the variation of sky glow that should be monitored in short and long term.

### **KEY ASPECTS OF ADAPTIVE ROAD LIGHTING. IN THE PREPARATION OF AN INTERNATIONALLY AGREED FRAMEWORK**

Road lighting technology has evolved dramatically in the recent years after it remained almost the same for many decades. LED technology gave a boost to the luminaire design by increasing the energy efficiency, by offering a great flexibility in lens design and technology and by using efficient drivers. This resulted to a significant reduction of energy consumption in road lighting. The introduction of intelligent control systems combined with luminaire specific controllers, introduced the concept of the Adaptive Road Lighting (ARL).

Despite the wide use of ARL in modern systems, there is a lack in common strategies on how these installations should be operated. Operators seek for agreed information on the control methods, the priorities, the technology used as well as the general responsibility of operating such installations. Since safety is the most important factor in road lighting, there is a need for ensuring all safety aspects under lighting control schemes. This presentation deals with the key aspects of adaptive road lighting operation and describes the first steps on an international experts group under the CIE to prepare a commonly agreed framework on such systems.

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*Balážová Lenka, Murguía Sánchez Laura, Light Lab*

### **LIGHTING DESIGN OF OUTDOOR PUBLIC SPACE**

The improvement of the outdoor public space has reached a more active extent in recent years, together with the public lighting component, which recreates its overall visual perception and comfort at night. The lighting planning of these spaces has a short history yet executed works provide us with a quite significant overview for feedback. Based on them, we can try to outline some strategies and justification of the principles in the lighting design itself. The lecture seeks to point out the importance of the context and the added value of the concept, which form the night visual compared to purely metric and economic indicators. Topic will also address environmental impact and sustainability issues.

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*Darula Stanislav, Czafík Michal, Puškar Branislav, Ústav stavebníctva a architektúry SAV, Bratislava, Fakulta architektúry STU, Bratislava*

### **DAYLIGHTING IN ROOMS WITH LOGGIA**

The standard STN EN 17037 which changes the criteria for the evaluation of daylight in buildings is valid since february 2021. The classical Daylight Factor is replaced by a climatic criterion and the required level of daylighting. EN 17037 does not differentiate between lighting requirements according to the type of buildings and their operation time. In the case of residential buildings, the requirements of EN 17037 lead to excessive dimensions of the windows or cannot be met. The paper discusses the subject of daylighting in living rooms with loggia.

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*Dolníková Erika, Stavebná fakulta TUKE Košice*

### **EVALUATION OF ADAPTATION OF BALCONIES TO LOGGIAS ON THE LIGHTING CLIMATE IN THE INTERIOR OF AN APARTMENT BUILDING**

Reconstruction of balconies and loggias is a key element in the renovation of apartment buildings. Artificial light never replaces natural light. When renovating balconies, people often change the character of this protruding building from a façade to a loggia. To evaluate the daylight conditions prevailing in residential buildings, the DF was considered as a parameter to indicate the amount of daylight received. DF values and CIE illuminated sky were calculated using DIALux 9.1 software. The aim of the paper is to compare two variants of the level of daylight in the rooms of an apartment building. There is a variant with balconies to get even more natural light into the window. Loggias are satisfactory in terms of static and thermal technology, but daylight conditions are deteriorating. The article provides an insight into the solution of the renovation of balconies and loggias in a specific apartment building. The result is their influence on changes in the conditions of natural daylight in the interior of two rooms.

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*Dubnička Roman, Mokrání Marek, Janiga Peter, Slovak University of Technology in Bratislava*

### **INFLUENCE LATERAL TRANSLATION AND ANGLE ORIENTATION OF LUMINAIRES ON LIGHTING DESIGN OF INTERIORS**

By means of goniophotometry are measured luminous intensity distributions of luminaires. These measurements are important for lighting designers who use results from these measurements for lighting designs of indoor lighting system in the form of photometric

files. Uncertainty of installation of luminaires is at the present another big unknown when real installation of lighting system is performed. Lighting designers often are not responsible for errors which occurred at installation of luminaires. Till now it could not be found agreement among lighting designers community what expression or tolerance should be assumed. Goniophotometry is close connected with lighting designs for indoor lighting systems. Therefore it can be possible influence of uncertainty lateral translation and angle rotation of luminaire depending of already measured LIDC of luminaire on photometric parameters which are verified by field measurement. Simultaneously it can solve problem to improve of knowledge of lighting designers or customers who concerns about this to predict possible errors influenced by installation errors. Thus lighting designers can do better lighting designs what can avoid possible inconveniences which sometimes occurs at design realisations. Furthermore avoiding these problems can save a lot of things which occur of improper installations. Paper concerns about problematic of influence of installation position particular luminaires with particular LIDCs. The results from performed research work can serve as background for future work how to express and treat influence of error about installation of luminaires on lighting designs. At the end of paper is introduced analysis which can serve for new treatment about tolerance intervals which can be assumed at lighting design level.

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*Gašparovský Dionýz, Slovak University of Technology in Bratislava*

#### **APPLICATION OF THE INDICATORS OF ENERGY PERFORMANCE OF ROAD LIGHTING**

Energy performance of road lighting is, according to the norm STN EN 13201-5, expressed in terms of the pair of compound numerical indicators PDI (Power Density Indicator) and AECI (Annual Energy Consumption Indicator). Examples of calculation of the indicators and typical values for various combinations of different road profiles, lighting classes and lamp technologies are also included in the standard. In 2021, an updated draft of the norm has been prepared, still based on the previously established indicators. However, several improvements of the practical application, and updated typical values of the indicators in particular, have been specified. Recommendations on the presentation of input data and results of the assessment have been extended. Aim of the paper is to introduce to the professionals key points of the draft standard, to provide additional comments and explanations and to highlight important circumstances of its elaboration. The new draft standard should strengthen practical implementation of the indicators PDI and AECI.

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*Gašparovský Dionýz, Raditschová Jana, Slovak University of Technology in Bratislava*

#### **PREFERENCES AND PERFORMANCE OF HOME LIGHTING**

The paper aims to publish updated data from investigation of home lighting in 2021. Focusing on current preferences of lighting users in households and energy performance of home lighting, statistical data will be accompanied by causal analyses. Progress compared to previous investigation performed in 2013 will be demonstrated. The paper will also present a new draft of regulation for assessment of energy performance indicators applicable for energy certification of houses for living. Role of home lighting in home officing increased in consequence of the pandemic lockdowns will be dealt in the paper as well.

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*Góra Pavol, ZG Lighting Slovakia s.r.o.*

### **HUMAN-CENTRIC LIGHTING PLANNING**

People spend most of their time indoors, primarily under artificial lighting. The result of incorrectly setting of artificial lighting is a constant stressful factor for a person. In my presentation, I will introduce the principles of human-centric lighting planning, which is based on the biological needs of individuals, in order to ensure biological and mental health, higher performance and creativity at work. We will present you the possibilities provided by the current technology in lighting in order to create human-centric lighting in indoor spaces. We will also clarify the positive effects of new generation of LED light with artificial modification of its spectral characteristic which called Zumtobel Spectrum technology.

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*Hanuliak Peter, Hartman Peter, Slovak University of Technology in Bratislava*

### **DOSIMETRIC MEASUREMENT OF LIGHTING CONDITIONS IN THE OFFICE ENVIRONMENT**

The paper discusses the method and processing of recording lighting conditions in the office environment using standard and dosimetric devices. The measurement used a device placed on the human head to measure the illumination on a vertical plane near the eyes. In this way, we can better quantify the amount of light to which the user is exposed in an office space. The result also serves to more accurately assess real lighting conditions, which are important in terms of biological stimulation of the body by light.

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*Hraška Jozef, Slovak University of Technology in Bratislava*

### **A NEW PHILOSOPHY OF STANDARDIZING DAYLIGHT IN BUILDINGS AND ITS PRACTICAL IMPLICATIONS**

Sufficient daylight in the indoor environment of buildings is important not only for the vision, but daylight also has significant physiological and psychological effects on the humans. Daylight in buildings is generally preferred by people. The use of daylight in buildings also means the use of renewable energy. The provision of daylight significantly depends on the urban and architectural parameters of the built environment. In several European countries, standards specifying the requirements and criteria of daylight in buildings mainly became established in the second half of the 20th century. National daylighting standards and related various building regulations were based on empirical experience, they were applied in stages for different functional spaces, e.g. especially for residential buildings, classrooms in schools, administrative premises and the like. The new EN 17037 has brought a number of changes to the design of daylight in buildings, which result from other starting points of standardization compared to "traditional". EN 17037 does not distinguish between the concrete functional use of indoor spaces from the point of view of daylight provision, at the vaguely defined reference level it requires to achieve the same minimum level of illumination in all regularly occupied indoor spaces half daylight time of all days of a reference year in the respective locality.

The proposed contribution will focus on:

- analysis of the minimum target daylight factor according to EN 17037 in several types of indoor spaces in relation to the criteria that have been used in Slovakia for decades,
- specification of the practical implications of the daylight criteria according to EN 17037 for the design of buildings and the urban density.



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*Hrdlík Milan, AMI spol. s r.o.*

### **HORTICULTURE LIGHTING**

Food production appears to be one of human's major future problems. Lighting technology will play an important role in this.

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*Hrdlík Róbert, AMI spol. s r.o.*

### **FIRE PROTECTION OF BUILDINGS - EMERGENCY LIGHTING**

Types of emergency lighting and its use in fire protection of buildings.

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*Iringová Agnes, UNIZA Žilina*

### **INFLUENCE OF INDOOR ATRIUM GEOMETRY ON DAYLIGHT DISTRIBUTION IN ADJACENT WORKSPACES.**

The paper deals with the theoretical analysis of physical determinants affecting the function and design of an atrium in an office building. The function of an atrium in dependence on the zone boundary conditions.

Optimization of its geometry in terms of its primary function - distributing daylight in spaces without the possibility of side lighting. Legislative requirements for daylighting in workplaces in the Slovak Republic.

The construction solution and geometry of the atrium in an office building in terms of microclimate optimization considering the light comfort in adjacent work and relax spaces. Optimization of physical parameters of atrium roof glazing in terms of the diffuse light distribution and heat load reduction in the summer period. Examples of solutions.

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*Janiga Peter, Slovak University of Technology in Bratislava*

### **BIM SYSTEM IN LIGHTING DESIGN**

The building information model, called BIM is a technology used in civil engineering for more than 10 years. Especially in recent years, there is a greater interest of designers. This is a consequence of competition and better software availability. The aim of the paper is to present the potential that BIM offers in the field of lighting technology. It is also necessary to mention the risks and shortcomings that BIM presents. Practical examples are focused on the design and modelling of daylight and artificial lighting.

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*Janig Peter, Gašparovský Dionýz, Raditschová Jana, Duda Filip, Slovak University of Technology in Bratislava*

### **RESEARCH OF TRAFFIC INTENSITY IN DIFFERENT URBAN AREAS**

Traffic density significantly affects the design and operation of public lighting. New digital technologies are also changing the approach to traffic monitoring. New methods provide more accurate numbers, and it is possible to distinguish other parameters such as speed or type of vehicle. The paper describes new technologies, their positives and negatives. Outputs from modern monitoring devices are shown on specific roads.

The second part of the paper focuses on the processing of the obtained data. The data are evaluated in terms of days of the week and in terms of communication classes. From the monitoring results, standard traffic curves are compiled for different types of roads in different urban areas. From the results it is possible to understand the dynamics of the use of roads from the main traffic routes to residential areas.

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*Janiga Peter, Grega Miloš, Slovak University of Technology in Bratislava*

### **3D PRINT OF LAMPS**

3D printing is a technology whose potential is perceived by designers and engineers. Although the potential is great, the experience is relatively small. The paper aim is describing the technology on two printed lamps. The theoretical part describes the materials and technologies that are used for printing. The analysis describes the basic tools for modelling of elements and compares them. The printed lamp and shade show the risks and limitations that 3D prints. Finally, the measurements on the goniophotometer evaluate and quantify the differences between conventional production and 3D printing.

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*Kocifaj Miroslav, ICA SAV*

### **SKY LUMINANCE PATTERNS DUE TO HETEROGENEOUS CLOUD ARRAYS**

Accurate predictions of sky luminance distribution are important for daylight availability modeling in various urban areas. While some progress has been achieved in the last few years, the stochastic cloud fields still remain the largest sources of uncertainty in characterizing diffuse light near the ground. Due to its mathematical complexity the highly accurate theoretical luminance models are currently unavailable for characterization of arbitrary sky states. However, we have modified the theory of successive orders of scattering and computed the scattered light from broken clouds and a cloud-free atmosphere. This has appeared as a trade-off between time-consuming numerical solvers and simplified empirical tools. We present a number of numerical results and demonstrate how the luminance from broken clouds and a cloud-free atmosphere interfere, while producing the total luminance field and how this differs from luminance distributions on homogeneous skies. We also analyze how successful our model is in explaining the wide range of luminance patterns observed in nature. The mass computations based on our model show that the theoretical predictions are now more consistent with experimental data.

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*Kocifaj Miroslav, ICA SAV*

### **VERTICAL PLANE IRRADIANCE UNDER PARTLY CLOUDY SKIES**

Solar energy is an increasingly cost efficient tool with attractive applications in green technologies. Window-less surfaces of tall buildings situated in a complex urban environment are ideal bases for photovoltaic panels mountings. Although the peak energy conversion is normally achieved when solar panels track the sun path on sky, the vertical panels on static constructs can become partly useful for building's operation energy demands. In mid-latitude climate zones like Central Europe cloudless skies are quite rare compared to what we can observe in dry areas. Partly cloudy skies represent the most

frequent conditions which makes the prediction of global irradiance difficult by using simple empirical models. Here we present vertical wall irradiance computed for the range of atmospheric conditions and for isolated clouds distributed arbitrarily over the sky vault. Radiative transfer model we have developed allows for rapid computations independent of shape, size and positions of clouds.

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*Kómar Ladislav, ICA, SAS Bratislava*

### **INFLUENCE OF ATMOSPHERIC AEROSOL ON THE INTENSITY OF DIRECT AND DIFFUSE RADIATION**

In addition to air molecules, small particles with dimensions of hundreds of micrometers to tens of micrometers, so-called atmospheric aerosol, exist in the Earth's atmosphere. Its variation causes changes in the intensity of direct and diffuse radiation known as atmospheric turbidity. However, at elevated aerosol concentrations, e.g., in smog events in large cities or desert storms, it can play an important role in reducing the availability of radiation for photovoltaic panels or daylight for building interiors. The basis for modeling the radiation reduction effect is the radiation transfer equation, in which the properties of aerosols and their scattering phase functions are usually unknown. The aerosol particles are generally of irregular shape, and their size distribution, concentration, as well as its optical properties, can change over time and space. This contribution aims to calculate the radiation reduction for photovoltaic panels for various properties of atmospheric aerosol and to model extreme atmospheric conditions (smog situations, desert storms, forest fires, volcanic eruptions, ...) and their impact on the solar panel power output.

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*Kómar Ladislav, Kocifaj Miroslav, Petržala Jaromír, ICA, SAS Bratislava*

### **MODELING DIFFUSE ILLUMINANCE ON VERTICAL PLANES USING MINIMIZATION TECHNIQUE**

Although calculation of direct sunlight penetration into the building interiors is straightforward, diffuse illuminance of the vertical windows is still unknown due to the high variability of the sky situations, especially under broken cloud arrays. Usual modeling techniques of diffuse illuminance can scarcely be compared in accuracy with the actual measurements. Using unified sky model (Unisky) with minimization of differences between measured and computed horizontal illuminances varying the input parameters such as cloud fraction and cloud base altitude, atmospheric turbidity or ground reflection, can simulate real sky conditions. In this paper, one month illuminances with 10-minutes time step were modeled using minimization between horizontal illuminances. Then, the obtained sky characteristics together with vertical illuminances computed on their basis were compared with the measured data and cloud properties gained from Slovak Hydrometeorological Institute. A good agreement of calculated and measured data is obvious.

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*Kómar Ladislav, Petržala Jaromír, Lipnický Lukáš, Dubnička Roman*

### **MORE ACCURATE PREDICTION OF LUMINOUS INTENSITY OF LED LUMINAIRES**

The I-table contains luminous intensity values for a limited number of angles for the LED luminaires. It causes smoothing of the luminous intensity diagram omitting possible local

extremal values which affect the calculations of the photometric parameters such as average illuminance, average luminance, uniformity or threshold increment. Nowadays, the interpolating methods used for calculation of luminous intensity seem to be insufficient for novel LED systems and can lead to omitted unexpected glare or impact on the skyglow by upward light rays not including into the calculations. In the paper standard interpolation methods used up to now are compared with newly proposed hybrid adaptive splines and verified by goniophotometric measurements. In some cases, newly proposed method has even higher accuracy than standardly used linear or spline interpolation.

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*Kundracik František, FMFI UK Bratislava*

### **THE EFFECT OF DIRECTIONAL REFLECTIVITY ON THE EFFICIENCY OF HIGHLY REFLECTIVE HOLLOW LIGHT GUIDES**

Modern light guides utilize highly reflective materials with a reflectance of up to 98%, which corresponds to the perpendicular reflection from the high-glossy surface of silver. However, the real efficiency of light guides is significantly lower due to several reasons, such as multiple reflections in the light guide, unevenness of the light guide surface and, last but not least, the fact that the reflectance depends on the angle of incidence of light. It is not possible to use conventional simple flow methods for calculating the efficiency of light guides to analyze the effect of individual reflections, but it is necessary to use methods using ray-tracing of individual light rays coming both directly from the Sun and diffusely scattered in the atmosphere. Such a program is HOLIGILM, whose new version allows to include in the calculations the directional reflectivity from the high-glossy metal surface using Fresnel relations, as well as random surface unevenness.

We performed systematic calculations of the efficiency of a model light guide covered with a high-reflective layer of silver (perpendicular reflectance 98.3%) for a cloudy sky (CIE Overcast, 1: 3) and a clear sky (CIE Clear, country side). We also changed the height of the Sun above the horizon. The length of the light guide was 2 m and its diameter was 0.52 m. The surface of the light guide was either flat or accidentally wrinkled (corresponding to the use of a highly reflective film) with varying degree of wrinkling. The results of the calculations showed that, in general, the efficiency of the light guide is significantly lower than the reflectivity of the surface. The inclusion of the angular dependence of the reflectance further reduces the efficiency. The position of the Sun also has a great influence, because the number of reflections in the light guide depends very much on its height above the horizon. The unevenness of the high-gloss surface of the light guide has a particularly large effect on the efficiency.

The work was supported by the agency VEGA, grant no. 2/0010/20.

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*Mokran Marek, Gašparovský Dionyz, Dubnička Roman, Slovak University of Technology in Bratislava*

### **TOLERANCE INTERVALS OF LUMINOUS INTENSITY DISTRIBUTION CURVES**

Luminous intensity distribution curves (LIDC) are one of the main input parameters required when designing a lighting system. For the design of the lighting system to be correct, it is necessary to consider that the measured LIDC may differ from the real radiating characteristic of the luminaire. For this reason, the designer has to some extent oversize the lighting system to ensure that the photometric parameters will be met after

verification of the system by measurement. The lighting system can be oversized only to a limited extent, while it is necessary to take into account the energy efficiency of buildings defined by Act 555/2005 Coll. Large oversizing of the lighting system is undesirable in terms of normative requirements and the investor's requirements for the lowest possible investment and operating costs. The difference between the luminaires' real and measured luminous intensity distribution is due to several influences explained in this article. Furthermore, the article deals with the definition of the permissible oversizing of the lighting system in terms of tolerance intervals of LIDC.

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*Novák Tomáš, Tesař Jiří, Dolejší Ondřej, Valíček Pavel, VŠB -TU Ostrava*

#### **SAFETY INCREASING IN THE NIGHT TRAFFIC AREA**

The paper deals with the possibilities of increasing safety in the night traffic area. In particular, it is a solution to the link between traffic lighting, traffic signs, other light sources and the visibility of obstacles on roads at night. The paper also presents the methodology of night road safety inspection, which is linked to the methodology of performing daily road safety inspection in accordance with EU directive 2008/96 / EC and EU Premium Light directive for version 3.0 from 2017.

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*Maixner Tomáš, Česká společnost pro osvětlování*

#### **OBTRUSIVE LIGHT AND MYTHS AROUND IT**

The text discusses some inaccuracies concerning the issue of Obtrusive light. Related to the effort to reduce Obtrusive light is the effort to regulate outdoor lighting systems. The author polemics these efforts.

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*Kunc Josef, KNX národní skupina České republiky, z.s.*

#### **ADVANTAGEOUS COMMON KNX CONTROL OF LIGHTING AND OTHER FUNCTIONS**

The decentralized KNX system occupies a sovereign position in the ever-increasing number of bus wiring systems. This is based on the possibility of using programmable devices from different manufacturers in a common installation. Above all, however, from the more than 30 years of continuous development of the KNX system in parallel with the development of technology. Depending on the development of the system, common design software ETS is also subject to ever-increasing requirements and is therefore constantly updated and supplemented with new functionalities that allow designers to easily use the possibilities of ever-expanding application possibilities of devices, while meeting all even the most demanding customer requirements. . At the same time, it is also the best secured system - access to the installation is practically impossible for unauthorized persons. At the same time, it easily cooperates with other sub-specialized systems designed for the management of selected functional areas.

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*Novák Filip, Baxant Petr, Škoda Jan, Motyčka Martin, Brno university of technology, FEEC*  
**ALAN MEASUREMENT IN BRNO**

The article deals with light pollution (also called ALAN) measurement in Brno and subsequent data quantification using a luminance distribution analyser. The contribution of public lighting to the total value of skyglow is also discussed in the article.

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*Petržala Jaromír, Ústarch SAV, Bratislava*

**OPTIMIZATION OF SCATTERING FUNCTION OF TUBULAR LIGHT GUIDE DIFFUSER – A CASE OF DIFFUSE LIGHT OF SKY**

Recently, there was presented a theoretical study dealing with the inverse method of determination of bidirectional transmittance distribution function (BDTF) of a diffuser from a required illuminance distribution on a workplane or floor. Moreover, a technical solution how the computed BDTF could be eventually realized by a particle-doped transparent medium was proposed. That study was focused on direct sunlight passing through the light guide, because it forms a dominant component of daylight and is responsible for discomfort glare. However, the method derived can be applied also in case of diffuse light of the cloudy sky. This work presents the diffuser scattering functions computed for some specific illuminance distributions considering just the diffuse input light. Such light is more significantly affected by attenuation by usual optically dense diffusers than the more intensive direct sunlight. Therefore, an alternative construction with required diffusing properties could be desirable.

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*Podmanický Marek, Letisko M. R. Štefánika – Airport Bratislava, a.s.*

**APPROACH LIGHTING SYSTEM FOR PRECISION APPROACH WITH LED AIRFIELD LIGHTS IN BRATISLAVA AIRPORT**

The paper deals with the first light approach system, which was equipped with LED airfield lights in the Slovak Republic. It describes its individual lighting systems as well as the design solution. The article describes the gradual development of approach lighting systems at the Bratislava airport and evaluates the most significant differences that come with airfield lights with LED light sources.

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*Valíček Pavel, Novák Tomáš, VŠB -TU Ostrava*

**CONTROL OF INDOOR LIGHTING SYSTEMS TO A CONSTANT LEVEL OF ILLUMINANCE**

The paper addresses the issue of the behavior of sensors located on the ceiling, on the basis of which the dimming of luminaires of indoor lighting systems is realized. The authors aim to point out the fact that when combining contributions from artificial and daylight, there may be a significant under-regulation of lighting systems, even below the values of the hygienic minimum in classical offices or classrooms. The article will indicate the possibility of finding the optimal reception characteristics of sensors and their location on the ceiling so that there is no under-regulation and at the same time the benefit caused by reducing the energy consumption of luminaires of the interior lighting system is maintained.

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### **THE CONSPICUITY OF PEDESTRIANS: A DOMINANT CONTRAST PROBLEM**

Collisions between vehicles and pedestrians are devastating and unfortunately happened frequently. In the year 2019, 93 pedestrians were killed (approx. 17% of all traffic fatalities) and 439 were severely injured (approx. 15% of all traffic fatalities) in Czech Republic. The problems that result from inconspicuous pedestrians interacting with traffic per both day and night challenge to safety researcher including lighting experts and textile designers. It is known that risk of a fatal crash of vehicle with pedestrians in darkness is almost seven times greater than under daylight. While driving, the driver must not only drive the car, but also recognize any obstacles on the road, including moving pedestrians. The ability to distinguish obstacles in road traffic is primarily influenced by the light contrast between the obstacle itself and its background. In the night traffic area, the driver's visual performance is affected by several other factors, such as adaptation luminance, size, and movement of the object, and finally, the driver's age, the quality of his visual abilities respectively. The concept of dominant contrast (DC) published by Saraji and Oommen in 2015 is defined as the contrast of any part of the pedestrian that provides the highest visibility. They found that pedestrian contrast is bipolar and dynamic, nevertheless concept of DC itself is mostly focused on static scene ignoring biomotion concept of increasing conspicuity. This work is focused on the study of the influence of position, size, optical parameters of retroreflective elements on sportswear based on the concept of biomotion together with contribution of color information to rapid conspicuity and visibility of pedestrians in daytime and nighttime hours.

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### **AVAILABILITY OF DIRECT AND DIFFUSE SUNLIGHT UNDER PARTLY CLOUDY SKY CONDITIONS**

The presence of clouds dramatically affects the amount of direct and diffuse light that hits a horizontal surface. Standard sky models predict only average values of available light. However, the accidental passage of a cloud in front of the Sun dramatically affects the situation. Therefore, the average values are only a very basic characteristics and much more detailed information is needed to better understand the effect of clouds on the availability of sunlight.

The "UniSky Simulator" program allows to generate randomly broken cloud layer. Various parameters of the layer can be set, such as the size of individual clouds, the percentual coverage of the sky, the height of the cloud layer, the altitude of the Sun, aerosol content and so on. One of the outputs of the program is the value of the illumination of the horizontal plane. Using this program, it is therefore possible to obtain detailed characteristics of horizontal illumination, such as histogram, mean, median, and so on. Using the "UniSky Simulator" program, we performed systematic calculations of the illumination of the horizontal plane by direct and diffuse sunlight at different cloud coverage of the sky and at different heights of the Sun above the horizon. We also investigated the effect of the amount of aerosol in the atmosphere on the direct and diffuse light.

The obtained histograms showed that the average value of the amount of available light is significantly influenced by the solar periods, even when the Sun is hidden behind the clouds most of the time. Therefore, percentiles, such as the upper quartile, are better

characteristics of the illuminance value that we observe most of the time. It has also been shown that the illumination of the horizontal plane and its distribution function is also influenced by the aerosol content in the atmosphere, which can be a significant factor, especially in urban and suburban environments.

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### **REDUCING THE DISTURBING EFFECTS OF OUTDOOR LIGHTING**

Artificial lighting and its use by humans has a long history and has significantly influenced the development of our society. It is used in a wide range of application areas, such as lighting of workplaces, roads, sports grounds or architecture. One of the important aspects of outdoor lighting and the issues discussed are the disruptive effects of outdoor lighting on the environment. In the Czech Republic, a new building law was approved in May this year, which is to enter into force in 2023. The new building law is followed by implementing decrees, which should include addressing the disruptive effects of artificial lighting on the environment. In order to link the requirements of the decrees with practice, a task was set for the elaboration of a national technical standard. The issue of disturbing effects of outdoor lighting is relatively extensive and complex and the basis for its solution is an understanding of basic concepts, causes and consequences. The paper describes the approach, principles and basic structure of the proposed technical standard to reduce the disturbing effects of outdoor lighting.

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