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PRESENT AND FUTURE ACTIVITIES OF THE INTERNATIONAL COMMISSION ON ILLUMINATION (CIE)

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ABSTRACT

The article describes the main activities of the International Commission on Illumination in recent years. The most important publications are reflecting recent developments in lighting science and industry, including LED sources and luminaires test methods, fundamental recommendations concerning colorimetry, discomfort caused by glare from luminaires with a non-uniform luminance, as well as intelligent control of lighting systems. Human centric lighting and the non-visual effects of light on humans was highlighted. To promote standardization in the field of horticultural lighting the CIE is in the process of establishing a new JTC. In view of *COVID-19* pandemic outspread the use of germicidal UV radiation is of relevance to reduce both contact spread and airborne transmission of infectious agents. The CIE is responsible for worldwide standardization of the fundamentals, including metrology and vocabulary, as well as lighting education. The CIE considers it important to make digital products including validated calculation tools, apps, databases and machine-readable documents more available for many experts and it takes a step in this direction by provide open access to the individual CIE publications.

Keywords: CIE, Joint Technical Comittee (JTC), colorimetry, International Electrotechnical Vocabulary, weights and measures, human centric lighting, non-visual effects, ganglian cells (ipRGCs)

INTRODUCTION

It is with reverence and humbleness but also with great pleasure that I accept the Presidency of the International Commission on Illumination (CIE), this outstanding and honourable organization founded in 1913 by the lighting societies of several countries.

In recent years, the lighting industry has gone through a turbulent period. This technological but also structural transformation has a direct impact on the work of the CIE. The LED has largely replaced the "classical" light sources. Accordingly, the CIE has adapted many of its guidelines and recommendations. Some of the examples are presented below.

– **CIE S025:2015** [1] *Test Method for LED Lamps, LED Luminaires and LED Modules*: it is the first international agreed standard in respect to the measurement of LED light sources. These standards also include considerations on measurement uncertainties, a concept that not yet fully established in the industry. CIE offered, therefore, several pieces of training and tutorials, including a very successful tutorial in Moscow organized in collaboration with Russian Lighting Research Institute named after Sergey Vavilov (VNISI) in November 2018. A supplement has recently been published dealing with organic LEDs (OLEDs) [2].

– **CIE015:2018** *Colorimetry, 4th Edition* [3], this document collects the fundamental recommendations of the CIE concerning colourimetry. Specifically, it includes the use of the standard colorimetric observers and standard illuminants, the reference

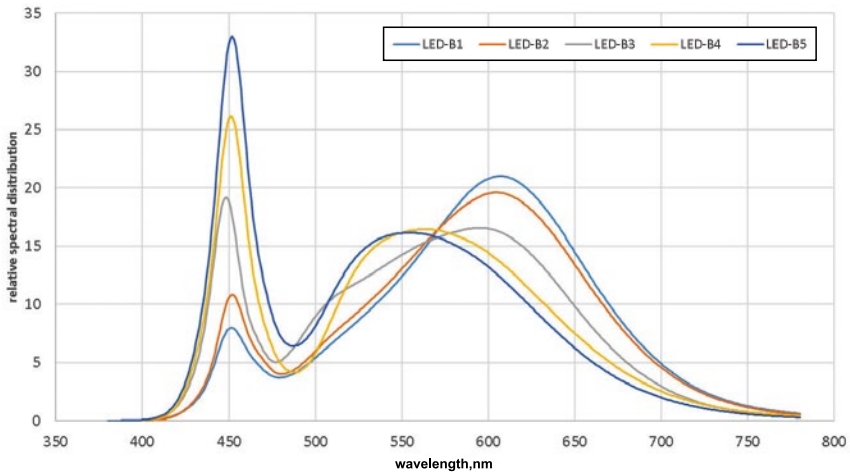

Fig. 1. Relative spectral distribution of LED illuminants as defined in CIE15:2018 [3]

standard for reflectance, chromaticity coordinates, colour space coordinates and colour differences and various other colorimetric practices and formulae. It its latest edition new illuminants for different LED types are introduced (Fig. 1). Furthermore, new findings on cone-fundamental-based tristimulus functions based on CIE170–1 [4] and CIE170–2 [5] are included;

– **CIE232:2019** *Discomfort Caused by Glare from Luminaires with a Non-Uniform Source Luminance* [6]. LEDs allow the design and realisation of aesthetically beautiful, but technically sophisticated luminaires. Among other things, the light distribution, the spectral composition but also the illuminated surface can be adapted practically as desired. However, if this is not done correctly, it can lead to glare. The CIE232 report gives for the first time a recommendation on how to assess the glare of non-uniform illuminated surfaces. The step to evaluate the glare of a non-uniform light source is shown in Fig. 2.

The technological revolution in the field of light and lighting was initially triggered by the increase in luminous efficacy of the light sources. However, for physical reasons, the luminous efficacy of light sources cannot increase indefinitely. An important way to increase energy efficiency is the intelligent control of lighting systems. It includes adaptive light sources as well as smart sensors. In this interconnected world, it is important for the CIE to position itself clearly and address issues such as dynamic or adaptive lighting. CIE has, therefore, set up a new technical committee TC4–62 to analyse needs, specify recommendations, develop methodology and promote the application of adaptive road lighting.

The lighting industry has created the term "Human Centric Lighting" to describe the non-visual effects of light on humans induced or supported by the intrinsically photosensitive retinal ganglion cells (ipRGCs). Personally, I prefer the term "integrative lighting", which is used within the CIE and ISO. It represents the versatility of light and lighting, namely the combination of visual and non-visual effects to produce physiological and/or psychological benefits on humans. With the introduction of the International Standard CIE S026:2018 CIE *System for Metrology of Optical Radiation for ipRGC–Influenced Responses to Light [7]* the CIE has created an important basis for the different stakeholders to use the same terms and metrics. Now it is a matter of establishing these metrics in the research community and, thus, generate results that can be applied for the benefit of the human being.

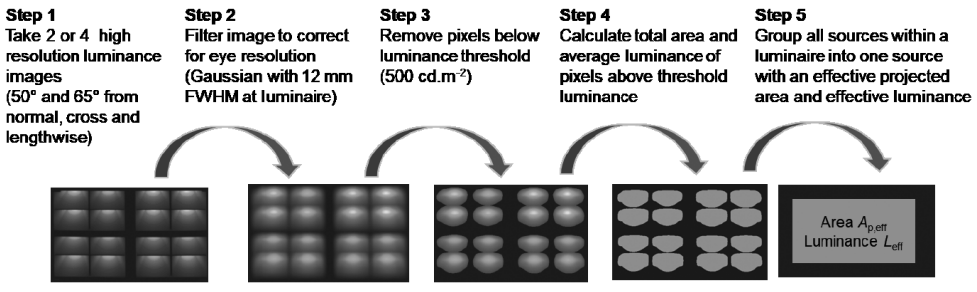

Fig. 2. Overview of the measurement and image processing steps required to obtain the effective projected area and the effective luminance used to predict the glare of a non-uniform light source according to CIE232:2019 [5] (© CIE)

As an important tool, I note the CIE research strategy, which takes a forward-looking approach to the major topics on our field.

But the subject of light and lighting does not end with integrative lighting for humans. Optical radiation is used for horticultural lighting or disinfection applications. In addition to the clever use of optical radiation, it is also about minimizing negative effects, e.g. through light pollution or photobiological damage.

It was with great pleasure that I took note of the initiative of VNISI to promote standardization in the field of horticultural lighting. Based on this proposal, the CIE is in the process of establishing a new joint technical committee, and I hope that many Russian experts will be able to participate in this important activity and contribute their knowledge. I have a fond memory of the first *International Scientific and Technical Greenhouses Lighting Conference*, organized in September 2019 in Moscow.

Triggered by the pandemic outspread of the coronavirus, CIE has recently released a position statement on the use of ultraviolet (UV) radiation to manage the risk of *COVID*-19 transmission. The use of germicidal UV radiation is an important environmental intervention, which can reduce both contact spread and airborne transmission of infectious agents (like bacteria and viruses). However, germicidal UV radiation must be knowledgeably applied with appropriate attention to dose and safety. Inappropriate GUV application can present human health and safety issues and produce insufficient deactivation of infectious agents. Therefore, application in the home is not advisable, and GUV should never be used to disinfect the skin, except when clinically justified. With the help of the different national committees, the CIE position statement was translated into many different languages, including Russian. In addition, CIE has two publications freely available (CIE187:2010 *UV–C Photocarcinogenesis Risks from Germicidal Lamps* [8] and CIE155:2003 *Ultraviolet Air Disinfection* [9]) to support the international community in the fight against the virus. Both publications were translated also in Russian language.

INTERNATIONAL COOPERATION CIE

The CIE is not only a global organisation dealing with the science and technology of light and lighting. It is also a standardization organization since its foundation. Through the cooperation of experts from various national committees, internationally recognised standards are created. The CIE was the first and is still one of the few standards development organisations recognised by the International Organisation for Standardisation (ISO). The cooperation with *ISO*, in particular ISO TC274 Light and Lighting, is defined in a PSDO-Agreement (Partner Standards Developing Organization), which was renewed last year. The *CIE* is responsible for worldwide standardization of the fundamentals, including metrology and vocabulary, while ISO TC274 focuses on standardization in the field of applications. The CIE also works very closely with the International Electrotechnical Committee IEC, in particular IEC TC34 and IEC TC76. The work of the IEC standardization committees focuses on product safety and performance. Examples of the successful cooperation with the IEC is the important lamp and luminaire safety standard IEC62471/CIE S009 [10], which was developed in the CIE and then published as a dual logo standard. Experts are also working together to revise the International Lighting Vocabulary (ILV) [10], which in its latest edition to be published soon, will be fully harmonised with IEC60050–845 (the International Electrotechnical Vocabulary, IEV) [12]. This is very important work, because a common understanding of the meaning of words is needed to eliminate ambiguities and uncertainties. It is therefore important that this comprehensive work is translated into as many languages as possible. The national committees of the CIE also play an important role in this respect. However, language is not something static, but is constantly evolving, especially as new areas are explored. The most recent example is the field of horticulture lighting, which is being worked on together with IEC TC34.

CIE also has a mutual agreement with the Committee for Weights and Measures (CIPM), which recognizes the respective competencies. In particular, CIE recognises the role of CIPM in respect to the definition of units (i.e. the SI-units), whereas the CIPM recognises that CIE is responsible for the definition of quantities and action spectra in the field of photometry, photobiology and photochemistry. Therefore, CIE made a significant contributed to the 9th edition SI-Brochure, in particular, *Annex 3* on photobiological and photochemical quantities [13]. In addition, the joint publication “Principle

Governing Photometry" [14, 15] was updated, reflecting the fundamental changes of the International System of Units of Measurement on May 20, 2019, in which the concept of the seven base units has been replaced by a system based on seven defining constants, including the constant for luminous efficacy of monochromatic radiation of frequency (540×1012) Hz, K_{cd}.

LIGHTING EDUCATION

The field of light and lighting is becoming increasingly interdisciplinary, which is why the CIE has created the possibility of horizontal the technical committees and joint technical committees *(*JTCs*)*. Recently, the number of JTCs has increased significantly. It is a challenge to manage this JTC structure, and the code of procedure may need to be adapted in support of this. The efficient interaction between the different division is not only important at CIE*,* but also within the national committees. Again, good communication between all the concerned experts is relevant. In this context, I would like to highlight the newly created the joint technical committee JTC18 Lighting Education: as we all know, lighting is going through a historical technological change. Therefore, it is very important that these comprehensive changes are also incorporated into the training and education of new experts. The aim of the new JTC is to revise and update the outdated technical report CIE99:1989 Lighting education (1983–1989) [16] and to provide recommendations on curricula for higher education and continuing education. It will propose recommendations for the education of lighting professionals and recommend options to improve and support continuing lighting education throughout the professional working life.

PROGRESS IN COLOUR VISION

But we shouldn't forget the progress in the well established areas of CIE. The present colorimetric concepts are based on the research conducted almost a hundred years ago. In fact, at its eighth session in 1931, the CIE defined the standard illuminants, colour matching functions for standard observers and standard chromaticity diagrams. Since then, research in colour vision has made enormous progress. The colour sensation results from physiological processes, the first of which is the capture of photons by the cones of the retina. The fundamental sensitivities of the cones need to be precisely known to accurately specify a colour stimulus from a given spectral power distribution. Part 1 of CIE170 provides the scientific community with cone fundamentals, which are the relative spectral sensitivities of the long-wave sensitive (LWS), middle-wave sensitive (MWS), and short-wave sensitive (SWS) cones as measured at the entrance of the eye. Part 2 of CIE170 provides the user with practical colorimetric tools in the form of chromaticity diagrams. It includes a link has been established between colorimetry and physiology. Starting from the cone-fundamental based spectral luminous efficiency functions, it is possible redefine new colour spaces including the MacLeod–Boynton LMS tristimulus spaces. Moreover, as the model is based on physiology, it is possible to calculated responsivities for "non-standard" observers, i.e. at different ages, with different field sizes, and even calculated a new, cone-fundamental based spectral luminous efficiency function ($V_F(\lambda)$) or other derivate colour quantities.

PHOTOMETRY

In the field of photometry, the change of the reference spectrum used for the calibration of photometers is discussed in TC2–90, substituting incandescent based reference sources to LEDs. A change of reference spectrum will have a huge impact on many stakeholders of CIE, including the instrument manufacturers, the calibration laboratories, the National Metrological Institutes, and the users. Therefore, it is foreseen to propose a LED spectrum in addition to the existing CIE standard illuminant *A*, and both spectra will be used for calibration purposes.

Increased activity is also observed in the field of the characterization of the appearance of surfaces and materials: the technical committee TC2–85 is preparing a recommendation on the geometrical parameters for the measurement of the bidirectional reflectance distribution function (BRDF), TC*2*–94 deals with the measurement of total transmittance, diffuse transmittance, and transmittance Haze, JTC12 (D2/D1/D8) the measurement of sparkle and graininess, and lastly JTC17 (D1/D2/D8) with a gloss measurement and gloss perception. This latest JTC will prepare a framework for the definition and standardization of visual cues to gloss.

CONCLUSIONS

Finally, in the area of publications, there will be further challenges in the coming years. The call for free access to the publications and proceedings is getting stronger. Certain public research institutions request that the research results, which are financed by public funds, become publicly available. The CIE is taking a step in this direction by making the individual papers of the CIE session in Washington D.C. freely available. In addition to the free access to expertise, digitization is a challenge and an opportunity for the CIE. It will be important to make use of new forms of digital products, including validated calculation tools, apps, databases, machine-readable documents, etc. The digitalization of products, meetings, and events is obviously be pushed by the present extraordinary situation due to the pandemic spread of the coronavirus.

However, the CIE is not only an international forum for the discussion of all questions relating to the science, technology and art of light and lighting, but we should not forget that above all it is the umbrella organization of national associations in the field of light and lighting. The CIE is a fascinating organization. It lives from a high diversity of people and their expertise. I look forward to continuing to work with all the experts spread all over the world, and I hope to meet many experts in person during my term as CIE President.

The Editorial Board of Svetotekhnika / Light & Engineering Journals warmly welcomes member of its Editorial Board Dr. Blattner, the current President of CIE since 2019, and looks forward to fruitful cooperation of CIE with the Russian edition, as well as with the Russian National Committee of CIE

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Ph.D. in Physics. He has a Ph.D. in the field of Applied Optics from the University of Neuchâtel, Switzerland. He joined the Swiss Federal Institute of Metrology (METAS) in 2000, where he is currently the Head of the Optics laboratory. Since 2011 he has been the Director of CIE Division 2. In this role he represents CIE at the Consultative Committees for Units (CCU) and for Photometry and Radiometry (CCPR). Furthermore, he is active in several standardization committees (ISO/TC169, IEC/TC34, IEC/TC76, CEN /TC169) and chairs the Swiss Standardization Committee on light and lighting. In 2015 he received the CIE Wyszecki Gold Pin award for outstanding contribution in fundamental research. In October 2017 he was elected CIE President for the period 2019 to 2023