LED professional Review

www.led-professional.com

ISSN 1993-890X

LpR

Trends & Technologies for Future Lighting Solutions

Jan/Feb 2017 | Issue 59

CIE RESEARCH:

CIE Looking Forward - Top Research Strategy Topics

Special Excerpt

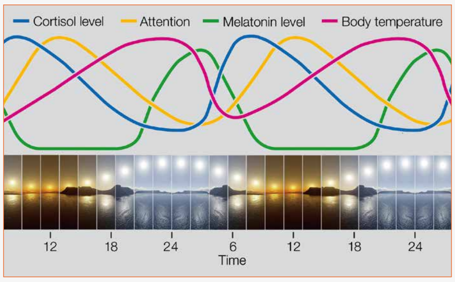
CIE Looking Forward - Top Research Strategy Topics

In 2013 CIE celebrated its centenary; one hundred years of contributing to the development and compilation of scientific and technical knowledge on light and lighting. During the past hundred years light has become more than just a way to illuminate the spaces around us with our knowledge of the way light interacts with matter being used in many aspects of our daily lives. In keeping with this, the CIE works in all areas covering vision, color, and measurement of light, interior and exterior lighting, photobiology and digital imaging - perhaps something not widely known amongst the lighting and LED professional communities.

It's clear that light and the interaction of light with matter will continue to be part of new technologies over the next hundred years. Current and new technologies require well-founded knowledge, both fundamental and applied, to ensure that they can be used with confidence in regards to their safety and quality. CIE publications provide that confidence. They are based on the strongest available scientific evidence and follow a rigorous review and ballot process. To develop consensus-based documents fit for the future scientists are required to engage now in building the knowledge base that will support them in the future.

Looking forward the CIE has developed a research strategy detailing the top ten topics needing input from researchers and awareness from stakeholders. The summarized research topics presented here are those considered by the CIE as needing immediate attention from the research community in support of developments in lighting technology and application. Publications in the peer-reviewed literature on these topics will provide the basis for the next generation of CIE technical reports and standards. ■

RECOMMENDATIONS FOR HEALTHFUL LIGHTING AND NON-VISUAL EFFECTS OF LIGHT



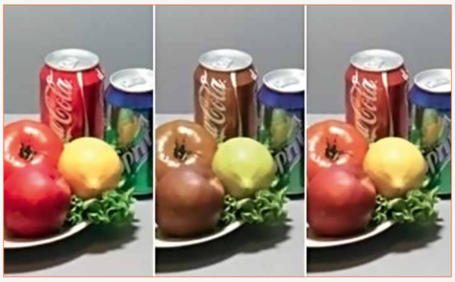
Although light is defined as electromagnetic radiation that provides the stimulus for vision, we now know conclusively that photo detection also has many other essential physiological and psychological effects on humans and other organisms. Fundamental photobiology research adds to this knowledge base daily. However, targeted research, performed in concert with applied lighting scientists, will be required to put this knowledge to use as part of integrated lighting recommendations and designs.

In May 2016, CIE published a detailed research agenda for this topic (CIE 218:2016).

Selected examples are:

- What pattern of daily light and dark exposure (intensity, spectrum, timing, duration) best supports well-being, both for circadian regulation and acute effects during waking hours (e.g. alertness, emotion, social behavior)? How does this vary throughout life, from infancy to old age?
- In addition to circadian regulation, what physiological and psychological processes are influenced by ocular light detection?
- There are known medical uses of light to treat certain skin disorders and hyperbilirubinemia. There is speculation that inadequate light exposure during childhood contributes to the development of myopia. These ideas lead to the general question: Are there behavioral or physiological effects of extra-ocular absorption of optical radiation that should influence lighting recommendations?

COLOR QUALITY OF LIGHT SOURCES RELATED TO PERCEPTION AND PREFERENCE



With the development of new lighting technologies, LED light sources are increasingly used for general lighting. These light sources are creating diversity in light spectra and imposing new challenges in assessing their color quality. While a new color fidelity index is being developed in CIE (TC 1-90) toward a future update of the CIE Color Rendering Index (CRI), a color fidelity index alone will not be sufficient to assess the overall color quality of light sources. Scores of a color fidelity index do not always agree with perceived color rendering experienced by end users.

Key research questions:

- How can "preference" (or a model for color quality perception) be clearly defined and assessed for the intended end use? It may also be affected by users' long term visual experience. How can it be addressed?
- Are the individual variations in such preferences too large to define general preference?
- Can the preference for Chroma saturation and white light chromaticity be substantially different in different regions (or races of people) in the world?
- What are the relevant parameters to measure the subjective aspects of color quality and the whiteness index?
- How do we design an index to measure the whiteness perception of a light source? How do we apply the surface whiteness indices for lighting applications?

INTEGRATED GLARE METRIC FOR VARIOUS LIGHTING APPLICATIONS

The brightness of light sources, be they electric luminaires or windows, may have a negative effect on the performance of visual tasks (disability glare) but it may also cause a feeling of discomfort without having a directly measurable effect on visibility: discomfort glare. This psychological effect has been extensively studied since the 1940s, when the increase in general illumination levels started to lead to complaints about discomfort from excess light. In general, discomfort is known to increase with increasing luminance of the light source, increasing light source size (at a fixed luminance), decreasing background luminance, and decreasing distance of the bright object from the line of sight. However, discomfort tends to be lower when the light source is daylight rather than when it is electric light. The exact relationship of these quantities has been modelled by various formulae that predict discomfort based on stimulus parameters.

Key research points:

- What physiological or psychological mechanism is responsible for discomfort arising from excessive luminance?
- Develop a model of the discomfort arising from excessive luminance, preferably based on parameters that can be related to the discomfort mechanism, which covers multiple application areas.
- Establish a glare metric method that allows the results to be generalized and applied to other application conditions and other lighting technologies.

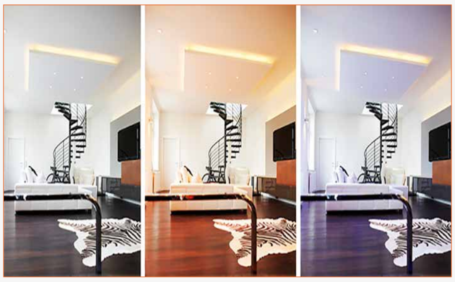
CALIBRATION SOURCES AND ILLUMINANTS FOR PHOTOMETRY, COLORIMETRY, AND RADIOMETRY

In photometry and radiometry appropriate calibration sources and transfer detectors are necessary to ensure traceability of measurements. In addition, calibration conditions should be chosen as close as possible to the measurement conditions. Incandescent lamps have been used for such calibrations for decades, but their availability is diminishing. LED-based standards would bring several benefits for calibration laboratories, photometer manufacturers, and for those using instruments for measurement of white LED lighting.

Key research questions:

- What spectral range is necessary for LED standard sources and what composition of LEDs should be used to realize such a standard?
- What would be the best reference spectrum (spectra) based on LED products for general purpose white lighting LEDs, considering that these products are still in evolution?
- What are the alternative sources to calibrate spectroradiometers over extended wavelength ranges, including NIR and UV?
- What are the impacts due to the changes to new calibration sources and in the definition of new (standard) illuminant(s)?

ADAPTIVE, INTELLIGENT AND DYNAMIC LIGHTING

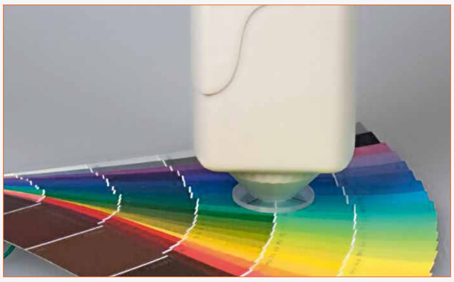


With the advent of advanced control systems incorporating LED sources, the opportunity to provide fully adaptable lighting is a significant direction being considered by industry. The term adaptive lighting refers to the changing of the light source condition, whether overall level, color, light distributions or some other metric based on the needs of the environment.

Key research questions:

- What is the impact of adaptive lighting on user behavior or reactions, such as occupants' space perception or driver safety?
- How should the system adapt itself to the circumstances to provide the optimal lighting; for example:
  - Could the system detect individual needs for varying visual conditions?
  - Could roadway lighting vary depending on traffic composition, traffic density, and weather conditions?
- What are the relations between lighting settings and user safety and comfort?
- Which types and levels of dynamics are acceptable in a lighting installation?
- Which types of input and feedback (e.g. road surface luminance monitoring, photocells, presence detection, algorithms for integrated multi-sensor input, automated fault detection) are necessary to ensure system usability?
- What are the energy and operational costs and benefits of adaptive lighting?
- Could adaptive exterior lighting have ecological benefits beyond energy savings?

APPLICATION OF CIE 2015 CONE-FUNDAMENTAL-BASED CIE COLORIMETRY



Since colorimetry was established in 1931, considerable improvements in the metrology of the color stimulus and immense advances in the knowledge of color vision have been made. Based on the modern knowledge of the human color visual system CIE published a set of new color-matching functions that takes into consideration the age of the observer and the field size of the stimulus, and provides a method to derive the associated chromaticity diagram (see CIE 170-2:2015).

Key research questions:

- How accurate are cone-fundamental-based colorimetry results compared with those of 1931 and 1964 in predicting typical colorimetry applications such as color difference, color appearance, whiteness, color rendering, etc.?
- Can the cone-fundamental-based colorimetry be used to quantify the age metamerism effect and the size metamerism effect? There is an urgent need to quantify observer metamerism. Evidence suggests that the earlier CIE method underestimates these effects.

VISUAL APPEARANCE: PERCEPTION, MEASUREMENT AND METRICS

How we perceive the world around us is clearly a fundamental part of our daily lives. It is often underestimated by individual,s but for many sectors is becoming more and more significant. The overall objective of this research topic is to define metrics describing the appearance of various materials in order to support relevant stakeholders (e.g. the automotive, cosmetics, paper, printing, coatings, plastics industry, etc.). In addition to the definition of a metric, measurement tools, methods and transfer artefacts shall be provided in order to characterize modern surfaces and to ensure traceability of measurement to the SI and a reliable and well managed visual and instrumental correlation.

Key research questions:

- What are the relevant parameters to describe appearance, gloss and translucency of various materials, including goniochromatic and sparkling samples?
- Which BRDF geometry (size, polarization, shape and uniformity of the illuminated area) according to the type of sample under investigation shall be standardized?
- If a simplified geometry is used as a standardized description of effect materials, how can the "uncertainty" with respect to the real visual appearance, i.e. the proficiency of the test method, be described?

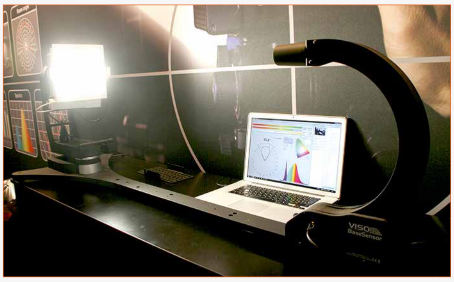
SUPPORT FOR TAILORED LIGHTING RECOMMENDATIONS

Individuals differ widely in visual capabilities and needs. Lighting recommendations are based on average results, usually for able-bodied young adults. A concerted research effort is required to deliver knowledge that can support specific lighting recommendations for specific populations. Two groups of particular interest are the elderly (a demographic group known to be increasing as a proportion of the population in most countries) and those with visual impairments. Other groups of special interest are those susceptible to migraine headache, epilepsy, and depression. Research in this field could lead to modifications to recommendations to aid these populations. With better knowledge, modifiers could be applied to any lighting recommendation to provide for the needs of identified groups.

Key research questions:

- What are the age-related changes in non-visual photoreceptors (ipRGC) and neural responses? How does this change lighting recommendations for the elderly?
- Which ageing effects of the visual system are most detrimental to the performance of workers, drivers and pedestrians and how could or should this be taken into account in lighting design and requirements?
- How do visual impairments or disabilities affect the performance of people and how should these be taken into account in lighting design?

METROLOGY FOR ADVANCED PHOTOMETRIC AND RADIOMETRIC DEVICES

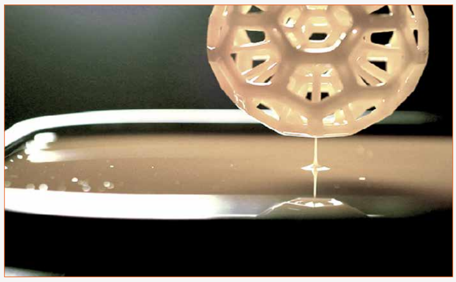


In the past, CIE has published technical reports and standards defining procedures for characterization, calibration and testing of photometric and radiometric devices and measurement systems such as illuminance meters, luminance meters, integrating spheres and goniophotometers. Due to technological progress, new types of photometric and radiometric measurement devices have appeared on the market, including.

Key research questions:

- What are the relevant quality indices to characterize advanced photometric and radiometric devices? How do these indices relate to the measurement uncertainty in typical lighting measurement situations?
- How can the measurement equations describing the measurement procedure be described?
- What would a standard measurement uncertainty budget look like for measurements on particular types of equipment?
- How can these new types of devices be calibrated? What are the best artefacts to transfer the photometric quantities to the measurement device?
- How can temporal exposures of the eye from sources that may flicker (up to about 1 kHz) or where the source and observer move in relation to each other generating a temporally changing exposure at the eye be assessed?
- How can these topics be divided into different parallel threads to improve the efficiency of the respective TCs?

REPRODUCTION AND MEASUREMENT OF 3D OBJECTS



3D printing technology is one of the most revolutionary technologies in recent years. The materials used in the process are not just limited to polymers but also metals and biological tissues. This technology is used for quick prototyping, manufacturing complex 3D parts, prostheses, educational training objects and even prefabrication of housing. 3D reproduction needs to satisfy high requirements for visual attributes such as surface color, translucent color, just to name a few. Characterization of the color appearance of 3D objects requires a design software with the ability to capture both the physical properties of the materials and the visual adaption properties of the observations.

Key research points:

- To develop the metrology of non-uniform 3D objects, including the 3D shape, the local roughness, the texture aspect and other properties impacting on the visual aspect.
- New ideas for measurement instruments and their realization for the aspect above.
- To define a set of metrological distance/ similarity metrics between two objects embedding the set of differences in 3D shape, color, texture, and surface morphology.
- How to make a simple or comprehensive surface model including the physical and visual characteristics to develop the market and industry of 3D-numerical objects.
- How to reproduce the desired shape, color, appearance and texture, especially when the target surface has translucent characteristics will be a major challenge since this problem has yet to be fully solved even for 2D materials.

LED professional SYMPOSIUM +EXPO

2018

The Lighting Event for Technologies of Tomorrow

8th International LED professional Symposium +Expo

The leading lighting technologies event for design, testing and production of lighting systems, controls and equipment.

www.lps2018.com

September 25th - 27th 2018 | Bregenz | Austria

Organized by Luger Research e.U.