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CIE RESEARCH:

CIE Fosters Co-Ordination of Global Research and Standardization on Temporal Light Modulation

Special Excerpt

CIE Fosters Co-Ordination of Global Research and Standardization on Temporal Light Modulation

Dr. Jennifer Veitch, recently convened the CIE Stakeholder Workshop for Temporal Light Modulation Standards for Lighting Systems. Below is the exclusive report she provided on the workshop findings and the attitude of the CIE towards this important issue.

Everyone reading this magazine is aware of the profound technological changes in lighting equipment and systems over the past 15 years. Individual light-emitting diode (LED) packages, are moving close to what is thought to be the practical maximum efficacy of 300 lumens per watt (lm/W), and commercial luminaires are said to be aiming to deliver 200 lm/W by 2025 [1] – roughly 3-4 times more efficient than the fluorescent lighting systems they will replace. By comparison, if automotive fuel efficiency were to improve to the same degree, common gasoline-fuelled cars would consume 1.77 l/100 km in 2025, rather than their projected performance of 2.14 l/100 km in 2025 [2]. The lighting industry is contributing strongly to the achievement of international targets for energy efficiency and reduced greenhouse gas emissions.

However, success depends on the widespread adoption of new lighting technologies. The relatively low uptake of compact-fluorescent lamps offers lessons in how not to change the market. One important consideration is that the new product must at least maintain the performance levels of the one it replaces, and if possible there should be an improvement. New products that cause problems for users, particularly if they become associated with discomfort or health concerns, will not succeed in the long run.

Unlike the familiar incandescent, fluorescent, and discharge light sources that LEDs replace, the new lighting systems are diverse. LEDs are semiconductors that reproduce the current waveform faithfully with a very rapid response, and the electronics to drive the device vary from one device to another. Therefore, there is a wide variety of temporal patterns of light output. These temporal variations are known colloquially as flicker, and more precisely as temporal light modulation (TLM). In addition to the driver designs of the light source itself, dimming controls can add flicker even to light sources that do not exhibit flicker when operated at 100% output. Many systems use pulse-width modulation (PWM) dimming (100% modulation at one flicker frequency with varying duty cycles).

TLM needs attention from researchers, standards development organizations, industry, and regulators, because it can be a source of problems for viewers. The problems can include visual perceptions known collectively as temporal light artifacts (TLAs). TLAs include flicker (the perception that the light appears to vary in intensity), stroboscopic effect (the perception that a moving object looks still), and phantom array (pattern appears when eyes move). Other phenomena include effects on eye movements, visual performance, headaches, eyestrain, brain activity, and cognitive performance. Several factors influence whether or not these effects occur, including the frequency and amplitude of the modulation, the occurrence of spectral variations, the adaptation luminance, the contrast of the target, the size of the retinal area being stimulated, and the location of the source in the visual field. Moreover, individuals vary in their sensitivity to TLM. At the extreme, a small percentage of people can experience an epileptic seizure following a very short exposure to TLM. A larger percentage might experience mild discomfort, which is a less severe consequence but one that could adversely affect the uptake of new lighting technologies.

Recognizing these potential problems, many organizations have undertaken

activities to improve our understanding of TLM and its effects, and to develop recommendations and standards to limit the potential for those effects. One of the first publications was IEEE S1789-2015, which recommended practices to limit the potential for adverse effects. CIE formed a technical committee to develop a technical report to identify metrics for TLM that would predict whether or not viewers would experience TLA. The National Electrical Manufacturers' Association is developing a recommendation for TLM measurement and metrics. There are also activities under way in several other national, regional, and international bodies.

All of this activity is healthy, but we at CIE could see a danger of competing recommendations being produced by different bodies. There are only so many experts available to serve on these various committees. Unlike some topics, there is no reason to think that recommendations for TLM would need to be regionally specific, and therefore we all would be better served by a co-ordinated, harmonized approach to reduce duplication and to speed the development of a single set of documents covering metrics, measurement, and criteria for protecting public health. CIE took the lead in bringing together all of the interested parties to begin the process of working together: we convened the CIE Stakeholder Workshop for Temporal Light Modulation Standards for Lighting Systems, a 2-day workshop held in Ottawa, Canada from February 8-9, 2017. Financial support was provided by Natural Resources Canada – Office of Energy Efficiency; National Electrical Manufacturers' Association; Philips Lighting; BC Hydro, the IESO Conservation Fund (Province of Ontario), and the National Research Council of Canada.

The workshop brought together 30 experts from around the world, drawn from standards development

organizations, industry associations, research institutions, regulators, and certification laboratories. The photo adjacent was taken at the workshop. The objective of this meeting was to develop a roadmap of research, recommendations, and standards activities related to TLM from lighting systems. Although the participants represented the many stakeholders, we were not empowered to recommend the content of any of these documents: our focus was on developing the roadmap that will lead to the standards we agree are needed.

Over the two days, a professional facilitator guided our discussions as we came to agreement about broad areas where much is known and gaps in our understanding – suggesting directions where researchers could fruitfully advance knowledge that will support recommendations and standards. Among the big research challenges will be to move from laboratory studies of simple, controlled light exposures, to more naturalistic settings with multiple light sources. Participants also developed agreement about some urgent needs for immediate action, particularly to come to a shared practice of measurement so that research labs produce results that can be compared and, later, industry and regulators have reliable ways to determine whether or not products and systems comply with whatever standards may be set.

At the end of the two days, we had developed a roadmap, but perhaps most importantly we had developed rapport and willingness to work together. The roadmap will be published as a CIE Technical Note in summer 2017, which will be freely available. In the meantime, CIE will soon begin work on a measurement protocol, and will establish a Research Forum for continuing discussion; meanwhile, the existing work on metrics to predict TLA continues. Existing activities in our sister organizations also continue, but the intent is to develop joint activities where appropriate. Equally importantly, we will seek to work together to involve allied researchers from vision science, cognitive psychology, and physiology in developing the knowledge base, and will promote TLM to research funding bodies as an important topic needing their investment.

We at CIE are excited about the potential to work together with others to address this problem, so that we can harness the creative energy of technology developers both to reduce energy use and to create lit environments that serve all of us well. ■

References:

[1] https://www.energy.gov/eere/ssl/why-ssl

[2] https://www.c2es.org/federal/executive/vehicle-standards/fuel-economy-comparison

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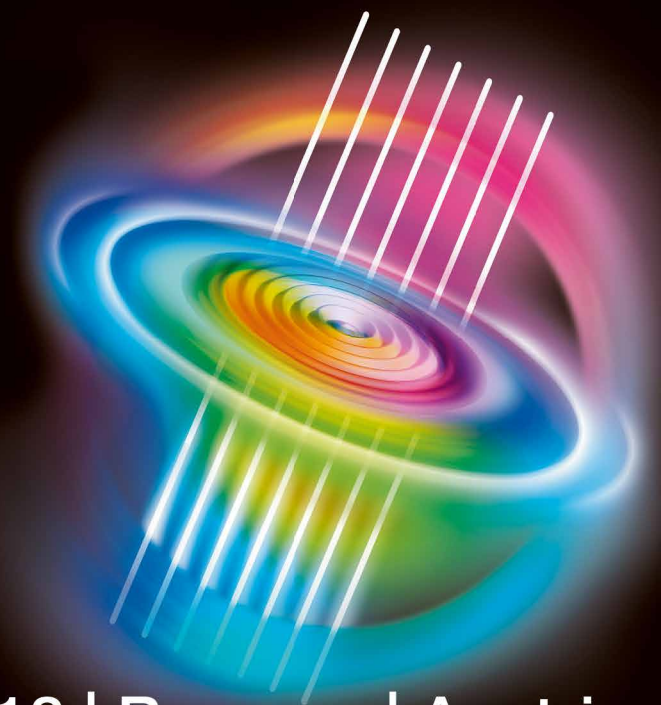

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