ACT LIGHTING DESIGN

About the current debate on Color Quality Metrics and IES TM-30-15

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Shortcomings of the Color Rendering Index (CIE CRI), the current CIE color quality metric employed by the industry, have been long acknowledged, especially for LED spectra. The performance lack for narrowband spectra, was highlighted as early as 2004, in a paper presented by Bodrogi at the CIE expert symposium on LED Light Sources, titled "Why does the CIE CRI fail for white RGB LED light sources". Here at ACTLD, when assessing color quality of light sources, we employ the current CIE metrics CRI R_a and R_i (for some challenging applications we have also assessed Color Quality Scale performance), however we do not solely rely on them. We always perform visual assessments and real life mock ups to purpose evaluate the light sources we include in our specifications.

The replacement of CIE CRI with an alternative index has long been debated within CIE and the lighting industry. Color Quality Scale and CIE CRI2012 were thoroughly discussed within CIE, while a CIE Technical Committee (TC-1-90) is currently working on an alternative light quality metric and it is expected that its work is going to be completed within 2016. CIE has been particularly slow in finding a widely accepted alternative, but this has not come as a surprise. Even though industry is the driving force of most of the technological advancements in lighting technology and science (this is not to say that academic research has not contributed, on the contrary, Akazaki and Amano's Nobel prize winning academic research is the one that made blue LEDs available), different industry interests have caused friction and subsequently delays. The lighting manufacturers themselves are used to current metrics and their products are optimized to perform for them. However, several suppliers, manufacturers (Philips, OSRAM, Xicato and Soraa to name a few) have produced and endorsed research to replace or supplement CRI.

The industry is not the only one to blame for the delays in replacing CRI. While scientific fields like Physics and Chemistry have been around for thousands of years, applied color and color vision science only count few hundred years (Goethe's Theory of Colors was published only in 1810). The relatively young age of color science is the main reason behind the lack of a common language between researchers. Any researcher proposing a CRI alternative will have to choose between different existing color adaptation formulas and color spaces which will most likely be updated in the years ahead as even the most up to date come with their limitations and problems. One of the main problems of CIE CRI, is the use of~~,~~ the 2° standard observer (instead of the 10°), the use of a limited palette of test samples (8 for R_a and 14 for R_i), the out of date Von Kries transform for chromatic adaptation and the equally out of date CIE 1960 UCS color space (the non-uniformity of the color space hierarches light performance gamut areas differently. For example metrics that use the CIEUVW space tend to have more tolerance for light sources that don't render colors accurately in the green gamut area than those with similar performance in the red area.

The IES TM-30-15 method

With all the above in mind, the proposal of a new method for evaluating color quality in IES Technical Memorandum 30-15 could be only good news for the lighting industry. A new proposed method with the support of an important body like the IES could act as a catalyst and force the CRI debate to its long due resolution.

The IES TM-30-15 method itself implements a lot of interesting innovations and accounts for several limitations of CIE CRI. Firstly, it introduces a two dimensional characterization of light sources quantifying color fidelity and gamut. The idea of using more than one index to characterize color quality of light sources is not new. A version of the method

used for IES TM-30-15 has been proposed by Houser et al in 2012, while several other indices have been discussed to coexist with CRI to characterize different aspects of light quality. CIE TC-1-91 currently works on the implementation of a color preference index (several color preference indices have been proposed in the past). Adding dimensions to the characterization of light sources will be really beneficial for all stakeholders involved from manufacturers who will be in a better position to explain the merits of their product, to specifiers that will be better equipped to evaluate them and end-users that will have more information for the appropriate product. The method also introduces a way for quantifying saturation without penalising as is the case with CRI (generally, it is accepted, that observers favour more saturated illuminants that enhance colourfulness of objects, illuminants that would be punished by CRI). To add to the characterisation information provided, a vector graphics representation of color shift due to illumination is proposed, incorporating research previously done by Burgt and Kamenade of Philips Research (even though Philips Lighting seems not to be in favour of the new method).

IES TM-30-15 method makes use of the CIECAM02 color appearance model, thus the most modern CAM02-UCS color space and CIECAT02 chromatic adaptation. Incorporating the most up to date colour science toolkit is a very important aspect of the method, however it is still not sufficient and alternative models are likely to be discussed in due course. An another really important merit of the new method is the use of a vast number of test samples and their meticulous selection. Such a big number ensures a better assessment of color quality performance in a larger gamut area. It will also not allow manufacturers to optimize their products for the limited test set employed by CIE CRI without paying particular attention to the rest of the gamut, a practice that is common for narrow band spectra (specially for fluorescent light sources). That practice, if it happens, is no longer going to be possible with the implementation of big sample sets, while at the same time, it does not arise significant computational issues for calculating color differences. A wider test gamut area is only going to benefit light quality.

Based on our experience and the research we do at ACT in color quality metrics, we appreciate that there is an urgent need for replacing CIE CRI and the introduction of IES TM-30-15 has an overall positive effect on the lighting industry and practice, accelerating the discussion within CIE. The new method is a big step forward and a holistic approach for evaluating colour rendering performance of light sources. However, and despite the many merits of the new method, adoption of regional metrics, methods and standards of characterization, could enhance the existing fragmentation of the industry, thus create barriers for exchange of research and know-how. It is our opinion, that color quality metrics should be universal and to that extent any adoption of a new metric would have to be through CIE proceedings. We also firmly believe, that as progress in color science - triggered by LED technology - is rapid, color quality metrics should come with a shorter life span and with a provision for incorporating new findings and we strongly endorse any further academic and industry research on the field.

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