Lighting practitioner knowledge and usage of fundamental concepts and accompanying metrics

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Introduction

When designing and conducting lighting research, the researcher must often make assumptions about the knowledge and abilities of the end user. We may not fully know if these assumptions are correct until the work is complete and digested by those end users. It is critically important that these assumptions be as accurate as possible. To the knowledge of this author, objective data about the knowledge and ability of lighting practitioners (designers, engineers, interior designers, architects, etc.), related to complex but fundamental lighting topics, does not exist or is not easily accessible.

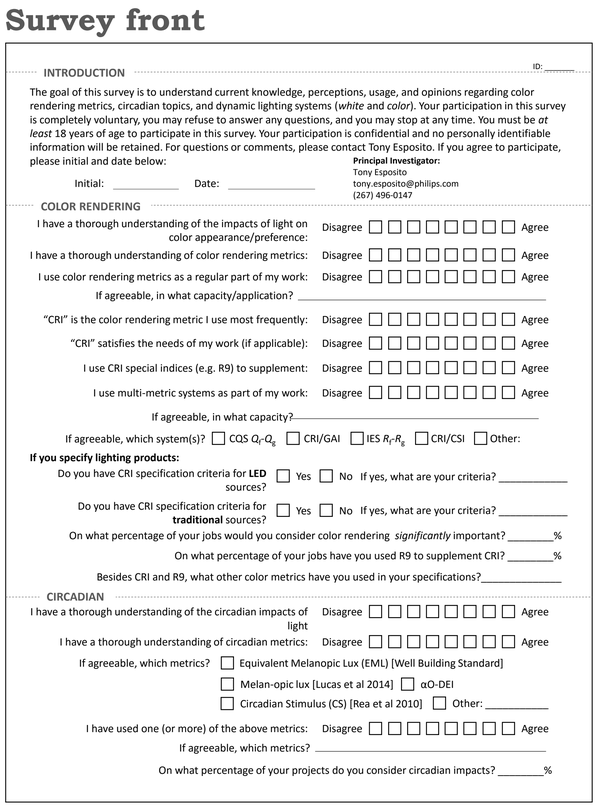
The primary research goals of this study, therefore, were to assess the current knowledge of lighting professionals related to complex topics (i.e. color rendering, circadian lighting, dynamic lighting systems, and temporal light artefacts) and how they apply (if at all) various metrics which capture and distill these complex topics. This survey also provided a platform for lighting professionals to express specific challenges they experience in the field. With the recent release of IES TM-30-15, another particular interest was to assess awareness and use of TM-30.

The author hopes that the results of this study will spark a dialogue focused on improving education and establish a precedent for collecting objective data regarding the knowledge, application, and design needs of the lighting community.

Methodology

Participants completed a one-page paper survey (double-sided) at the 2016 Annual IES Conference in Orlando, FL. Most questions asked participants to provide a response along an 8-point disagree-agree Likert scale, with "Disagree" as the left anchor word (value of 1), and "Agree" as the right anchor word (a value of 8). To incentivize participation, participants received a raffle ticket for a chance to win a prize. The prize was announced on stage during the conference.

Survey front



INTRODUCTION

ID: _____

The goal of this survey is to understand current knowledge, perceptions, usage, and opinions regarding color rendering metrics, circadian topics, and dynamic lighting systems (*white* and *color*). Your participation in this survey is completely voluntary, you may refuse to answer any questions, and you may stop at any time. You must be *at least* 18 years of age to participate in this survey. Your participation is confidential and no personally identifiable information will be retained. For questions or comments, please contact Tony Esposito. If you agree to participate, please initial and date below:

Initial: _____ Date: _____

Principal Investigator:
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(267) 496-0147

COLOR RENDERING

I have a thorough understanding of the impacts of light on color appearance/preference: Disagree ☐☐☐☐☐☐☐☐ Agree

I have a thorough understanding of color rendering metrics: Disagree ☐☐☐☐☐☐☐☐ Agree

I use color rendering metrics as a regular part of my work: Disagree ☐☐☐☐☐☐☐☐ Agree

If agreeable, in what capacity/application? _____

"CRI" is the color rendering metric I use most frequently: Disagree ☐☐☐☐☐☐☐☐ Agree

"CRI" satisfies the needs of my work (if applicable): Disagree ☐☐☐☐☐☐☐☐ Agree

I use CRI special indices (e.g. R9) to supplement: Disagree ☐☐☐☐☐☐☐☐ Agree

I use multi-metric systems as part of my work: Disagree ☐☐☐☐☐☐☐☐ Agree

If agreeable, in what capacity? _____

If agreeable, which system(s)? ☐ CQS Q_f-Q_g ☐ CRI/GAI ☐ IES R_f-R_g ☐ CRI/CSI ☐ Other:

If you specify lighting products:

Do you have CRI specification criteria for **LED** sources? ☐ Yes ☐ No If yes, what are your criteria? _____

Do you have CRI specification criteria for **traditional** sources? ☐ Yes ☐ No If yes, what are your criteria? _____

On what percentage of your jobs would you consider color rendering *significantly* important? _____%

On what percentage of your jobs have you used R9 to supplement CRI? _____%

Besides CRI and R9, what other color metrics have you used in your specifications? _____

CIRCADIAN

I have a thorough understanding of the circadian impacts of light: Disagree ☐☐☐☐☐☐☐☐ Agree

I have a thorough understanding of circadian metrics: Disagree ☐☐☐☐☐☐☐☐ Agree

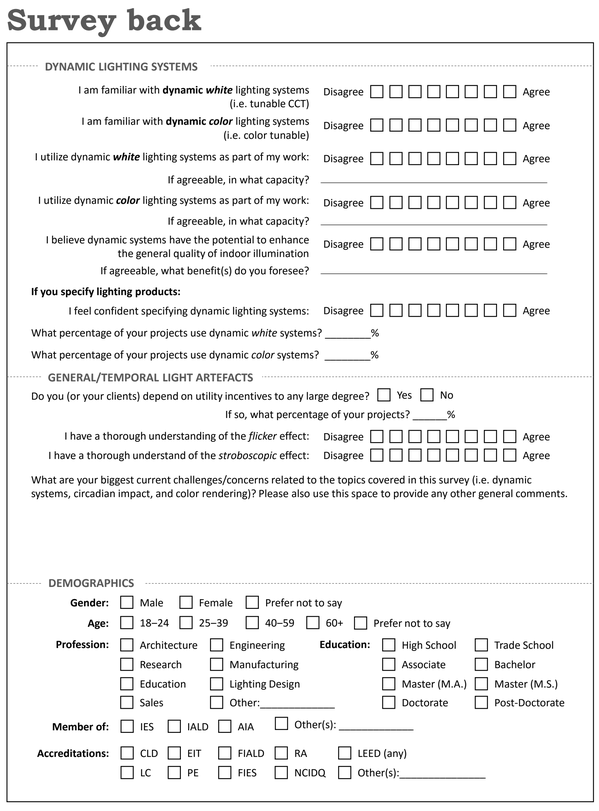
If agreeable, which metrics? ☐ Equivalent Melanopic Lux (EML) [Well Building Standard]
☐ Melan-opic lux [Lucas et al 2014] ☐ αO-DEI
☐ Circadian Stimulus (CS) [Rea et al 2010] ☐ Other: _____

I have used one (or more) of the above metrics: Disagree ☐☐☐☐☐☐☐☐ Agree

If agreeable, which metrics? _____

On what percentage of your projects do you consider circadian impacts? _____%

Survey back



DYNAMIC LIGHTING SYSTEMS

I am familiar with **dynamic *white*** lighting systems (i.e. tunable CCT): Disagree ☐☐☐☐☐☐☐☐ Agree

I am familiar with **dynamic *color*** lighting systems (i.e. color tunable) Disagree ☐☐☐☐☐☐☐☐ Agree

I utilize dynamic ***white*** lighting systems as part of my work: Disagree ☐☐☐☐☐☐☐☐ Agree

If agreeable, in what capacity? _____

I utilize dynamic ***color*** lighting systems as part of my work: Disagree ☐☐☐☐☐☐☐☐ Agree

If agreeable, in what capacity? _____

I believe dynamic systems have the potential to enhance the general quality of indoor illumination Disagree ☐☐☐☐☐☐☐☐ Agree

If agreeable, what benefit(s) do you foresee? _____

If you specify lighting products:

I feel confident specifying dynamic lighting systems: Disagree ☐☐☐☐☐☐☐☐ Agree

What percentage of your projects use dynamic *white* systems? _____%

What percentage of your projects use dynamic *color* systems? _____%

GENERAL/TEMPORAL LIGHT ARTEFACTS

Do you (or your clients) depend on utility incentives to any large degree? ☐ Yes ☐ No

If so, what percentage of your projects? _____%

I have a thorough understanding of the *flicker* effect: Disagree ☐☐☐☐☐☐☐☐ Agree

I have a thorough understand of the *stroboscopic* effect: Disagree ☐☐☐☐☐☐☐☐ Agree

What are your biggest current challenges/concerns related to the topics covered in this survey (i.e. dynamic systems, circadian impact, and color rendering)? Please also use this space to provide any other general comments.

DEMOGRAPHICS

Gender: ☐ Male ☐ Female ☐ Prefer not to say

Age: ☐ 18–24 ☐ 25–39 ☐ 40–59 ☐ 60+ ☐ Prefer not to say

Profession: ☐ Architecture ☐ Engineering ☐ Research ☐ Manufacturing ☐ Education ☐ Lighting Design ☐ Sales ☐ Other:_____

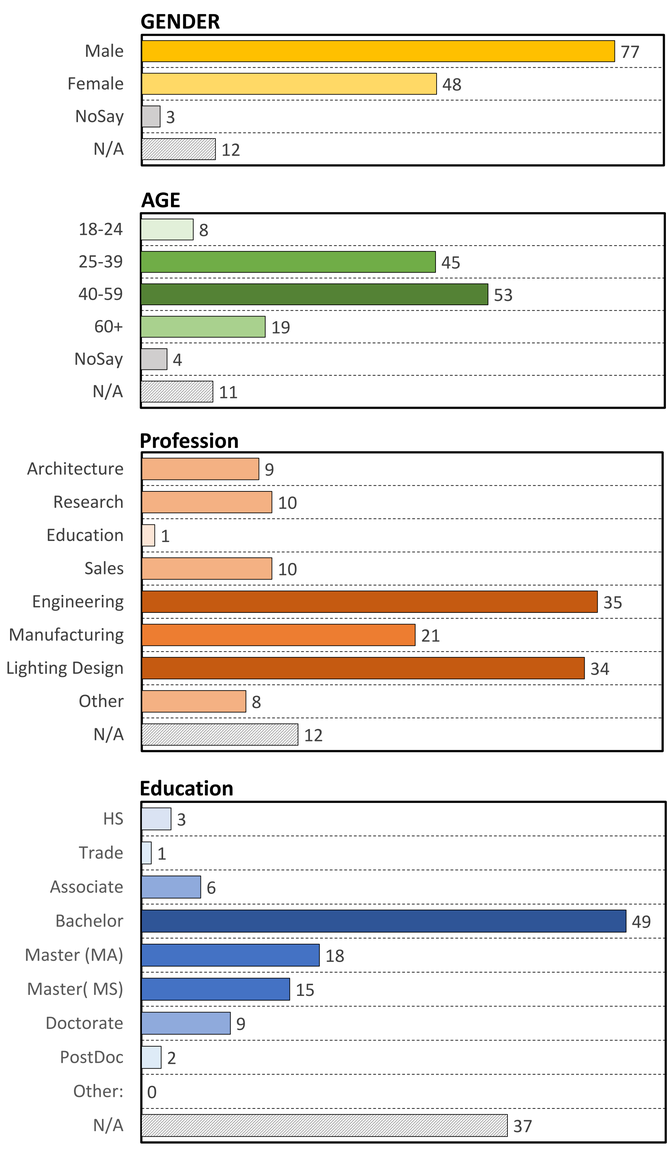
Education: ☐ High School ☐ Trade School ☐ Associate ☐ Bachelor ☐ Master (M.A.) ☐ Master (M.S.) ☐ Doctorate ☐ Post-Doctorate

Member of: ☐ IES ☐ IALD ☐ AIA ☐ Other(s): _____

Accreditations: ☐ CLD ☐ EIT ☐ FIALD ☐ RA ☐ LEED (any) ☐ LC ☐ PE ☐ FIES ☐ NCIDQ ☐ Other(s):_____

Participant Demographics

A total of 140 people completed the survey.



A larger percentage of participants were male than female. Three people selected "prefer not to say" and 12 people did not provide a response.

Most participants (78.4%) were between the ages of 25 and 59. Approximately 15% of participants were above the age of 60. Only eight (6.4%) of the respondents were between the ages of 18 and 24, and all eight were either students or designers; none worked in sales or manufacturing.

Seventy percent (70%) of participants collectively worked in engineering (27.3%), lighting design (26.6%), and manufacturing (16.4%). Fewer participants worked in professions of research, sales, architecture, and education, respectively. Men were more likely to work in professions of engineering and sales; women were more likely to work in lighting design, architecture, and research. Men and women were equally as likely to work in manufacturing.

A Bachelor's degree was the most common degree among participants, followed by a Master's degree (MA or MS), and a doctorate. A large number of participants (37 people) did not indicate their education.

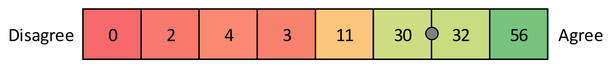
(Not shown) The most common accreditation was Lighting Certified (LC), which is held by 51 respondents (36.4% of total). Eight participants were fellows of the IES (FIES). The fellows have various professions and educational backgrounds; six (6) of the 8 were male. All were above the age of 40.

Results

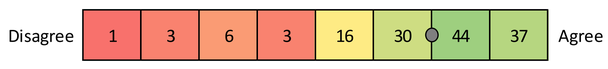
Results are presented below for each survey section. The numbers represent the count of participants that selected the corresponding cell.

COLOR RENDERING

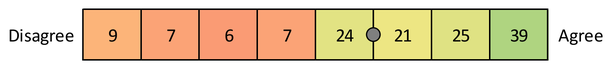
I have a thorough understanding of the impacts of light on color appearance/preference:



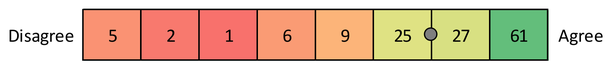
I have a thorough understanding of color rendering metrics:



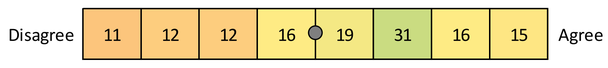
I use color rendering metrics as a regular part of my work:



"CRI" is the color rendering metric I use most frequently:

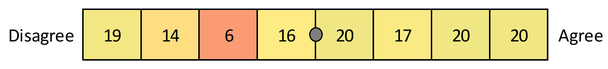


"CRI" satisfies the needs of my work (if applicable):

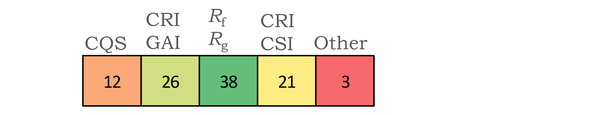


I use CRI special indices (e.g. R9) to supplement:

I use **multi-metric systems** as part of my work:



If agreeable, which systems?



Participants, overall, indicated a thorough understanding of the impacts of light on color appearance/preference and a thorough understanding of color rendering metrics. Eighty-five percent (85%) of participants indicated agreeably that they used color rendering metrics as part of their work.

Seventy-eight percent (78%) of lighting designers reported using color rendering metrics in their work, followed by engineers (66%), sales (60%), and manufacturers (48%).

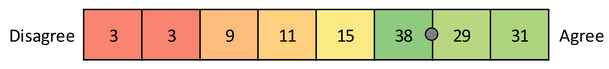
Majority of participants (83%) indicated that "CRI" is the color rendering metric that they use most frequently, though less than a majority (47%) indicated that "CRI" satisfies their needs. Manufacturers were more likely than engineers and lighting designers to indicate that CRI does not satisfy the needs of their work.

On average, participants did not indicate that they use multi-metric color rendition systems as part of their work. Forty-eight percent (48%) of manufacturers, 40% of engineers, and 38% of lighting designers reported using two-metrics systems.

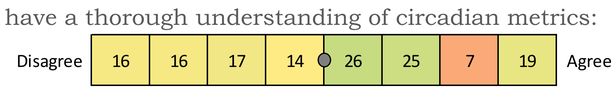
Participants who use two-metric systems indicated using IES R_f-R_g the most frequently (38 times), followed by CRI/GAI (26 times). Lighting designers were more likely than manufacturers to use IES R_f-R_g, and manufacturers more likely than lighting designers to use CRI/GAI; manufacturers were equally as likely to use IES R_f-R_g as CRI/GAI.

CIRCADIAN IMPACTS

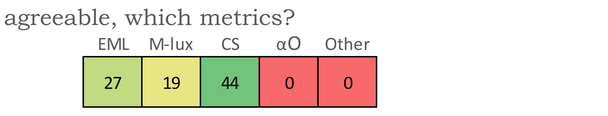
I have a thorough understanding of the circadian impacts of light:



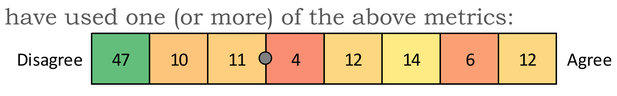
I have a thorough understanding of circadian metrics:



If agreeable, which metrics?



I have used one (or more) of the above metrics:



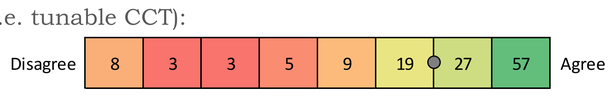
Majority of participants indicated a thorough understanding of the circadian impacts of light; many less participants indicated a thorough understanding of circadian metrics. Researchers were most likely to report understanding and using circadian metrics.

Participants with a thorough understanding of circadian metrics most frequently indicated an understanding of Circadian stimulus (CS) (44 times), followed by Equivalent Melanopic Lux (EML) (27 times), and Melanopic Lux (ML) (19 times).

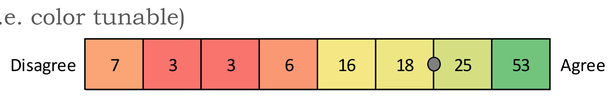
Despite apparent understanding of circadian concepts, and to a lesser degree circadian metrics, the majority of participants indicated that they have not used circadian metrics.

DYNAMIC LIGHTING SYSTEMS

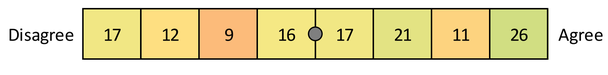
I am familiar with **dynamic white** lighting systems (i.e. tunable CCT):



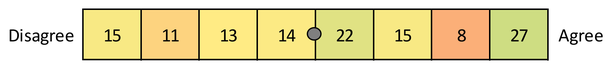
I am familiar with **dynamic color** lighting systems (i.e. color tunable)



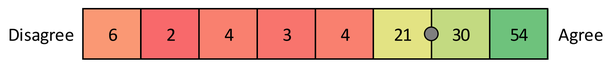
I utilize dynamic ***white*** lighting systems as part of my work:



I utilize dynamic ***color*** lighting systems as part of my work:



I believe dynamic systems have the potential to enhance the general quality of indoor illumination:



If agreeable, what benefit(s) do you foresee?

Majority of participants (85%) indicated that they believe dynamic systems have the potential to enhance the quality of indoor illumination. A large majority of lighting designers indicated this belief (91%), followed by manufacturers (81%), engineers (80%), architects (78%), and sales (70%). Researchers were least likely to hold this belief (60%). Participants were asked to list the benefits they foresee. The most frequently mentioned words were health, circadian, improved, mood, enhancement, healthcare, and productivity.

Conclusion

There will always be a need for more education. However, with the right data, we can hone our educational efforts to focus resources where it matters most. According to the current results, the focus areas should be: 1. Using two metric systems of color rendition, 2. How to understand circadian metrics, and how to build a lighting specification around them, and 3. To help lighting professionals educate themselves and their clients.