Embracing Uncertainty

Perspectives on Uncertainty in an Uncertain World

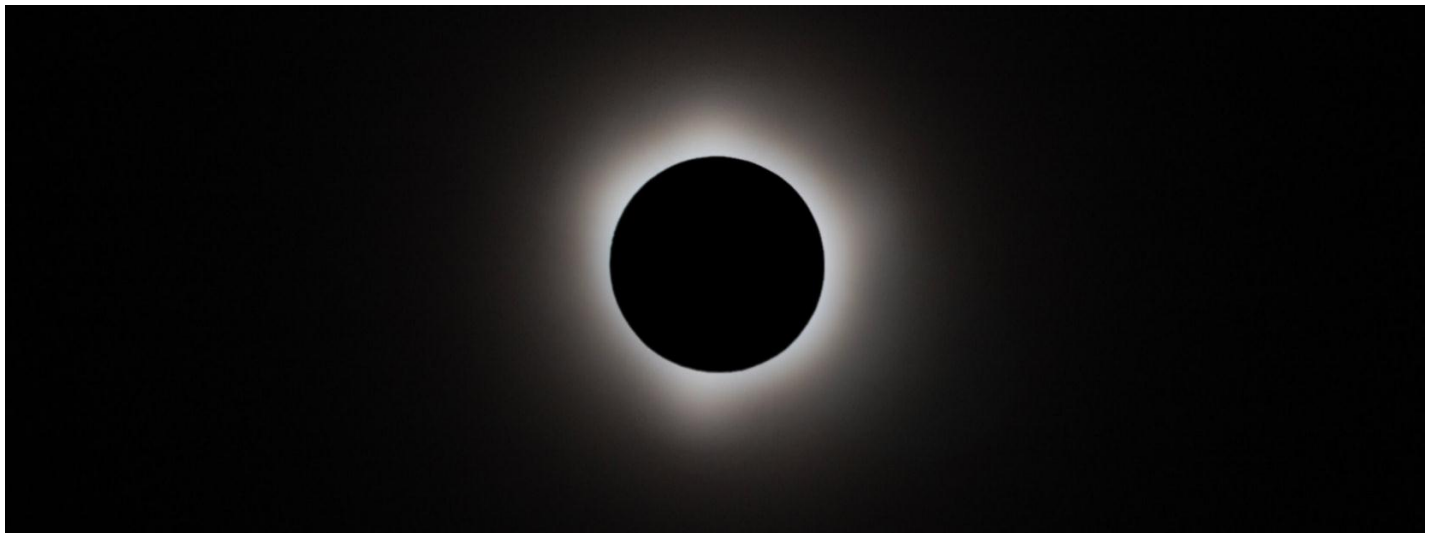
Michael Grather
Photometric and Lighting Engineer

Perceptions of Photometry

The State of Photometry in the Victorian Era

- "A history of light and color measurement – Science in the Shadows" by Sean F Johnston

- Task issued in 1858 by Astronomer General George Biddell Airy



Perceptions of Photometry

The State of Photometry in the Victorian Era

- Quote from Henry Fox Talbot - 1834

William Henry Fox Talbot, by John Moffat, 1864.

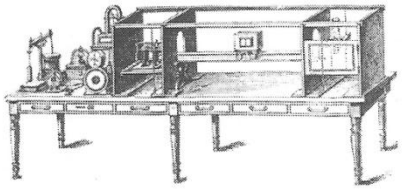


Fig. 2.—Letheby Photometer.

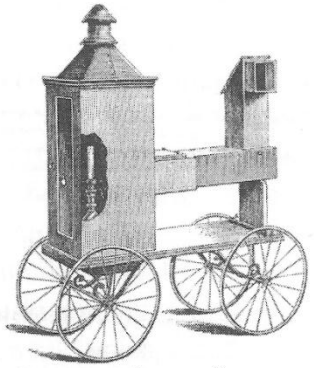


Fig. 14.—Sugg's Travelling Photometer.

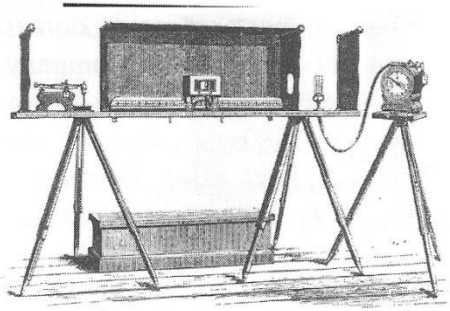


Fig. 8.—The Portable Photometer.

Perceptions of Photometry

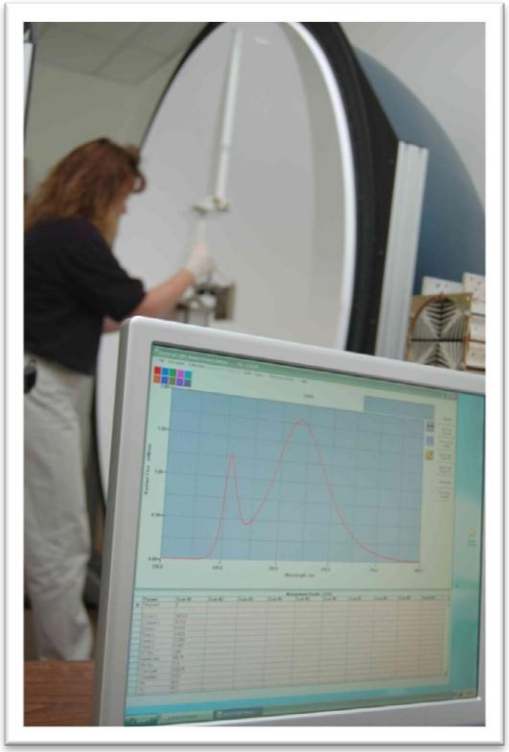
The State of Photometry in the Past 20 Years

- Luminaire Photometry – Relative Photometry
- Luminaire Photometry – Absolute Photometry (LM-79)
- The Mysterious 2%
- IES LM-61: "IESNA GUIDE FOR IDENTIFYING OPERATING FACTORS INFLUENCING MEASURED VS. PREDICTED PERFORMANCE FOR INSTALLED OUTDOOR HIGH INTENSITY DISCHARGE (HID) LUMINAIRES"

Perceptions of Photometry

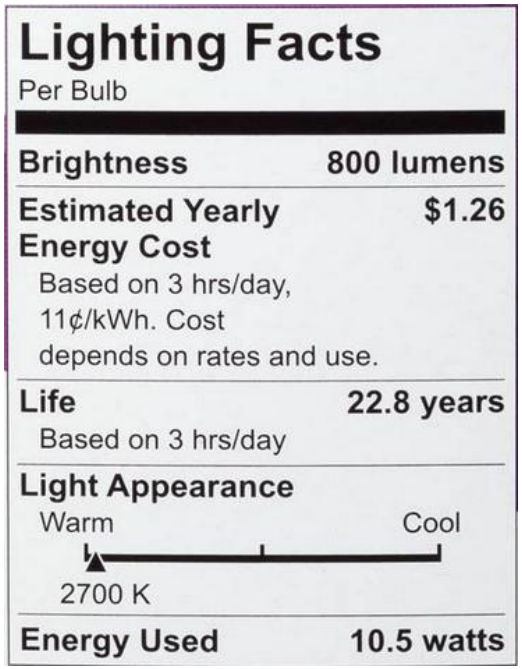
The State of Photometry in the Past 20 Years

- Worst-case estimations of uncertainty
- Experience: inter-laboratory comparisons
- Experience: sphere vs goniophotometer flux measurements



The Usefulness of Measurement Uncertainty Calculations

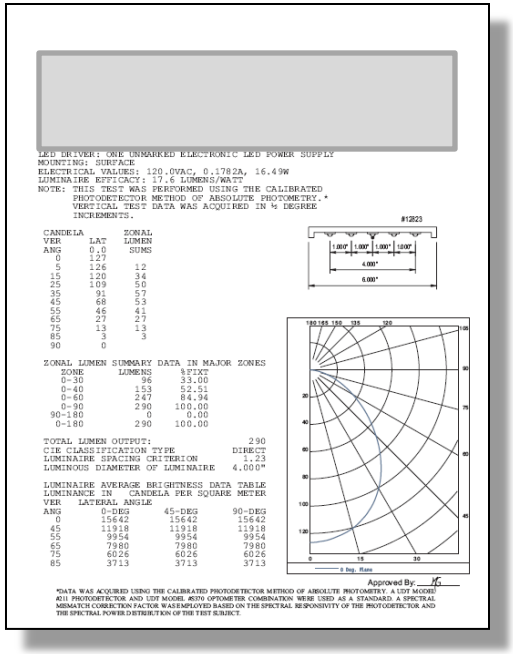
- In Scientific Applications – error bars in experimental measurements
- In Engineering Applications – tolerance when attempting to meet a set of criteria
- From an Operations Perspective – often seen as a gauge of the quality of measurements from the laboratory
- Marketing Perspective – provides confidence when making claims about a product's performance
- Consumer's Perspective - ???



The Usefulness of Measurement Uncertainty Calculations

With a well constructed uncertainty budget:

- Increased confidence in measurements
- Tools for identifying the "low hanging fruit"
- Tools for justifying equipment purchases
- Tools to evaluate where procedures should be improved



LED DRIVER: ONE UNMARKED ELECTRONIC LED POWER SUPPLY
MOUNTING: SURFACE
ELECTRICAL VALUES: 120.0VAC, 0.1782A, 16.49W
LUMINAIRE EFFICACY: 17.6 LUMENS/WATT
NOTE: THIS TEST WAS PERFORMED USING THE CALIBRATED PHOTODETECTOR METHOD OF ABSOLUTE PHOTOMETRY.* VERTICAL TEST DATA WAS ACQUIRED IN ½ DEGREE INCREMENTS.

#12823

CANDELA VER ANG	LAT	ZONAL LUMEN SUMS
0	0.0	127
5	126	12
15	120	34
25	109	50
35	91	57
45	68	53
55	46	41
65	27	27
75	13	13
85	3	3
90	0	

ZONAL LUMEN SUMMARY DATA IN MAJOR ZONES

ZONE	LUMENS	%PLT
0-30	96	33.00
0-40	153	52.51
0-60	247	84.94
0-90	290	100.00
90-180	0	0.00
0-180	290	100.00

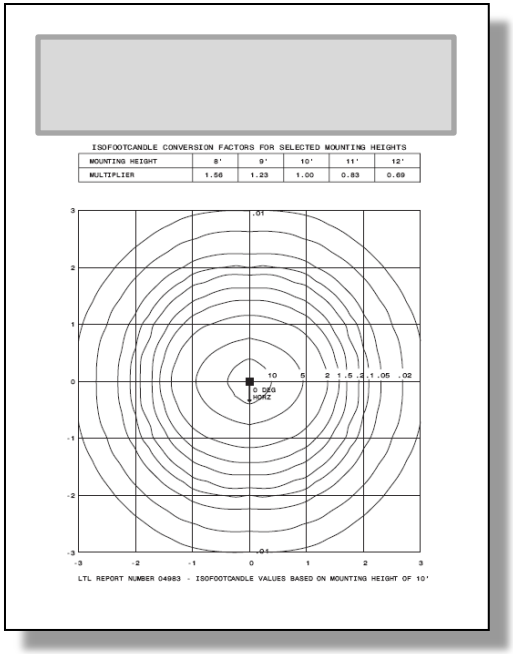
TOTAL LUMEN OUTPUT: 290
CIE CLASSIFICATION TYPE: DIRECT
LUMINAIRE SPACING CRITERION: 1.23
LUMINOUS DIAMETER OF LUMINAIRE: 4.000"

LUMINAIRE AVERAGE BRIGHTNESS DATA TABLE
LUMINANCE IN CANDELA PER SQUARE METER

VER ANG	LATERAL ANGLE 0-DEG	45-DEG	90-DEG
0	15642	15642	15642
45	11918	11918	11918
55	9954	9954	9954
65	7980	7980	7980
75	6026	6026	6026
85	3713	3713	3713

Approved By: MG

*DATA WAS ACQUIRED USING THE CALIBRATED PHOTODETECTOR METHOD OF ABSOLUTE PHOTOMETRY. A UDT MODEL 211 PHOTODETECTOR AND UDT MODEL 265O OPTOMETER COMBINATION WERE USED AS A STANDARD. A SPECTRAL MISMATCH CORRECTION FACTOR WAS EMPLOYED BASED ON THE SPECTRAL RESPONSIVITY OF THE PHOTODETECTOR AND THE SPECTRAL POWER DISTRIBUTION OF THE TEST SUBJECT.



ISOFOOTCANDLE CONVERSION FACTORS FOR SELECTED MOUNTING HEIGHTS

MOUNTING HEIGHT	8'	9'	10'	11'	12'
MULTIPLIER	1.56	1.23	1.00	0.83	0.69

LTL REPORT NUMBER 04983 - ISOFOOTCANDLE VALUES BASED ON MOUNTING HEIGHT OF 10'

Concerns from the Independent Testing Community

- Level Playing Field –

  higher uncertainties can hurt business

- Positive Feedback Situation –

  more effort in measurement uncertainty estimation often means higher uncertainties

- The Potential for Misuse by Clients –

- Financial Burden –

  It will cost time and resources to properly include measurement uncertainty… for no sales benefit.

Concerns from the Independent Testing Community

- Level Playing Field –
  an accrediting body can set a bar for the minimum requirements and level the playing field.
- Positive Feedback Situation –
  having a bar set at an appropriate level will limit this issue
- The Potential for Misuse by Clients –
  education is a lot easier with a consistent approach
- Financial Burden –
  with a level playing field, the need for "reinventing the wheel" is reduced

Conclusions

- The science of photometry has been evolving for a long time and we should continue this process

- Developing an uncertainty budget is a very effective tool in the photometric laboratory

- More rigorous requirements for measurement uncertainty can "raise the bar" for laboratories, but won't change the mindset of the community.

Conclusions

- A closing thought about the proper mindset for developing a thorough measurement uncertainty budget:

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Thank You!

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