maxLED by MAXLITE

WELCOME

S/P RATIO, TM30 & TOTAL LUMENS VS. DELIVERED LUMENS

12/17/15

maxLED by MaxLite

PART 1

Scotopic/Photopic Ratio

- **The issue:**

  Human perception of the lighted environment is driven by both Photopic and Scotopic vision.

  … but …

  Only Photopic vision is typically considered applicable to light metering.

HOW DO WE MEASURE LIGHT NOW?

Photopic:

- Known as light or daylight vision (“cones”)
- Higher sensitivity in “brighter” light
- Peak sensitivity towards “red” (550 nm)
- Basis for modern photometry (light metering)

Scotopic:

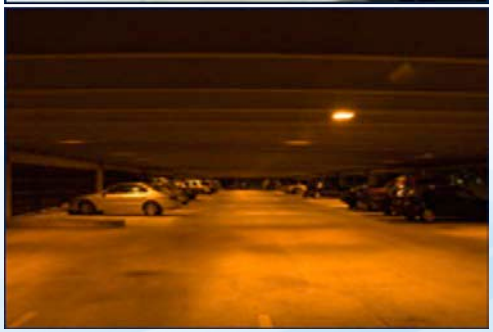
- Known as dark or night vision (”rods”)
- Higher sensitivity and speed in different spectral range
- Peak sensitivity towards “blue” (500 nm)
- High color temperature lamps 5000K - 7000K

- Rods are active in bright light and do contribute to the perception of brightness.
- Scotopic contributes to improved acuity but this is not yet well defined.
- Higher Scotopic sources can provide equivalent brightness with lower energy.

Now let's discuss S/P Ratio…

Combination of Scotopic & Photopic

- There is usually complexity, if not trouble, whenever we mix physics with biology.
- The physical side of things - the radiant power of a light source – is simply enough defined and is well-behaved.
- The biological side of things - the evoking of a visual sensation - is very hard to define and not at all well-behaved.

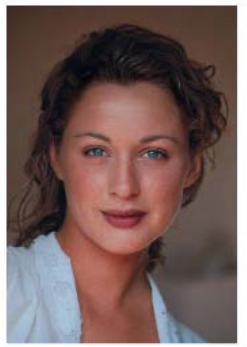


SCOTOPIC/PHOTOPIC RATIOS

Light Source	Scotopic / Photopic Ratio (S/P)
High Pressure Sodium (35W)	0.40
Low Pressure Sodium	0.20
Warm White Fluorescent	1.00
Cool White Fluorescent	1.46
Metal Halide (Sodium/Scandium)	1.49
Quartz Halogen (~3200° K)	1.50
4100°K LED/Fluorescent	1.54
5000°K LED/Fluorescent	1.96
6500°K LED/Fluorescent	2.14


3000k - 52 CRI


3000k - 82 CRI


6500k - 82 CRI

250W
HPS

= 24,500 Photopic Lumens X 0.62 S/P Ratio = 15,190 Scotopic Lumens

140W 5000K
MaxLite LED
Area Light

= 8,400 Photopic Lumens X 1.96 S/P Ratio = 16,464 Scotopic Lumens

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PART 2

TM30

TM30 SYNOPSIS

- TM30 is a new quality metric that was recently adopted by the IES to **supplement, and eventually replace the old CRI (CIE) Metric for measuring fidelity of a light source.**

- TM30 has 3 main components:
  - R_f which is a similar metric to the CRI (R_a) standard that measures color rendering based on comparison to a color palette of 99 colors (CRI only had 9)
  - R_g which measures the average gamut shift (hue/saturation) of the source
  - A graphical representation of R_g to visually represent which colors are washed out or more vivid due to the light source

TM30 SYNOPSIS (CONT.)

- **Why is this important?**
  - CRI is not going away right now. The IES is still waiting for feedback and will most likely make some form of adjustment to TM30 before it is slated to replace CRI
  - You will most likely start to see TM30 used here and there, especially in places where color rendering is of concern (specifiers, retail shops etc.)
  - CRI can be gamed (it only compares to 9 colors, so if you engineer your output to those 9 colors you can inflate your score without really improving the quality of the light)

IES Method for Color Rendition

Color Fidelity

The accurate rendition of color so that they appear as they would under familiar (reference) illuminants

Fidelity Index (R_f)
(0-100)

Color Gamut

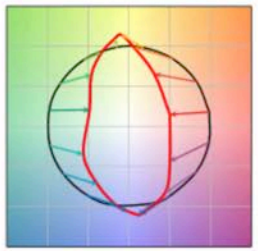
The average level of saturation relative to familiar (reference) illuminants.

Gamut Index (R_g)
~60-140 when $R_f > 60$

Graphics

Visual description of hue and saturation changes.

Color Vector Graphic

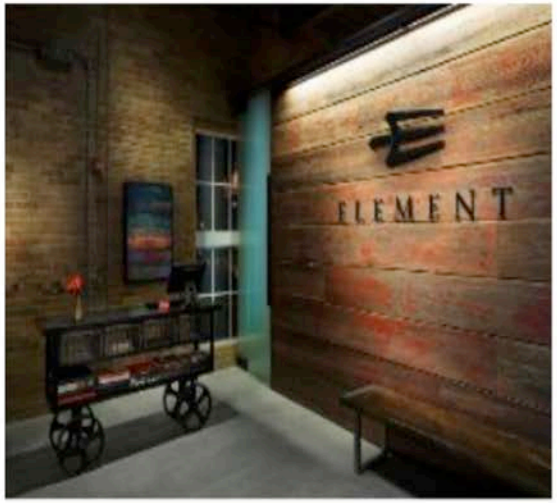


Specifiers

- TM-30-15 is an approved method: USE IT!
- Provide feedback to help it reach maturity.
- Choosing a “better” light source may be more challenging, but also more rewarding.

Measure	Scale	Comparisons
CIE R_a	? – 100	Higher may be "better"
TM-30 R_f	0 – 100	Higher may be "better"
TM-30 R_g	60 – 140 (Approx.)	Varies
TM-30 Icon	None (Visual)	Varies

(Theoretical)

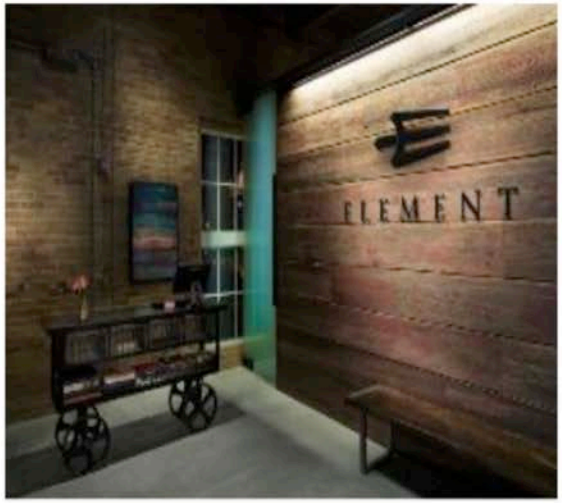


Original

CRI = 95

R_f = 93

R_g = 100

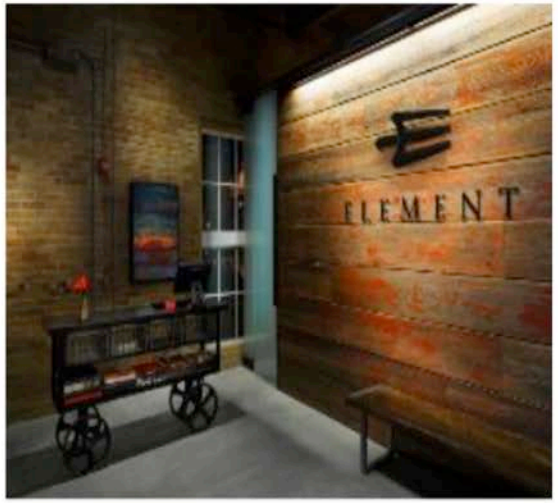


Desaturated

CRI = 80

R_f = 78

R_g = 90



Red-Enhanced

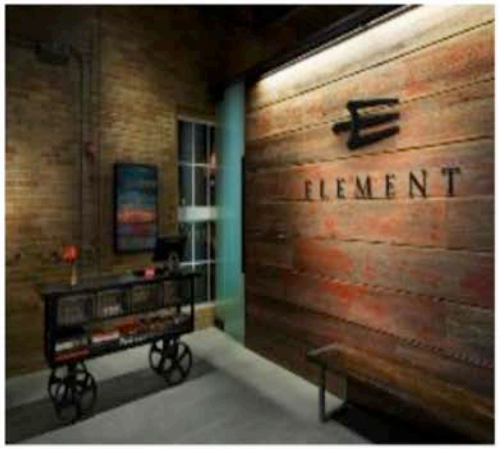
CRI = 80

R_f = 78

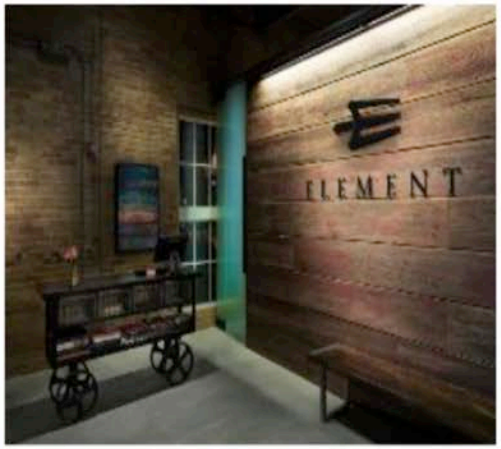
R_g = 110

Images courtesy of Randy Burkett Lighting Design

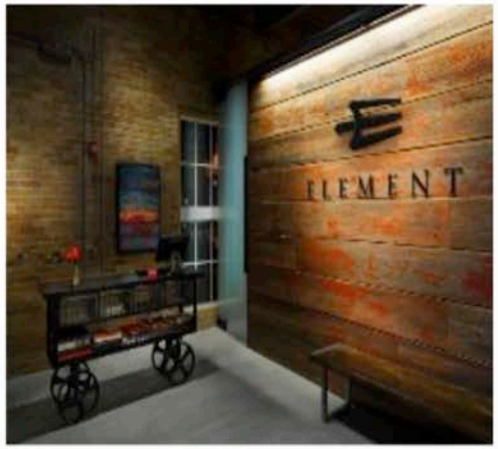
TM30:



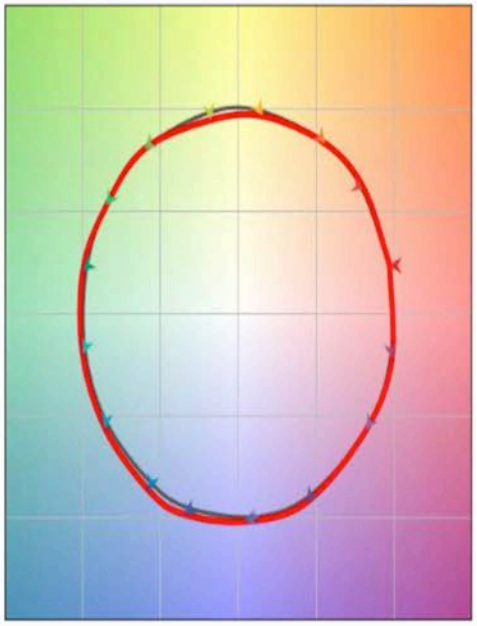
Original

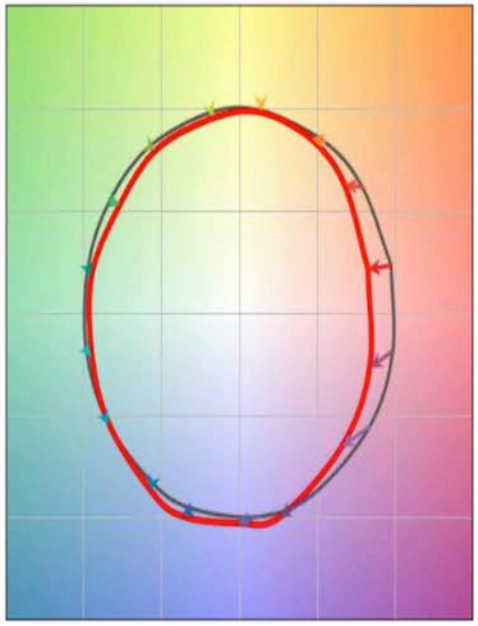


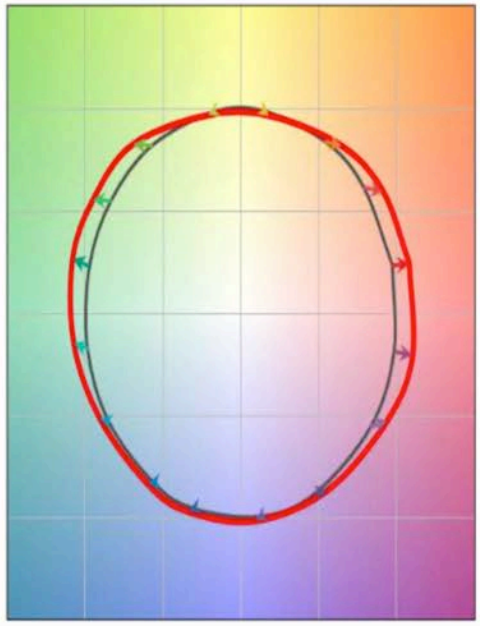
Desaturated

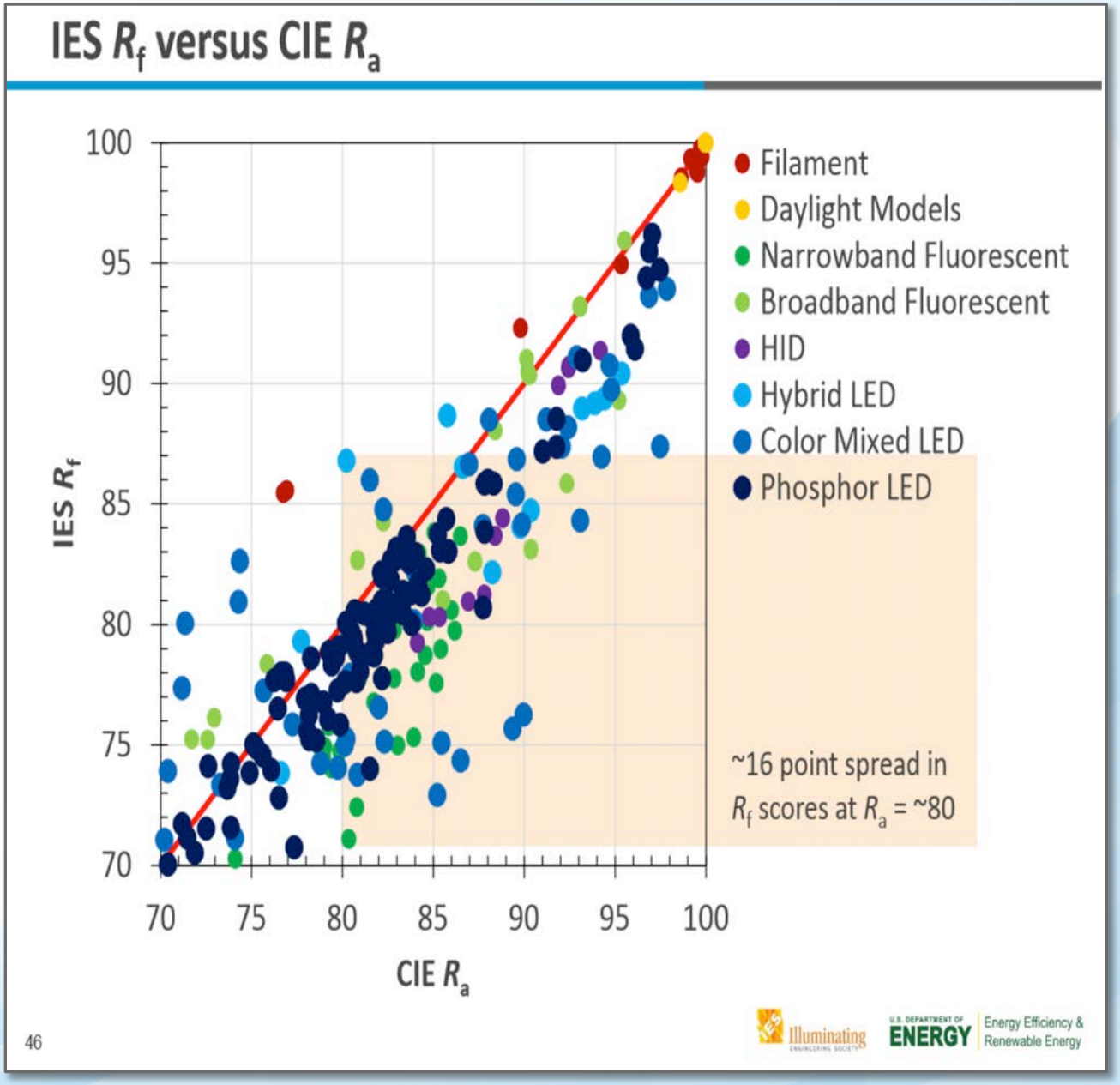


Red-Enhanced








IES R_f versus CIE R_a
100
95
90
85
80
75
70
IES R_f
70
75
80
85
90
95
100
CIE R_a
Filament
Daylight Models
Narrowband Fluorescent
Broadband Fluorescent
HID
Hybrid LED
Color Mixed LED
Phosphor LED
~16 point spread in
R_f scores at R_a = ~80
46
Illuminating
U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

TM30 INFORMATION SOURCES

Slides from:

- http://energy.gov/sites/prod/files/2015/09/f26/tm30-intro-webinar_9-15-15.pdf

Video presentation:

- http://energy.gov/eere/ssl/webinar-understanding-and-applying-tm-30-15

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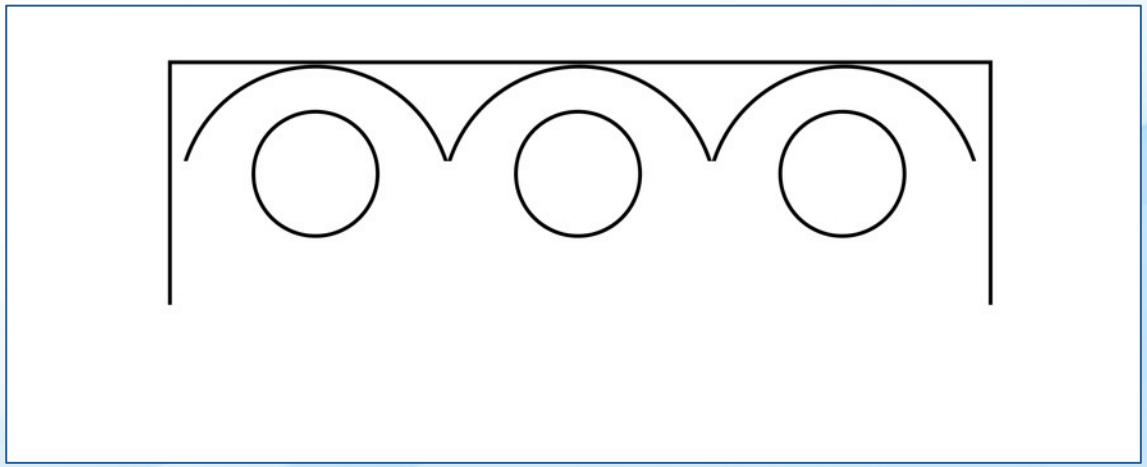
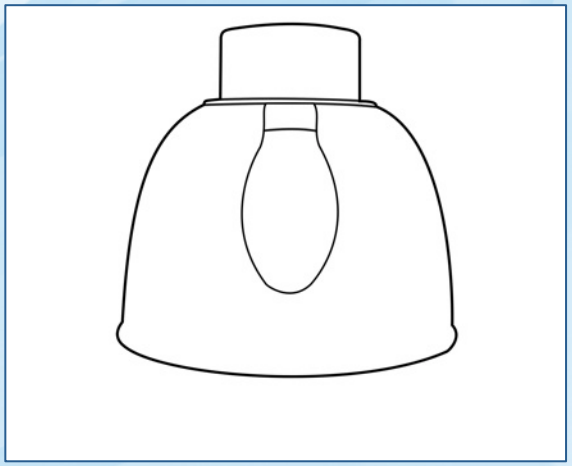
PART 3

DELIVERED LUMENS VS. TOTAL LUMENS

Total Lumens:

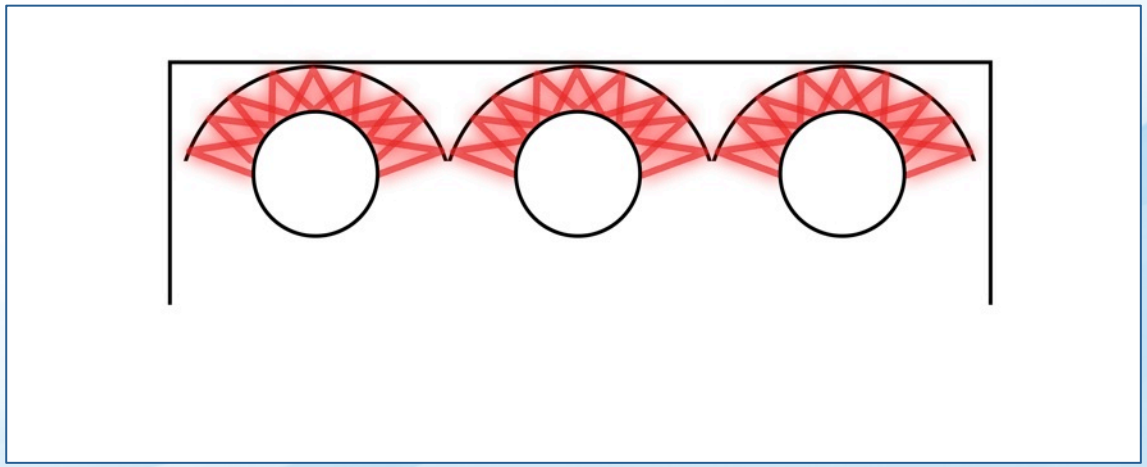
- Omni-directional light sources require 78% of the output to be redirected.

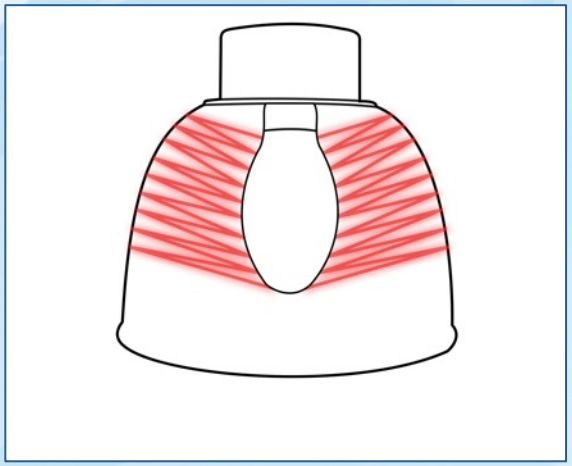




Total Lumens:

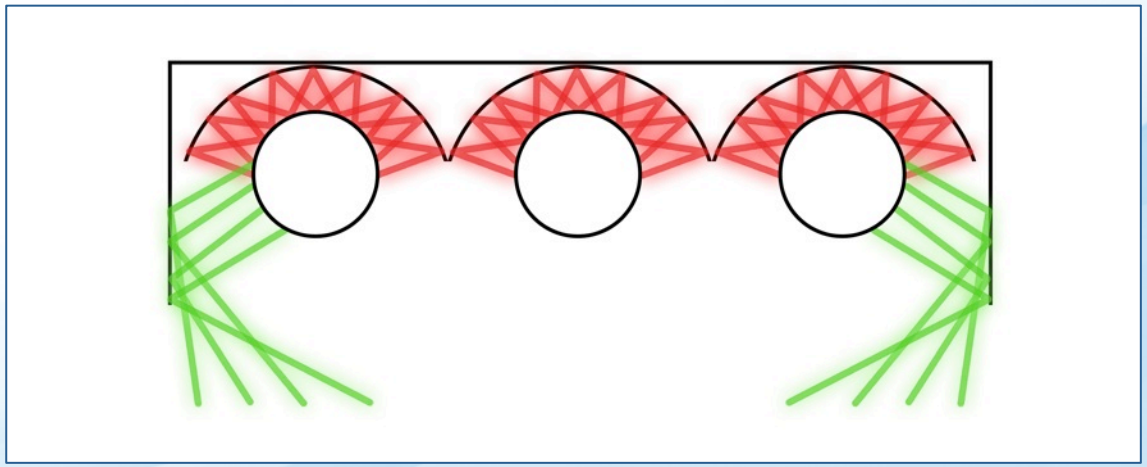
- Omni-directional light sources require 78% of the output to be redirected.
- Majority of the reflections are directed back into the bulb. (light source)

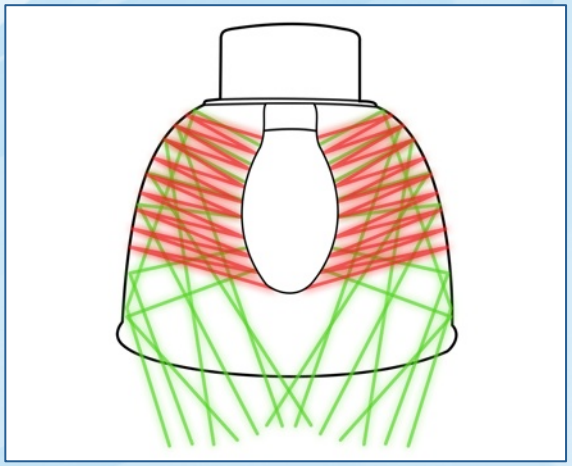




Total Lumens:

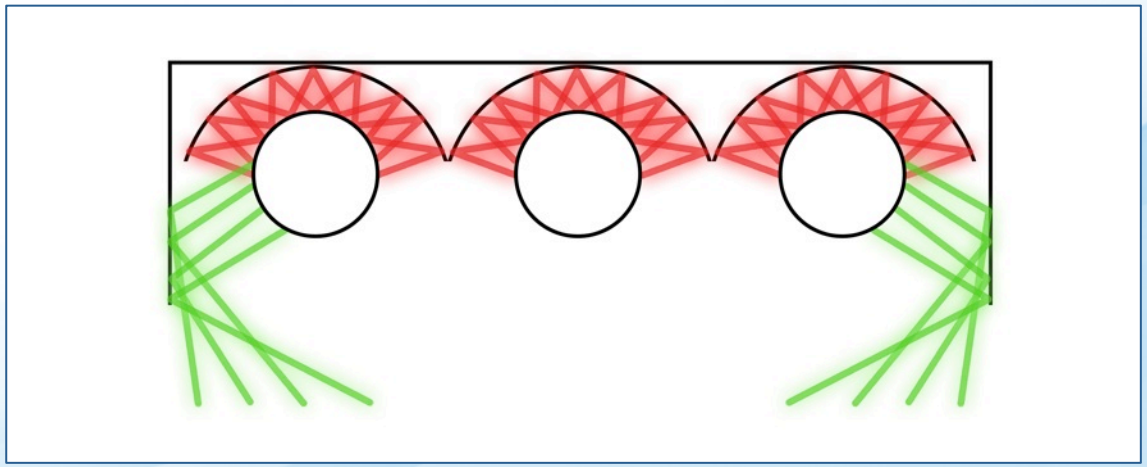
- Omni-directional light sources require 78% of the output to be redirected.
- Majority of the reflections are directed back into the bulb. (light source)
- Energy is lost and compounded with every reflection.

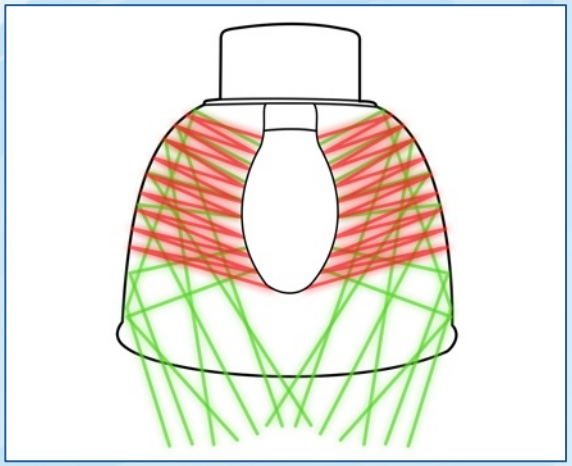




Total Lumens:

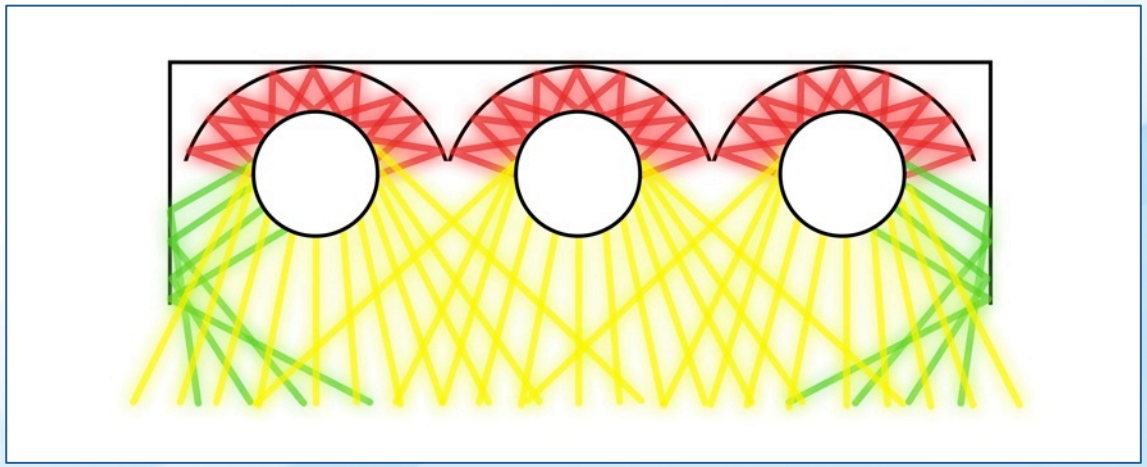
- Omni-directional light sources require 78% of the output to be redirected.
- Majority of the reflections are directed back into the bulb. (light source)
- Energy is lost and compounded with every reflection.
- Most light traces require multiple reflections before hitting the work surface.

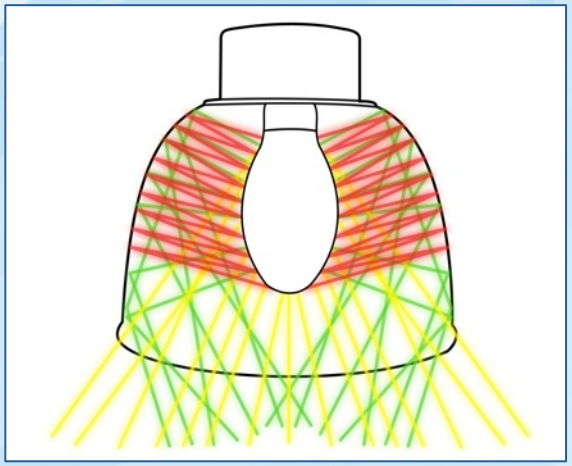




Total Lumens:

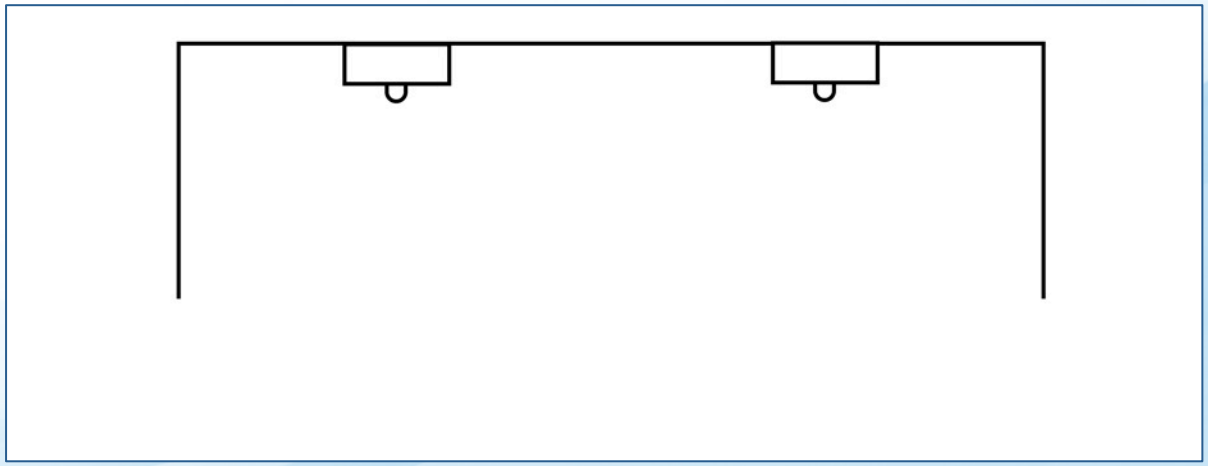
- Omni-directional light sources require 78% of the output to be redirected.
- Majority of the reflections are directed back into the bulb. (light source)
- Energy is lost and compounded with every reflection.
- Most light traces require multiple reflections before hitting the work surface.
- Less then 14% of the source lumens trace directly to the work surface.

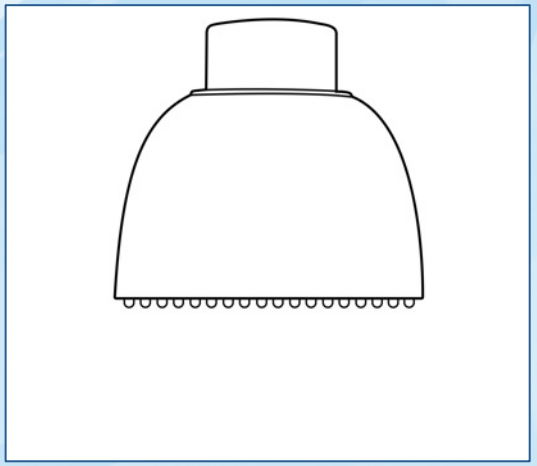




Delivered Lumens:

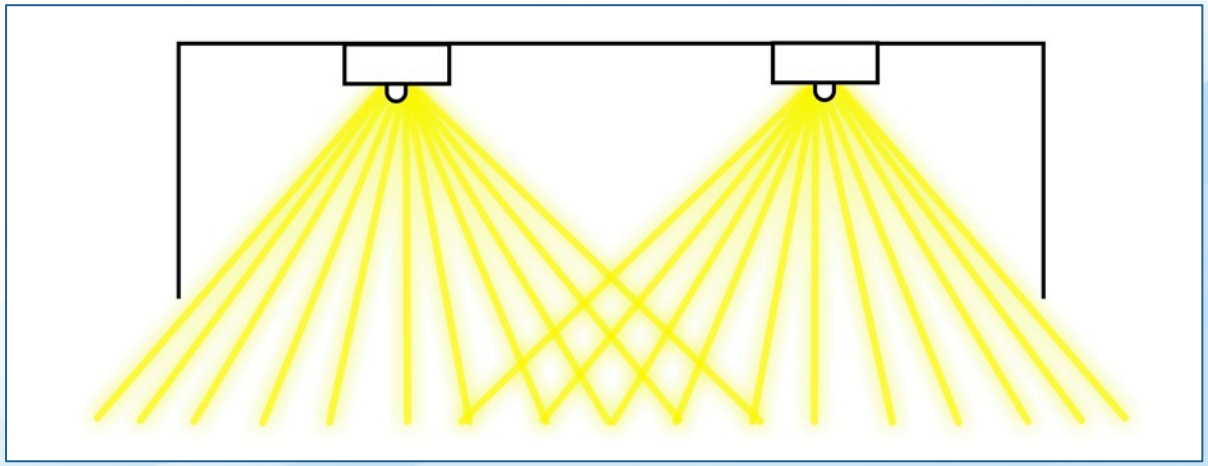
- More then 94% of (mono) directional lumens are delivered.

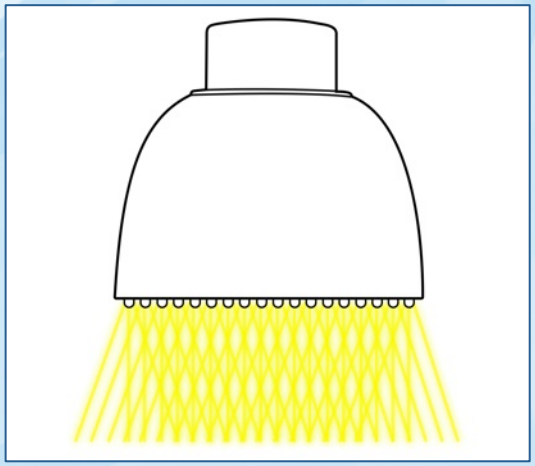




Delivered Lumens:

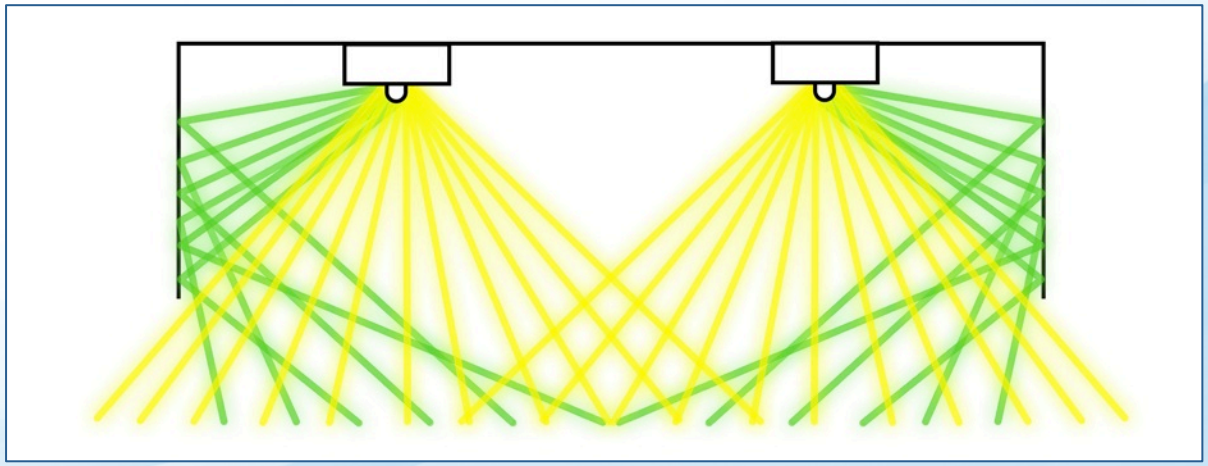
- More then 94% of (mono) directional lumens are delivered.
- 80% of total lumen output is delivered directly to the work surface.

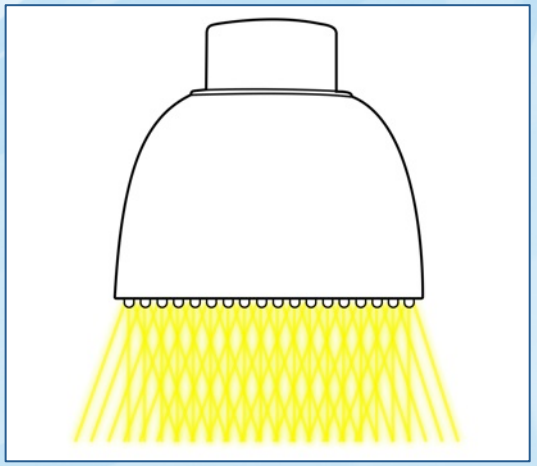




Delivered Lumens:

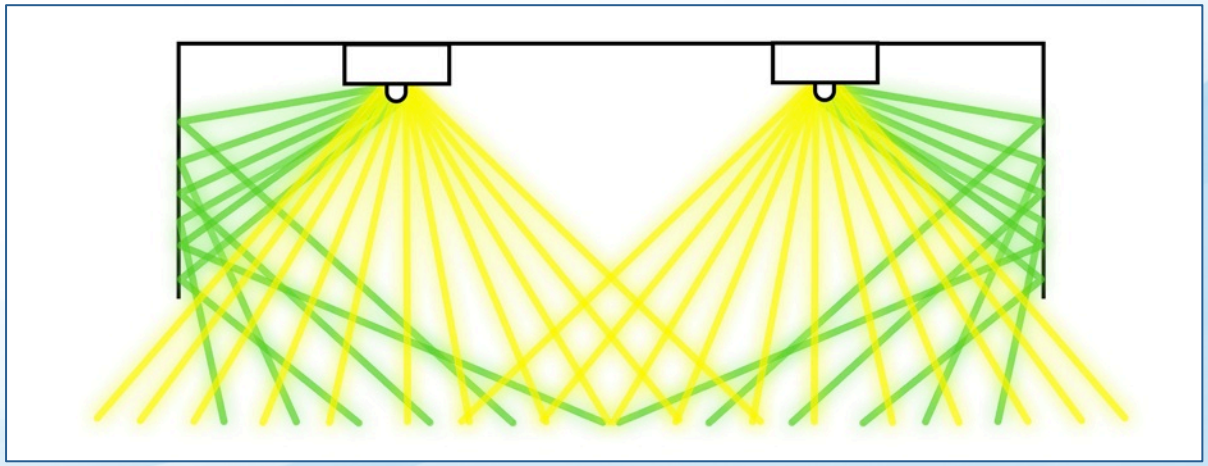
- More then 94% of (mono) directional lumens are delivered.
- 80% of total lumen output is delivered directly to the work surface.
- The remaining 20% are reflected only once to the target.

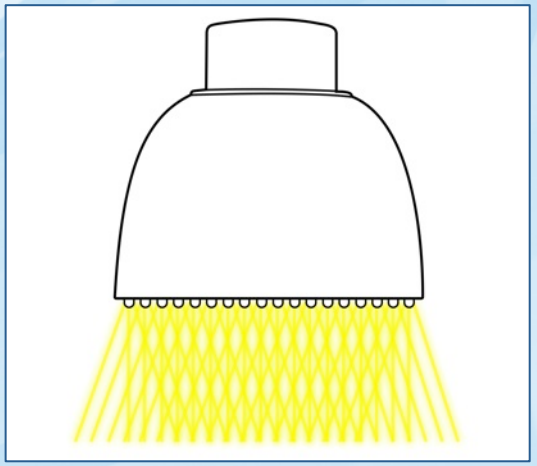




Delivered Lumens:

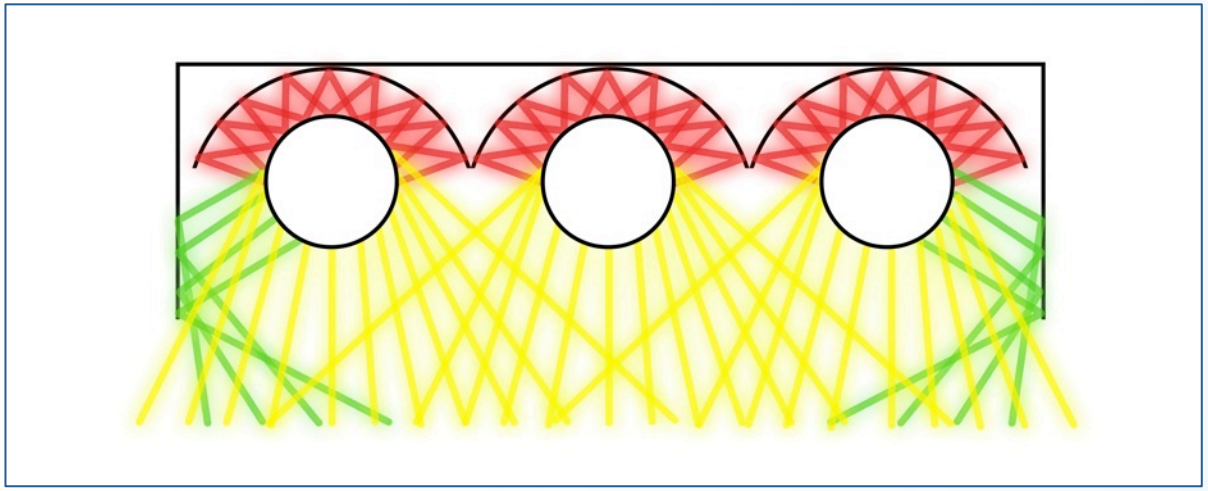
- More then 94% of (mono) directional lumens are delivered.
- 80% of total lumen output is delivered directly to the work surface.
- The remaining 20% are reflected only once to the target.
- None of the lumens are reflected back into the bulb. (light source)

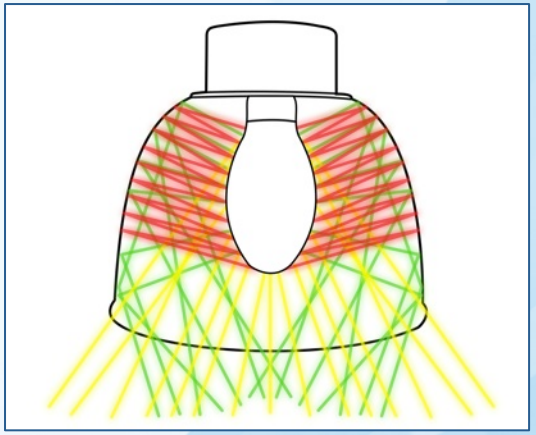




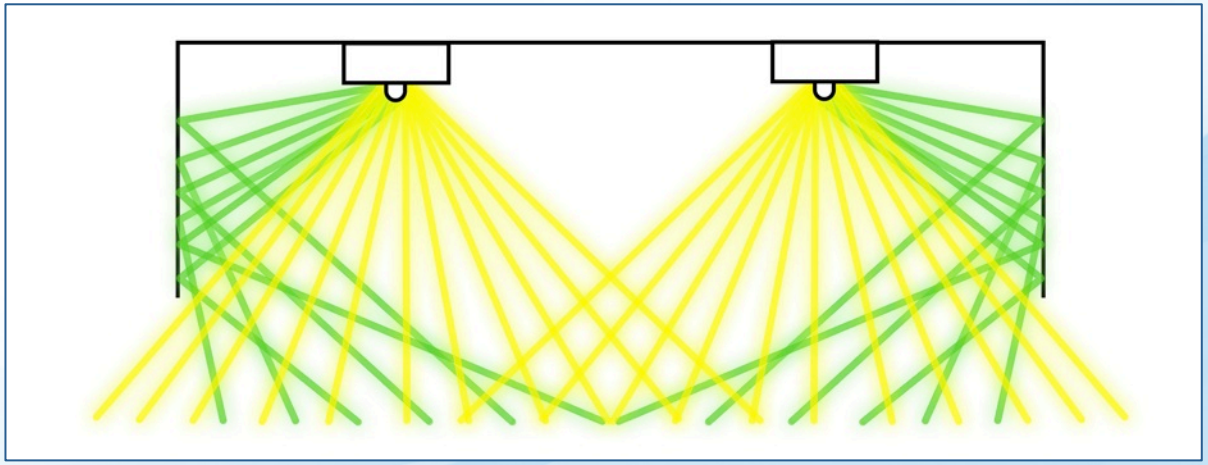
DELIVERED LUMENS VS. TOTAL LUMENS

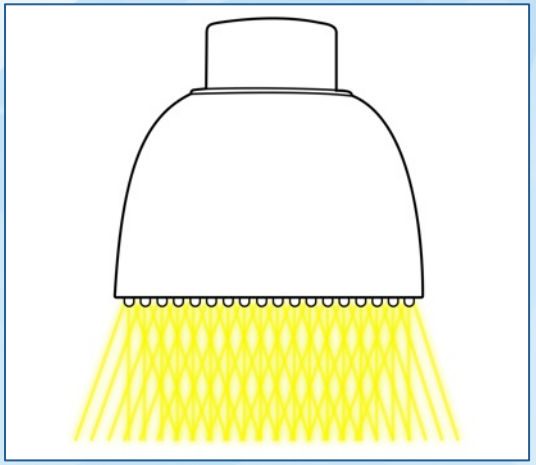
Total Lumens:



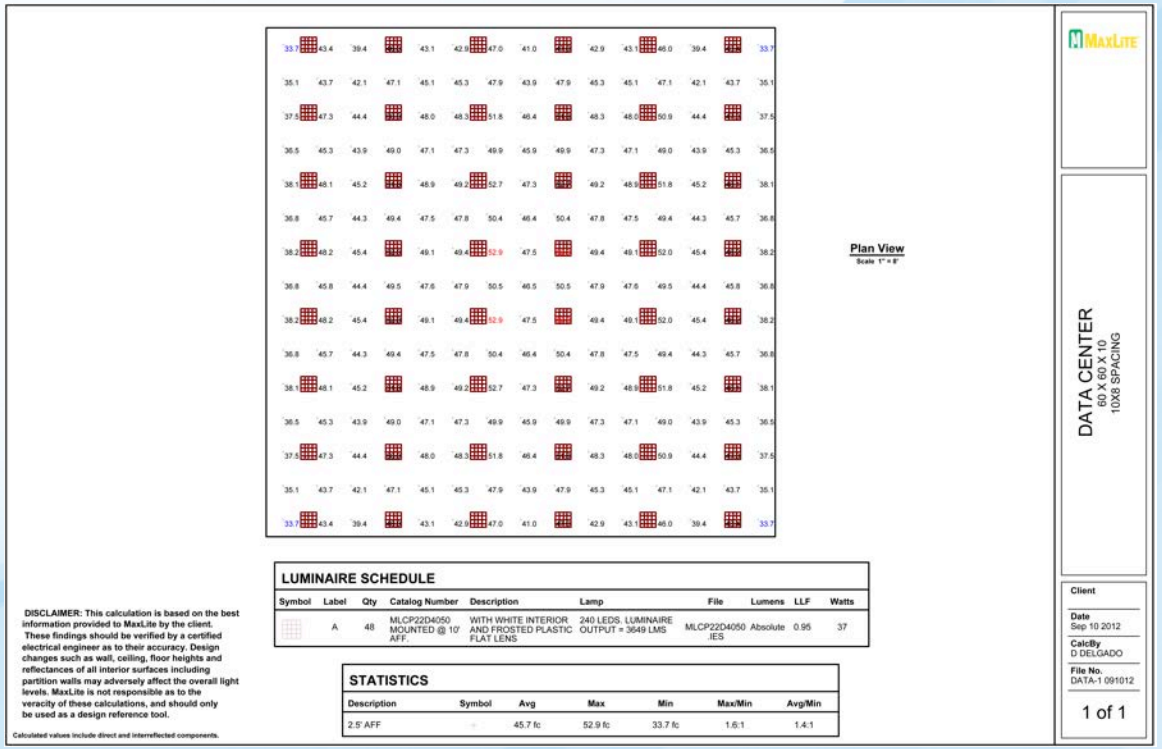


Delivered Lumens:





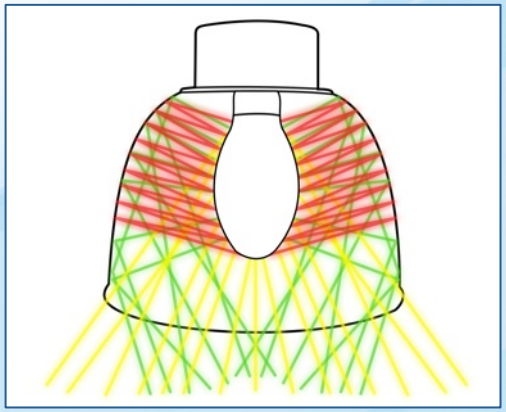
Instead of lumen output, the best and most relevant measurement for evaluating LED light fixtures and for making accurate comparisons with conventional light fixtures is **Delivered Light**. The formal term for measurements of delivered light is illuminance. Roughly speaking, illuminance is the intensity of light falling on a surface area. If the area is measured in square feet, the unit of illuminance is **Foot-Candles**. If measured in square meters, the unit of illuminance is lux.

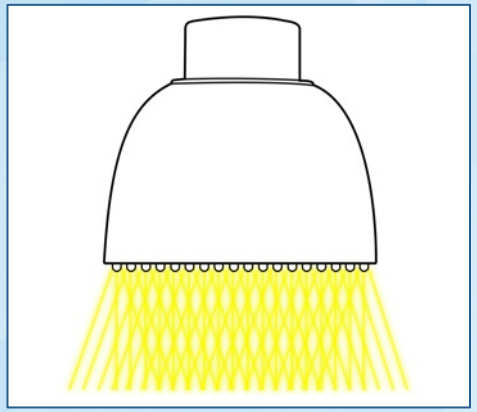


DELIVERED LUMENS

Delivered light aka **Delivered Lumens** describes how much useful light a light fixture can deliver to a task area discounting any wasted light. Light can be wasted in a number of ways: It can be partially blocked or dispersed within the fixture housing, it can be emitted in a direction away from the task area, or it can be lost through filtering, lensing, fixture positioning, or any of a number of other factors relevant to a specific installation.

A fixture's total lumen output does not account for wasted light. Because LED lighting fixtures are fundamentally directional, LED fixtures typically waste much less light then their conventional counterparts, and deliver more of their total light output to a task or target area. An LED light fixture with lower rated lumens, therefore, may deliver the same or more useful light in a specific application than a comparable conventional lighting fixture with a higher rated lumen output.





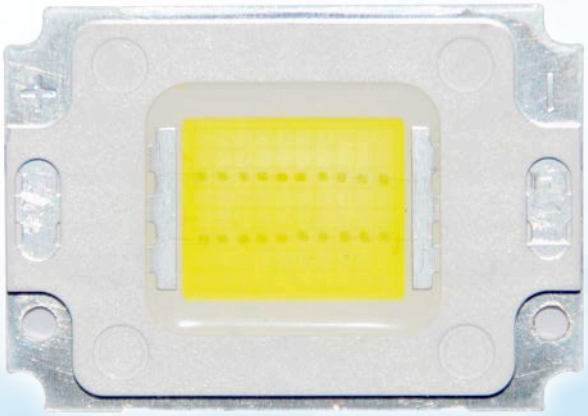
Traditional Fixtures

Conventional lighting fixtures are tested using the relative photometry method. In relative photometry, luminaires and the lamps used within them are tested separately. Lamp and luminaire testing differ so much from one another, in fact, that lamp photometry engineering and luminaire photometry engineering are separate specialties, each with its own standards and practices. The total luminous flux and chromaticity (color) of a fixture's lamps are typically measured with integrating spheres, while the luminous intensity distribution and efficiency of the luminaires are usually measured with goniophotometers.

LED Fixtures

Because LEDs are typically inseparable from the luminaires in which they act as light sources, relative photometry is inappropriate for measuring the light output of LED fixtures. Instead, LED fixtures are tested using absolute photometry. The approved procedures and testing conditions for absolute photometry are spelled out in Electrical and Photometric Measurements of Solid-State Lighting Products, publication **IES LM-79-08**, published by IESNA in early 2008.

In absolute photometry, only fixture lumens are measured, and not lamp lumens, because a separate measurement of the LEDs independent of the fixture is neither possible nor meaningful. Fixture efficiency, which compares lamp lumens to fixture lumens, therefore has no meaning for an LED lighting fixture.



Specifiers, designers and distributors need to compare the total lamp lumens of a conventional lighting fixture with the total fixture lumens of an LED fixture. To make a valid comparison, you must reduce the measured lamp lumens of the conventional fixture by its efficiency. This reduction is typically reported in a Zonal Lumen Summary chart.

For example, the T2 under-cabinet fluorescent light fixtures, prominently reports 860 lumens for the two T2 lamps used within the fixture. However, the Zonal Lumen Summary chart reports 575 total fixture lumens, because the fixture outputs Only 66.9% of the total lamp lumens (66.9% of 860 = 575). That means that 33.1% of the light produced by the fixture's lamps is wasted or lost within the fixture housing. When comparing a T2 under-cabinet fixture to an LED-based under-cabinet fixture designed for similar lighting applications, you should compare the LED-based fixture's total lumens with the efficiency-corrected lumen total of the T2, not with its reported lamp lumens. The best way however is to have a lighting layout showing before and after fc's.

ZONAL LUMEN SUMMARY

Zone	Lumen	% Lamp	% Fixt.
0-30	113	12.1	19.6
0-40	199	23.1	34.6
0-60	382	44.4	66.3
0-90	534	62.1	92.8
90-120	38	4.4	92.8
90-130	40	4.7	7.0
90-150	41	4.8	7.2
90-180	41	4.8	7.2
0-180	575	66.9	100.0

The total fixture lumens of a conventional lighting fixture, which accounts for fixture efficiency, should be used in comparisons with the lumen output of LED fixtures.

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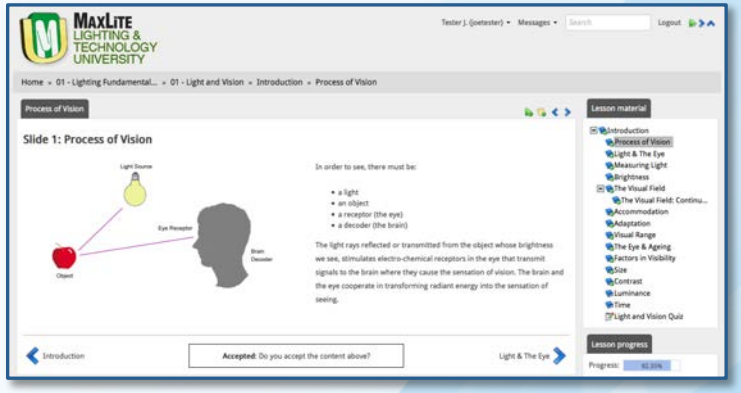

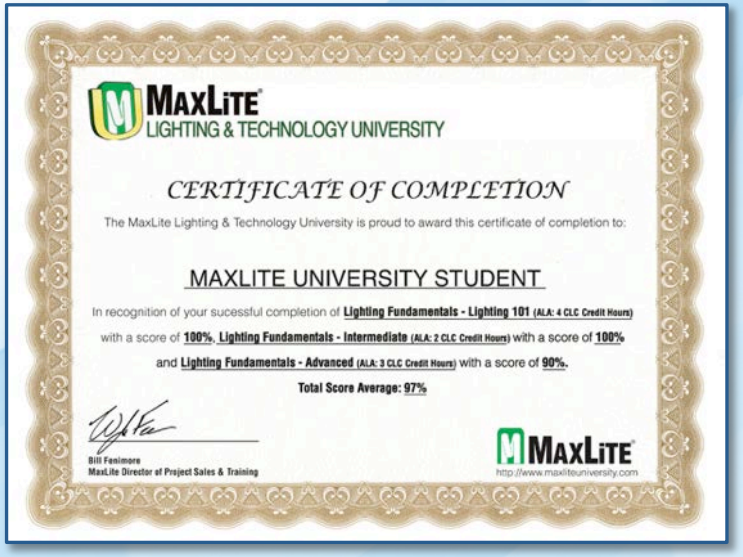

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THANKS FOR ATTENDING!

QUESTIONS/ANSWERS

Thank you everyone for your attention! Please feel free to use this opportunity to ask any questions you may have about MaxLite or the products/topics discussed in this presentation.

FOR MORE INFORMATION ABOUT OTHER MAXLITE PRODUCTS, OR FOR LIGHTING QUESTIONS IN GENERAL; PLEASE CONTACT:

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