Exterior Lighting 101

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Lighting Metrics Made Easy

Important Lighting Terms







Lumens – amount of light produced by each luminaire



https://www.energy.gov/energysaver/save-electricity-and-fuel/lighting-choices-save-you-money/lumensand-lighting-facts

Correlated Color Temperature (CCT): Measured in degrees Kelvin (K)



Color Rendering

 TM-30-15 – Gamut Index (Saturation)





B.U.G. Rating: Backlight, Uplight, Glare



Light Effects on Environmental and Human Health

What are the adverse effects of lighting at night?



Light Dark Cycle - Humans



Human - Ocular Action Spectra



dapted from Brainard et al. Journal o

Sky Glow Impact (LED)





Lighting Criteria

Nighttime Visibility: The Whole Story





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Design Considerations: Vision at Night

- Nighttime vs. daytime vision
- What affects our vision at night?
- Quality issues to improve our vision at night





Illuminance

Refers to light level

Units

Footcandles (US)

Lux (Metric)



Illuminance Examples



- 100 footcandles (fc): some over-lighted gas stations
- 6-10 fc: over-lighted parking lots
- 1 fc: street lighting and some parking lots
- Full moonlight?

Uniformity and Uniformity Ratio

RATIO	VISUAL EFFECT
2:1	No discernable difference
3:1	Still considered uniform
5:1	Accent
10:1	Strong accent
100:1	Adaptation problems

Luminance

What we actually see
Surface Brightness
Light Source Brightness











What motorists "see"



Glare



Nuisance Glare

Discomfort Glare

Disability Glare (veiling luminance)

Disability Glare (Veiling Luminance)

Loss of contrast... Cannot see ...

May be the major cause of accidents



Loss of Visibility - Adaptation





High Contrast - Positive

Low Contrast

High Contrast - Negative

Visibility – Contrast example





What are the community's expectations?

What is the purpose of lighting?

When is lighting needed or not needed? How can intelligent controls help?













1. Anchorage

2. San Diego

3. San Jose

4. Seattle

Objective Data Was Collected by Virginia Tech Transportation Institute





It is all about Contrast!





Figure 9: Detection Targets used within Test Areas



Light Source Effectiveness



Making Informed Decisions


Tonight's Survey Questions https://bit.ly/2IWHaY6



Site 1 - 16th Street Mall

General Information

It would be safe to walk here, alone, during darkness hours.						
	1	2	з	4	5	
Strongly Disagree	0	0	0	0	0	Strongly Agree
The lighting is comfortable.						
	1	2	з	4	5	
Strongly Disagree	0	0	0	0	0	Strongly Agree
This area has enough light.						
	1	2	з	4	5	
Strongly Disagree	0	0	0	0	0	Strongly Agree
The light is evenly distributed or uniform.						
	1	2	з	4	5	
Strongly Disagree	0	0	0	0	0	Strongly Agree
The light sources are not glaring.						
	1	2	3	4	5	
Strongly Disagree	0	0	0	0	0	Strongly Agree
The lighting enables me to recognize faces.						
	1	2	з	4	5	
Strongly Disagree	0	0	0	0	0	Strongly Agree
I like the color of the light.						
	1	2	з	4	5	
Strongly Disagree	0	0	0	0	0	Strongly Agree
NEXT			-			Page 1 of 7

Tonight's Survey Sites: https://bit.ly/2IWHaY6

Sites:

- 1. 16th Street Mall
 - Take Mall shuttle
- 2. Wewatta & 16th
- 3. Millennium Bridge
- 4. Light Rail Plaza
- 5. <u>17th St. Pedestrian</u>

<u>Area</u>

- 6. <u>Commuter Rail</u>
 - **Terminal**
- 7. Union Station

Day 2 – Lighting Continuing the Journey



Survey Results









https://www.wnycstudios.org/po dcasts/radiolab/episodes/21111 9-colors

- How animals perceive color
- How humans perceive color
- Color history



Lighting for pedestrians ... instead of vehicles



Crosswalk Safety

Pedestrians are silhouetted in lighted crosswalk

Crosswalk entry is dark, pedestrians are undetected when they enter the crosswalk



Requires additional luminaires on sidewalk between oncoming car and crosswalk.

Crosswalks







Minimize adverse effects of lighting



Make it all gorgeous! (and save a lot of energy)



Keeping Control

Integrated Lighting Controls



Adaptive Lighting

Adaptive strategies include: Curfew Seasonal Weather controls Astronomy **Demand response** Emergency response

Controls and Asset Management

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Electrical and Small Cell Infrastructure

THE PROMISE: IMPROVE PUBLIC LIFE



SENSORS ALLOW

- Adaptive lighting
- Lighting asset management
- Metering of power or water usage
- WiFi or LiFi
- Gunshot detection
- Security Cameras
- Atmospheric sensors
- Parking space detection and metering
- Car charging
- Public interaction

THE SKY IS THE LIMIT

NETWORK PROVIDERS WANT...

- To fill in areas like residential areas.
- Increase data in high density areas
 - Rallies
 - Concerts
 - Farmer's markets
- Provide data at all times
 - Instagram
 - Calls to find people









FCC-18-133 REGULATIONS (JAN 2019)

- Federal Communications Commission (FCC)
- Regulations on Small Wireless Facilities "SWF"
- <u>Significantly limits state and local</u> jurisdictions deployment control of SWF in right of way.
 - Timing for permits (60 to 90 days)
 - Limits fees (permitting fees and leasing fees)
 - Cannot discriminate between carriers



5G Spectrum Usage by Carrier

Not all service providers use the same frequency band for 5G. Like we mentioned above, there are advantages and disadvantages to using any part of the 5G spectrum.

- T-Mobile: T-Mobile plans to <u>use low-band spectrum (600 MHz)</u> as well as midband spectrum.
- Verizon: Verizon's <u>5G Ultra Wideband</u> network uses millimeter waves, specifically <u>28 GHz and 39 GHz</u>.
- **AT&T**: <u>AT&T's deployment strategy</u> is to use millimeter wave spectrum for dense areas and mid and low-spectrum for rural and suburban locations.
- Sprint: Sprint claims to have more spectrum than any other carrier in the US, with <u>three spectrum bands</u>: 800 MHz, 1.9 GHz and 2.5 GHz.



SMALL WIRELESS FACILITY

- FCC's definition (from Natoa):
 - Mounted on structures **50 feet or less** in height including their antennas; or

• Mounted on structures **no more than** 10 percent taller it structure or than other adjacent structures.





TIMING FOR PERMIT REVIEW

- 60 days for an existing structure
- 90 days for a new structure





How quickly can your city or town process 10,000 applications?

LIMITS FEES

<u>**Caps all fees**</u> related to small wireless facilities ("SWF") at "a reasonable approximation of the state or local governments' actual and reasonable costs."

- Caps apply to application/review or similar fees for SWF inside and outside the rights of way ("ROW"); ROW use fees; and fees for use of municipal property in the ROW (not outside the ROW).
- The following fees are presumed to meet the standard:
 - <u>Non-Recurring Fees:</u> \$500, including a single up-front application that includes up to five SWF, with an additional \$100 for each SWF beyond five, or \$1,000 for non-recurring fees for a new pole to support SWF.
 - <u>Recurring Fees:</u> \$270 per SWF per year for all recurring fees, including any ROW access fee or fee for attachment to municipally-owned structures in the ROW.



CANNOT DISCRIMINATE BETWEEN CARRIERS

Carriers are allowed <u>anywhere</u> in the public ROW

Unless ...

The local agency develops reasonable <u>aesthetic requirements</u> for small cell deployment



AESTHETICS (DEFINE!)

- Pole height
- Equipment sizes
- Placement criteria
- Acceptable locations
- Number of Carrier's per pole



PLACEMENT







INFRASTRUCTURE

- Every location requires:
 - Fiber for Network Provider
 - Electrical service
- Make sure the permit shows both fiber and electrical connections



ELECTRICAL INFRASTRUCTURE: <u>METERED</u>

- Need a transformer or secondary service pedestal
 - Located within 400 ft of small cell
 - May have to install a new transformer
- Separate service lateral ran to **every** small cell
 - <u>Cannot</u> splice service laterals
 - <u>Cannot</u> connect to streetlight electrical lines www.clantonassociates.com



ELECTRICAL INFRASTRUCTURE: WITH STREETLIGHT

- <u>Three (3) separate conduits</u> <u>needed</u>
 - 1. Service lateral ran to **every** small cell
 - 2. Streetlight electrical
 - 3. Fiber



ASK THE RIGHT QUESTIONS

- What other equipment or infrastructure is required?
 - Do you need a splice box next to pole for electrical and fiber?
 - How many splices boxes are need?
- Is fiber and electrical service shown on the permit plans?
- What are the underground impacts?



PLAN FOR FUTURE INSTALLATIONS

- Dig Once!
 - Install spare electrical/fiber conduit in ground
 - Future proof location
- Install spare dark fiber conduit


DEVELOP GUIDELINES OR MASTERPLANS

- Where is equipment allowed?
- Are your requirements reasonable?
- Consider integration with other street furniture



SMALL CELL TYPES

- 4G/LTE is prevalent
- 5G is just being installed
 - 5G requires <u>line of sight</u>
 - 5G antennas are exposed



KNOW THE IMPACT: SIZING





KNOW THE IMPACT: INFRASTRUCTURE

- Separate access for separate owners
- Conduit
 - Streetlight electrical
 - Small cell electrical
 - Small cell fiber
 - Other sensors?
- Foundation size



KNOW THE HEALTH IMPACT

 Percentage maximum permissible exposure (%MPE)

> _ 50% of FCC Maximum Permissable Exposure

100% of FCC Maximum Permissable Exposure



KNOW THE HEALTH IMPACT

- Distance to occupied building
- Frequency interference?



WHAT DON'T WE KNOW

- Frequency interference
 - 900 MHz
 - Lighting control nodes
 - Other sensors
- Acceptable distances between installations?
- Are impacts additive?
- Impacts to animals?



TAKE CONTROL

Develop permitting requirements

- How much does permitting cost?
- Certified Radio Frequency Reports?
- Site permit requirements?
- Construction plans?



INCOME STREAM

- Rent out space on poles for sensors
- Rent out spare conduit
- Rent out dark fiber



FCC doesn't regulate fiber or conduit leases

WELCOME TO THE FUTURE

- Autonomous vehicles
- Increased data speed
- Free WiFi





Resiliency and Renewables?



Start with LED Streetlights



Add Spectral Tuning



Just in Time... Incorporate Smart Controls



Wifi (Lifi?) Enabled



Renewable Energy & EV Charging













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