COLLEGE OF ENGINEERING
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3 Oct 16

MEMORANDUM FOR RECORD

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SUBJECT: LiMoST-Net Progress - Week 1

1. The purpose of this memorandum is to report our progress in accordance with our predetermined schedule.

2. The specific purpose of this memorandum is to review the objectives of week 1 and what we have accomplished.

3. Over the course of the week, we went off on our own time to accomplish what we could for the projected goals, then came back together to consolidate our efforts. This utilized our free time since our schedules usually conflict. We worked based off of the Week 1 Schedule:

Week	*Date*	*Projected Goals*	*Comments*
1	9/25/16	Research: Street lamp standards Li-Fi standards Current traffic prediction techniques	Physical and electrical requirements of streetlamps. Do current Li-Fi standards exist? What regulations would we have to follow to broadcast Li-Fi? How are traffic patterns predicted and modified to improve flow? Basics of how Li-fi works.

4. Street lamp standards. Referencing the *FHWA Lighting Handbook* from 2012. A large part of our time was looking at Chapters 6 and 7 since it pertained to lighting selection and application. Important takeaways from the handbook are below.

a) One lumen per square meter is one lux. One lumen per square foot is one footcandle.
b) Luminaires (one complete light unit) should have:
    i) An Ingress Protection (IP) rating of 65 or 66 for maximum performance
    ii) Lens material using glass since polycarbonate and acrylic materials discolor and reduce light output needing replacement every 5 years

iii) Housed in aluminum with powder coat finish that is easily accessible and secured to the pole

iv) Internal (electrical) components will include a ballast, starter, and capacitor. Ballast being a constant wattage autotransformer (CWA) type

v) Meet BUG ratings where they are available

c) Luminaire Classification System (LCS) tables:

i) The amount of glare generated by a luminaire is strongly influenced by the intensity (candlepower) emitted at angles close to the horizontal.

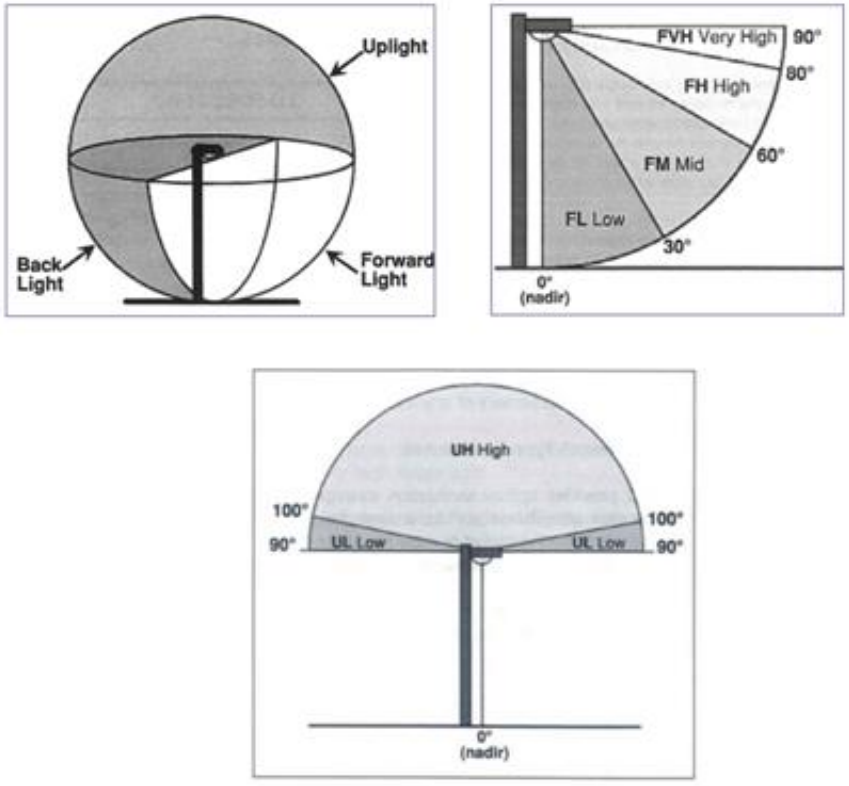


Figure 27 - Lamp Lumen Zones and Front Light Zone (from IESNA TM-15)

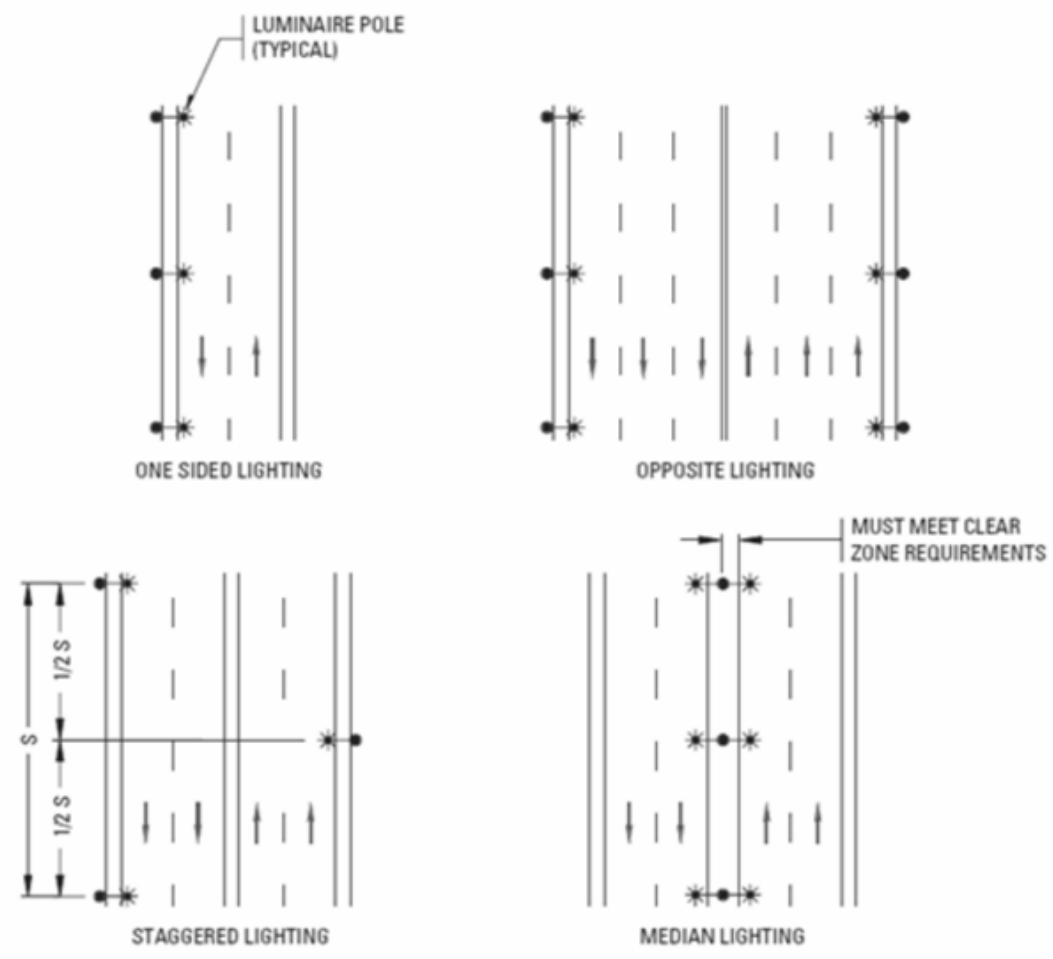
ii) Research has already been done comparing different types of street lamps so we do not have to reinvent the wheel.

Metal Halide	 Internal Refractor Optic (250 W Type V)	 External Refractor Optic (250 W Type V)	 Louvered Reflector Optics (250 W Type III)	 Hydro-formed Refractor Optics with Horizontal Lamp (250 W Type I)	 Sag Lens Refractor Optics (250 W Type III)	 Sag Lens Refractor Optics (250 W Type I)	 Sag Lens Refractor Optics (100 W Type I)
Forward Light							
Luminaire Lumens	4133.4	5405.6	6306.5	6487.6	10115.6	10557.0	3716.3
% Lamp Lumens	19.70%	25.70%	30.00%	29.50%	46.00%	48.00%	45.90%
FL (0°-30°)	0.20%	0.90%	1.20%	2.40%	7.40%	13.10%	12.60%
FM (30°-60°)	5.40%	3.70%	14.40%	15.30%	27.20%	24.80%	23.40%
FH (60°-80°)	8.90%	17.30%	12.90%	11.20%	11.20%	10.00%	9.60%
FVH (80°-90°)	5.10%	3.80%	1.40%	0.50%	0.20%	0.10%	0.20%
Back Light							
Luminaire Lumens	4133.4	5352.5	4220.2	4880.5	5384.3	7138.1	2465.6
% Lamp Lumens	19.70%	25.50%	20.10%	22.20%	24.50%	32.40%	30.40%
BL (0°-30°)	0.20%	0.90%	0.80%	2.30%	5.40%	7.70%	7.20%
BM (30°-60°)	5.40%	3.60%	9.40%	13.20%	14.50%	17.00%	16.10%
BH (60°-80°)	8.90%	17.10%	8.80%	6.00%	4.40%	7.60%	7.00%
BVH (80°-90°)	5.10%	3.90%	1.00%	0.70%	0.10%	0.10%	0.10%
Up-light							
Luminaire Lumens	9997.6	2477.0	957.5	163.2	0.0	0.0	0.0
% Lamp Lumens	47.60%	11.80%	4.60%	0.70%	0.00%	0.00%	0.00%
UL (90°-100°)	10.70%	2.40%	1.40%	0.50%	0.00%	0.00%	0.00%
UH (100°-180°)	37.00%	9.40%	3.20%	0.20%	0.00%	0.00%	0.00%

Figure 28 – LCS Comparison (IES TM-15-07)

d) Lighting master plans typically address: Improved safety provided by lighting, improved sense of security provided by lighting, casts (capital and operating), aesthetics (daytime and nighttime), lighting design criteria, environmental issues and constraints, including the control of spill light, glare and sky glow, energy use (through definition of unit power density), potential for economic development and the enhancement of nighttime activities through lighting, preservation of areas of darkness, such as areas around observatories, and maintenance requirements.

e) Layout and geometry: not necessarily a requirement, but a guideline to do at least, there are certain layouts that cities already implement to place their street lamps on roadways.



f) Adaptive lighting controls allow lighting levels to be reduced during off-peak periods. Simply, a significant amount of power can be saved by varying the levels of lighting between peak and nonpeak periods.

5. LiFi Standards. Since LiFi is so young and hasn't been integrated with street lamps, there is no certain standards or restrictions of use. We would mainly reference city ordinance for specific guidelines. The main take away is to always try and minimize power consumption and maintenance needs.

6. Traffic prediction techniques. It seems the traditional way of predicting traffic conditions is having physical sensors that can detect a car and its speed. Depending on the amount of cars passing that sensor and their speed, a relative travel time to a certain location can be calculated. The problems is this system would mainly be implemented on a highway or major roadway where the city took the time and money to put in these sensors. A method that Google Maps is trying is using meta data from users. If a user has the google maps app open, google is anonymously receiving information such as the driver's location and speed. Doing the same job as the sensors, but can now be done on any roadway. The more user's with the app open, the more accurate the predictions for travel time since sample size is so large.

7. Over the past week, we looked into street lamp standards, LiFi standards, and current traffic prediction techniques. This will help us in the future by giving us an idea of how the current market works and how we can tailor our product to actually solve a problem.

8. If you have any questions, comments, or concerns, please feel free to contact us at:

- Chris Askings: (817) 367 – 8273 or via email at chrisaskings@gmail.com
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1 Attachment:
Documentation

Documentation:

All material pertaining to our project can be found on GitHub:
https://github.com/NathanRuprecht/EENG4910_SeniorDesign

Articles in GitHub under “References” used in this week’s report:
Standards – FHWA Lighting Handbook