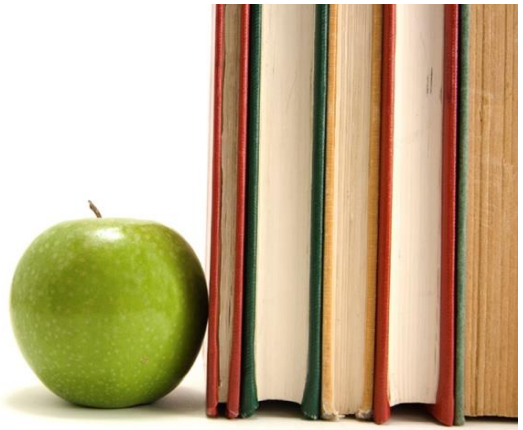
Introduction to Outdoor Lighting

And How it Affects Light Pollution

IDA in Partnership with NOAO, NSF and IYA
Dark Skies Awareness

Scope of Lesson

- We will discuss the history of outdoor lighting
- Its purpose
- Types of Lamps
- Fundamentals of Design
- Why too much light at night is harmful
- Activities to demonstrate good lighting.



Nighttime

Define Nightscape

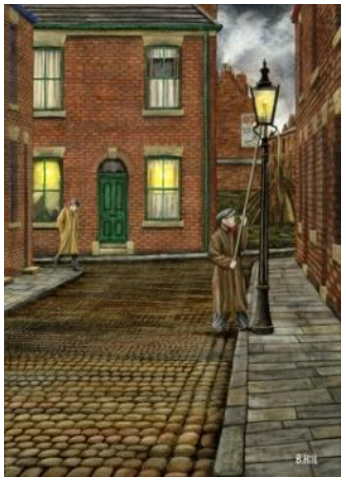
- For many centuries the nightscape was the moon and stars. During a full moon it would be relatively bright and during a new moon, rather dark.

- For urban dwellers over the last 100 years it has come to be described as lighting buildings, streets, and open spaces.

- Could there be a compromise?

History

- Street lighting as we know it began approximately 300 years ago.
- These were oil lamps placed on wooden poles
- By the early 18th century oil lamps were still used but the poles and lamps were made of cast-iron fixtures.
- The beginning of the 19th saw gas lamps come into use.
- By the 20th century electric lamps were in wide use.

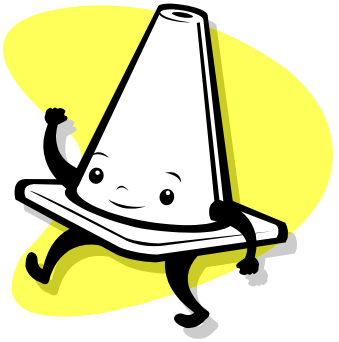


What is outdoor lighting now?

- Street lighting
- Roadway lighting
- Parks
- Stadiums
- Parking lots
- Landscaping
- Residential
- Buildings
- Pedestrian and Bicycling Pathways

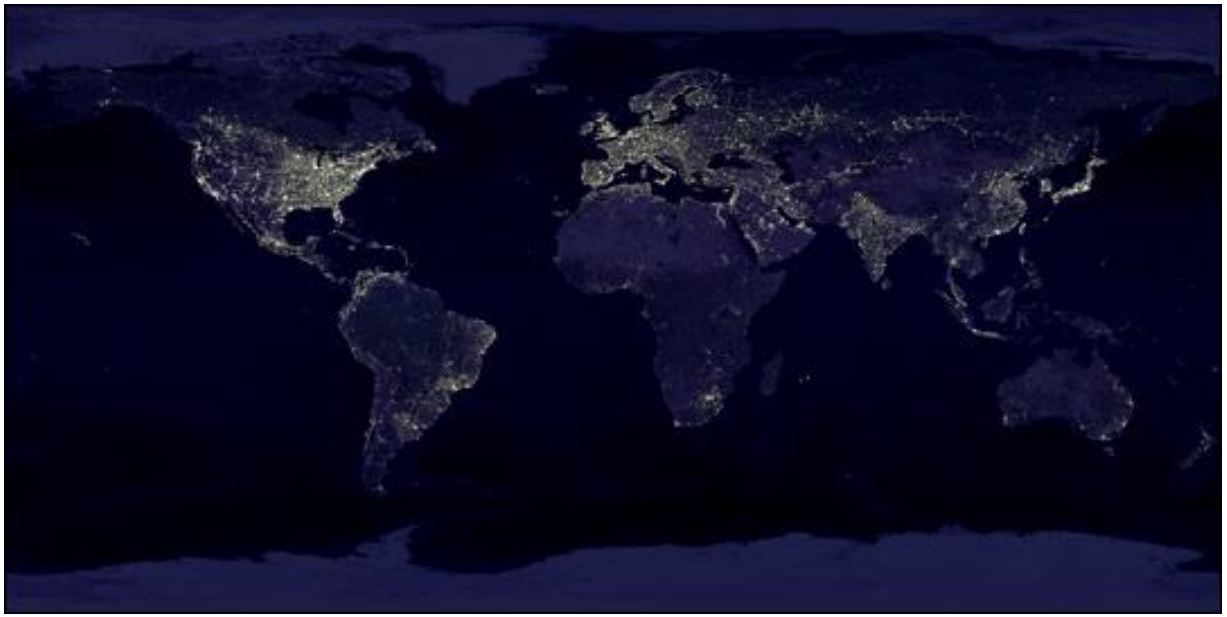
Purpose of outdoor lighting

- Provide a safe and secure environment at night.
- Extend the use of parks and walkways into the night.
- To enhance historic/notable features
- To enhance travel on the roads and at intersections.



What is light pollution?

- It is wasted light that performs no function or task
  - Such as sky glow
  - Glare
- It is artificial light that goes where it's not supposed to go
  - Neighbor's window
  - Into the sky



Outdoor Lighting

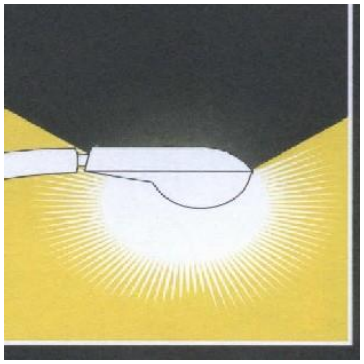
Outdoor lighting should…

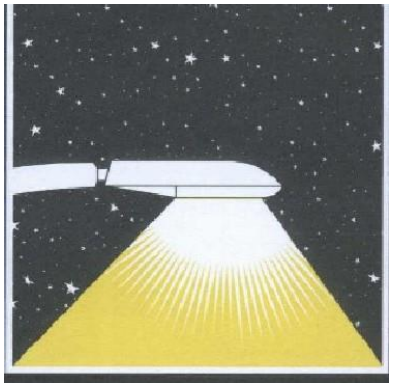
- Enhance visibility, not impede it
- Not produce glare
- Be a part of the total nightscape, not all of it
- Not allow light trespass on other's property
- Have a master plan

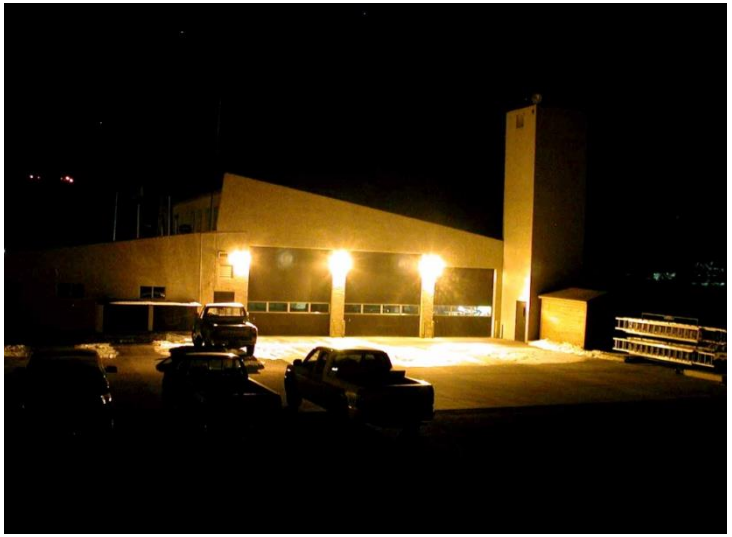
Outdoor lighting should…

- Provide a safe and secure environment
- Create safe routes for traffic, cyclists and pedestrians
- Facilitate the extended use of outdoor spaces

Shielded Luminaires







Importance of Shielding Light

- Unshielded lights produce
  - Sky Glow
  - Glare

The Issues

Unshielded Luminaires Waste Energy

- Light that spills out, away from the task it needs to be used for is wasted energy, and wasted money.
- Environmentally responsible outdoor lighting reduces this waste and costs no more than earlier manufactured light fixtures.
- Below- the Escondido Education Center before on the left and after on the right. Unnecessary lights on the roof only added to their light bill, not to the safety of the parking lot.

Non-shielded lights are unsafe

- The glaring lamp to the right of the path was installed to protect students at night.

Where did the student go?

Negative Impact on Wildlife

- Animals and plants live by a rhythm based on a 24 hour cycle. Wildlife and fish can become disoriented by too much artificial light at night.
- It interferes with migration, mating, foraging for food, and sleep.

Negative Impact on Human Health

- Light trespass into bedrooms disrupts sleep patterns.
- Glare in our eyes can be blinding and reduce our night vision.
- New research is being done to discover the impact to our biological clocks.

Negative Impact on Astronomy

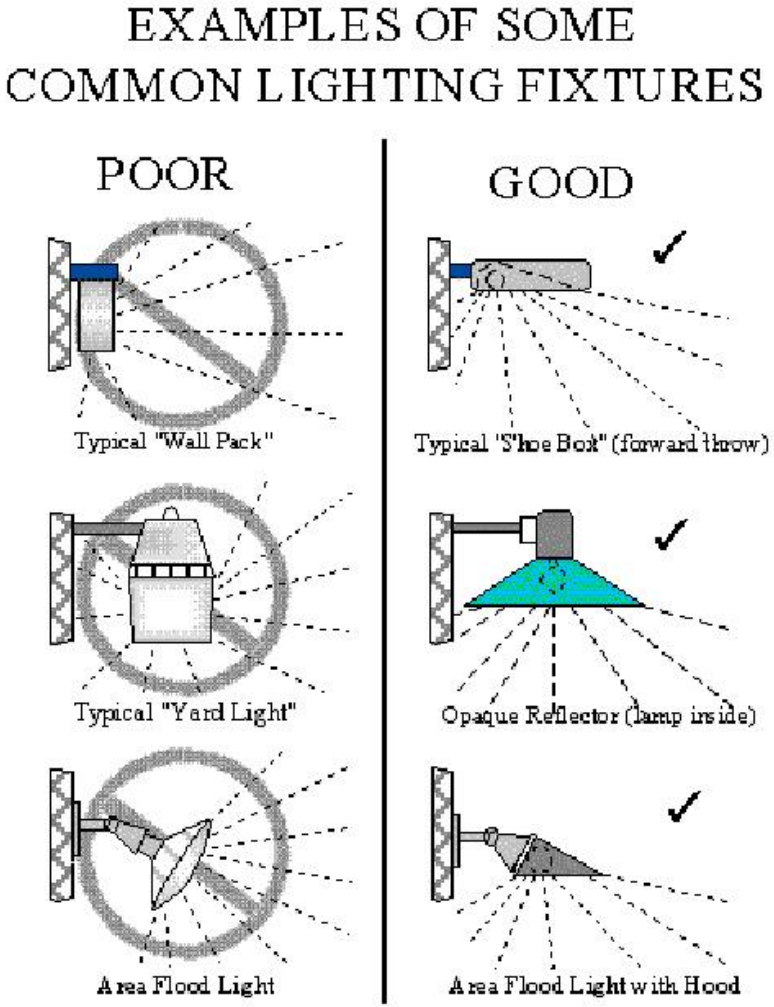
- Light pollution negatively affects one of our greatest natural laboratories, the night skies.
- This is an important industry that has given us
  - Cell phone technology
  - X-rays, MRI's, and medical imaging
  - Satellite communications

Solutions

Solutions

- Outdoor lights should be “full cut-off” or “fully shielded.” That means no light above the 90 degree angle.
- Fully shielded lighting can be purchased or retrofitted
- Use timers, dimmers, and motions sensors.
- Motion sensors in a parking lot or on a house provide an alert to after hours activity that a dusk to dawn sensor does not.

Lamps


EXAMPLES OF SOME
COMMON LIGHTING FIXTURES
POOR
GOOD
Typical "Wall Pack"
Typical "Shoe Box" (forward throw)
Typical "Yard Light"
Opaque Reflector (lamp inside)
Area Flood Light
Area Flood Light with Hood

Types of Lamps

- There are four basic types:
  - Incandescent
  - Fluorescent
  - High-intensity discharge
    - Including: Mercury Vapor, Metal Halide, High Pressure Sodium and Low Pressure sodium
  - Light Emitting Diode (LED)
    - LED technology is still relatively new

CFL

High-Pressure Sodium

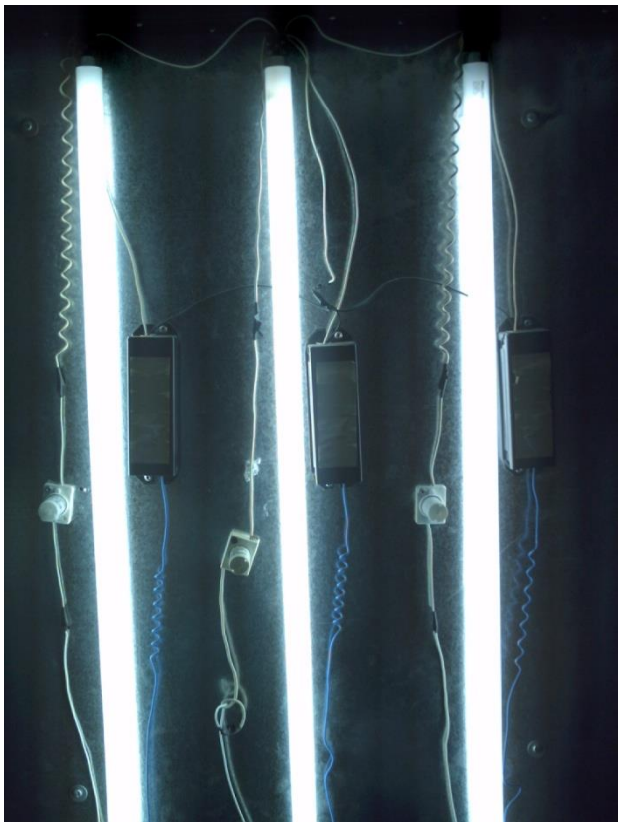
Low-Pressure Sodium

Incandescent

- Most common in homes
- It uses electric current to heat a tiny coil of tungsten metal inside a glass bulb to produce light.
- Have short lives
- Convert most of their energy into heat rather than light

Fluorescent

- Used mostly in commercial settings
- It produces light when electric current is conducted through mercury an inert gases.
- 3 to 4 times more efficient than incandescent, and lasts 10 times longer
- Produces up to 100/lumens per watt (approximately)



High-Intensity Discharge

- Used mainly for large area applications
- Provide higher efficacy and longer service life
- Most common types are mercury vapor (MV), metal halide (MH), and high-pressure sodium (HPS)
  - Metal Halide – 100/lumens per watt
  - HPS – up to 150/lumens per watt
  - MV – being phased out

HID continued
Low-Pressure Sodium

- Also considered a high intensity discharge lamp, but it has some unique characteristics.
- Used in outdoor applications
- Most efficient form of artificial lighting
- Maintain their light output better than other lamps
- Older technology, not many manufacturers producing new product
- Produces up to 200/lumens per watt

Types of Luminaires

- Column mounted fittings: used for streets, car parking, cycle tracks and pedestrian areas (pictured: Pacific Lighting model TRL)
- Wall mounted lanterns: used most commonly for security
(pictured: Lighting by Brandford model Glarebuster)

Types of Luminaires

- Lighting bollards: used for pathway and area lighting
  (pictured: Architectural Area Lighting model Concrete bollard)

- Recessed fittings: used for pathways, or where buried in the ground for uplighting structures, trees and other incidents. (pictured: Deck-Lighting model deck light)

Following six slides show shielded and unshielded outdoor lighting examples

Recessed lighting done badly, and Recessed lighting done well.

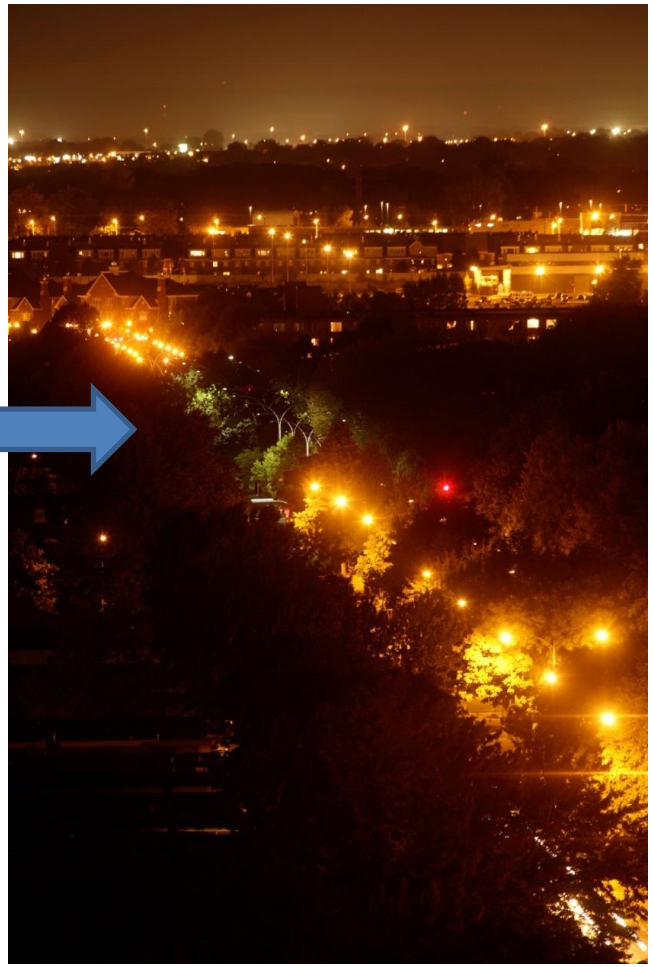
Fully shielded lighting at an airport

Unshielded lighting at an ATM

A typical un-shielded mercury vapor luminaire

How shielded lighting reduces glare

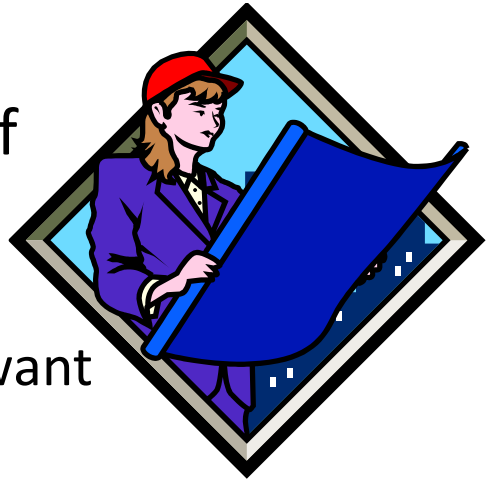
- The image below is a test site for fully shielded street lights. To the right; the same lights shown in comparison to the un-shielded existing lights.



Design & Measurements

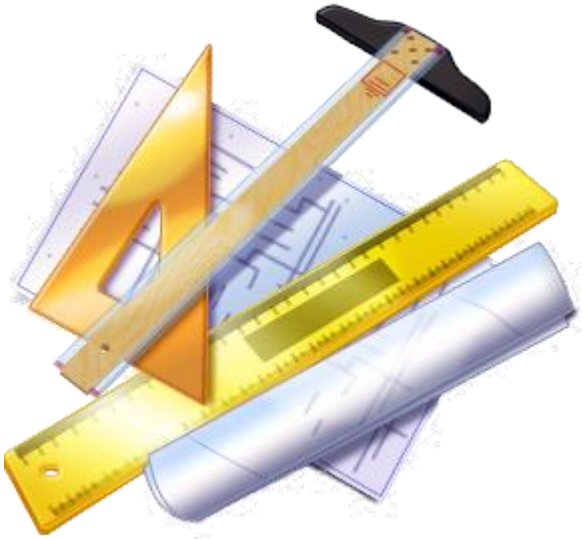
Designing a Lighting Audit

- We need to be familiar with some more terms before we go on:
  - Area lighting: lighting provided to illuminate open areas uniformly
  - Annual operating costs: cost per year of electricity, maintenance including replacement parts & labor
    - This contributes to how much energy we want to save
  - Illumination: the distribution of light on a horizontal surface, measured in footcandles



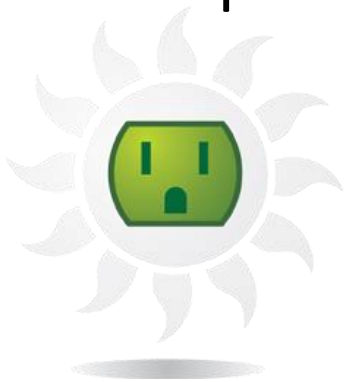
More things to consider

- Luminance: The photometric quantity most closely associated with the perception of brightness.
- Lumens is the overall output of the luminaire.
- Energy Use: The product of power (watts) and time (hours).



Power Density or Light Footprint

- Power density is a measure of electrical power per unit area, measured in watts per square foot or square meter. Many building codes prescribe maximum power density values for various areas of use in an effort to promote the use of energy-efficient products.
- Unit Power Density is the energy for lighting, divided by the outside area. Unit Power Density (W/sq.ft.) = Total System Input Wattage (W) ÷ Total Area (Square Feet)



Pole Mounting Height

- Luminaires on poles can provide illumination in every direction at distances of two to two and half times the mounting height from the pole. Thus, luminaires on a single pole can serve an area of about four times the mounting height - squared. For example, a 50-ft pole can cover about 40,000 sq ft and a 150-ft pole about 369,000 sq ft.

Thank You

- Good luck with your activities, and remember “dark skies” does not mean “dark ground.”
- You are now unofficial lighting geeks.

Let’s get to work!

- It’ll be fun, really!

Activity One - Vocabulary

- Vocabulary
  - The instructor will have a glossary of lighting terms that the students should be familiar with before beginning any of the activities.
  - Presentations from the activities should include the use of these terms
    - Knowing the language of lighting terms will enhance the understanding of the activity
    - For lighting ordinances to be enforceable, they need to be written with the proper language.

Activity Two – Energy Audit

- Audit the types of outdoor lights on the buildings at your school.
- Ultimately, you will be making recommendations on how to be more energy efficient with outdoor lighting.

Activity 3 - Measurements

- Choose 2 different types of luminaires from the audit. For each lamp prepare at least 2 of the following measurements and observations listed in the workbook.

Activity Four – Master Plan

- Produce a revised lighting scheme for your school campus or neighborhood. Using the material you have learned, determine:
  - If all the lights in audit are now necessary
  - Review what task/purpose a lamp is used for
- Recalculate the energy consumption of the new plan.
  - Have we saved money?

More Plan Considerations

- Design a visual master plan for your cam
- What are the goals for the plan
- Show a diagram of the area
- Consider these issues (you are welcome to make your own assumptions) and address each in your final presentation.
  - How will it be used? A lot, a little? Ball Park? Walk/Cycling path? Restrooms? Nearby parking lot? Sculpture? Fountain?
  - What are the hours of use?
  - What safety precautions are in place?
  - Has glare been reduced or eliminated?
  - What type of luminaires are you recommending and why?
  - What is around your park/campus? Residential, open space, businesses, mixed use?