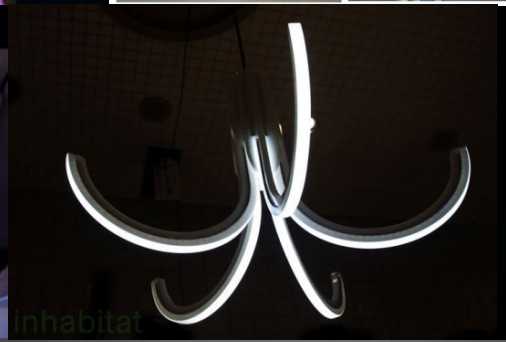
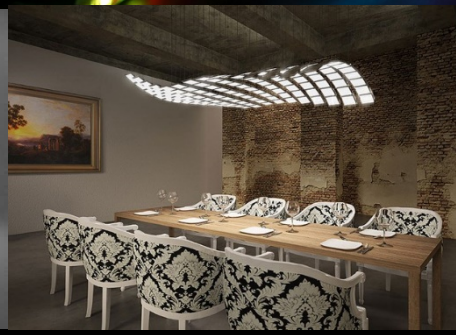


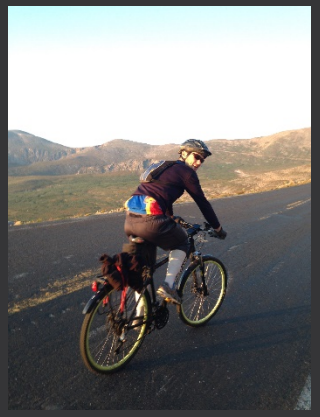


LED Lighting

ARCHITECTURAL ENGINEERING DESIGN GROUP, INC.
1900 Wazee Street | Suite 350 | Denver, Colorado 80202 | 303.296.3034 voice | www.aedesign-inc.com

About AE Design

- Started in 2004 by **Jon Brooks** and **Jeff Mullikin**
- Fundamental belief in **Sustainable Design**
- Specialize in **Lighting Design** and **Electrical Engineering**
- About **process** as well as **results**
- 17 team members
- Offices located in **Denver** and **Chicago**

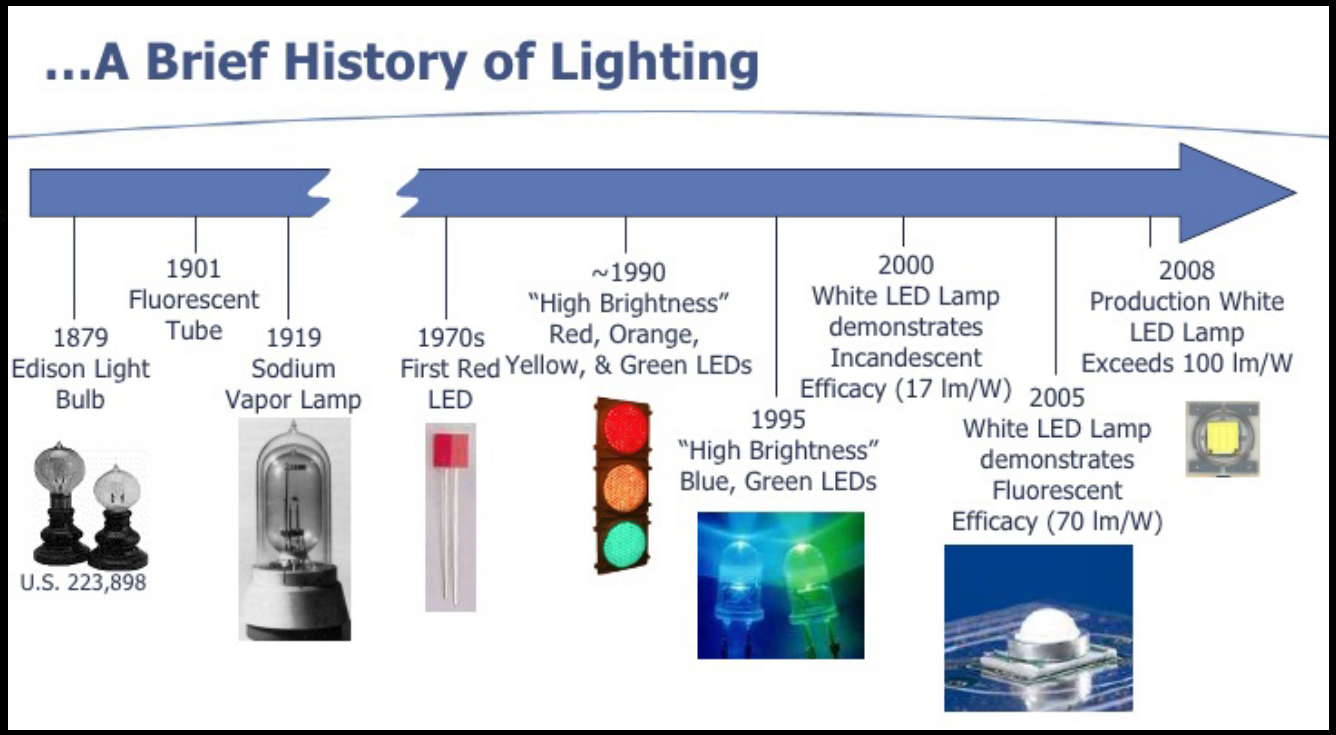


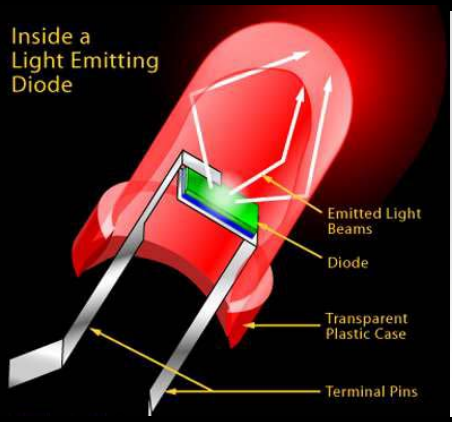
Objectives of Today's Discussion:

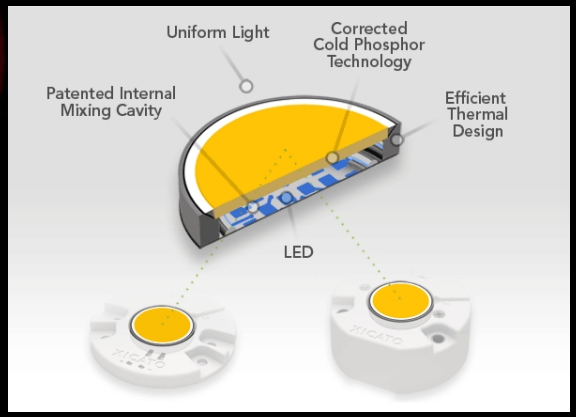
- Understanding the history and evolution of lighting
- Some crucial technical aspects of light
- Why LEDs?
- How do I know when to use LEDs?
- Challenges and drawbacks
- Lighting Applications
- What we do
- What is in store for our future?

Jeff Mullikin, PE, LEED AP BD+C – Principal
Anna-Lisa Conners, LC – Designer

History







Driving Technological Advances:

- Better efficiencies
- Creative Innovation/Competition
- Price competitive
- Unexplored Applications
- RGB LEDs
- Phosphor LED

Important Lighting Distinctions

1 Light Output *or* Lumens

How much light is the source putting out? Compare these values when you are choosing between replacement sources.

When replacing lamps, this is an approximate chart for going from older incadescent lamps to LEDs while keeping the same lumens, or brightness

Old Fashioned Incandescent

100W	1600 lumens
75W	1100 lumens
60W	800 lumens
40W	450 lumens

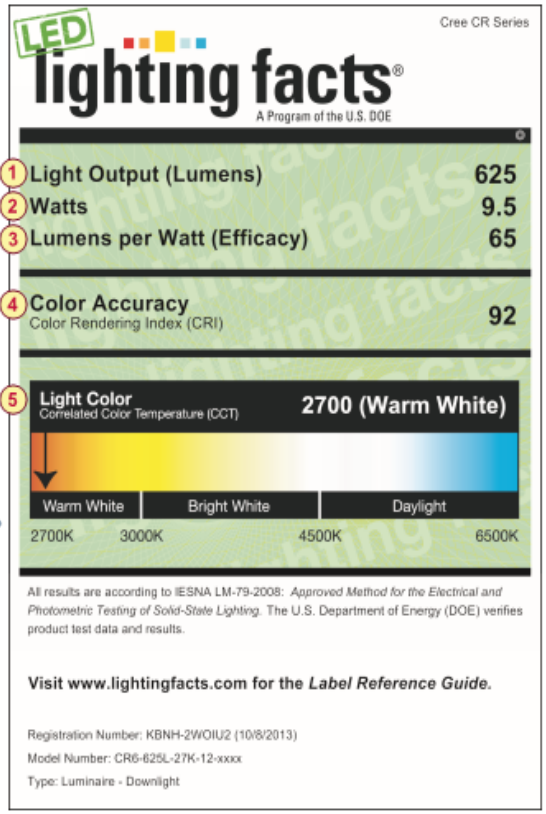
2 Watts

How much power does the lamp use? The lower the number, the lower the usage, the lower the energy bill.

Note: *Higher wattage does not mean more lumens, or brightness, when comparing different sources.*

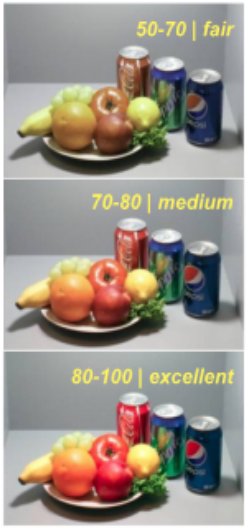
3 Lumens per Watt

How energy efficient is the source? A typical incandescent lamp is 20 lumens/watt, while some LEDs are now over 100 lumens/watt.



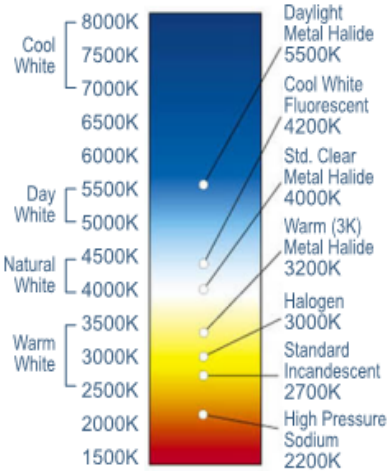
4 CRI *or* Color Rendering Index

How "true" does the object look? Can you tell what color the object is? Is each object in a scene the color it should be? CRI describes how accurately the source is able to illuminate an object's color.



5 Color Temperature

Describes what color the light source is. Does the source look warm (yellow,) cool (blue,) or neutral?



Comparing Light

- So where do I use these?
- Which one is the best?

LIGHT SOURCE COMPARISON CHART

LIGHT SOURCE	LIFE* (YEARS)	COLOR TEMPERATURE (K)	COLOR RENDERING INDEX (0-100)	DIMMING
INCANDESCENT	0.2-1.5	2700 (WARM - RESIDENTIAL/HOSPITALITY)	100 (EXCELLENT)	STANDARD INC DIMMER
HALOGEN	0.2-1.0	2700 (WARM - RESIDENTIAL/HOSPITALITY)	100 (EXCELLENT)	STANDARD INC DIMMER
METAL HALIDE	0.7-4.5	2900-4300 (WARM-COOL - PARKING/INDUSTRIAL)	65-94 (FAIR-EXCELLENT)	STEP DIMMING
HIGH PRESSURE SODIUM	3.5-9.0	1900-2200 (ORANGE - PARKING/LOW SECURITY)	20-22 (POOR)	NO
LOW PRESSURE SODIUM	3.5	1800 (ORANGE - LABORATORIES)	45-0 (VERY POOR)	NO
CFL	2.5-4.5	2700-5000 (WARM-COOL - ALL)	75-83 (MEDIUM)	ELV DIMMER
LINEAR FLUORESCENT	1.5-7.0	2700-6500 (WARM-COOL - ALL)	75-90 (MEDIUM-GOOD)	ELV DIMMER
LED	9.2-13.7	2700-6500 (WARM-COOL - ALL)	75-98 (MEDIUM-EXCELLENT)	NEED DIMMING DRIVER

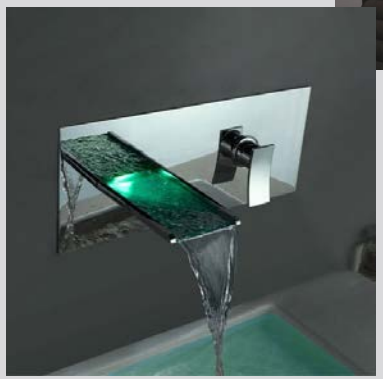
**LIFE BASED ON 12 HOUR/DAY ON TIME*
AVERAGE VALUES, NOT INCLUSIVE OF ALL MANUFACTURERS AND LAMP TYPES

CCT-Color Temperature

CRI-Color Rendering Index

LED Pros

- Higher Efficiency
- Higher Color Variation
- Smaller “Bulb” Size
- Quick On/Off Time
- Customizable Dimming
- Longer Lifetime
- Shock Resistance
- Better Focus
- Great Outdoors



LED Cons

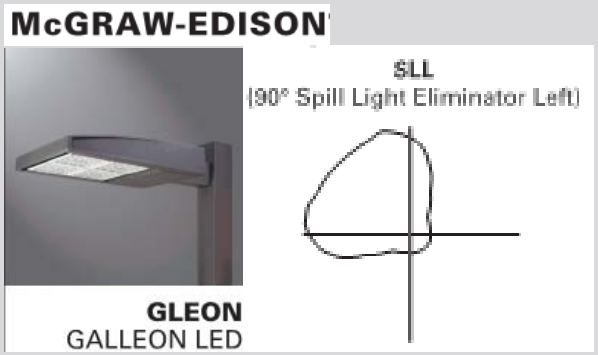
- High Initial Price
- Remote Driver
- Blue Light
- Egress Lighting
- LED Replacement

LED Applications

Steps for Choosing a Replacement Light Source or Fixture

1. Make sure the lamp base, ballasts/transformers, controls, dimmers and voltages are compatible.
2. Check to make sure the light output, CRI and color are adequate for your application.
3. Make sure you are actually saving energy by verifying the wattage on the replacement bulb.

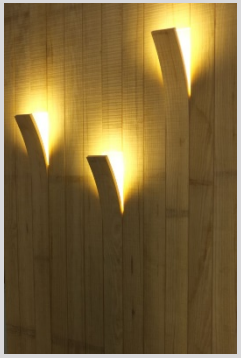
LED Applications – Exterior

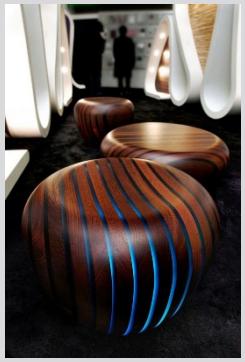


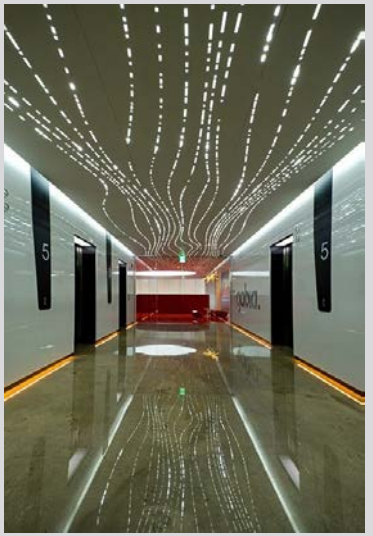
Parking Lots and Area Illumination:

- Better lamp efficacy and better light distribution from a directional source creates higher fixture efficiencies
- Reduce fixture quantity and therefore cost
- Utility Rebates
- Replamping and maintenance costs
- Unique fixture shapes

LED Applications



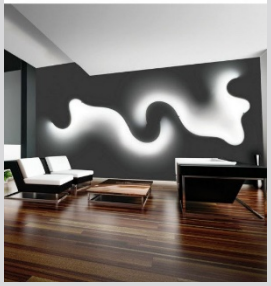






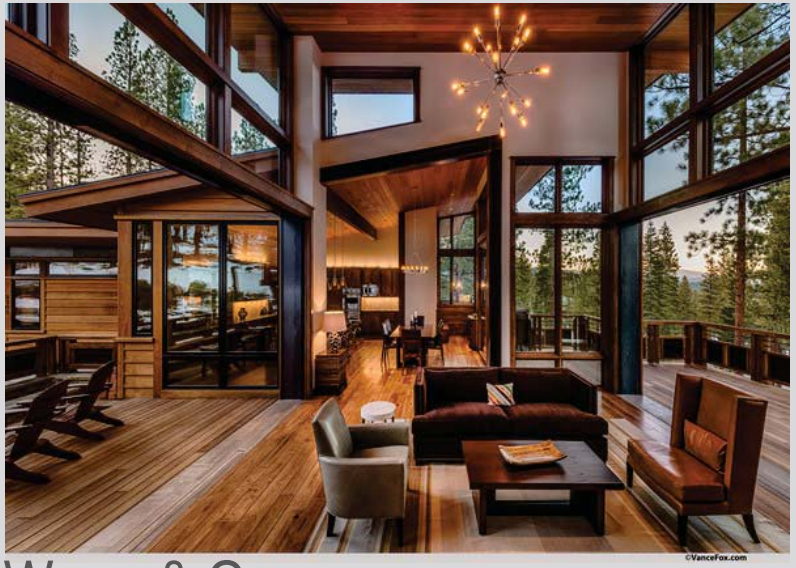






Lighting to set an Environment

Mysterious



Warm & Cozy

Vintage / Eclectic

Bright

Case Study – Mushrif Central Park

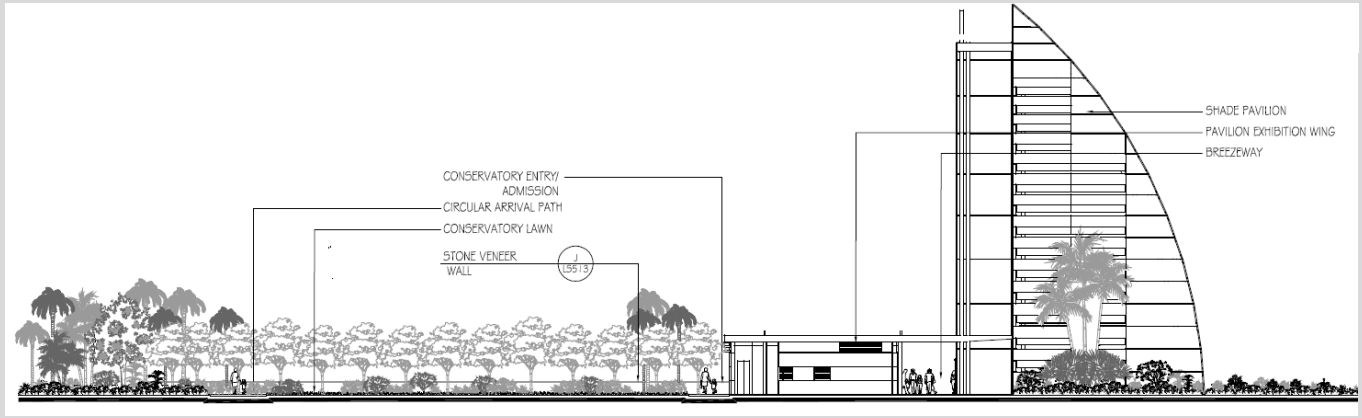
Mushrif Central Park

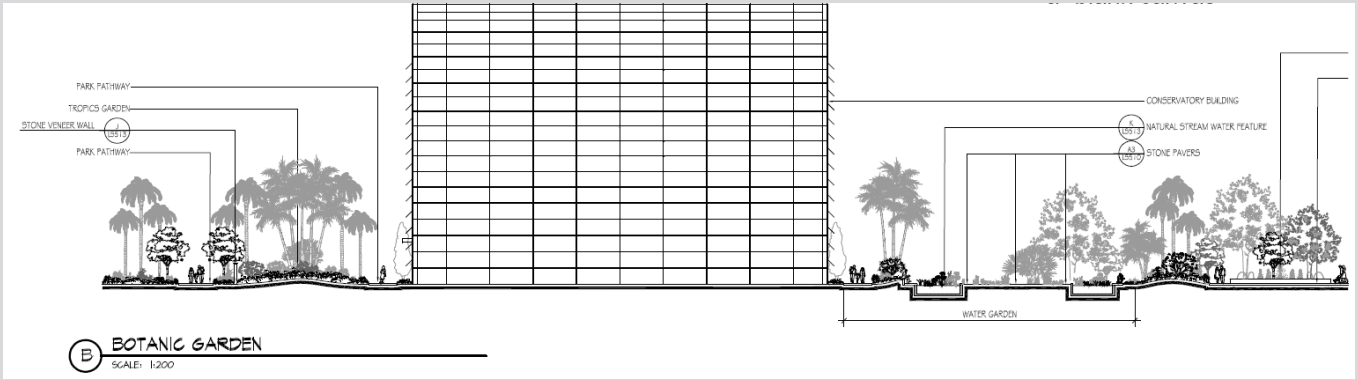
Shade House

Case Study – Mushrif Central Park

حديقة المشرف المركزية
Mushrif Central Park

Mushrif Central Park will be a People's Park. Connecting communities in a safe and secure environment and creating opportunities to explore, enrich and educate through a vibrant range of facilities.





The Architect Sets the Scene

The Architect wanted to create a Beacon would be visible at night.

The main function at night will be a viewing platform that is visible from any other point in the park.

The white tube design was intentionally a "blank canvas."

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Case Study – Mushrif Central Park

Lighting Designer Communicates Ideas

We compile concept imagery that displays the overall lighting effects.

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Lighting Designer Communicates Ideas

We present (2) options – Illumination from the from and from the back.

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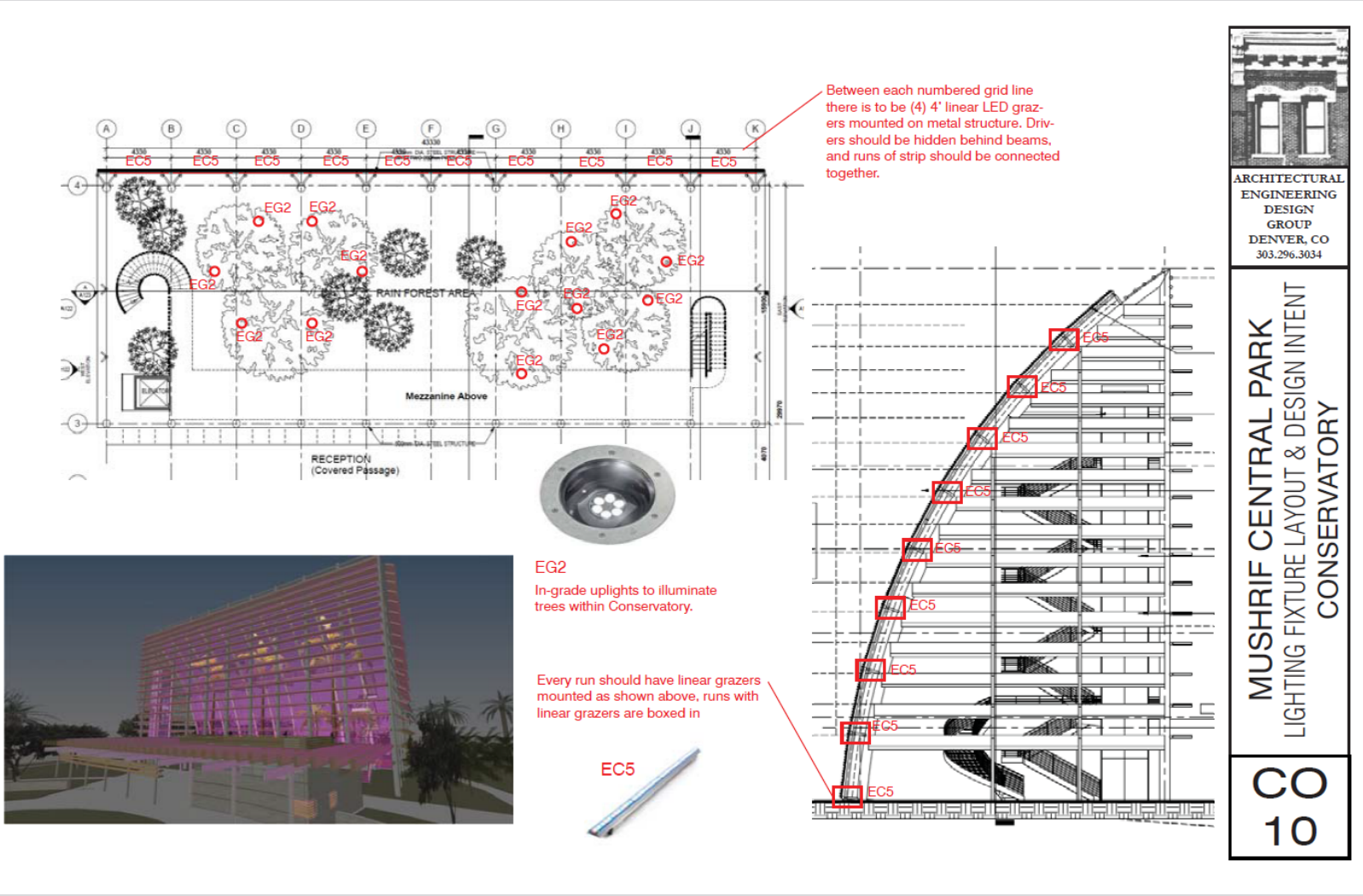
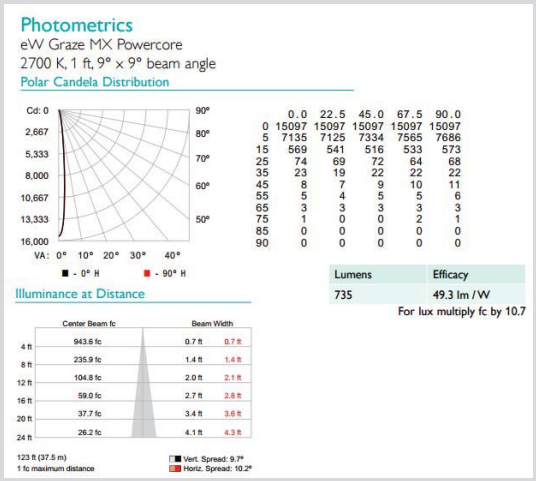
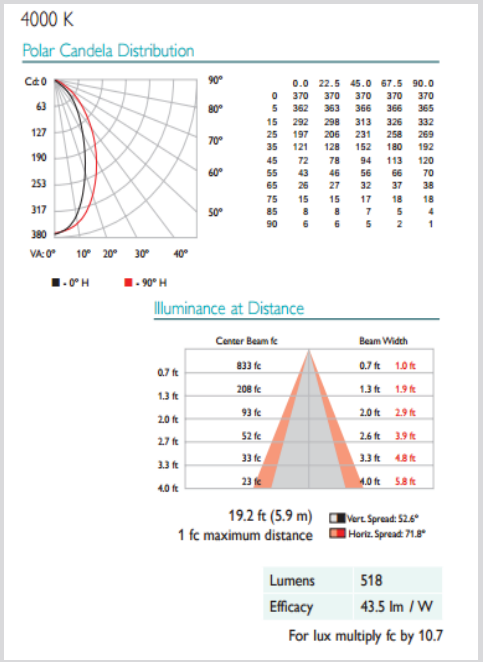


Figuring Out the Details

We figure out the placement of fixtures.

Fixture Selection – Mushrif Central Park





Typical Items During Fixture Selection

Lumen Output
Beam Spread (Typically Multiple Options)
Static White – CCT
Colored Light – Available Channels of Color
CRI (Color Rendering Index)
Wattage (Efficacy)
Voltage
Dimming Ability
Integral Power Supply or Remote
Warranty

Fixture Selection – Mushrif Central Park

Static White

Static White

Colored Light

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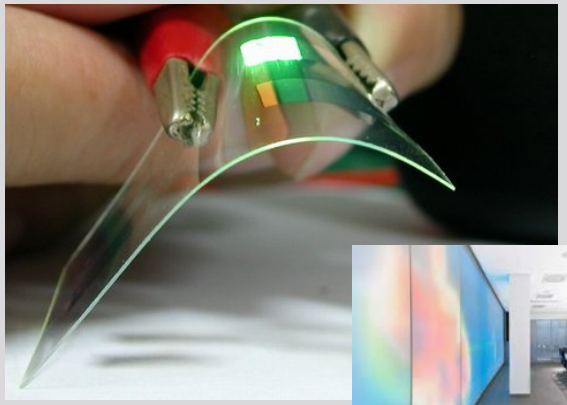
Fixture Selection – Mushrif Central Park

Final Photos

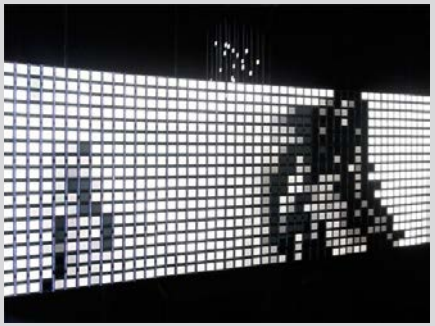


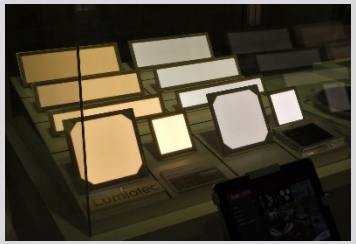


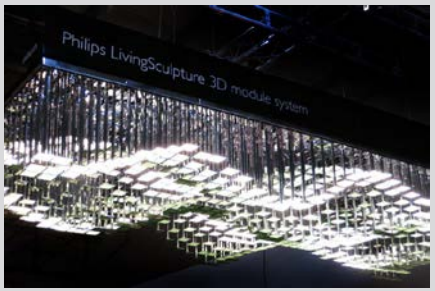

OLEDs

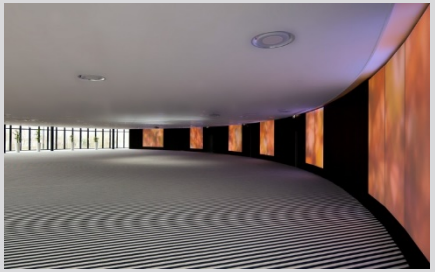


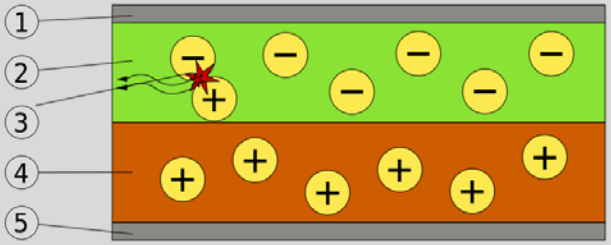
- Lightweight and flexible
- Improved brightness
- Better power efficiency and thickness
- Short Lifespan
- Poor color balance
- Easily damaged with water
- Poor readability outdoors
- High power consumption with white light











The Future of LEDs

Industry Drivers:

- Energy Codes
- Building Automation
- Energy Consumption Awareness
- How do I know when to use LEDs?
- Challenges and drawbacks
- What is in store for our future?

Inspired INGENUITY

Questions?

info@aedesign-inc.com

Thank you!