312a Fundamentals of Networked Lighting Controls

Presented by
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Senior Lighting Specialist
April 20, 2022

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Before we begin…

During the Class

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions every ~10 minutes
- Please participate in the online polls.

Following the Class

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

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Seattle City Light

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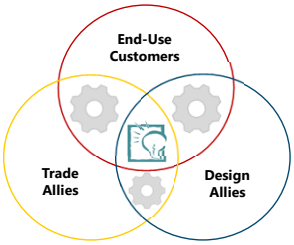
Who We Work With



It takes a village…

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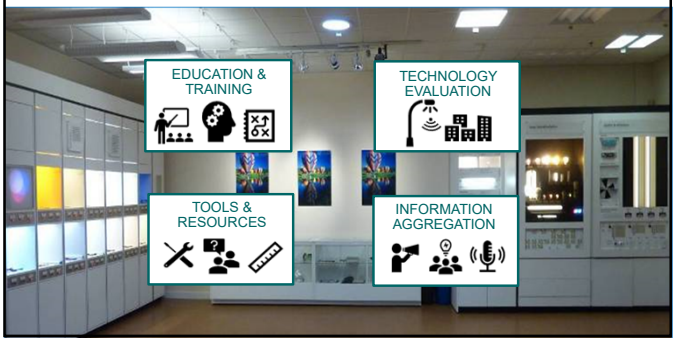
LDL's Four Core Service Areas



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Shaun.Darragh@seattle.gov

- More than 30 years in the lighting industry as an architectural lighting designer, instructor, daylighting and sustainability specialist, lighting control system consultant, and theatrical designer.
- Has taught and consulted on sustainability issues, lighting, and daylighting for the Lighting Design Lab and University of Washington Architecture Department

Selected Projects

- King Abdullah University of Science and Technology
- Masdar Headquarters
- Pearl River Tower
- Canyon Ranch Spa Club
- Amgen Helix Campus
- Reebok World Headquarters
- Reno Sparks Convention Center
- Pacific Place Retail Center
- Ala Moana Retail Center
- REI Denver Flagship Store
- Boeing Commercial Airplanes Offices
- Real Networks Headquarters
- Tommy Bahama Headquarters
- Microsoft B16/17
- San Francisco PUC Headquarters

Selected Awards

- Amgen Helix Campus
- Amgen Helix Pedestrian Bridge
- Canyon Ranch Spa Club
- Harvard University 60 Oxford
- King Street Station
- Lighting Design Lab
- Methodist Hospital Research Institute
- Microsoft B16/17
- One Cambridge Center
- Pacific Place Retail Center
- Reebok World Headquarters
- Reno Sparks Convention Center
- Real Networks Headquarters
- SFPUC Headquarters
- Tommy Bahama Headquarters

AIA COTE Top 10

- REI Flagship Store Denver
- King Abdullah University of Science and Technology
- San Francisco PUC Headquarters
- Manitoba Hydro Place

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Brief Survey

- Please tell me a little bit about yourselves….

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Learning Objectives

- Understand and be able to apply common control strategies
- Understand and be able to apply typical controls hardware
- Understand how networked control devices may be configured

- Understand the essentials of system startup for networked systems.
  - Pairing devices
  - Setting high trim
  - Setting timeouts
  - Setting daylight zones
  - Gaining comfort with hardware and software

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Why use advanced lighting controls?

- Flexibility
- Productivity
- User Satisfaction
- Aesthetics
- Maintenance
- LEED / WELL / LBC
- Energy Savings
- Energy Codes

Tommy Bahama Headquarters
SkB

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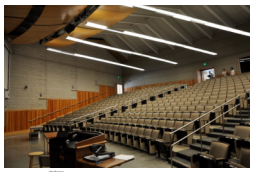
Flexibility

- Well designed controls can promote effective use of spaces for a variety of tasks.
- Poorly designed controls can preclude normal use of a space.



UC Davis Lecture Halls
Various Buildings

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Productivity

- Tuning light levels
- Balancing contrast / brightness
- Reducing glare

Microsoft One Cambridge Center
SMB

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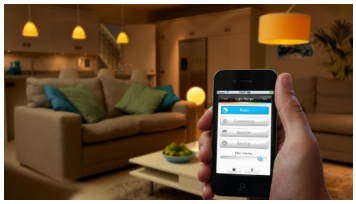
User Satisfaction

- Personal Control
- We all like to have control over our work environment.
- Frequently users will dim to a lower lighting level than current practice recommends when given the option.



Courtesy: Philips, Lutron, Eaton

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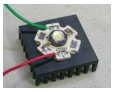
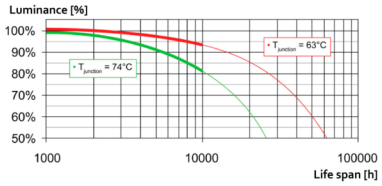
Maintenance

- LED Sources generate heat. The less heat, at the junction point of the LED, the longer it will function as intended.
- Under-driving LED lamps may result in increased system life
- System dashboards may offer data on light source burn time.
- Digital drivers offer talk back functionality raising warning flags.





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Sustainability Programs

- LEED
- Built Green
- Living Building Challenge
- WELL
- Others?

Courtesy: WELL Building Institute

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Energy Savings

- Most significant control strategies consist of dimming to a desired light level or turning lights off when un-needed.
- Dimming LED is reasonably close to a linear relationship between output and energy consumed.
- The potential savings ranges have been well verified over a large project base.

Courtesy: BPA

APPENDIX A: LIGHTING CONTROL SAVINGS VALUES:

Space Use Type	Control Types & Prescriptive Savings Values Applied					
	$0.15/kWh saved				$50 / controlled fixture	
	Daylight Control Multi-step or Continuous Dimming	Occupancy Sensor mounted anywhere	Occupancy Sensor w/ Daylight Control	Non-QPL Listed Advanced Lighting Controls	QPL Listed Advanced Lighting Controls Networked	QPL Listed Advanced Lighting Controls LLLC
Assembly	30%	25%	25%	25%	25%	25%
Break Room	30%	25%	40%	40%	40%	50%
Classroom	30%	25%	25%	25%	25%	25%
Computer Room	30%	25%	40%	40%	40%	50%
Conference	30%	25%	40%	40%	40%	50%
Dining	30%	15%	40%	40%	40%	50%
Gymnasium	30%	25%	40%	40%	40%	50%
Hallway	30%	50%		40%	40%	50%
Hospital Room	30%	25%	40%	40%	40%	50%
Industrial	30%	25%	40%	40%	40%	50%
Kitchen	30%	25%	40%	40%	40%	50%
Library	30%	25%	40%	40%	40%	50%
Lobby	30%	25%	40%	40%	40%	50%
Lodging (Guest Rooms)	30%	25%	40%	40%	40%	50%
Open Office	30%	15%	40%	40%	40%	50%
Parking Garage	30%	25%	40%	40%	40%	50%
Private Office	30%	15%	40%	40%	40%	50%
Process	30%	25%	40%	40%	40%	50%
Public Assembly	30%	25%	40%	40%	40%	50%
Restroom	30%	50%	50%	40%	40%	50%
Retail	30%	25%	40%	40%	40%	50%
Stairs	30%	25%	40%	40%	40%	50%
Storage	30%	50%	50%	40%	40%	50%
Technical Area	30%	25%	25%	25%	25%	25%
Warehouse	30%	60%	60%	40%	40%	50%
Other	30%	40%	40%	40%	40%	50%

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Energy Codes

- Meeting an energy code should be considered a fundamental baseline.
- Meeting an energy code does not necessarily result in a good lighting control system.
- We'll review more on codes later.

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Others?

Any other reasons we should be using advanced lighting controls?

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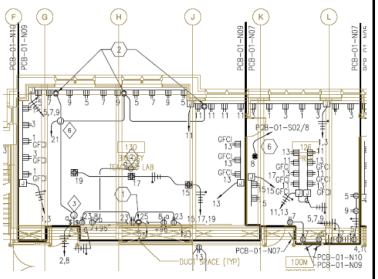
Power Circuit

- The power circuit delivers electricity to the luminaire.
- May be the same grouping as the control zone
- May be independent from the control zone
- If the circuit is the same as the control zone, make sure that only contiguous, like type, luminaires are fed by the same circuit



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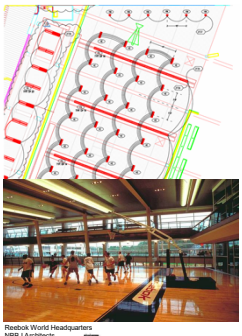
Control Zone / Channel

- A Control Zone is a logical grouping of luminaires that are controlled together.
- May be the same grouping as the power circuit
- May be independent from the power circuit
- Generally, the more control zones, the more flexible the system will be.
- Poor zoning is among the most common errors in controls.



Reebok World Headquarters
NBBJ Architects

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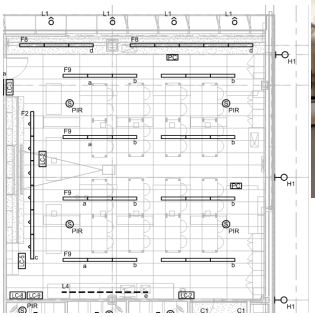
Control Zoning



North Seattle College Allied Health Building
Schacht Aslani Architects

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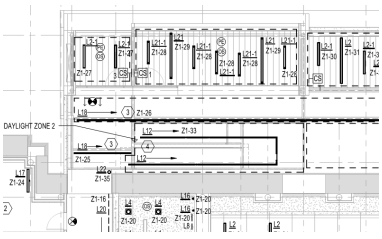
Control Zoning



WSU Troy Hall
Perkins + Will

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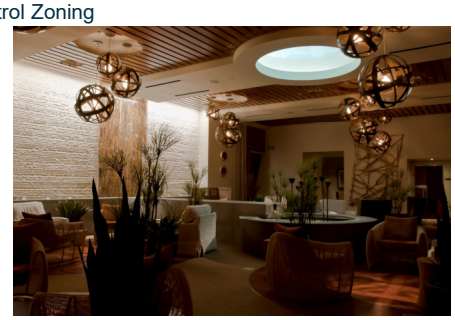
Control Zoning



Canyon Ranch Spa Club
RTKL | HKS

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Control Zoning

1111 Third Avenue
LMN

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Scene / Preset / Look

- A Scene is a programmed collection of zones set at predetermined light levels
- Repeatable
- May use Dimming or Switching
- May have adjustable Fade Rates

Courtesy: Lutron

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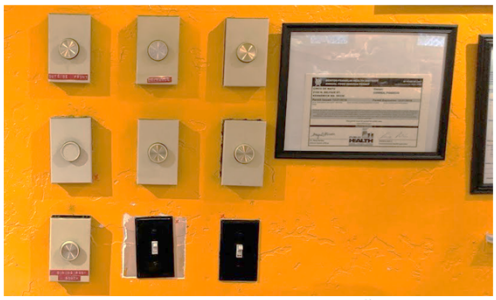
●25

Scene Control



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Scene / Preset / Look

Semiahmoo Resort
GGLO

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Pop Quiz

- What are some of the reasons we might want to use advanced lighting controls?

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Typical Control Strategies

- Manual Switching
- Manual Dimming
- Scene / Preset Control
- Occupancy Sensing
- Vacancy Sensing
- Daylight Harvesting
- Task Tuning
- Time Scheduling
- Astronomic Scheduling

San Francisco Public Utilities Commission Headquarters
KMD

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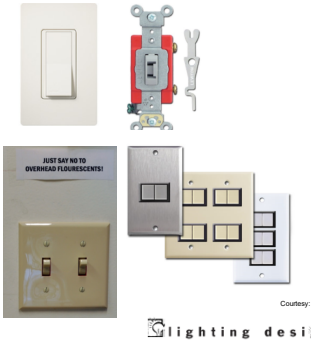
Manual Switching

- Line voltage
- Low voltage with relays
- Zones or groups
- Simple to design
- Easy to understand
- May not meet codes
  - Residential
  - Public Space
  - Mechanical/Electrical



Courtesy: GE, Leviton

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Manual Dimming

- Line voltage
- Low voltage remote dimming
- Networked System
- Zones or groups
- Simple to design
- Easy to understand
- Users like personal control
  - Residential
  - Commercial

Courtesy: Lutron, Leviton, Crestron

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Scene / Preset

- Grouping of zones at specific levels
- More complicated
- Simply Repeatable
- May be confusing
- Consider engraving

  - Residential
  - Commercial
  - Retail
  - Hospitality
  - Education
  - Conference

Courtesy: Lutron, Leviton, Pharos

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Switching…Dimming…..Scene Control

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Occupancy Sensing

- Automatically turn lights on or off depending on occupancy
- May have some residual angst over older systems
- Supplanted by vacancy sensors in many cases.

  - Public spaces
  - Corridors / Stairwells
  - Toilet rooms
  - Warehouses
  - Parking garages
  - Site lighting

Courtesy: Leviton

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Vacancy Sensing

- Automatically turn lights off when no occupants are present
- Requires manual touch to turn on.
- May have some residual angst over older systems.
- Users may require some training.
  - Almost all enclosed commercial spaces
  - Offices
  - Classrooms
  - Storage

Courtesy: Leviton

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Occupancy/Vacancy Sensors

Passive Infrared

- Passively scans the field of view for moving heat sources across sensor segments.
- Must have line of sight to function
- May be wireless or wired

Courtesy: Wattstopper, Echoflex, Leviton, Steinel

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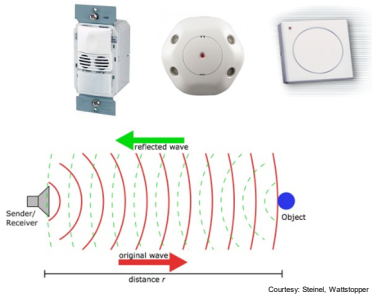
Occupancy/Vacancy Sensors

Ultrasonic

- Emits high frequency sound waves and measures return waves for doppler shift.
- Does not need line of sight to function
- Generally used in larger or obstructed areas
- Great for restrooms
- May have problems in areas with heavy airflow
- Requires wired installation



Courtesy: Steinel, Wattstopper

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●37

Occupancy/Vacancy Sensors

Dual Technology

- Uses both technologies to maximize sensing capabilities
- Usually requires wired installation



- Other options exist
  - Microphonics
  - Microwave
  - Radar

Courtesy: Wattstopper, Unenco

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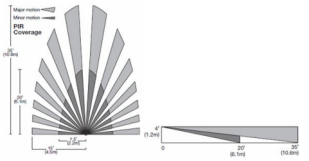
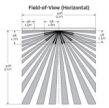
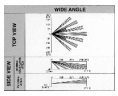
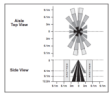
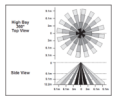
Occupancy/Vacancy Sensors

- Coverage area is specific and will be noted on cut sheets
- Confirm the coverage area
- Confirm the coverage area
- Confirm the coverage area
- Also – confirm the….



Courtesy: Wattstopper, Lutron

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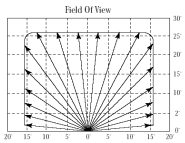
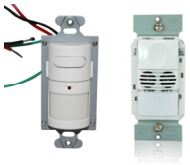
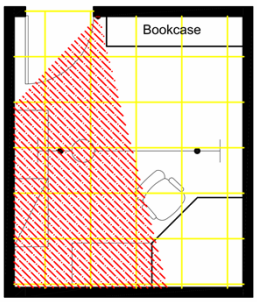
Line of Sight



Courtesy: Wattstopper

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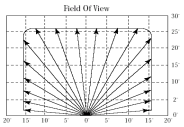
Occupancy/Vacancy Sensors

Wall Mounted

- Wall rather than ceiling when line of sight or access is better
- Frequently corner mounted
- Consult product spec sheets for effective coverage area and field of view
- Generally requires a remote relay pack or networked system
- Wired or wireless



Courtesy: Lutron, Wattstopper

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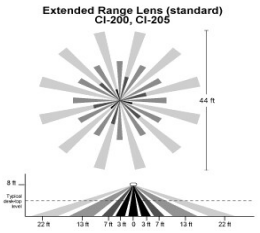
Occupancy/Vacancy Sensors

Ceiling Mounted

- Will require a remote relay pack or provide data to a networked system
- Larger coverage areas
- Wired or wireless



Courtesy: Wattstopper

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Daylight Harvesting

- Luminaires are governed by photo-sensors determining real time daylight availability
- Continuous range dimming is preferable to threshold based switching.
  - Offices
  - Education
  - Public Spaces
  - Circulation
  - Warehouse / Industrial

Chemeketa Community College Health Sciences Building
SRG

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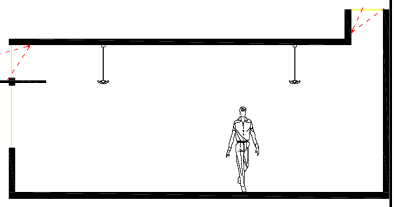
●43

Open Loop

- Open loop sensors look for available daylight only.
- Easier to commission
- Less precise
- Better performance with top light than side light



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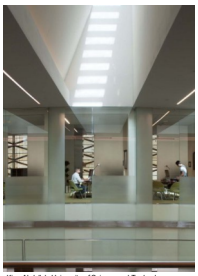
Open Loop

University of Montana Rec Center
DT Architects



King Abdullah University of Science and Technology
HOK

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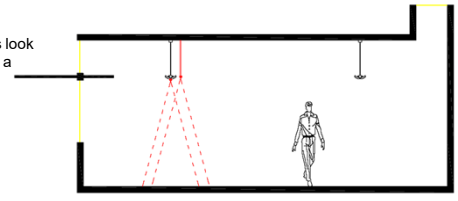
Closed Loop

- Closed loop sensors look for available light on a workplane.
- More difficult to commission
- More precise
- Finicky



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Task Tuning / High Trim

- Setting a high trim tuned to deliver the target illuminance level.
- Can reduce glare
- Can balance brightness
- Can save as much as 20-30% of the energy in a typical system.
  - Offices
  - Education
  - Public Spaces
  - Circulation
  - Warehouse / Industrial

Bullitt Center
PAE/Luma

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Task Tuning – Adaptive Compensation

- Counterintuitively, we may need less light at night.
- When our eyes are adapted to lower night time light levels, dimming the lighting may be appropriate.
  - Public Spaces
  - Circulation
  - Retail

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Time Scheduling

- Lighting is governed by time of day events rather than occupancy or vacancy sensing.
- Multiple calendars required for effective use.
  - Public Spaces
  - Circulation
  - Retail
  - Areas in which OS/VS would pose difficulty

Seattle Public Library
OMA | LMN

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Astronomic Scheduling

- Lighting is governed by time of day with respect to locally calculated sunrise / sunset.
- Requires longitude and latitude.
- For Seattle: 47.6°N 122.3°W
  - Site Lighting
  - Facades
  - Adaptive Compensation

Amgen Helix Bridge
Johnson Architecture

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Load Shed – Demand Response

- The ability to reduce lighting load by a set amount when signaled to do so by a utility.
- Wide area dimming makes load shed events less disruptive.
- Check out www.openadr.org

San Francisco Public Utilities Commission Headquarters
KMD

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Bi-Level Switching - Pointless when dimming is standard

- Configure luminaire with 2 or more switched circuits.
- Characteristics:
  - Simple
  - Easy to Understand
  - May be used with an Occupancy Sensor
- Considerations:
  - All lamps frequently left on
  - Installed cost may be equivalent to dimming
  - May change light distribution

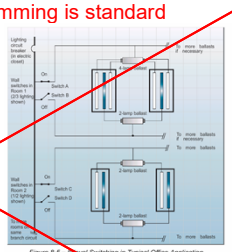
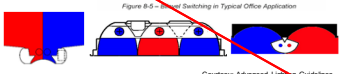


Figure 8-5 – Bi-level Switching in Typical Office Application



Courtesy: Advanced Lighting Guidelines

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Newer Controls Strategies

- Color selection
- Tunable White
- Circadian Lighting
- Dim to Warm
- Architainment

- Based on the properties of LED light sources

Children's Hospital
ZGF

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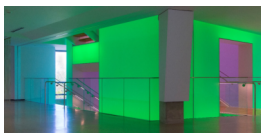
●53

Color Selection

LED inherent color, and color mixing, coupled with digital control allows for the widespread use of colored light in ways that were difficult or impossible previously.



Microsoft Building 17
Gensler

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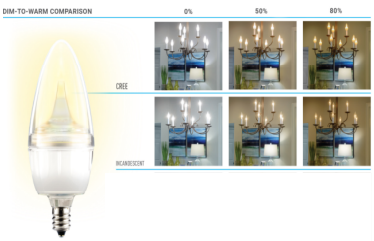
●54

Tunable White – Warm Dim

- Incandescent sources "warm" as they dim.
- Fluorescent and basic LED sources do not.
- Warm dim introduces a color curve to the dimmed LED to emulate incandescent red shift.

  - Hospitality
  - Residential
  - Boutique Retail



Courtesy: Cree

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●55

Tunable White

- Specific color tuning adjusting the correlated color temperature / SPD along the black body radiator curve.
- Meant to affect mood or alertness.
- Circadian lighting.
- Aesthetic reasons.

Courtesy: Fagerhult

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●56

Tunable White

Courtesy: Finelite

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●57

Color Tuning

Courtesy: Finelite

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●58

Circadian Controls

ENERGY
OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

Measuring Light Exposure and its Effects on Sleep and Behavior in Care Center Residents

ACC Care Center - Sacramento, CA

November 2019

ACC Care Center

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●59

Architainment

Ars Electronica Centre
TREUSCH Architecture

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●60

Hardware Evolution

- Line voltage switch
- Three way switch
- Contactor
- Low voltage hardwired relay
- Strap and wallbox dimmers
- Preset control dimming
- Luminaire addressable hardwired
- Zone control wireless
- Luminaire addressable wireless
- POE (Power Over Ethernet)
- IOT (Internet of Things)

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●61

Hardware Evolution

- Line voltage switch
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- Strap and wallbox dimmers
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- IOT (Internet of Things)

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●62

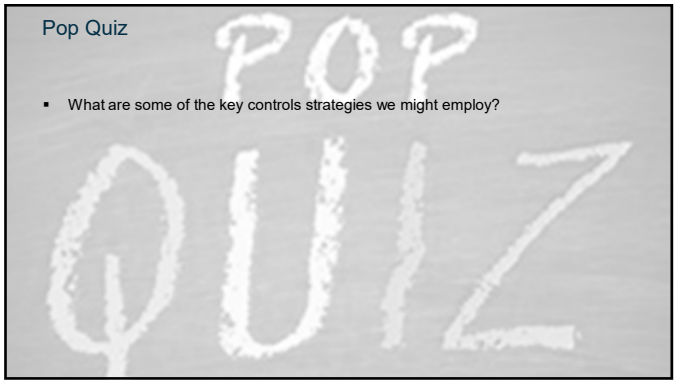
Typical Control Strategies Matrix

Typical Space Strategy Options											
Lighting Controls											
Space Type	Manual Switch	Manual Dimmer	Occupancy	Vacancy	Daylight	Task Tuning	Time Clock	Astro. Time Clock	Preset Scene	Tunable White	RGB
Café		■	■	■	■	■			■		
Big Box Retail			■		■	■		■			
Board Room				■	■	■			■	■	■
Boutique Retail		■		■	■				■	■	■
Cafeteria			■		■	■	■				
Circulation			■		■	■	■				
Classroom		■		■	■	■				■	
Conference				■	■	■			■	■	
Department Store					■	■	■	■			
Exam Room		■		■		■					
Fine Dining									■	■	■
Gymnasium			■	■	■	■					
Industrial			■	■	■	■	■				
Lab		■	■	■	■	■					

●63

Pop Quiz

- What are some of the key controls strategies we might employ?



●64

Dimming 101

- LED light sources are inherently dimmable when provided with dimming drivers.
- Almost all quality LED product is dimmable by at least a 0-10v control signal.
- OK – we're going to dim our light sources….what are some of the key ways we make that happen?

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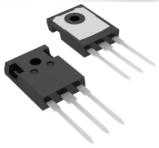
●65

Semiconductors…..

- Semiconductors revolutionized dimming….
- The first triac controlled wallbox dimmer – 1959
- IGBTs and FETs provided forward phase in the 1980s…
- Phase cut dimming



Courtesy Strand, Lutron, Dialux

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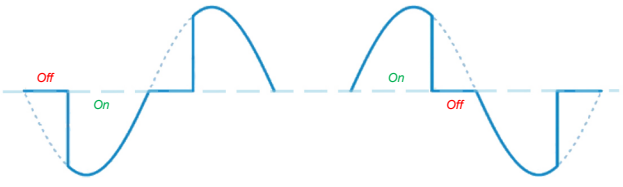
●66

Phase Cut Dimming



Forward Phase Cut

Reverse Phase Cut

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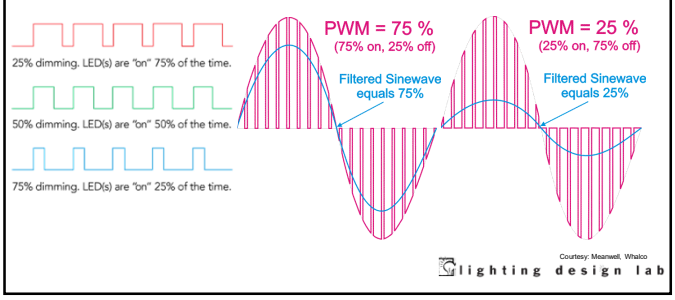
●67

Pulse Width Modulation



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●68

How about a demonstration?

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●69

Electric Lamps

Resistive
- Incandescent
- Halogen
- Low Voltage

Discharge
- Fluorescent
- Metal Halide
- High / Low Pressure Sodium
- Mercury Vapor

Solid State
- LED
- OLED
- Electroluminescent

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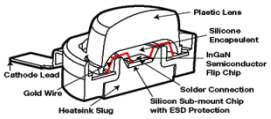
●70

LED – the defacto light source du jour….

- Solid state light source
- Extremely flexible
- Potentially long lamp life
- Dynamic color opportunities
- White light
- Poor to excellent color rendering



Courtesy: Philips

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●71

Architectural Impacts of LED

- Smaller fixtures
- Better efficacy
- Possibly better color
- More flexibility in control
- Longer lamp life
- Reduced maintenance
- Better optics
- Back to dimming
- Better integration
- Potential confusion

Plymouth Church LMN

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●72

LED Lamps

Consumer lamps tend to be cast into familiar shapes.

Courtesy: Philips Feit, Satco, GE, Sylvania

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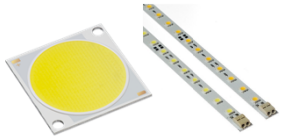
●73

LED Lamps

Native LED sources come in a staggering variety of shapes and configurations.



Courtesy: Xicato, Philips , Sylvania, Insight

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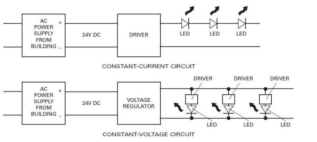
●74

LED Drivers

- Microprocessor switching power supply:
  - Voltage (typically 12-24)
  - Direct Current
  - Power Regulation
  - Power Conditioning
  - Similar to fluorescent ballasts
  - Constant Current
  - Constant Voltage



Courtesy: Meanwell, Eldoled, Lutron, James Benya

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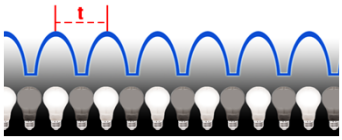
●75

Flicker

- All light sources can flicker under the right circumstances
- LED sources may be particularly susceptible with low quality drivers or in specific cases.
- This may be ok, mildly annoying, hugely annoying, or disastrous.
- In some cases (think LiFi) very high frequency flicker is desirable)



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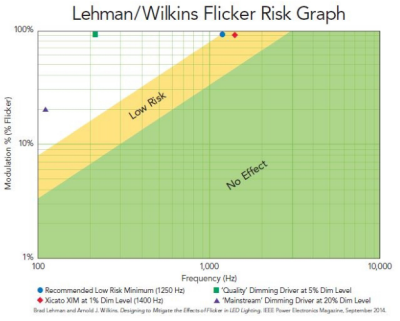
Flicker

- Is it flicker, flutter, shimmer, or other?
- % flicker = amplitude
- Amplitude and frequency both matter.
- Check at multiple dimmed light levels.

- Do the research upfront to ensure compatibility
- When in doubt ask for samples and test



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●77

Flicker

Please take out your flicker checkers…..

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●78

Pop Quiz!

- What is doing the actual dimming in most LED systems?

●79

Dimming Control Protocols

Control Protocols include a wide range of options

- Line Voltage
- 0-10v
- Dali
- DMX-512
- KNX
- Proprietary flavors

Jacques Brel

Courtesy: ACT

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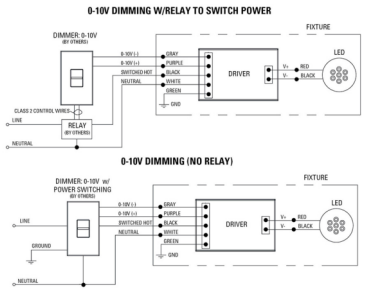
●80

0-10v

- Fluorescent
- LED
- Metal Halide

- Simple
- Widespread
- Defacto LED Standard

- Limited communication
- Imprecise



Courtesy: USAI

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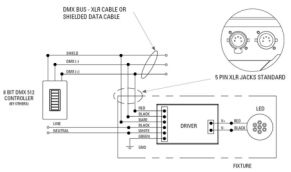
●81

DMX-512 – Digital Multiplex 512 Channels

- Color changing
- Color tuning

- Theatrical lighting standard
- Flexible / Complicated
- Reasonably precise 256 steps
- Bi-directional communication
- Distance limitations
- Each universe limited to 512 zones
- Various flavors



Courtesy: USAI, ETC

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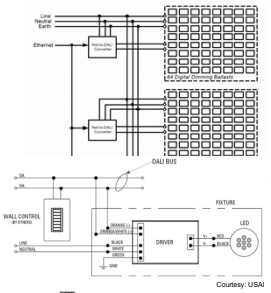
●82

DALI – Digitally Addressable Lighting Interface

- Fluorescent
- LED
- Incandescent
- Metal Halide

- Open Source Standard
- Each Ballast/Driver/Controller has a unique address
- 64 addresses per node
- Maximum Flexibility
- Maximum Commissioning



Courtesy: USAI

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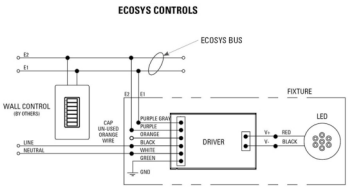
●83

Proprietary Protocols

- Many manufacturers have some flavor of proprietary digital communications.

- Usually a 2 wire data bus
- May have wiring limitations
- Cat 5/6
- POE



Courtesy: USAI

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●84

Wireless Communications

- Zigbee
- Bluetooth
- BLE
- Enocean
- Zwave
- WiFi
- IEEE 802 Networks
- Proprietary
- Others

Courtesy: Leviton

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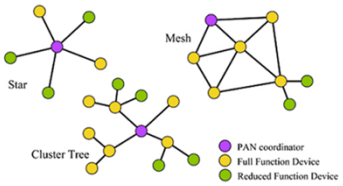
●85

Wireless Communications

- Variety of communication protocols.
- Multipoint – Hub / Spoke
- Point to Point Peer
- Mesh Network



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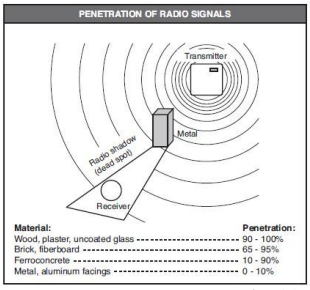
●86

Wireless Communications Considerations

Wireless communications is robust, but there are some considerations:

- Physical obstacles and mass
- Distance between devices
- Number of devices per node or hub
- Other systems on similar frequencies
- E-mag interference
- IOT



Courtesy: Leviton

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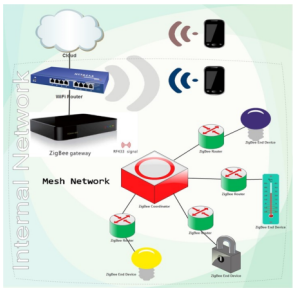
●87

Wireless Communications Considerations

Cybersecurity:

- In an increasingly connected digital realm, lighting may be a gateway to attack just like other building systems.
- Expect this to become a greater issue over time.
- Lighting controls and building automation may be precluded from corporate networks.



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●88

Lighting Control Systems

- May be power handling
- May use relay packs
- May be networked
- May be automatic
- May be manual

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●89

Low Voltage Relay Systems

Characteristics:

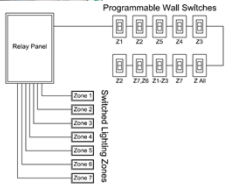
- On/off switching control only
- May be hardwired analog or digital
- Generally includes scheduling capability
- Will accept input from occupancy sensors, photo-controllers, and other systems

Considerations:

- May require considerable commissioning
- Older method of whole building control
- Home run circuiting required for each zone
- Digital control is simpler than hard wired

- Still relevant?

Courtesy: GE



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●90

Preset Architectural Dimming Systems

Characteristics:

- Dimmers located in remote cabinets
- Advanced programming and playback
- Will include scheduling capability
- Will accept input from occupancy sensors, photo-controllers, and other systems

Considerations:

- Dimming modules may be load type specific
- May require coordination with AV systems
- Likely to require digital protocols like DMX-512
- Still relevant?

Courtesy: ETC

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●91

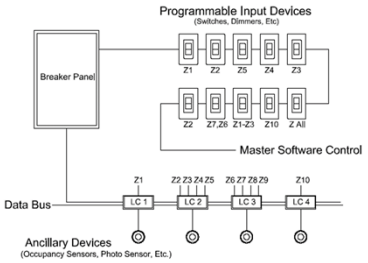
Distributed Systems

Characteristics:

- May be stand alone or integrated.
- Will be a scalable digital system.
- May incorporate scheduling capability
- Will accept input from devices including occupancy sensors and photo-controllers
- Inherently Flexible

Considerations:

- Coordinate digital protocol - LON, BacNet, etc



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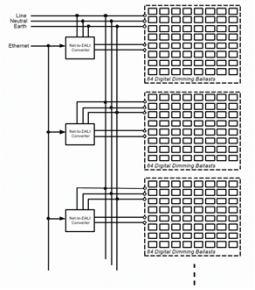
●92

DALI – Digitally Addressable Lighting Interface

- Open Source Standard
- Each device has a unique address
- Maximum flexibility
- Maximum commissioning
- All controls strategies possible

- Energy management software
- Lumen Maintenance
- Scheduling
- Data Logging



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●93

Luminaire Level Lighting Controls

- Wrap all of the sensors and most of the logic into the luminaire itself
- Simple to specify and install
- Will require commissioning to function most effectively.
- May be capable of all control strategies
- May be capable of only OS/VS and Daylight harvesting
- Smarter systems will be more capable

Courtesy: Acuity, Cree

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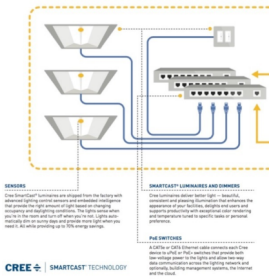
●94

POE – Power over Ethernet

- Open Source Standard?
- Each device has a unique address
- Maximum flexibility
- Maximum commissioning
- All controls strategies possible

- Energy management software
- Lumen Maintenance
- Scheduling
- Data Logging



Courtesy: Cree

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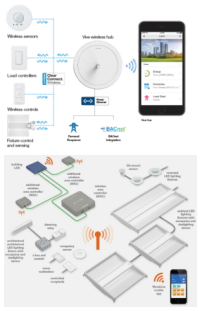
●95

Networked Lighting Controls Today

- Distributed
- Wireless
- More Capable
- More Complex
- Less Complicated
- Less Costly
- Easier to Install / Commission
- Compatible
- Integrated
- Better!



Courtesy: Lutron, Eaton

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●96

Pop Quiz!

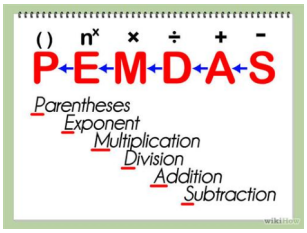
- What is the most common dimming control protocol in use today?

●97

Sequence of Operations

Ok….so now we have all of this great hardware….now what?

- Who is going to tell us what it's really supposed to do?
  - Lighting Designer?
  - Electrical Engineer?
  - Architect?
  - Owner?
  - Factory Tech?
  - Contractor?



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●98

Sequence of Operations

Ok….so now we have all of this great hardware….now what?

- Who is going to tell us what it's really supposed to do?
  - Lighting Designer? May not be contracted to design controls…
  - Electrical Engineer?
  - Architect?
  - Owner?
  - Factory Tech?
  - Contractor?

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●99

Sequence of Operations

Ok….so now we have all of this great hardware….now what?

- Who is going to tell us what it's really supposed to do?
  - Lighting Designer? May not be contracted to design controls…
  - Electrical Engineer? May not really know what the plan was…
  - Architect?
  - Owner?
  - Factory Tech?
  - Contractor?

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●100

Sequence of Operations

Whoever winds up doing it….a sequence of operations is required to tell the contractor, startup technician, and commissioning agent how the system is supposed to function.

- What are the time and astronomic schedules
- Which sensors are vacancy and which are occupancy?
- What is the vacancy timeout?
- What are the target light levels for task tuning?
- What switches or dimmers are tied to which zones?
- What zones are included in each preset and at what levels?
- What are the daylight zone dimming thresholds?
- Are there any specialty programming tasks like partition controls?

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●101

Sequence of Operations

There are lots of ways that SOO information may be conveyed.

- Basic Matrix
- Narrative
- Detailed Matrix
- Panel Schedule
- Dimming Schedule
- Most manufacturers have their own system

Microsoft Building 87
JPC

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●102

Sequence of Operations

J. Typical private office

1. All general lighting will be programmed to automatically turn "ON" as the user enters the room through the Occupancy Sensor initial light level will be 50% of light output,
2. Four button switch with off and raise/lower function override switch located at door will override current light setting as long as the override light level isn't above the set point for the daylight sensor during daytime hours.
   a. Pressing Button 1 will turn all fixtures to 50% light output.
   b. Pressing Button 2 will turn all fixtures to 70% light output.
   c. Pressing Button 3 will turn all fixtures to 90% light output.
   d. Pressing Button 4 will turn all fixtures to 100% light output.
   e. Pressing Button 5 will turn all lighting fixtures "OFF".
3. Photo sensor will continuously dim the light fixture up/down depending on the amount of daylight present. Daylight sensor to be calibrated to provide an average of (+/-) 50 footcandles measured at work surface (30" above finished floor).
4. When the user leaves the room, the lights will automatically turn "OFF" after a 15 minute delay (from unoccupied signal).

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Sequence of Operations

Project X Sequence of Operations Matrix

Room Number	Control Zone	Space Type / Use	Lighting Type	Target Light Level	LCS	Manual Switch	Dimmer Switch	Preset Station	Time Clock	Astronomic Time Clock	Occupancy Sensor	Vacancy Sensor	Occupancy/Vacancy Time Out	Daylight Dimming	Daylight Threshold	Task Tuning	Site Occupancy Sensor	Site Photo Control	Specialty See Note	Typical Sequence of Operations
1	a	Conference Room	Linear Indirect / Direct	30	1			1					30						1	1
	b		North Wall Wash	NA																
	c		South Wall Wash	NA																
2	a	Janitor	Industrial	20									10							
3	z1	Private Office	Recessed Troffer	30			1						15		200%					2
	z2		Art Accent	NA			2													
4	z2-12	Open Office	Indirect Direct - Daylight	30									15		200%					3
	z2-13		Indirect - Direct Inboard	30				1							200%					
	z2-14		Circulation	10											150%					

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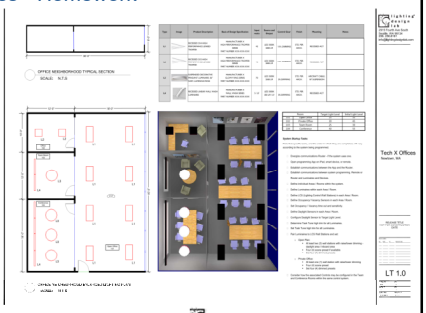
●104

Project – Tech X Offices - Homework

Let's look at part of a typical Tech Office TI

- Plan
- Section
- Renderings
- Luminaire Schedule
- Initial Light Levels



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●105

Project – Tech X Offices

Rendered Side Views

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●106

Project – Tech X Offices

- Initial Light Levels
- Luminaire Schedule

Room		Target Light Level	Initial Light Level
101	Open Office	25	35
102	Private Office	30	45
103	Team Room	25	30
104	Conference	40	55

Type	Image	Product Description	Basis of Design Specifcation	Input watts	Source and Output	Control Gear	Finish	Mounting	Notes
L1		RECESSED 2X4 HIGH PERFORMANCE LENSED TROFFER	MANUFACTURER X HIGH PERFORMANCE TROFFER SERIES PART NUMBER XXX-XXX-XXX	42	LED 3500K 5000 LM	10% DIMMING	STD. PER ARCH.	RECESSED ACT	
L2		RECESSED 2X2 HIGH PERFORMANCE LENSED TROFFER	MANUFACTURER X HIGH PERFORMANCE TROFFER SERIES PART NUMBER XXX-XXX-XXX	42	LED 3500K 5000 LM	10% DIMMING	STD. PER ARCH.	RECESSED ACT	
L3		SUSPENDED DECORATIVE PENDANT LUMINAIRE, 36" NOM. LUMINOUS RING	MANUFACTURER X GLOWY RING SERIES PART NUMBER XXX-XXX-XXX	70	LED 3500K 5500 LM	5% DIMMING	STD. PER ARCH.	AIRCRAFT CABLE; 18" SUSPENSION	
L4		RECESSED LINEAR WALL WASH LUMINAIRE	MANUFACTURER X WALL WASH SERIES PART NUMBER XXX-XXX-XXX	5 / LF	LED 3500K 350 LM / LF	5% DIMMING	STD. PER ARCH.	RECESSED ACT	

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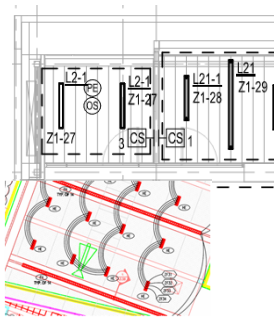
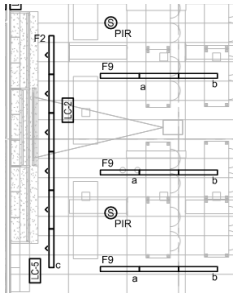
Nomenclature





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Sequence of Operations

Project X Sequence of Operations Matrix - Homework

Room Number	Control Zone	Space Type \ Use	Lighting Type	Target Light Level	LCS	Manual Switch	Dimmer Switch	Preset Button	Time Clock	Astronomic Time Clock	Occupancy Sensor	Vacancy Sensor	OS \ VS Time Out	Daylight Dimming	Daylight Minimum	Task Tuning	Site Occupancy Sensor	Site Photo Control	Specialty Note	Typical Note

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And now – a few words from LDL

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Upcoming LDL Online Events

LDL Course	Delivery Date	Time
NLC Fundamentals Day 2	April 28	10:00 - Noon
Energy & Alterations: Meeting the Alterations Requirements Of the Energy Code	May 5	10:00 - Noon
NLC for Healthcare	May 12	10:00 - Noon

Today's slide deck and previous online courses can be found on our website

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Todays slide deck will be posted here!

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