
# Commissioning Lighting Control Systems: 3 sides of the coin

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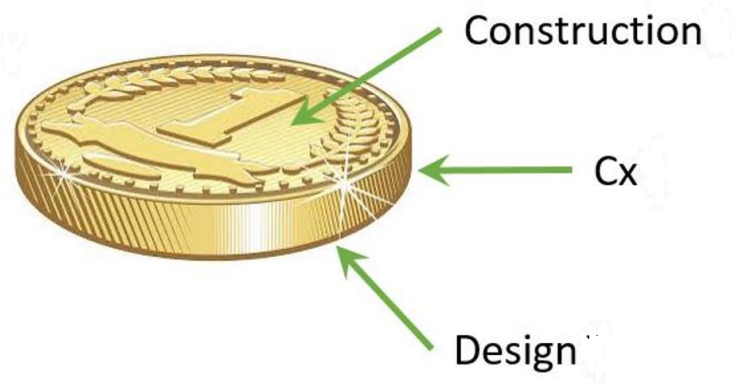
Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

# Learning Objectives

- At the end of this session you will be able to:
  1. Make intelligent comments in the design review that would improve the energy efficiency and the quality of bids
  2. Review a lighting controls sequence of operation with confidence
  3. Recognize when lighting control sequences require manufacturer-specific sequences instead of generic sequences that can be used across many projects and know where to go to find that information in manufacturer literature
  4. Identify maintainability issues for lighting controls in design review, just like mechanical equipment

# What We'll Cover

- Perspective
- Lighting Control Basics
  - Components
  - Systems
- Design
  - Reviews
  - Sequences of operation
  - Productive comments
- Maintainability
- Constructability challenges
- Trends



# Perspective: How we got here

- On/Off to DDC Time Warp
  - HVAC - 40 years
  - Lighting – 5 years

- Hot Potato
  - Lighting designers
  - Electrical engineers
  - Contractor
  - CxP

| | HVAC | LIGHTING/ ELECTRICAL |
|---|---|---|
| **Consultants** | One: HVAC & Controls | Two: Lighting Circuiting |
| **Deliverable** | SOO | No standard |
| **Design driver** | Client's ability to maintain | Consultant's standard/ opinion |
| **Implementation** | HVAC Controls Sub-contractor | Electrical Sub |

# Perspective: IRL

## HOT POTATOES….

- Or just pass it onto the Cx why don't we…

3.5 ACCEPTANCE TESTING SUPPORT SERVICES

A. On all California projects, a certified lighting controls acceptance test technician (CLCATT) must verify the installation of the lighting control system. Manufacturer should include an extra day of factory technician's time to assist the CLCATT review the functionality and settings of the lighting control hardware per the requirements in the California State forms. It will be the CLCATT's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the CLCATT with this task.

END OF SECTION

# Perspective: IRL

## HOT POTATOES….

- What are the problems with this Sequence of Operation?

**Sequence**: Dimmed lights are controlled in this space as (5) scenes.

**ON:** The normal power lights turn via switch station.

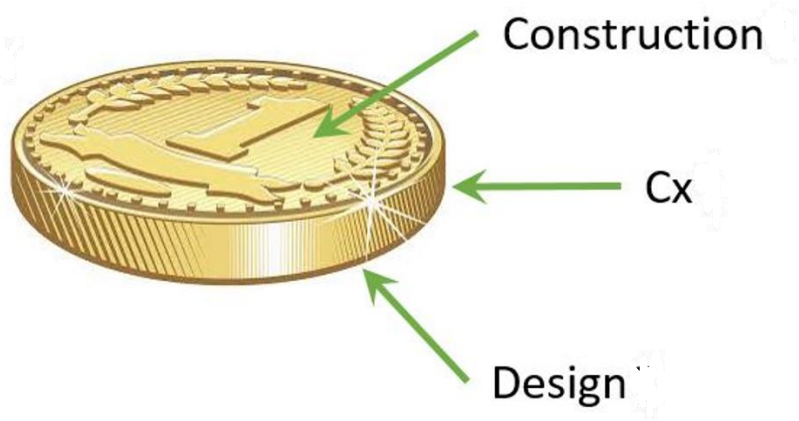
**ADJUST:** The scenes are adjusted using raise/lower control and lights are adjusted by selecting a scene button. The lights will continuously adjust to maintain a preset footcandle level based on the scene at +30" based on the available daylight within the space. The preset control module is located in the AV room for programming. An override switch with shade control shall be located at the door. Local over-ride switches shall provide 120 minutes of additional illumination.

**OFF:** After the space has been vacant for 15 minutes, the lights will automatically turn off.

**ADDITIONAL CONTROL:** Coordinate shade control with scene presets.

# Perspective: The CxP's role

- Cx brings them all together
- Guide (aka "Cat Herder")
    - Your input is critical
    - Understand big picture
- You must know:
    - Where we came from
    - What you're talking about



# The Designer(s)

## What is their thought process?

- Lighting Consultant:
  - Often Partial scope (Front of House/Public spaces only)
  - Design Services to 100%DD or 50%CD level
  - Not fully engaged for Construction/Bid Set
- Architect:
  - Creates base plans
  - Often selects decorative lights/scones (if not included in lighting designer's package)
  - Makes changes
- Electrical Engineer:
  - Often responsible for BoH areas
  - Has to pull together the latest base plans/designs from the Architect/Lighting Consultant
  - Responsible for Circuiting
  - Documents the controls in the Permit/Bid Set

# The Designer(s)

## What's Missing???

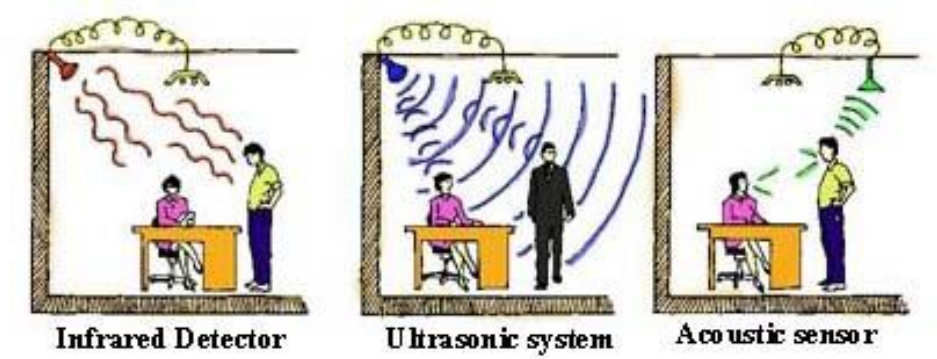
- Lighting Consultant:
  - Not responsible for complete system
  - Not involved during construction when design is refined
  - Not responsible for circuiting (thus controls/details)
- Architect:
  - Makes changes to base plans (forgets to share with team)
  - Doesn't address control intent
  - *Did I mention? ...*Makes changes
- Electrical Engineer:
  - Is often not involved in the OAC meetings where users discuss operational needs.
  - Often defaults to the Manufacturer's recommendations
  - Often defaults to the code requirements (code minimum)
  - Struggles with documentation with multiple named specs

# Basic Components

- Occupancy sensors
- Daylighting
- Timeclocks, Janitor Overrides, Scene Controllers

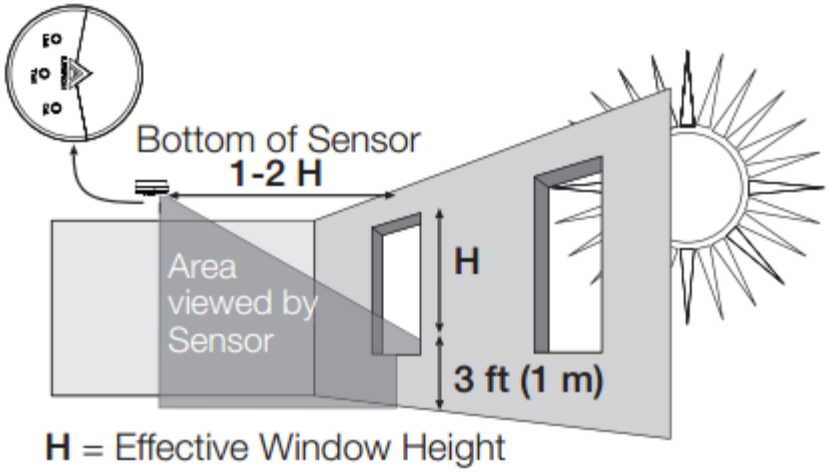
# Occupancy Sensors

- Types:
  - PIR (Passive InfraRed)
  - Ultrasonic
  - Microphonic
  - Dual Technology
- Trigger/Retrigger Occupancy/Vacancy
- Delay to Off (Dwell)
- Coverage range
- Location




Occupancy Sensor Technologies

# Photocells/Daylight Sensors




- Types
  - Open loop
  - Closed loop
  - Combo
  - skylight
- Technology
  - Affects placement

Coverage range

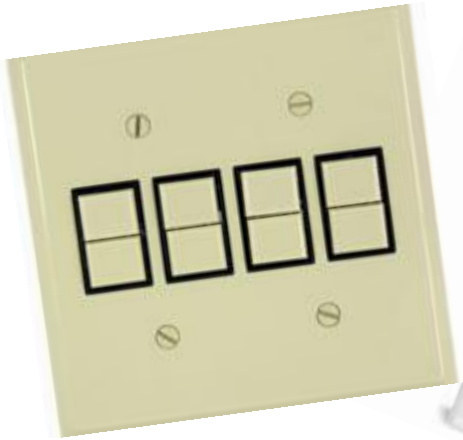
- Closed vs open loop

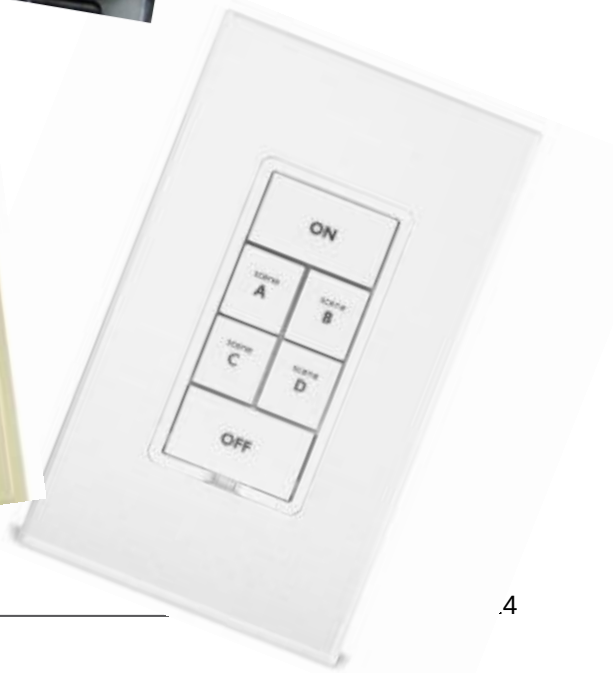
Mounting location

- Not too high
- Not obstructed
- No hot spots

# Timeclocks, Janitor Overrides, Scene Control

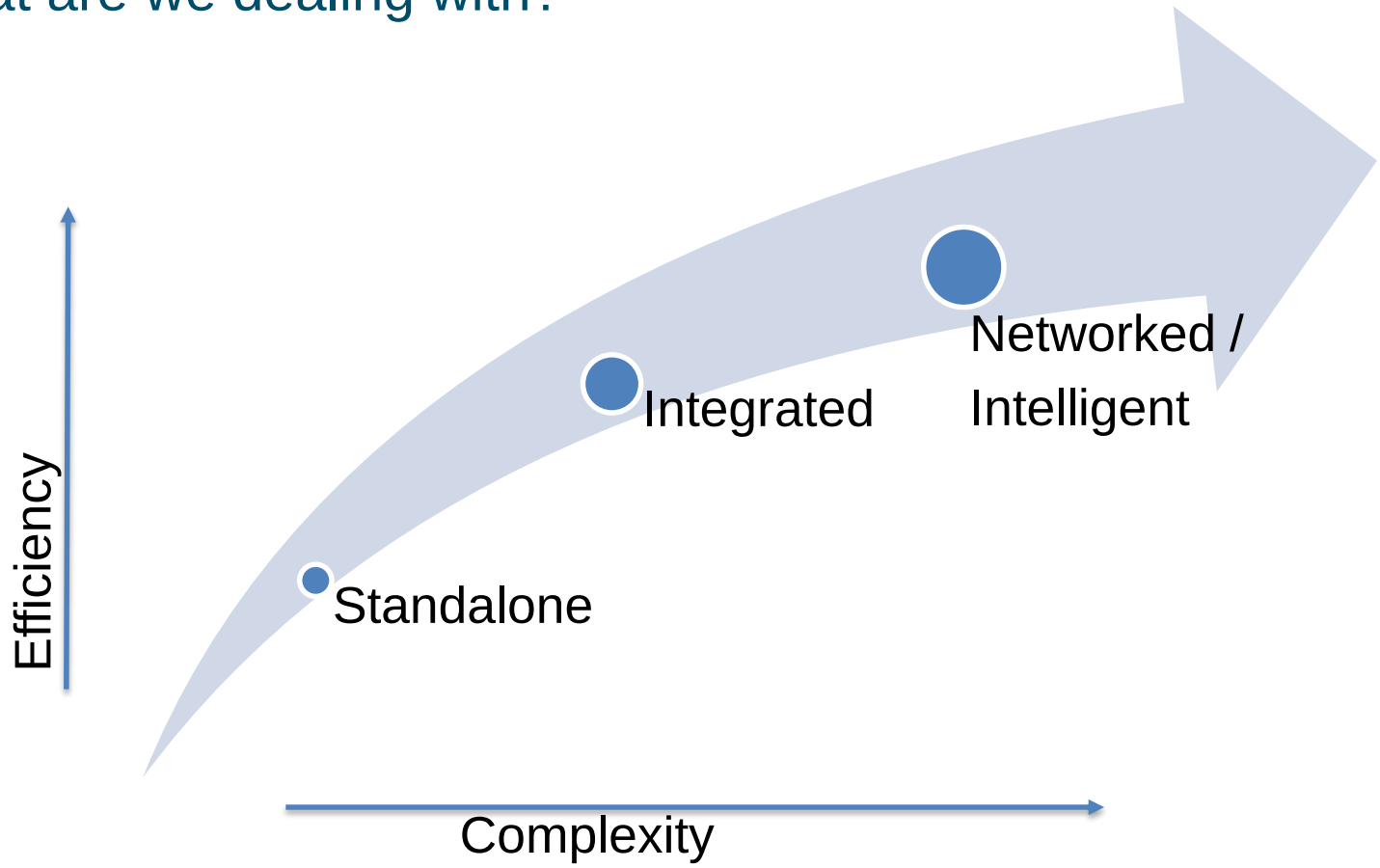
- Shown on drawings?
- Timeclock
  - Hours of operation
  - Sweeps
  - Zones
- Janitor Override
  - Dwell
  - Retrigger?
- Scene Control
  - Labels
  - Zones
  - Sequence





# Lighting Control Systems

## What are we dealing with?



# Lighting Control Systems

## What are we dealing with?

- **Standalone**
  - Doesn't talk to anyone but itself
  - Usually single function
  - Local programming

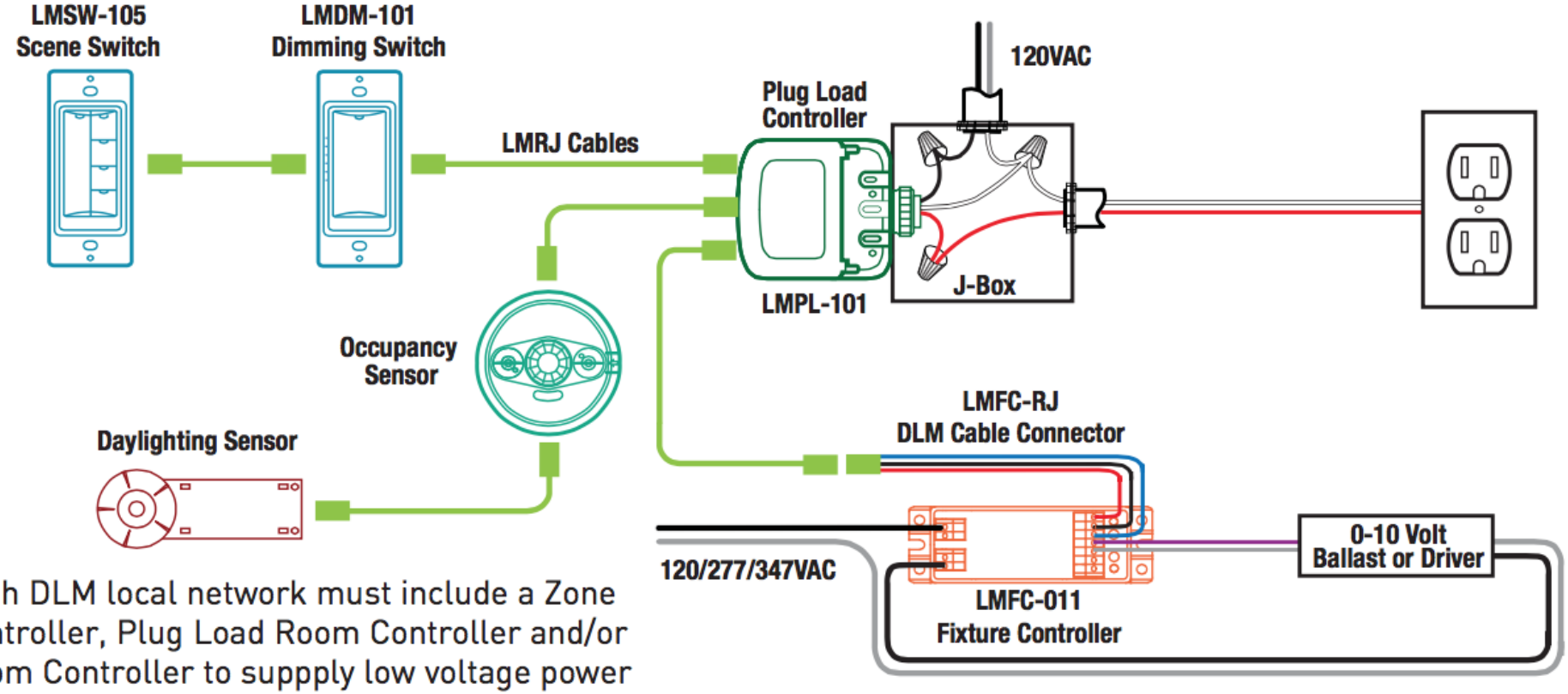
- **Local Integration**
  - Multiple devices / inputs
  - Local programming
  - Local control
  - Additional inputs

- **Networked / Intelligent**
  - Wired or Wireless
  - Addressable
  - Intelligent Fixtures

# Lighting Control Systems

## Standalone

### Sample Connection Diagram with Dimming Switches and Plug Load Control




Each DLM local network must include a Zone Controller, Plug Load Room Controller and/or Room Controller to suppply low voltage power

# Lighting Control Systems

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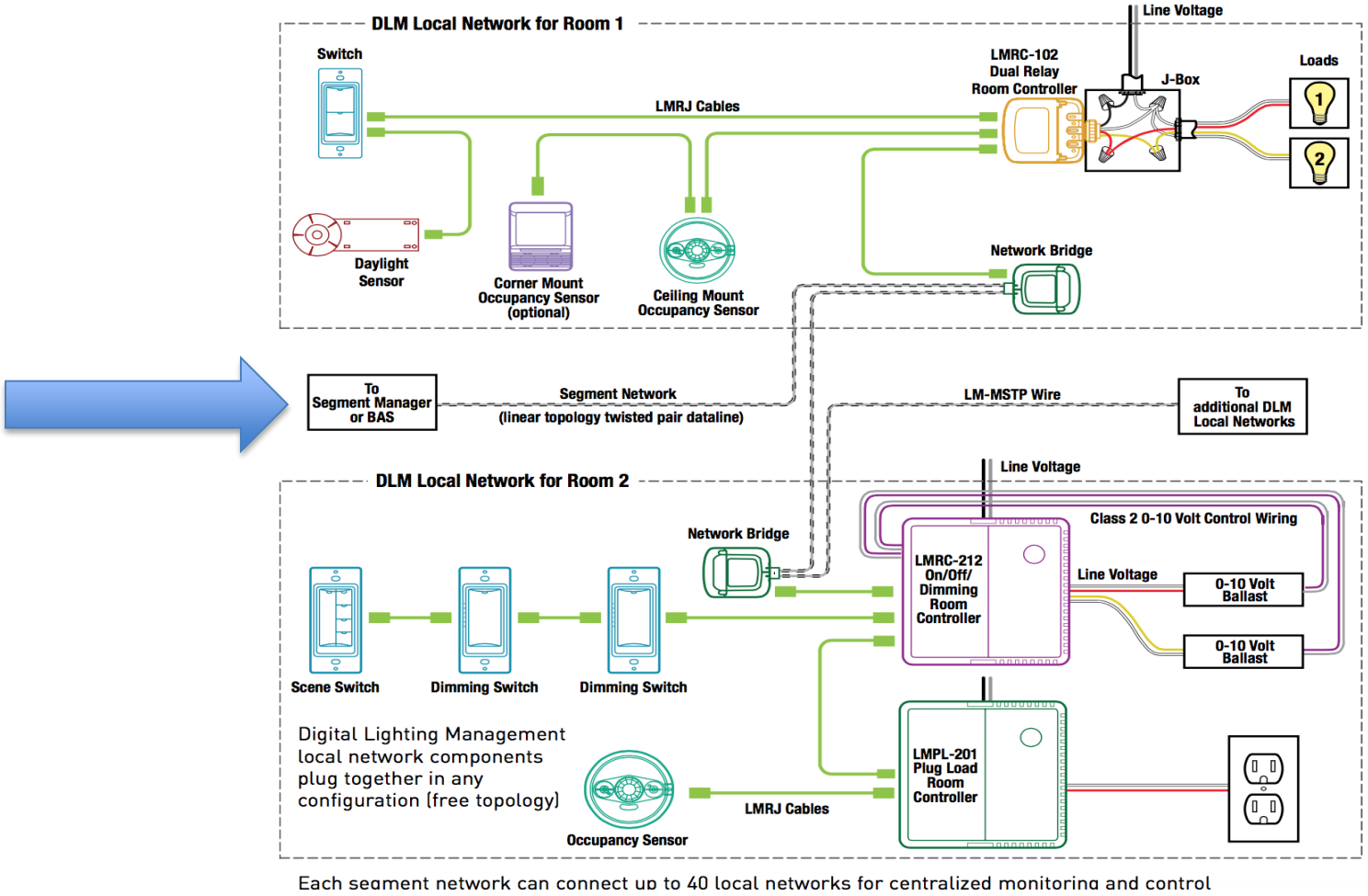
# Lighting Control Systems

## Local Integration




Each segment network can connect up to 40 local networks for centralized monitoring and control

# Lighting Control Systems

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# Networked Lighting Control Systems

## Capabilities

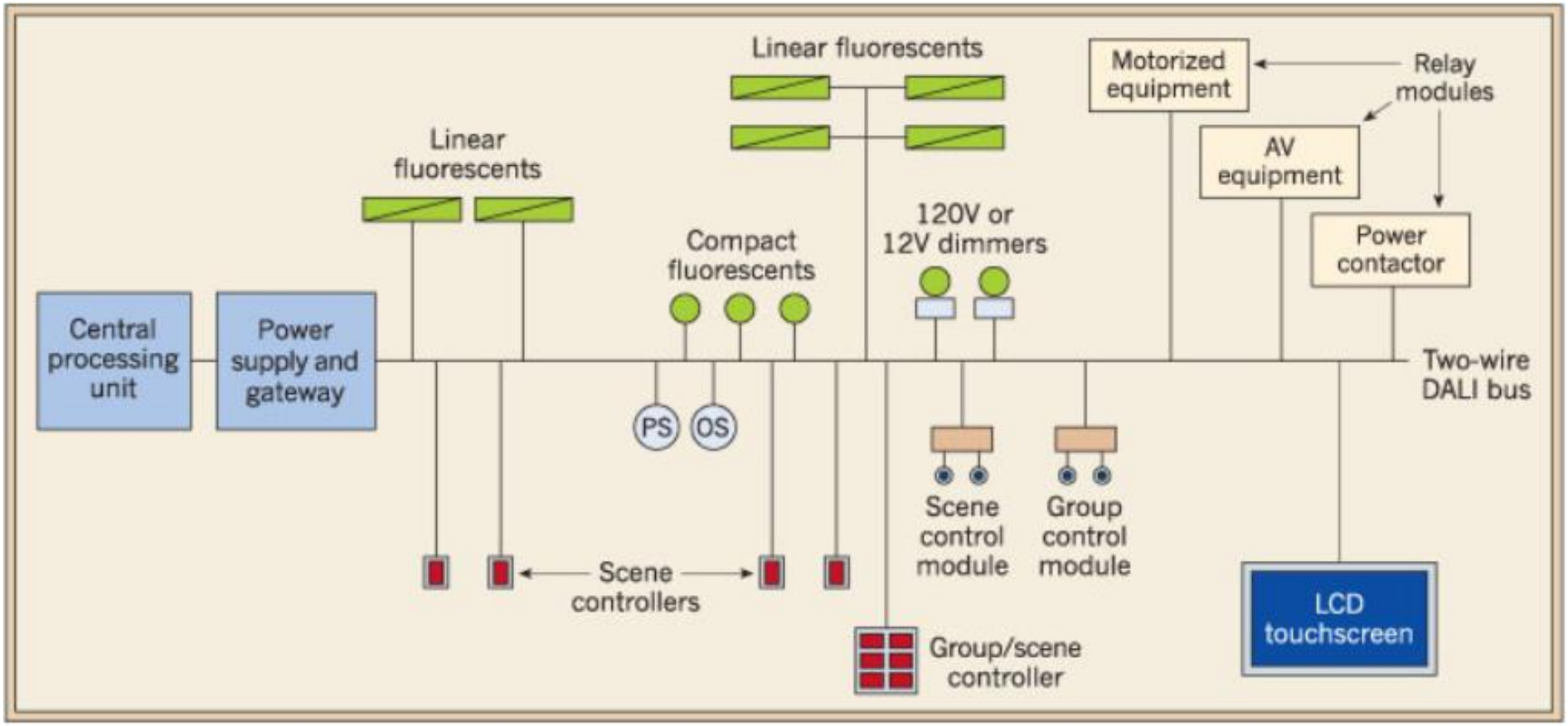
- Layer multiple control strategies
- Customize / reconfigure
- Integrate with HVAC, security, etc.
- Monitoring
  - Performance
  - Energy use

## Fully Networked

- Remote programming
- I/O
  - Local controls
  - Remote inputs/controls
  - To/From Multiple devices
- Wired
  - Network
- Wireless
  - Network bridge

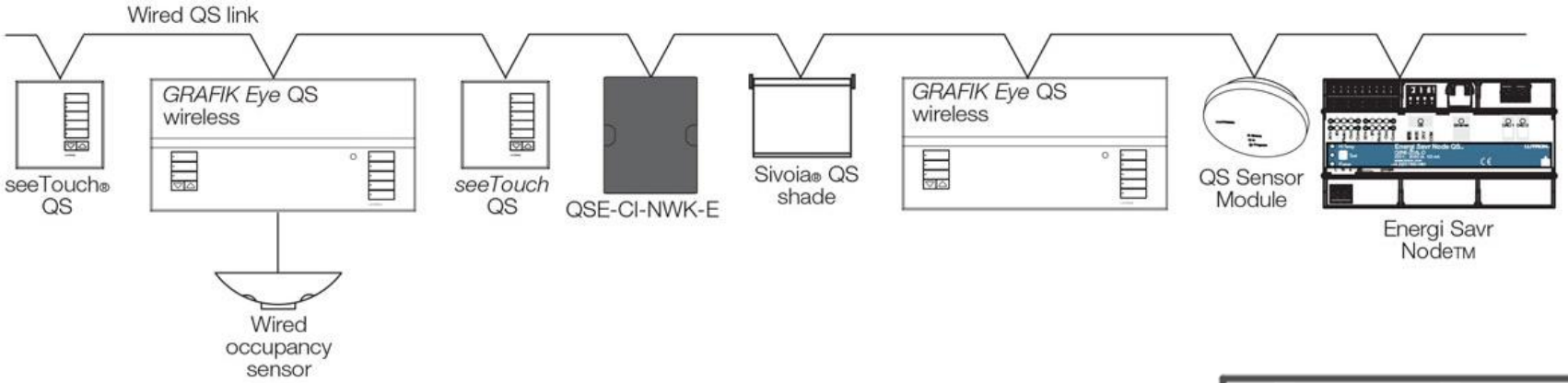
# Networked / Intelligent Lighting Control Diagram

## Addressable

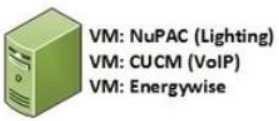


# Networked / Intelligent Lighting Control Diagram

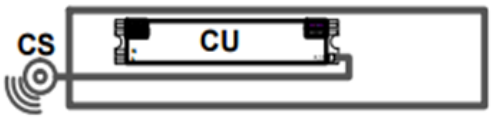
## Wired -OR- Wireless












ROOM CONTROL

# Beyond the Perspective and Basics

## Implementation

# Owner's Project Requirements (OPR)

- Owner and User Requirements
  - Energy savings goals
  - Material quality
  - Future expansion
- IEQ
  - Occupancy schedules
  - Target footcandles and temperatures
  - Occupancy sensor type and time to off
  - Switching: Checkerboarding vs dimming
- Level of automation
- O&M
  - Maintenance expectations
  - Preferred manufacturer

- Target energy savings – up to 70%
  - Occupancy control 35-40%
  - Daylighting 10-30%
  - Manual Dimming 10%
  - Direct/indirect fixtures 10-40%
  - Demand Response 10% overall, 20%+ during event

# Basis of Design (BOD)

- Design assumptions
- Basic control strategies
  - Timeclocks, janitor overrides
  - Occupancy control
    - Integrate with HVAC?
  - Daylighting
  - Demand response
  - Outdoor lighting
  - Manual dimming
    - Which spaces?
  - Task tuning
- Manufacturer
- Standalone or Networked?

# Design Review

- Encourage sole-source
  - Parallels with HVAC Controls
- Encourage SOOs
  - Lay it out for them
    - Invest in a go-to explanation
  - Can the product do what the SOO asks?
    - Examples
      - daylighting control + continuous dimming and non-dimming ballasts
      - ADR with standalone system
      - Bathrooms set on vacancy mode

# Reviewing the Lighting Controls

## Don’t Be Caught in a Dark Bathroom with Your Pants Down

- Lighting controls legend
  - Symbols should differ for model type
  - Hallway occ sensor vs office occ sensor
- Occ Sensor application
  - Ultrasonic or Dual Technology Sensors in spaces with barriers
  - Coverage pattern matches application & area
- Fixture schedule
  - Lamp type
  - Ballast/driver type
- Specs
  - Sensors
  - Control system
  - Standalone or Networked?

# More Simple Design Checks

- Daylighting
  - Fixtures can do dimming
  - Number of photocells match control type
- Demand Response
  - Disaggregated zones
  - Dimming
- Timeclock
  - Hours of operation
  - Zones controlled
- Overrides
  - Locations
  - Zones
  - Time delay

# Creating and Reviewing Sequences of Operation (SoO)

**DO YOU WANT TO BUILD A …**

**…A SYSTEM?**

**…A PLATFORM?**

# General Process

| Inputs | General Design Intent or Strategy during normal Operation | Modifications: 1 | Modifications: 2 | Modifications: 3 |
|---|---|---|---|---|
| Photo-sensor / Daylighting | | | | |
| Occupancy Sensing | | | | |
| Tuning | | | | |
| Personal Controls | | | | |

# General Process

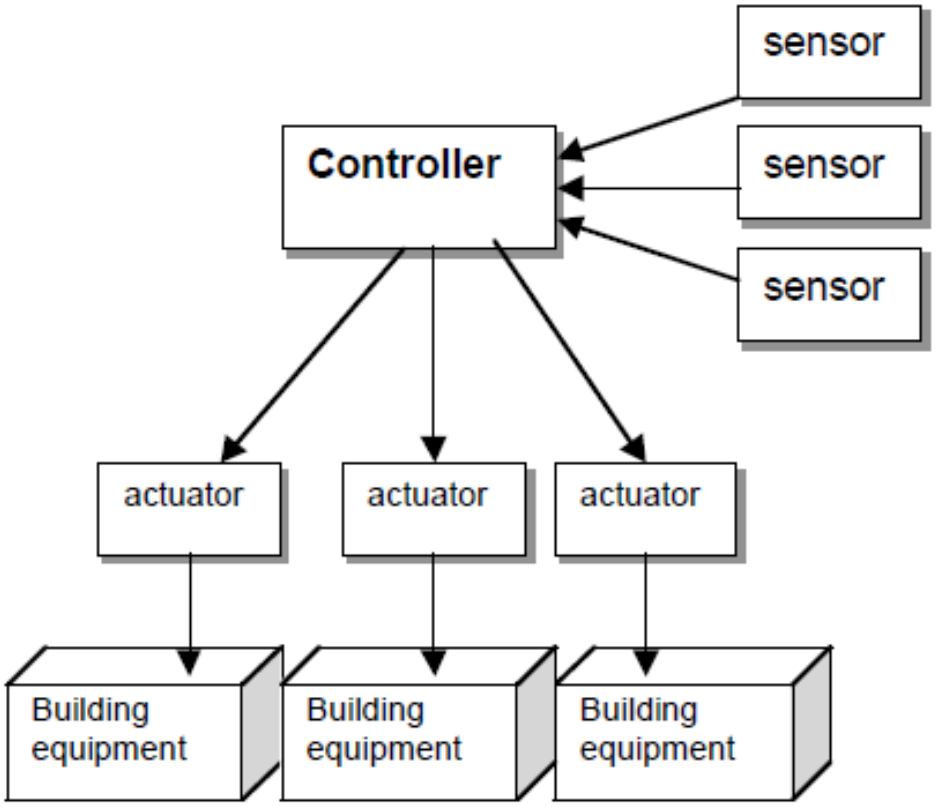
| Inputs | General Design Intent or Strategy during normal Operation | Modifications: 1 | Modifications: 2 | Modifications: 3 |
|---|---|---|---|---|
| Photo-sensor / Daylighting | Automatically balance available daylight using dimmable electric lighting to provide 50FC at +30” at all occupied times | | | |
| Occupancy Sensing | Reduce Light levels in corridors, stairwells, & unoccupied spaces during time of vacancy | | | |
| Tuning | Reduce light levels on area basis to correct for over-lighting | | | |
| Personal Controls | Light levels are selected based on local user preference | | | |

# General Process

| Inputs | General Design Intent or Strategy during normal Operation | Modifications: 1 After hours / Weekends | Modifications: 2 ADR | Modifications: 3 ADR – Alt. |
|---|---|---|---|---|
| Photo-sensor / Daylighting | Automatically balance available daylight using dimmable electric lighting to provide 50FC at +30” at all occupied times | No Mod. | Reduce set point to 20FC | |
| Occupancy Sensing | Reduce Light levels in corridors, stairwells, & unoccupied spaces during time of vacancy | Turn light off in corridors, stairwells and unoccupied spaces when vacant | Turn light off in corridors, stairwells and unoccupied spaces when vacant | Reduce timeout intervals |
| Tuning | Reduce light levels on area basis to correct for over-lighting | No Mod. | Reduce light levels even further | |
| Personal Controls | Light levels are selected based on local user preference | No Mod. | Light levels prevented from exceeding set level | |

# Sequence of Operations Structure

- Components
  - OS, PC, BMS, Time of Day
- Their role
    - Fixture-integrated
    - Standalone
- Information flow:
    - Input
    - Associated Output
- Communication protocol
    - Wired
    - Wireless
    - BACNet, ZigBee, other…



# SoO's come in numerous forms

- Narrative/Descriptive: Pros/Cons
- Tables or Operational forms: Pros/Cons
- Graphic: Pros/Cons
- Details with Notes (Pictorial): Pros/Cons
- Manufacturer Checklist: Pros/Cons

# Example SoO: Narrative/Descriptive

3.5 LIGHTING CONTROL SEQUENCE OF OPERATION

A. The network control system shall utilize Lumen Maintenance strategies to reduce energy waste in initial installation. All luminaires shall be dimmed to a maximum output of 80% with the capability to increase output over the course of the lighting systems rated life for consistent illuminance levels. Fine-tuning of acceptable illuminance levels for task tuning shall be done after furniture and finishes are completely installed.

B. Luminaires over workstations in the open office shall include compact sensors integrated in the housing. When occupancy is undetected, open office luminaires shall dim to 30% output during business hours to avoid dark sections of the open office. Those luminaires shall turn-off during non-business hours when occupancy is undetected.

1. Compact sensors shall be installed in 4' or 8' each section of continuous rows of luminaires as specified in the luminaire schedule.

a. Occupancy settings shall include all sections and rows of luminaires within a cluster of workstations.

b. Photosensors settings shall include sections of luminaires within primary and secondary daylight zones.

C. All luminaire types other than the open office shall turn-off during non-occupancy at all times.

D. Business hours and holiday scheduling will be determined by the End User.

E. All sensors shall incorporate a photosensor set to maintain 30 footcandles on the work surface where contributing daylight is present.

F. Task tuning for spaces where specific illuminance is preferred, personal control, and multi-scene settings will be determined by the End User with the assistance of the Lighting Designer.

# Example SoO: Tables / Operational Form

CALIFORNIA TITLE 24
SEQUENCE OF OPERATIONS

**For New Construction and TI Interior Spaces**

Sequence of Operation is meant as a general guideline only. Although most requirements are shown below, individual projects should review T24 and adjust to projects as required.

Update January 26, 2016 v8.3

MANDATORY | BEST PRACTICE | EXEMPT

AO: Auto ON

MO: Manual ON

MO/AO: Manual ON and Auto OFF

PO/MO: Partial Auto On, Manual to achieve FULL ON. When Unoccupied lighting power is reduced by 50%

PO5/AO: Partial ON/OFF. Lighting is turned on by time clock to 50% (or by OS first ON during operating hours triggered by occupant). When Occupied lights automatically go to full output. When Unoccupied ligting power reduced by 50% automatically.

PO2-5/AO: Parking Garage Only. Partial ON/OFF. Lighting is turned on by time clock to 50% (or by OS first ON during operating hours triggered by occupant). When Occupied lights automatically go to full output. When Unoccupied ligting power reduced by 20- 50% automatically.

MG: Motion Group

Time Schedules

| DAY | MON | TUES | WED | THURS | FRI | Attached Schedule if needed | SAT | SUN |
|---|---|---|---|---|---|---|---|---|
| Weekdays | | | | | | | | |
| Operating Hours | | | | | | | | |
| After Operating Hours | | | | | | | | |
| Weekend | | | | | | | | |
| Operating Hours | | | | | | | | |
| After Operating Hours | | | | | | | | |

| PROFILES (adjusted as needed for site conditions) | Task Tuning lowers MAXIMUM light output to Target Foot Candle Level for Energy Savings | 130.1(a) AREA CONTROLS (a) Wall Switch - Wall Control - Keypad On/Raise Off/Lower (Scene Control Optional) General lighting must be controlled separetly display, ornamental, track lighting, accent lighting, etc. all controlled separately | 130.1 (b) MULTI LEVEL | SENSOR BEHAVIOR | 130.1(c) AUTOMATIC SHUTOFF Occupancy Sensor During Operating Hours | 130.1(c) AUTOMATIC SHUT OFF Occupancy Sensor During Non-Operating Hours (Auto Shutoff Required) | 130.1(c) AUTO SHUT OFF Time Schedules | 130.1(d) AUTOMATIC DAYLIGHT CONTROLS (primary) exempt if < 120w or <100 sq ft or less than 24sq ft glazing | 130.1(d) AUTOMATIC DAYLIGHT CONTROL (secondary) exempt if < 120w or <100 sq ft or less than 24sq ft glazing | 130.1(d) AUTOMATIC DAYLIGHT CONTROL (skylight) exempt if < 120w <100 sq ft | 130.1(e) Mandatory AUTO-DEMAND RESPONSE shall reduce light level by 15% if space or building is >10k sq ft. *Optional Demand Response* | 130.5(d) PLUG LOAD SHUTOFF (receptacle) required in New or TI construction within 6' of standard receptacle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| By Space Type - Most common space types are defined below | Maximum Light Output (Task Tuning) TARGET DESIGN or reduced to 80% output (depending on furniture and finishes typically can dim to 60% light output) | Ope... Hours ON th... OFF is... for mos... see abb... at... | | | | | | | | | | |
| 1 Atrium | 60-80% | | | | | | | | | | | |
| 2 Breakroom/Kitchenette | 60-80% | | | | | | | | | | | |
| 3 Cafeteria Serving Area | 60-80% | | | | | | | | | | | |
| 4 Cafeteria Prep | 60-80% | | | | | | | | | | | |
| 5 Classrooms | 60-80% | | | | | | | | | | | |
| ... | ... | | | | | | | | | | | |

## INTERIOR LIGHTING & RECEPTACLE CONTROLS SEQUENCE OF OPERATION

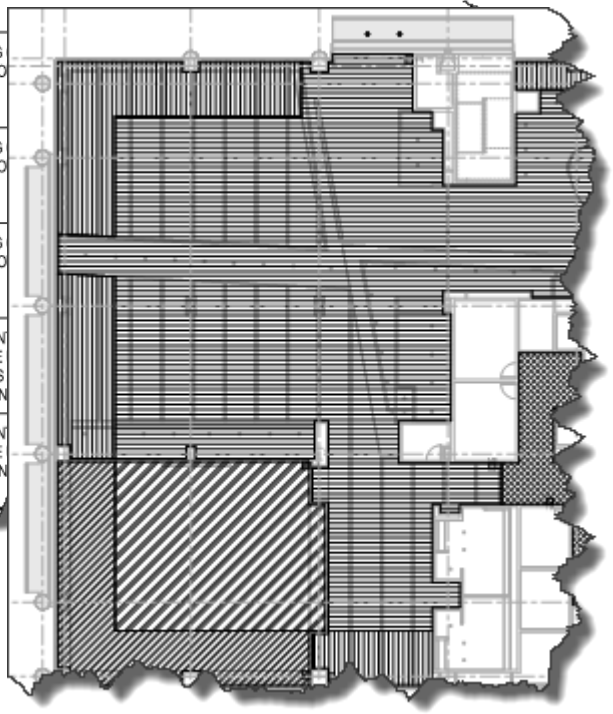
| ROOM TYPE | FUNCTION: OCCUPANCY SENSOR - MANUAL ON | OCCUPANCY SENSOR - AUTO ON | OCCUPANCY SENSOR - AUTO OFF | OCCUPANCY SENSOR - PARTIAL OFF | CONTINUOUS DIMMING TO OFF | ON/OFF SWITCH | MULTI ZONE DIMMING | AUTO TIME CLOCK-OFF | AUTO TIME CLOCK-ON | DAY LIGHT SENSOR - AUTO DIMMING (WHERE SHOWN ON PLANS) | OVERRIDE SWITCH CONTROL | SET LIGHT LEVEL TO IES RECOMMENDATIONS | SET LIGHT LEVEL TO 100% ON | ACCEPTANCE TESTING OF CONTROLS BY CLCATT | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRIVATE OFFICE < 250 FT$^2$ | • | | • | | • | | | | | | • | | • | | |
| BREAK ROOMS | • | | • | | • | | • | | | • | | • | • | | |
| STAIRS | | • | | • | | • | | • | • | | • | | • | • | DIM TO 50% WHEN UNOCCUPIED/'ON' AND 'OFF' TIME SET PER OWNER. |
| SMALL RESTROOMS < 100 FT$^2$ | • | | • | | | • | | | | | | | • | • | |
| ELECTRICAL/MECHANICAL/UTILITY ROOMS | | | | | | • | • | • | • | • | | | • | • | 'ON' AND 'OFF' TIME SET PER OWNER. |
| RETAIL/SORTING | | | | | • | | • | • | • | | | | • | • | |
| CONTROLLED RECEPTACLES | | • | • | | | | | | | | | | | • | |

GENERAL NOTE:
LIGHTING CONTROL SYSTEMS SHALL BE CAPABLE OF MEETING DEMAND RESPONSE REQUIREMENTS OF CALIFORNIA TITLE 24.

# Example SoO: Graphic

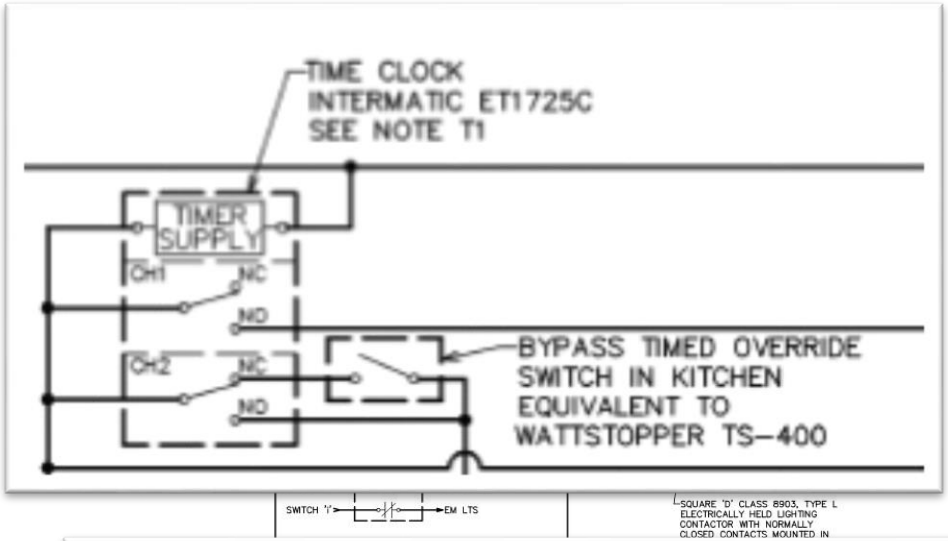
**ZONE CONTROL KEY**

| SPACE TYPE | EQUIPMENT | SEQUENCE |
|---|---|---|
| LEVEL 2 - ZONE 1<br>BUILDING CORE | SWITCH | ON: LIGHTS WILL AUTOMATICALLY TURN ON AT BEGINNING OF WORKDAY.<br>OFF: AT END OF WORKDAY LIGHTS WILL BE SHUT OFF. IF OVERRIDE SWITCH IS SELECTED A 120 MINUTE DELAY WILL BEGIN. |
| LEVEL 2 - ZONE 2<br>OPEN OFFICE SOUTHEAST | SWITCH | ON: LIGHTS WILL AUTOMATICALLY TURN ON AT BEGINNING OF WORKDAY.<br>OFF: AT END OF WORKDAY LIGHTS WILL BE SHUT OFF. IF OVERRIDE SWITCH IS SELECTED A 120 MINUTE DELAY WILL BEGIN. |
| LEVEL 2 - ZONE 3<br>OPEN OFFICE SOUTHWEST | SWITCH | ON: LIGHTS WILL AUTOMATICALLY TURN ON AT BEGINNING<br>OFF: AT END OF WORKDAY LIGHTS WILL BE SHUT OFF. IF O |
| LEVEL 2 - ZONE 4<br>OPEN OFFICE NORTHWEST | SWITCH | ON: LIGHTS WILL AUTOMATICALLY TURN ON AT BEGINNING<br>OFF: AT END OF WORKDAY LIGHTS WILL BE SHUT OFF. IF O |
| LEVEL 2 - ZONE 5<br>OPEN OFFICE NORTHEAST | SWITCH | ON: LIGHTS WILL AUTOMATICALLY TURN ON AT BEGINNING<br>OFF: AT END OF WORKDAY LIGHTS WILL BE SHUT OFF. IF O |
| LEVEL 2 - TRAINING ROOM PERIMETER<br>ZONE AS SHOWN ON LIGHTING PLAN | DIMMING | ON: LIGHTS MANUALLY TURN ON USING LOCAL SCENE CONT<br>ADJUST: LIGHTING IS ADJUSTED BETWEEN PRESET SCENE<br>ADJUST TO MAINTAIN 50 FOOT CANDLES AT THIRTY INCHES<br>OFF: LIGHTS AUTOMATICALLY TURN OFF WHEN NO MOTION |
| LEVEL 2 - TRAINING ROOM INTERIOR<br>ZONE AS SHOWN ON LIGHTING PLAN | DIMMING | ON: LIGHTS MANUALLY TURN ON USING LOCAL SCENE CONT<br>ADJUST: LIGHTING IS ADJUSTED BETWEEN PRESET SCENE<br>OFF: LIGHTS AUTOMATICALLY TURN OFF WHEN NO MOTION |



# Example SoO: Details / Pictorial

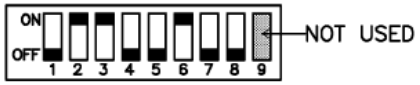
TITLE 24 SYMBOL LEGEND
*GN* = GENERAL LIGHTING FIXTURE
*FD* = FLOOR DISPLAY FIXTURE
*WD* = WALL DISPLAY FIXTURE
*OR* = ORNAMENTAL DISPLAY FIXTURE



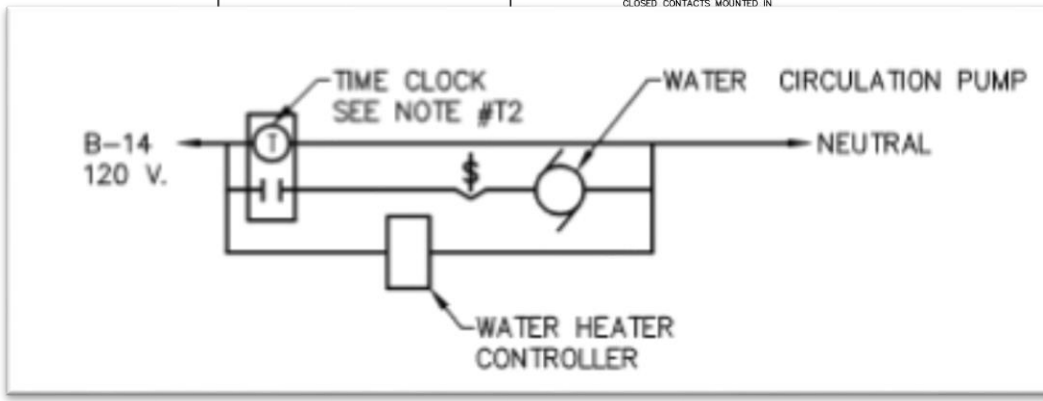

## LIGHTING CODED NOTES

(101) OCCUPANCY SENSOR SWITCH FOR CONTROL OF ROOM LIGHTING. OCCUPANCY SWITCH SHALL BE A WATT STOPPER PW100. SET SWITCH FOR MAXIMUM SENSITIVITY. CONTROL AND ADJUST SWITCH TO MAINTAIN LIGHTS ON FOR 15 MINUTES AFTER LAST MOTION IS DETECTED. SWITCH SHALL BE ADJUSTED TO OVERRIDE THE LIGHT LEVEL ENERGY SAVING FEATURE. DIP SWITCH SETTING OF THE SWITCHES BENEATH THE COVER SHALL BE SET AS FOLLOWS:

ON – DIP 2,3,6
OFF – DIP 1,4,5,7,8
NOT USED – DIP 9



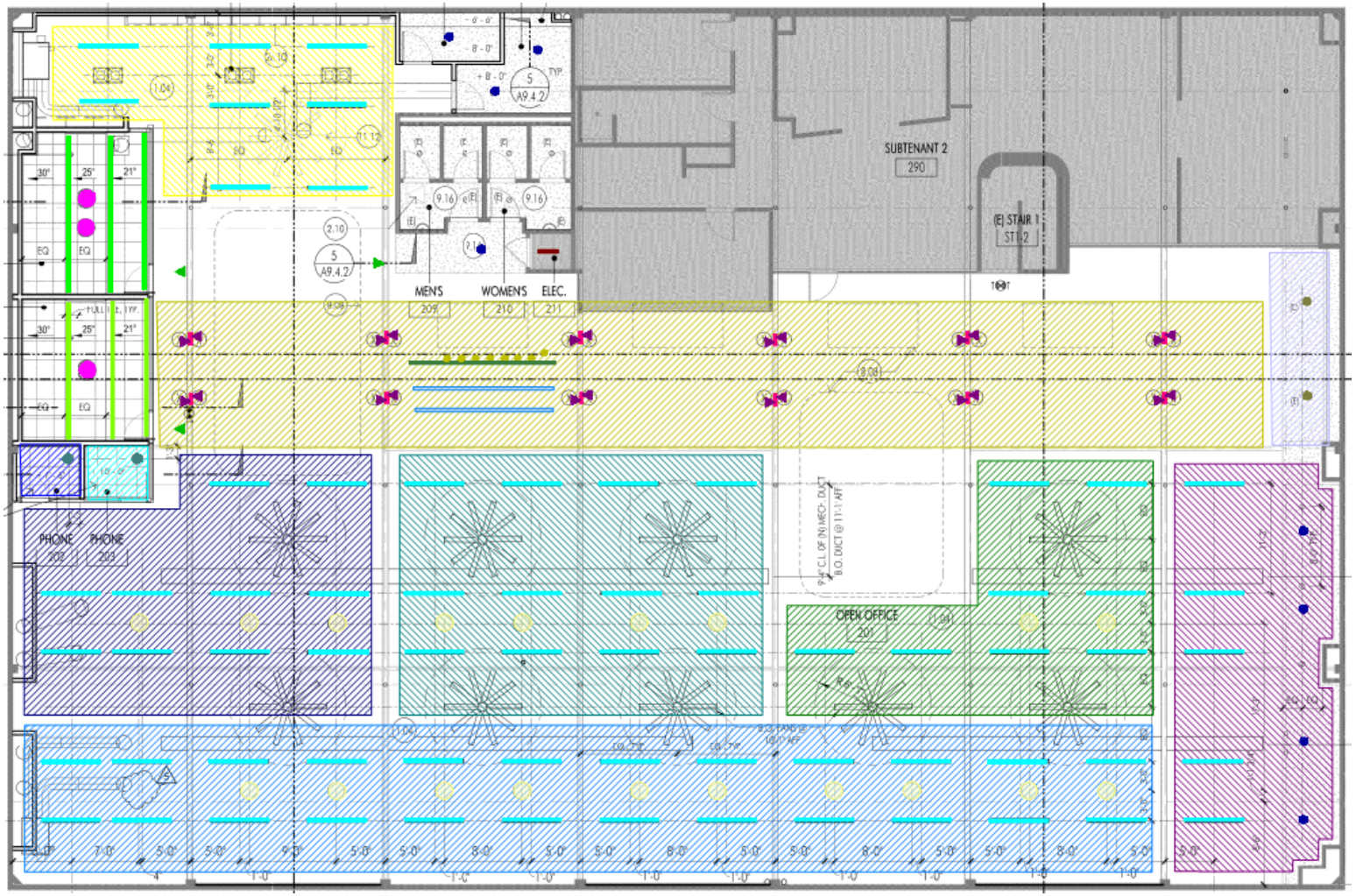

(102) BYPASS BUTTON LIGHTING CONTROL SWITCH. DIP SWITCH SETTINGS ARE FACTORY SET FOR 2 HOURS.




ELECTRICAL CONTRACTOR SHALL ROUTE THE SWITCHED HOT LEG FROM THE LOAD SIDE OF THE WATTSTOPPER DLM MODULES THROUGH THE CONTACTOR SO AS NOT SO SHUT OFF POWER COMPLETELY TO THE WATTSTOPPER DLM MODULES.

3 TIMECLOCK CONTROL WIRING DETAIL
N.T.S.

# Example SoO: Pictorial / Narrative



# Example SoO: Pictorial / Narrative

| Sequence of Operations | |
|---|---|
| Custom Sequence for 206 Copy | |
| **Areas Affected** | 2nd Floor\206 Copy |
| **Lights Controlled** | Type K |
| **Light Controls** | *Lights* : Dimmed lights are controlled in this area as described below. |
| | *Occupancy:* Lights automatically turn on to the lessor of 80% or Daylight Level when the user enters the area and 15 minutes after the room has been vacated, the lights will automatically turn off. Type H3 Lights will accept occupancy signals from OS within the area and remain on for 30 minutes after the room has been vacated. |
| | *Daylighting* : Lights will automatically adjust to harvest daylighting. Target FC level in this area is 25FC. When maximum daylighting is achieved, the lights will dim to low end and turn off when overall light level is 40FC (measured on the desktop)<br>- Lights to accept signal from PC mounted within each corresponding control zone area. |
| | *Time of Day Schedule:* Currently no time of day scheduling is anticipated for this area. Time of day scheduling may be added at a later date should it become necessary to keep the lights on during normal business hours. |
| | *Upper Level Trim:* Sewt upper level trip at 80% output. |
| | *Manual Wall Control:* Pico dimmer switch mounted on wall. One dedicated Pico dimmer per control zone as defined below. To control lights manually, the user can select On+Off with Raise/Lower using the control station. |
| **Additional Controls** | Emergency Lights: Egress lighting in this area will be provided by separate, self contained emergency lighting units. |
| | *Kill Switch:* All lights on Quantum System, except Lighting at Fitness, Stair 1, and Stair 2; and D6 at entry to turn off upon signal from BMS / Kill Switch Signal that the office is now empty and secure. Type D6 lights will turn off 15 minutes after the space has been vacated. Stairs 1 and 2 remain occupancy based control via their respective occupancy sensors. |
| | *Demand Response* : Upon signal from BMS, reduce overall lighting energy by and additional 30%. For example if the lights are at 80%, reduce them further to 56% output. |
| **Quantum** | This area will be part of Quantum System. Other requirements for this system include BACnet for Building Management System Integration.<br>Report Occupancy status, and lighting status to BMS.<br>Accept inputs from BMS for Demand Response, additional dimming, and Kill Switch. |
| **Other** | PICO: Master Raise/Lower of Type K lights in this room. |

# Example SoO: Mfr's Check Lists…

| ELECTRICAL CONTRACTOR'S PRE-COMMISSIONING CHECKS - GENERAL REQUIREMENTS | | |
|---|---|---|
| 1 | Lighting Control System Turnover to Lutron for Commissioning Prerequisites | Before turning a Lighting Control System (LCS) over to Lutron for commissioning, the Electrical Contractor (EC) must confirm that: |
| | | a) All panels, wall controls, and other items of LCS equipment are fully installed and wired in accordance with applicable installation instructions. |
| | | b) All wiring terminations were subject to a "Wire Pull" test at the termination point. Specifically, using appropriate electrical safety precautions, gently tug on each wire termination and ensure that the wire is secure. |
| | | c) All LCS controlled lighting fixtures are permanently installed, wired, and tested to confirm that they operate at full brightness. |
| | | d) The system specific Electrical Contractor Pre-Commissioning checks (e.g. EcoSystem, Panel Based Systems, Grafik QS, etc.) have been completed satisfactorily. |
| | | e) The Bypass Jumpers are still in place in the XP (switching or relay) and LP (dimming) panels. |
| | | f) All spaces are "move-in ready" (furniture, carpeting, shades, blinds, wall covering, pictures, etc. are installed) prior to daylight sensor calibration and daylight harvesting commissioning. |
| | | g) Lutron personnel will have unrestricted and unobstructed access to the LCS equipment being commissioned. |
| | | h) Lutron personnel will be able to turn the LCS controlled lighting fixtures "on" and "off" without restriction. |
| | | i) Lutron personnel will be free to operate the lighting circuit breakers in the Lutron Lighting Distribution Panels without restriction. |
| | | j) The final, approved Load Schedule and Control Specifications have been supplied to Lutron. |
| | | k) The Pre-Commissioning Startup Checklist(s) has been completed satisfactorily and faxed to Lutron. |
| 2 | Commissioning Objectives | The goals of the Commissioning process are (as dictated by the installed equipment): |
| | | a) Verify LCS components are installed in the approved, documented locations using proper mounting techniques |
| | | b) Verify proper feed and load wiring at the Lighting Distribution, Dimming, and Switching Panels |
| | | c) Verify communications wiring |
| | | d) Check panels for correct load types and ensure circuit loading is within published limits |
| | | e) Energize the Lutron Hubs/Processor and upload the databases |
| | | f) Address ballasts, QS devices, Panels |
| | | g) Remove bypass jumpers |
| | | h) Set up, and then verify, the proper operation of every circuit and control device in the system |

# Example SoO: Mfr's Check Lists…

| ELECTRICAL CONTRACTOR'S PRE-COMMISSIONING CHECKS - GENERAL REQUIREMENTS | | |
|---|---|---|
| | | i) Verify the operation of Lutron's integration equipment (does not include commissioning of other manufacturer's equipment with which Lutron is integrating) |
| | | j) Assist Electrical Contractor in troubleshooting installation issues and miss-wires |
| | | k) Obtain sign-off on system function, excluding the Graphical User Interface (GUI) |
| | | l) Identify the Owner's GUI design contact (if purchased on the BOM) |
| 3 | **Documentation and Assistance Required for Startup Visit** | To help ensure that the Lutron Field Service Engineer(s) have sufficient time to complete the Startup activities, Lutron requests that the EC have the following items available upon their arrival on site (as applicable): |
| | | a) A complete set of the "Final" LCS drawings and Specifications |
| | | b) A complete list of system modifications and field changes |
| | | c) Accurate Load Schedules posted on the door of each Lighting Panel or in a folder if all panels are clearly and permanently labeled |
| | | d) "Sequence of Operation" specifications and settings approved by an authorized party (if not documented in the submittal) |
| | | e) "Timeclock Events" specifications and settings approved by an authorized party |
| | | f) Door keys, badges and/or security codes, required for access into secured areas |
| | | g) Electrician assistance |
| 4 | **Caution** | Please note that extra charges (overtime/return visit) may result if additional on-site time is required due to: |
| | | a) Incomplete system preparation |
| | | b) Improper equipment installation |
| | | c) Excessive installation errors |
| | | d) Unexpected system design modifications |
| | | e) Excessive system design modifications |
| | | f) The unexpected presence of non-Lutron supplied interface equipment |
| | | g) The need to revise "Sequence of Operation" settings due to incorrect information being provided |
| | | |
| | | |

# Manufacturer-Specific Requirements

## The case for sole-source

- Manufacturers adjustment parameters are different
  - This affects the sequence
- Daylighting sexample:
  - Lutron - gain
  - Wattstopper - ramp rate, FC level
- Occupancy sensor example:
  - Wattstopper - US/PIR trigger/retrigger
  - Nlight - microphonics, sensor & room controller delays
- Prepare:
  - Review literature
  - Knowledgeable Rep
  - Training

# Do your homework

- Control system manufacturer (in BOD)
- Research product during SD
- Meet with Mfr/Rep to understand programming constraints.
- Identify compromises (often necessary)
- SoO is a living document
  - Updates throughout design
  - During submittal  process
- Include lighting in controls integration meeting
- *Bottom Line:*
  - You need to be smarter than the Designers and the Contractors.

# Anatomy of a productive comment

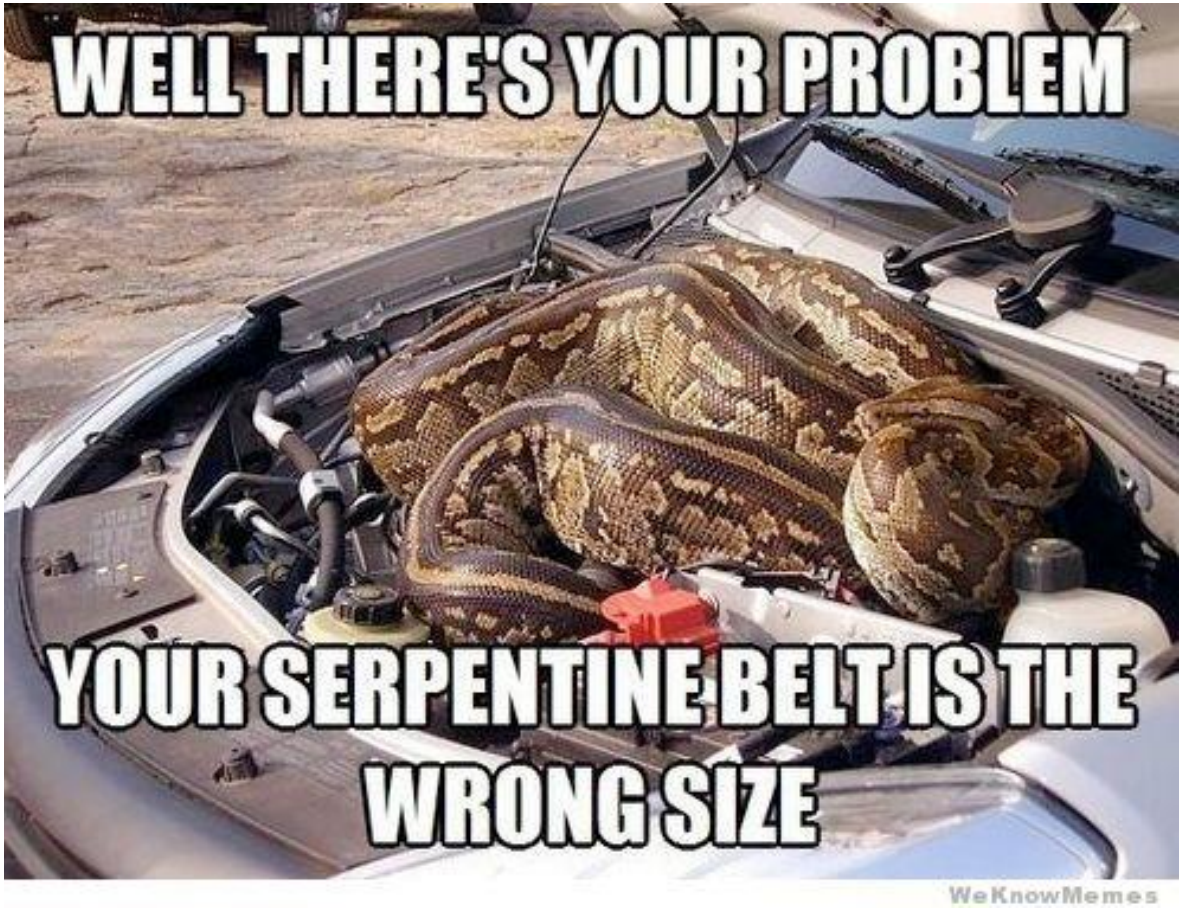
## Prevent drama

- State what the design says/shows
  - Include pictures
- Explain why its needed
  - Standards? OPR? Agreement with BOD? Best practice?
- Put it in context
  - Explain the consequences of not implementing it
  - Lay out your case
- Make your recommendation
  - Be diplomatic
- Bonus points:
  - Priority
  - Making it easy
  - An example
  - Reference/further reading

# Implementable comments

- What do we see?
- What's wrong?
- Significance?
- How to Fix it?

- What do we recommend?



# Recommendations that aren't controversial

- Be respectful
  - It's not about you – it's about the project
- Establish a positive tone
- Avoid Authoritarian tone
  - Best: "*We recommend…*"
  - Bad: "*In our opinion…*"
- Provide an example – make it easy for them

# Example Design Statement

| Description | Dwg | Recommended Changes |
|---|---|---|
| The mechanical drawings indicate that occupancy sensors will be used in the mechanical control sequences. | M6.3<br>E5.1 | Coordinate with the mechanical engineer and make it clear that the lighting control system will need to support the HVAC control system.<br>According to WattStopper, you can either:<br>1. Add an LMRL-100 to each room, which has a contact closure that can relay occupancy status to the HVAC control system.<br>2. If a Segment Manager is used on the project, it's possible to export a table of room status to the HVAC control system over BACnet/IP, but the two control systems must be on the same network.<br>Clarify which option will be used and make it clear in the mechanical and electrical drawings which will be used. |
| It is not clear on the electrical drawings that the WattStopper system will support the exchange of this information to the HVAC controls. | | |
| Bringing this point from the lighting control system to the BMS will be a significant effort (i.e. time and money for the contractor) and would require a fair amount of coordination with the lighting control vendor (more time & money). If the contractor misses it and then has to do the work they didn't budget for (but is contractually obligated to), there is a chance that the quality of workmanship will be deficient and the system may not work reliably. | | |

What we see

What's wrong

Significance

Recommendation

# Maintainability (don’t buy cheap stuff)

- How is cheap achieved?
  - Product support
  - Quality
  - Set up/configuration
  - Installation
- Infant mortality
- Quality
  - Literature
  - Website
  - Phone support
- Cost
  - Installed cost vs first cost
  - Persistence of energy savings

# Challenges faced by contractors

- GUESSWORK
- Impossible sequences
- “Performance specification”
- New technologies
- New codes

# Trends…. Smart Lighting

- Embedded wireless
- Open Standard vs. “Spec-Lock”; Web Based
- New Value chains


- Data mining, IoT
- Luminaire Level Lighting Controls (LLLC)
- New protocols
  - –Zig-Bee, Blue Tooth, DALI
- Addressable system
  - –Point to point checking
- Auto-_____
  - –Provisioning, Set-up, Formation, Cx
  - –“Auto-____” is only start-up!

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