312b Fundamentals of
Networked Lighting Controls

Presented by
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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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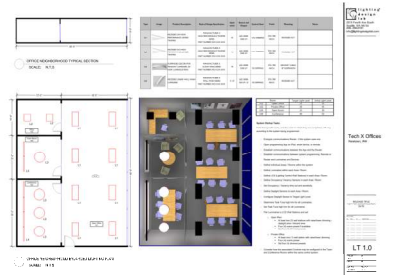lighting design lab

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Click the logo to check them out!

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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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Traditional NLC Approach

LC-1   LC-2   LC-3   LC-4

Courtesy: Cooper, Crestron, Lutron, Osram Encelium, Wattstopper

TRADITIONAL NETWORKED LIGHTING CONTROLS APPROACH
SCALE: N.T.S

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Controls Schedule

Networked Lighting Controls
Wall Station Schedule

Type	Description	Image	Notes	Catalog
LC-1	Three single gang wireless NLC control devices mounted behind a common matching device style face plate. Devices are one (1) two button entry station, and two (2) three button with raise/lower stations.		See Engraving Schedule for each wall station. See Sequence of operations for programming.	(1) PJ2-2B-L01-WH (2) PJ2-3BRL-L01-WH (3) PICO-WBX-ADAPT (1) CW-3-WH
LC-2	Single gang wireless programmable wall station with three buttons plus raise / lower and off. Battery operated.		See Engraving Schedule for each wall station. See Sequence of operations for programming.	See Section 260943 Specifications
LC-3	Programmable preset select station with four presets plus raise / lower and off. Requires convenience power at 120v. Communications is wireless.		LC3 is used only in Team Rooms. Engrave all as noted in specifications. Confirm with architect prior to fabrication. See Sequence of operations for programming.	See Section 260943 Specifications
LC-4	Programmable preset select station with four presets plus raise / lower and off. Requires convenience power at 120v. Communications is wireless.		LC-4 is used only in Conference Rooms. Engrave all as noted in specifications. Confirm with architect and owner prior to fabrication. See Sequence of operations for programming.	See Section 260943 Specifications

Notes:
1. Examples depict control stations from several manufacturers to show concept only. For a real project, only one manufacturer would be selected to ensure that all interface controls looked and functioned consistently.
2. Several different styles of station description are used, particularly with respect to the number and type of buttons. On a project, select one style and be consistent. If possible choose the basis of design manufacturer and describe stations as they do.
3. Notes refer back to specification sections in many cases. It is best to keep detailed information in one place for the project, e.g. catalog numbers.
4. Catalog number may be shown for specific parts and pieces in the schedule, as is shown for type LC-1, but be consistent. Do not show them elsewhere on the project documentation.
5. If engraving is to be done, be very specific about what that entails and who needs to sign off prior to fabrication.

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Sequence of Operations - Matrix

Project X Sequence of Operations Matrix - Traditional NLC

Room Number	Control Zone	Space Type / Use	Lighting Type	Target Light Level	LC5	Manual Switch	Dimmer Switch	Preset Station	Time Clock	Astronomic Time Clock	Occupancy Sensor	Vacancy Sensor	OG / VB Time Out	Daylight Dimming	Daylight Minimum	Task Tuning	Site Occupancy Sensor	Site Photo Control	Specialty Note	Typical Note
101	a	Open Office	Recessed Troffer	25	1						7p-7a	7a-7p	15	20%	30%				1	1, 4, 5, 6
	b																			
	c										7p-7a	7a-7p								
	d																			
102	e	Private Office	Recessed Troffer	40	2						7p-7a	7a-7p	5		15%				2	1, 5
103	f	Team Room	Suspended Indirect Direct	25	3								5		15%				1	1
	g		Recessed Wall Wash	n/a																
104	h	Conference	Suspended Indirect Direct	40	4								10		25%				4	1
	k		Recessed Wall Wash	n/a																
105	z1-10	Open Office	Recessed Troffer	25	1						7p-7a	7a-7p	15	10%	30%				1	1, 4, 5, 6
	z1-11		Recessed Troffer																	
	z1-12		Recessed Troffer								7p-7a	7a-7p								
	z1-13		Recessed Troffer																	

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Sequence of Operations – Sheet Notes

Project X Sequence of Operations Sheet Notes - Traditional NLC

Typical Notes:
1. Normal business hours are Monday – Friday 7am to 7 pm.
2. Corridors and Back of House Stairs: Occupancy sensors will dim to 20% output during normal business hours and to off after business hours.
3. Toilet Rooms: Occupancy sensors will dim to 10% output during normal business hours and to off after business hours.
4. Open Plan Offices: Vacancy sensors will dim to 20% light output during normal business hours.
5. All Offices: After business hours, vacancy sensors will reset to occupancy and dim to off.
6. Open Plan Offices: Daylight Harvesting will be set to a minimum 20% light output.

Specific Notes:
1. Open Office Wall Station type LC-1

Two Button Zones a-c	Three Button Zones a,b	Three Button Zones c,d
1: 100%	1: 50%	1: 50%
b: as def	b: raise	b: raise
	3: Off	3: Off

2. Private Office Wall Station type LC-2

Button 1: General	Button 2: Bright	Button 3: Reading
e: 50%	e: 100%	e: 20%

3. Team Room Wall Station type LC-3

Button 1: Meeting	Button 2: Present	Button 3: Video	Button 4: Relax
f: 100%	f: 50%	f: 20%	f: 10%
g: 100%	g:75%	g: 50%	g: 10%

4. Conference Room Wall Station type LC-3

Button 1: Meeting	Button 2: Present	Button 3: Video	Button 4: Telcon
h: 100%	h: 50%	h: 20%	h: 60%
k: 75%	k: 15%	k: 25%	k: 25%

Site Occupancy Sensor	Site Photo Control	Specialty Note	Typical Note
		1	1, 4, 5, 6
		2	1, 5
		3	1
		4	1

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LLLC NLC Approach

LC-1 LC-2 LC-3 LC-4

Courtesy: Cooper, Crestron, Lutron, Osram Encellium, Wattstopper

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LLLC NETWORKED LIGHTING CONTROLS APPROACH
SCALE: N.T.S

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Sequence of Operations - Matrix

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Sequence of Operations - Matrix

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Project X Tech Offices - Implementation

For startup we'll assume that the program looks like this:

- z1: Open Office Primary Daylight Zone
- z2: Open Office Secondary Daylight Zone
- z3: Conference Room Pendants
- z4: Conference Room Wall Wash
- z7: Private Office 2x2
- Vacancy Sensors
- Lighting Control Stations
- Daylight Sensor
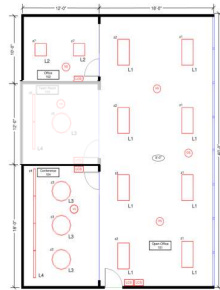
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POP QUIZ!
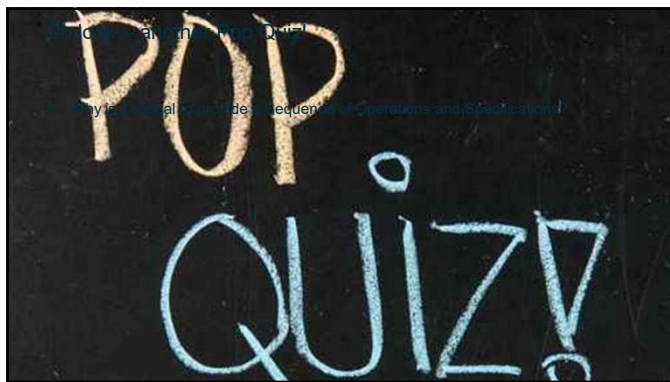
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Common Energy Code Control Highlights

Energy Codes handle lighting controls in different specific ways, but there are many commonalities.

Washington State, Seattle, Idaho, and Montana energy codes are based on the IECC.

Energy code should be baseline -

2015 Seattle Energy Code

2014 Oregon Energy Efficiency Specialty Code

TITLE 24 CA Compliant

2012 Washington State Energy Code

IECC 2015 International Energy Conservation Code
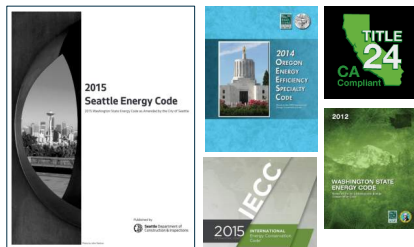
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Extinguish Lighting When Not Needed

Occupancy / Vacancy Sensing - Required in most project areas.

- Open Plan Offices
- Private Offices
- Conference Rooms
- Classrooms
- Stairwells
- Toilet rooms
- Storage
- Janitorial
- Copy / Print
- Lounges
- Break Rooms
- Warehouses
- Public spaces

- Corridors
- Parking garages
- Site lighting

- Spaces 300 sf or less enclosed by ceiling height partitions.

- May be programmed to dim rather than extinguish

Courtesy: Leviton

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Schedule Lighting Only When Needed

Time of day events generally used for large areas or public spaces.

Multiple calendars are generally required.

- Open Plan Offices
- Public spaces
- Corridors
- Site lighting
- Retail
- Hospitality

- Spaces that need to be controlled together or may be difficult to control by sensors.

- May include required dimming events.

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Manual Control

Spaces required to have light reduction controls shall have a manual control that allows the occupant to reduce the connected lighting load in a reasonably uniform illumination pattern by at least 50 percent. Lighting reduction shall be achieved by one of the following approved methods:

1. Controlling all lamps or luminaires.
2. Dual switching of alternate rows of luminaires, alternate luminaires or alternate lamps.
3. Switching the middle lamp luminaire of luminaires independently of the outer lamps.
4. Switching each luminaire or each lamp.

Manual controls for lights shall comply with the following:

1. Shall be readily accessible to occupants.
2. Shall be located where the controlled lights are visible, or shall identify the area served by the lights and indicate their status.

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Stairwells and Corridors And Garages Oh My!

- Each stairway shall have one or more control devices to automatically reduce lighting power by not less than 50 percent when no occupants have been detected in the stairway for a period not exceeding 15 minutes, and restore lighting to full power when occupants enter the stairway. (there is more)

- Lighting in parking garages shall have one or more control devices to automatically reduce lighting power in any one controlled zone by not less than 50 percent when no occupants have been detected in that zone for a period not exceeding 30 minutes, and restore lighting to full power when occupants enter or approach the zone.

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Reduce Lighting When Daylight is Available

Daylight harvesting.

- Dim or extinguish electric lighting when daylight is available

- Some codes require single daylight zones, others require primary and secondary zones.

- Determining those actual zones can take some work.
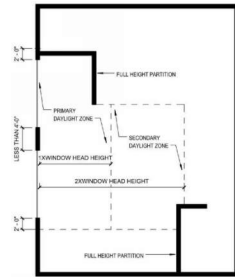
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Reduce Lighting When Daylight is Available
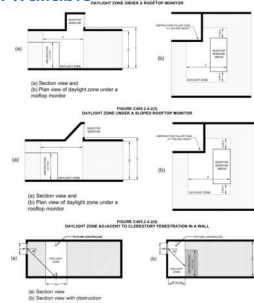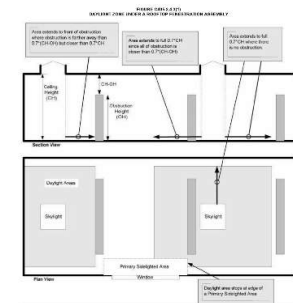
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Emergency – 24 hour lighting

- Emergency lighting was frequently provided by a 24 hour constant hot circuit in the past.

- That is no longer allowed in most cases.

Spokane Public Library

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Emergency Lighting Using UL924 Relays

Emergency Feed

Normal Feed

Load Controller

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Emergency Lighting Using UL924 Load Controllers

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Exterior Lighting

- Where lighting the building facade or landscape, the lighting shall have controls that automatically shut off the lighting between midnight or business/facility closing, whichever is later, and 6 a.m. or business/facility opening, whichever is earlier.

- Exterior occupancy control
- Exterior dimming
- Migratory patterns, etc

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Controlled Receptacles

- 50% of all outlets to be controlled
- Scheduling
- Occupancy Sensing

- Vampire plug loads
- Don't plug in CPUs….

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Commissioning

- Third Party Commissioning may be required

  - Commissioning Plan
  - Certified Commissioning Professional
  - Functional Testing
  - Final Report

- Startup and Commissioning are not the same thing

Design Guide for **The Commissioning Process Applied to Lighting and Control Systems**
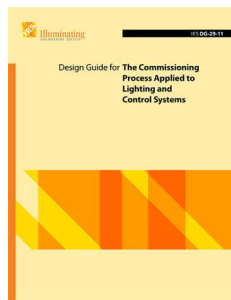
Courtesy: Illuminating Engineering Society

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LLLC – Easy Compliance

- Using LLLC luminaires basically guarantees energy code compliance.

- Some jurisdictions allow LLLC use to eliminate the need for further controls documentation.

- www.lightingdesignlab.com/resources
  - Videos
  - Learning Guides

LUMINAIRE LEVEL LIGHTING CONTROLS

SMARTER CONTROLS, BIG BENEFITS

Courtesy: NEEA

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Commissioning

- One of the most often overlooked Commissioning elements….

  Commission the occupants….

- Let them know what to expect from the system and how it operates….and why….

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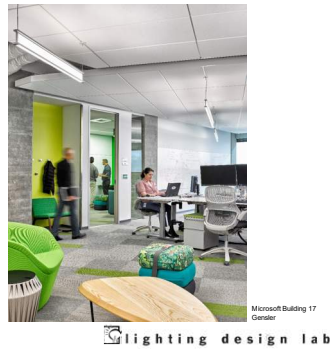
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Quick Case Study

- Occupant is an MEP engineering firm in the third floor of the Bullitt Center in Seattle.

- Approximately 6,100 square feet

- TI renovation

- Completed in 2017

Bullitt Center
Miller Hull

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Lighting Design

- High performance LED lighting
- LED decorative
- 3400 watts connected load
- LPD: ~ 0.55 W/sf

- Controls
  - Dimming
  - Task tuning
  - Vacancy sensing
  - Daylight harvesting
  - Manual dimming

Courtesy: PAE/Luma

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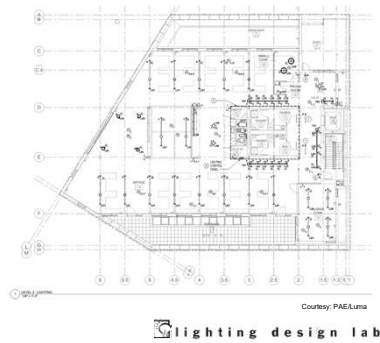
●149

Value Engineering

- Controls design VE
- Met Energy Code…
- Cheapest way possible..
- Barely functional…

- Not possible to fully extinguish electric lights…
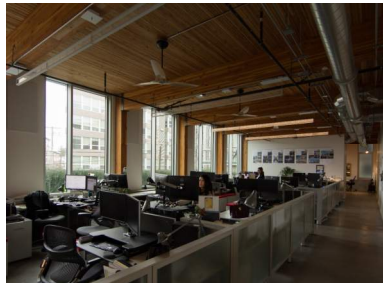
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Lighting Control Retrofit

- Distributed load controls
- Luminaire level addressing
- Wireless switches/dimmers
- Wireless sensors
- Daylight harvesting
- Task tuning
- Manual dimming
- Time of day schedule
- More or less LLLC
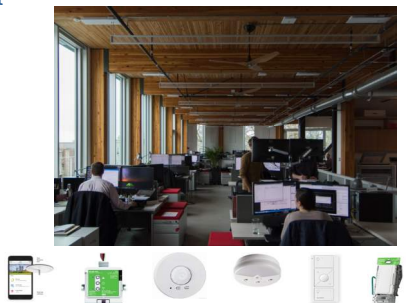
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Results

- Staff can turn all of the lights off
- Staff can select appropriate dimmed levels
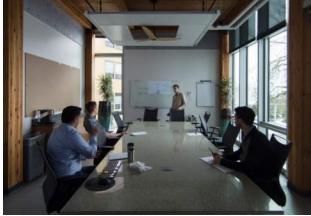
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Results

- Task-tuned by more than 25%
- Daylight dimming fully functional
- Vacancy sensing by contiguous row

- Effective LPD is ~ 0.15 W/sf
- More than 70% effective reduction

- Controls cost: ~ $4,500
- ~ $0.78 / sf
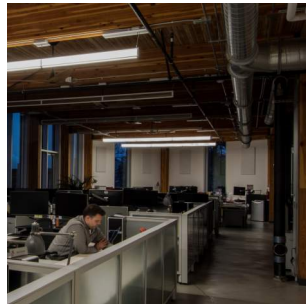
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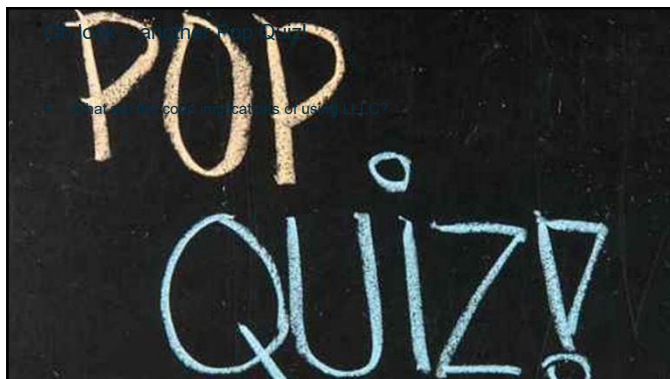
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Control Systems

We work with many different control systems manufacturers for this class.

- Acuity nLight Air
- Audacy by Ideal
- Cooper Wavelinx
- Cree Smartcast
- Crestron Zum
- Encellium Edge
- ETC Echoflex
- Lutron Vive

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Control Systems

- Each manufacturer is capable of the basic lighting controls strategies that we have been discussing.
- All may be considered for retrofit as well as new construction.
- In most cases the for factors of the equipment are quite similar.
- Most are programmable by a smartphone app.

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Acuity nLight Air

SIMPLE AS

1 — Install nLight® AIR enabled fixtures. The embedded smart sensor helps to achieve energy code compliance.

2 — Install wireless battery powered wall switch. Multiple configurations available to meet the needs of your customer.

3 — Download the CLAIRITY app, pair the fixtures to the wall switch and configure the lights to match your space.
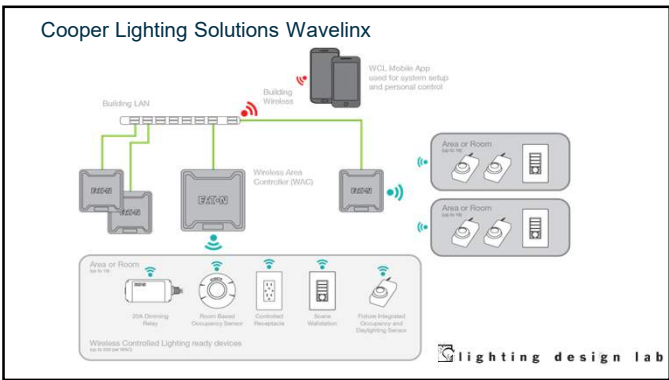
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Audacy by Ideal

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Cooper Lighting Solutions Wavelinx

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Cree SmartCast

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Crestron Zum

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Encelllium Edge

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ETC Echoflex

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Lutron Vive

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So……see any commonalities?

- There are certainly differences between the systems.
- Specifying and installing the hardware is really not that different.
- Programming? Well…also not really all that different – at least for the basic concepts.

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Communication Hubs

- Lets Start with basic communications

- Most networked or semi-networked systems will feature a communications and programming hub.
- Devices communicate via radio frequency - zigbee…or blue tooth…or some proprietary protocol…or…or…

Courtesy: Lutron, Cooper, Encellium, Audacy

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Load Controllers

- Load controllers are the basic dimming or switching modules
  - 0-10v
  - 2 wire
  - 3 wire
  - Digital
- Lighting
- Plug loads
- Other loads

Courtesy: Echoflex, Encellium, Lutron, Cooper

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LLLC Fixtures

- Provided from the factory with load controllers or digital drivers already installed.

- 0-10v load controllers
- Digital Drivers:
  - DALI
  - Bluetooth
  - Proprietary

Courtesy: Signify, Cree, Lutron

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Switches / Dimmers

- Switches / Dimmers

- Number of buttons
- Raise Lower
- Scene Control
- Wireless communication with devices and hub
- Powered by:
  - Battery
  - Convenience circuit
  - Enocean

Courtesy: Audacy, Lutron, Cooper, Echoflex

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Occupancy / Vacancy Sensors

- Ceiling
- Wall
- Specialty
- Powered by:
  - Battery
  - Enocean
  - Convenience circuit
  - Power pack

Courtesy: Lutron, Cooper, Echoflex

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Daylight Sensors

- Open Loop
- Closed Loop
- Combination
- Powered by:
  - Battery
  - Enocean
  - Load Controller
  - Power Pack

Courtesy: Encellium, Lutron, Cooper, Echoflex

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LLLC Luminaire Integrated Sensors

- Daylight
- Occupancy
- Vacancy

- Temperature
- Humidity
- CO2
- Others?

Courtesy: Cooper, Lutron, Enlighted

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Plug Loads

What if the outlet could be controlled directly as part of the networked wireless control system?

Courtesy: Cooper, Lutron

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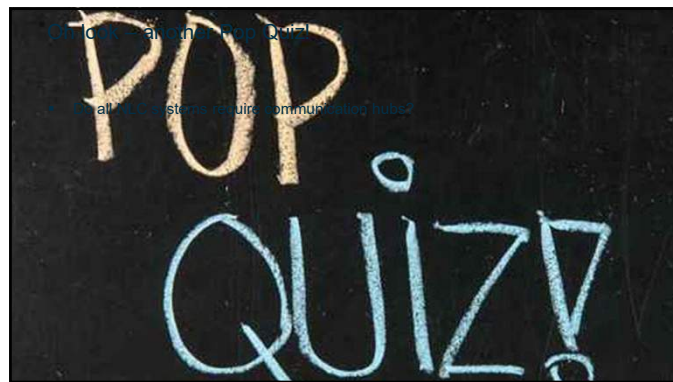
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Demonstration Boards

- When we get back to being able to meet in person

- Control boards are meant to emulate building or fixture wiring in miniature.

- Each fixture represents one of the luminaires in the example – per the photos on each.

- Each luminaire represents one control zone
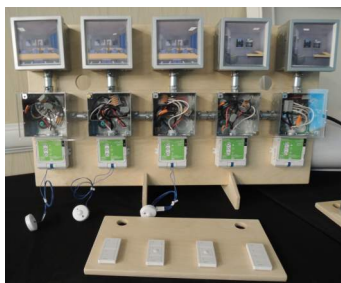
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System Startup / Programming

- Ok – we've seen the parts and pieces and how to do the basic wiring.

- We've seen how the major components are installed.

- What about the system programming?
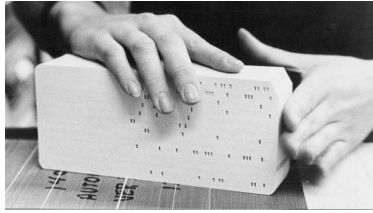
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Apps

- Many systems today are configurable by smart device app – not just for lighting.
- These apps may all be downloaded to your phones or tablets from apple or google to work with your respective devices.

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Communications

- Programming…where to begin?

- The first step is to power up the communications hub, router, etc

- To save time, the hubs are already powered and have a base configuration.

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Next Steps

- The following steps will be general practice.

- The order of information entry and coordination may vary significantly but the actual information required and entered will be very similar.

Congratulations, You Made it!
Now what?

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Device Discovery

- Some systems will query the local area in search of devices that may be new to the area or system.

- Some systems will require you to physically touch the devices you with to add to the system or engage in some other specific step such as scanning a QR code.

- The specific steps and order will vary so let's look at general concepts.

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Project Information

- Project Name
- Project Location
- Project Latitude and Longitude
- Designer?
- Engineer?
- Any others?
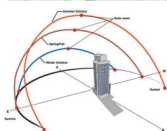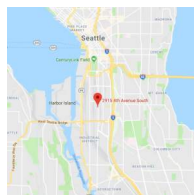
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Areas / Rooms

- Define each logical physical area on the project.
- Normally this will mean rooms enclosed by full height partitions, but not always.
- Sometimes it helps to define subareas within areas to control them separately with simple systems.

REI Flagship Store Denver, CO
Mithun

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Control Zones

- Add control zones / load controllers for each area.
- Take the time to name them according to project plan nomenclature.
- If space, add the function as well.

- Z1-27 Office Linear L2-1
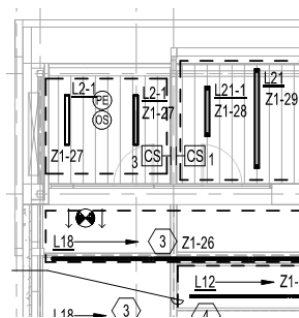
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Plug Load Zones / Controllers

- Add plug load controllers or outlets.
- Take the time to name them according to project plan nomenclature.

Courtesy: Enerlites

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Switches / Dimmers

- Add the number and type of switches / dimmers in each area.
- On/off
- Raise Lower
- Scene Control
- Does it have a logical function?
- Name them if appropriate:
  - S Door
  - N Door
  - Teacher Wall

Courtesy: Lutron, ETC

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Occupancy/Vacancy

- Add the number and type of sensors in each area.
- Vacancy
- Occupancy
- Timeout
- Sensitivity
- Does it have a logical function?
- Name them if appropriate:
  - Corridor S
  - Corridor N

Courtesy: Cooper, Lutron

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Daylight Harvesting

- Add the daylight sensors in each area.
- Designate primary and secondary daylight zones if appropriate.
- Open loop or closed loop? Both?
- Set dimming level if appropriate
- Any other functions that may be set?
- This may be the trickiest bit of setup.
- Name them if appropriate:
  - Corridor S
  - Corridor N

Courtesy: Lutron, ETC, Crestron

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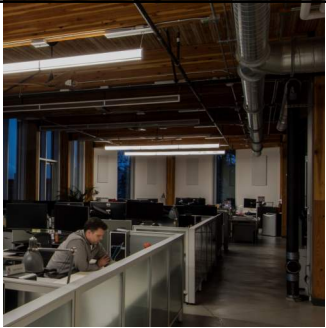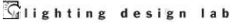
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Pairing

- Define which control zones are paired to:
- Switches
- Dimmers
- Switch Buttons
- Groups
- Scenes / Presets
- Vacancy Sensors
- Daylight areas
- Plug loads

PAE / Luma

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Setting Levels

- Set lighting levels within the area.
- Individual switch/zone
- Scene / Preset
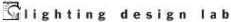
- Visual balance
- Energy Savings

Semiahmoo Resort
GGLO

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Task Tuning

- Set a high trim for the control system aligned with the target light level for the area.

- This can frequently result in as much as 30% initial energy savings in a well designed space.

Microsoft Building 16
Gensler

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Scheduling

- Add any time of day events for each area.
- Time On
- Time Off
- Weekday
- Weekend
- Astronomic
- Logical Events

2018 MARCH

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

www.free-printable-calendar.com

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Demand Response - Load Shed

- Define the control zones to be dimmed
- Define the dimming level
- Configure to accept the signal from the utility.

- Dimming wide areas by a small amount can meet the reduction target while retaining functionality.

King Abdullah University of Science and Technology
HOK

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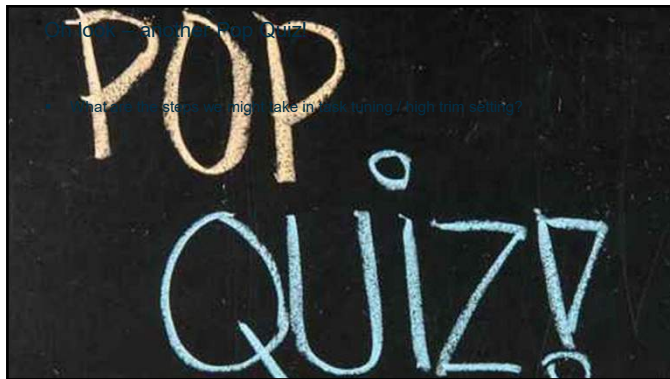
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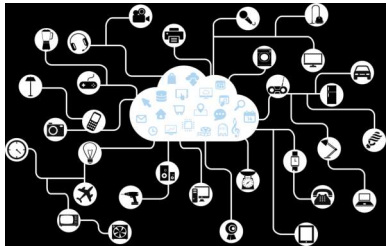Future of Lighting Controls

Where do we go from here?

What do YOU think?

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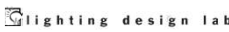
IOT

- HVAC
- Room Scheduling
- Communications
- Tracking
- Security
- Audio
- Video
- Your Toaster
- What else?

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IOT?

LEDs MAGAZINE

Target gives the go-ahead on IoT lights at half its stores

Published on: October 9, 2017
By Mark Halper
Contributing Editor, LEDs Magazine, and Business/Energy/Technology Journalist

At last the retailer and Acuity will roll out the world's largest lighting-based indoor positioning system, using Bluetooth but not VLC.

The world's largest known deployment of lighting-based indoor positioning is finally going full speed ahead, as US retail giant Target plans to roll out a customer engagement system in nearly half of its 1800 stores by Christmas.

Interested in articles & announcements on indoor positioning and IoT applications?

Using Bluetooth chips embedded in LED ceiling lights from Acuity Brands, Target will send signals to shoppers' phones. Drawing on a Target app, the phones will display an interactive map that guides individuals around the aisles, helping them find specific items and providing information about discounts.

Courtesy: LEDs Magazine

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Pop Quiz

- How many of you find this a bit creepy?

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Asset Tracking

- How might lighting / lighting controls be used for asset tracking?

- Other functions?

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Color Tuning

Courtesy: Finelite

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Circadian

Courtesy: CIBSE Journal, Sunn Light

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Key Light Stimulus Variables

- Intensity
- Distribution
- Spectral Power Distribution
- Duration – Dose
- Timing
- Photobiological History

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LiFi

- Requires line of sight
- More bandwidth
- Infrared or Visible
- Security
- Health Care
- Schools
- Public Realm

An LED will flicker light at extremely high speed that goes undetected by human eyes, nonetheless, a photodetector will pick it up easily. In the next step, it converts the received signal into electric current to provide you ultra-high speed.

Courtesy: GrayB

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Great day!

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NLC / LLLC Best Practice Guides

- LLLC Videos
    - Demonstrate simple primary control strategies
    - Simulates tenant improvement to highlight system flexibility

    - https://www.lightingdesignlab.com/resources

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Late Breaking News

- Report commissioned by NEEA on replacement vs redesign with LLLC

- Included in the downloadable handouts

- Also available from NEEA:

  - https://neea.org/resources/lllc-replacement-vs-redesign-comparison-study

September 3, 2020
REPORT #E20-315

Luminaire Level Lighting
Controls Replacement vs
Redesign Comparison Study

Prepared For NEEA:
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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 Value Proposition	March 16	10:00 - Noon
NLC for Warehouses	April 6	10:00 - Noon
NLC for Healthcare	April 20	10:00 - Noon
NLC for Schools	May 11	10:00 - Noon

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

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Click – Call – Connect

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Visit us online   **OR**   **Email Us**
lightingdesignlab@seattle.gov

Education

Advance your knowledge of complex lighting systems and energy-efficient strategies. From the science of light to the best practices of design...

LEARN MORE

Resources

Linking you to programs and technology experts that enhance your projects and support your business.

TAP INTO

Todays slide deck will be posted here!

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"That's all folks!"

Please take the online survey once you exit the webinar

We'll *SEE* you on the next call… ☺

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