Playing Nice: HVAC and Lighting Controls Integration

Lyn Gomes, PE, CCP, LEED AP, CLCATT, kW Engineering
Justin Lewis, PE, LEED AP, University of California Davis

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

Learning Objectives

After this presentation, attendees will be able to:

1. Describe how to modify standard VAV box control sequences for occupancy-based controls.
2. Recognize when and where the HVAC and lighting control systems need to be integrated.
3. Select the right type of integration that will blend with the facilities' maintenance structure and processes.
4. Discuss how occupancy sensor selection affects the control sequences

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Introduction

- Background
- 4 methods for integration
- Procurement process
- Lessons Learned and points of failure
- Integration
- Final thoughts

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Why should I care about lighting integration?

- Poor implementation of the integration and Cx :
  - Makes the Owner's life miserable
  - Makes the CxP's life miserable
  - Makes occupants miserable
  - Benefits may never be realized
  - May result in no energy savings
  - Money spent goes down the drain
- Designers dismiss the effort it takes to do the implementation – Don't do this!

Background- Why consider Integrating HVAC system to Lighting System

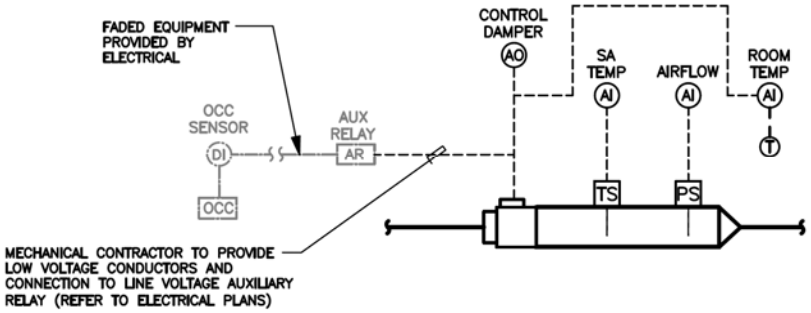
- Code requires occupancy based demand control of lights and HVAC(in certain space types)
  - Title 24 sec 120.1.c.3
- Owners desire energy savings
- Pushed by manufacturers, ESCOs, utilities
- Lightning⚡pace of lighting🤟controls industry
- Issues with the current design phase approach leads to finger pointing & hiccups
- Construction phase coordination difficult
- Lighting controls are uncharted territory for many electrical contractors

Four methods for implementing occupancy-based ventilation (Lyn)

1. Aux Relay within Occupancy Sensor
2. External Aux Relay
3. BMS/Lighting Control System Integration
4. Separate occupancy sensor
5. Others?

1. Aux Relay within Occupancy Sensor

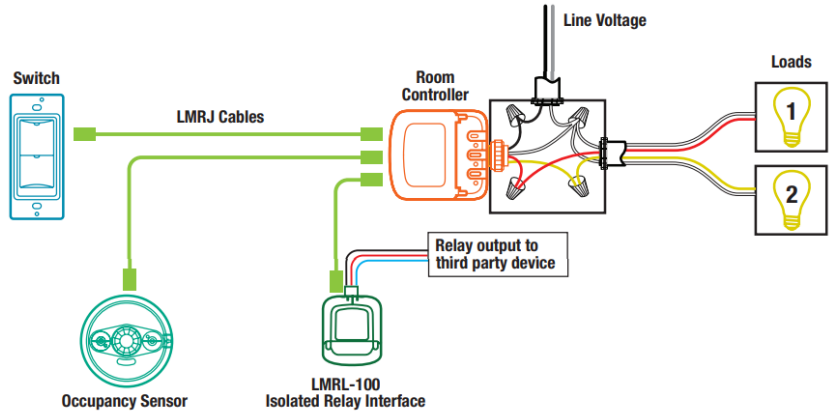
- Low or line voltage sensors only!!!!
- Responsibilities must be clearly defined
- Requires coordination in ALL phases
- How is occupancy status transmitted?



2. External Auxiliary Relay

- DDC Occupancy sensor plus:
  - o "Auxiliary isolated relay device", or
  - o "Auxiliary power pack"
- EE/LC specs components
- Best value to Owner
- Status? Multiple sensors?

External Aux Relay



3. BMS/Lighting Control System Integration

- Burden/responsibility shifts to contractor
- Specify very carefully!
  - Coordination table
  - Requires a fully networked lighting control system
- Include time in your budget for coordination
- Difficult for maintenance
- Don't forget about IT/networking!
- Status?
- Multiple sensors are easier

- Lighting
  - Occ sensor install (and rest of lighting control system)
  - Programming/adjusting occ sensor
  - Lighting panel configuration
- Data
  - Lighting Control Data Routers
  - Connection to campus network
  - Export table configuration
- HVAC Controls
  - HVAC controls wiring
  - HVAC BMS programming
    - Room
    - Panel
- Networking
  - Importing export table info into BMS (also with data)
  - Integrate lighting and HVAC systems together (also with HVAC and lighting)

Control System Coordination Table

INTERFACE / RESPONSIBILITY MATRIX

System	Division under which the following is specified				Remarks
	Equipment	Installation	Power wiring (note 1)	Control & interlock wiring (note 1)	
Energy Management & Control System (DDC)					
Central control workstations	15C	15C	16	15C	
Control panels	15C	15C	15C	15C	9
Control devices	15C	15C	15C	15C	
Lighting relay panels	15C	16	16	15C	10
Lighting wall mounted switch stations	16	16	16	16	
Lighting occupancy sensors	16	16	16	16	
Delighting sensors and controls	16	16	16	16	
Power monitoring sensors and gateway	16	16	16	16/ 15C	11

4. Separate occupancy sensor

- Architect: “Two occupancy sensors is ugly”
- Owner: “It’s more to maintain”
- Mechanical contractor may not understand how to install/adjust
- Responsibilities clearly defined
- Must be spec’d separately (usu in 250000)
- Mech engineer know about Occ sensors?
  - It’s usually “Sparky” territory

Sequences

- “Standard” VAV dual max sequence
- Explicit time delay
  - Coordinate with lighting, where applicable
  - Additional time delay may be appropriate
- Which occ sensors send the signal?
  - Easy for an office or conference room
  - Harder for a large assembly space
- Temp setbacks in the Goldilocks Zone
  - Risk losing control
  - 2 deg F is typical
- Pre-occupancy Purge Mode
- Minimum airflow when unoccupied
- Suppress demand?
- Off-hour trigger exemption

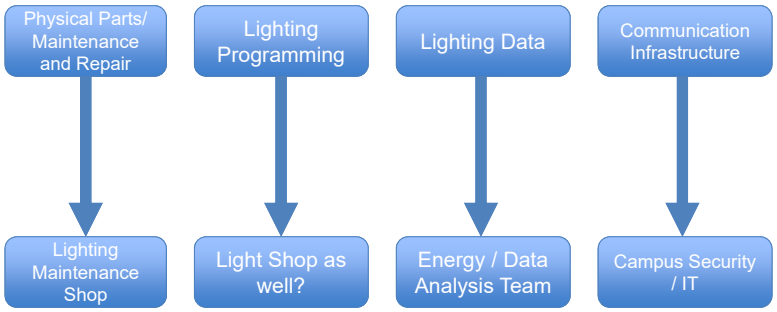
Make Decisions Early……*and not later*

- Figure out how you will control occupancy based HVAC at the start of the project
- Don't do it across multiple projects.
- Define how many lighting controls or metrics you need to manipulate or track centrally
- Define and assign responsibility for the commissioning and integration of all those systems and solutions.
- How much will be tested? 10% 100%

What do you want?

- What goes in the OPR?
- Mandates
  - What does code require?
  - LEED? GreenGlobes?
- Incentives
  - What are requirements?
  - Documentation?
- Energy Model?
- Beware of "or equals!"

Who is the Owner of the lighting control system?



- What are the requirements for each owner?
- What about the light system's integration to the HVAC system, who owns that?

HVAC Controls Group?

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How is your maintenance department set up? (Who will own it?)

- Maintenance - Physical Stuff
  - Lighting – lights, switches
  - HVAC – VAV controllers, thermostats, Air Handlers, etc
  - Control System Hardware- controls infrastructure
- IT Security
  - Network Architecture and infrastructure
  - Security Rules
- Data shop
  - Data Metering + integration with other energy metering
  - Data Historian
- Energy Manager
  - What is their role in your org?

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How Davis Does Energy Management - Team Approach

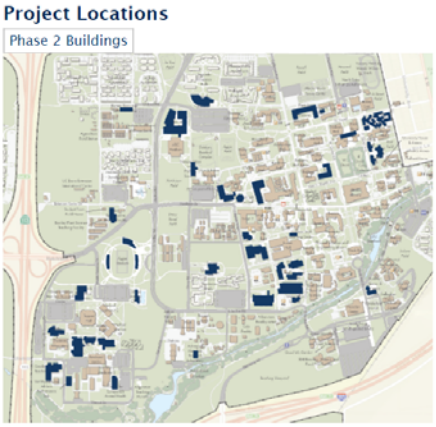
Associate Vice Chancellor of Facilities Management (AVC:FM)

- Energy Manager, Energy Conservation Office (ECO)
  - Energy Data (Utility and Whole Building Meter Level)
  - HVAC Controls Engineering/Energy Projects
  - LEED Existing Building/Operation Maintenance Group
- Building Maintenance Services (BMS)
  - HVAC Controls Shop
  - Lighting and Electrical Shop
  - Other Shops
- Central Campus IT
  - Security
- Design and Construction Management (DCM)
  - Architects and Engineers
- Researchers
  - Lighting (CLTC)
  - HVAC (Electrical Efficiency Center, Cooling Efficiency Center, LBNL partnership)
  - Other Research or Customer Based interests

Example Case: UC Davis' SLI Phase 2

Phase 2 Building Retrofits

- A $7.5 million design build project. Construction is completed. Work included lighting retrofits for 42 campus buildings representing 2.5 million square feet.
- Retrofit of Lights was efficient lamp and ballast replacements, LED fixture retrofits and advanced lighting controls to result in approx. 5.6 million kWh/yr savings.

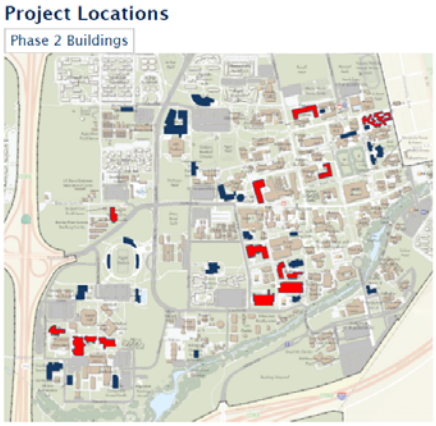


Procurement – the high level

- Originally a performance/value based bid.
- 3 qualified bidders, each with a ~$50k stipen to scope 42 buildings for the best performance
- Awarded contract was $5.5 million for 42 buildings.
- Attached to project was a custom lighting retrofit incentive program that would pay $.24/kwh saved. (Statewide Energy Partnership Program)

Example Case: UC Davis' SLI Phase 2

- **Phase 2 Building Digital Lighting Change Order**
- $2 million more to make lighting system centrally networked and integrated to HVAC in 14 buildings.
- HVAC Savings to be run thru separate incentive project



How to prevent a maintenance nightmare

- Say something goes wrong:
  - identifying the problem and fixing the issue should NOT require teamwork
  - Problems should be solved by one team, one trade
  - No finger pointing!
- Ensure issues can be resolved by existing staff
  - CxPs: frank discussion of staff's strengths, time commitments
  - Owners: If new expertise is needed, find it.

What didn't go well-Lessons Learned

1. Large scope changes disrupt schedule, require new design and due diligence, and additional planning to be done right… Schedule couldn't afford that. Due diligence wasn't done, good Cx wasn't done

   - LL-Don't make HVAC integration a change order.

What didn't go well-Lessons Learned

2. Incentive program prevented a combination lighting and HVAC project. HVAC integration was a separate project. So the lighting and HVAC projects were separate and non-coordinated.

   - LL-Don't make the HVAC integration a separate project

What didn't go well-Lessons Learned

3. Light project only partial per building, but HVAC demand control wanted the whole building. In order to get occupancy data from all rooms, the control scope of the lighting project grew a lot!

   - LL-Don't do a partial lighting upgrade or a partial HVAC integration

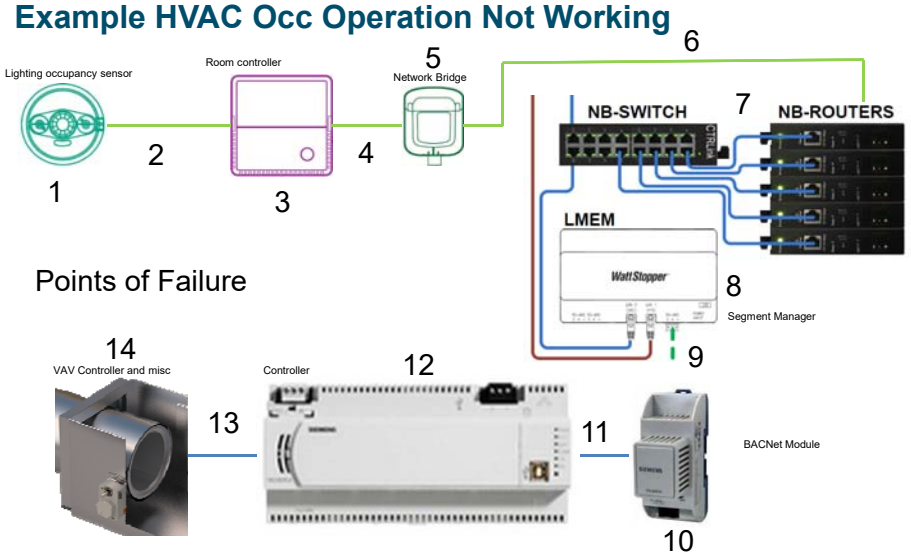
What didn't go well-Lessons Learned

4. We networked the lighting system centrally per building, and integrated the central HVAC system to central lighting system to do room level controls.
   - LL-We introduced 14 or more points of failure between an occ sensor and a VAV box that were just a few feet away from each other.
   - We're still having issues with the integration, too many failure points, lack of skills and tools to troubleshoot. It seems like more problems then it's worth.
   - We could have done room level integration instead with far fewer points of failure

What didn't go well-Lessons Learned

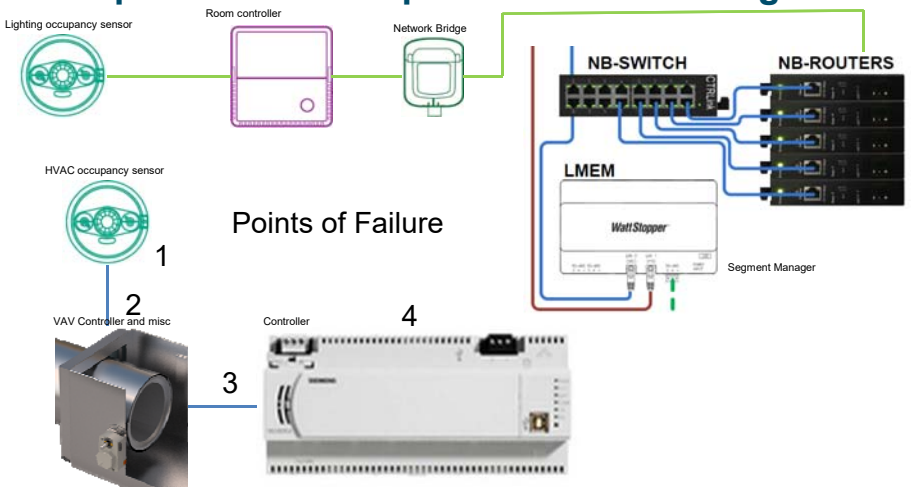
5. We didn't ever get the lighting trends commissioned, integrated into our historian, or ever really handed off to anyone.
   - LL-No one currently owns this expensive add-on. We will definitely think this through further on the next project.

Issues with Integration – Method 3
Example HVAC Occ Operation Not Working



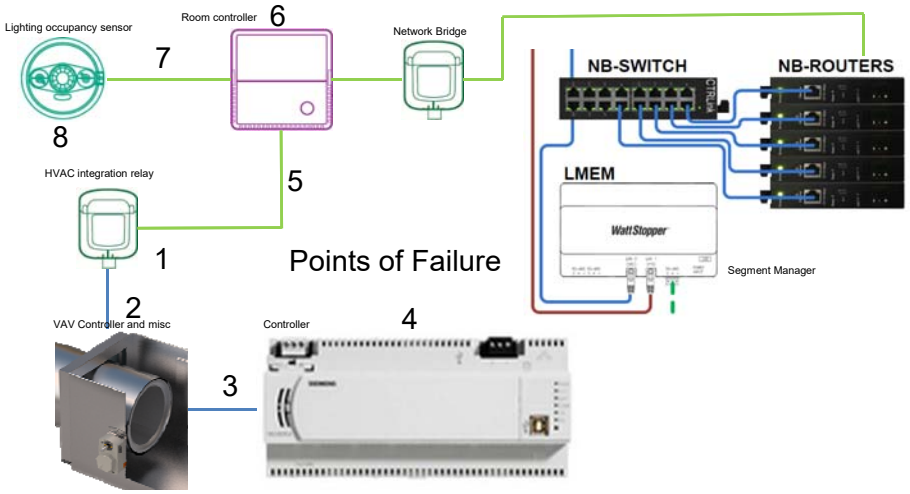
Points of Failure

Dedicated Occ Sensor – Method 4
Example HVAC Occ Operation Not Working



Points of Failure

Integration Relay – Method 2
Example HVAC Occ Operation Not Working



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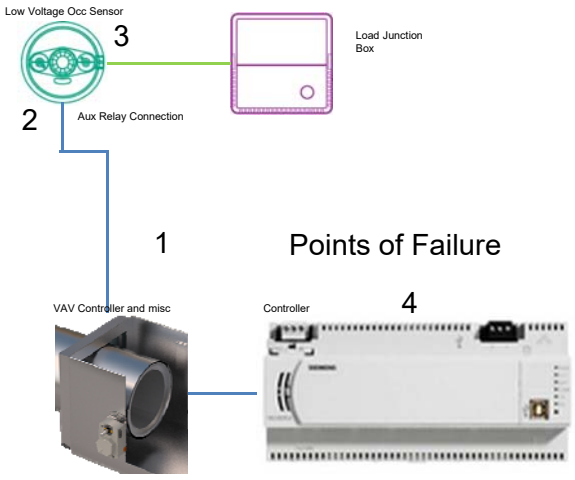
Integration Relay – Method 1
Example HVAC Occ Operation Not Working



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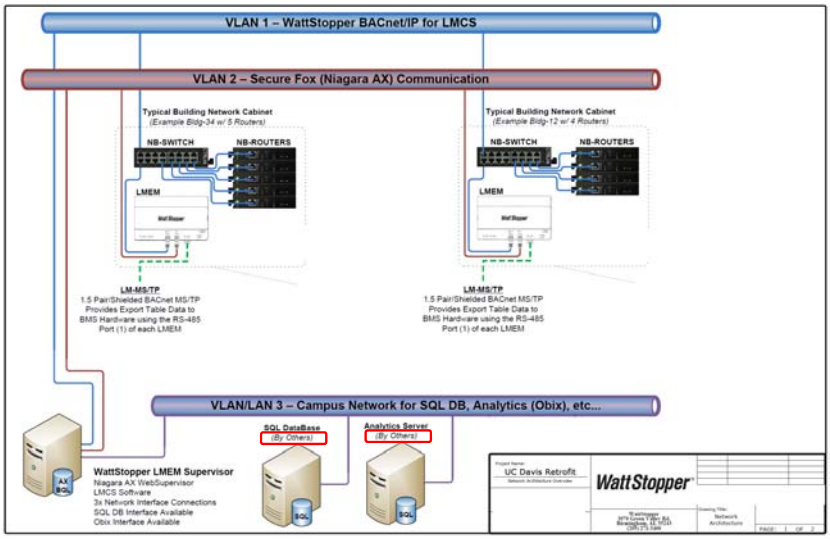
Examples of lighting data & where it pays off

- Wanted 24/7 lab but occ data showed occupied 2% of time during late night hours
  - Using data, their request for 24/7 operation was dropped
- Office building with a 12:00 pm to 3:30 am occupied hours. Previously would run from 6:00 am to 11:00 pm.
  - The schedule for the building was able to change using data.

UC Davis Data Integration



Results of Networking Trouble Shooting and Support

- Project finished in 2014
- Still having issues that were never resolved
- (Read long painful email)
- …Solution Pending…

Integration

- Don’t forgeddaboudit
- Which points are brought over?
- Best done by HVAC Controls technician or specialty integrator
- This must be explicitly stated in *both* EE/ME documents (specs & drawings)
- Commissioning: prepare for it!

Integration considerations – People

- Clearly define the scope of all the shops/trades involved
- Describe how to commission each part of the project
- Describe also how to trouble shoot each part for future issues, and which shop owns which pieces.
- Bring all parties together:
  - Project management
  - Facilities Management
  - Energy Conservation team
  - Data management team
  - IT/Security

Integration and Sequencing Questions

- How quickly does the HVAC system know when the room is vacant/occupied? How fast does it need to know and respond
- Is the time it takes for the HVAC system to go vacant the same as the lighting system? Are they on separate timers or subsequent timers
- What tools are in place to troubleshoot the occupancy state?
- If the occupancy/HVAC system isn't working, who do you call to fix it, the lighting shop, the HVAC shop, or the control engineers?

What can go wrong?

- Applied to inappropriate spaces
- Or-equal submittal not coordinated with mechanical (or shared with CxPM)
- Crappy sequences
- Lack of coordination
- Lack of knowledge
- Lack or clear responsibility ie
- Network latency
- Expectations not met
- Or-Equal lighting & HVAC control systems
- Incomplete integration
- Incomplete Cx – design/build/post-occ

EVERYTHING!

You have a choice…

- … But lighting control *systems* are not "or equals"
- Always defer to Owner's maintenance structure
  - *No energy savings will be realized if it is not programmed or maintained, or if it is disabled*
- Manufacturers report occupancy status differently
  - After time delay has expired
  - Instantaneously
- Sequences must be written differently
  - With lighting? Beware of too quick of a shift
  - Independent of lighting – dependent on manufacturer of occupancy sensor
  - Somewhere in between? Only for delay that is short
  - Staged delay? Industry isn't there yet

Summary: Lessons learned about application of this technology

- Make it easy to operate and maintain
- Get maintenance to work together
- Know what data you want, what you are going to do with it, where you're going to put it, and how it's going to get there.
- No project is ever perfect and will require a lot of work once it is installed
- Choose a dependable manufacturer

Bigger picture message – ideas:

- Commissioning is essential – before, during, and after projects
- Procurement (or PMs) must work with facilities. Holding capital planning accountable for how the system performs afterward is key to success.
- Get facilities buy-in before the project is initiated.
- Have clear success criteria
- Allow the time for ideas to gel

Conclusions

Lyn's Takeaways

- Lighting control systems advancements have left everyone in the dust
- You will never save energy if:
  - Not programmed
  - Not maintained
  - Disabled
- COORDINATION is essential – before/during/after design/construction/ occupancy

Justin's Takeaways

- Doesn't work when:
  - It's an afterthought
  - HVAC and lighting control systems are separate project
  - Never fully commissioned, so never working fully to begin with.
- Make sure systems are within your operations' staff's ability to troubleshoot

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Lyn Gomes, PE, CCP, LEED AP, CLCATT
kW Engineering
lgomes@kw-engineering.com

Justin Lewis, PE, LEED AP
University of California Davis
jlewis@ucdavis.edu

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