

Exponation

AIA Provider Number: 70119700

Lighting Commissioning: How to Do it; Why it's Important & Why it's Valuable

LSW13-S27

Lyn Gomes

James Donson

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Course Description

Without lighting commissioning, the energy savings from your high performance design could be wasted. The field of lighting commissioning is just developing and not many people understand how to do it, understand why it is important, or why it has value. This presentation will define lighting commissioning, describe its benefits, enumerate the how-to's of lighting commissioning, and provide lessons learned from past projects. Attendees will receive practical checklists for their next project.

Learning Objectives

At the end of this course, participants will understand:

- What lighting commissioning is and why it has value
- Why it is important to involve the Commissioning Authority during predesign
- What the Commissioning Authority looks for in the Owner's Project Requirements, Basis of Design and Design documents
- Tests the contractors need to perform on the lighting and lighting controls and what makes for good functional testing



Acronyms

- Cx – Commissioning
- CxA – Commissioning Authority or Agent
- OPR – Owner's Project Requirements
- BOD – Basis of Design
- BOM – Bill of Materials
- PFTs – PreFunctional Tests
- FPTs – Functional Performance Tests
- FTW – For the Win!



Agenda

Come with me and you'll see a world of pure illumination

- Introductions
- What is Commissioning (Cx)?
- Case Study
- Myths, Truths, Benefits, and Risks
- Cx Implementation
- Lessons Learned
- Building a Lighting Dream Team



So much time and so little to see...

Wait a minute. Strike that. Reverse It.



About Your Presenters

James Donson, PE, LC

- BSME Cal Poly Pomona, 2008
- kW's Lead Lighting Expert
- Diverse Project Load
 - Com & Ind. Audits/RCx
 - Lighting Buildouts
 - Lighting Design
- ZNE Retro-fit & Advanced Lighting Tech. & Controls

Lyn Gomes, PE, LEED AP

- BSME Cal Poly, SLO 2000
- kW's Lead CxA
- Triple Talent
 - HVAC Design
 - Construction
 - Startup
- 216,000 LEED Gold Lab and Office Space



What is Commissioning (Cx)?

The CxA is a lot like Refrigerator Perry...

- Cx is a quality *process*
- Begins *before* design
- Concludes *after* construction
- Ensures Owner Expectations are fulfilled
- Early Involvement Important
- New lighting systems cost money ...
 - ...so does energy lost due to poor function & setup
- Title 24 2013, CalGreen, & LEED all require Cx



.. they run the design intent into the endzone



Why Commissioning (Cx)?

What can a CxA do for you?

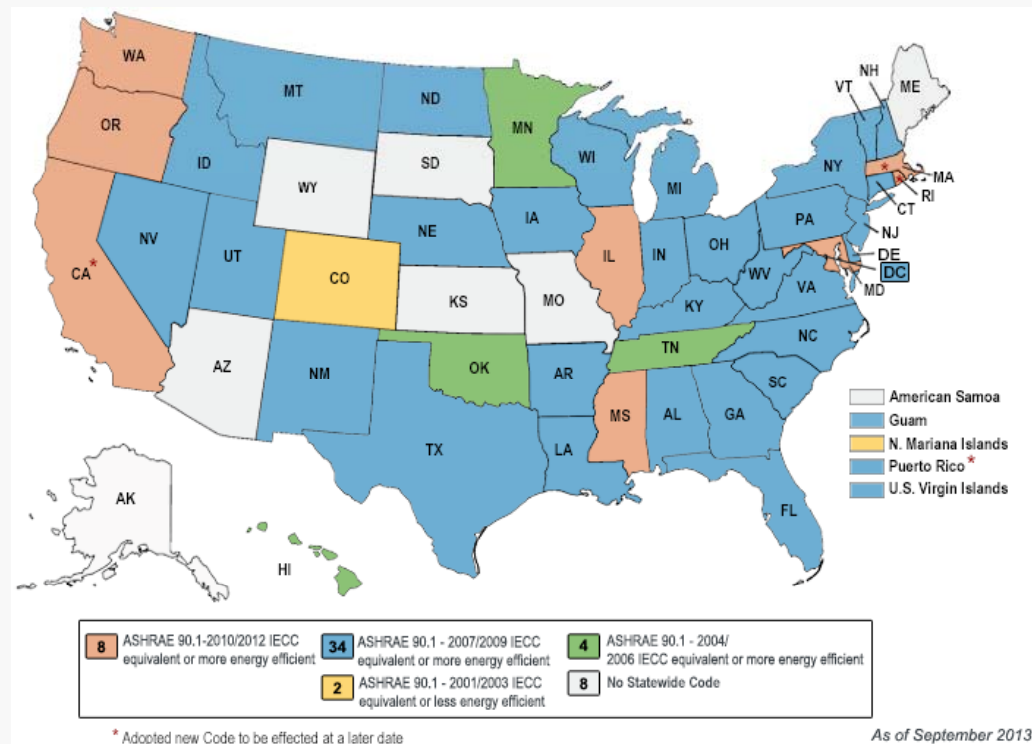
- Realize window sticker savings...
 - ... instead of losses from low tire pressure
- Set it up right
- Meets your needs
- Long term operation
- Green design gives you the theoretical...
 - ...Commissioning makes it reality



Energy Code & Lighting Controls

Controls that don't work don't save money

- Energy Codes
 - Title 24-2013
 - ASHRAE/IES 90.1-2010
- Iterative Changes
 - New technology
 - Expanded Applications
- Code requirements are evaluated on a cost-benefit basis
 - The benefits won't yield if commissioning is skipped



Case Study: Lighting with a CxA

Lab 126 TI of New Core & Shell Building

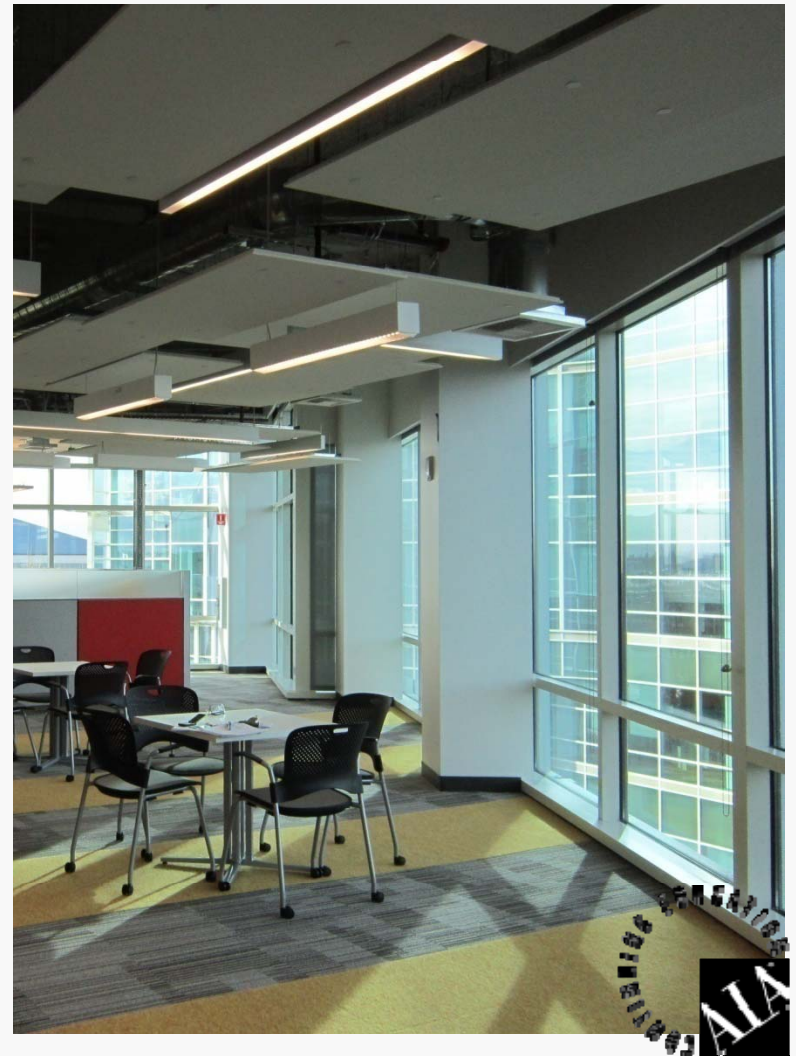
- Design Review:
 - 11 Lighting efficiency measures
 - 2.7 yr simple payback
- Submittal Review:
 - 2 Oversights
- Functional Performance Testing:
 - Occupancy sensor dwell
 - Daylighting calibration
- Total Savings to Owner \$7K annually
- Total Cost of Lighting Cx \$8K
- “Performance absolutely better than expected” - Owner



Attaining Better than Expected Performance

Lab 126 TI Owner Feedback

- Specifics Mattered
 - Lighting Control Zones
 - Correct Number
 - Sufficient Level of Control
 - Motion Sensors Actually Work
 - Sweeps Programmed & Time-Out
 - Easily Maintained Fixtures
 - Efficient Fixtures
 - Switches by the Doors
 - Complete Systems Manual
 - No “Lost Documentation”
- LEED CI versus LEED NC Issues





Does your lighting meet your needs?



Cx can make office lighting meet your design intent



Benefits of Involving a CxA

Managing Risk with a Commissioning Authority

- No CxA Creates Risk
 - Failure to Meet Expectations
 - More Change-Orders
 - Increased O&M
 - Loss of energy savings
 - From baseline
 - Over time (persistence)
- CxA alleviates Risk
 - Enforces the Owner's Project Requirements (OPR)
 - Extra QC prevents change orders
 - Systems Manual ensures persistence
 - Building Operators are trained



CxA: Mythbusters Edition

Myth

- Owner
 - Not worth the cost
 - One more sub to manage
- Architect
 - Will hold up the design
 - Disruptive
 - Blows up project budget
- Engineer
 - Makes me look bad
- Contractor
 - Will hold up construction



Reality

- Energy savings offset cost
- A good CxA is:
 - Proactive
 - Collaborative
 - Team-player
- Variables prevent design execution
- Fewer callbacks
- Focus on efficiency and persistence



Commissioning Implementation



So nice, we'll say it twice:

Cx can make office lighting meet your design intent



The CxA's Role in Lighting Design

A Guide Exists – IESNA DG 29-11

- DG 29-11: excellent overview of lighting Cx
- A CxA will review
 - Owner's Project Requirements (OPR)
 - Basis of Design (BOD)
 - Design
 - Submittals
- A CxA will create
 - Cx Plan, Specs
 - Prefunctional Tests
 - Functional Tests
 - Systems Manual
- Perform Functional Testing
- Ensure Training takes place



Do you have an OPR?



The Owner's Project Requirements (OPR)

Documenting what the owner wants from the design team

Pre-design

Design

Construction

- DG-29-11 documents all requirements
- Include big ideas with smart goals in the OPR
 - Who are the occupants
 - Describe tasks
 - Minimizing Lamp Types
 - Desired Level of Control
 - Integration Goals
- If no OPR, CxA needs to be aware of pitfalls in subsequent reviews
- Programming is not sufficient for an OPR Document

Table 1-1 from DG-29-11

General owner requirements that will establish the lighting Basis of Design	General owner requirements that will establish the lighting Basis of Design	Owner requirements for illumination of spaces
General requirements • Purpose of facility • Facility operating schedule • Day one use, future expansion, desired flexibility • Maintenance issues • General policies • Project schedule • Site information (pre-existing conditions, project history, goals) • Budget(s) (construction, costs)	Energy and sustainability goals • Applicable energy code and method of compliance • Design criteria beyond energy code (LEED, ENERGY STAR, utility rebates, demand response) • Additional energy systems related to lighting (daylighting systems, external louvers, natural ventilation) • Clarification of energy consultant roles • Alternate energy sources if applicable • Other sustainability goals (such as lamp and ballast recycling)	Daylighting • Overall daylighting performance goals such as code or program requirements • Daylight illumination objectives, including percent of each space which ambient and/or task light be provided mainly by daylighting • Variability of daylight expected diurnally or seasonally • Building form, orientation and envelope • Spaces in which occupants should have access to daylight and/or • What daylighting performance will be used—daylight factor or illuminance level • Envelope and glazing fenestration criteria for toplighting and sidelighting including heat loss/gain objectives • Interior materials criteria for reflectance and redistribution of light • Glare criteria and preferred control devices for mitigation
Owner directives • Site accessibility • Safety • Community affairs concerns • Preferred vendors • Budgets • Health or hygiene issues • Intersystem communication • Security requirements • Seismic requirements • Constructability issues • System training • Maintenance requirements (restricting lamp types, use of lamps) • Applicable building code	Training and operations and maintenance personnel expectations • Operating condition description • Warranty and maintenance requirements (building occupants, operating staff, service company, owner staff, other) • Training requirements (e.g., demonstration, instruction documents, procedures, maintenance expectations) • Systems Manual requirements (parts lists, system descriptions, troubleshooting needs, operations and maintenance requirements, level at which each set of material needs to be written for clear understanding) Commissioning • Designation of party responsible for updating OPR	Controllability • Code compliance • Degree of flexibility • Degree of automation • Integration of strategies • Integration with other building systems • Degree of occupant control • Ease of use



Basis of Design (BOD)

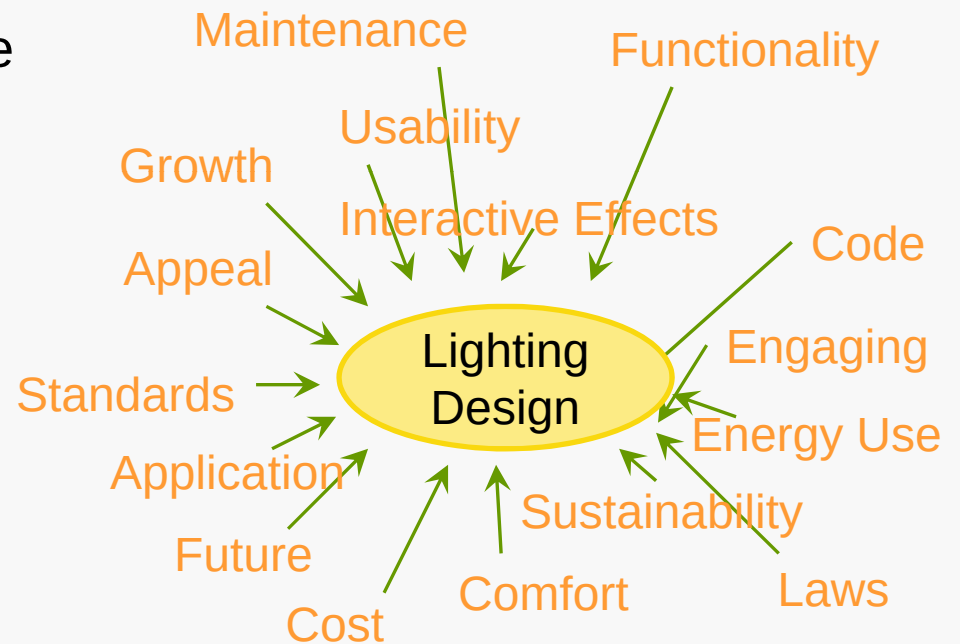
Where the design team documents their design plan

Pre-design

Design

Construction

- BOD informs the design as the OPR informs the BOD
- Identifying lighting issues now saves time and money later
- Review requirements include making sure the BOD meets the OPR
- BOD may not be achieved early in the pre-design process



Many considerations feed into the lighting design



Design Review & Lighting Design

Pre-design

- The CxA adds value in design review

- A CxA's success is team based

Design

- Reviews conducted include:

- Luminaire schedule
 - Control Selection & Layout
 - Specification

Construction

- End goal is to provide value for owner & maximize sustainability

- Attractive & Functional
 - Light Levels
 - Sparkle
 - Low Glare
 - Well Zoned
- Well documented
 - Schedules
 - Reflected Ceiling Plans
 - Control Programming
- Low Cost of Ownership
 - Efficient
 - Easily Maintained



Submittal Review

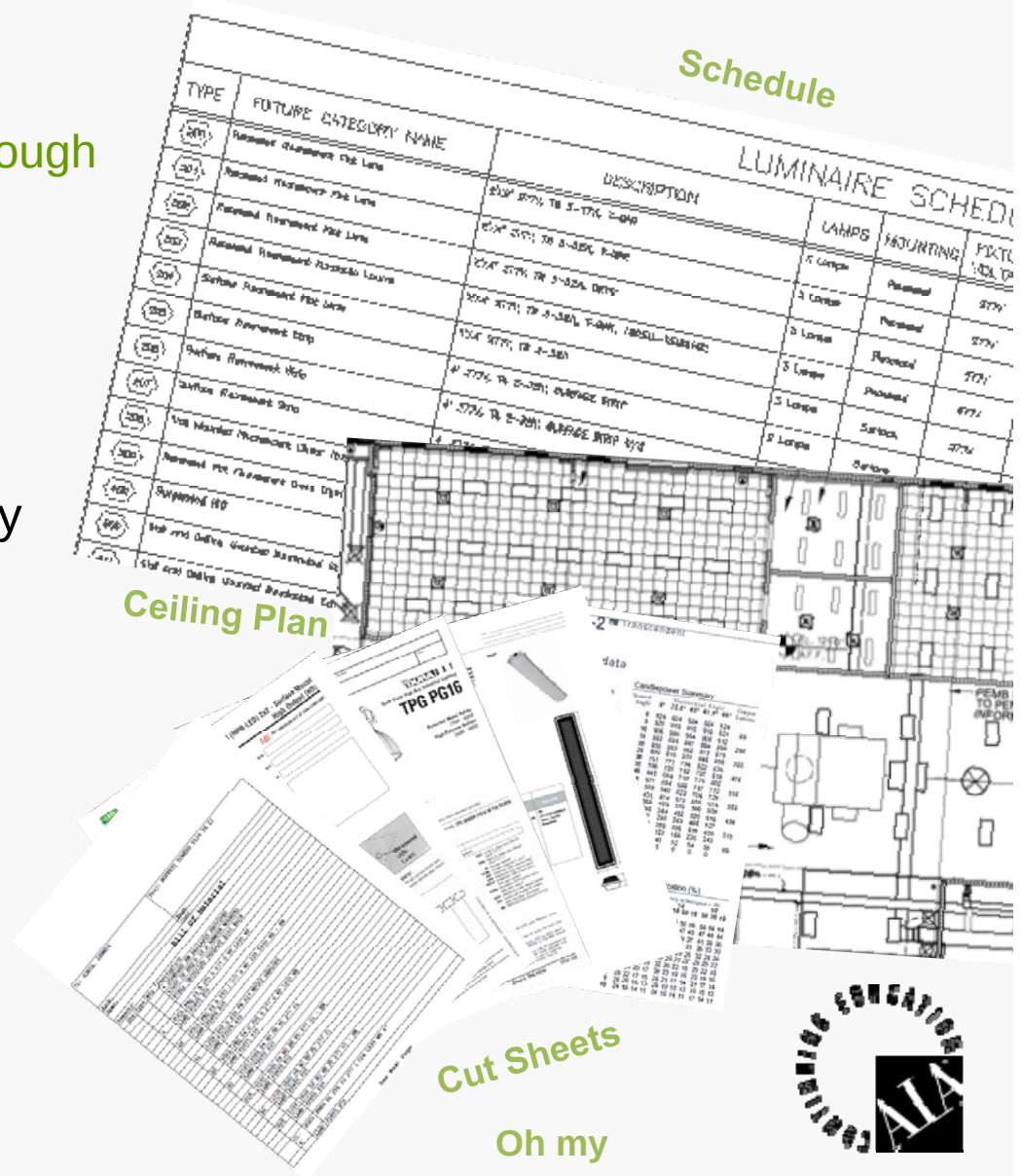
Making sure the design makes it through

Pre-design

Design

Construction

- Submittal Review includes:
 - Checking against design documents
 - Brief review of OPR & BOD
- Look for appropriate technology
 - Dimmable ballasts
 - Occupancy sensors
- True 'or equals'
- Make sure the BOM matches fixture cut sheets
- Lighting controls
 - Interfaces
 - Sensors



Lighting Controls Submittals

Interface & Component Selection Details

Pre-design

Design

Construction



- Interfaces vary by type & complexity
 - Computer (w/ BMS gateway?)
 - Human Machine Interface (HMI)
- Architecture
 - Network vs. Panel vs. Stand-Alone
- Control Components
 - Occupancy Sensors
 - Override Switches
 - Daylight Sensors
 - Scene Selectors



Prefunctional Tests

Better than a Van Halen greenroom

Pre-design

Design

Construction

- Includes a thorough check of all systems
- Occupancy sensors
- Photocells
- Sweeps & Schedules
- Noise
- Bad ballasts
- Lamps working properly



Functional Performance Tests

Why are we doing this? What should be checked?

Pre-design

Design

Construction

- If you know you're going to be checked... Don't you do it right?
- Find installation, calibration oversights
- Test:
 - Lighting levels
 - Sound
 - Control sweeps
 - Photocells and occupancy sensors
- Sampling can provide a balanced measure between cost and effectiveness



Training & Systems Manual

Pre-design

Design

Construction

- Lighting controls are more complex these days and require training
- Coordinated by contractor and performed by equipment rep
- Systems manual remains to provide a touchstone document to be there if building engineer changes
 - Lighting
 - Lighting controls
 - Drawings



Lessons Learned

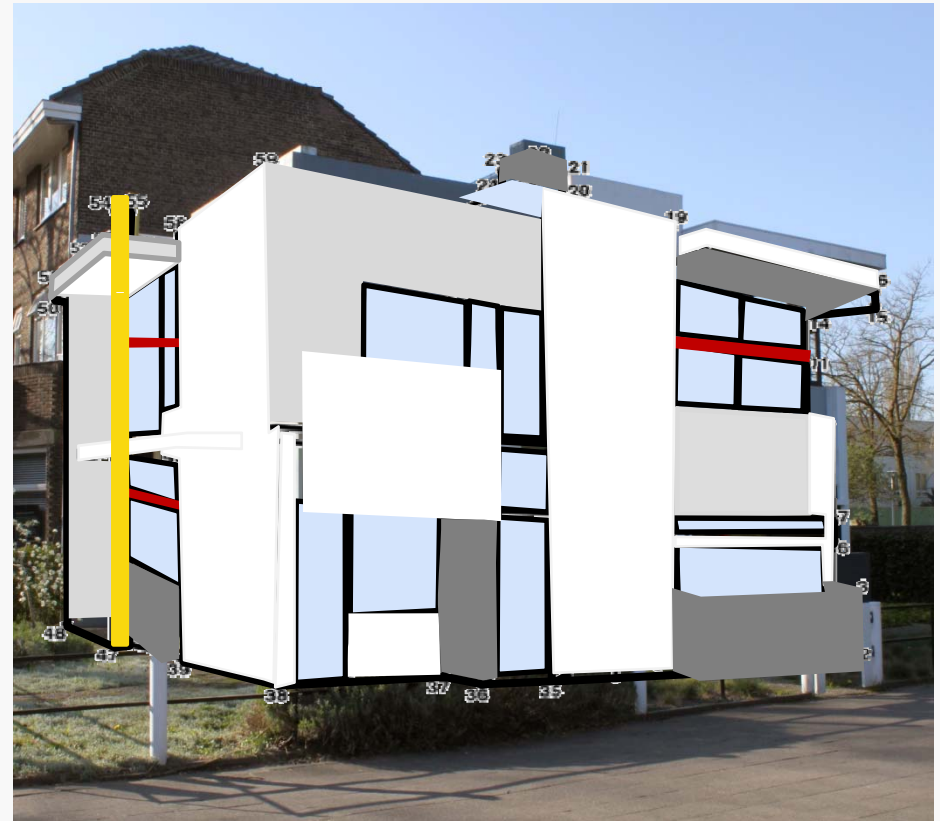
Things to keep in mind for successful project completion



Weak or Non-Existent OPR

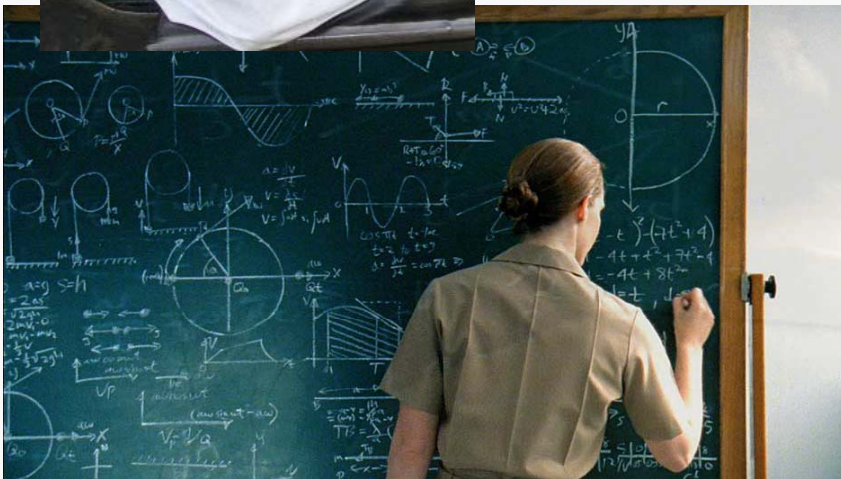
Connecting all the dots to success

- The OPR defines the Owner's expectations
- The design team connects the dots & fills technical details
- A weak OPR may have too few dots
 - Extends design period
 - More design revisions
 - Design review less helpful
 - Your needs are not met



Basis of Design is Out of Date

Breathe Life into this Living Document



- One of the first documents reviewed
- Most BODs are similar from job-to-job
 - Times & technology change
 - The design evolves
 - So must the BOD
- Keeping the BOD up to date ensures that design intent persists
 - Construction
 - Post Occupancy



Poor Commissioning Specifications

Leave no “teeth” for the CxA and Owner

- Weak or ineffective
- No firm requirements for Contractor
- Good specs have:
 - Procedures for repeated tests
 - Process description
 - Clear scope for CxA, Contractor



Common Design Review Feedback

These issues pop-up regularly

- Occupancy Sensors
 - Not located on drawings
 - No dwell schedule
 - Set to Auto-On 100%
 - Not applied to all appropriate space types
- Daylight Harvesting
 - Zone not indicated or incomplete
 - Sensors not on drawings
- No time clock/override schedule
- No sweep schedule
- Fixture Schedule
 - Model numbers don't match design requirements
 - Inconsistencies with OPR/BOD/VE items
 - One-off lamp types
- Design Plans/Layout
 - Egress path not indicated



Common Lighting Control Issues

Lights are on, but nobody's home

- Photocell
 - Calibration
 - Location
- Occupancy sensor
 - Dwell
 - Sensitivity
 - Location
- Network clock
 - Not programmed
 - Not there at all
- Lengthy overrides



Completing the Dream Team



How to Hire a Commissioning Authority (CxA)

- Establish goals for CX Process
 - OPR Assistance?

- Fundamental Cx

- Cx Plan, FPTs, & Cx Specs

- OPR, BOD Review

- Enhanced Cx

- Design Review, & Systems Manual

- Scope of systems Cx'd

- HVAC
 - Lighting
 - BMS
 - PV
 - Other Systems

- Questions to Ask a CxA

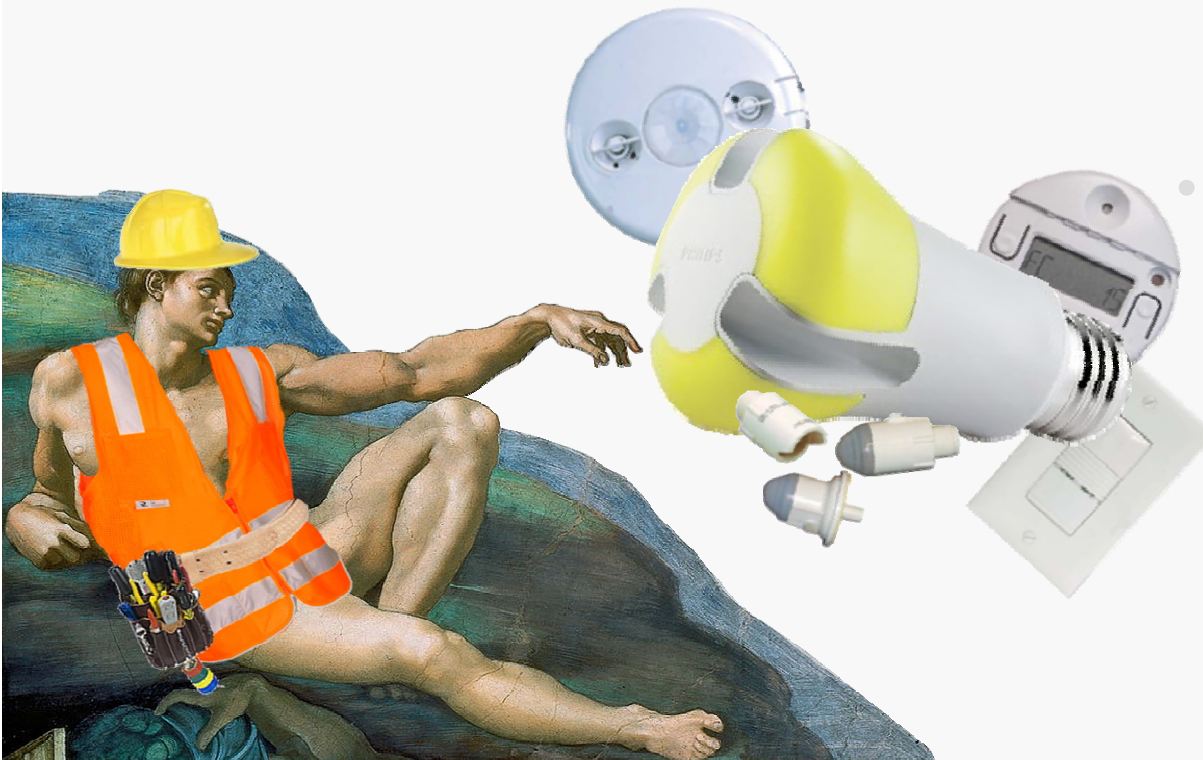
- Lighting Expertise?
 - Do you have experience with existing buildings?
 - How independent are you?
 - Do you customize your tests?
 - Sample Test
 - Systems Manual Approach?
 - Sample Manual
 - Design Review Approach?



Contractor Prequalification

Finding the Contractor with the Right Touch

- History of advanced lighting projects
- Advanced Lighting Control Training Program
 - CALCTP or NALCTP certified
- Ask to view past prefunctional tests



Next Steps

Reinforce what you've learned

- Go to the Show (if you haven't already)!
 - Look at control systems
 - What is it's ideal application?
- Checklists for Commissioning
- Helpful Reading:
 - IESNA DG-29-11
 - CCC Guide for Commissioning
http://www.cacx.org/resources/documents/CA_Commissioning_Guide_New.pdf
 - Energy Center of Wisconsin Guide for daylight sensors:
<http://www.ecw.org/project.php?workid=1&resultid=494>



Summary

There is no life, I know, to compare with pure illumination



- Commissioning is
 - Quality Control
 - Investment that pays off
- Involve the CxA early
- Create the OPR (Owner's Project Requirements) early & update often
- Design Review is in everyone's best interest
- Systems Manual delivers persistence



This concludes The American Institute of Architects
Continuing Education Systems Course



Lyn Gomes, P.E., LEED AP

lgomes@kw-engineering.com

James Donson, P.E., LC

jdonson@kw-engineering.com



Owner's Project Requirements and Basis of Design

Highlighting DG 29-11's Potential Requirements

Client Specific Requirements

- Vendors, Maintenance, Warranty

Application Specific Requirements

- Tasks & Work Surface Details
- Special Applications for Lighting
- Lighting Levels
- Color Temperature/CRI
- Daylighting Requirements & Glare Control

Indoor or Outdoor System Efficiency Requirements

Lighting Control System Requirements

Energy & Sustainability Requirements

Lighting System Design Goals

- Design Direction (planned approach to lighting)
- Illumination Levels for OPR tasks
- Design Criteria for Meeting or Exceeding Code
- Daylighting Integration within Design

Light Source Design Goals

- Lamp Varieties & Attic Stock
- Color Temperatures for Project
- Color Rendering Index
- Voltage

Exterior Light Design Goals

- Light Level Discussion & Illuminance Conditions
- Mounting & Prospective Pole Height/Spacing
- Environment Impact (trespass, sky glow)
- Security requirements

Lighting Control Design Goals

- Zoning Plan & Occupant Controls
- Control System Plan
- Scene Controls for Specialized Lighting
- Dimming, Daylighting, Occupancy Sensing

Indirect Design Elements Affecting Lighting

- Interior finishes (floor, ceiling, walls) & reflectances

Prefunctional and Functional Testing Checklists

Based on past experience, pre and post occupancy

Drawing review

Fixture Schedules

- Model numbers match schedule description
- Color temperatures are consistent
- Efficient lamps and technologies
- Program Start Ballasts for Occupancy Sensor Control

Match Dimming Controls with Daylighting

Reflected Ceiling Plans & Zone Maps

- Occupancy sensor locations, coverage, types
- Daylight zones
- Override switch locations
- Building shading & photocell location

Ensure Consistency

- Identify discrepancies
- High-priority items in specs and on drawings

Submittal review

OPR, BOD, VE, Change Orders, RFIs

Current Documents

Submittal

- Cut sheets
- Label from schedule
- Clear identification
- Compare the model numbers

Look for:

- Color temperature (within $\pm 100K$)
- Voltages
- Lamp types
- CRI (within ± 5)
- Missing information
- Circuits

Or Equals

- Save it for what matters



Prefunctional and Functional Testing Checklists

Based on past experience, pre and post occupancy

Prefunctional Testing

- Daylight sensor calibration
- Occupancy sensors
 - Ideal calibration: after construction complete, on night or weekend
 - Tough to do!

Functional Testing

- BE PREPARED
- Coordinate
- Occupancy Sensors
- Photocells/Daylight Sensors
- Fluorescent Ballasts
- Illumination Levels
- Timer Controls and Sequence of Operation