LCF LIGHTING CALIFORNIA'S FUTURE

PAC Show and Tell

Project 5: Retrofit Integrated Classroom Lighting System (R-ICLS)

Marc McMillan – Finelite

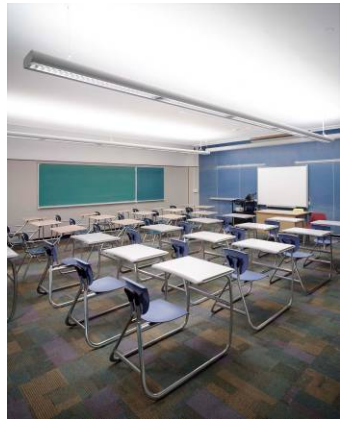
Wesley Morgan - CLTC

February 21, 2008

PIER PUBLIC INTEREST ENERGY RESEARCH "Research Powers the Future"

Project Summary

- Bring the benefits of the ICLS system to the retrofit market.
  - Meet the needs of today's teaching methodology.
  - Use an integrated system that meets CHPS and LEED standards for classroom lighting
    - General & AV Modes
    - Whiteboard illumination
    - Teacher Controls
    - Integrated occupancy and daylight sensors.



General Mode

Audiovisual Mode

Project Summary

- Deliver energy savings of 20% compared to Title 24
- Provide the functionality needed for today's teaching technology.
- Develop "Good", "Better" and "Best" solutions to meet different payback requirements.
  - Good: De-lamp luminaires where possible. Install dimming ballasts and Super T8 (3100 lumen lamps). New optical systems will be evaluated. Provide wall mounted and remote controls.
  - Better: Add a whiteboard luminaire to the "good" definition. Provide wall mounted and remote controls.
  - Best: Replace luminaires with new high performance 2x4 luminaire and add a whiteboard luminaire. Provide wall mounted and remote controls.

Project Summary

- End Result of Research
  - Data capturing teacher preference, energy savings, and system costs.
  - Direction for a retrofit guide for school districts
    - Provide decision makers with information necessary to make choices.
    - Costs, templates, implementation notes.
  - Lighting performance specification detailing necessary steps to commercialize system.

Current Activities

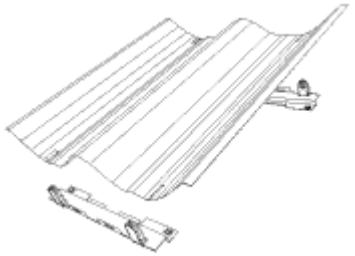
- Redeveloped Good, Better and Best Definitions
- Luminaire development and testing
- Control strategy development and testing
- Market analysis

Market Analysis

- Luminaires
  - Troffers
    - Prismatic
    - Parabolic
  - Pendants
    - Direct
    - Indirect
    - Direct/Indirect

Market Analysis

- Common Retrofit Products
  - Troffer Retrofit Kits (numerous mfrs)
    - Reflectors (film and white enamel)
    - Socket kits (delamping, T8 to T5)
    - Lenses/baffles
  - Controls Retrofit
    - Occupancy Sensors
    - Scene Controls



Market Analysis

- Advanced Classroom Systems
  - Components
    - Scene Controls
    - Occupancy Sensors
    - Daylight Harvesting
  - Manufacturers/Integrators
    - Finelite-ICLS
    - Lutron-BalanceLC
    - Lighting Control & Design
    - Peerless

Market Analysis-Initial Results

- Limitations
  - High Cost of Integrated Systems
    - New fixtures-HVAC Reroute
    - Labor intensive
    - Commissioning
  - Limited Savings of retrofit “kit” approach
    - Fixture based approach
    - Occupancy-dual circuitry
    - Daylight Harvesting (rarely)
  - Integration, warranty, troubleshooting costs of “custom” systems
    - Multiple component sources
    - Compatibility
    - Cost variability

Market Analysis-Initial Results

- Necessary Improvements
  - Cost-effective system integration
  - Complete savings potential
    - Fixture efficiency AND quality (IESNA)
    - Occupancy controls & classroom usage patterns
    - Daylight Harvesting
  - Simplified installation methods
    - Plug and Play
    - Less copper!!!

Product Specification

- Good, Better Definitions
  - Good
    - Delamp luminaires if necessary
    - Change lamps to high performing 3100 lumen T8 lamps
    - Change reflectors if necessary
    - Change ballasts to dimming ballasts
    - Incorporate teacher controls
  - Better
    - Perform same changes as “Good”
    - Add a whiteboard luminaire
- Best Definitions
  - Best
    - Replace luminaires with high performance recessed luminaire
    - Add a whiteboard luminaire
    - Incorporate teacher controls

Technical Advancements

- Luminaire Design
  - Multiple luminaire designs have been developed and evaluated.
    - Recessed luminaire with suspended lamp shielding element.
    - Benefits
    - Challenges

Technical Advancements

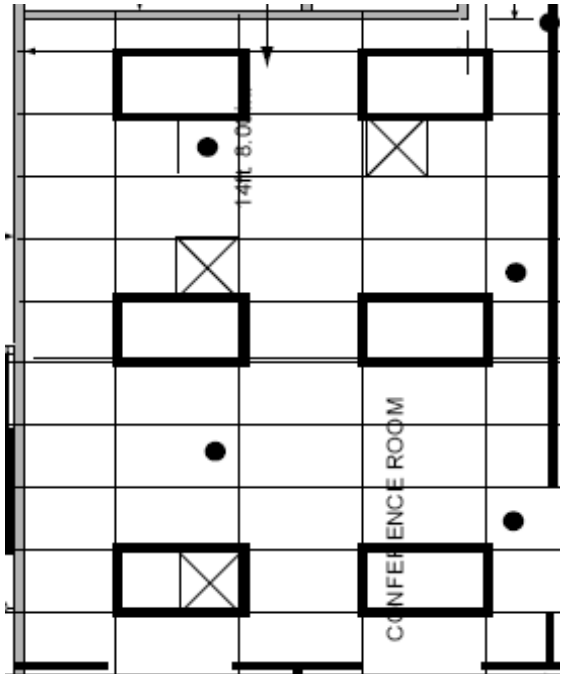
- Luminaire Design
  - Multiple luminaire designs have been developed and evaluated.
    - Recessed luminaire with suspended lamp shielding element.
    - Recessed luminaire with flush shielding element – T5 lamp

Technical Advancements

- Luminaire Design
  - Multiple luminaire designs have been developed and evaluated.
    - Recessed luminaire with suspended lamp shielding element.
    - Recessed luminaire with flush shielding element – T5 lamp
    - Recessed luminaire with regressed shielding element – T8

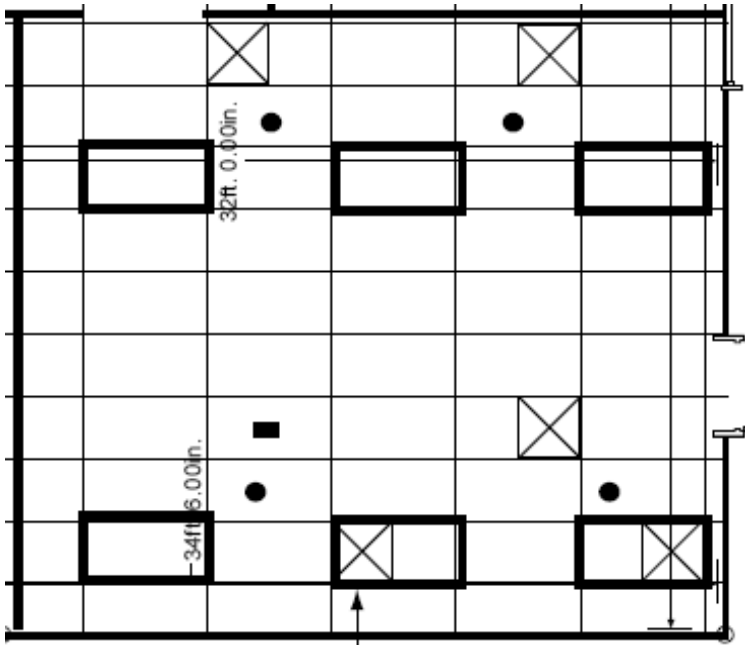
Technical Advancements

- Luminaire Design Advancements
  - Appearance Quality
    - Even brightness in the upper reflector
    - Lamp shielding
  - Performance – 1T8 on 8x8 spacing
    - 64 square feet
    - 1.2 BF ballast
    - 3100 lumen lamps
    - Energy: 0.59 w/ft^2
    - Average Illuminance: 50 fc



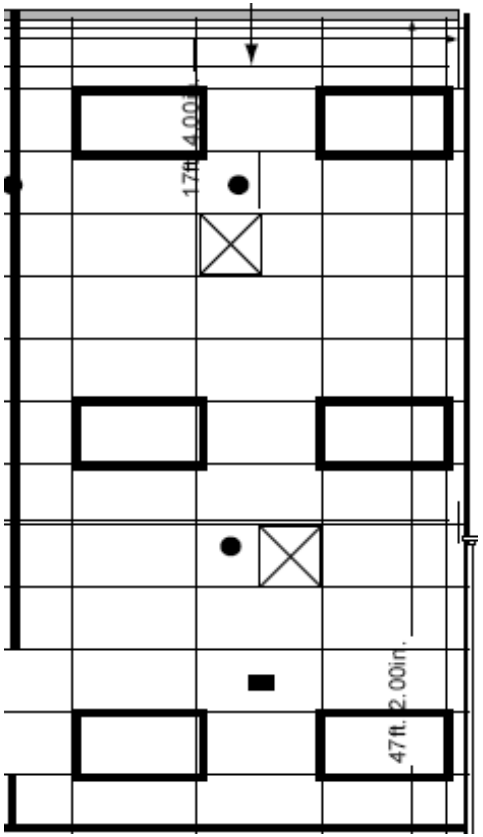
Technical Advancements

- Luminaire Design Advancements
  - Performance – 2T8 on 8'x12' spacing
    - 96 square feet
    - 0.88 BF ballast
    - 3100 lumen lamps
    - Energy: 0.57 w/ft^2
    - Average Illuminance: 44 fc



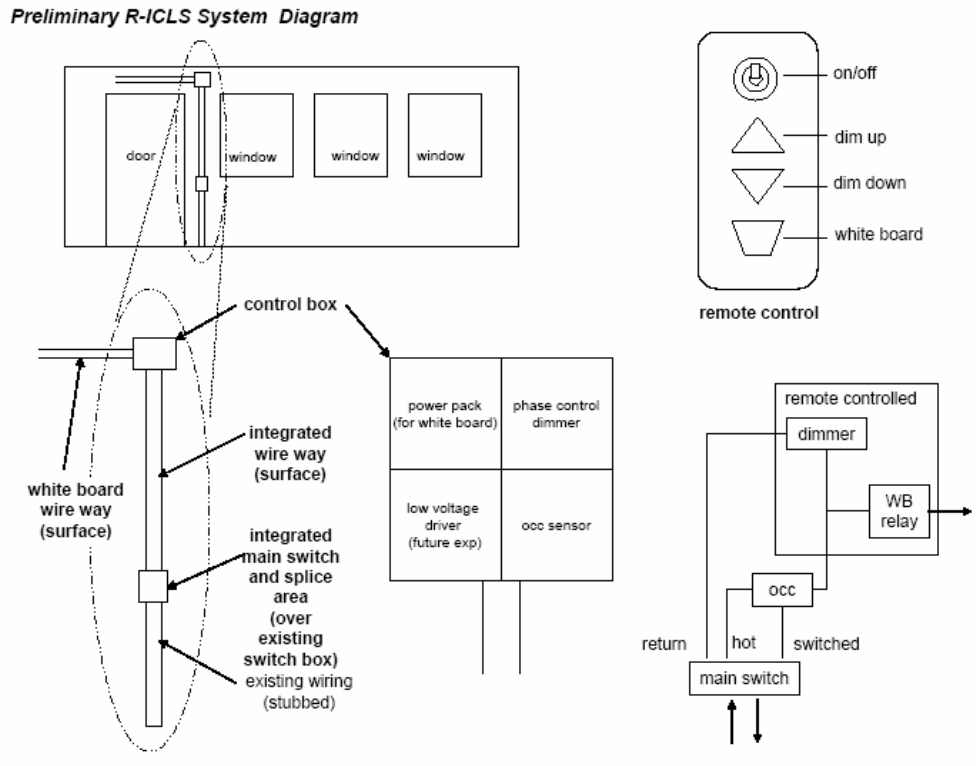
Technical Advancements

- Luminaire Design Advancements
  - Performance – 2T5 on 8'x10' spacing
    - 80 square feet
    - 1.0 BF ballast
    - 2730 lumen lamps
    - Energy: 0.81 w/ft^2
    - Average Illuminance: 58 fc



Technical Advancements

- Control Design General
  - Objectives:
    - Develop control strategy that can achieve Audiovisual mode without out the need to penetrate the ceilings and walls.
    - Develop methodology that enables the system to be installed easily, requiring little or no commissioning on site.
    - Incorporate occupancy control.
    - Incorporate teacher control.
    - Evaluate remote control applicability



Technical Advancements

- Control Design
  - Develop Powerline Dimming Module:
    - Off-the-shelf solution
    - Factory “Commissioned” RF signals by classroom
    - No interference between classrooms
    - Includes a wall mounted and handheld control
    - Includes an occupancy sensor
    - Phase cut dimming

Market Barriers

- Dimming Ballast Cost
  - We need the ballasts to decrease in cost before we can make major changes
- Commitment for Design
  - The system is in between to successful implementation strategies
    - Mass appeal and distribution
    - Special architectural feature

Challenges to explore

- We don't know how many fixtures will be in the classroom
  - The most attainable goal is to reduce connected load by 1/3
  - Usage will reduce energy consumption
  - We can create templates for the most common configurations, but can't always hit 1 w/ft^2
- Dimming is the logical way to achieve AV, but the high ballast cost may limit mass commercialization.
- Remote control is appealing to users, but may pose other issues – this needs to be explored in the research.
- Need for commitment to make the solution commercially viable

Next Steps

- Identify school sites-demonstrations
  - K-12
  - Universities
- Identify contractors
- Assemble and test control systems for installations
- Develop methodology to monitor difference between remote and wall mount control usage