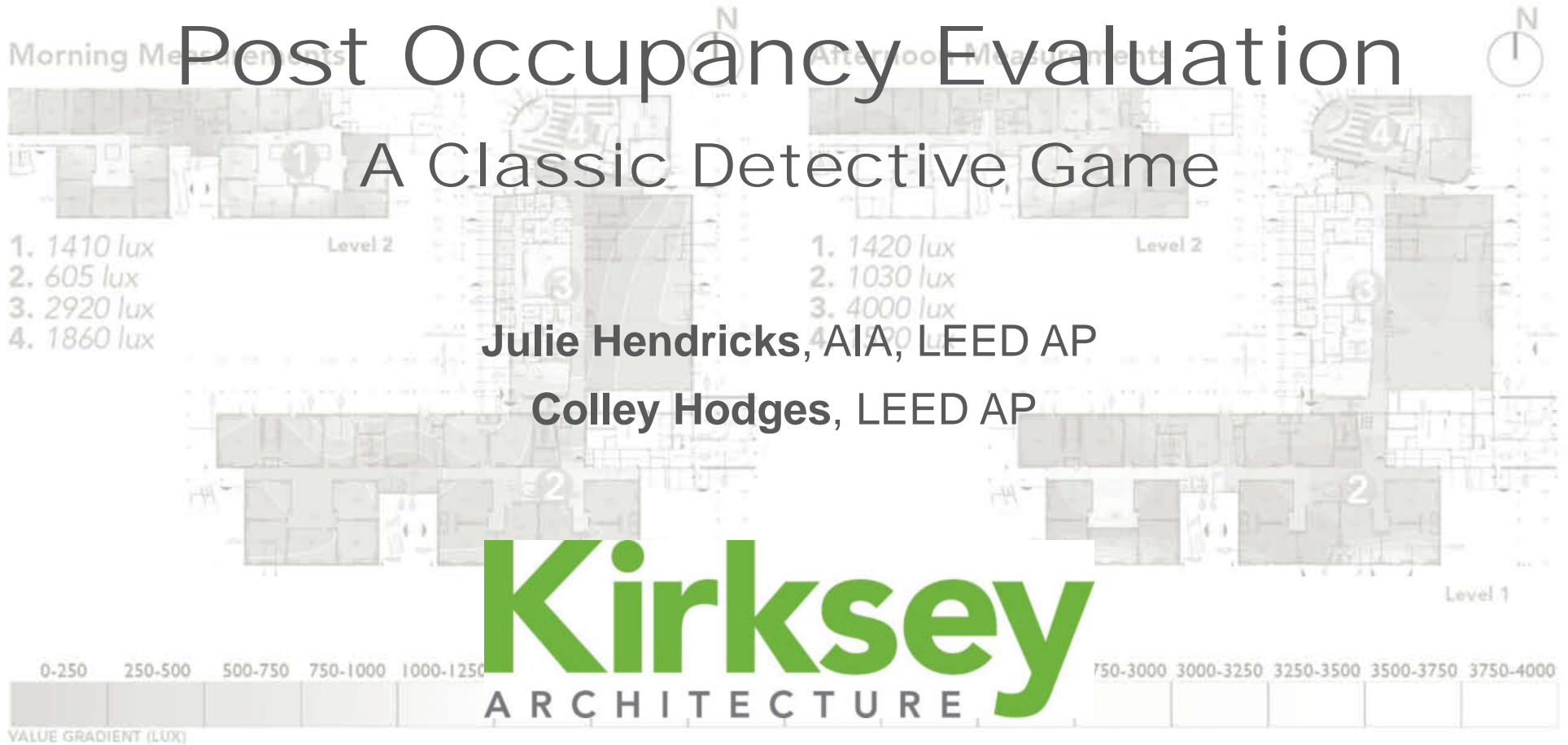


# Post Occupancy Evaluation

## A Classic Detective Game

**Julie Hendricks, AIA, LEED AP**

**Colley Hodges, LEED AP**



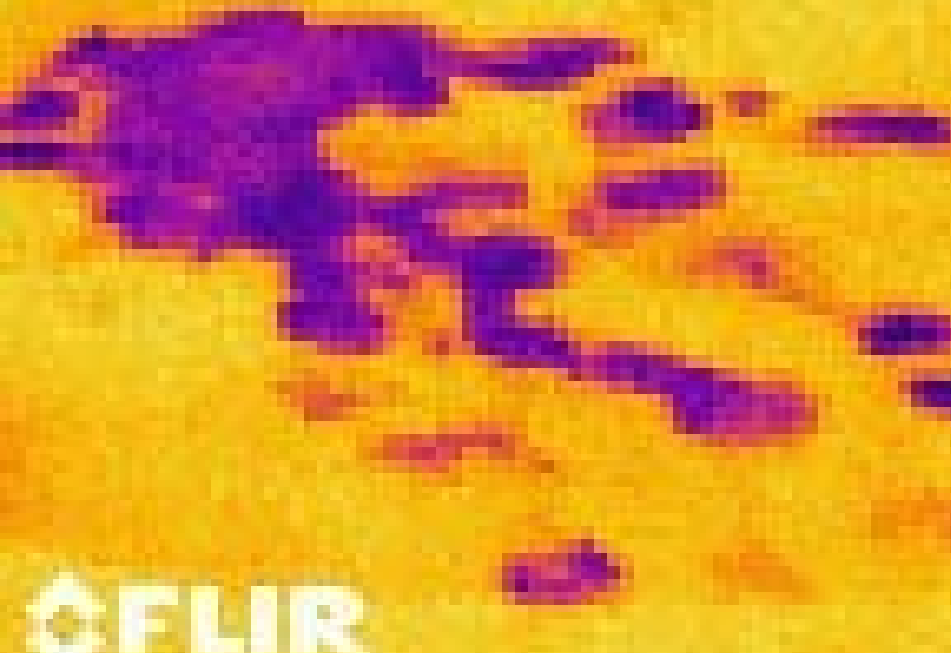
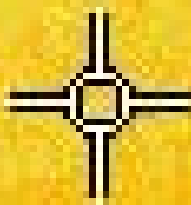
# Kirksey

ARCHITECTURE



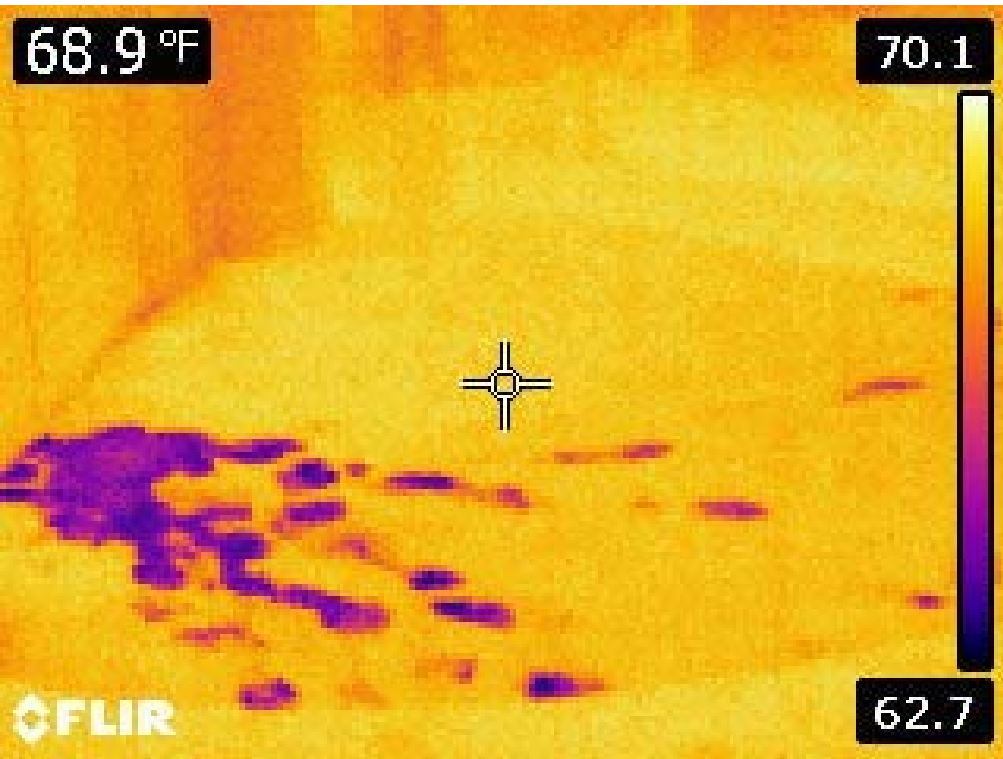
68.9 °F

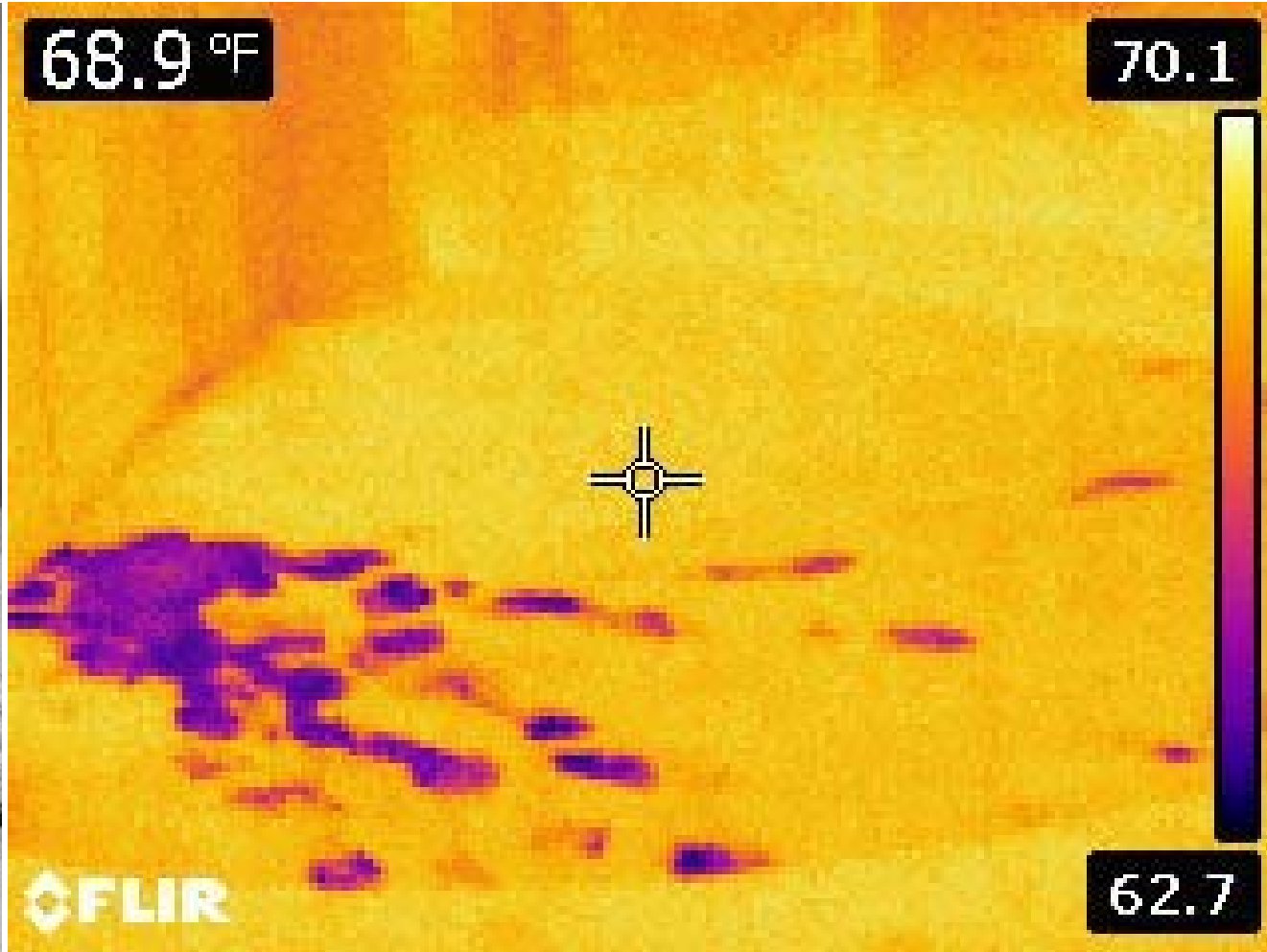
70.1

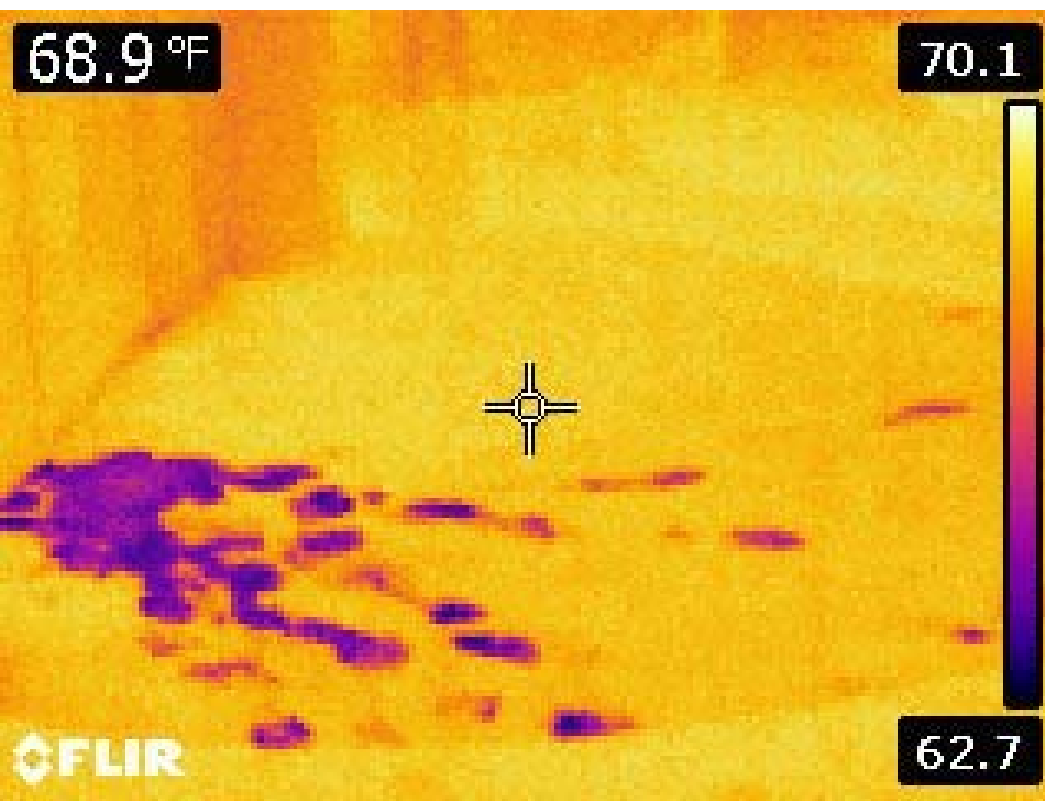


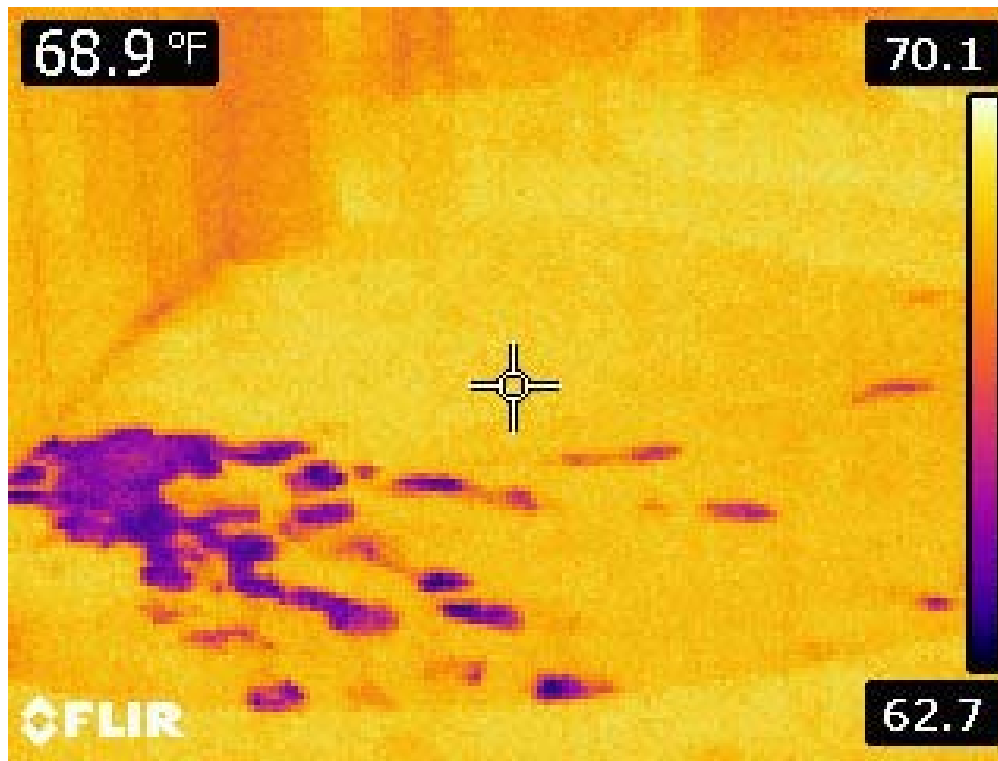
FLIR

62.7





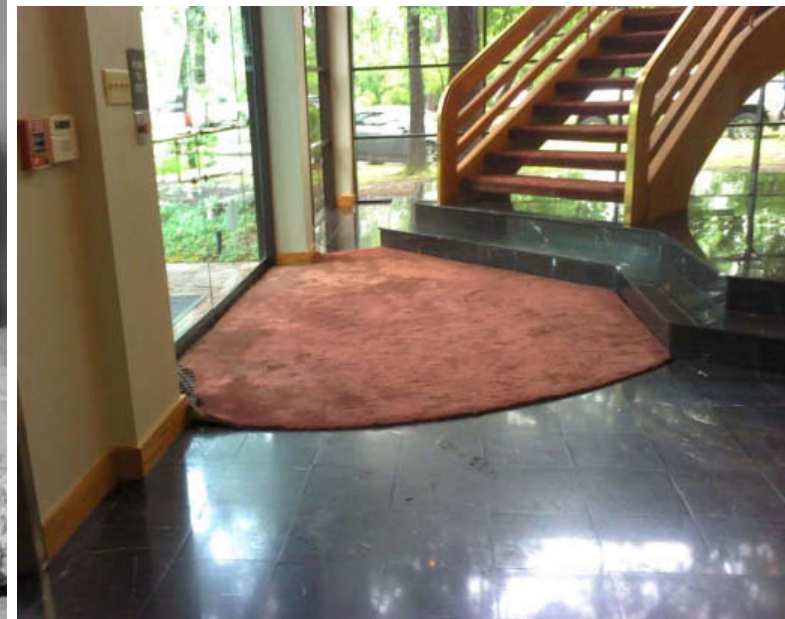


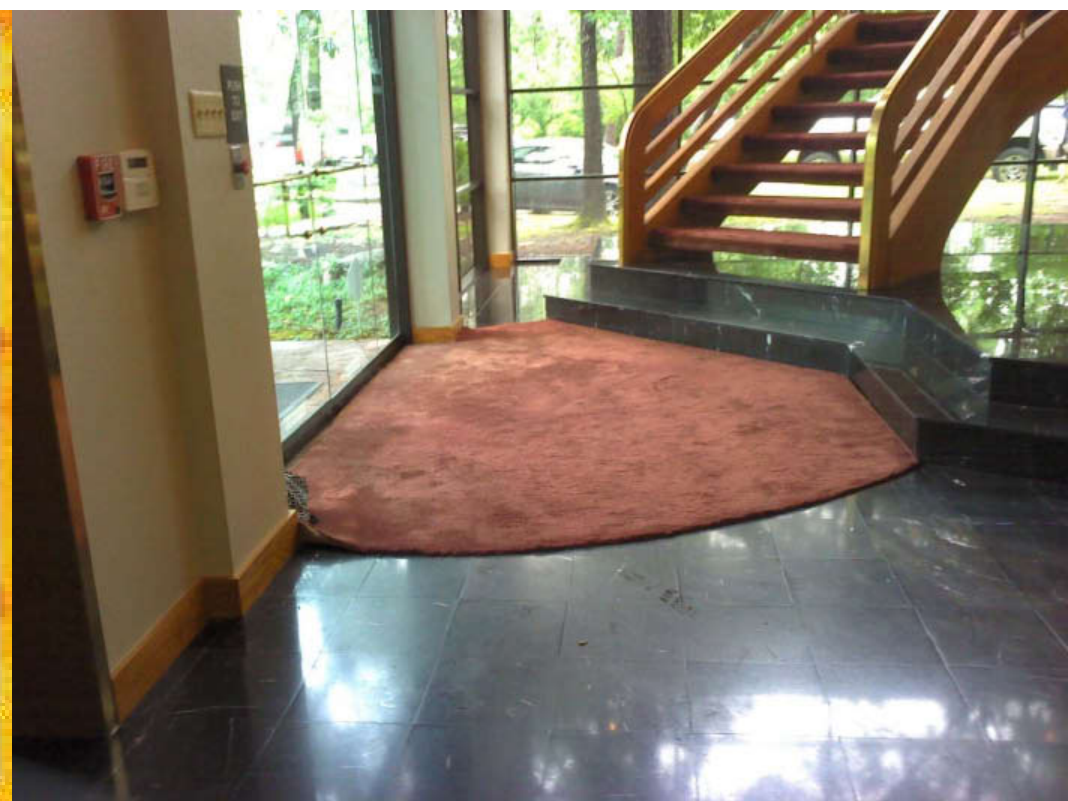
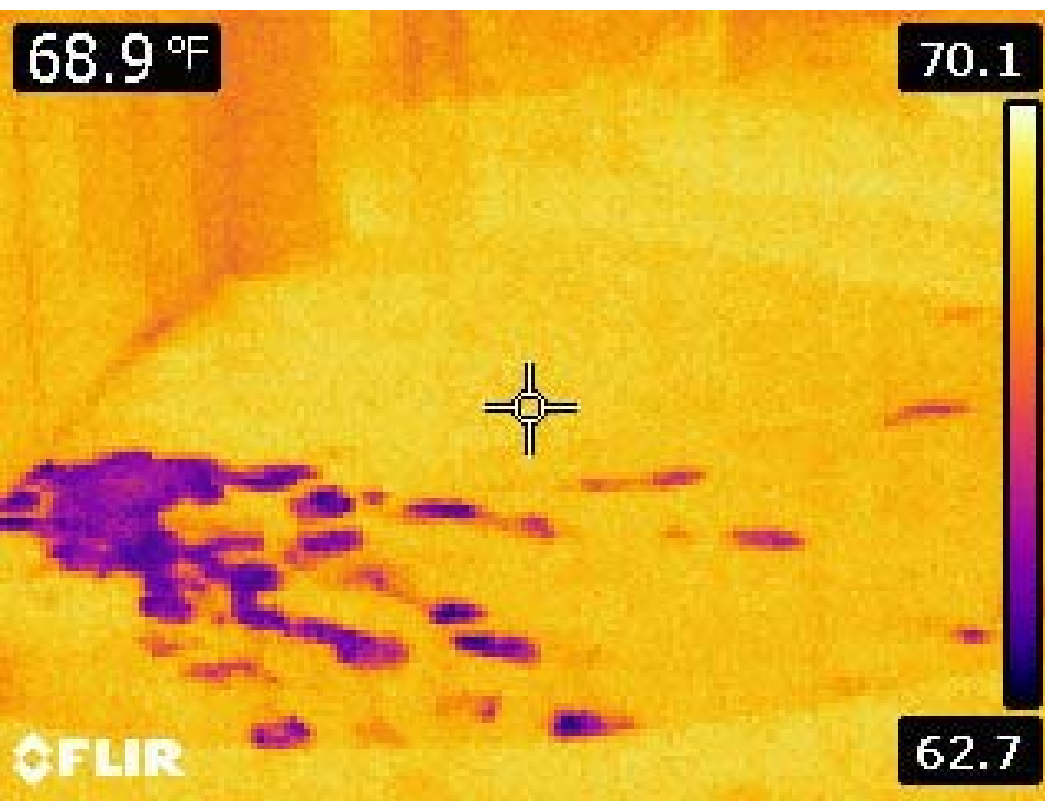


A.

B.

C.

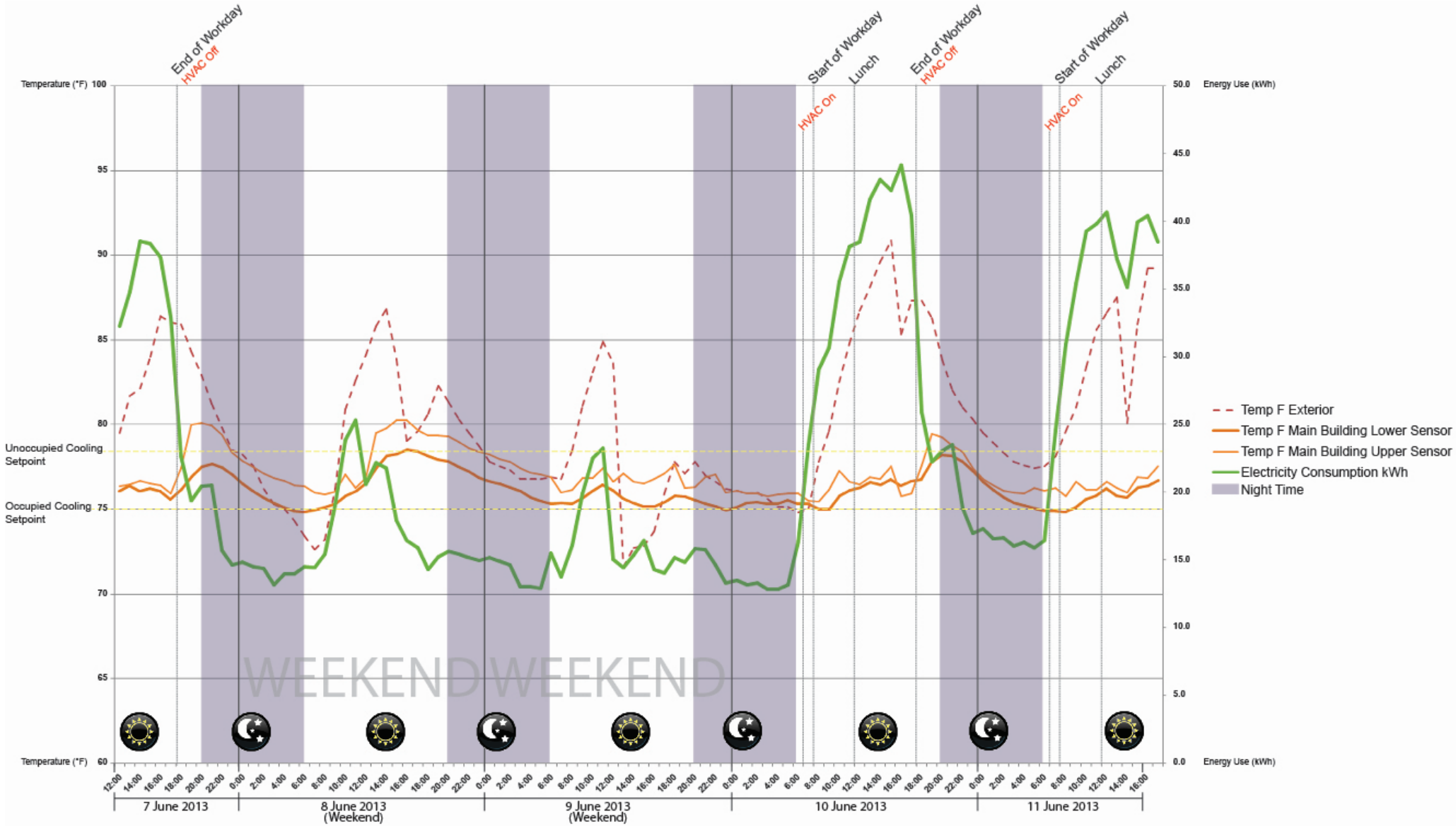








# FOCUS ON PERFORMANCE



# CHECK AGAINST DESIGN INTENT



# VERIFY PREDICTED PERFORMANCE



# PROVIDE RECOMMENDATIONS FOR BUILDING OPERATIONS

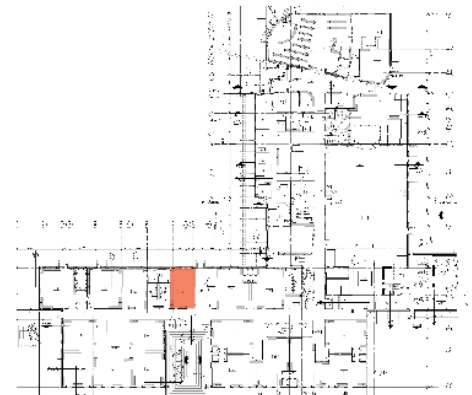


## Facilities Operation and Maintenance

The efficiency of a building is highly dependent on its operations and maintenance. Facilities operation and maintenance also greatly affect the occupant comfort.

### Survey Responses

- ▶ The most significant maintenance issue is ongoing issues with the air conditioning units
- ▶ The standard occupied setpoints for the building is 72° for cooling and 80° for heating
- ▶ Building zones are isolated to minimize energy use
- ▶ The HVAC systems are right sized for the building
- ▶ Room 177 receives the most complaints in the school about it being too hot
- ▶ The low-flow plumbing fixtures are somewhat satisfactory, often having issues with miscalibrated or malfunctioning auto sensors
- ▶ The drip irrigation system used on site has issues with some of the tubing coming loose
- ▶ Satisfaction was reported towards the green housekeeping being practiced



Room 177

# POEs - SUMMER 2013





# POEs - SPRING 2014



# POEs - SUMMER 2014



# POE TOOLS: QUANTITATIVE MEASUREMENTS



**THE FACTS  
MA'AM -  
JUST THE FACTS**



# ILLUMINANCE METER



[http://www.tequipment.net/assets/1/26/DimRegular/m502g\\_image\\_8.jpg](http://www.tequipment.net/assets/1/26/DimRegular/m502g_image_8.jpg)

Anything above  
considered  
uncomfortably  
bright

5,000 Lux

Anything below  
considered  
uncomfortably  
dark

250 Lux

# SOUND LEVEL METER



# CO2 MONITOR

Drowsiness may occur

1056 ppm

Average Outdoor  
CO2 Level

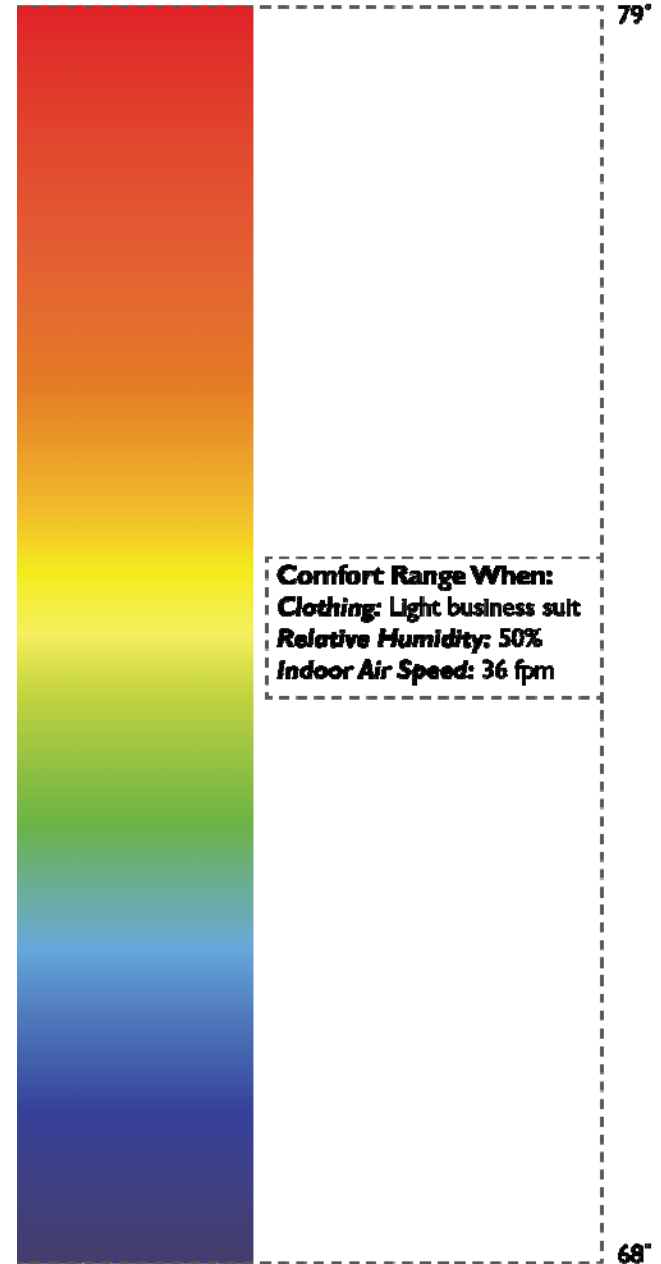
400 ppm



# PSYCHROMETER + THERMOMETER

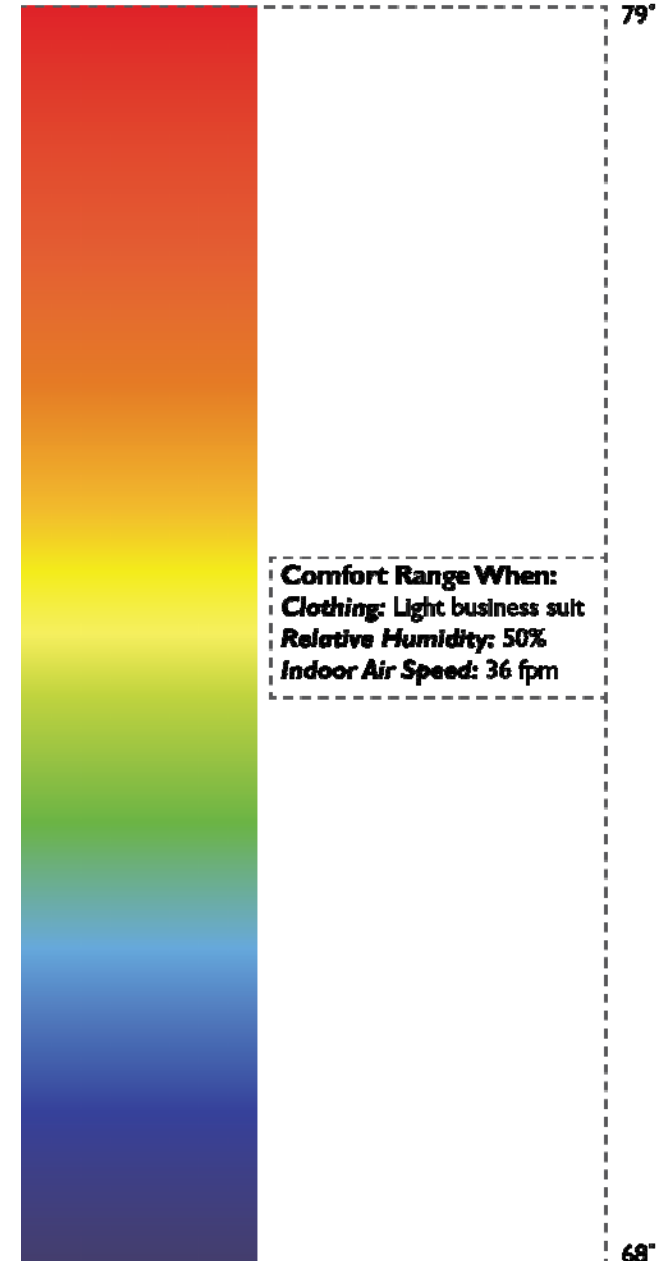


[http://www.hygrometer.us/wordpress/wp-content/uploads/Precision\\_Psychrometer.jpg](http://www.hygrometer.us/wordpress/wp-content/uploads/Precision_Psychrometer.jpg)



68°

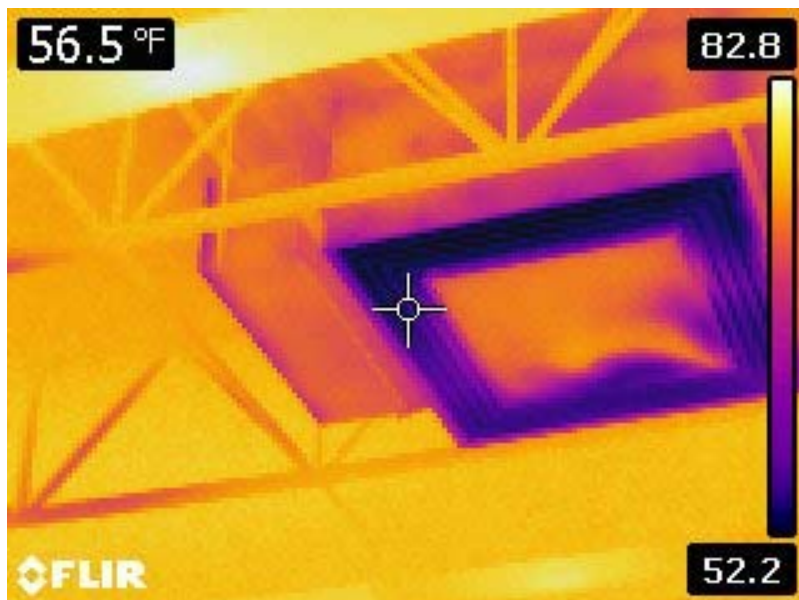
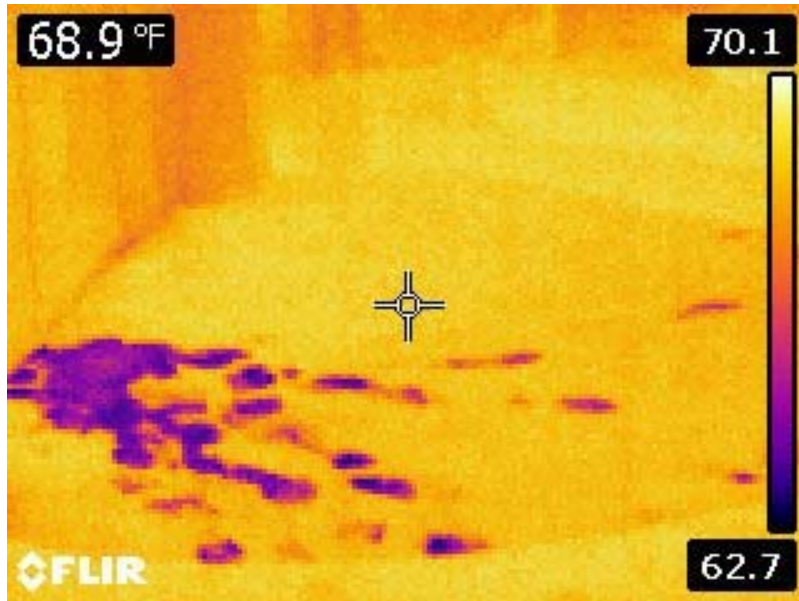
# AIR VELOCITY METER



# INFRARED THERMOMETER



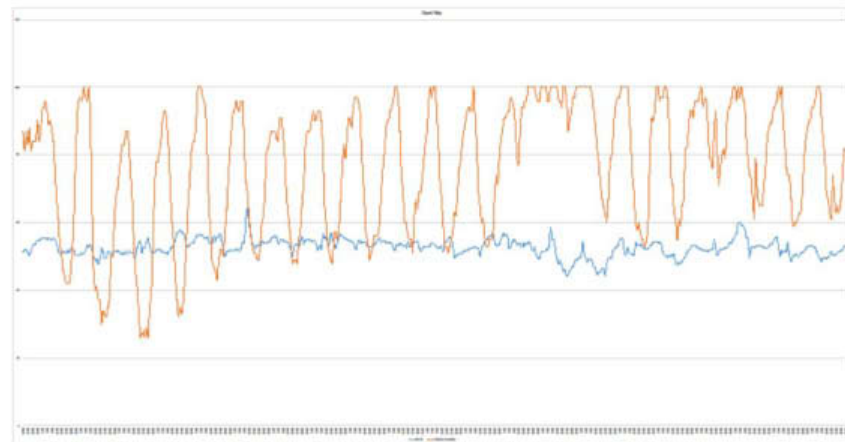
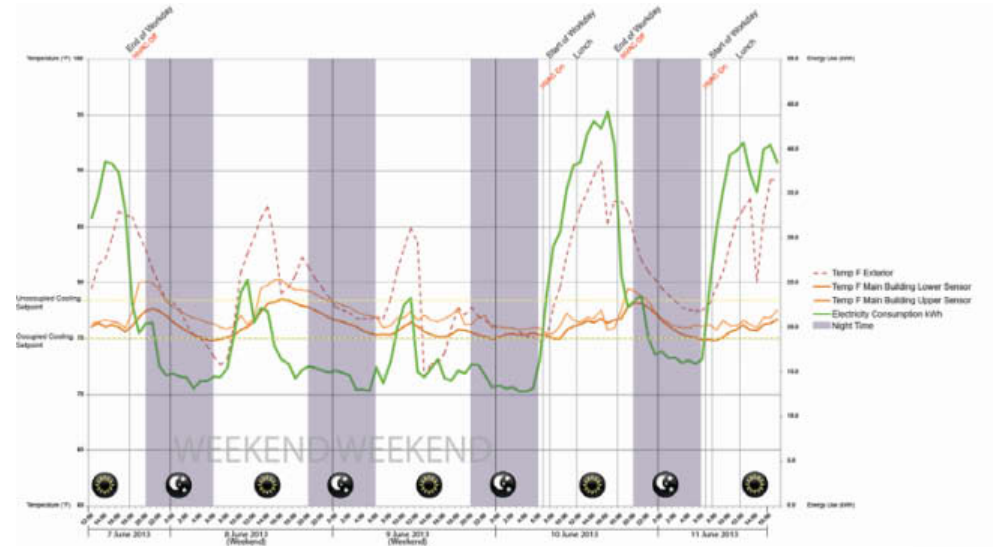
# THERMAL IMAGING CAMERA



# DATA LOGGER



<http://www.onsetcomp.com/images/products/images/logo14714.jpg>

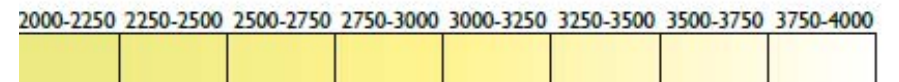
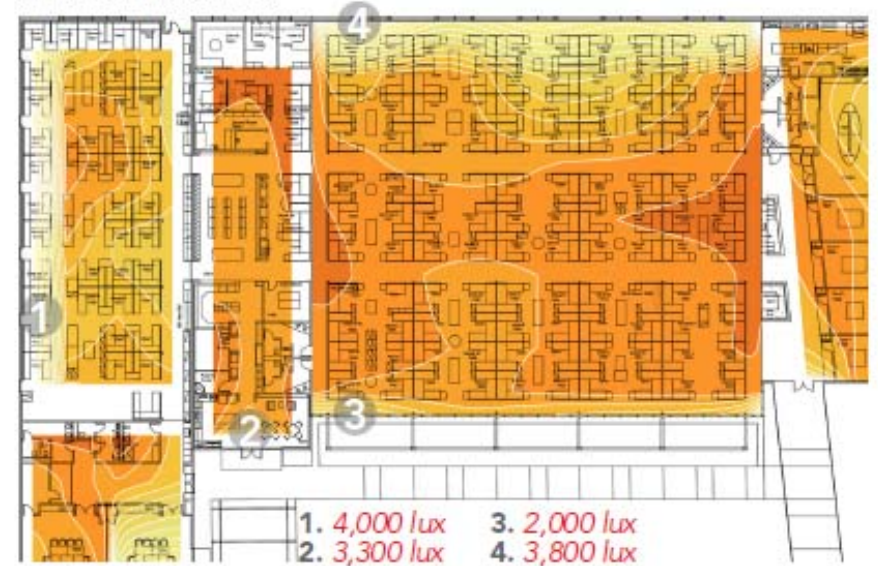




# GRID OF MEASUREMENTS



AFTERNOON MEASUREMENTS



# CONTOUR MAP

# POE TOOLS: ON-SITE OBSERVATIONS



# POE TOOLS: QUALITATIVE ASSESSMENTS



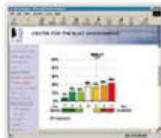
- Quick Links
- Mission and Organization
- Industry Partners
- Research Staff
- Research Portfolio
- Publications
- Membership Information
- Search Our Site
- 
- Search
- ▶ For Industry Partners
- ▶ Partner Login
- ▶ Partner Advisory Board Meeting
- ▶ For Prospective Partners
- ▶ For Prospective Students
- ▶ For Visiting Scholars
- ▶ For Job Seekers
- ▶ Contact Us
- ▶ Connect with Us
- 



**Symposium on Cleantech Innovations in the Commercial Building Sector April 2014** [▶](#)  
This event featured lively dialogue between commercial building stakeholders, technology and product developers, researchers, and cleantech leaders.



**Interactive Radiant System Buildings Map Now Available** [▶](#)  
CBE has developed an interactive online map of radiant system buildings across the globe. This is a valuable resource for design teams and commercial building stakeholders.



**What's Working: Occupant Satisfaction Surveys for Building Evaluation** [▶](#)  
CBE's occupant survey shows how well a building is performing from the perspective of its occupants. Use of the survey also qualifies for thermal comfort verification LEED credits.



**New Thermal Comfort Tool Available** [▶](#)  
Use this web-based tool to predict thermal comfort that meets ASHRAE Standard-55. Includes detailed options for conventional building systems, adaptive comfort, and increased air speeds.



**2013 Livable Buildings Awards Winner: UCSF Ray and Dagmar Dolby Regeneration Medicine Building** [▶](#)  
This UCSF building utilizes a challenging site in an urban setting, and provides ample outdoor space and natural light for its occupants.



#### Centerline Magazine

[View previous issues](#)

#### Research Areas

- Indoor Environmental Quality (IEQ)
- Building HVAC Systems
- Building Facade Systems
- Human Interactions
- Sustainability and Whole Building Energy

#### Related CBE Sites

- Mixed Mode
- Underfloor Air Distribution Technology

## Thermal Comfort

For the remainder of the survey, "your workspace" is defined as the space that you work in most frequently.

### Which of the following do you personally adjust or control in your workspace? (check all that apply)

- Window blinds or shades
- Operable window(s)
- Thermostat for heating
- Thermostat for cooling
- Portable heater
- Permanent heater
- Room air-conditioning unit
- Portable fan
- Ceiling fan
- Adjustable air vent in wall or ceiling
- Adjustable floor air vent (diffuser)
- Door to interior space
- Door to exterior space
- None of the above
- Other:

### How satisfied are you with the temperature in your workspace?

Very Satisfied Very Dissatisfied

### Overall, does your thermal comfort in your workspace enhance or interfere with your ability to get your job done?

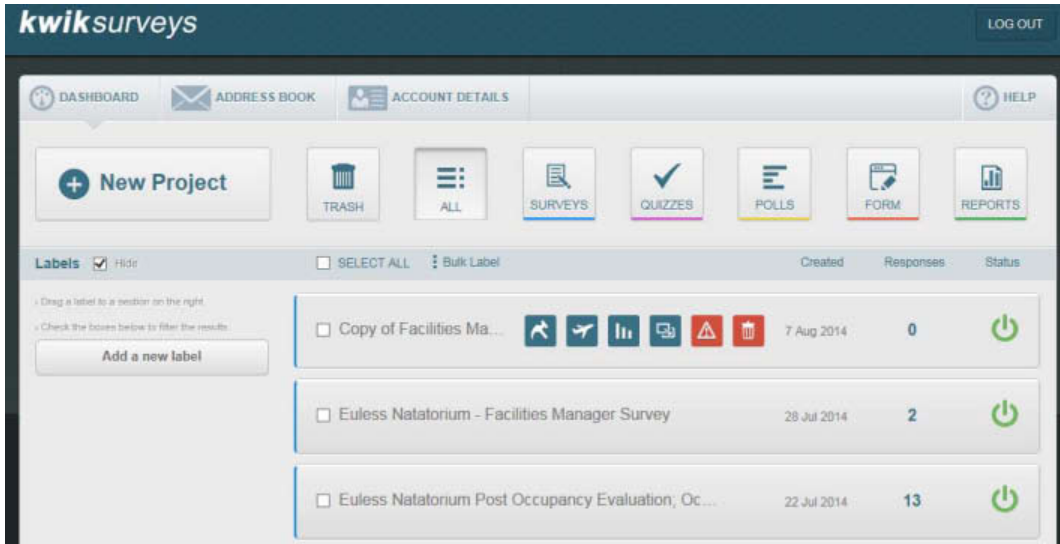
Enhances Interferes

[Continue](#)



Survey Progress...

# POE TOOLS: QUALITATIVE ASSESSMENTS



Michael Dixon *Prek & Kin*  
*doors too heavy use 2 twice for AP's grad. # had to remove doors or CP doors in still in case stop in case ea. CR.*

**Post Occupancy Evaluation: Facility Manager/ Maintenance Operator Survey**

This survey will cover the following information about building systems: HVAC & Lighting, schedule of operation, setpoints & control strategies. It may take 10 to 20 minutes to complete. Please keep the O&M manual handy before beginning the survey if the building has one. If certain questions are not applicable to the whole building, please answer the questions keeping the most important areas for the building in mind (eg. standard setpoints may apply to classrooms and not to multipurpose rooms or other general areas).

**General Questions**

2) How long have you been associated with this building? *17 yrs*

3) Any significant building improvements/ changes since you joined? *Y: added overhang for cafeteria, added or changed canopies from blog to*

4) What is the most significant problem in terms of maintenance? *AC breaks: compressor goes out or fan or relay goes out (frequency: weekly) puts in work order*

5) How is this problem addressed? *no thermostat to one in cafeteria b/c of inspector kitchen -> thermostat only in unit.*

*with unit, some units have none*

*help w/ not getting best*  
*added a platform for kids -> safety raised one step.*

**Post Occupancy Evaluation: Facility Manager/ Maintenance Operator Survey**

**General Questions**

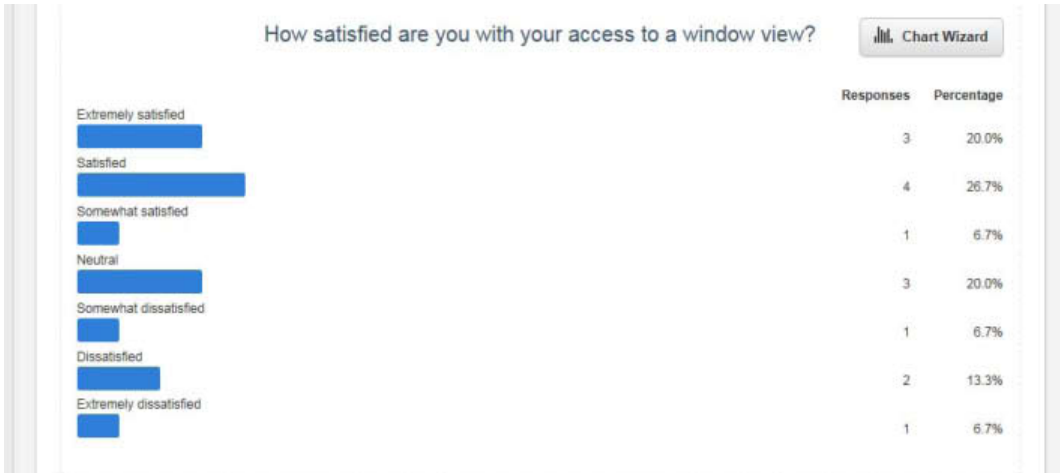
6) Operating schedules:

Weekday Operating Schedule: HVAC	8am-9pm
Weekday Operating Schedule: Lighting	8am-9pm
Weekend Operating Schedule: HVAC	*person on call
Weekend Operating Schedule: Lighting	↓
Holiday Operating Schedule: HVAC	on call
Holiday Operating Schedule: Lighting	on call
Cleaning Operating Schedule: HVAC	N/A
Cleaning Operating Schedule: Lighting	N/A

*↓ A filter ev. 3mo. in house by michael*

*downsets go into ground drainage go w/ straight post.*  
*added more cover to canopy @ entry b/c ppl. of the soaked.*

*Canopy @ drop off & platform for platform kids in ST. + 3 new drains in pty. lot b/c of site change*



# POE TOOLS: QUALITATIVE ASSESSMENTS



## Overall Satisfaction

Personal workspace: 90% occupant satisfaction (37% extremely satisfied)

GeoSouthern building overall: 78% occupant satisfaction (20% extremely satisfied)

## Ease of interaction with co-workers:

83% satisfaction, 43% extremely satisfied

## Workspace is a private office:

70% of respondees

## Workspaces within 15 feet of window:

83% of respondees

## Satisfaction with Lighting

70% of respondees

## Satisfaction with size of workspace:

80% satisfied, 40% extremely satisfied

## Office layout's effect on reported occupant productivity:

33% enhances

53% neither enhances nor interferes

13% interferes

# FINAL REPORT

## Lighting Quality

### Summary

- Daylighting quality is the parameter with the highest overall level of satisfaction.
- Illuminance readings throughout the school are comfortably high, which is mostly attributable to the skylights and windows into the classroom spaces.
- The teachers lounge and light wells recorded the highest light measurements but did not report any issues with glare.
- Closetories contribute to illuminance levels of between 1200-3700 lux within the corridors. Please note that lights were on when these measurements were taken.
- A room on the south elevation had readings of 124 lux with lights off, 285 with lights on, and a reading of 1296 with blinds up reflecting off the floor. The east elevation had illuminance reading of 1300 lux with blinds up. The Art room had readings of 260 lux with lights on, 240 lux by the windows with lights off, and 20 lux in the area furthest from the windows with lights off.
- Overall, the illuminance levels are constant in the morning and afternoon with some southwest classrooms registering lower readings in the afternoon.



### Insights

- Skylights and windows are effective in increasing occupant satisfaction with lighting, even at lighting levels as high as 4,000 lux (400 ft-c).
- Low window-wall area ratio can produce comfortable daylight levels in classrooms, at an average of 182 lux.
- The librarian reported significant issues with glare underneath the library clostery. The reading underneath the clostery on a sunny day was 1205 lux. This implies that while closteries are great for bringing natural light into corridors, perhaps they should not be used in spaces where work will be done underneath them.
- Many surveyed reported being able to work comfortably with lights off throughout the school and enjoy this. Based on measurements the average illumination with lights off is 182 lux. However, this varies based on elevation and time of day. More measurements on these levels are desired as only 3 are available.
- Blinds help prevent glare of around 1300 lux within many classrooms. It also seems that the concrete floors allow for natural light to reach fairly deep in a room.

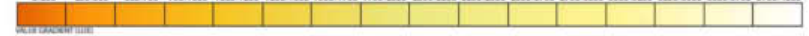
## Illuminance Levels

Morning Measurements-Summer Occupancy



Second Floor  
1,1410 lux 2,750 lux 3,2920 lux 4,1860 lux

First Floor  
1,1420 lux 2,670 lux 3,4000 lux 4,1590 lux



Afternoon Measurements-Summer Occupancy



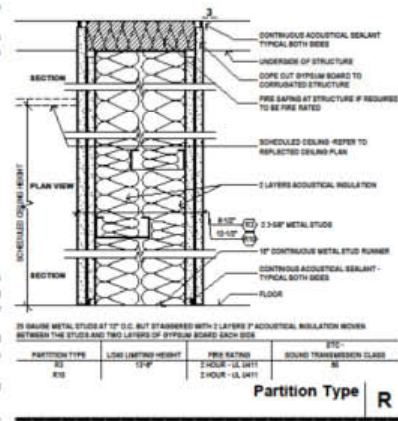
Second Floor  
1,1420 lux 2,670 lux 3,4000 lux 4,1590 lux

First Floor  
1,1420 lux 2,670 lux 3,4000 lux 4,1590 lux

## Acoustic Quality

### Summary

- Overall, acoustic quality documented the lowest levels of satisfaction of all the parameters for both students and teachers.
- Most of the dissatisfaction expressed throughout the building was due to high sound levels in the cafeteria and the hallways. These recorded a spot reading of 72 db when children exited the cafeteria into the hall which is defined as loud.
- Most other readings register between 50-70 which is defined as moderate noise levels.
- Both students and teachers are dissatisfied with the acoustic quality of their classrooms.



Partition Type through the Cafeteria and the Hallway

### Insights

- Based on comments and measurements it seems that the soundproofing on exterior walls is sufficient. However, the readings don't vary much between rooms and the halls, implying that soundproofing in interior walls and floors may not be adequate to compensate for the concrete floors and lack of other acoustical surfaces, such as carpets.
- All teachers expressed the fact that there is a prevalent echo in the hallways, gym, and especially the cafeteria. Within the cafeteria, during lunch, a spot reading of 72 db was recorded.
- Also interesting is that there is not a significant difference between the second floors during summer occupancy and normal occupancy.
- An average of 1.4db is recorded in the halls between students being present and not present, despite the fact that most children only whisper quietly when in the halls.

## Sound Levels

Sound Source Measurements - Summer Occupancy



Second Floor  
Some without gradation were considerable during the time of data collection.

First Floor  
Some without gradation were considerable during the time of data collection.



Sound Source Measurements - Normal Occupancy



Second Floor  
The diagonal lines show the level reached when children were in the cafeteria.

First Floor  
The diagonal lines show the level reached when children were in the cafeteria.



# POE DETECTIVE GAME



EACH TEAM ASSIGNED  
TO A CASE STUDY



# INDIVIDUAL ROLES

## TOOLS



Anything above considered uncomfortably bright

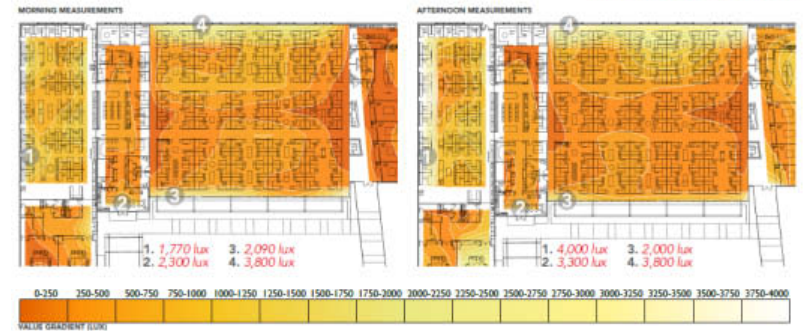
5,000 Lux

Anything below considered uncomfortably dark

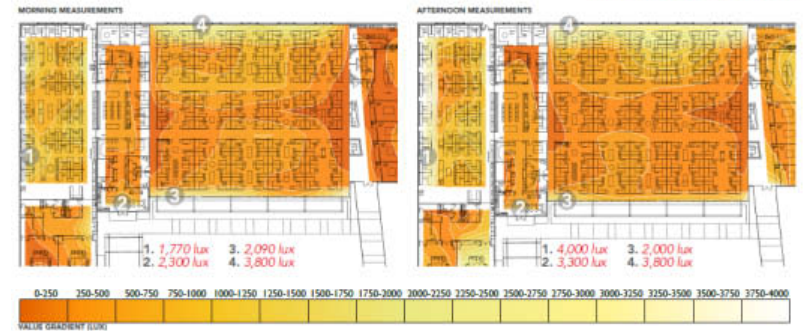
250 Lux

## CLUES

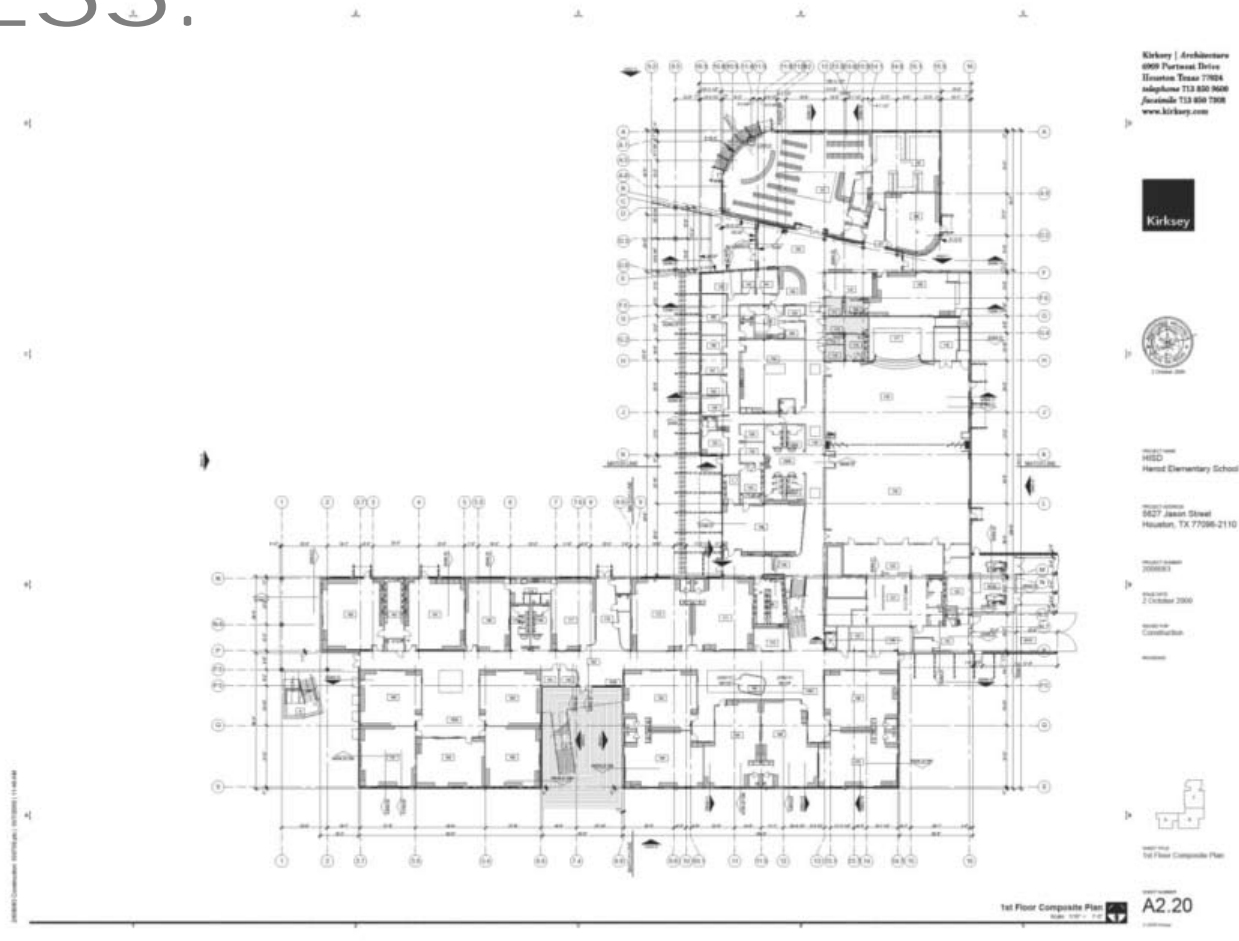
### Illuminance Levels



### Illuminance Levels



# PROCESS:

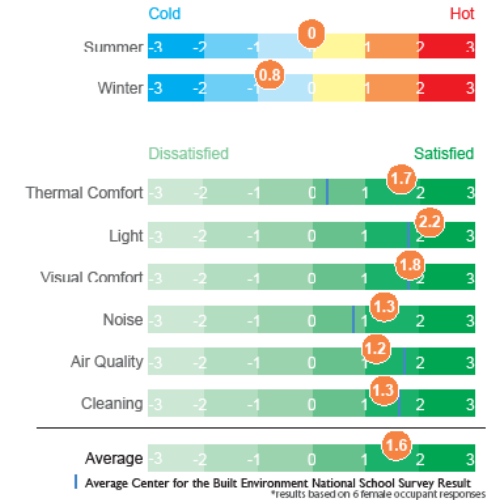


## STEP 1: REVIEW BUILDING AND KNOWN PROBLEM

STEP 2.  
TOOLS REVEAL CLUES  
(OPEN ENVELOPES)



CO2 Measurements



STEP 3.  
TEAMS REVIEW CLUES,  
IDENTIFY CAUSE OF PROBLEM  
AND POTENTIAL SOLUTIONS

[http://easypublicspeaking.co.uk/wp-content/uploads/2012/12/welcome\\_to\\_easy\\_public\\_speaking\\_slider.jpg](http://easypublicspeaking.co.uk/wp-content/uploads/2012/12/welcome_to_easy_public_speaking_slider.jpg)



## STEP 4. REPORT CONCLUSIONS

[http://media.trb.com/media/photo/2011-11/harry-morgan\\_66089558.jpg](http://media.trb.com/media/photo/2011-11/harry-morgan_66089558.jpg)



NAMES HAVE BEEN CHANGED  
TO PROTECT THE INNOCENT



SOME RESULTS HAVE BEEN  
ALTERED FOR THIS EXERCISE  
(BUT WE'LL TELL YOU THE FULL STORY AT THE END)

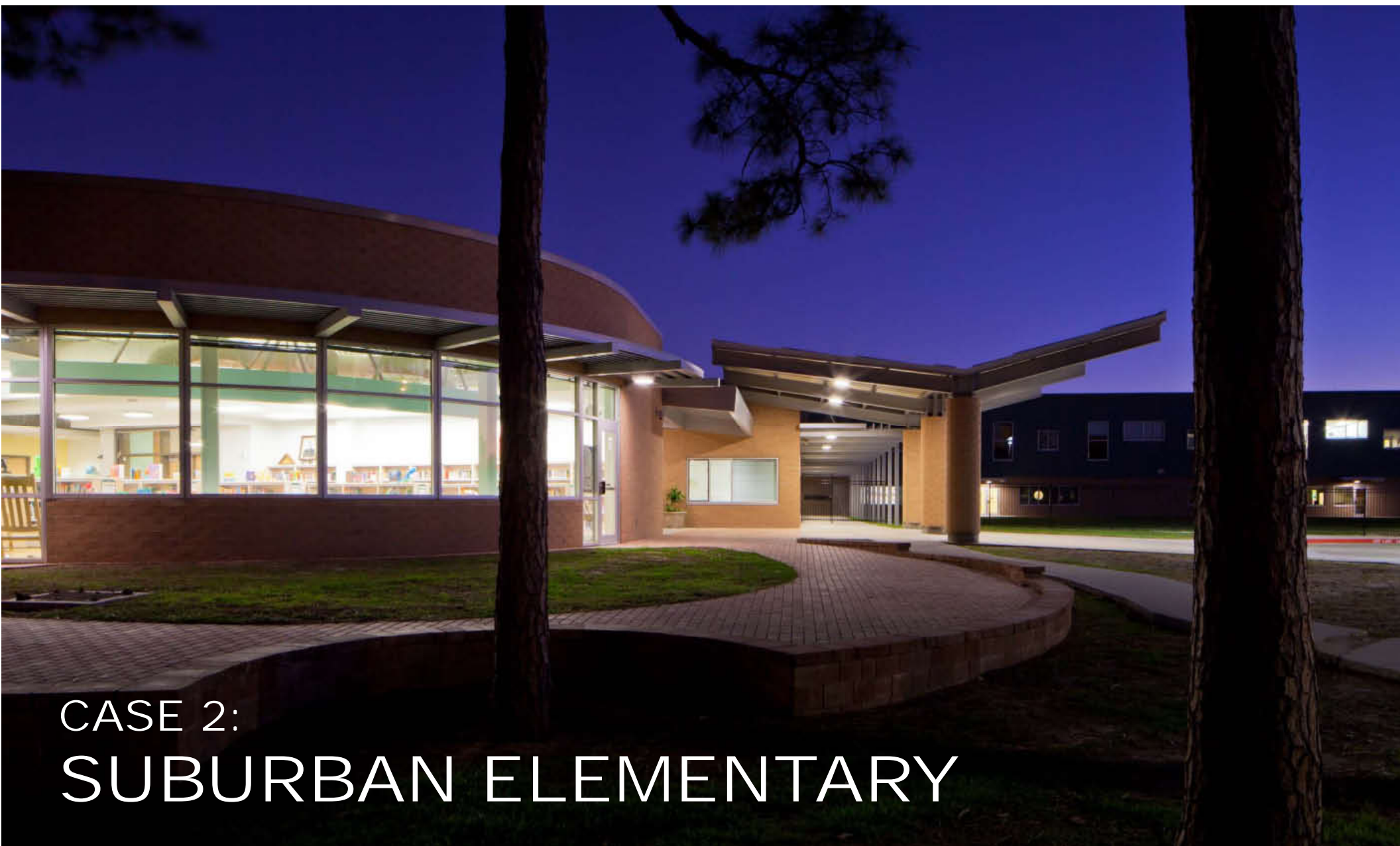


CASE 1:  
DOWNTOWN ELEMENTARY



A photograph of a modern, brightly lit hallway. The walls are a light yellow-green color, and the ceiling is white with several long, rectangular light fixtures. In the foreground, a woman is sitting at a blue reception desk with two computer monitors. In the background, another person is sitting at a desk, and a person is walking down the hallway. The floor is a dark, polished material.

PROBLEM:  
STUDENTS PERFORMING  
ABNORMALLY LOW ON  
STANDARDIZED TESTS



CASE 2:  
SUBURBAN ELEMENTARY



PROBLEM:  
THERMAL COMFORT COMPLAINTS  
FROM CERTAIN ROOMS,  
PARTICULARLY THE LIBRARY



CASE 3:  
URBAN PRESCHOOL

PROBLEM:

TEACHERS COMPLAIN THAT STUDENTS  
STRUGGLE WITH FOCUSING AND  
FOLLOWING INSTRUCTIONS



CASE 1:  
DOWNTOWN ELEMENTARY



CASE 3:  
URBAN PRESCHOOL



CASE 2:  
SUBURBAN ELEMENTARY

# CONCLUSIONS

# TOP 5 LESSONS LEARNED

5. (ALMOST) NOBODY FILLS  
OUT ONLINE SURVEYS





Michael Dixon

Prek & Kin:  
 doors too heavy for A/S grad  
 use a tube for A/S grad  
 had to remove doors on every in-stall  
 placed stops in door - ok.

**Post Occupancy Evaluation: Facility Manager/ Maintenance Operator Survey**

This survey will cover the following information about building systems: HVAC & Lighting, schedule of operation, setpoints & control strategies. It may take 10 to 20 minutes to complete. Please keep the O&M manual handy before beginning the survey if the building has one. If certain questions are not applicable to the whole building, please answer the questions keeping the most important areas for the building in mind (eg. standard setpoints may apply to classrooms and not to multipurpose rooms or other general areas).

**General Questions**

2) How long have you been associated with this building? 7yrs

3) Any significant building improvements/ changes since you joined? cafeteria, added on ~~direction~~ canopies from blog to blog

4) What is the most significant problem in terms of maintenance? AC breaks: compressor goes out or fan or relay goes out frequently weekly - puts in work order

5) How is this problem addressed? add thermostat to one in cafeteria b/c of inspector kitchen - thermostat only in unit.

1. All have 1-3 units.

added overhang for (help w/ not getting wet)  
 added a platform for kids - safety raised one step.

**Post Occupancy Evaluation: Facility Manager/ Maintenance Operator Survey**

**General Questions**

6) Operating schedules:

Weekday Operating Schedule: HVAC	8am - 4pm	
Weekday Operating Schedule: Lighting	8am - 4pm	
Weekend Operating Schedule: HVAC	person on call	
Weekend Operating Schedule: Lighting	↓	
Holiday Operating Schedule: HVAC	on call	
Holiday Operating Schedule: Lighting	on call	
Cleaning Operating Schedule: HVAC	N/A	↓ Driller ev. 3mo.
Cleaning Operating Schedule: Lighting	N/A	↓ in by by window

downsets go into ground drain go w/ straight post.

Canopy @ drop off platform  
 + new drains in play lot b/c of sink drainage

added more cover to canopy b/c ppi. of the soaked.

## TOP 5 LESSONS LEARNED

4. LOOK FOR HANDMADE FIXES

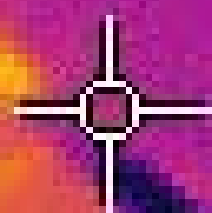


## TOP 5 LESSONS LEARNED

3. MANY PEOPLE WHO OPERATE BUILDINGS  
KNOW LITTLE ABOUT BUILDINGS

70.2 °F

86.9



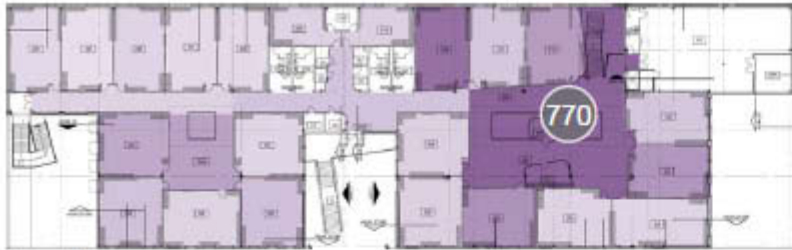
62.3

 FLIR

# TOP 5 LESSONS LEARNED

## 2. RETURN TO THE SCENE

CO2 Measurements - Summer Occupancy



Second Floor

CO2 Measurements - Normal Occupancy



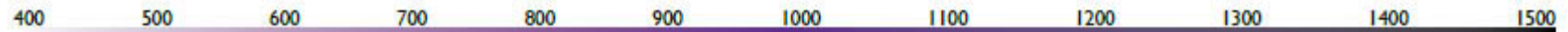
Second Floor



First Floor



First Floor



Value Gradient (PPM)

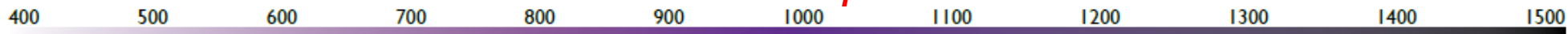
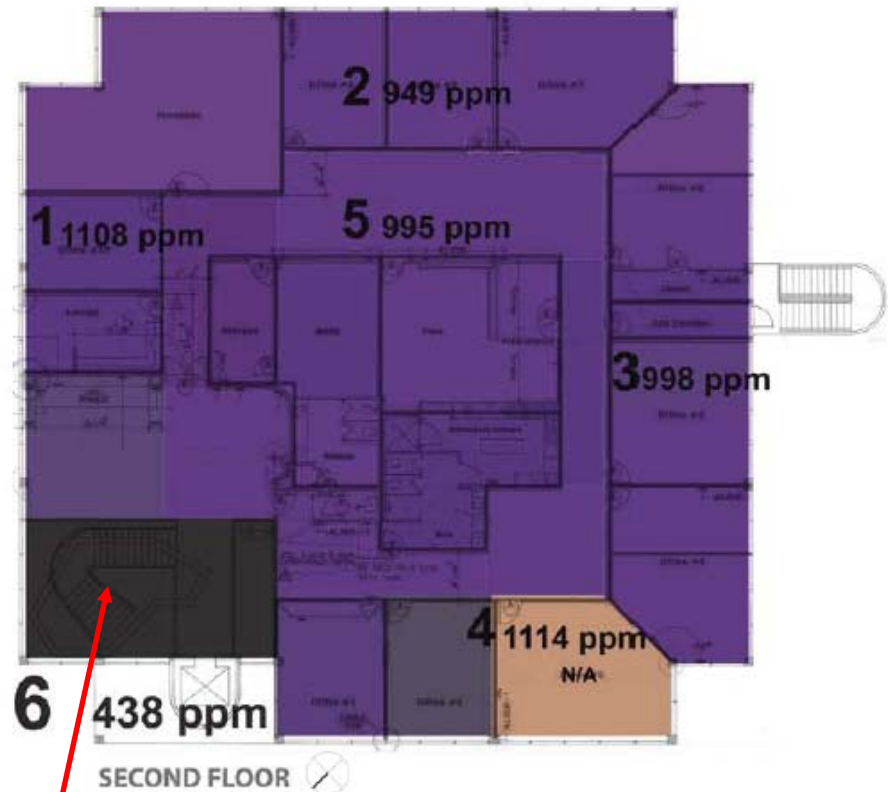
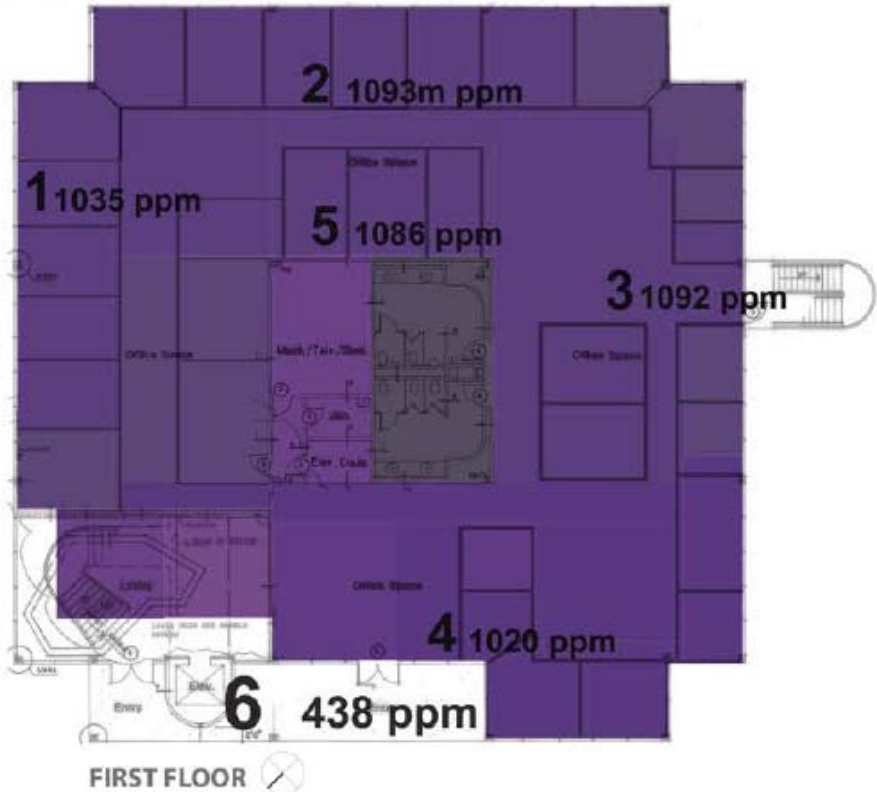
# TOP 5 LESSONS LEARNED

1. YOU'LL FIND OUT THINGS  
YOU WISH WEREN'T TRUE



# CO2 Levels

Carbon Dioxide Measurements



Value Gradient (PPM)

1507 PPM !!!

## Survey Responses

- ▶ 47% of respondees are satisfied with indoor air quality, and 17% are extremely satisfied
- ▶ 32% of respondees said air quality related symptoms improved away from work
- ▶ Occupants have expressed dissatisfaction with kitchen odors and stuffy air, which relates to the low score of -0.25 in Zone 5 of the first floor.

Julie Hendricks - [JulieH@Kirksey.com](mailto:JulieH@Kirksey.com)

Colley Hodges - [ColleyH@Kirksey.com](mailto:ColleyH@Kirksey.com)

