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Learning from Experience

Value of Post Occupancy Evaluations

Stantec

Sustainability Research + Benchmarking Program

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AIA: 1 LU/HSW

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Post Occupancy Evaluations

LEARNING OBJECTIVES:

1. Understand what a Post Occupancy Evaluation Study includes, who is involved and its process.

2. Understand how new standards like the WELL Building Standard are concentrating on human experience, health and wellbeing - and how post occupancy evaluations are key in achieving these goals successfully.

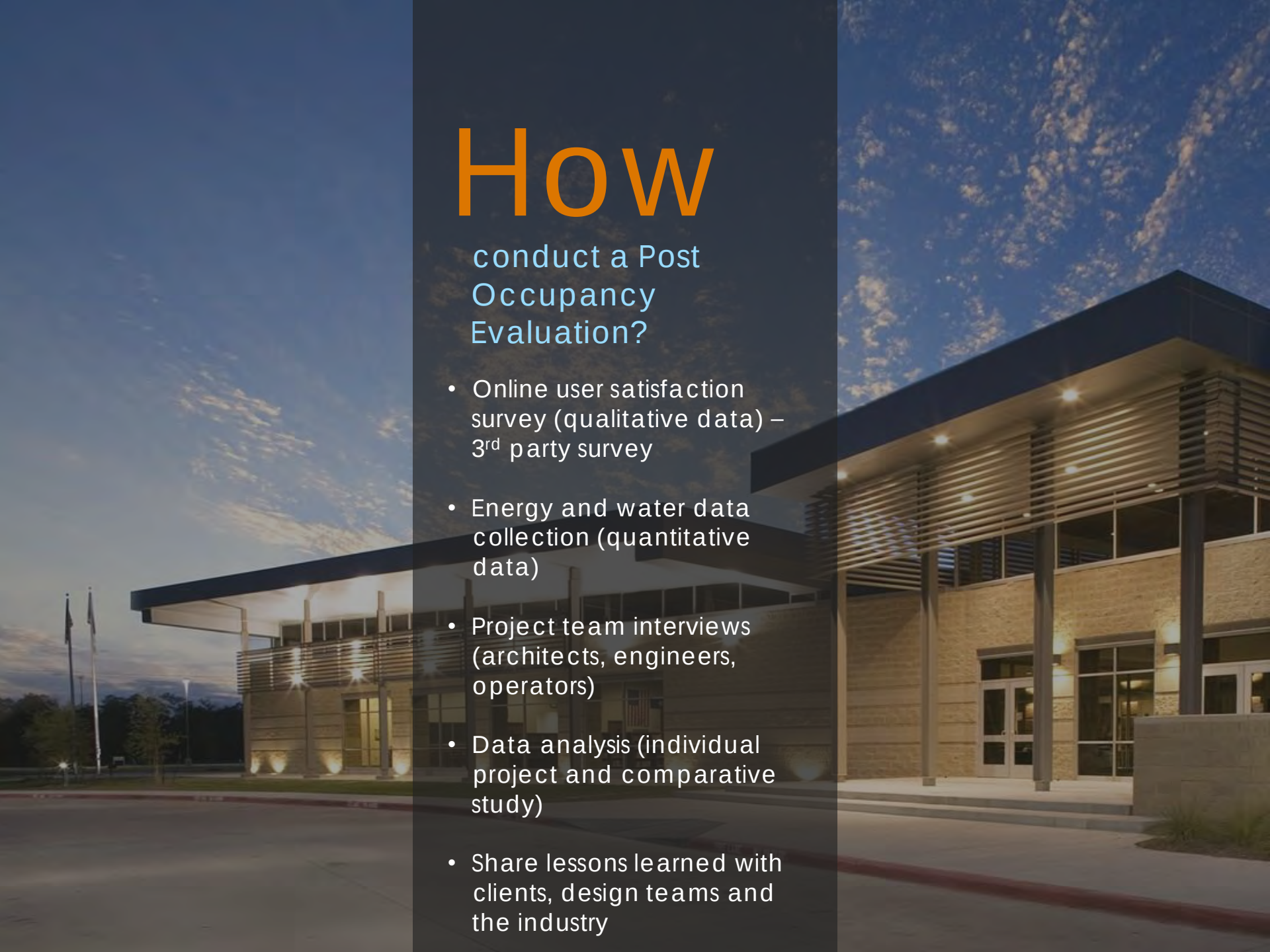
3. Understand what approaches and strategies towards high performing buildings are successful in creating efficient and healthy environments.

4. Identify lessons learnt and future research needs through this study that can inform school building design.

What

is a Post Occupancy Evaluation?

- The process of evaluating buildings in a systematic manner
- Performed approximately 1-3 years after project completion
- Quantitative and qualitive evaluation



How

conduct a Post Occupancy Evaluation?

- Online user satisfaction survey (qualitative data) – 3rd party survey
- Energy and water data collection (quantitative data)
- Project team interviews (architects, engineers, operators)
- Data analysis (individual project and comparative study)
- Share lessons learned with clients, design teams and the industry

Why

conduct a Post Occupancy Evaluation?

- Measure project successes and address challenges
- Identify issues with an existing facility (or prototype)
- Inform the design process
- Bring added value to client

WELL Building Standard v1

WELL Building Standard explores how design, operations and behaviors within the places where we live, work, learn and play can be optimized to advance human health and well-being. Covering seven core concepts of health and hundreds of features, WELL v1 is a flexible building standard and represents the future of modern design.

WELL is managed and administered by the International WELL Building Institute (IWBI).

3rd party certified by GBCI.

AIR	Quality standards including filtration, cleaning protocols, microbe control, material safety
WATER	Testing and monitoring to control public water additives and system contaminants
NOURISH-MENT	Promotion of healthy food options, nutrition labeling, safe food preparation and sourcing
LIGHT	Glare free and circadian lighting design, effects of surfaces & contrast, light quality, daylighting
FITNESS	Active design, enhanced ergonomics, activity incentives, and structured fitness programs
COMFORT	Physical and visual ergonomics; thermal, olfactory, and acoustic comfort
MIND	Organizational policies and transparency, bio-phillic design, flexible and adaptable spaces

(105 Features – 41 preconditions for New and Existing Buildings)

Center for the Built Environment

(a University of California Berkley Organization)

(CBE surveys are required as a precondition for the WELL Building Standard)

Survey Categories:

10 core building categories + 4 specific survey categories chosen by each school

- Acoustics
- Air quality
- Cleanliness and Maintenance
- Office furnishings
- Office layout
- Classroom furnishings
- Classroom layout
- Thermal comfort
- General satisfaction building
- General satisfaction workspace

Additional modules (views and daylight added for this set of POEs)

User Online Survey Style

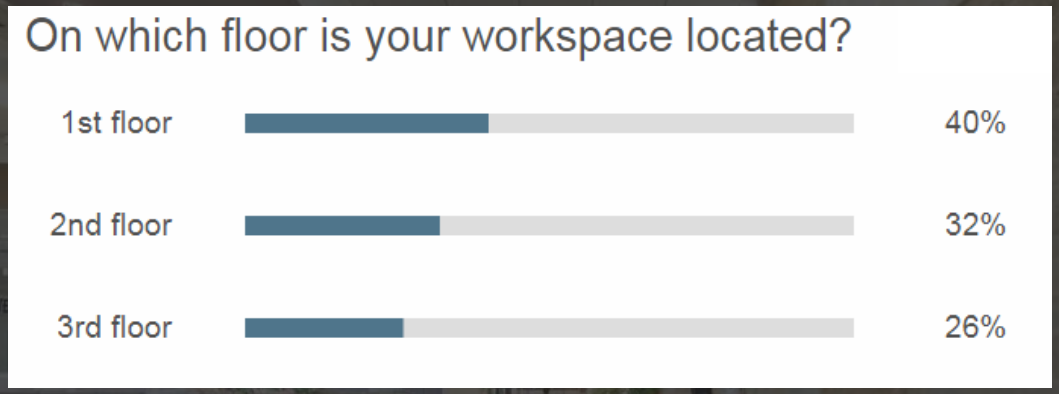
You have said that you are dissatisfied with the level of visual privacy. Which of the following contributes to your dissatisfaction? (Check all that apply)

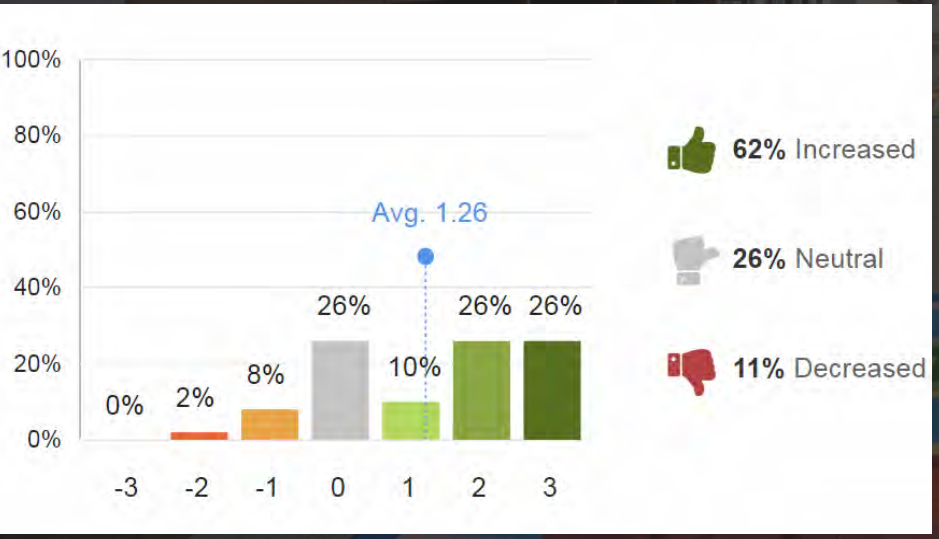
- [ ] High density-- too little space separating people
- [ ] Partitions or walls are too low or transparent
- [ ] People can easily see in through exterior windows
- [ ] Too many people walking in my work area
- [ ] Other

How satisfied are you with...

	Very satisfied	Satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Dissatisfied	Very dissatisfied
The amount of light in your workspace	○	○	○	○	○	○	○
The visual comfort of the lighting (e.g., glare, reflections, contrast)	○	○	○	○	○	○	○

Survey Reports + Comments





27 Responses

1. Would feel safer if the view to the exterior of the building were more accessible. No one has visibility to the parking lot or the entrance into the building. Not very safe.
2. ac rarely works
3. The majority of the work I perform must be done in a confidential setting. This office is far from being a private setting.
4. It's difficult to hide in a lockdown drill.
5. There are too many windows. No safe way to hide from intruders.
6. Desk hookups are set at the front of the room which is not the idea space for a teacher desk. All windows and being by the exit windows are not safe in lockdown situations.
7. No issues
8. The library has too many windows. There is no coating on the windows, so the books fade. No shelving could go on the outside walls, due to windows on 3 sides, so the shelving is tall, blocking the view of students in the stacks. However the number of windows makes it difficult to get an entire class "out of sight" during a lock down drill. The windows also make it hard to see the projector screen. And there's no space for a casual reading area. The library is located out of the way and is not convenient for students and staff to stop by.

Post Occupancy Study

4 Middle Schools with

Similar climate zone
Similar program/scope
Similar populations
Similar schedule/utilization
New projects

(6 Elementary schools POEs previously done in 2013)

Energy Star Middle School

Central Texas Middle School

Houston Middle School

CHPS Middle School

Four New Middle Schools

Energy Star MS

Area: 163,500 sq. ft.
Cost: $149/sq. ft.
Occ: 2013
Designed to Energy Star

Central Texas MS

Area: 198,893 sq. ft.
Cost: $164/sq. ft.
Occ: 2013

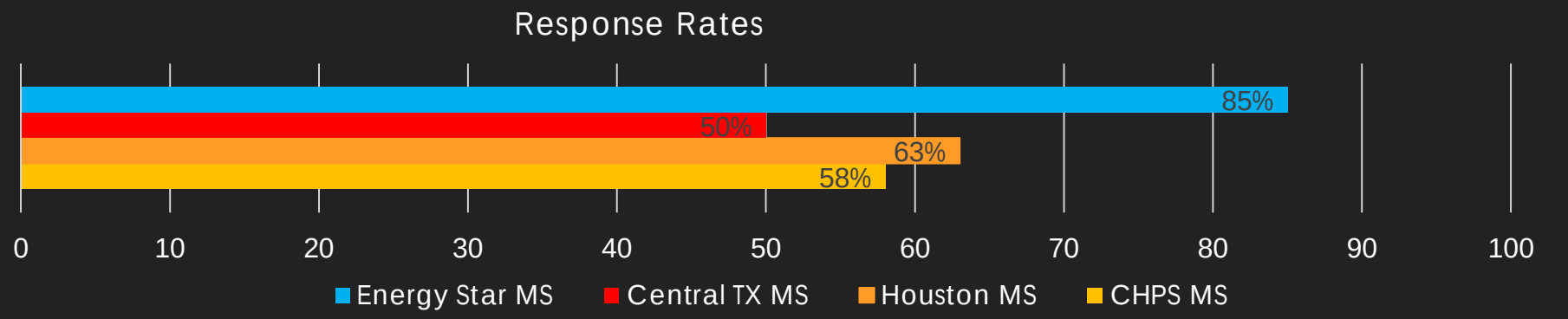
Houston MS

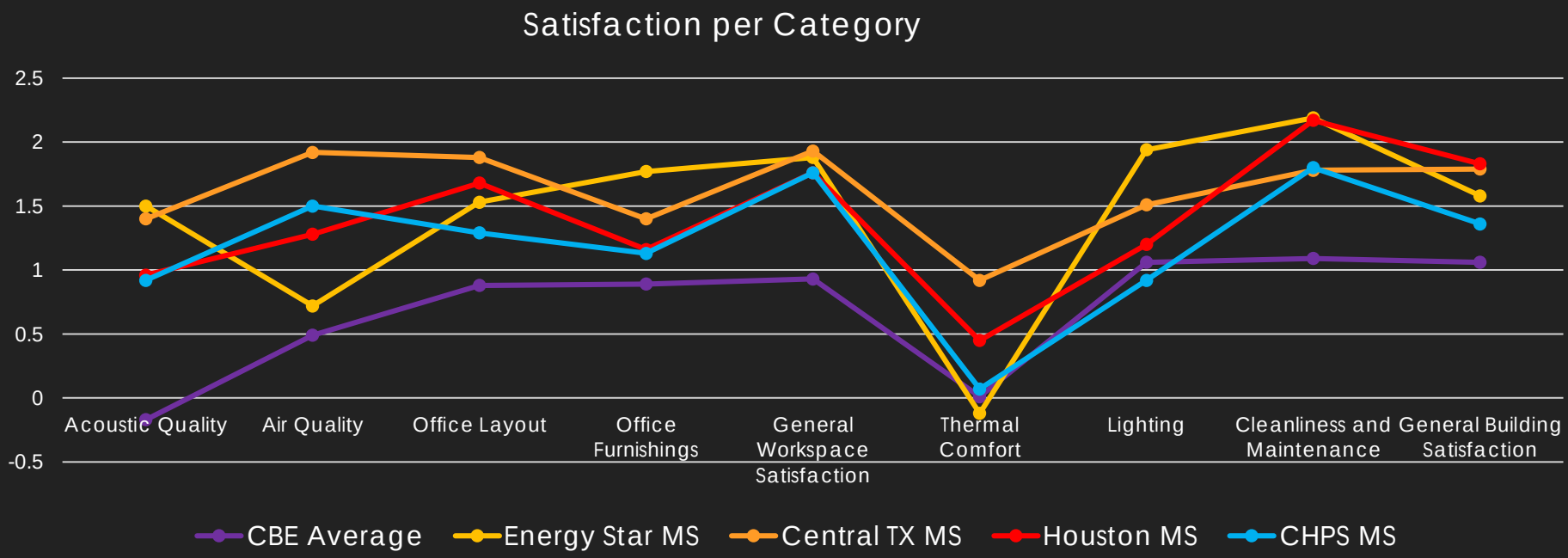
Area: 196,140 sq. ft.
Cost: $152/sq. ft.
Occ: 2009

CHPS MS

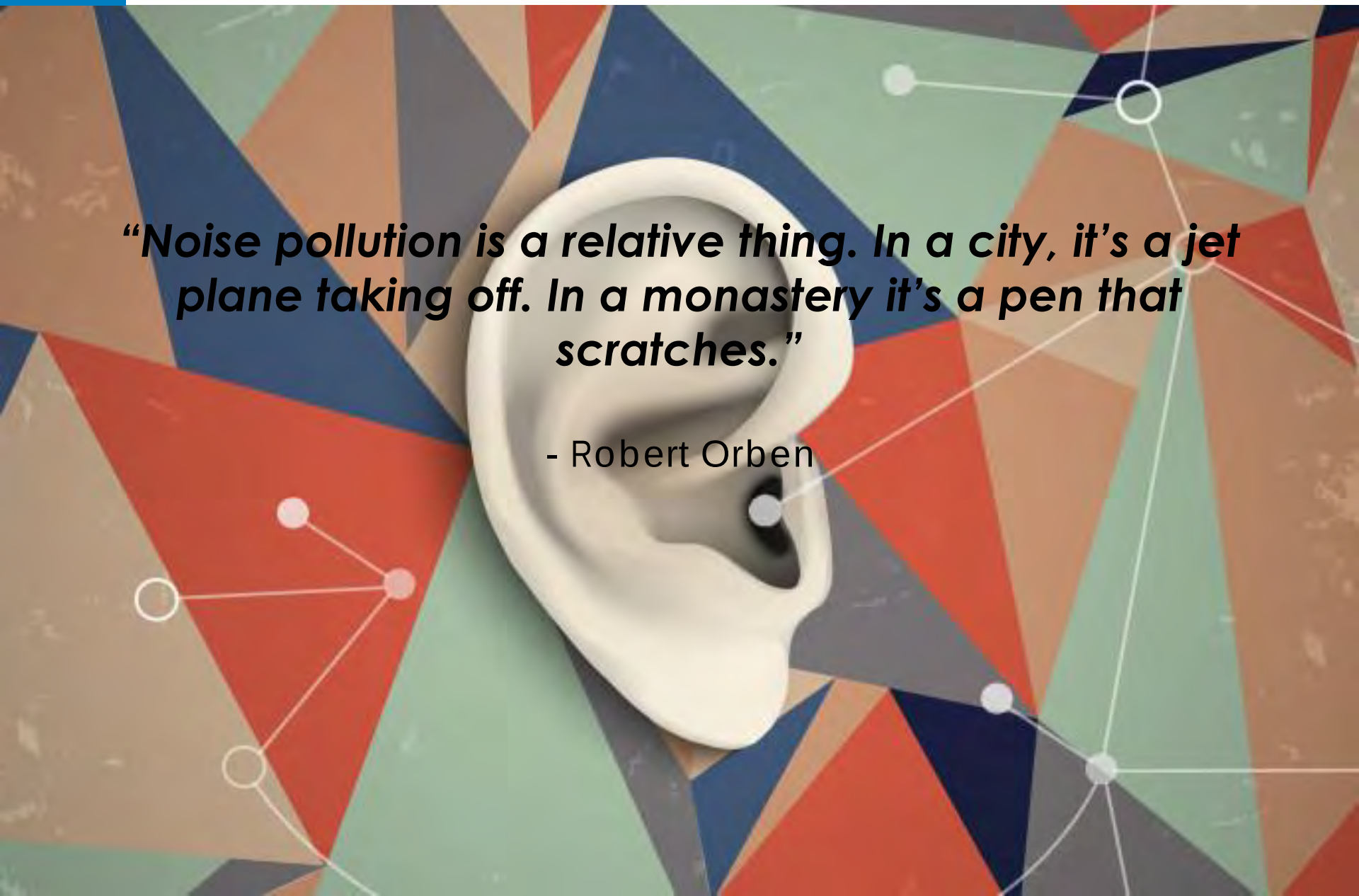
Area: 248,348 sq. ft.
Cost: $122/sq. ft.
Occ: 2011
Designed to CHPS Standard

User Survey Analysis

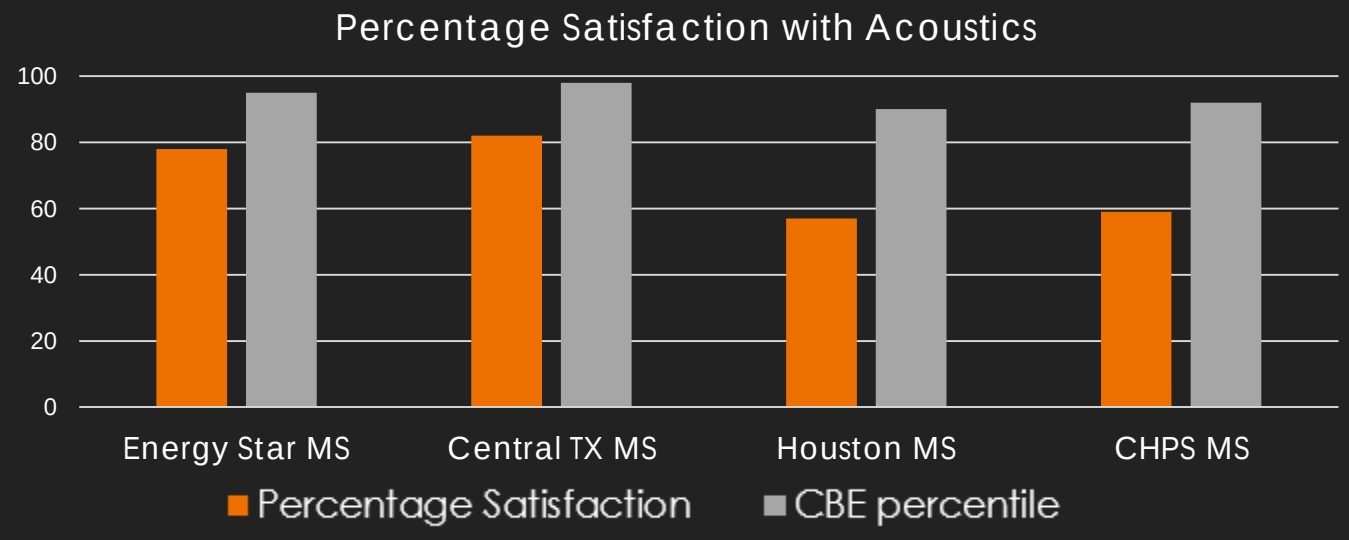


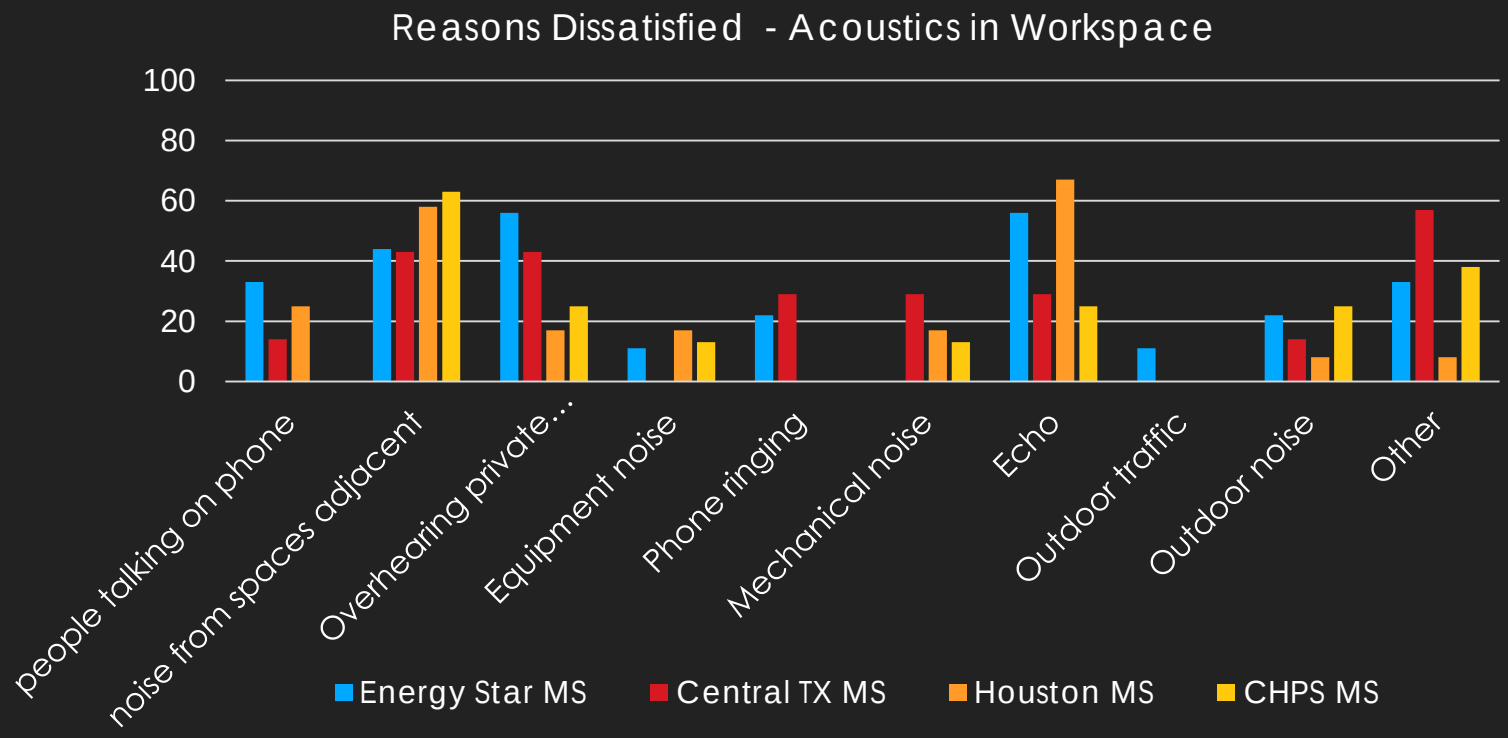


Acoustics


"Noise pollution is a relative thing. In a city, it's a jet plane taking off. In a monastery it's a pen that scratches."
- Robert Orben

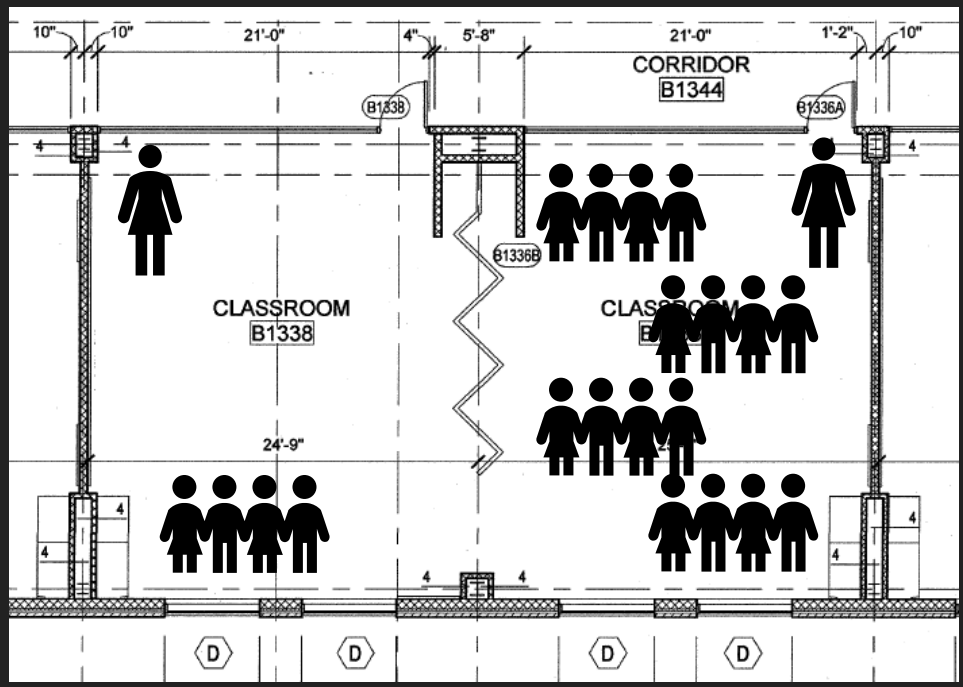
Acoustics


Percentage Satisfaction with Acoustics
100
80
60
40
20
0
Energy Star MS
Central TX MS
Houston MS
CHPS MS
Percentage Satisfaction
CBE percentile


Reasons Dissatisfied - Acoustics in Workspace
100
80
60
40
20
0
people talking on phone
noise from spaces adjacent
Overhearing private…
Equipment noise
Phone ringing
Mechanical noise
Echo
Outdoor traffic
Outdoor noise
Other
Energy Star MS
Central TX MS
Houston MS
CHPS MS

Acoustics

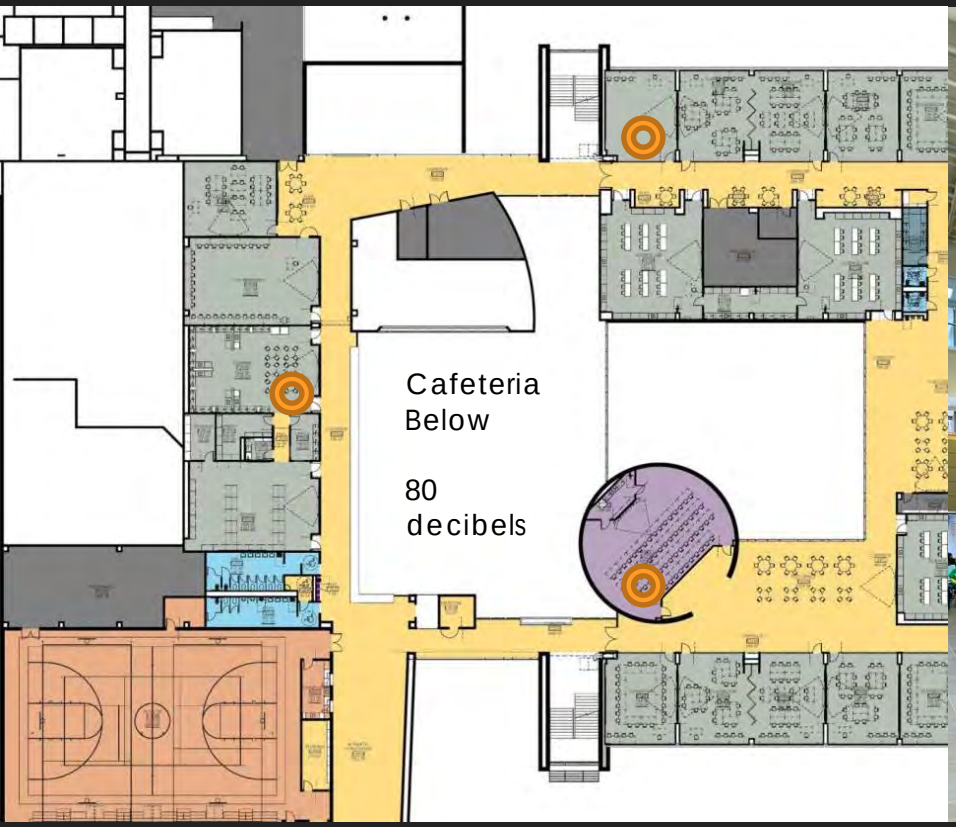
- *"We have the foldable walls. We can often hear what is happening in the classroom next to us while teaching"*
  - 4" Panelfold partition w/STC 49



CHPS MS

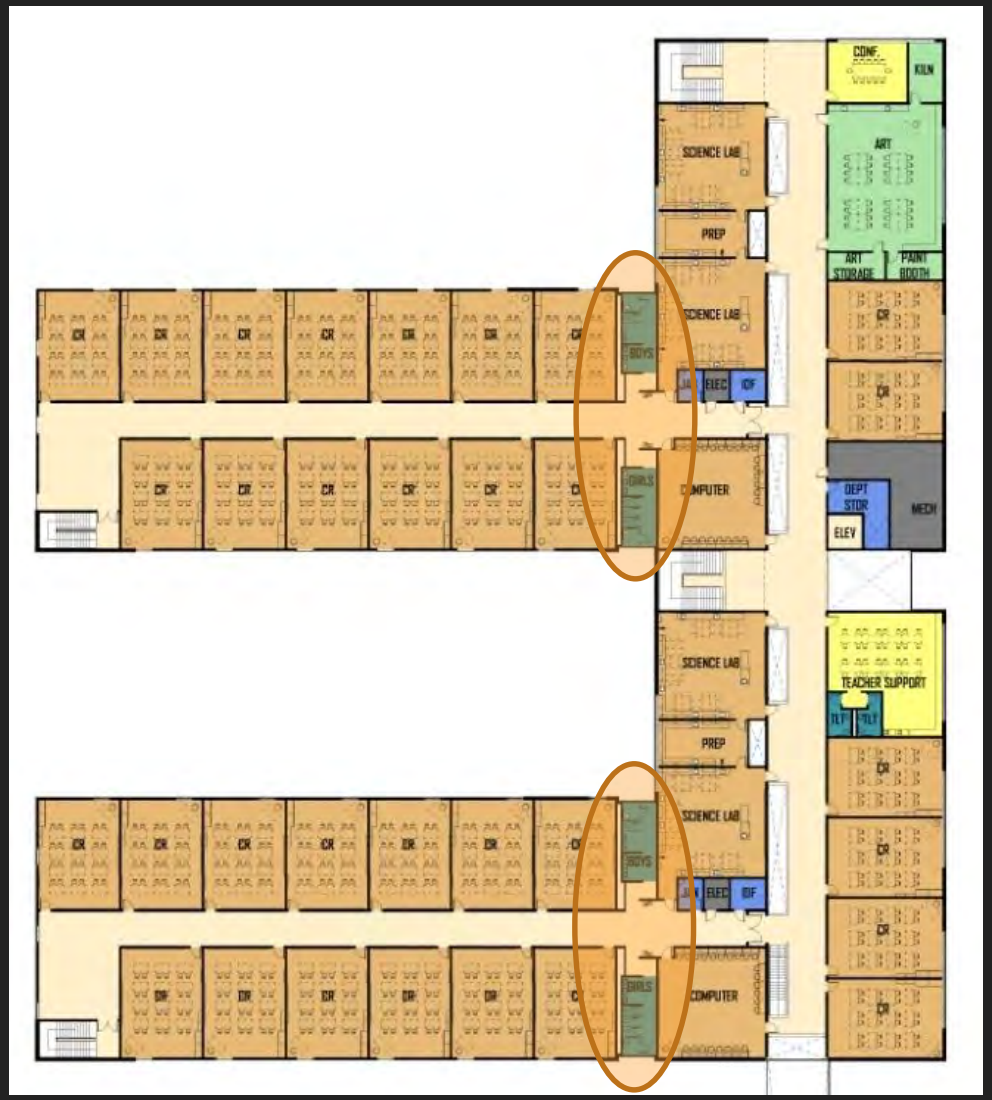
Acoustics

- *"Constant noise in the student cafeteria and downstairs institutional kitchen."*



CHPS MS

Acoustics



- *"We hear the toilet flush every time somebody uses it."*
- *"We can hear heels tapping down hallways above us. Gets extreme when desks are being moved around and we can hear every screech echoing throughout the library."*

- Insulation between hallways and CRs
- Insulation between CRs
- Insulation between bathrooms and user spaces
- Long corridor flooring and acoustic treatment

Central Texas MS

Acoustics

Decibels (dB), dBA, and Noise Criteria (NC)

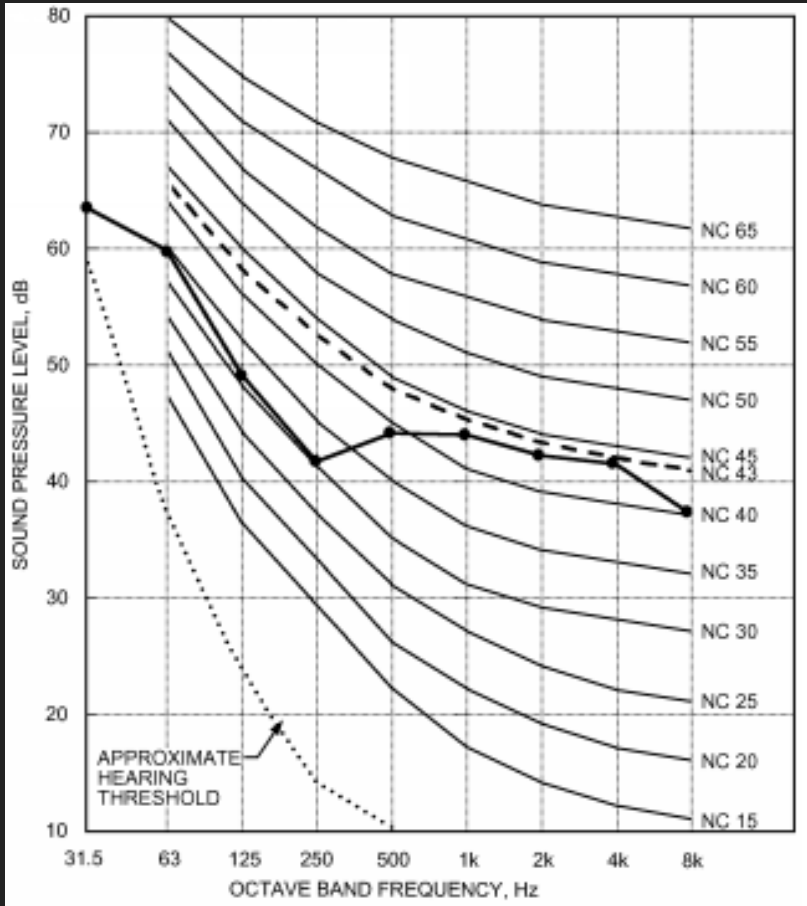


Fig. 7 NC (Noise Criteria) Curves and Sample Spectrum (Curve with Symbols)

From ASHRAE Handbook, Fundamentals 2017

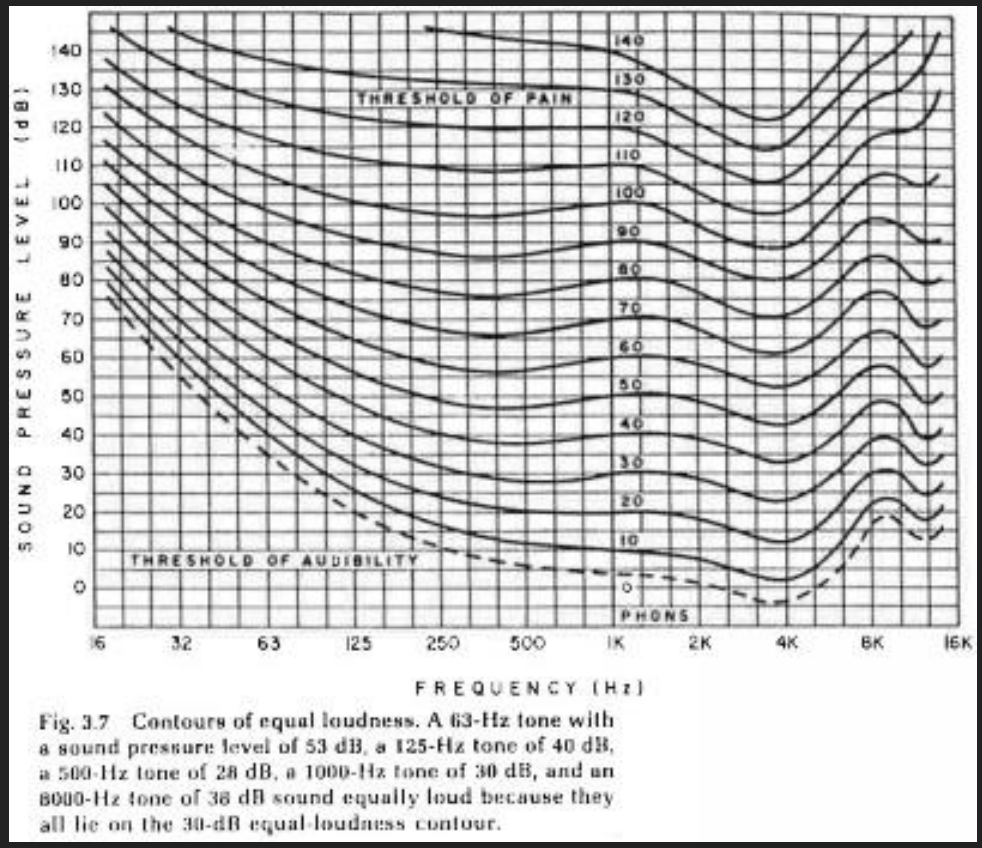
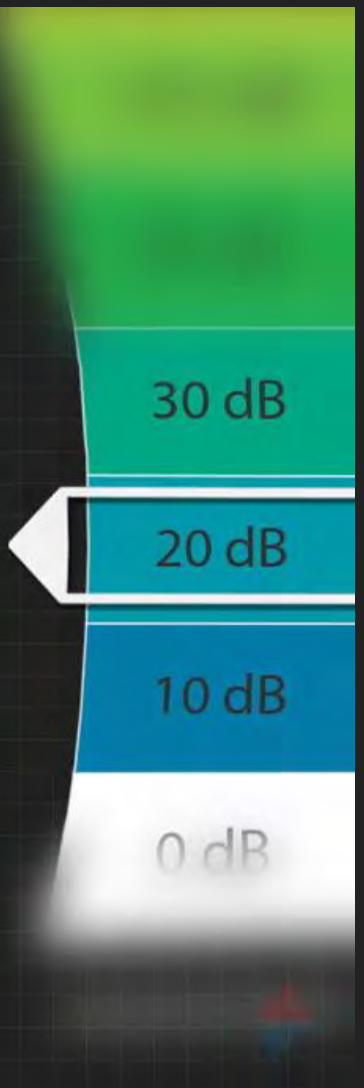


Fig. 3.7 Contours of equal loudness. A 63-Hz tone with a sound pressure level of 53 dB, a 125-Hz tone of 40 dB, a 500-Hz tone of 28 dB, a 1000-Hz tone of 30 dB, and an 8000-Hz tone of 38 dB sound equally loud because they all lie on the 30-dB equal-loudness contour.

From Environmental Acoustics, Leslie L. Doelle, Eng., M. Arch., 1972

- Decibel (dB) – a measure of sound pressure on a logarithmic scale
- dBA – a weighted measure of sound across the audible frequency spectrum that corresponds to relative loudness
- Noise Criteria (NC) – weighted curves specifically for background noise levels

Whisper



Acoustics

Architectural Considerations

- Reverberation time increases background noise level
- Use hard surfaces and exposed structure with caution
- Limited space for HVAC can increase air velocities and noise.
- Consider paths for sound to travel from noisy to quieter spaces.

"It's about designing, not appearance, but experience"
– Julian Treasure

Preconditions:
- Exterior Noise Intrusion – 50 dBA
- Internally Generated Noise – HVAC – 40 dBA or 35 dBA in Classrooms

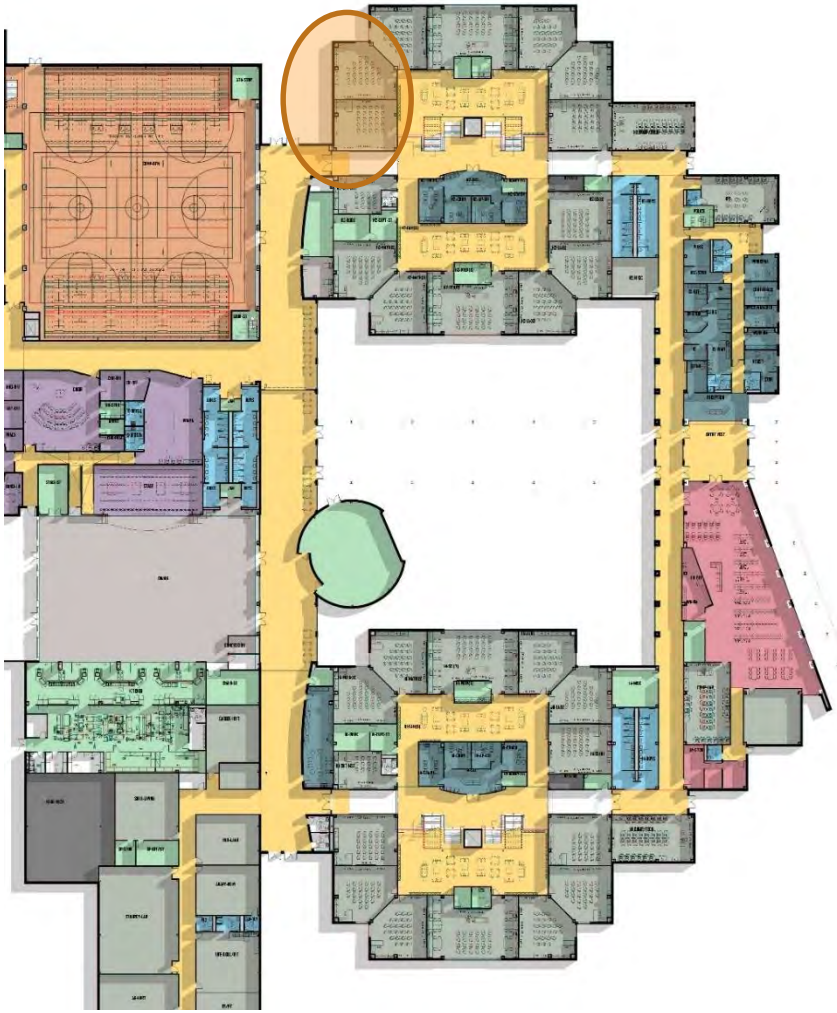
WELL

Acoustics

- Due to poor acoustics, student may miss 50% of what their teachers say.
- Student behavior and test results are negatively impacted by noise.
- Teachers are suffering from noise exposure. The average classroom noise level is 65 decibels, a level that was found to affect the teachers heartrate and increased possibility of heart attack.
- Acoustic quality has the ability to affect our quality of life, social behavior and productivity.

Daylighting

Daylighting

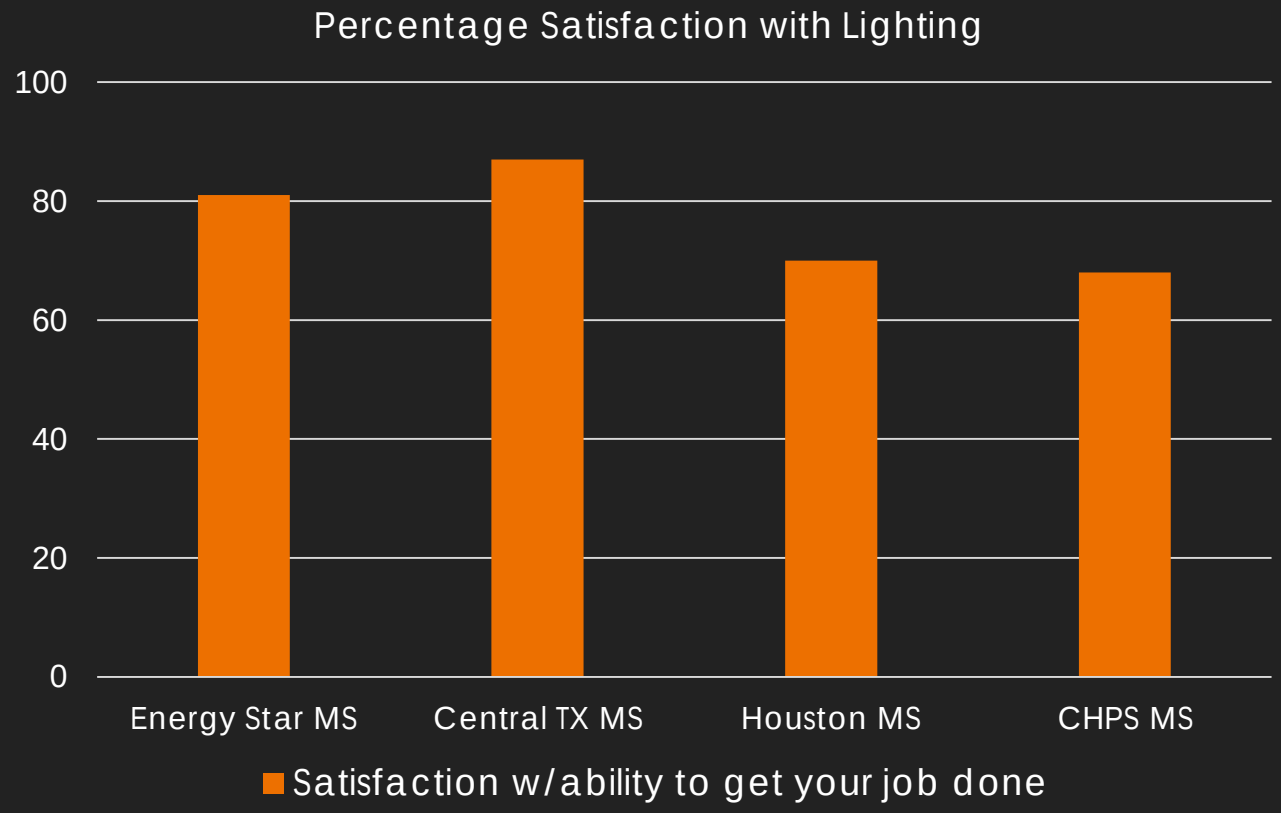


Houston MS 1st Floor Plan

Daylighting

CHPS MS 3rd Floor Plan

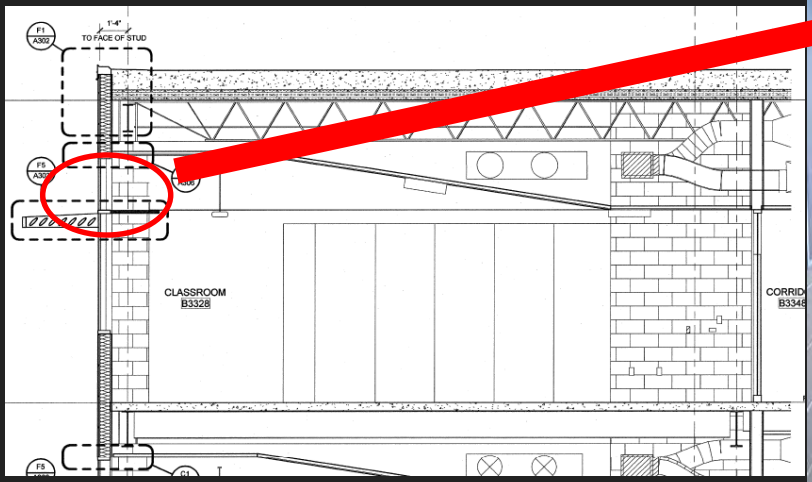
Daylighting



CHPS MS:

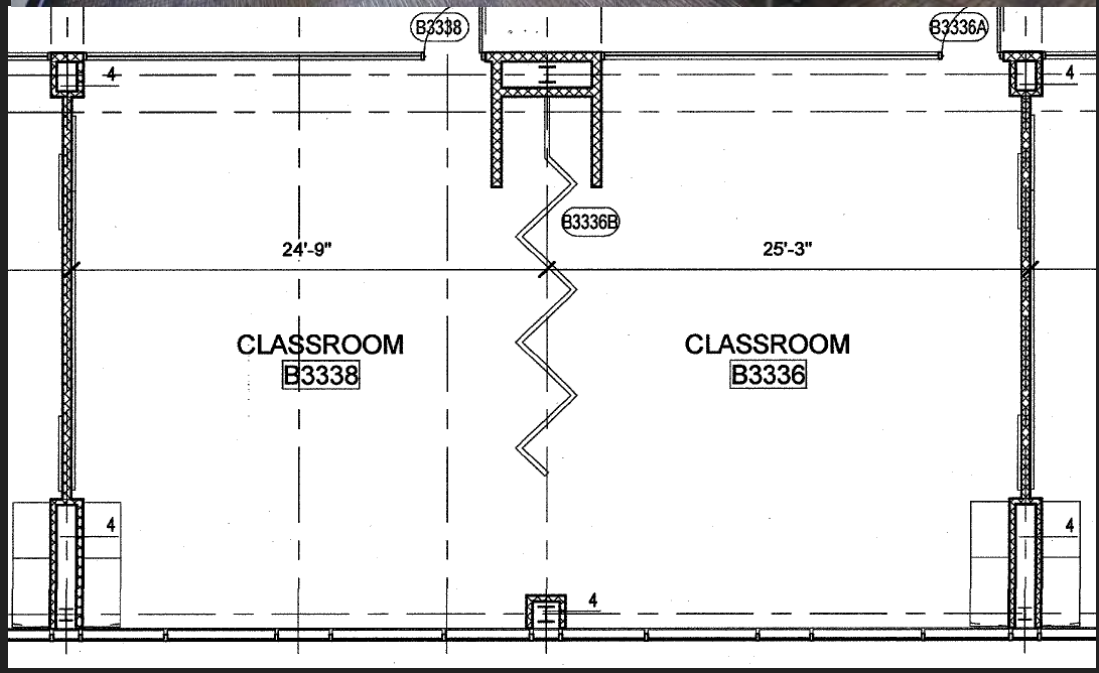
- *"Too bright, too much daylight. Hard to darken classrooms for projection"*
- *"Glare from top windows that do not have blinds is too much for projection surfaces" (smartboard)*
- *"Light switches don't seem to be working by on/off." (daylight sensors in Classrooms)*

Daylighting

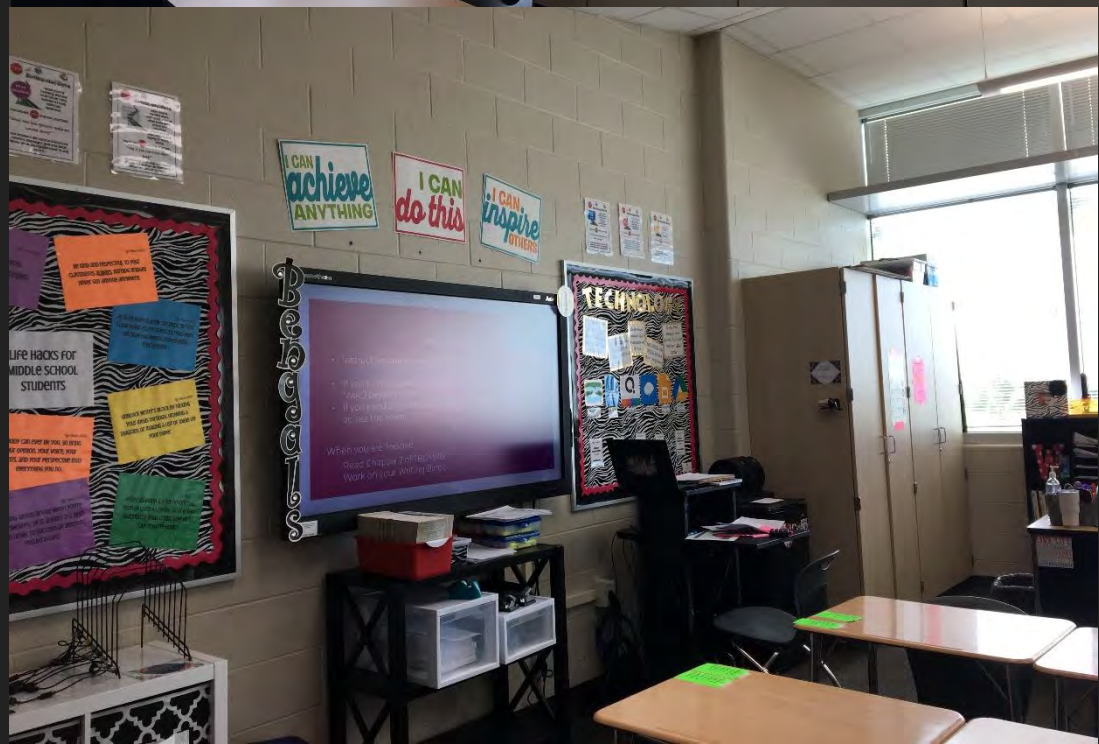


CHPS MS

- "Glare from top windows that do not have blinds is too much for projection surfaces" (smartboard)
- "Classroom layout should focus on location of windows and teaching walls"



Daylighting

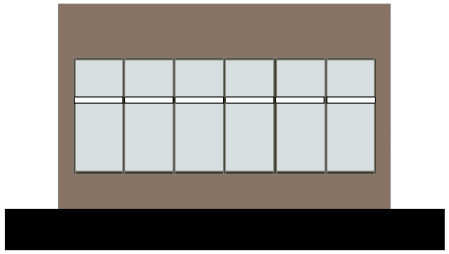


CHPS MS

- Actual Conditions
- Added blinds - inaccessible

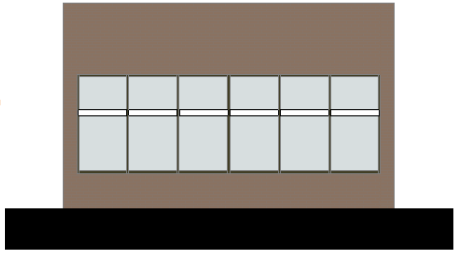
Daylighting Research

1



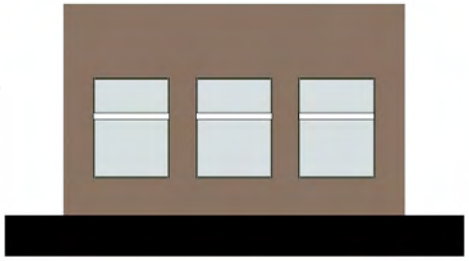
52% WINDOW TO WALL RATIO
2'-8" SILL, 24'-0" WIDE, 11'-4" LINTEL

2



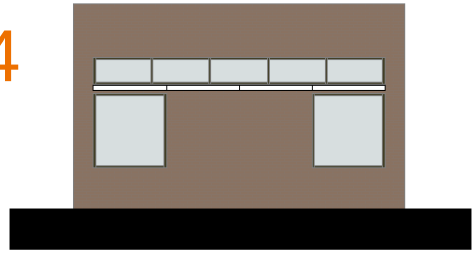
44% WINDOW TO WALL RATIO
2'-8" SILL, 24'-0" WIDE, 10'-0" LINTEL

3



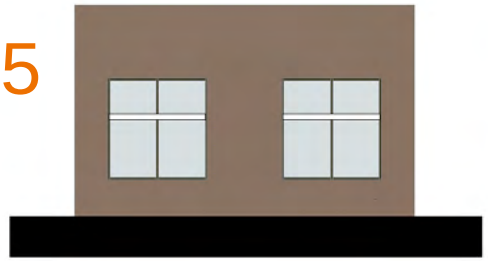
33% WINDOW TO WALL RATIO
2'-8" SILL, 6'-0" WIDE AND 10'-0" LINTEL

4



29% WINDOW TO WALL RATIO
3'-0" SILL, 24'-0" WIDE, 8'-8" AND 11'-4" LINTEL

5



28% WINDOW TO WALL RATIO
2'-8" SILL, 8'-0" WIDE AND 10'-0" LINTEL

Daylighting Research

How does:

- Glazing Size and/or configuration
- Sunshades and/or Light shelves
- Orientation

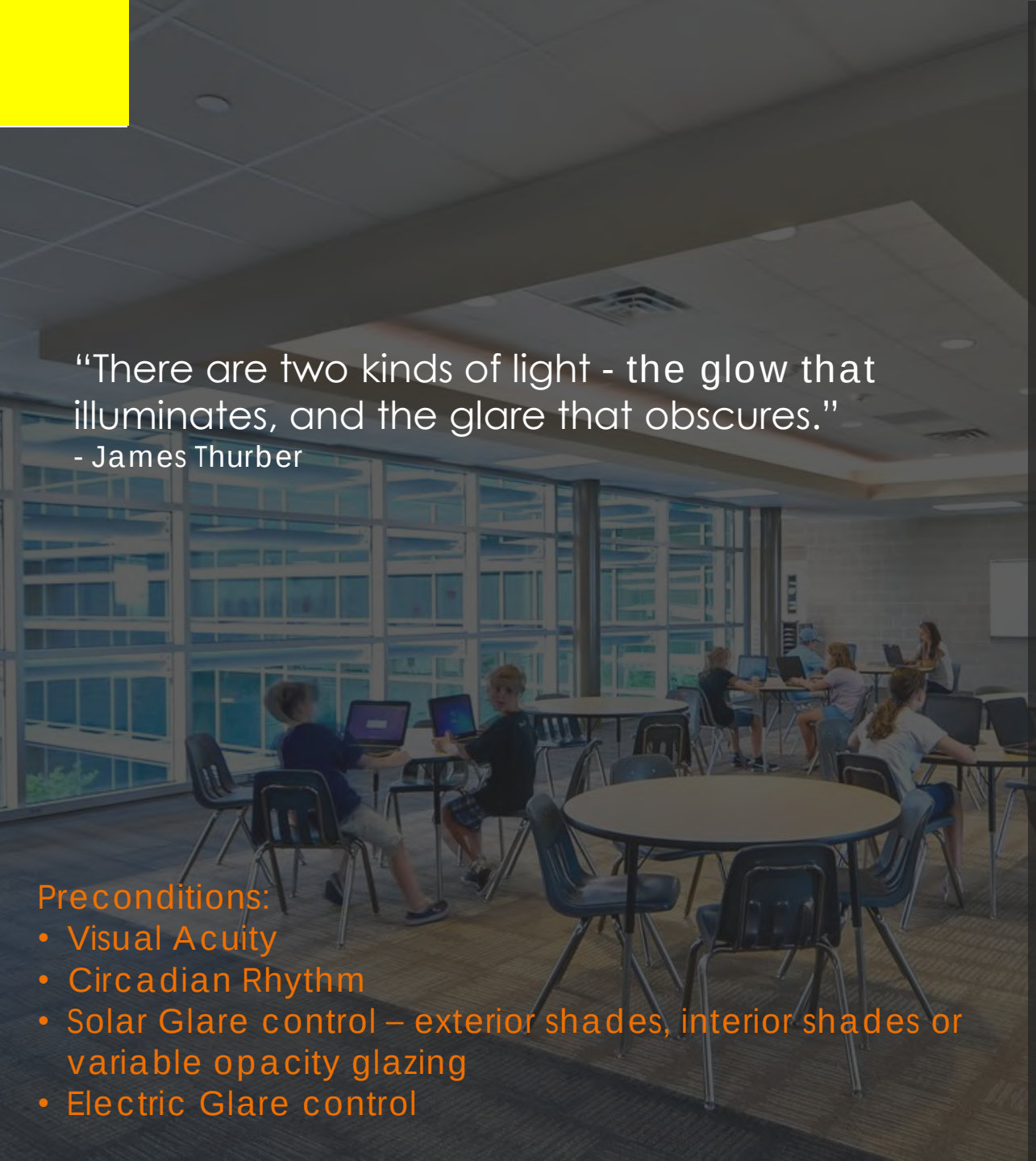
Effect:

- Daylight Quality and User Comfort
- Heat Gain/ Thermal Comfort
- Construction Costs

Daylighting in common spaces

Lighting/ Technology/ Controls

- Almost 100 percent LED Lighting – easier to meet IECC 2015
- Projection technology needs to be designed keeping in mind uncontrolled daylight – can be expensive
- Training needs to be done of the users to know how the sensors and controls work.
- Motion sensors need to be part of closeout or commissioning. One needs to check the sensors and adjust them before occupancy.



"There are two kinds of light - the glow that illuminates, and the glare that obscures."
- James Thurber

Preconditions:
- Visual Acuity
- Circadian Rhythm
- Solar Glare control – exterior shades, interior shades or variable opacity glazing
- Electric Glare control

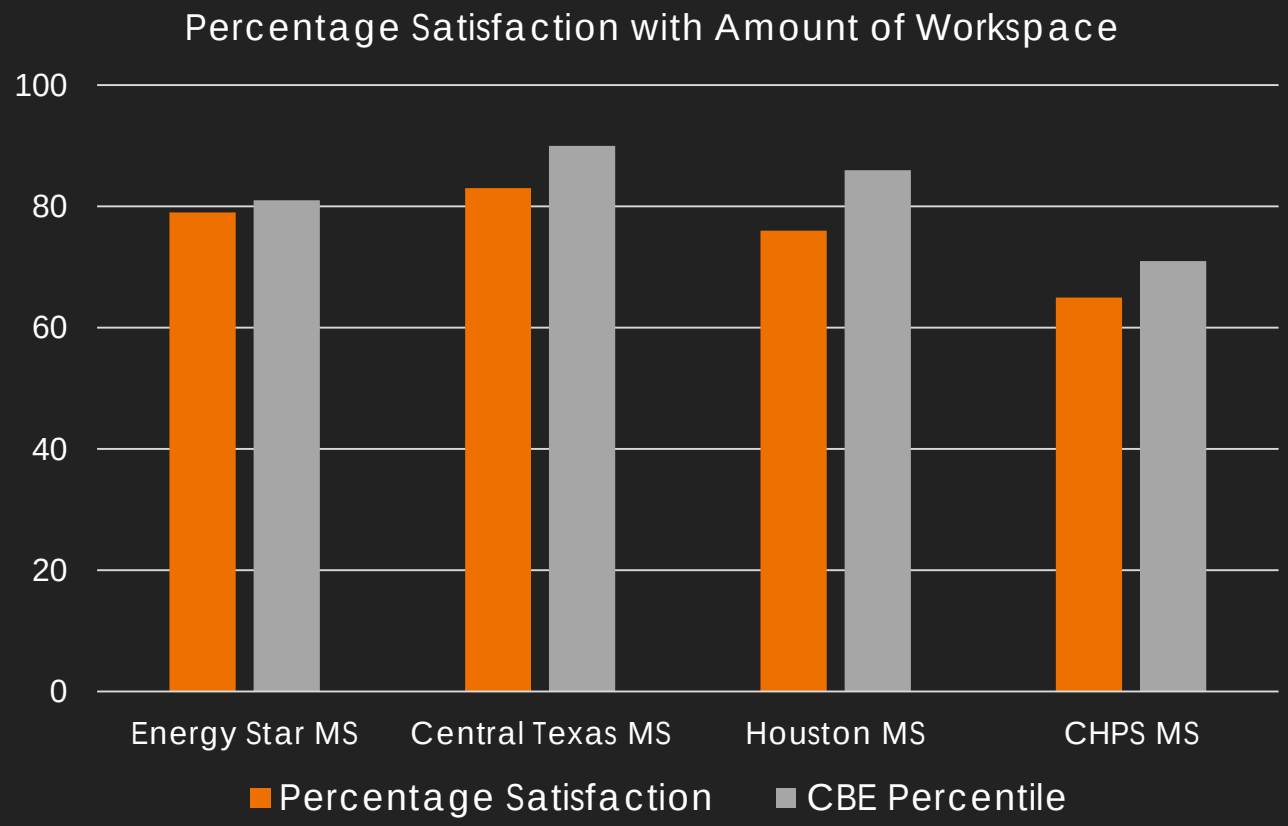
WELL

Daylighting

- Exposure to natural light can improve occupant mood, alertness and overall health.
- Ideal lighting involves proper exposure to diffuse daylight, as well as careful design of windows and glazing to avoid excessive glare and heat gain.
- Balancing energy performance, thermal comfort and access to quality daylight are essential to proper building design.

Overall Design

CR Size/Space



- *"Too many desks, not enough room."*
- *"My classroom is long and the front of the room is on the short end. Due to the placement of workstations and tables, it is very difficult to do a whole class activity which requires students to look at each other or the front of the room?"*
- *"The classroom is crowded with 30 students and its hard to arrange the desks so that they can all view the projector screen?"*

CRs are crowded with lots of students
Classrooms vary from 725 – 768 sf
TEA requirements – max. 25 students – min. 700sqft
Current occupancy – 30 students

CR Layout

Teacher Flexibility

"More flexibility with teachers desk is needed"

"There is only one area in my class that my desk can fit and be connected to the internet. I would really love to move my desk to a different location in the room."

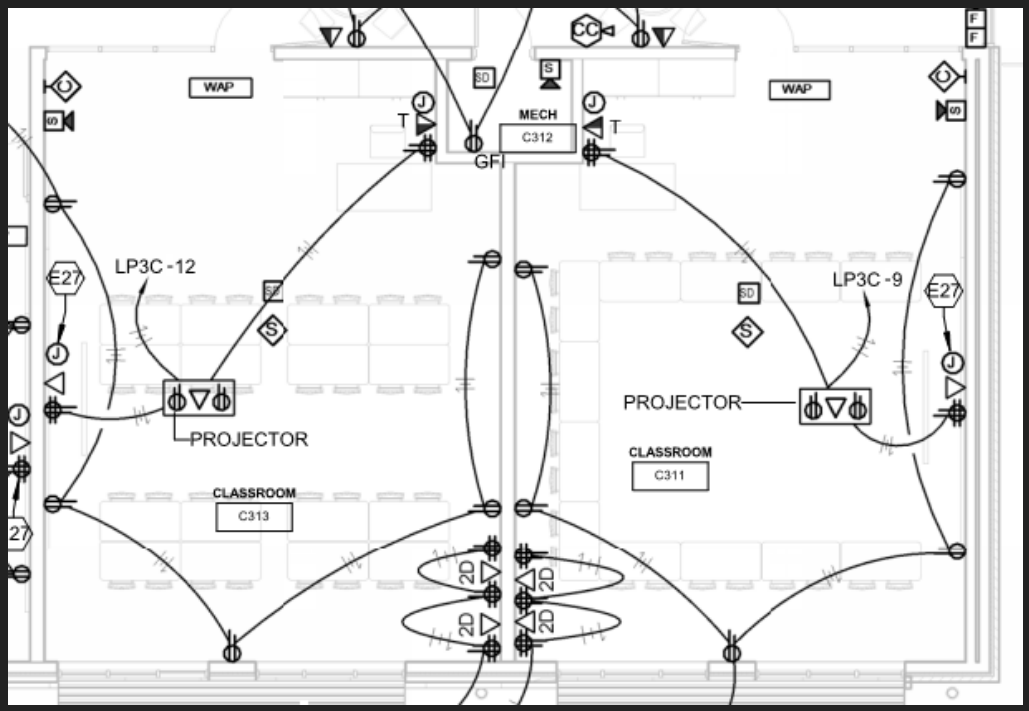
Student Flexibility

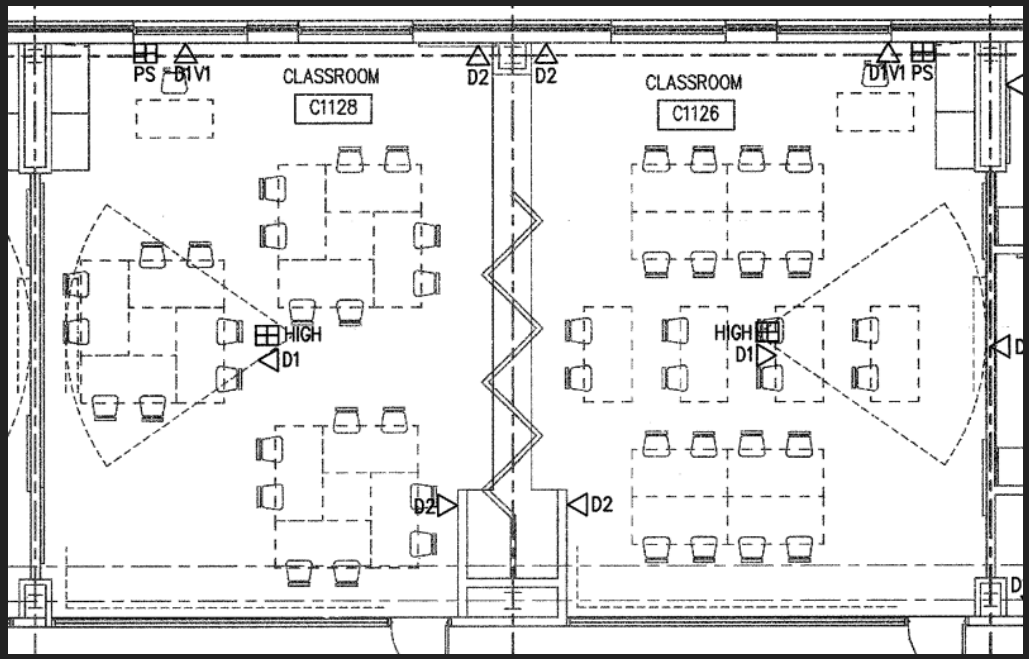
"Due to the placement of workstations and tables it is very difficult to do whole class activities which require students to look at each other or the front of the room"

"The separate desk/chairs for students are difficult to arrange. In order to move the room around you have to move each piece of furniture individually"

Technology Flexibility

Costly to integrate flexibility into wired AV systems. Wireless systems will help when ease of use and reliability improves.





Flexibility

WELL

Adaptable Spaces

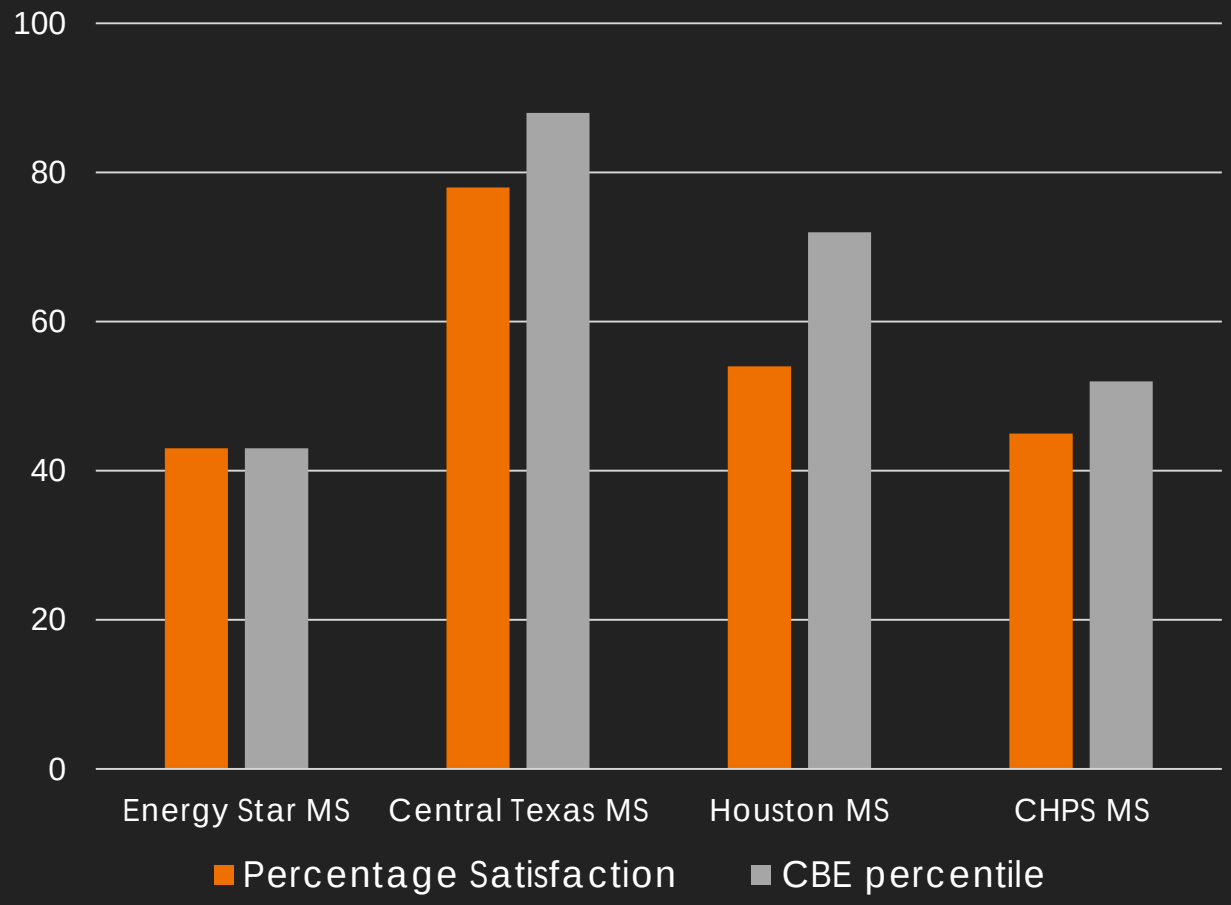
- Healthy work environments should be designed to mitigate stress and optimize productivity, and should therefore be sufficiently adaptable to working, focusing, collaborating and resting as needed. Research demonstrates that the presence of a variety of workspaces that enable individuals to adjust their environments and choose the degrees of engagement is associated with job satisfaction and group cohesiveness.

Optimization:

- Collaboration Spaces
- Quiet Spaces – with sound barriers, low Kelvin lighting, flexible seating

Thermal Comfort & Air Quality

Thermal Comfort



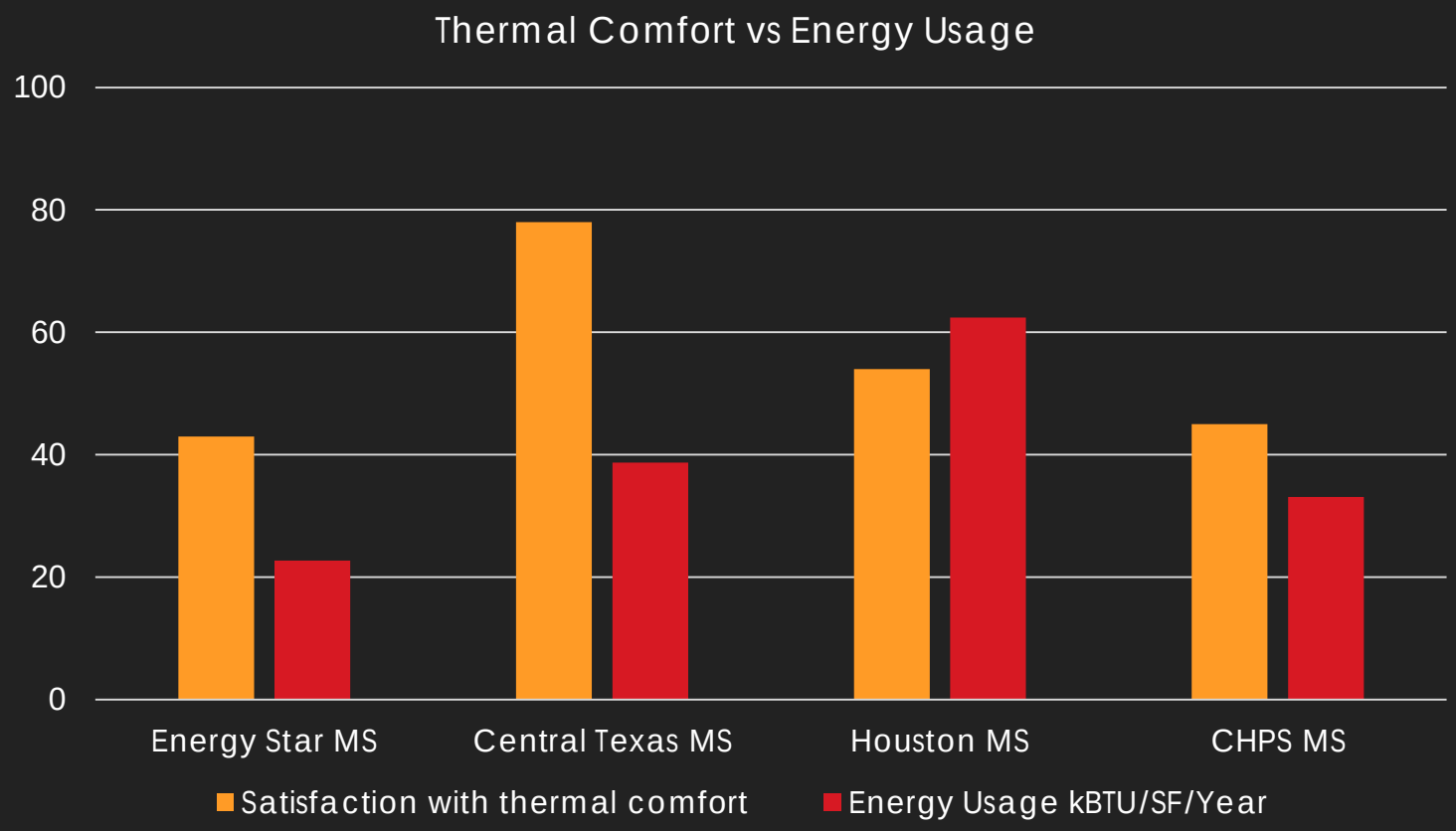
Energy Star MS:

- *"Share heat and AC with another room, not always comfortable in each room"*
- *"Majority comments – very very hot, tough to concentrate, stuffy!"*
- *"Science rooms vent hoods to be specified with dampers"*

Difficult to get higher satisfaction in this category

Users need to be trained and informed about the controls and how HVAC system design is contributing towards high performance

Thermal Comfort vs Energy Usage

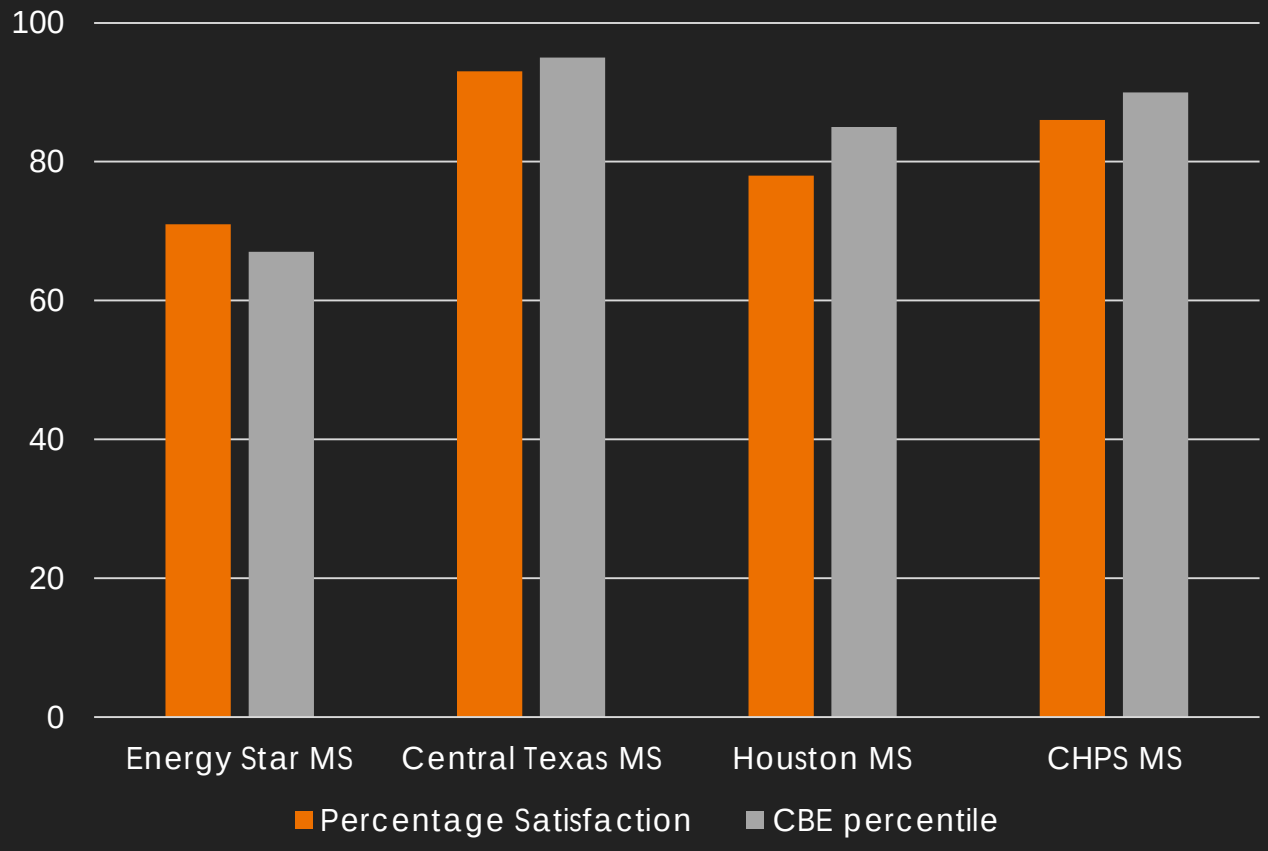


Correlation between too hot and energy savings?

Lack of control for better efficiency?

Training of why less control if given would help with satisfaction.

Air Quality



Energy Star MS:

- *"Sulfur smell in air vents, smells like rotten eggs around 10am and 1pm everyday (2 year battle with this smell, but nothing permanent is being done about it)"*
- *"The auxiliary band hall is stuffy and smells bad as the day progresses. The lack of air flow increases the smell and, since the doors have to stay closed to effectively use the sound proofing, it gets hot and smelly fast. The band office is just stuffy from lack of air flow"*

Scheduling is a big factor in stuffiness in rooms after hours

POEs bring about issues in a facility that are easily rectifiable but may be unknown to the management

"...to deny or ignore the psychology involved in comfort measurements is not only shortsighted, but treats the human subject as a machine, which it is not."
- Prof. F. Rohles

Preconditions:

- All spaces meet requirements for standard thermal comfort zone compliance per ASHRAE 55 – 2013

Optimization:

- 5 degree F variation and 50% free address in open offices

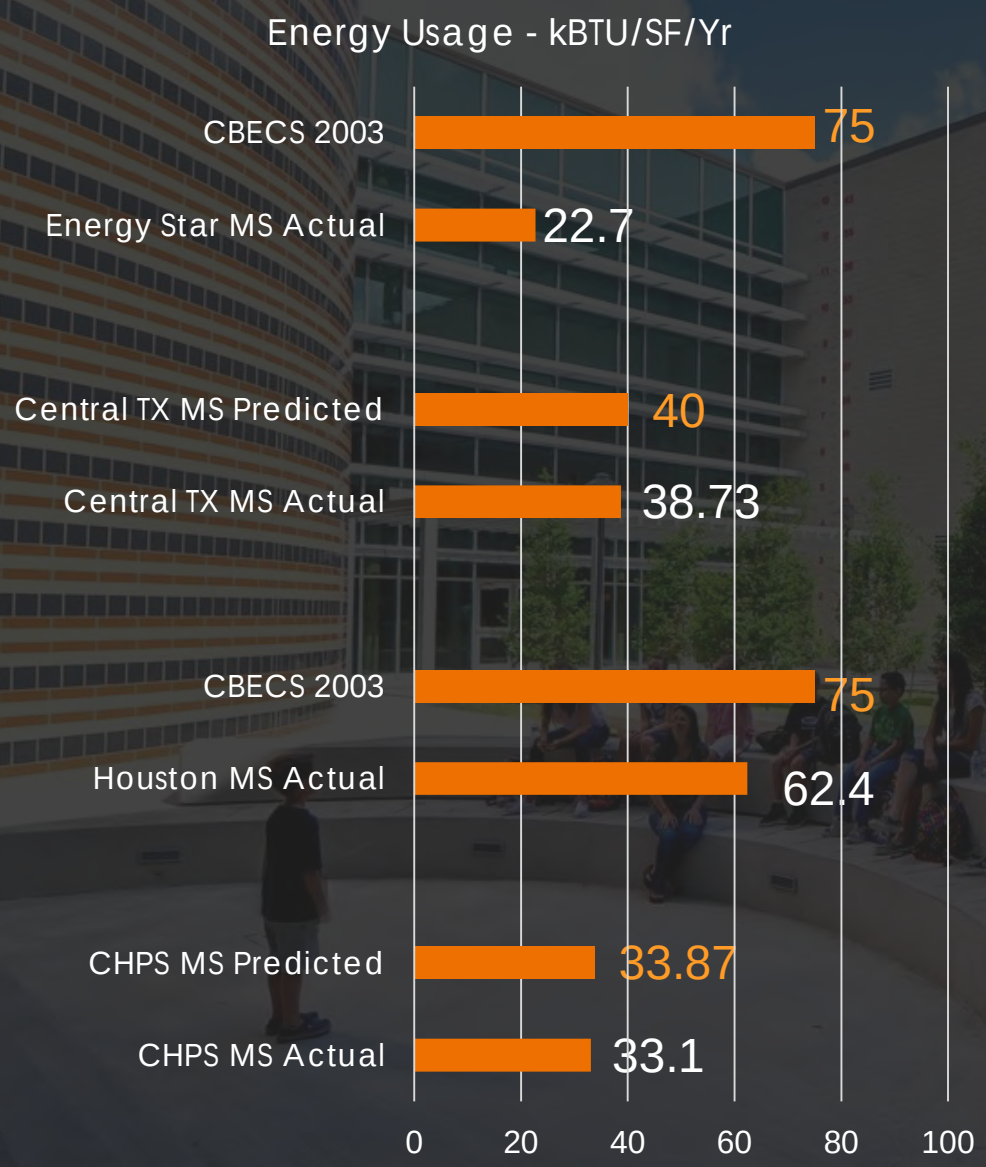
WELL

Thermal comfort

- Energy-efficient buildings are only effective when the occupants of the buildings are comfortable.
- If they are not comfortable, then they will take alternative means of heating or cooling a space such as space heaters or window-mounted air conditioners that could be substantially worse than typical systems.
- As many as 41% of office workers have expressed dissatisfaction with their thermal environment. Leading research also indicates employees perform 6% poorer when the office is overheated and 4% poorer when the office is cold.

Energy Usage

Energy Usage



HVAC cost/sqft

2013
$20.76/sqft

2013
$18.06/sqft

2009
$17.80/sqft

2011
$20.00/sqft

Energy Star MS

- Geothermal System at Classrooms
- Some LED lighting
- Energy Star

Central TX & Houston MS

- Single duct, variable volume system with hot water reheat
- Air Cooled Chillers

Houston MS

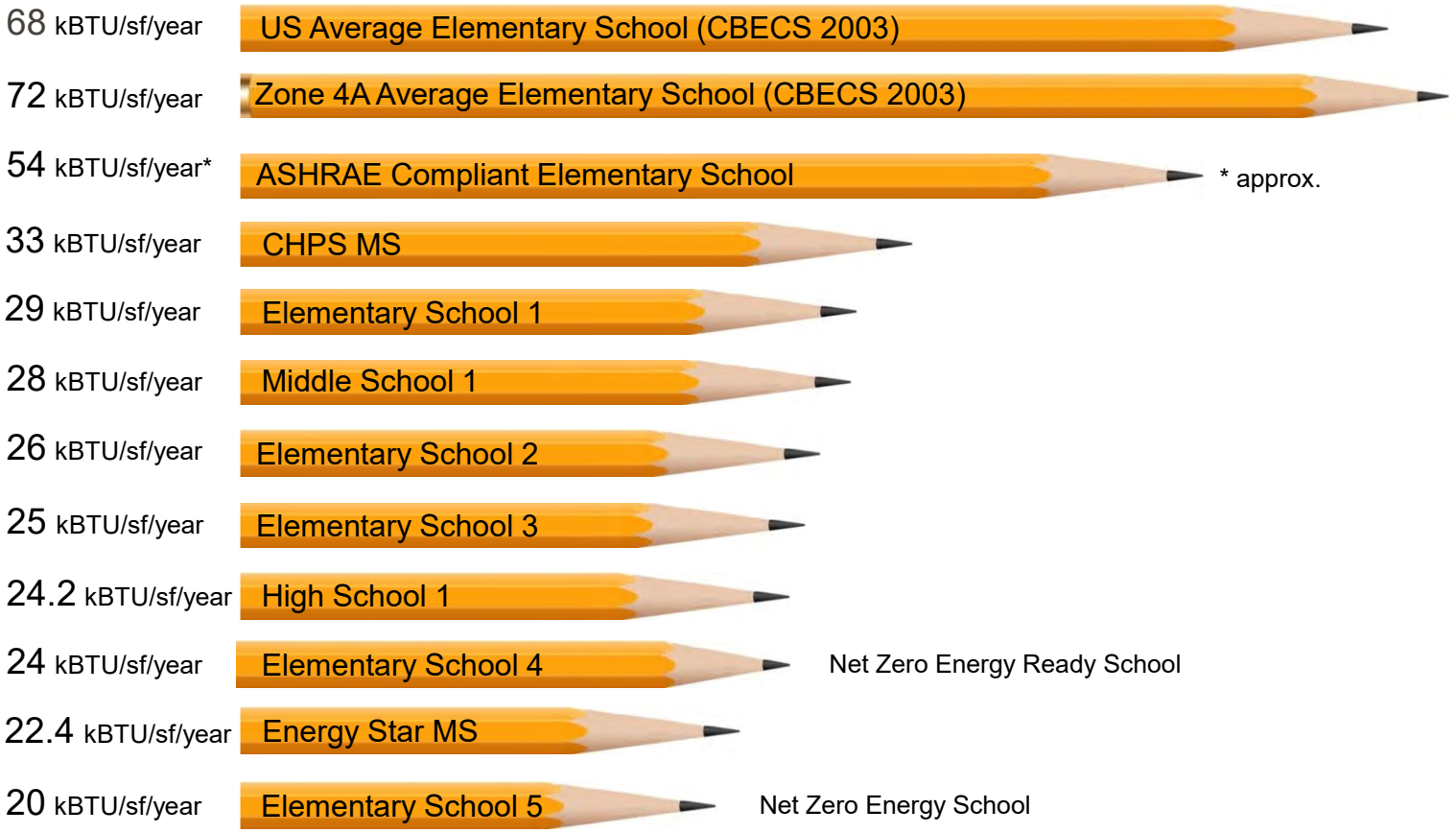
- Reused existing chillers owned by the district

CHPS MS

- Dual duct, variable volume system
- Water Cooled Chiller
- CHPS

(COSTS CONVERTED TO 2013 DOLLARS)

Energy Usage



History of High Performance Schools

Overall Performance/Satisfaction

CBE's Livable Buildings Award

"*project meets the highest standards for providing healthy and productive indoor environments, and represents best practices for sustainability and overall design*"

3 out of 6 finalists in 2016 among 40 projects worldwide

Energy Star MS won the award

(70% better than average energy usage)

Post Occupancy Evaluations

W Checks on the wellbeing of users. Well Building Standard has preconditions for conducting CBE surveys for minimum 3 years after occupancy

N There is need for proof of effectiveness of products that are meant to be used for years to come and are sometimes duplicated

H Extremely helpful in teaching us lessons learnt. Making sure we are designing healthy buildings

O Help our owners make proven informed decisions for future projects. Their decisions impact many projects and many users

Y Makes you a better professional

T Teach ourselves, clients and the industry to constantly improve built environments

Questions?

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