

Empirical Measurement of Facility Impact on Learning

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Empirical Research

Types of Research

Survey Based

- Collection of subjective opinions
- Statistics

Empirically Based

- Tracks standardized testing
- Scientific measurement of impact factor

Measuring impact on learning

Components vs. Composite

Components

- Acoustics
- Air quality
- Lighting
- Moisture Control
- Etc.

Composites

- General Building Condition
- Green Buildings
- High Performance Buildings
- Sustainable Design
- Job Order Contracting

Claims of impact on learning often based on including proven impact components

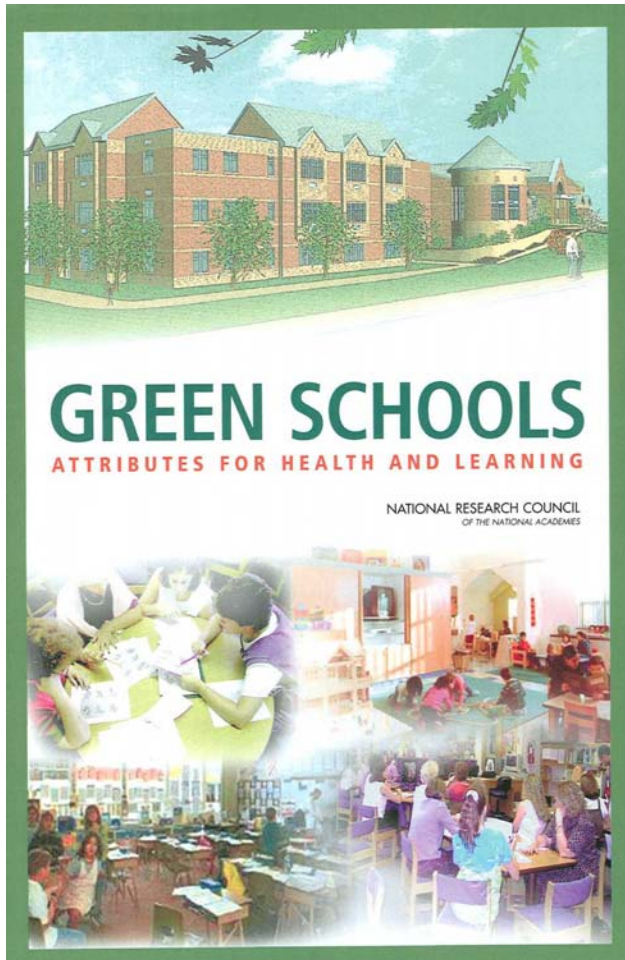
Cross Section of Research

- Can find research to support many positions on one impact factor
- Consider pro and con research
- Sample research attached to handout

Research Status

- Limited number of empirical studies
- More research is needed
- Presentation based on cross section of current research

Notable Resource



Green Schools Attributes For Health and Learning National Research Council of the National Academies 2007

Sponsors:

Massachusetts Technology Collaborative
Barr Foundation & National Academy of Sciences
Connecticut Clean Energy Fund
U.S. Green Building Council

Impact Scale

Causal



Sufficient Evidence of a Causal Relationship

Highest Level of Empirical Support

Association



Sufficient Evidence of an Association

Possible Association



Limited or Suggestive Evidence of an Association

Insufficient Evidence



Inadequate or Insufficient Evidence to Determine if Association Exists

Suggests No Association



Limited or Suggestive Evidence of No Association

Lowest Level of Empirical Support

Study Needed



No Well-Planned Empirical Studies

Acoustics

Causal

- Reverberation & noise.

Association

- Most studies included noise from traffic, trains, airports, etc.

Possible
Association

- “Excessive background noise is typically a more significant problem than is too much reverberation” . . .
Green Schools

Insufficient
Evidence

Suggests No
Association

Study
Needed

Building Age / Condition

Causal

- More empirical support for association of age with student achievement.

Association

Possible
Association

- Most “condition” studies subjective based.

Insufficient
Evidence

- Some condition studies did not factor in educational variables (parental education, socioeconomics, etc.)

Suggests No
Association

Study
Needed

Building Cleanliness

Causal

Association

- Hand cleaning, air filtration, cleaning for doors/fixtures/desktops, & UV treatment can inhibit transmission of viruses/diseases.

Possible
Association

- Infers that absenteeism associated with spread of virus/disease will inhibit learning.

Insufficient
Evidence

- More study needed.

Suggests No
Association

Study
Needed

Indoor Air Quality

Causal

- Impact factors include ventilation, filtration, temperature control, humidity, excessive moisture, cleaning, and allergens

Association

- Assumes impaired health impacts learning

Possible Association

Insufficient Evidence

Suggests No Association

Study Needed

Lighting - Daylight

Causal

- No association – Demos 1967, Larson 1975

Association

- 5 subjective studies

- 2001 Heschong-Mahone study - up to 21% test score improvement.

Possible Association

- P.R. Boyce analysis of Heschong-Mahone Study indicated only 0.3% improvement.

Insufficient Evidence

- 2003 Heschong-Mahone follow-up study found daylight not significant in predicting student performance.

Suggests No Association

- Insufficient scientific evidence to determine whether or not an association exists between daylight and student achievement . . . Green Schools

Study Needed

Lighting – Light Levels

Causal

- Possible association – Mayron 1974, Dunn 1979

Association

- Lighting matching learning styles a factor

Possible
Association

- Corrected eyesight a factor

Insufficient
Evidence

- Green Schools indicated insufficient evidence of association of quantity/quality of light with learning

Suggests No
Association

Study
Needed

Moisture Control

Causal

- Association between excess moisture/mold and adverse health effects

Association

- Studies linked to IAQ research

Possible
Association

Insufficient
Evidence

Suggests No
Association

Study
Needed

School Size

Causal

- Appears to matter more with lower socioeconomic students

Association

- One study (Howley 2001) found poor students performed better in small schools and affluent students performed better in larger schools

Possible Association

- Consensus difficult because of numerous variables

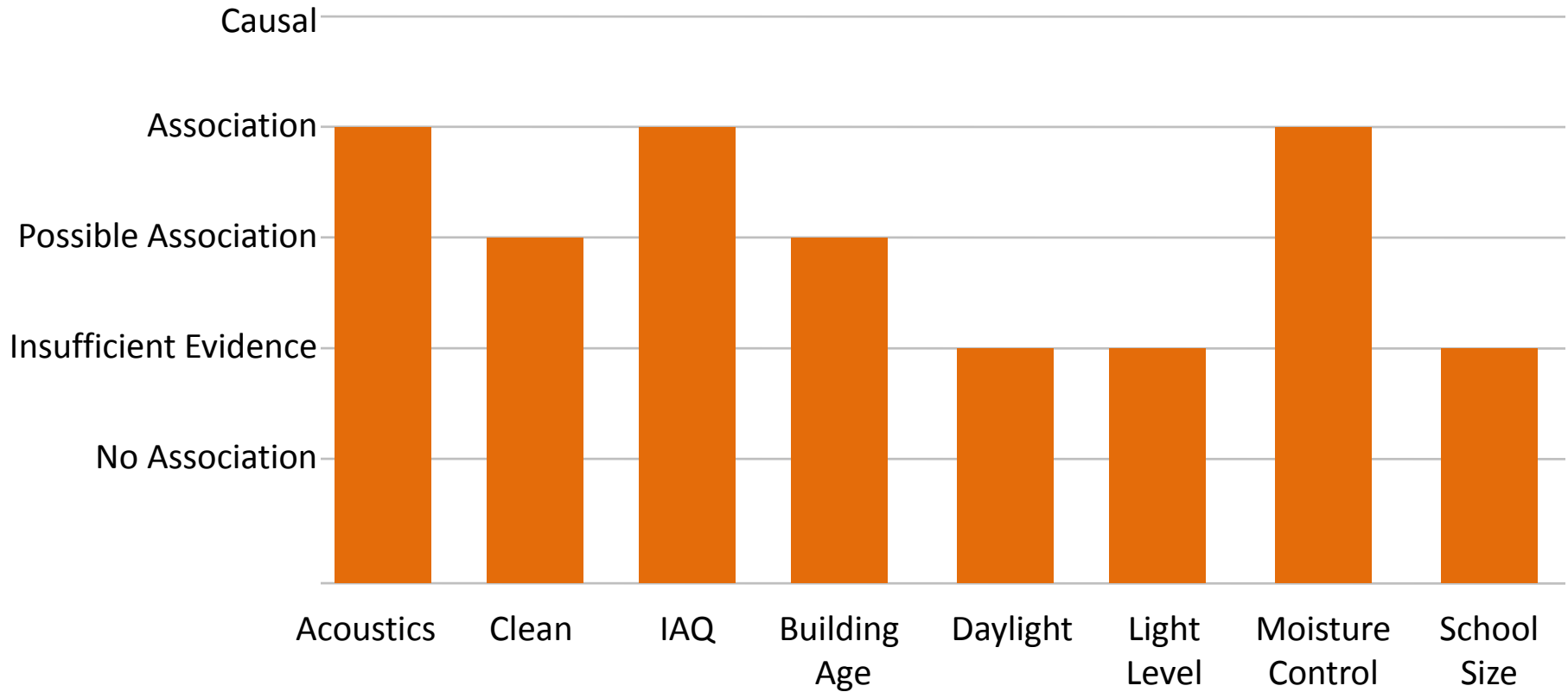
Insufficient Evidence

- Mixed findings . . . more study needed

Suggests No Association

Study Needed

Summary of Impact Factors



Hawthorne Effect

Causal

- Expected results

Association

- 2007 study in Texas

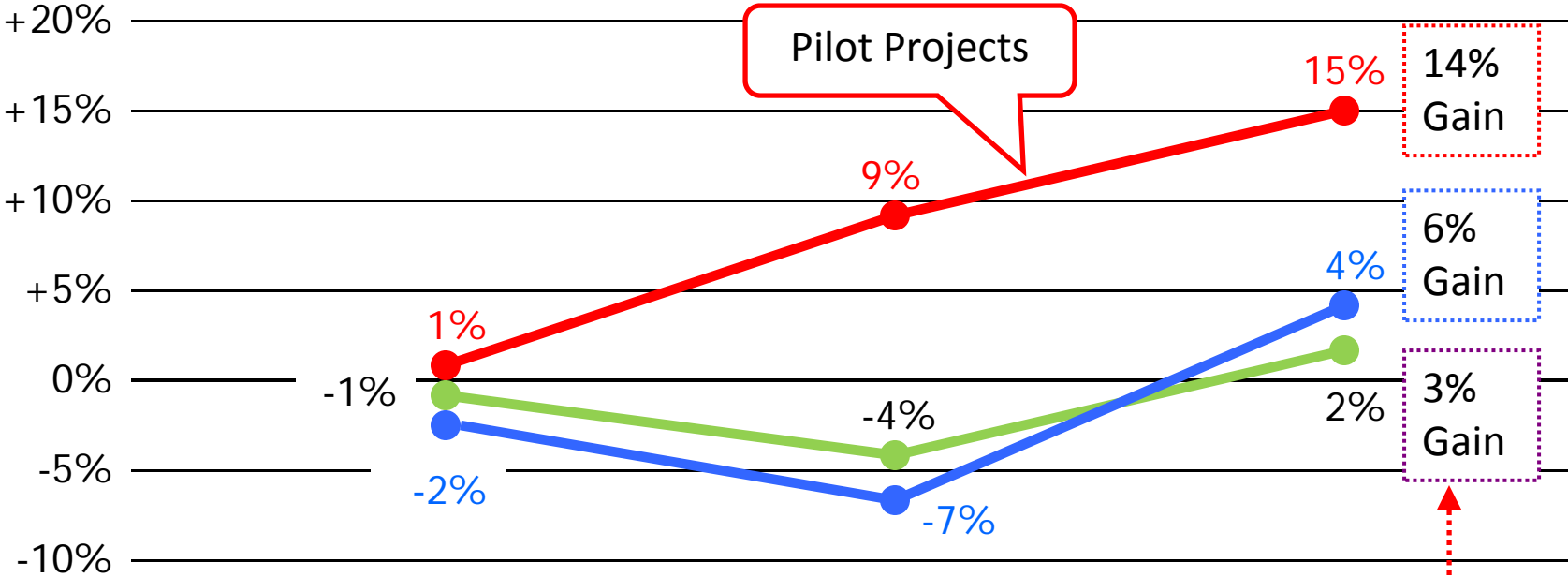
Possible
Association

Insufficient
Evidence

Suggests No
Association

Study
Needed

Year Before Construction Year of Construction Year After Construction



Homogeneous Groups

- ECISD Elem Campuses Not Renovated, 2003-2005
- Elementary bond projects other than pilot projects
- Pilot Projects - Blackshear, Milam, Reagan

Green/Sustainable Buildings

Causal

- Components of green buildings have association with learning

Association

Possible

Association

- No known well-designed, evidence-based studies concerning the overall effects of green schools on learning or productivity . . . Green Schools.

Insufficient
Evidence

Suggests No
Association

Study
Needed

Research Status

- Limited number of empirical studies
- More research is needed

Implementing Impact Features

Balancing Systems

Improving This



Can Compromise

Energy Use

Energy Use

Light Levels

Energy Use

Indoor Air Quality

Acoustics

Indoor Air Quality

Light Levels

Energy Use

Moisture Control

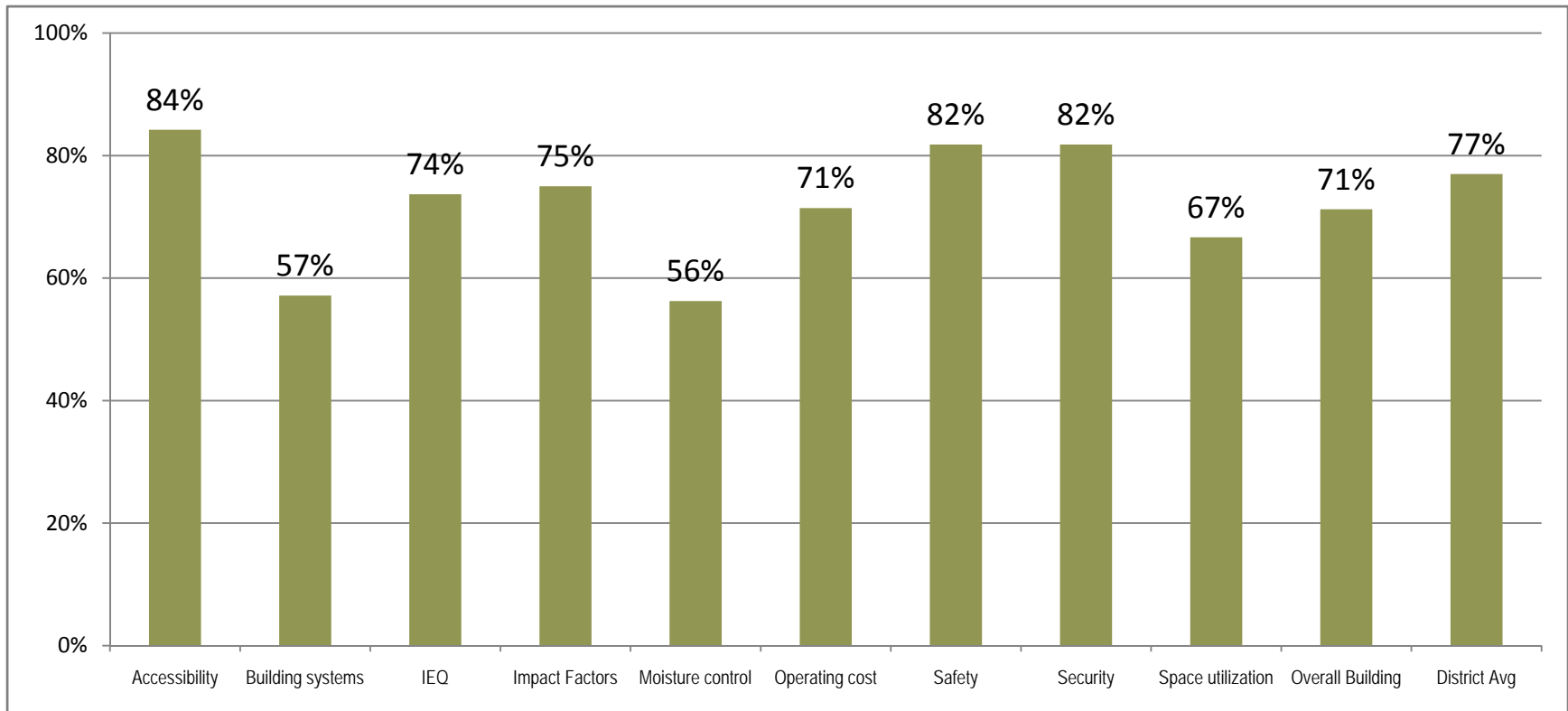
Acoustics

Indoor Air Quality

Balance Improvement Efforts

Monitor for Balance

Monitor periodically depending on conditions

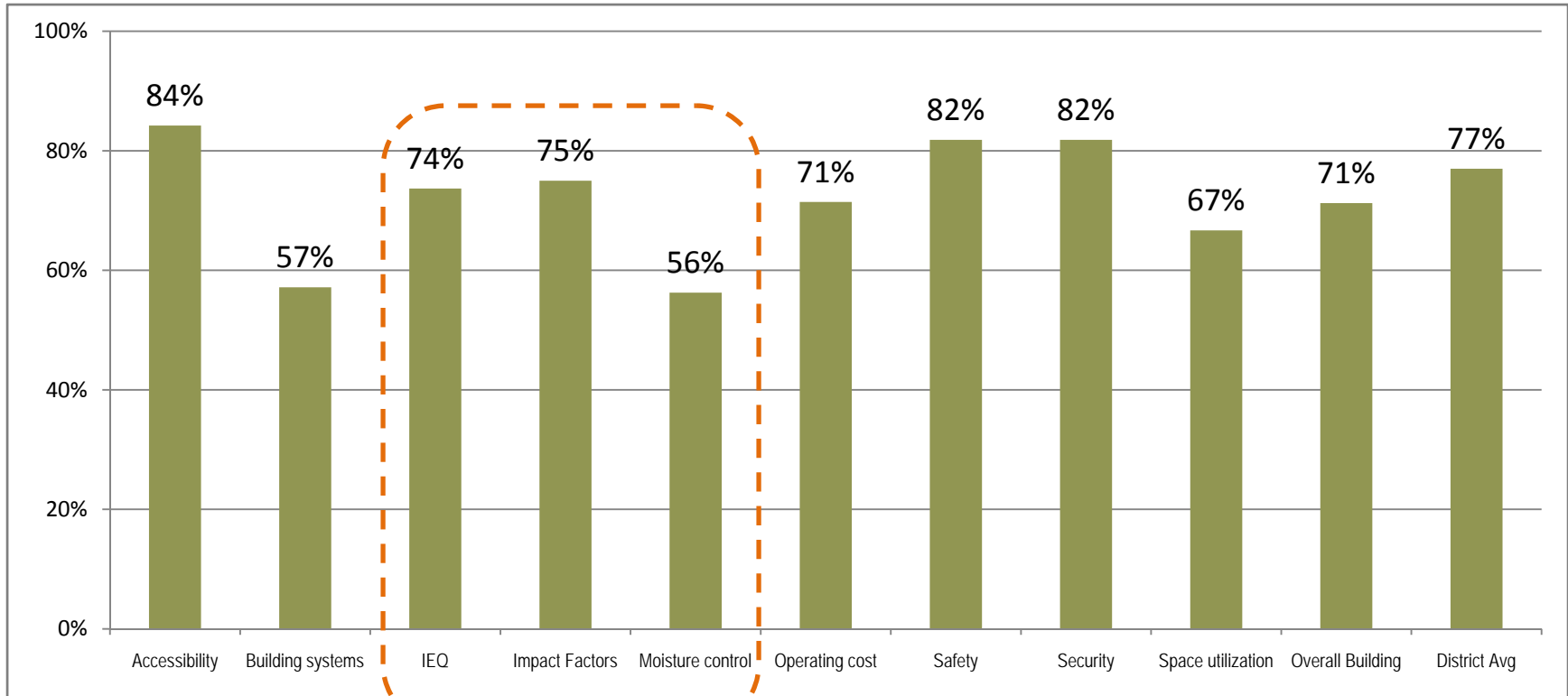


Measuring Impact

Measuring Impact on Learning

- Acoustics - background noise & reverberation
- IAQ – humidity, temperature, allergens, carbon dioxide
- Lighting levels – foot candles and lumens
- Moisture – observation & infrared scans for moisture
- Condition – observation & systems age

Measuring Impact on Learning



Percentage of measurable criteria met

Impact Factor	Standard Range	Avg	Remarks
Noise	Max 40 dB with AC running	38	Within range
Lighting	55 to 80 foot candles	71	Within range
Space	750 to 900 sq.ft.	804	Within range
Temp Control	Maintain 70 to 75 F (winter)	74	Within range
Relative Humidity	30% to 60%	41	Within range
Carbon Dioxide	Max 1,000 ppm	809	Within range
Carbon Monoxide	Max 9 ppm in 8 hr period	3.1	Within range
VOC's	Max 0.64 ppm	0.41	Within range
Fungal Spores (mold)	Less than 313 (less than outdoor)	212	Within range
Formaldehyde	0.04 ppm	0	Within range

Built Environment Index:
Percentage compliance

HCA Research Underway

- Texas Hill Country & West Texas school districts
- Measure impact factors (lighting levels, IAQ, temperature, background noise, etc.)
- Compare to test scores, attendance & absenteeism
- Factor in variables (socioeconomics, ed programs, etc.)
- Regression analysis
- Develop association of impact on learning, attendance and absenteeism.

IEQ Trends

- Many impact factors environmental
- In our 27 years observed pendulum swings
- Originally . . . risk and solutions overstated
- Asbestos, fiberglass, mold, etc.
- Eventually moderates to reasonable

Thank You

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