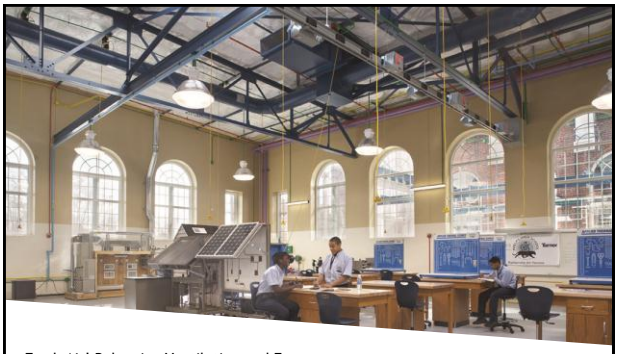

Fresh Air! Balancing Ventilation and Energy

creating places to learn

FANNING HOWEY

Feb 23, 2012

The Framework for Effective School IEQ Management:

Six Key Drivers

The Framework for Effective School IEQ Management:

Six Technical Solutions

HVAC
Moisture/Mold
IPM
Cleaning & Maintenance
Materials Selection
Source Control

Quality HVAC
- Inspect HVAC systems regularly
- Establish a maintenance plan
- Change filters regularly and ensure condensate pans are draining
- Provide outdoor air ventilation according to ASHRAE Standard or local code
- Clean air supply diffusers, return registers, and outside air intakes
- Keep unit ventilators clear of books, papers, and other items

Control of Moisture/Mold
- Conduct routine moisture inspections
- Establish mold prevention and remediation plan
- Maintain indoor humidity levels between 30% and 60%
- Address moisture problems promptly
- Dry wet areas within 24-48 hours

Strong Integrated Pest Management (IPM)
- Inspect and monitor for pests
- Establish an IPM plan
- Use spot treatments and baits
- Communicate with occupants prior to pesticide use
- Mark indoor and outdoor areas treated with pesticides

Effective Cleaning & Maintenance
- Conduct routine inspections of school environment
- Develop a preventative maintenance plan
- Train cleaning/maintenance staff on protocols
- Ensure material safety data sheets (MSDS) are available to staff
- Clean and remove dust with damp cloth
- Vacuum using high-efficiency filters

Smart Materials Selection
- Maintain products inventory
- Develop low-emitting products purchasing and use policies
- Use only formaldehyde-free materials
- Use only low-toxicity and low-emitting paint
- Select products based on product rating systems
- Use least toxic cleaners possible (only those approved by the district)

Aggressive Source Control
- Conduct regular building walkthrough inspections
- Test for radon; mitigate if necessary
- Implement a hazardous materials plan (use, label, storage and disposal)
- Establish a school chemical management and inventory plan
- Implement Smoke-Free policies
- Establish an anti-idling school bus policy
- Use walk-off mats at building entrances
- Conduct pollutant-releasing activities when school is unoccupied

Agenda

- What is IAQ?
- Current Findings– Energy and IAQ
- Basics of Ventilation
- Summary and Questions

Introductions

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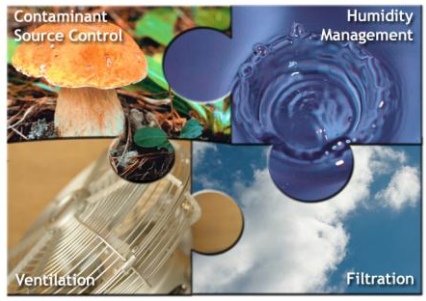
CEFPI National IAQ Champion
Energy/Sustainability Services Manager
Fanning Howey

What is "Indoor Air Quality"?

The nature of the indoor air as it relates to the health, well-being and productivity of the building's occupants.

Fundamental Elements of IAQ



energy & IAQ findings

Qualities That Affect Student/Teacher Performance

Topic	# of Studies
Indoor Air Quality	13
Thermal Comfort	6
Lighting	7
Acoustics	13
Building Quality	19
School Size	42

Do School Facilities Affect Academic Outcomes?

National Clearinghouse for Educational Facilities

Summary Data Collated by Fanning Howey
From National Clearinghouse for Educational Facilities Booklet
"Do School Facilities Affect Academic Outcomes?",
by Mark Schneider, November 2002

Current Indoor Air Quality Research

	RESEARCH OUTCOME	SUPPORTING RESEARCH
1.	Teachers perceived air quality more positively in LEED certified buildings	Bruick, Sewall, Pearson and Van- Neely
1.	D-Limonene and other terpene compounds can react with ozone creating aldehydes and ultrafine particles which can be irritating	Sarwar et al (2002), Welscher and Shields (1999) Wolkoff et al (2000), Apte and Erdmann (2002) *Chemicals in Common Products* Greenguard
2	If offices are associated to schools, inadequate ventilation is now related to a substantial excess of preventable symptoms.	Mendell and Heath (2005)
2	Studies link microbiological and chemical exposures from indoor sources, excessive dampness, and (possible indoor) exposure to pollutants from outdoors to respiratory infections , asthma, etc, all documented to reduce school attendance.	Mendell and Heath (2005)
3	Post renovation academic achievement of students demonstrated markedly	Zulli, Lighthall & Carruthers higher % of students scoring at or above grade level.
4	Increasing outdoor air supply rate and reducing moderately elevated classroom temperatures significantly improved task performance speed.	Wargocki and Wyon (2006)
2	In survey so far, green buildings are superior to conventional buildings in perceived air quality.	Abbaszdeh, Zagreu, Leher and Huizenga (2006)in
3	There is an association between moisture problems in buildings and adverse outcomes, particularly asthma. There is growing body of evidence that teacher productivity and student learning may be affected by IAQ.	National Academy of Science (2006) health

Design Direction Indicated by Research Findings :
1 Indoor Air Quality has a direct affect on health, attendance and performance.
2 Contaminant sources are not limited to ventilation. VOCs impact Indoor Air Quality
3 "Green" buildings have better perceived Indoor Air Quality.

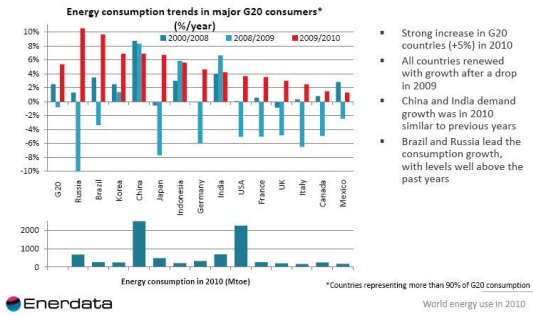
Asthma

- 1 in 13 children now suffer from asthma resulting in 5,000 deaths (246 children) per year
  National Association of School Nurses Issue Brief June 2002
- 7% of the US adult population suffers from asthma
  Asthma in the United States: Burden and Current Theories – Stephen C. Redd Feb 2002
- American children miss more than ten million school days each year from asthma exacerbated by poor IAQ
  (ALA2002, EPA 2000)
- Estimated Cost of asthma at least $12.7B in 2000
  Public Health Policy Advisory Board, 2002
- Rate for African Americans is 2-3 times higher
  Asthma in the United States: Burden and Current Theories – Stephen C. Redd Feb 2002

Why is energy important

- 2nd largest expense after people
- $192.1 billion in energy costs for commercial buildings
  - 2008 EIA
- Poor owners can't afford to build cheap.
- Energy consumption grows with population and square footage

G20 Energy Consumers

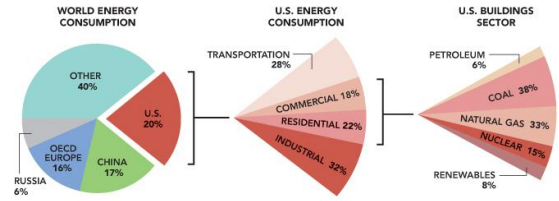


- Strong increase in G20 countries (+5%) in 2010
- All countries renewed with growth after a drop in 2009
- China and India demand growth was in 2010 similar to previous years
- Brazil and Russia lead the consumption growth, with levels well above the past years

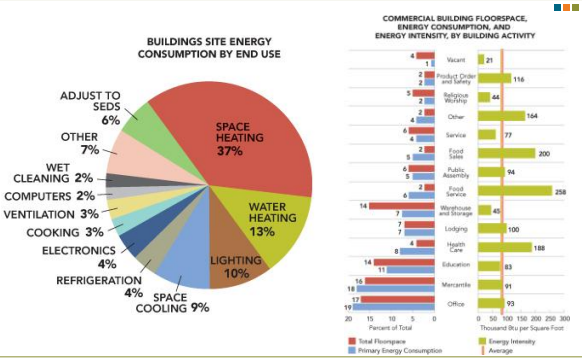
*Countries representing more than 90% of G20 consumption

World energy use in 2010

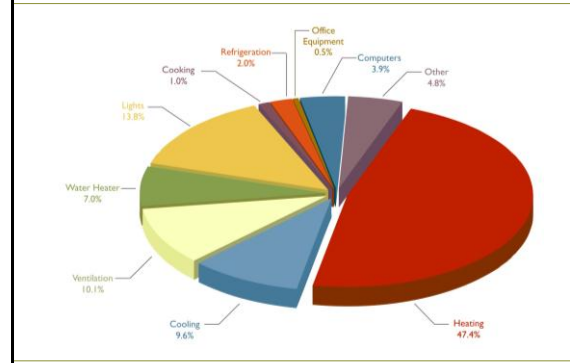
DOE Building Energy

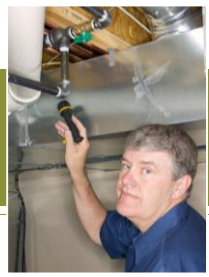


DOE Commercial Building Energy



National School Building Load Profile





maintenance & operations

Implement Plans to Control Mold

ASHRAE Position Paper, Released May 2005

- "Due to the proliferation of mold in buildings, sound moisture management should take precedence over energy cost savings."

New Position Document From ASHRAE President, Ron Vallort

- "Energy conservation goals may conflict with moisture management goals. In fact, traditional methods of dehumidification, such as reheat systems, may increase energy use. However, the impact of mold proliferation suggests that energy cost savings should not be achieved at the expense of sound moisture management."

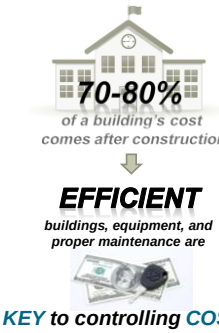
Control Humidity At All Times

- Limits microbial and dust mite growth
- Significantly reduces pull-down periods
- Prevents furnishings and porous materials from "storing" moisture

Maintain ≤65% RH even when building is unoccupied

Utilities

- Ventilation is the single largest cost of HVAC
  - Heating and cooling outside air consumes significant energy
  - HVAC equipment size must increase to accommodate for the ventilation load.
- Continuous ventilation means more hours of HVAC operation



KEY to controlling COSTS

How Important Is It?

- Proper maintenance of indoor air is more than a "quality" issue; it encompasses safety and stewardship of your (our) investment in students, staff and facilities *
- 2 greatest causes of poor IAQ are inadequate HVAC maintenance and lack of ventilation **
- What isn't measured isn't maintained
- Leadership sets the tone

*EPA TFS Reference Guide
**Armstrong Laboratory

Codes and Requirements

Does your state have…

- **Mechanical Code** for ventilation requirements?
  - What are they?
  - Do you want to be minimally compliant?
  - ASHRAE/ANSI 62.1-2010
- Are you using your tools?
  - Design TfS & TfS
  - Healthy SEAT
- An **Energy Code**?
  - What is it?
  - Do you want to be minimally compliant?
  - ASHRAE/ANSI 90.1-2010 excellent reference
- Have you discussed them with your design team?

BE AN INFORMED CLIENT!

Ventilation Control Strategies

- Scheduled ventilation
- CO_2-based demand-controlled ventilation
- Ventilation reset control
- Re-commission Schools based upon current occupancy

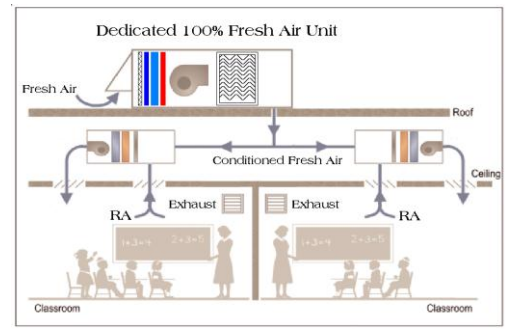
THE ABILITY TO MEASURE AND CONTROL OA IS KEY!

leading systems design

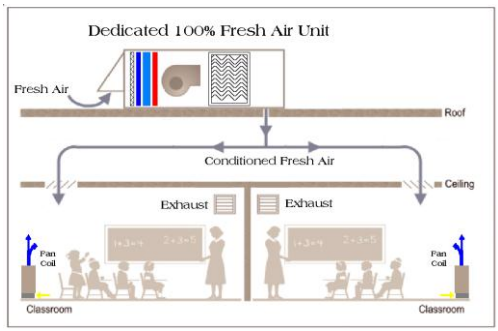
Benefits of Dedicated Outside Air Systems (DOAS)

- Provides sufficient ventilation while imposing the maximum relative humidity limit
- Unoccupied dehumidification without operation of terminal units or central plant
- Units are easily added to existing buildings (to comply with ASHRAE 62)
- Ability to measure outside air
- Can downsize terminal units with cold supply air
- Engineered solution for cooling, dehumidification and heating of extreme OA temps

Indirect to the Space - Cold or Neutral Temperature

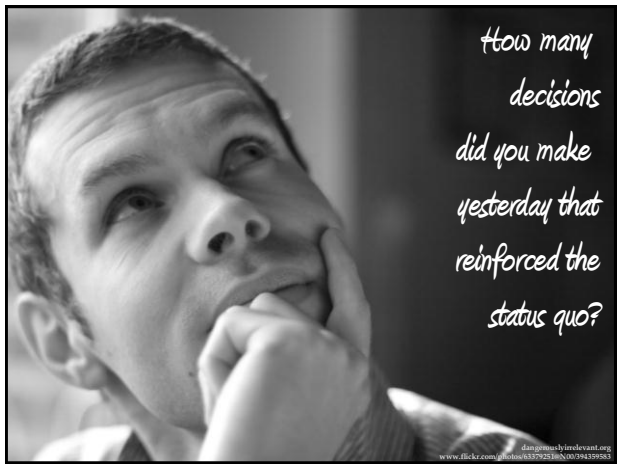


Direct to the Space – Cold or Neutral Temperature



Final Thoughts

- Good IAQ practices support the core mission of public schools – educating children
- Academic facilities do impact academic outcomes so they should promote learning
- Communication helps balance IAQ and energy
- Design and build for the long term; schools live a long time
- The school building can teach more than the students



Contact Information

ENERGY STAR AWARD 2012 PARTNER OF THE YEAR

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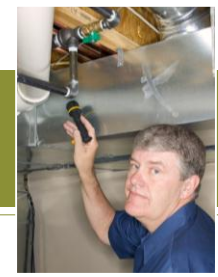
new construction

existing facilities

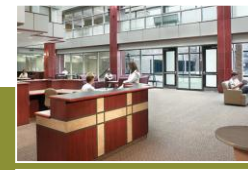


maintenance & operations

new construction

existing facilities

leading systems design



application in today's world

Federal Actions

- High Performance Green Buildings Act of 2007
  - Created Office of Green Buildings
  - Directed EPA to create school siting guidelines
  - Directed EPA to create state grant program to accelerate health school environments
  - Authorized federal study on "green" schools including effects of sustainable features on IEQ stressors
- EPA Air Toxics Monitoring Project
  - Reported in USA Today
  - Outside 64 schools in 22 states and 2 tribal nations
  - http://content.usatoday.com/news/nation/environment/smokestack/index

Analysis by Healthy Schools Network

State Activities

- California Air Resources Board
  - Formaldehyde is a known carcinogen
  - 2010 standards more stringent than Europe or Japan
  - Study by Shendell et al 2004 found individual whiteboards with unsealed edges as a significant source
  - Casework, composite wood, insulation
- Minnesota Department of Health
  Cleaning, Indoor Environmental Quality and Health: A Review of Scientific Literature, Tanner, 2008
  - Schools that implemented IAQ management plans emphasizing cleaning showed reduced levels of allergens in 70% of areas sampled
  - Staff perception of IAQ improved
  - Districts working with MNDH report reducing maintenance costs

State Activities

- New York State School Facility Data
  - 1/3 of NY schools (excluding NYC) had at least 1 asthma related building system that was self-rated "unsatisfactory"
  - Schools with "unsatisfactory" conditions had
    - Higher suspension rates
    - Lower attendance
    - Lower test scores
  - 72% of districts use an IAQ management program

The Benefits

- "Studies indicate that the benefits of green schools are numerous.
  - Green schools can save 40 percent or more on energy costs.
  - Students in schools that rely primarily on daylighting perform up to 26 percent better on standardized tests than their counterparts in poorly lit schools.
  - An estimated 17 million school days were lost in 1997 due to asthma. Taking steps to address air pollutants leading to asthma would mean higher school attendance."

Statement of Chairman James M. Jeffords

Senate Environment & Public Works Committee

Hearing on Green Schools: Environmental Standards for Schools

Past Indoor Air Quality Research

	RESEARCH OUTCOME	SUPPORTING RESEARCH
1	Poor IAQ increases student absenteeism Rosen and Richardson (1999) EPA (2000) American Lung Association (2002)	Smedje and Norback (1999)
2	Improving Air Quality Reduces Absenteeism	Rosen and Richardson (1999)
3	Increased Relative Humidity Reduces Absenteeism	Leach (1997)
4	Mental Tasks Are Affected By Changes in Temperature	Wyon (1991)
5	Mental Tasks Are Performed Best In 40-70% Humid./ 68-74F. Temp. Wyon, Andersen, and Lundqvist (1979)	Hamer (1974)
6	Most Staff Health-related Problems are Due to Poor Indoor Air Quality	Schneider (2002), Chicago and DC Schools
7	Improved Ventilation Systems Reduce Reports of Asthma	Smedje and Norback (1999)
8	Students in Schools Low Ventilation Rates Have More Nasal Mucosa Swelling (Which may lead to increased absenteeism)	Walinder et al. (1997), Study in Swedish Schools
9	VOCs Are 2 to 8 times Higher in Schools with Low Ventilation Rates (Which may lead to increased absenteeism)	Walinder et al. (1997), Study in Swedish Schools

Design Direction Indicated by Research Findings :

1 Indoor Air Quality has a direct affect on attendance and performance.
2 The temperature range most conducive to learning is 68 - 74 degrees F.
3 The humidity range most conducive to learning is 40-70% RH.

Common Volatile Organic Compounds in Schools

VOC	Source(s)	VOC	Source(s)
Tolulen	Cleaner, construction materials	**Hexanal**	Cleaners, adhesives, deodorizers, cabinetry
Xylenes	Cleaners, construction materials	**2-Butoxyethanol**	Wood cabinetry, cleaners, paints
Siloxanes	Waxes, polishes, deodorants	**Ethanol**	Cleaner, disinfectants
Formaldehyde	Furniture, ceiling tile, wood shelving, cabinetry	**TXIB**	Plastics, paints
Hexane	Markers, cleaners	**Acetaldehyde**	Plastics, paints, foam insulations
Acetone	Markers, art supplies	**Longifolene**	Cleaners, wood products, flooring
1,4 Dichlorbenzen	Cleaners, deodorizers	**Naphthalene**	Adhesives, art supplies rubber flooring

Source: Study by Air Quality Sciences of VOC levels in US schools, referenced in "Chemicals in Common Products: Risky Business for Children's Health" by Greenguard Environmental Institute

The Challenge

- Between the ages of 5 and 18, a student may spend 14,000 hours inside a school building
  (Environmental Defense Fund, 1999)
- Children are more severely affected by air pollution than adults because of their narrow airways, more rapid rate of respiration, and the fact that they inhale more pollutants per pound of body weight
  (American Academy of Pediatrics)
- Schools have four times as many occupants per square foot as offices, and they contain a host of pollution sources including lab chemicals, cleaning supplies, chalk dust, white board marker fumes, and molds in addition to contaminants introduced by the students and staff.

Building Envelope

- Moisture control step 1: Don't let it in your building
- Envelope is the first line of defense
- Installation of air and vapor barriers
  - Must be in the correct location based on local dew points
- Regular inspections
  - Window and doors
  - Wall penetrations
  - Roof
  - All flashing