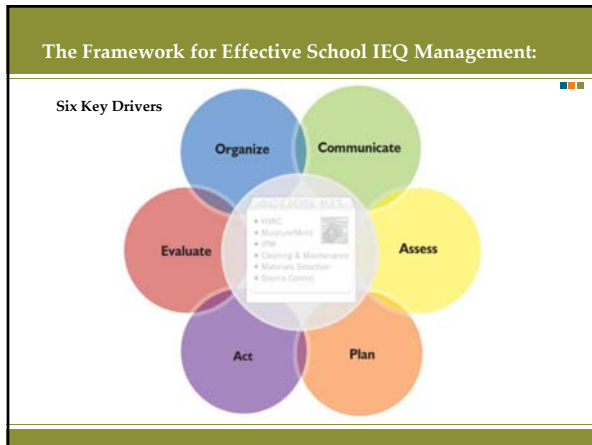




Quality HVAC

- 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

Indoor Air Quality (IAQ)



The Framework for Effective School IEQ Management:

Six Technical Solutions

- 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
- 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)
- 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
- 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 Research – Buildings & Academic Achievement
 - Basics of Ventilation
 - Savannah/Chatham County Experience
 - Summary and Questions

Introductions

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CEFP National IAQ Champion
Energy/Sustainability Services Manager
Fanning Howey
- BART STEWART, PE, CEM**
Energy Projects Team Leader
Griffith Engineering, Inc.
- MICHAEL COON**
Sr. Director Maintenance and Operations
Savannah/Chatham Public Schools

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

educational research

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?
 Answer: Definitely in Certified Facilities

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

Past Indoor Air Quality Research

RESEARCH OUTCOME	SUPPORTING RESEARCH
1. Poor IAQ increases student absenteeism Rosen and Richardson (1999) EPA (2008) 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, Anderson, and Lundquist (1979)	Harner (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.

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 higher % of students scoring at or above grade level.	Zull, Lighthall & Carnuthers
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.	Abbaszadeh, Zagrei, Leber and Hutzenga (2006)jn
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.

Common Volatile Organic Compounds in Schools			
VOC	Source(s)	VOC	Source(s)
Toluen	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.

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

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.”

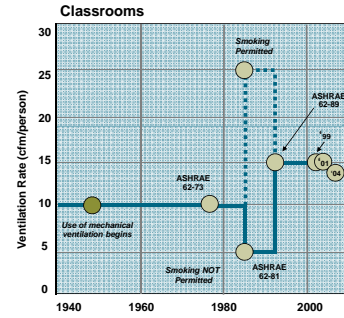
Statement of Chairman James M. Jeffords
Senate Environment & Public Works Committee
Hearing on Green Schools: Environmental Standards for Schools

Why Do We Ventilate Buildings?

- Dilute the build-up of indoor contaminants using clean outdoor air
- Provide make-up air to replace air that is exhausted (bathrooms, combustion products, etc.)



History of Ventilation Levels




Year	Ventilation Rate (cfm/person)	Standard / Event
1940	10	Use of mechanical ventilation begins
1973	10	ASHRAE 62-73
1981	15	ASHRAE 62-81 (Smoking NOT Permitted)
1989	25	ASHRAE 62-89 (Smoking Permitted)

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 $\leq 65\%$ RH even when building is unoccupied



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.”

Michael Coon
Savannah Chatham County Public Schools

Bart Stewart, PE, CEM
Griffith Engineering Inc.


HVAC Systems

- Design Guidelines and Limitations
- Installation
- Operation
- Maintenance



HVAC Design

- System Selection
 - Water Source Heat Pumps
 - Geothermal
 - Boiler/Tower
 - Chilled Water
 - Fan coils (2pipe/4pipe)
 - VAV
 - Packaged DX units
 - Rooftop units
 - Packaged Wall Hung units



HVAC Design cont.

- Pros and Cons of system types
 - Ventilation methods
 - Comfort
 - Cost to operate
 - Cost to maintain
 - First Cost
- Controls
 - Central DDC
 - Local programmable thermostats

HVAC Installation

- Qualified contractor
- School Liaison manage installation
- System and Controls Commissioning

HVAC Operation

- Operating schedules
- Operating temperatures
 - ASHRAE comfort zones
 - Teacher comfort zones
- Adapting to changes
 - Call in to schedule
 - Local overrides
- Ventilation controls

HVAC Maintenance

- Filters
 - Compatibility
 - Storage by different sizes and unit types
 - Filter Changeout Schedule
 - In house vs. sub-contract
- Preventative Maintenance
 - Inspections (belts, bearings, air leaks filter covers)
 - Drain pans
 - Coil Cleaning

HVAC Maintenance cont.

- Building Controls
 - T.C.
 - S.C.
 - Annual Re-Commissioning spot checks
 - Basic monitoring equip. (temp, humidity, co2, lights)

HVAC review

- Design
 - System selection
- Installation
 - Commission
- Operation
 - Set firm Schedules and control off hour usage
- Maintenance
 - What isn't measured isn't maintained

Building Design Today

- Walk off grates or other permanent entryway systems
- Construction cleanliness
- Protection of ductwork before and after installation
- Deck to deck walls and exhaust for all chemical use areas including custodial closets
- Post construction air quality testing
- IAQ Management Programs

Building Design Today – Materials Execution

- Low VOC Adhesives, Sealant, Paints and Coatings
- Green Label Plus certified flooring products
- Greenguard for Children and Schools drywall and mud
- Greenguard for Children and School furniture and furnishings
- No added urea-formaldehyde in composite wood and insulation
 - Exterior and interior walls
 - Thermal and acoustic
 - Pipe and ductwork

Setting Goals Ensures Support of Senior Management


- Have clear Board of Education support
- Develop written Board Policy
- Prioritize items based on educational impact (teaching and learning)
- Communicate Board Policy to the entire design team (staff, consultants, public, etc.)
- Involve Principal, staff, and maintenance representatives in design

Adopted Policy

- *Dayton Public Schools* is committed to enhancing our students' ability to learn by providing environments that support teaching and learning most effectively. We believe the research supports school design practices that include:
 - integrated daylighting,
 - improved indoor air quality,
 - energy-efficient building systems,
 - environmentally-preferable building materials,
 - improved classroom acoustics, and
 - design approaches that allow the building itself to be used as an instructional tool
- We believe that these practices assist in providing superior learning environments, while reducing life-cycle costs through conservation of energy, and we embrace these student-centered sustainable design practices as the most appropriate means to achieve our goals.

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
- Your commitment is the first step
- The O&M staff is a critical link
- Design and build for the long term; schools live a long time
- The school building can teach more than the students and should represent the values of your community



How many decisions did you make yesterday that reinforced the status quo?



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maintenance & operations



new construction



existing facilities



leading systems design




application in today's world



Breakout Session Q&A

- Review your actions and strategies that you would like to apply to your own work.
- Please be ready to discuss these actions in your own words.



Indoor Air Quality (IAQ)