

EPA Tools for Schools National Symposium

Fresh Air: Optimal HVAC Management for Improved Health




Agenda

- What is IAQ?
- Current Research – Buildings & Academic Achievement
- Basics of Ventilation
- Operations and Maintenance
- Leading System Designs
- Application in Today's World
- Summary and Questions

FANNING+HOWEY

Introductions



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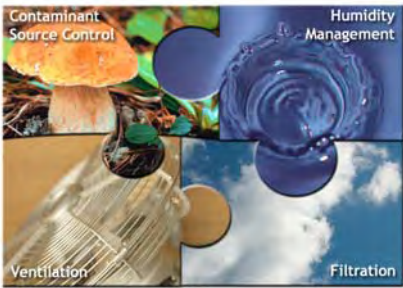
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What is "Indoor Air Quality"?

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




Contaminant Source Control

Humidity Management

Ventilation

Filtration





educational research




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

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Indoor Air Quality

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)	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 :

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

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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)

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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

SPANISH HEALTH

Student Health

- Children breath more rapidly and inhale more pollutants per pound of body weight than adults and thus are especially vulnerable to respiratory hazards
- 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.

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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

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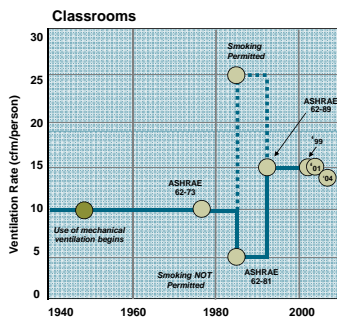
Why Do We Ventilate Buildings?

- 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.)



IPAS/HRRC H2Zero

History of Ventilation Levels



IPAS/HRRC H2Zero

Control Humidity At All Times

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

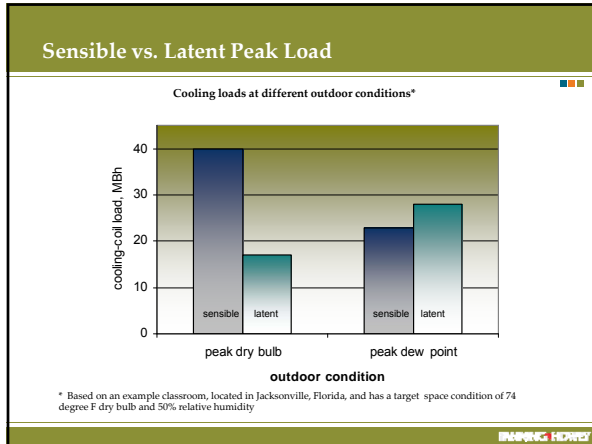
Maintain $\leq 65\%$ RH even when building is unoccupied



IPAS/HRRC H2Zero

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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."




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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 **
- Good O&M and custodial practices are a critical first step towards good IAQ
- District O&M staff needs to hear from District Administration and Board how important they are to achieving high student performance
 - Ensure the staff understands this is a new way of operating

*EPA TFS Reference Guide
**Armstrong Laboratory




Best Practices – Regular Preventative Maintenance

- Invest in your building staff with proper training, just as you do with your teachers
- Get religious about filter changes
 - Work with purchasing department to obtain the right filter, not the lowest cost filter
- Follow manufacturers’ maintenance recommendations
 - Clean condenser coils and cooling coils where possible
- Review ventilation openings. Are they in your grass mowing, weed eating, snow blowing path?
- Invest in Building Automation and benchmark your performance (EPA Portfolio Manager)



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




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Utilities

- Nationally, K-12 schools spend more than \$6B annually on energy – Typically the 2nd largest single budget item after employees
- 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
- *70-80% of a building's cost comes after construction*
- *Efficient buildings, equipment and proper maintenance are key to controlling costs*

* Rebuild America, 2002






new construction



Codes and Requirements

- Does your state Mechanical Code have ventilation requirements?
 - What are they?
 - Do you want to be minimally compliant?
 - ASHRAE/ANSI 62.1-2007
- Are you using your tools?
 - Design TIS & TIS
 - Healthy SEAT
- Does your state have an Energy Code?
 - What is it?
 - Do you want to be minimally compliant?
 - ASHRAE/ANSI 90.1-2007 excellent reference
- Have you discussed them with your design team?

Be an informed client!



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existing facilities

Ventilation Control Strategies

- Scheduled ventilation
- CO₂-based demand-controlled ventilation
- Ventilation reset control
- Re-commission Schools based upon current occupancy

The ability to measure and control OA is key!

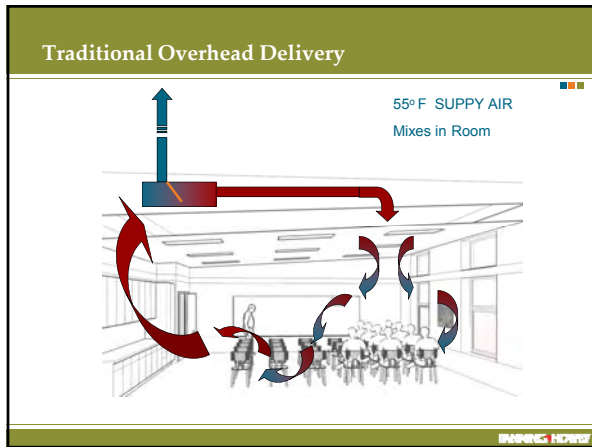
What About Renovations?

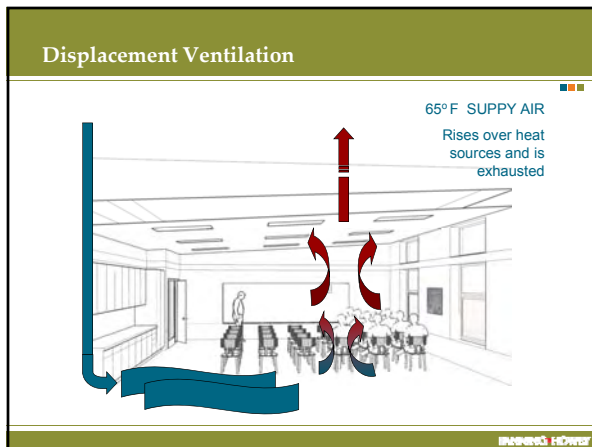
- How am I going to perform maintenance on the system?
 - Get everything you can out of the classroom
 - Match accessibility with your climatic environment
- How am I going to control ventilation, temperature and humidity?
 - Dedicated Outside Air vs. space level control
 - Demand Control Ventilation where appropriate
 - Building Automation / Energy Management Control Systems
- Does this impact my electrical system?
 - Larger units typically required to handle ventilation
- How is HVAC impacting classroom acoustics?
 - Provide new or alter existing distribution
 - Does it really have to be in the classroom?
 - Are \$\$ saved on mechanical changes worth the educational impact?

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How Does Displacement Ventilation Work?

Cool, clean fluid is injected at the bottom of the beaker

Warm, contaminated fluid is forced to the top of the beaker

Overhead Mixing vs. Displacement

Mixing

Displacement

Displacement Ventilation

Advantages

- Improved Classroom IAQ
 - Increased ventilation effectiveness
 - Reduced spread of airborne contaminants
- Improved Classroom Acoustics
 - Eliminates decentralized fans
 - Smaller ductwork and lower pressures
 - Supports compliance with ANSI S.1260-2002
- Reduced Operational Costs
 - Increased economizer hours
 - Reduced fan energy
 - May reduce cooling equipment size
 - With increased effectiveness may be able to reduce total amount of OA conditioned

Disadvantages

- Not a common system design, yet
- Doesn't match well if your market is predominantly DX
 - Small Split systems
 - Small Packaged units
- Architectural appearance

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How Does This Relate To A Classroom?

- Cool air enters at the floor
- People and computers warm the air
- Warm air, with contaminants, rises to the ceiling
- Return air is routed back to the central system

Typical Dedicated Outdoor Air Systems Designs

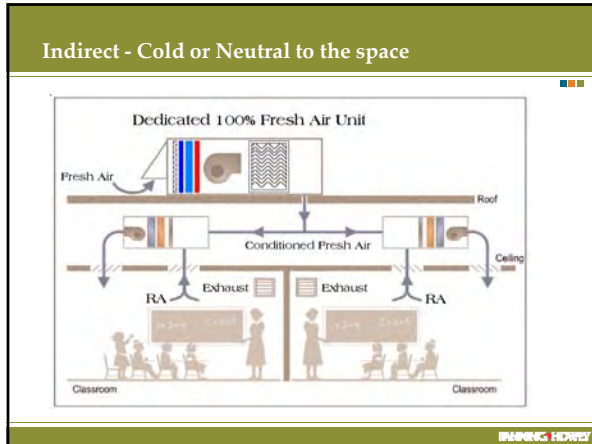
Space(s) served	Market (application)
Single space	<ul style="list-style-type: none"> ◆ Lodging (hotel hallway) ◆ Life sciences (pharmaceutical plant) ◆ Retail (grocery)
Multiple spaces	<ul style="list-style-type: none"> ◆ Education (classroom) ◆ Health care (office) ◆ Government (underfloor air)

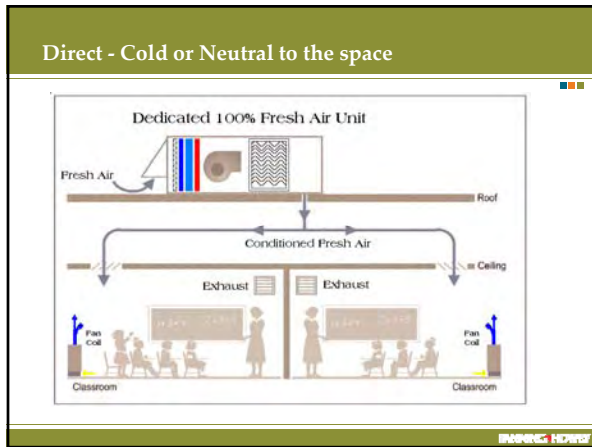
Benefits of Dedicated Outside Air Systems (DOAS)

- 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

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Multiple-Space, Dedicated

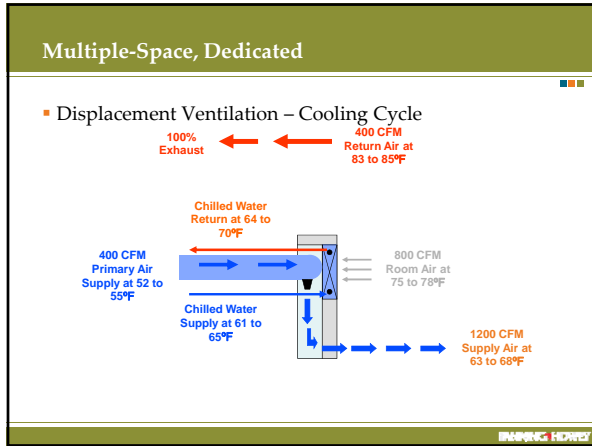
- One AHU conditions 100% OA to several spaces
- Another AHU conditions RA to space(s)

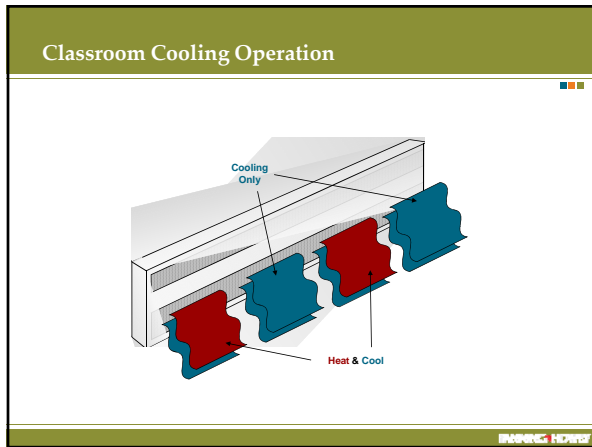
- Advantages
 - Readily available
 - Multiple filtration choices
 - Ventilation
 - Humidity control
 - Redundancy
- Disadvantages
 - Higher first cost
 - Minimizes ventilation control

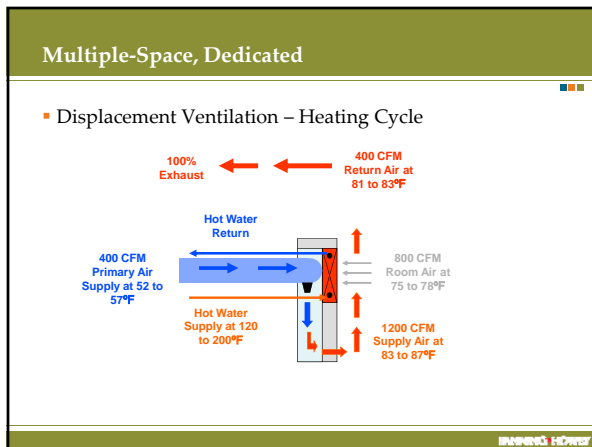
Examples:
AHU providing OA to
WSHP in a school

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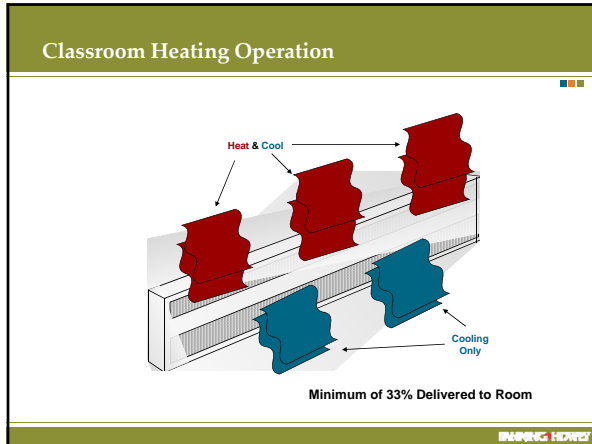




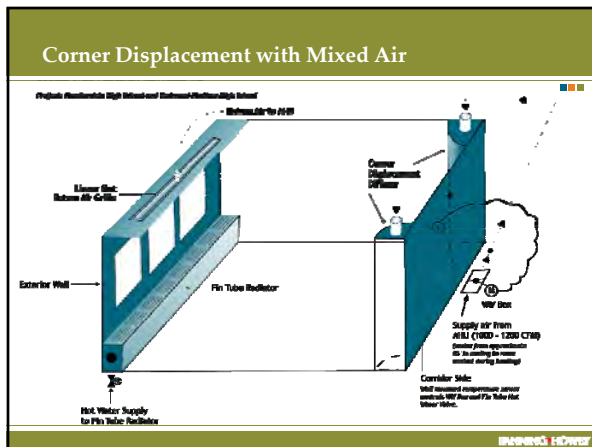


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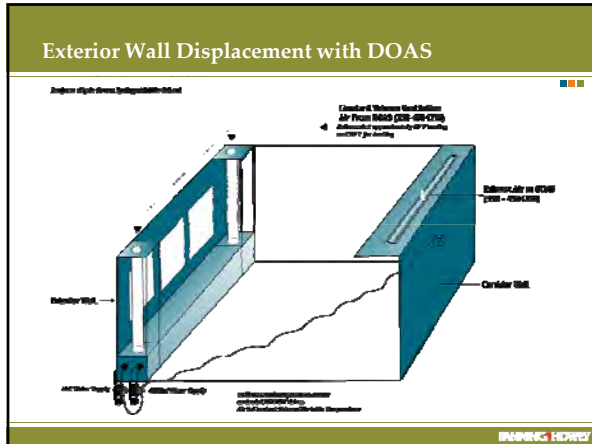






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Building Design Today

- 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
 - Maple wood gym floors are currently the only major issue
- 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

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Setting Goals Ensure 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



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