Worried about the air quality in your schools?

Now you can breathe a little easier. (And so can everyone else.)
The Situation

The Environmental Protection Agency documented that in 1995 that one in four schools of our nation’s 110,000 schools reported having poor ventilation.

*This number is most likely an underestimate.*

The issue is not only comfort control but improved air quality.
Risks of Poor Ventilation

- Adverse Health Effects
- Poor Learning Environment
- Decreased Teacher/Student Productivity
- Increased Teacher/Student Absenteeism
  - Asthma/allergies #1 cause of students missing school
- Public Perception of School District
- Risk of Litigation
- Costly Repairs & loss of use until repairs completed
Risks of Poor Ventilation

- Up to 50% of IAQ problems are related to insufficient ventilation
- Indicative of poor building control and excess utilities
Elements of Ventilation

Impacts

>>> Air quality

>>> Comfort

>>> Environment for Learning
Elements of Air Quality

- Cleanliness from *air borne dust*
- Cleanliness from *mold* and microbial growth
  - in coils
  - in carpet
  - in walls
- Adequate fresh air make-up
  - to maintain acceptable CO$_2$ levels
  - for odor control
  - to replace stale air
Elements of Air Quality

Also,

- Low *background noise* levels
  - Other classrooms
  - Halls
  - Equipment in the room
    - AHU Diffusers
    - Univent blowers
Elements of Comfort

- Even air distribution >> no stagnant areas
- Even air temperature >> no hot nor cold spots

Plus,

- Responsive air temperature control
- Responsive humidity control
The Problem with Classroom Univents

- Classrooms with univents may have low levels of fresh air make up. This is due to the balloon effect of using univents.
- Univents, by themselves, have no means of relieving the excess supply air.
- Unless a relief system is properly designed, very little fresh air can come into the room.
- Air simply tumbles near the front of the univent with little air reaching the opposite wall of the classroom.
The Problem with Classroom Univents

TYPICAL CLASSROOM WITH NO RELIEF
Classrooms without air conditioning

These univent systems are economical to install and provide adequate, though uneven heat in the winter months.

But,
In hot Spring, Summer, and Fall days, *heat only* univent systems do not provide any
• Humidity control.
• Temperature control.
Classrooms with air conditioning

These univent systems provide adequate, though uneven heat in the Winter and cooling in the Spring, Summer, and Fall.

But,

In cooling season problems may turn to
- Mold growth
- High energy use
Add a Ventilation/Relief System

How it works

The ventilation system provides for a path to exhaust air from classrooms that employ unit ventilators.

The intent is to;
1. Increase air flow penetration throughout the classroom.
2. Improve air quality and total classroom comfort.
3. Assure Code required fresh air is present.
4. CO$_2$ levels decrease dramatically.

5. With increased airflow across the room, the temperature becomes more even. Hot and cold spots are minimized.

6. Damp carpets and walls dry up.

* Improves learning environment.
Noise Control

- Increased ventilation has also proven to reduce noise levels in classrooms by allowing univents to function on “Low” blower speed.

- In mild Spring and Fall months, often teachers turn off univents due to the noise levels on high speed.

- The problem with limited room penetration as experienced by air churning in front of the unit ventilators is addressed.
IAQ Improvement

By adding a ventilation system,
- Air changes increase
- Room penetration increases
- Surfaces are kept drier
- Air distribution is improved

By improving airflow, mold and bacteria growth in univents, in carpets and on walls are minimized.
System Configurations

Version 1 – Individual Room Control

Employs barometric dampered air relief vents in each room.

The airflow through the relief vents adjusts automatically to changing outside air brought in through the univents.

- Simple to install.

But,

- Concerns with large number of roof penetrations
  - Leaks
  - Maintain operation of relief dampers
  - Cold air dumping through dampers
  - Relief path must be designed for low pressure drop
System Configurations

Version 1 – Individual Room Control
Employs barometric dampered air relief vents in each room.
System Configurations

Version 2 – Constant Speed Ventilation
Employs constant speed air relief fans in the roof vents.

- Dedicated relief in large rooms.
- Common relief in smaller conjoined rooms.

But,

- When it is cold outside, building pressure goes negative.
  - Outside air gets pulled through walls causing mold to grow inside walls, carpets, etc.
System Configurations

Version 2 – Constant Speed Ventilation
Employs constant speed air relief fans in the roof vents.
System Configurations

Version 3 - $\Delta P$ VAV Controlled Ventilation
Employs variable speed air relief fans controlled by Differential Pressure Sensors

- Dedicated relief in large rooms.
- Common relief in smaller conjoined rooms.
- The airflow through the exhaust fans adjusts to changing building pressures in each area of the building.

But,
- Does not recognize impact of exterior conditions.
System Configurations

Version 3 - $\Delta P$ VAV Controlled Ventilation

Employs variable speed air relief fans controlled by Differential Pressure Sensors
System Configurations

Version 4 – Fully Integrated Ventilation System
Employs variable speed air relief fans and system controller to maintain ASHRAE Std. 52.2 airflow rates.

- Dedicated relief in large rooms.
- Common relief in smaller conjoined rooms.
- The airflow through the exhaust fans adjusts automatically
  - to match the particular use, i.e., CO$_2$, and temperature.
  - to changing exterior temperature, atmospheric pressure, and humidity.
- Fully integrates all elements of the system.
System Configurations

Version 4 – Fully Integrated Ventilation System
Employs variable speed air relief fans and system controller to maintain ASHRAE Std. 52.2 airflow rates.
Financial Impact of Ventilation

Utilities

- During heating season – no appreciable difference noted even with fresh air increase 300%
- During cooling season – reduce hours of running air-conditioning 10% and reduce the cooling load by 5°F would decrease electric load by 20%. (Actual reduction closer to 10°F.)
Financial Impact of Ventilation

Maintenance
Increased air flow will keep surfaces drier – extend life of carpets @ $20/yd >> $1000/classroom
Could be a surprise $20,000+ investment to replace carpets!

State Aid
Aid relating to head count is severely effected by mold and pollen related absenteeism.
Financial Impact of Ventilation

Capital Investments
By adding a ventilation system to work with your existing systems, an air conditioning system may not be necessary. Reduce a $1MM cost to < $100K.

Operating Expenses
Used with air-conditioning, the number of air-conditioning hours will decrease and the electric load will be cut dramatically.
Retrofit Example

Case Study – 2 floor/32 Classes around LRC Atrium

$85,000

Vs.

$1,000,000

for

A/C
Facility example is “heating only”.

- System installed in existing facility in August 2002.
- Initial investment < $85,000.00
- In Spring and Fall days, reduced interior temperatures to 5°F below exterior temperatures at end of school day.
- Increase airflow from 280 cfm (450 cfm BOCA) to 800 cfm.
- Operate system controller year-round for air quality and comfort control. No appreciable increase in utility costs.
1. Where air conditioning is present, dramatically reduces the cooling load.

2. Maintain Code required minimum fresh air requirements of 15 cfm per person in a room.

3. Improves building comfort by dynamically responding to load fluctuations.

4. $\text{CO}_2$ levels decrease dramatically. Students are alert.
Fully Integrated Ventilation System Benefits

5. With increased airflow across the room, the temperature becomes more even. Hot and cold spots are minimized.


7. Reduces capital investment to $1/10$ of putting in an Air-conditioning system

* Improves learning environment.
Retrofit Examples

Version 4 Case Study – 2 floor/32 Classes around LRC Atrium

$85,000
Version 4 Case Study – 1 floor/31 Classes/4 Offices

$82,000
Version 4 Case Study – 1 floor/25 Classes

$78,000
Version 4 Case Study— 1 floor/2 pods/24 Classes

$78,000
Summary

1. Unit ventilator systems must be designed with a relief path.
2. Older systems may not have this path. Retrofit possibilities exist.
   - Check for Code compliance issues regarding plenum ceilings and fire damper requirements.
3. Versions discussed represent solutions with increasing levels of cost, control/performance, and comfort.
   - It is possible to retrofit existing designs to the next level.
4. Relief/Transfer grills should be located near wall opposite unit ventilator.
Fully Integrated Ventilation System Specifiers

1. Dynamically responding to load fluctuations created by
   - student movement in and out of classrooms.
   - with changes in weather and sun loads.

2. Provide *variable air volume control* in a unit ventilator system
   similar to more expensive systems that use roof top air
   handing units.

3. Provide improved *economizer functions* for unit ventilator
   systems.
Fully Integrated Ventilation System Specifiers

4. Install easily
   • as a stand alone controller.
   • as an integral component of the building’s automation system.

5. Provide contacts to interface with the smoke detection/fire alarm system.

6. Provide CO₂ monitoring and response capabilities.
Other Ventilation Applications

- Gymnasiums – a heat/CO₂ issue
- Pools – moisture issue
- Boiler rooms – CO issue
- Office areas – comfort issue
- ???
ABOUT THE PRESENTER

Frederick J. Ringe - Vice President for EMA Chicago, Inc.

Holds BS and MS degrees in Mechanical Engineering from Michigan State University. Also holds a MBA degree from Northern Illinois University. Active member of ASHRAE and IASBO professional associations.

Has lectured to ASHRAE Chapters across the United States regarding energy efficiency, system design, and commissioning of HVAC systems.

Provides Commissioning and Contract Management Service for institutional and commercial customers to ensure projects are designed, installed and certified to perform as originally intended by the owner. Conducted a $3MM upgraded of two Middle Schools in 2002 with final project - 10% under budget, less than 1% variance, and on time.

Distributor for several air filter media products including multiply poly filters, pleated filters, Hepa filters, and electrostatic filters.

Developed and implement a ventilation scheme used year round in 18 schools at Indian Prairie SD to maintain ASHRAE minimum air flow rate standards without adding to utility bills.
Finally, a building system that will improve the quality of air in our schools.