



A Hybrid Solution to Heating, Cooling, and Ventilating Schools

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Systemair



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Speakers



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Product Manager, Systemair

Agenda

1. Why schools are becoming progressive with HVAC [Amir]
2. Why ventilation matters? [Amir]
3. Traditional school HVAC designs [Larry]
4. The most important needs of a school and school board [Larry]
5. The hybrid design for HVAC [Larry]
6. Satisfying ASHRAE 62.1 – IAQ Standard [Larry]
7. How stakeholders benefit [Larry]
8. Future-proof design [Amir]
9. Sustainability [Amir]

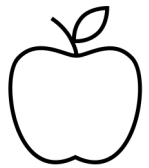
Learning Objectives

1. Strategies for combining different HVAC technologies for optimizing school IAQ
2. Strategies for mitigating classroom infections
3. Best practices for on-time design and delivery of equipment
4. Sustainability improvements

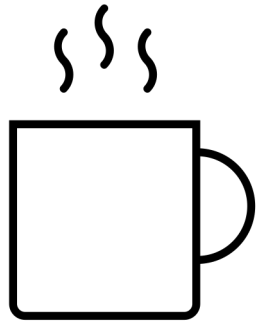
Progressive with HVAC



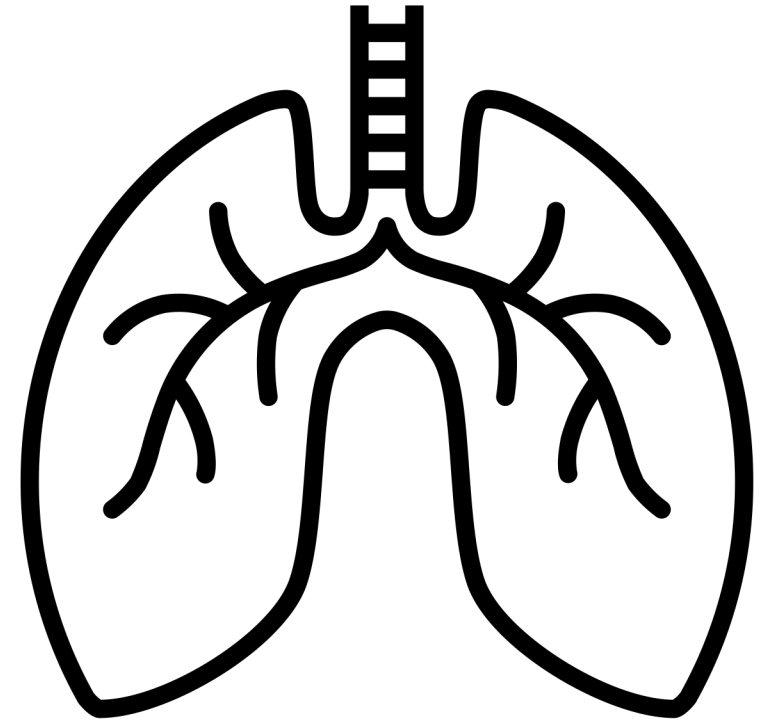
You are what you breathe



Eat = 1kg



Drink = 2kg



Breathe = 15kg

A background image showing a group of students in a modern classroom or office setting. A young man in the foreground is focused on his laptop. Other students are visible in the background, some working on laptops and others looking at papers. The scene is brightly lit with large windows.

D+

The American Society of Civil Engineers gave the nation's 100,000 public K-12 schools a D+ in their infrastructure report

“ Human exposure to indoor air pollutants can be 2 to 5 times, and sometimes more than 100 times, higher than outdoor air pollutants!

EPA

"Why Indoor Air Quality is Important to Schools." EPA, 2021, <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>.

ASHRAE Standard 62.1 - 2022

- Minimum ventilation rates
- To provide IAQ that's acceptable to humans and minimizes health effects



ANSI/ASHRAE Standard 62.1-2022
(Supersedes ANSI/ASHRAE Standard 62.1-2019)
Includes ANSI/ASHRAE addenda listed in Appendix Q

Ventilation and Acceptable Indoor Air Quality

See Appendix Q for approval dates by ASHRAE and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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ASHRAE

Standard 241

- Standard 241 establishes minimum requirements to reduce the risk of airborne disease transmission
- The standard applies to new and existing buildings and major renovations and provides air system design, installation, operation and maintenance requirements.

Occupancy Category	241 Equivalent Clean Airflow (lps/person)	Calculated Equivalent Air Changes per Hour	Calculated Equivalent CO2 (ppm)	62.1 Outdoor Air Ventilation Rate (lps/person)
Correctional Cell	15	5	710	4.9
Correctional Dayroom	20	8	660	3.5
Restaurant	30	28	600	5.1
Cafeteria	30	40	600	4.7
Gym	40	3.7	770	22.9
Office	15	1	790	8.5
Call Center	15	12	790	3.5
Retail	20	4	850	7.8
Transportation Waiting	30	40	600	4.1
Daycare	20	6.7	620	8.6
Elementary School	20	6.7	600	7.4
High School	20	9.3	660	6.7
Lecture Hall	25	50	620	4

Why Ventilation Matters



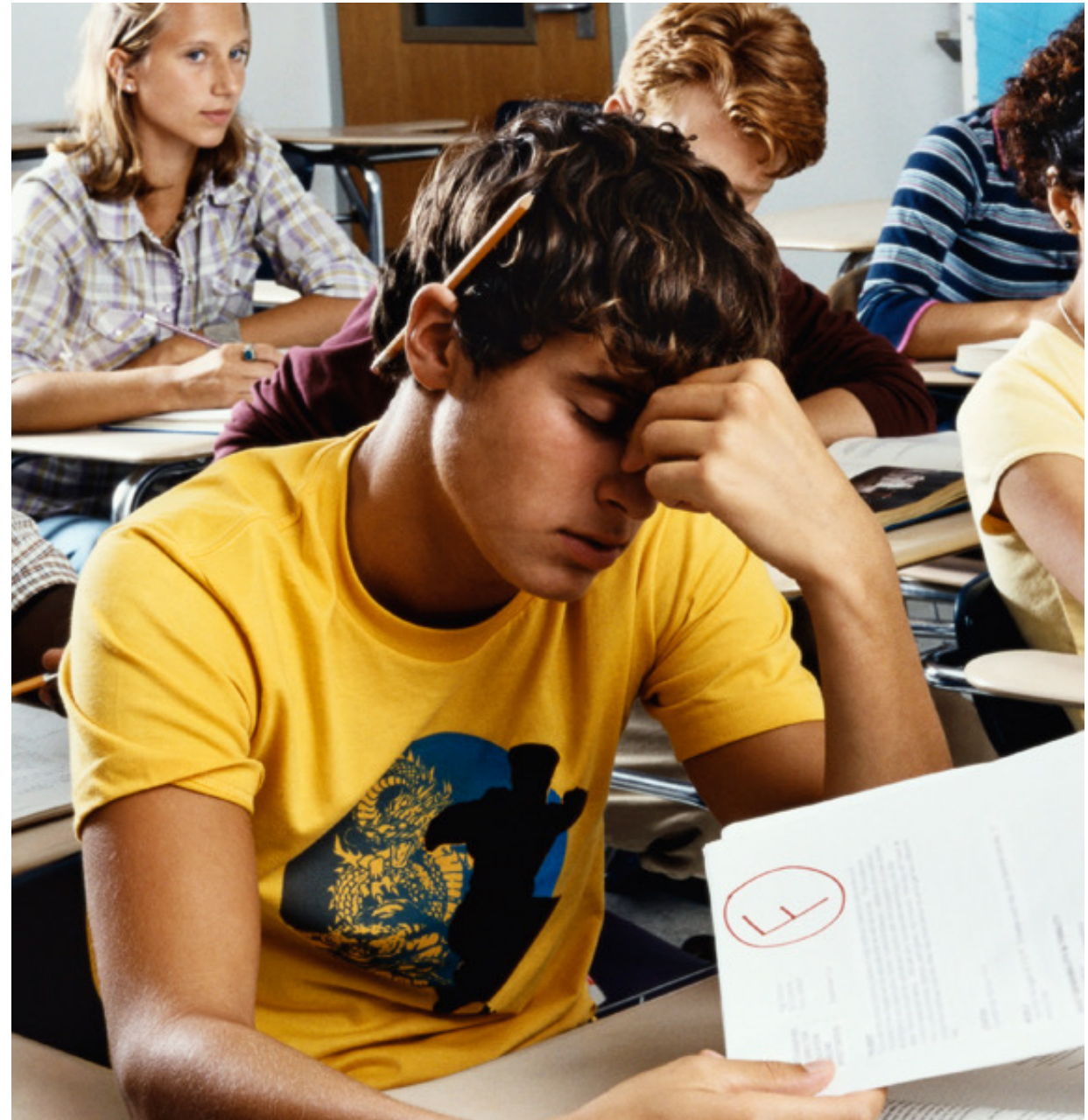
Poor IAQ

- SAB: Top 5 risks to public health
- Coughing
- Eye Irritation
- Headaches
- Allergic Reactions
- Asthma and/or other respiratory illnesses



Poor IAQ can

- Affect student attendance, comfort, and grades
- Reduce faculty performance
- Increase the possibility of school closings
- Cause communication breakdowns among school administration, faculty, and parents
- Result in negative exposure
- Erode community trust



Importance of Indoor Air Quality



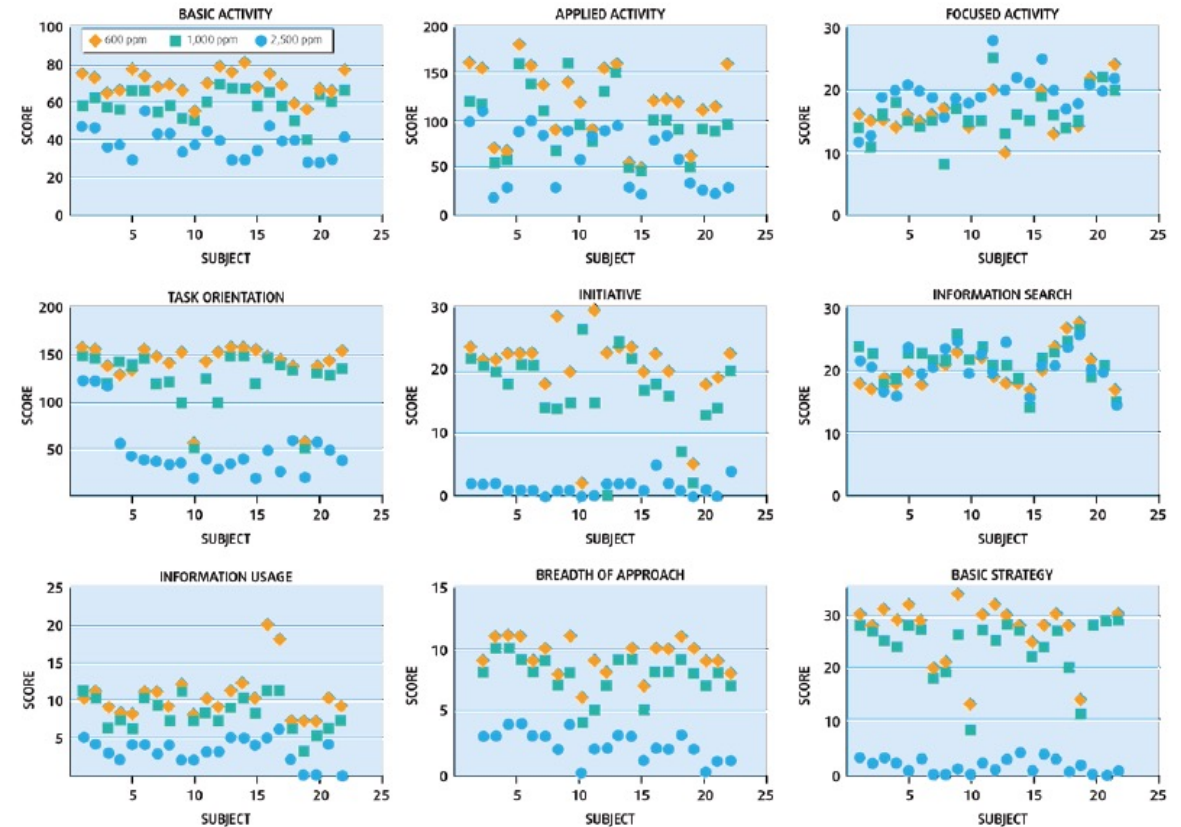
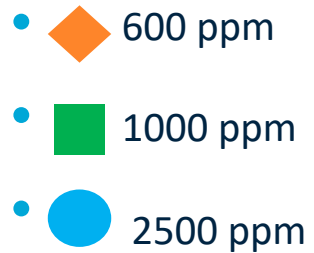
Good IAQ

- Healthier students and faculty
- Students are more attentive
- Retain information better
- Performance improves



Improved Decision Making

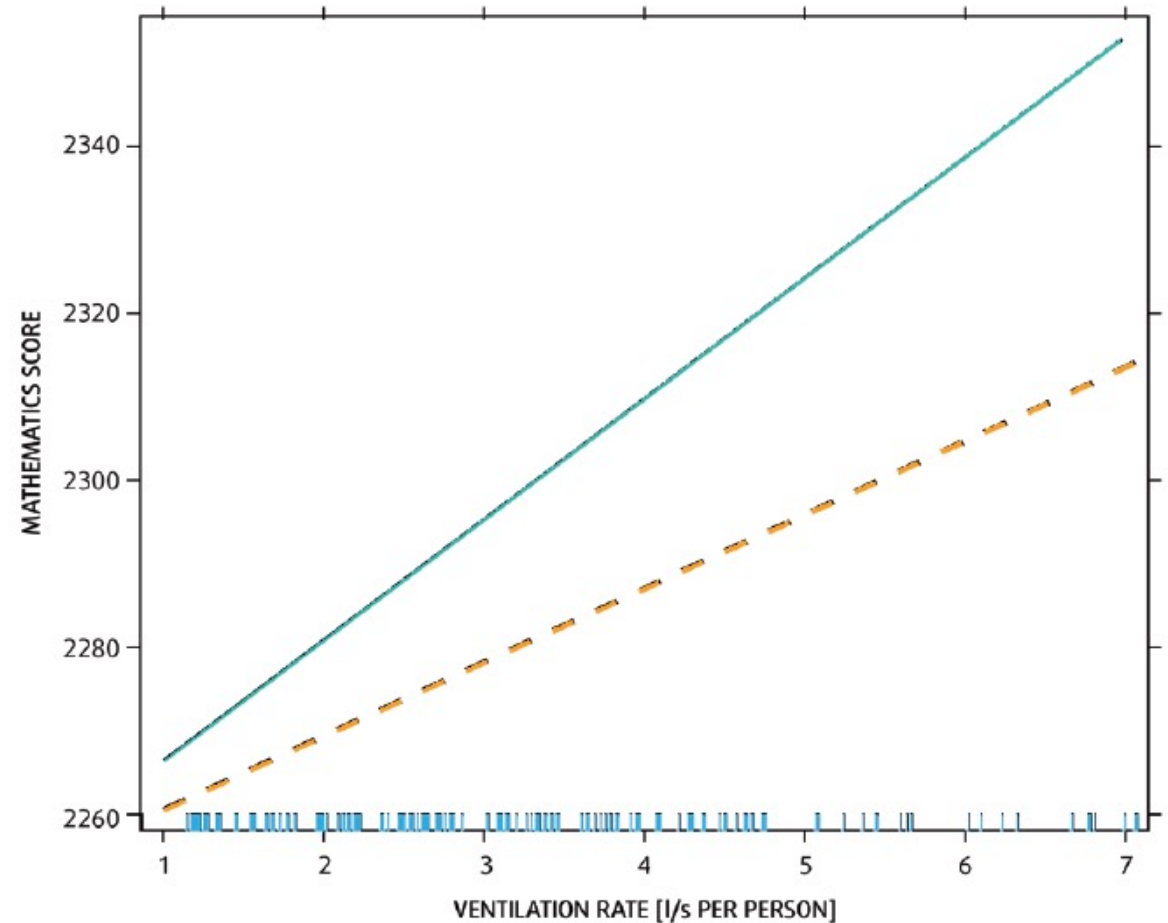
- Ventilation & CO₂ focused
- Data reflect a correlation between raw scores and CO₂ levels for decision-making tests



ABOVE: Figure 1 shows participants in rooms with 1,000 or more ppm CO₂ had significant reductions in their raw scores.³

Improved Test Scores

- Figure shows with increased ventilation, math scores **improved by an average of 74 points.**
 - Increased ventilation rates
 - Decreased temperature



Better Air Everywhere

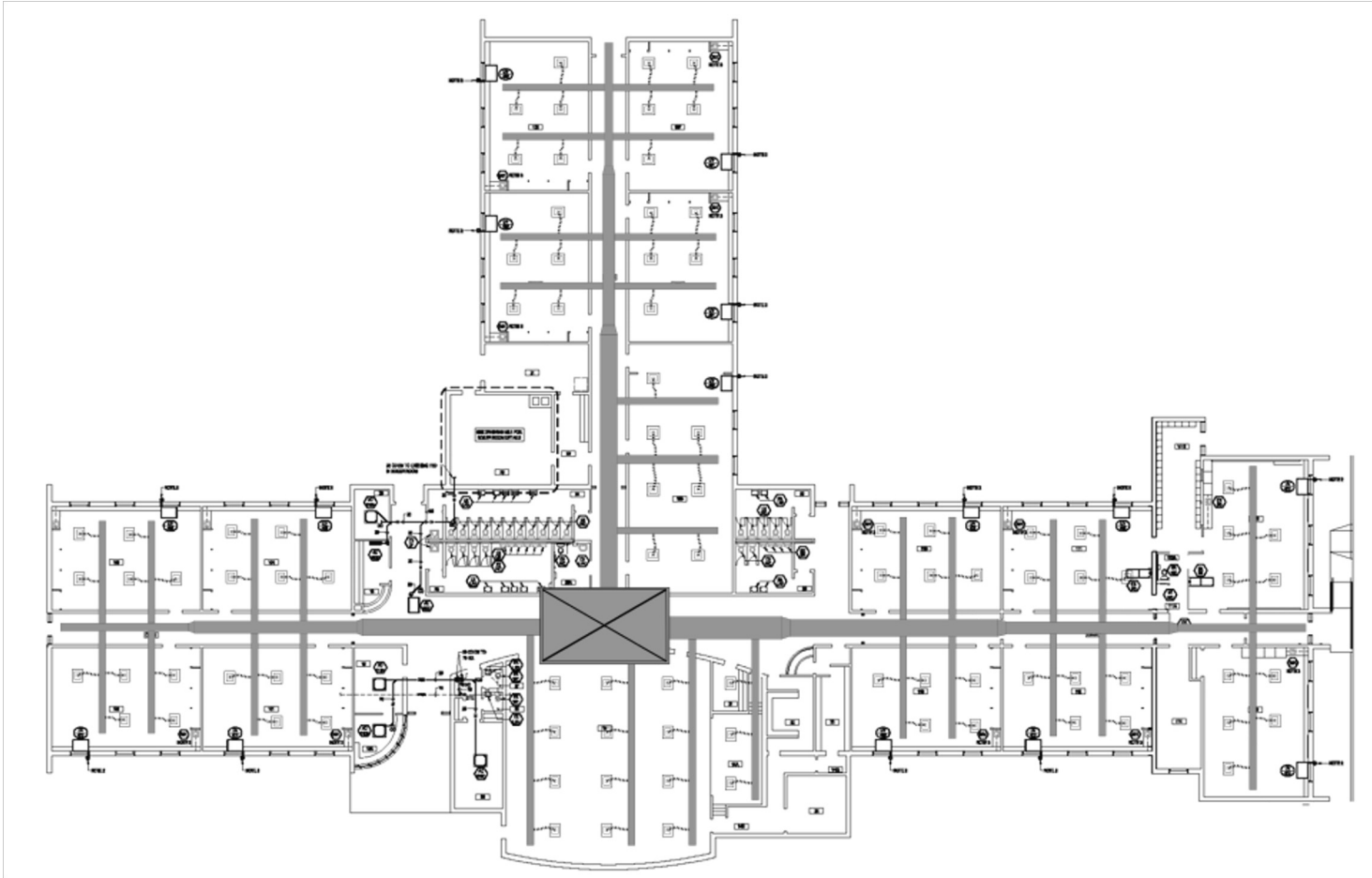
School wide healthy air



Classroom designed healthy air

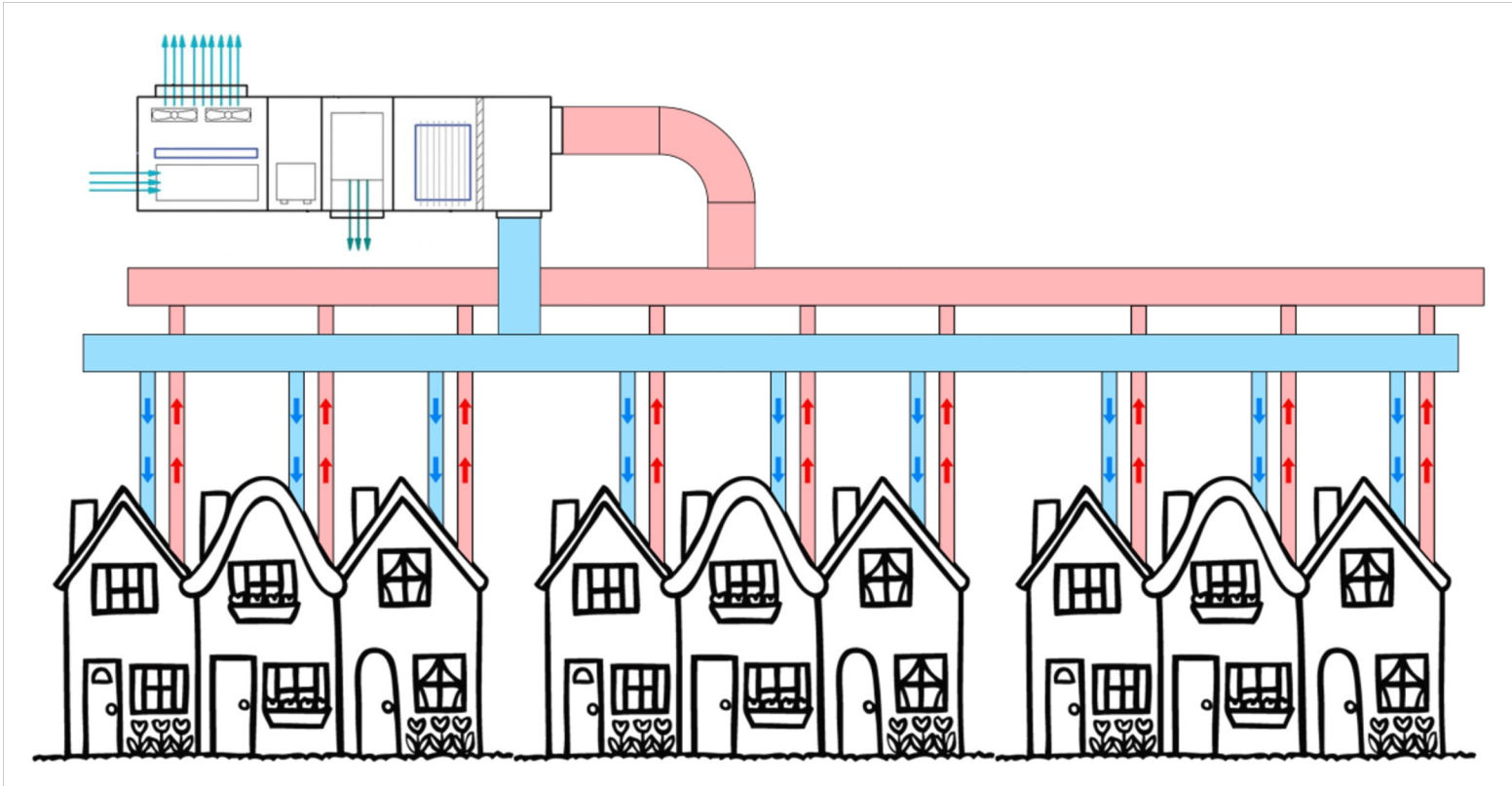


Traditional School HVAC Design



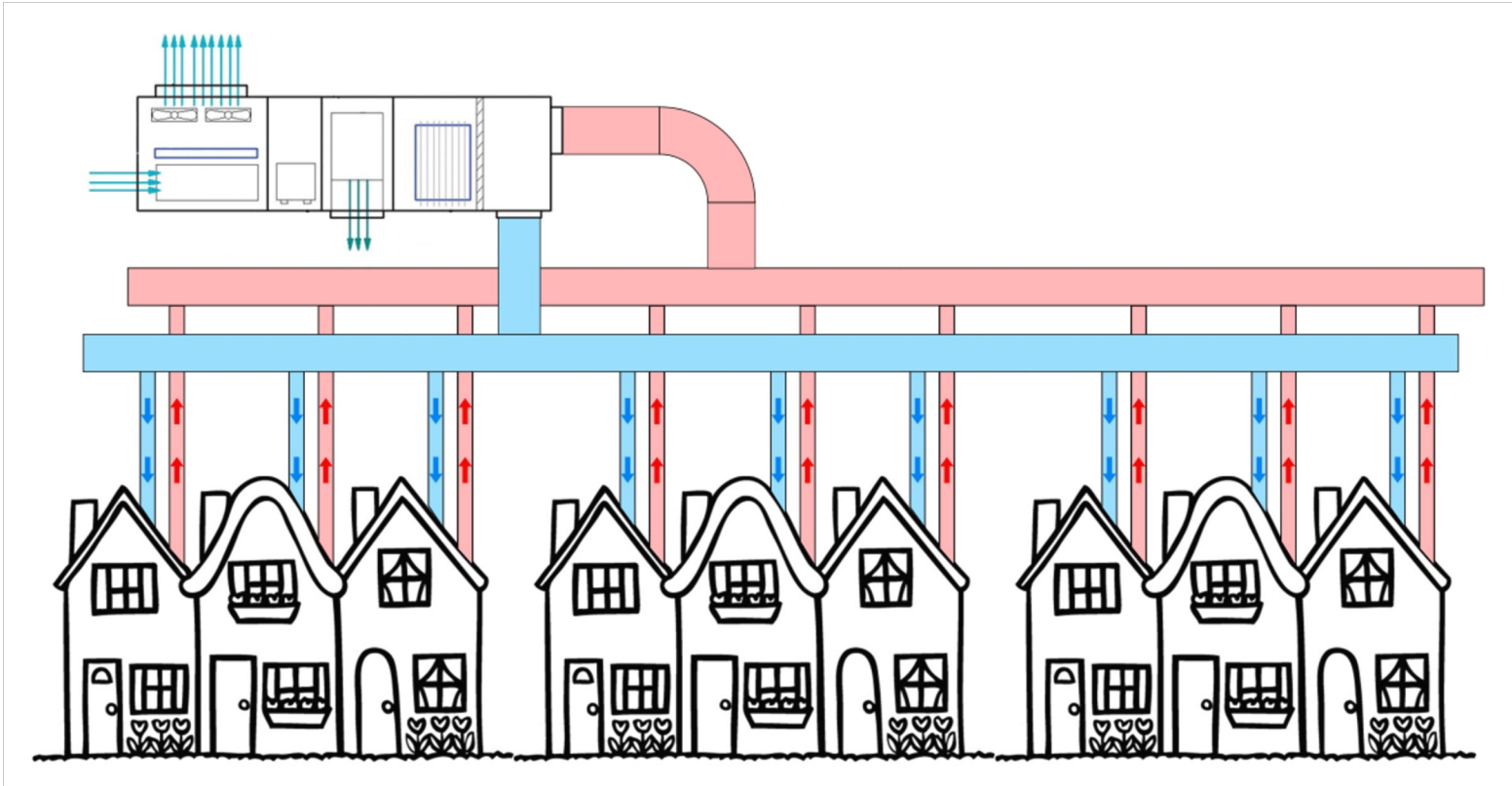
- One central AHU serving all rooms
- Classrooms, admin rooms, atrium
- One source for ventilation and filtration

A School Is Like A Neighbourhood



Do you want to share the air and recirculate with the people next door?

Central Systems



- Contaminants and airborne molecules will crossover
- Air is highly recirculated throughout the school in typical central rooftop air handler
- The final filter is your last line of defense for an entire school!
- Teachers appreciate having control over their learning environment, comfort is personal

The Most Important Needs of HVAC Equipment According to Facility Managers



Costs

Initial Costs

Operating Costs

Replacement Part Costs

Life Cycle Costs



Service & Maintenance

Component accessibility

Coil Cleaning

Drain Pan & Drain lines

Refrigerant Line access

Control Panel location

Disconnects & Lockout

Frequency

Filter changes



Replacement

Age & Lifespan

Upgradeability

Regulatory Compliance

Compatibility

Parts Accessibility

Future Proofing



Controls & Automation

Open Integration

Scheduling

Sensors

Zone Control

Remote Monitoring

Trending

Fault Detection

A Hybrid Solution



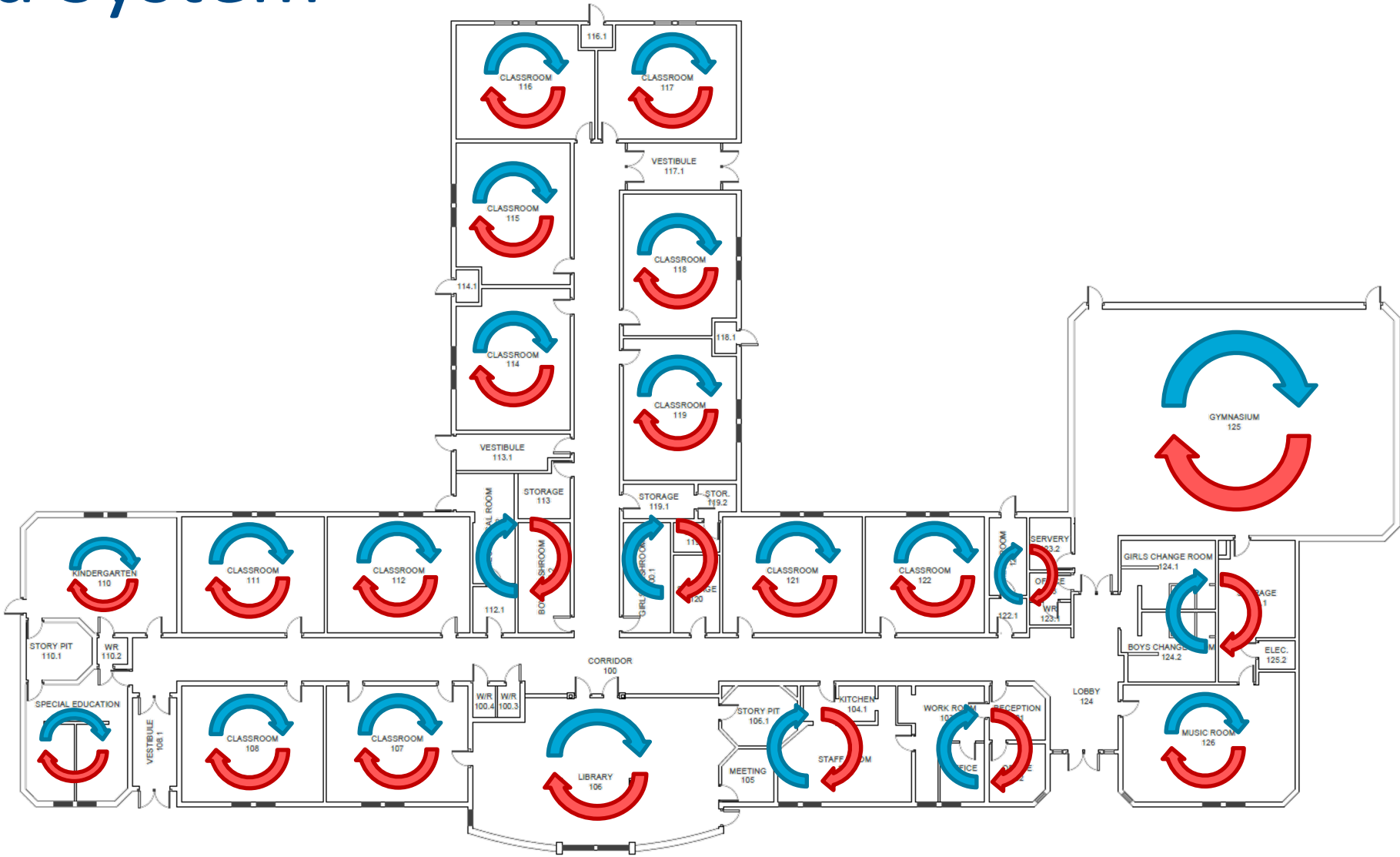
“Engineers have called to inquire about lead times so that they may specify a product that at least makes the completed construction schedule.

New School Design Criteria Has Shifted



Students spend from 66-85% of their school day sitting in a classroom.

Hybrid System



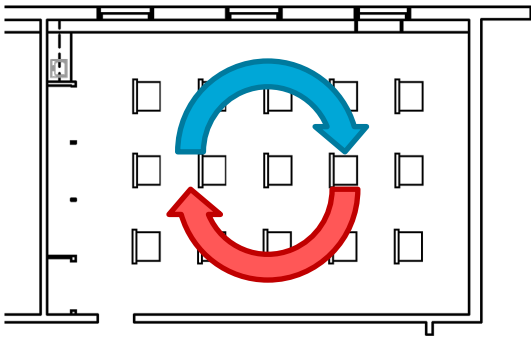
The Hybrid Design for HVAC

Classrooms – Vertical Unit Ventilator (VUV)

Gymnasiums – RTU / AHU-ERV

Admin/Office – Fan Coil-ERV

Libraries – Fan Coil / RTU / AHU / VUV / ERV



- ✓ Decoupled/Decentralized Ventilation
- ✓ Unitary Sizing
- ✓ Allows for Repurposing Equipment
- ✓ Optimized Envelope
- ✓ Universal for Brick n' Mortar or Modular
- ✓ Easy Serviced & Maintained
- ✓ Independent Control
- ✓ Long Life Span



The Hybrid Design for HVAC

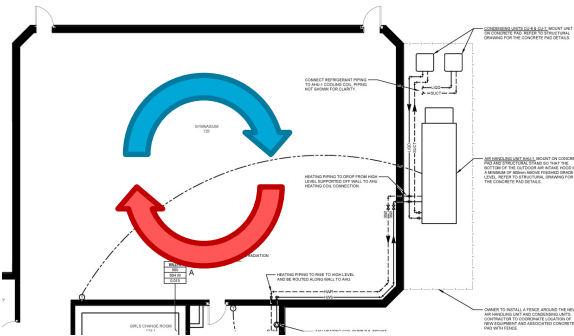
Classrooms – Vertical Unit
Ventilator (VUV)

Gymnasiums – RTU / AHU-ERV

Admin/Office – Fan Coil-ERV

Libraries – Fan Coil / RTU / AHU /
VUV / ERV

- ✓ Large Space Ventilation
- ✓ Single Zone CAV or VAV Control
- ✓ Large yet simple
- ✓ Unitary Sizing (Avoid Custom)
- ✓ Optimized Envelope
- ✓ Easy Serviced & Maintained
- ✓ Independent Control



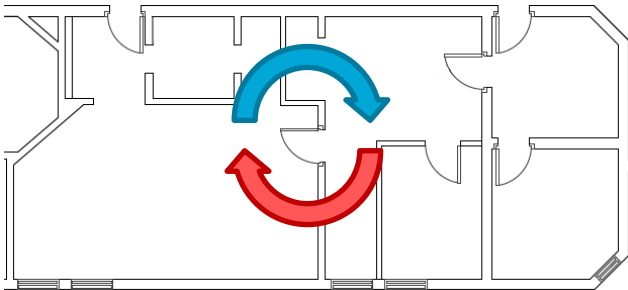
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Classrooms – Vertical Unit Ventilator (VUV)

Gymnasiums – RTU / AHU-ERV

Admin/Office – Fan Coil-ERV

Libraries – Fan Coil / RTU / AHU / VUV / ERV



- ✓ Easily coupled with ERV for Ventilation
- ✓ Flexibility (especially interior zones)
- ✓ Efficiency
- ✓ Single Zone CAV or VAV Control
- ✓ Optimized Envelope
- ✓ Independent Control



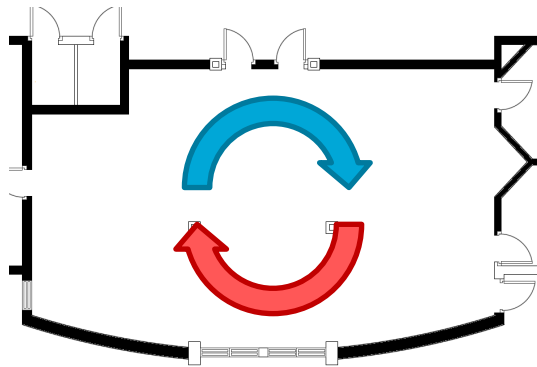
The Hybrid Design for HVAC

Classrooms – Vertical Unit Ventilator (VUV)

Gymnasiums – RTU / AHU-ERV

Admin/Office – Fan Coil-ERV

Libraries – Fan Coil / RTU / AHU / VUV / ERV



- ✓ Decoupled/Decentralized Ventilation
- ✓ Highly Modulating
- ✓ Unitary Sizing
- ✓ Single Zone CAV or VAV Control
- ✓ Easy Serviced & Maintained
- ✓ Independent Control
- ✓ Long Life Span



DUAS - Design for Unitary, Accessible, Selectable



VUV

- 2,000 cfm or lower
- Ventilation up to 600 cfm
- Short lead times
- Floor Mounted
- Easy to install



AHU/RTU

- 10,000 cfm or lower
- Ventilation up to 5,000 cfm
- Short lead times
- Standard designs
- Easy to install



Fan Coil

- 1,200 cfm or lower
- Wide market range
- Highly configurable
- Easy to install



ERVs

- 5,000 cfm or lower
- Wide market range
- Demand Control Ventilation
- Off the shelf solutions
- Easy to install

62.1 – A Comprehensive Ventilation System

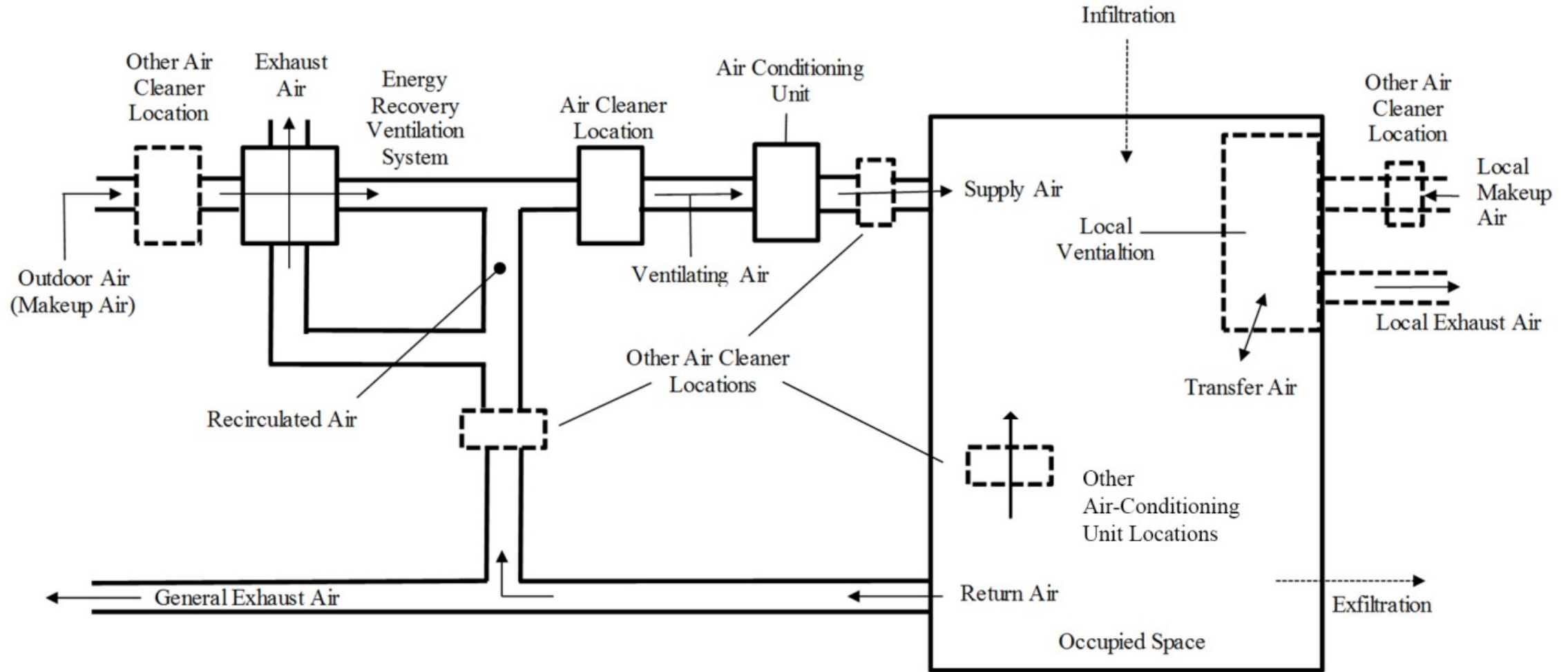


Figure 3-1 Ventilation system.

Hybrid Approach Satisfied IAQ & 62.1

1. Building Exfiltration – matching ventilation or exceeding
2. Aspects of Cooling Cycle - Resistance to mold growth and spread
3. Superior Design for VAV / DCV design and independent Control
4. No recirculation or crossover with other Air Class levels 1,2,3
5. Convenient Maintenance and Accessibility

62.1 Systems & Equipment

Balanced Airflow System

5.11 Building Exfiltration. Ventilation systems for a building equipped with or served by mechanical cooling equipment shall be designed such that the total building outdoor air intake equals or exceeds the total building exhaust under all load and dynamic reset conditions.

- Generally, schools are slightly over-pressurized to avoid infiltration



62.1 Systems & Equipment

The Cooling Cycle

5.4.1 Resistance to Mold Growth. Material surfaces shall be determined to be resistant to mold growth in accordance with a standardized test method, such as the mold growth and humidity test in UL 181, ASTM C1338, or ASTM D3273.

5.12 Drain Pans. Drain pans, including their outlets and seals, shall be designed and constructed in accordance with this section.

5.12.1 Drain Pan Slope. Pans intended to collect and drain liquid water shall be sloped at least 0.125 in./ft (10 mm/m) from the horizontal toward the drain outlet or shall be otherwise designed such that water drains freely from the pan whether the fan is ON or OFF.

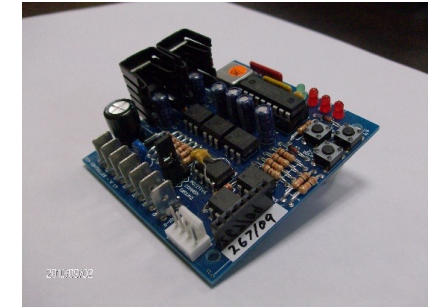


62.1 Systems & Equipment

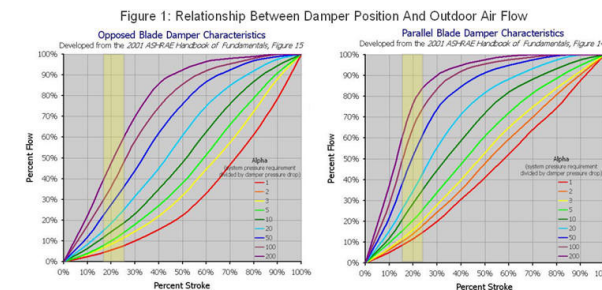
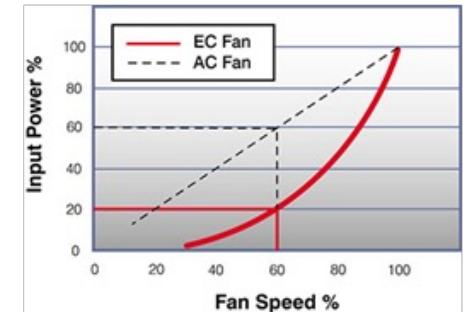
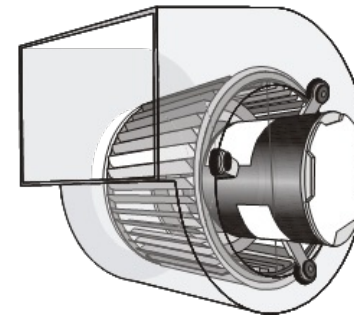
HVAC Component Design

5.1.1.1 Designing for Varying Loads and Operating Conditions. The ventilation air distribution system for variable air volume (VAV) and multispeed constant air volume (CAV) applications shall be provided with means to adjust the system to achieve at least the minimum ventilation airflow as required by Section 6 under any load condition or dynamic reset condition

- In laymen's terms, the ventilation portion inside the equipment must have modulation capabilities
 - i.e. multispeed fans and/modulating dampers
- ECM type supply fans motors have superior range and efficiency compared to AC fans
- Modulating dampers from 0-100% of rated airflow



ECM Motor Speed Control Board



Damper position vs outdoor airflow in %



62.1 CLASS Air Levels

Class 1: Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odour.

Class 2: Air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors. (Class 2 air also includes air that is not necessarily harmful or objectionable but that is inappropriate for transfer or recirculation to spaces used for different purposes.)

Class 3: Air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odour.

Class 4: Air with highly objectionable fumes or gases or with potentially dangerous particles, bio-aerosols, or gases, at concentrations high enough to be considered as harmful.

CLASS 1

- Classrooms (Ages 5 to 9+)
- Computer Lab
- All other Rooms

CLASS 2

- Art Classroom
- Daycare (up to age 4)
- Science Laboratories
- Wood/Metal Shop
- Toilets

CLASS 3

- Daycare Sickroom

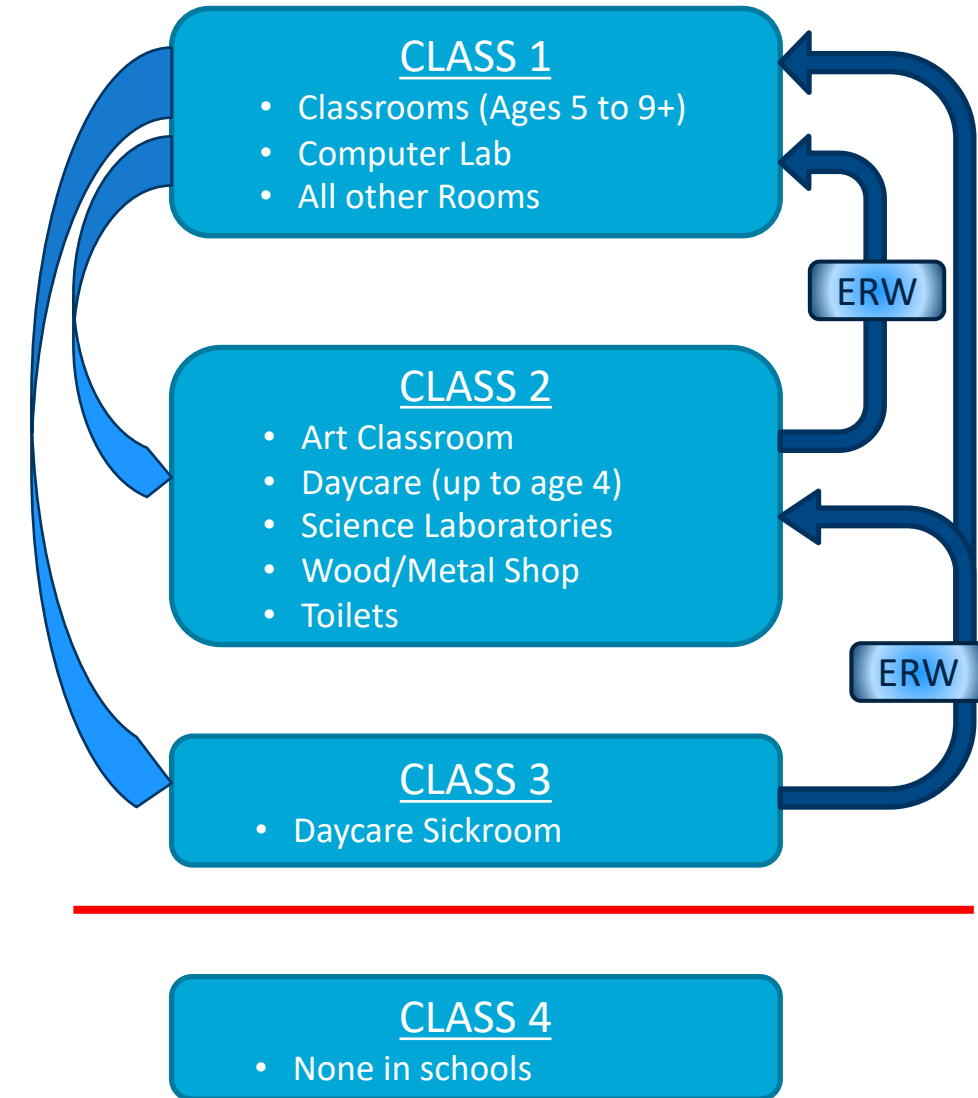
CLASS 4

- None in schools

Educational
Facilities

62.1 Recirculation

- **5.18.3.2.5 Class 2** air shall not be recirculated or transferred to Class 1 spaces.
 - **Exception to 5.18.3.2.5:** When using any energy recovery device (ERW), recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted.
 - Recirculated Class 2 air shall not exceed 10% of the outdoor air intake flow.
- **5.18.3.3.2 Class 3** air shall not be recirculated or transferred to any other space.
 - **Exception to 5.18.3.3.2:** When using any energy recovery device (ERW), recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted.
 - Recirculated Class 3 air shall not exceed 5% of the outdoor air intake flow.



Educational
Facilities

62.1 Systems and Equipment

Access for Inspection, Cleaning, and Maintenance

5.15.1 Equipment Clearance. Ventilation equipment shall be installed with working space that will allow for inspection and routine maintenance, including filter replacement and fan belt adjustment and replacement.

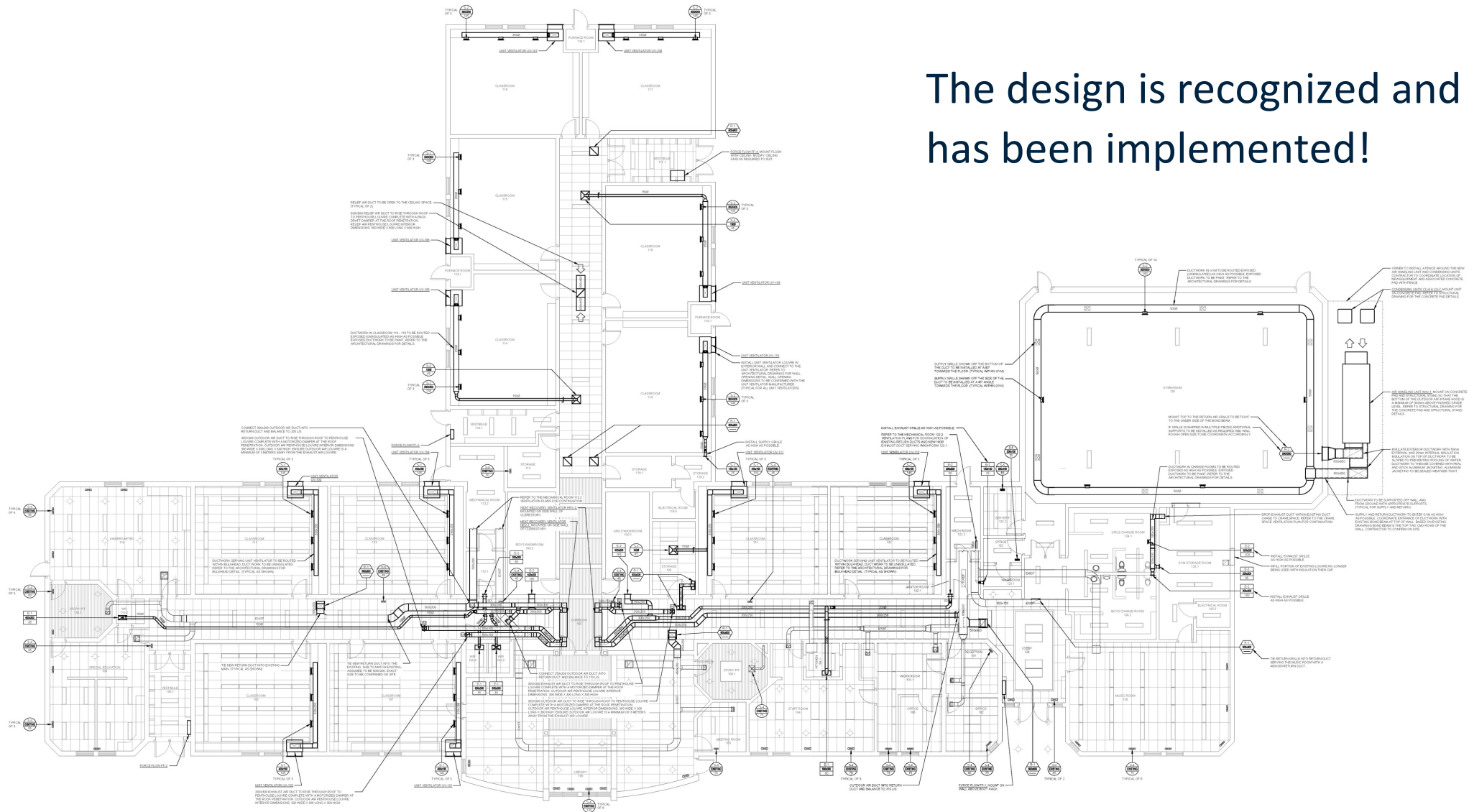
5.15.3 Air Distribution System. Access doors, panels, or other means shall be provided in ventilation equipment, ductwork, and plenums, located and sized to allow convenient and unobstructed access for inspection, cleaning, and routine maintenance of the following:

- Outdoor air intake areaways or plenums
- Mixed-air plenums
- Upstream surface of each heating, cooling, and recovery coil
- Air cleaners
- Drain pans and drain seals
- Fans



The Perfect Hybrid Example

The design is recognized and has been implemented!



How Stakeholders Benefit

- Lead time
- Pricing
- Ease of installation
- Simple serviceability
- Independent control
- Ease of troubleshooting



How Students & Teachers Benefit

- Improved ventilation proves better test scores
- Independent control
- HVAC is highly personal
- Perception (in-sight in-mind)
- Simple serviceability
 - (won't obstruct other classrooms)



How does the Community Benefit?

- Highest perceived and guaranteed IAQ scores
- Building longevity
- Lower operating costs
- Lower tax demand



Future Proof Classroom Design



School Upgrades



Expansion/Renovation
Additions



Modular Classrooms

Sound Solution

Low dB HVAC equipment has been linked to better learning environments and focus in the classroom



Sustainability



Sustainability

1. Energy-efficient equipment (with energy recovery, EC motors, modulating dampers, heat pumps)
2. Natural ventilation (economizer strategies)
3. Energy Recovery Systems
4. Green Roof and Vegetation: (solar panels) save roof space
5. Repurposing equipment (VUVs have been used in multiple schools)
6. Zoning and BMS integration

Energy Modeling



In Summary

1. Improved learning environment
2. Ventilation-focused design
3. Decoupled ventilation strategy
4. Intelligent yet simple HVAC control
5. Design for DUAS
6. Satisfy 62.1 above and beyond
7. Green ventilation– sustainability!



We welcome your questions!



Thank you!

Fresh Air Changes Everything

**To receive PDH credit, you must complete
the post-course evaluation**

