

MSBO Webinar - Building Systems

HVAC, Electrical & Technology



Use the QR code to start participating in the Mentimeter





Materials

Building Systems - HVAC, Electrical & Technology

<https://www.msbo.org/msbo-certification-class-materials/>

Introductions



Ron Boezwinkle
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GMB



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Electrical Engineer
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Director of Technology
Forest Hills Public Schools





Agenda

Common Existing Systems

Current Systems

Advanced Systems

System Integration / Data

Commissioning

Common Existing Systems



What is HVAC?

1. Heating

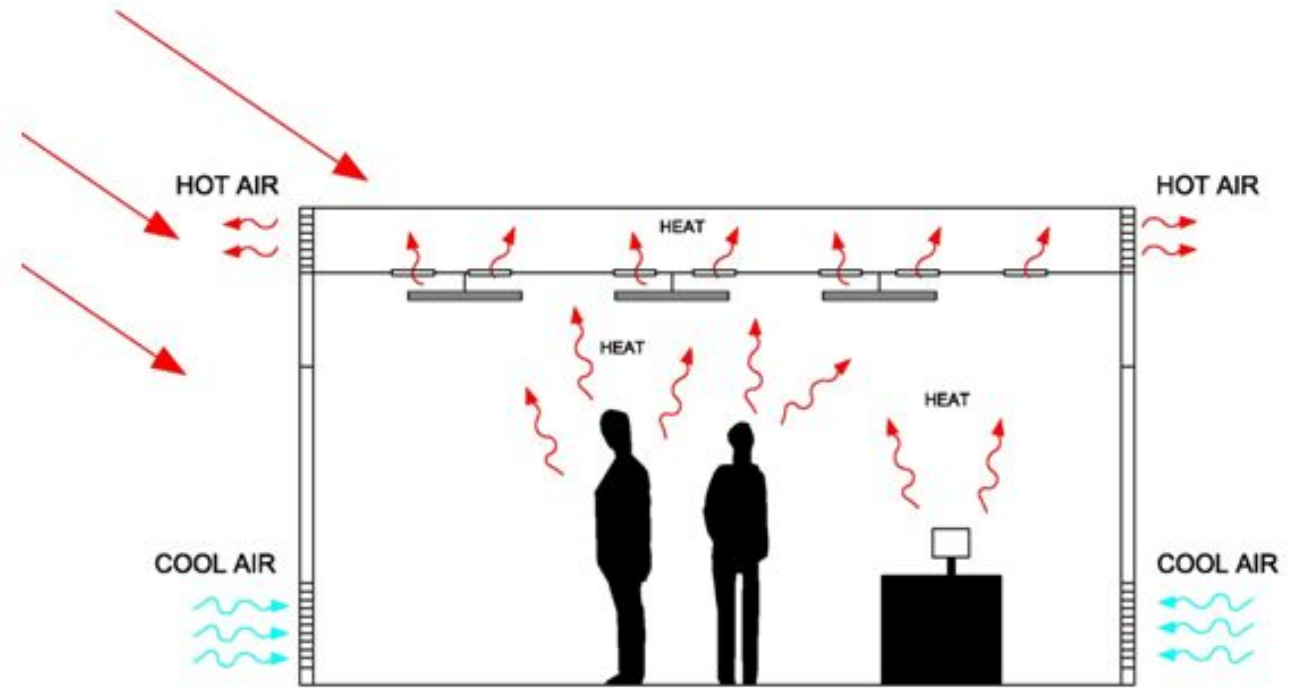
- condition outside air
- overcome envelope losses

2. Ventilation

- provide IAQ (indoor air quality)
- remove odors/contaminants
- air filtration, humidity
- pressurization

3. Air conditioning

- condition outside air
- overcome envelope gains
- overcome internal gains



HVAC PERFORMANCE REQUIREMENTS

HVAC SYSTEM PERFORMANCE IS CRITICAL TO PROVIDING A QUALITY LEARNING ENVIRONMENT

COMFORT

- Space Temperature and Humidity Control

ACOUSTICS

- Low noise levels to enhance learning

INDOOR AIR QUALITY

- Filtration
- Ventilation

MAINTENANCE FRIENDLY

- Accessibility / Cost / Time

ENERGY PERFORMANCE

- HVAC systems typically consume 60%+ of building energy use.

Types of Equipment

Common Existing Systems



ROOFTOP UNIT



UNIT VENTILATOR



CABINET UNIT HEATER



EXHAUST FAN



MINI-SPLIT



AIR HANDLING UNIT



FAN COIL



VERTICAL UNIT VENTILATOR



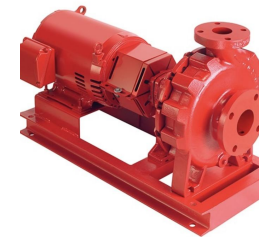
ICE STORAGE



VAV BOX



BOILER



PUMP



AIR COOLED CHILLER

Unit Ventilator

(Horizontal)

Description:

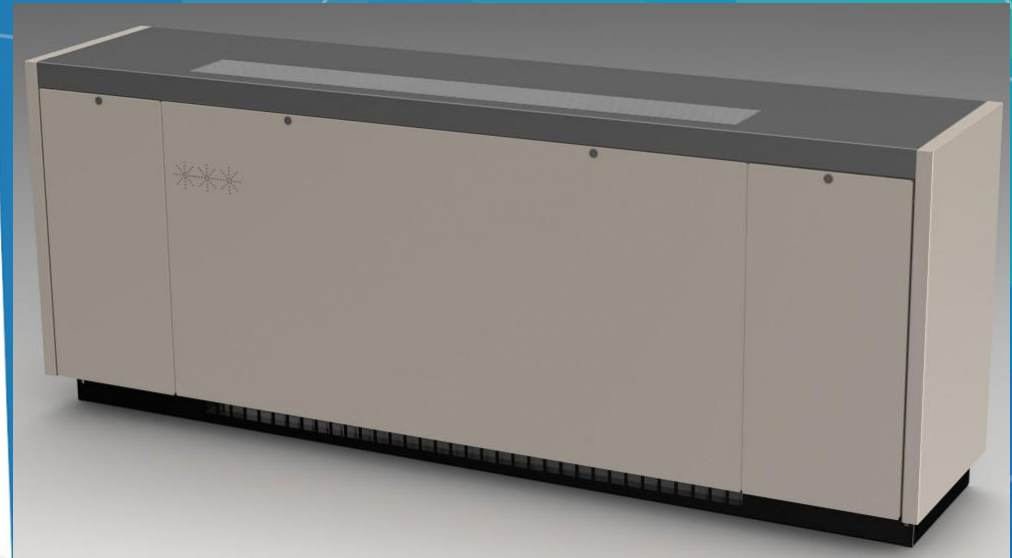
- In classroom heating, cooling and ventilating unit. Typically, hot water heating, DX or CHW cooling.

Advantages:

- No ductwork
- Ventilation specific to each space
- Cost effective

Challenges:

- Occupies classroom floor space
- Noisy
- Poor air distribution



Multizone

Description:

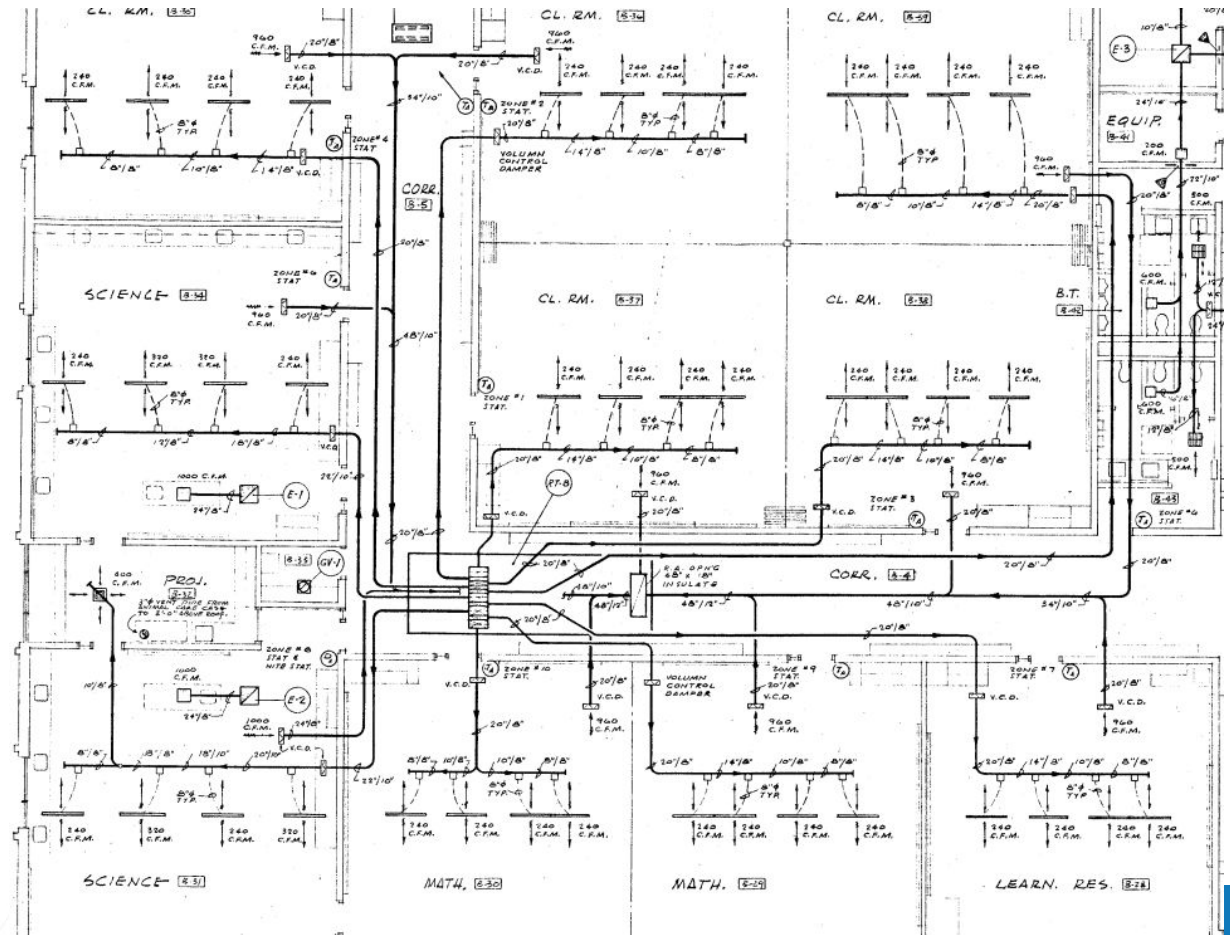
- Central air handling unit with hot and cold airstreams that mix and are ducted to each separate temperature zone.

Advantages:

- Zone temperature control
- Centralized maintenance

Challenges:

- Inefficient, simultaneous hot and cold decks.
- Lots of ductwork
- Can require significant modifications to convert to modern systems.



Packaged Rooftop Units

Description:

- Packaged Heating and Cooling Air handling system. Typically, DX cooling, gas heating supply either a single zone or multiple zones with VAV boxes.

Advantages:

- Cost effective
- Standardized

Challenges:

- Maintenance on roof
- Short expected life, compared to central systems
- Average system efficiency



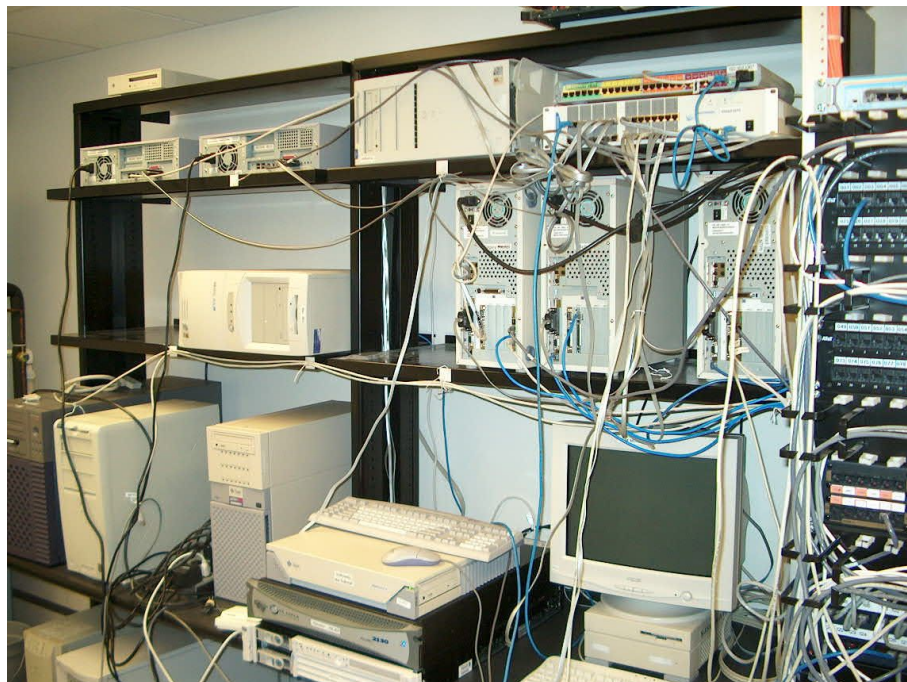
What is Technology?

- Any tools, systems, or techniques used to solve problems and accomplish tasks more effectively.

- End user devices
- Audio visual
- Sound Amplification
- Security systems
- Data Centers / Cabling
- Networking
- Phone Systems
- Public Address Systems
- Access Control



The Technology Museum



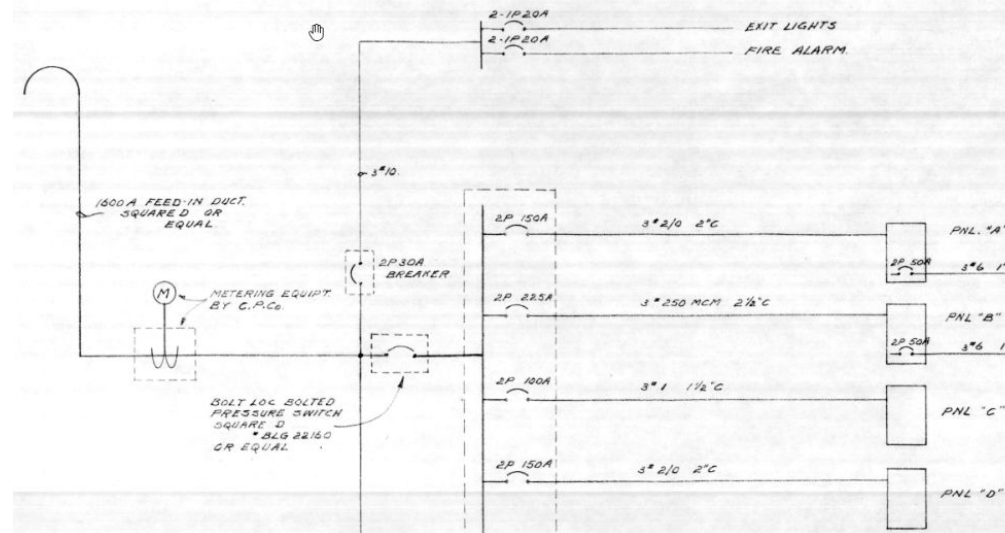
What is Electrical?

- Power
- Lighting
- Safety Systems
- Building Systems
 - Notification systems
 - Security systems
 - Cabling



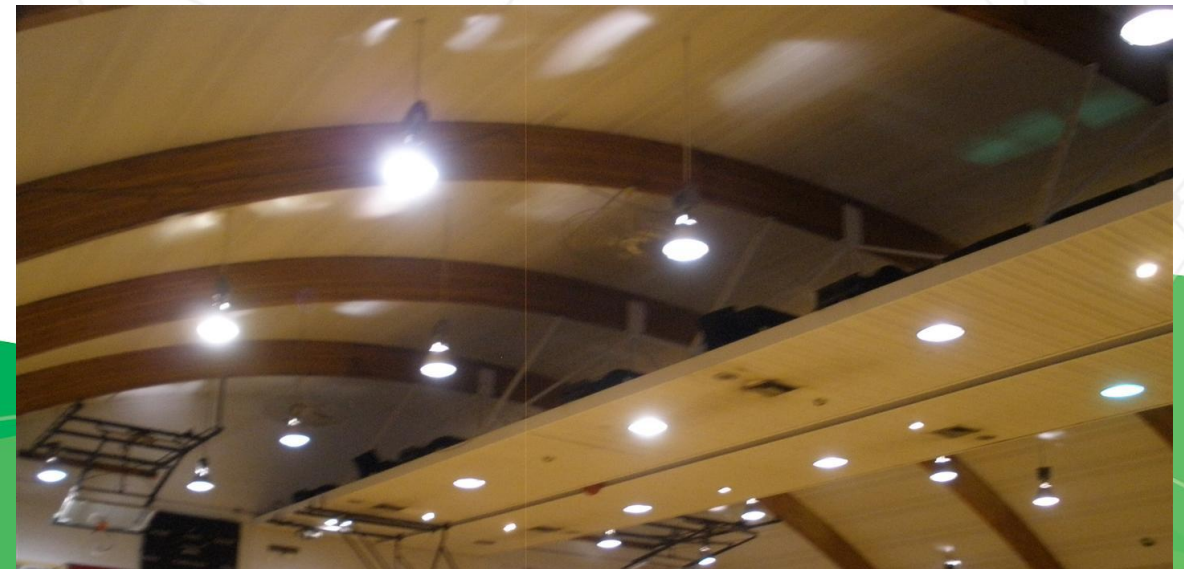
Power

- Electrical Utility Services
- Voltages
- Grounding
- Switchboards, Panelboards
- Emergency Power



Lighting

- Incandescent lamps
- Fluorescent
- High Intensity Discharge (HID)
 - Mercury Vapor
 - High Pressure Sodium
 - Metal Halide
- Lighting Controls



Safety and Building Systems

- Fire Alarm
- Intercom and Bell
- Clocks & PA
- Ethernet Network
- Video Surveillance



The background of the slide is a photograph of an industrial facility, possibly a refinery or chemical plant, featuring large storage tanks, complex piping, and structural steel. The image is darkened and overlaid with a network of white lines and circular nodes, suggesting a digital or interconnected system. The text 'Current Systems' is centered in a white, bold, sans-serif font.

Current Systems

Vertical Unit Ventilators

Description:

- In classroom heating, cooling and ventilating unit. Typically, hot water heating, DX or CHW cooling.

Advantages:

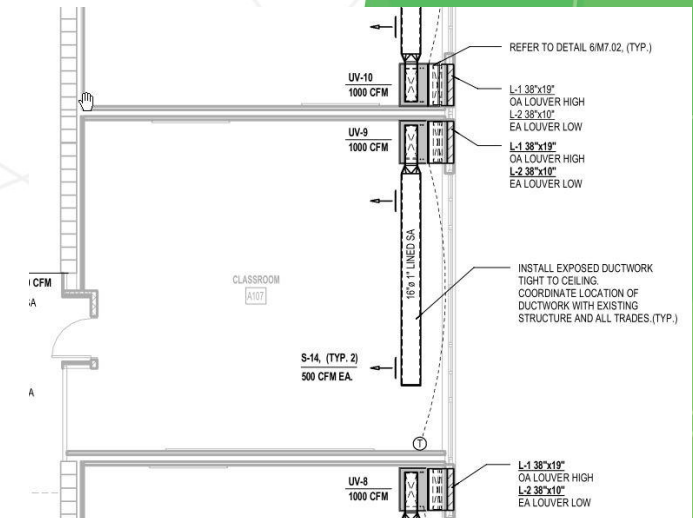
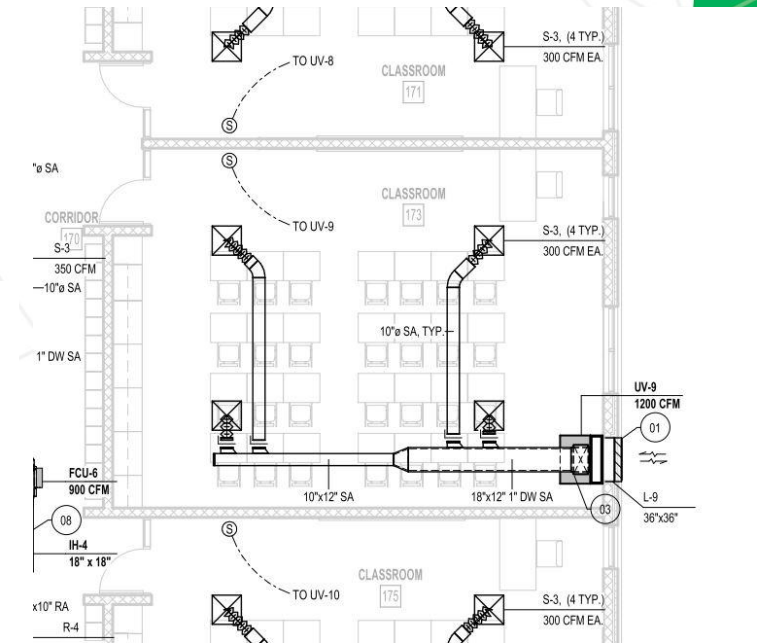
- Good ventilation effectiveness to each zone, easy demand control ventilation.
- Energy efficient
- Simple system and design
- Cost effective
- Good air distribution
- Better maintenance access than under window UVs.

Challenges:

- Occupies classroom floor space
- Noise concerns of equipment in the space (can be mitigated)



Current Systems



Variable Air Volume (VAV System)

Description:

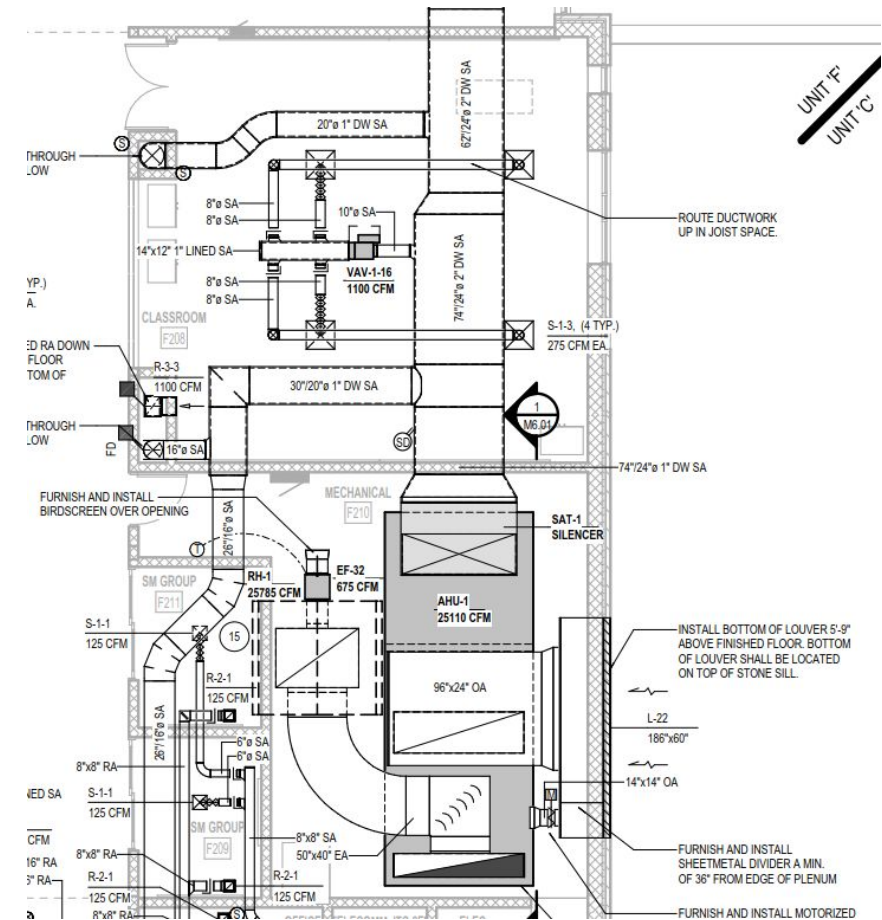
- Central Air Handling Unit delivers cool air to zone VAV boxes with reheat. Typically, HW/CHW/DX but very customizable.

Advantages:

- Centralized fans/filters for maintenance
- Minimal above ceiling maintenance
- Good temperature control

Challenges:

- Less energy efficient, lots of fan energy
- Large ductwork requires larger ceiling plenums
- Poor ventilation effectiveness
- Inefficient simultaneous heating and cooling with reheat
- Large mechanical room space requirements



Condensing Boiler Systems

Description:

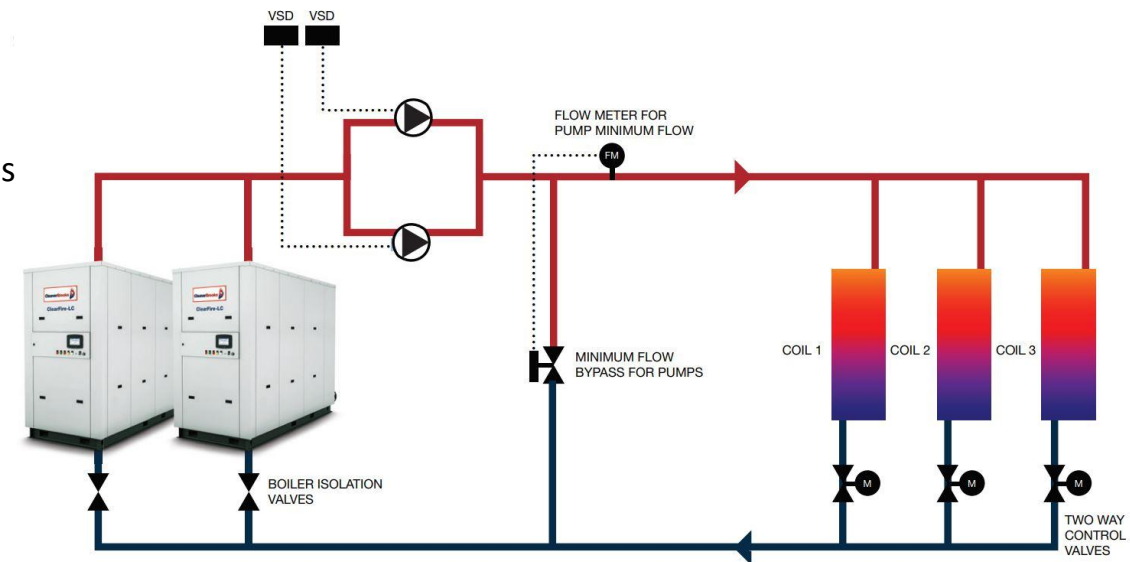
- Gas fired condensing boilers operating at 94%+ efficiency with low temperature heating hot water (<140F) and central heating pumps to distribute hot water throughout building.

Advantages:

- More efficient than non-condensing heating boilers or gas fired equipment
- Centralized heating system for easier maintenance
- Good temperature control
- Flexible, can be used for many system types and is easily modified for renovations

Challenges:

- Requires building square footage for mechanical room



Air Cooled Chilled Water Systems

Description:

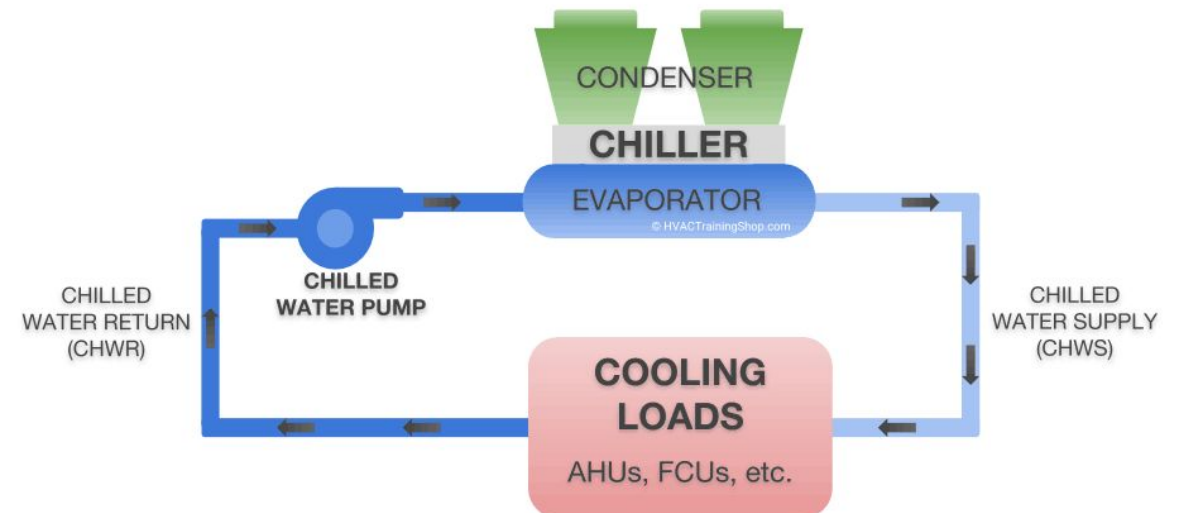
- Central air cooled chiller and pumps deliver chilled water to all building cooling equipment

Advantages:

- Efficient cooling equipment
- Centralized maintenance and simple replacement
- Flexible, can be used for many system types and is easily modified for renovations

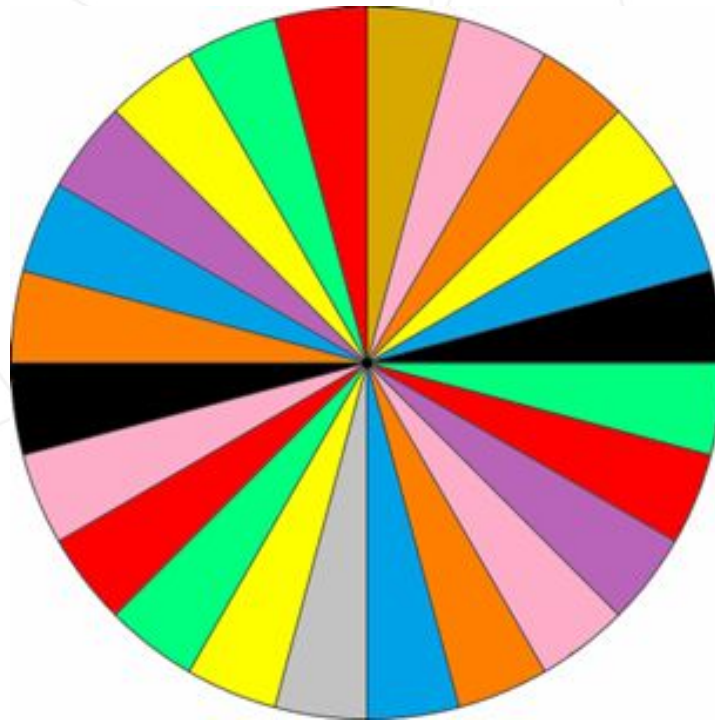
Challenges:

- Requires building square footage for mechanical room
- Requires dedicated outdoor area adjacent to mechanical room
- Initial cost can be higher for smaller buildings



Break Time

We'll resume in 15 minutes and spin the wheel for a gift card prize!



Current Technology

- Projectors
- Computers, Tablets, Carts
- Document Cameras
- Interactive Flat Panels
- Door Security / Card Access
- Video Surveillance
- Audio Enhancement
- Wireless

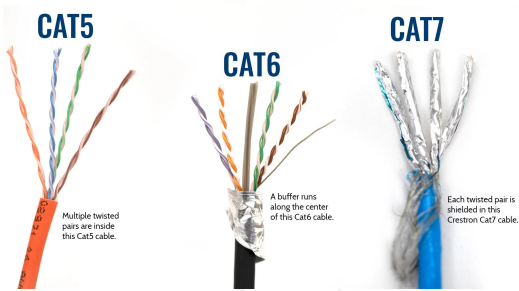


Current Systems



Digital Classrooms

Advantages	Challenges
Untethered Classroom Experience	Wireless requires MANY wires
Increased Collaboration	Equitable Resources & Coverage for All
Cost Savings	Bond / E-Rate / Consolidation of Services
Interactive Access to the World	Security / Privacy / Exposure to Attacks
Expanded Learning Environments	Extending Network / Other Interference
Up-to-date Resources	Investing and updating in Infrastructure
Real-time Data & Communications	Provide reliable high-speed connectivity



Power Distribution

- Utility Service Types
- Power Distribution Equipment
- Backup and Alternative Power Sources
- Grounding and Bonding



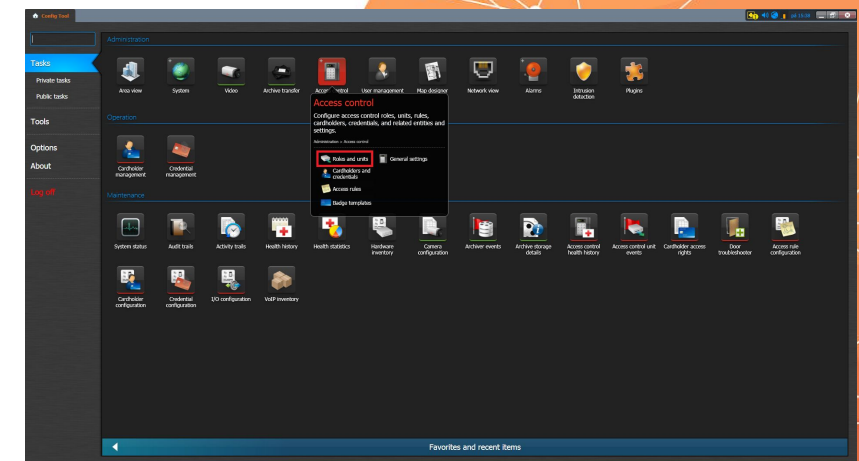
Lighting

- LED
- Lighting Controls



Safety and Building Systems

- Fire Alarm
- Clock/Displays
 - 'Mass Notification'
- Intercom
- Access Controls
- Wireless Networking



The background of the slide is a photograph of an industrial facility, possibly a refinery or chemical plant, featuring large storage tanks, complex piping, and structural steel. The image is semi-transparent and overlaid with a network diagram consisting of white dots connected by thin white lines. The dots are of varying sizes and are distributed across the entire image, creating a sense of interconnectedness. The overall color palette is dominated by the teal and blue tones of the industrial scene, with the white text and network lines providing contrast.

Advanced Systems

Dedicated Outdoor Air Systems

Description:

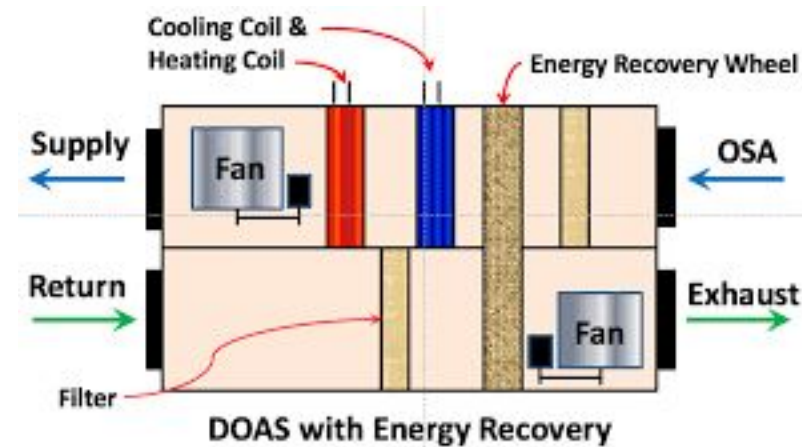
- Dedicated outdoor air unit delivers 100% fresh air to each zone or terminal unit. System can be applied in many different configurations.

Advantages:

- Decentralized systems use less energy by reducing fan power
- Energy recovery on all building ventilation and exhaust air
- Smaller mechanical space requirements
- Smaller ductwork and ceiling space requirements
- Better ventilation distribution to occupants

Challenges:

- Requires zone terminal units that may require maintenance



Dedicated Outdoor Air Systems

Typical Terminal Unit Options

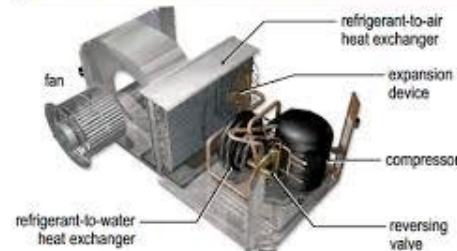
Description:

- Zone terminal unit that delivers the heating and cooling required for the zone.

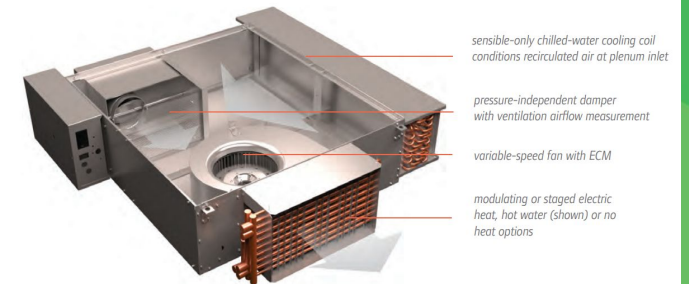
Typical Equipment Options:

- Water/Ground Source Heat Pumps
- Active Chilled Beams
- Radiant heating and cooling
- Sensible cooling fan powered VAV boxes
- Variable Refrigerant Flow (VRF) systems
- 4 pipe fan coil units

Water-Source Heat Pump



Heating and sensible cooling in terminal unit



Sensible Cooling Terminal Units

Description:

- DOAS delivers fresh, dehumidified air to sensible cooling terminal units (SCTU) above the ceiling. The SCTU has a sensible only cooling coil and reheat coil. A high temperature chilled water loop (~57F) serves the sensible cooling coils. Ventilation air provides all required space dehumidification.

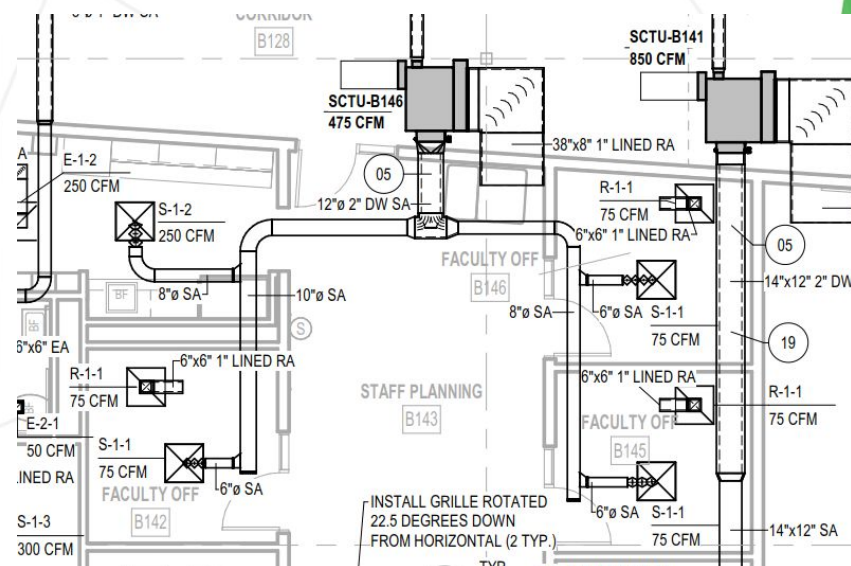
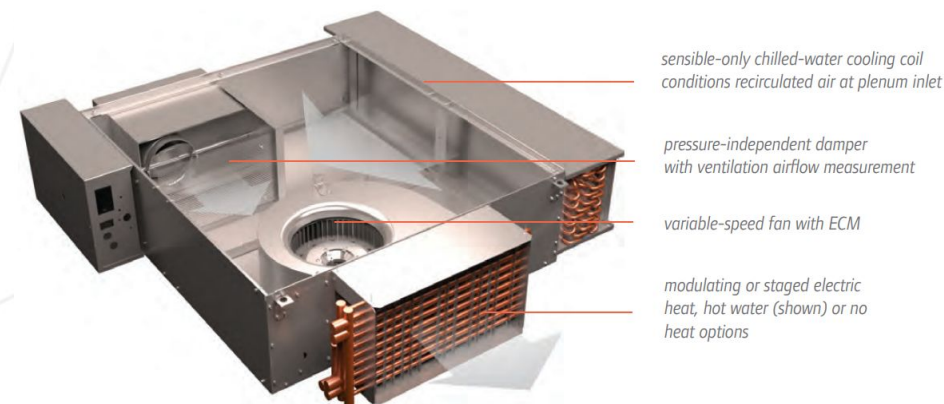
Advantages:

- No equipment in classrooms
- Ventilation specific to each space, no over ventilating
- Demand Control Ventilation, DOAS is VAV
- Energy recovery on all building exhaust
- Increased energy efficiency
- DOAS does not have to operate for unoccupied conditioning
- No condensate drain piping

Challenges:

- Higher first cost
- Somewhat complex controls to ensure proper dehumidification provided
- Fan powered box noise, can be mitigated

Heating and sensible cooling in terminal unit



Geothermal

Description:

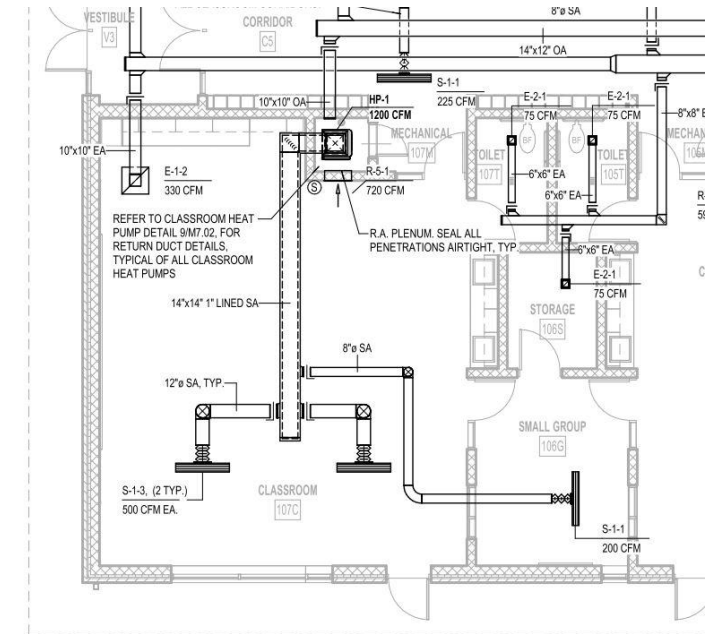
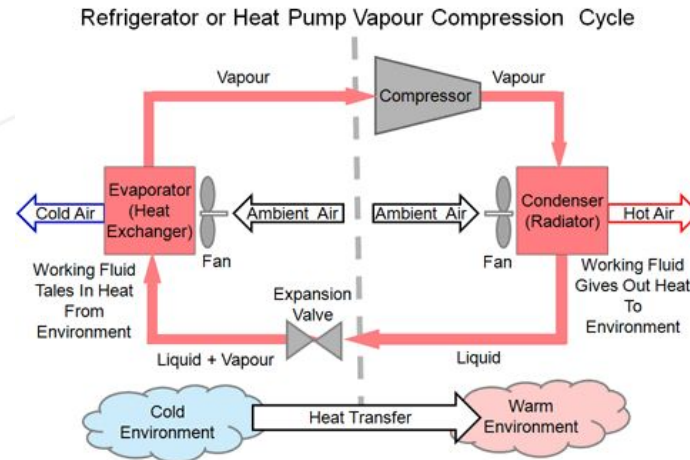
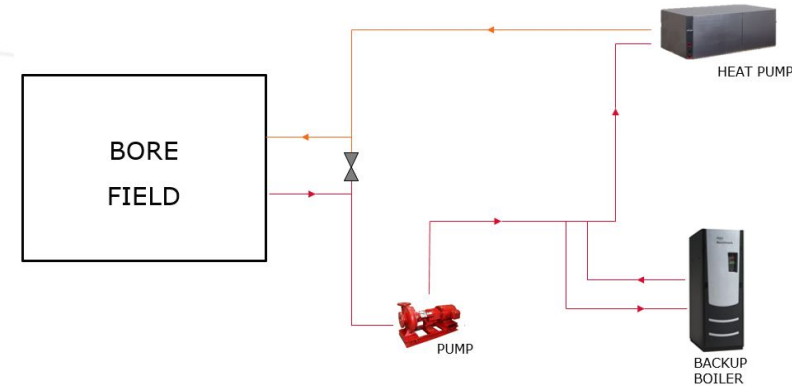
- Ground coupled heat exchanger used as the primary source for heating and cooling energy transfer. Central or distributed heat pumps use ground source water to deliver heated or cooled air to all zones.

Advantages:

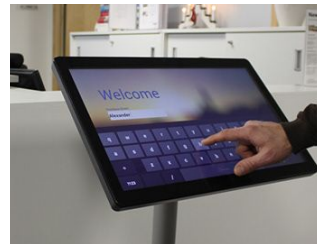
- Very low building EUI
- Very high energy efficiency
- Qualifies for Inflation Reduction Act (IRA) Tax Credit (up to 40% of system cost)
- Low maintenance, long lifespan (borefield is 50+ year warranty)
- Less classroom floor area utilized, compared to VUV system
- Zero energy ready – Adding onsite generation (solar) now or in future could make the building net zero due to this systems low EUI, electric based heating

Challenges:

- Ground heat exchanger utilizes real estate adjacent to buildings, can be a challenge for future expansion



Emerging Technology



Photovoltaic (PV) Systems

Description:

- A system to generate electricity through photovoltaic modules. Typical equipment include the modules, mounting structures and inverters.

Advantages:

- Savings on electrical utility costs
- Reducing carbon footprint
- Options to shift operating expense to capital expense.

Challenges:

- Economic payback dependent on utility rate.
- Capital costs and maintenance
- Load profile (Summer vs. Winter)



ESTIMATED MONTHLY ENERGY



System Integration / Data

- BMS
- Analytics Utilizing BMS Data
- Intelligent Buildings
- Commissioning



How Smart is your Environment?

Smart School -

- HVAC Systems
- Occupancy Sensors
- Digital Signage
- Building Access Control
- Fleet Tracking
- Classroom Devices
- Networking Infrastructure

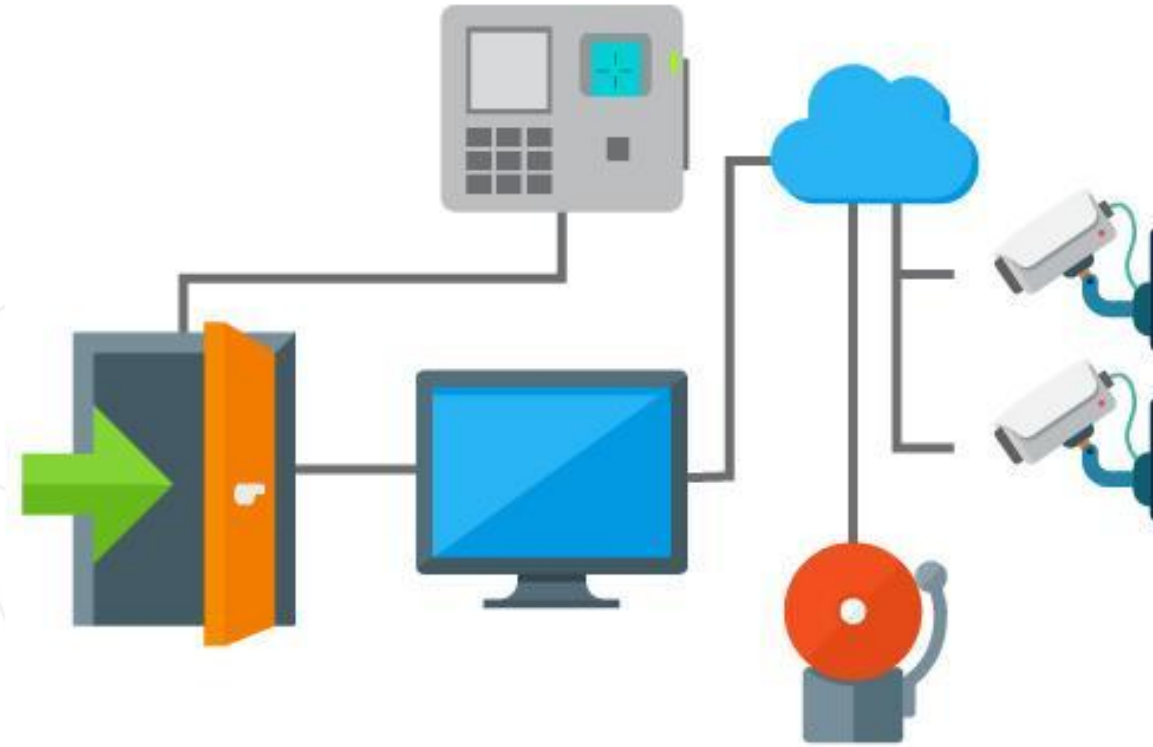
Smart Home -

- Alexa / Google Home Assistant
- Apple TV / Amazon Firestick
- Nest Thermostat
- Ring Doorbell
- Garage Door Opener
- Lighting Control



Technology Considerations

- Infrastructure
- Support
- Security
- Privacy
- Availability
- Redundancy
- Automation
- Sustainability
- Integration



Can We Better Prepare Buildings For The Future?

Intermediate Steps

Near Term

- OT / IT Networks
- IP Connected Controllers and Systems
- Standardized Data Tagging Requirements
- Specifying major systems have communication ability
- Implement facility analytics software for on-going commissioning and monitoring of existing systems

Long Term

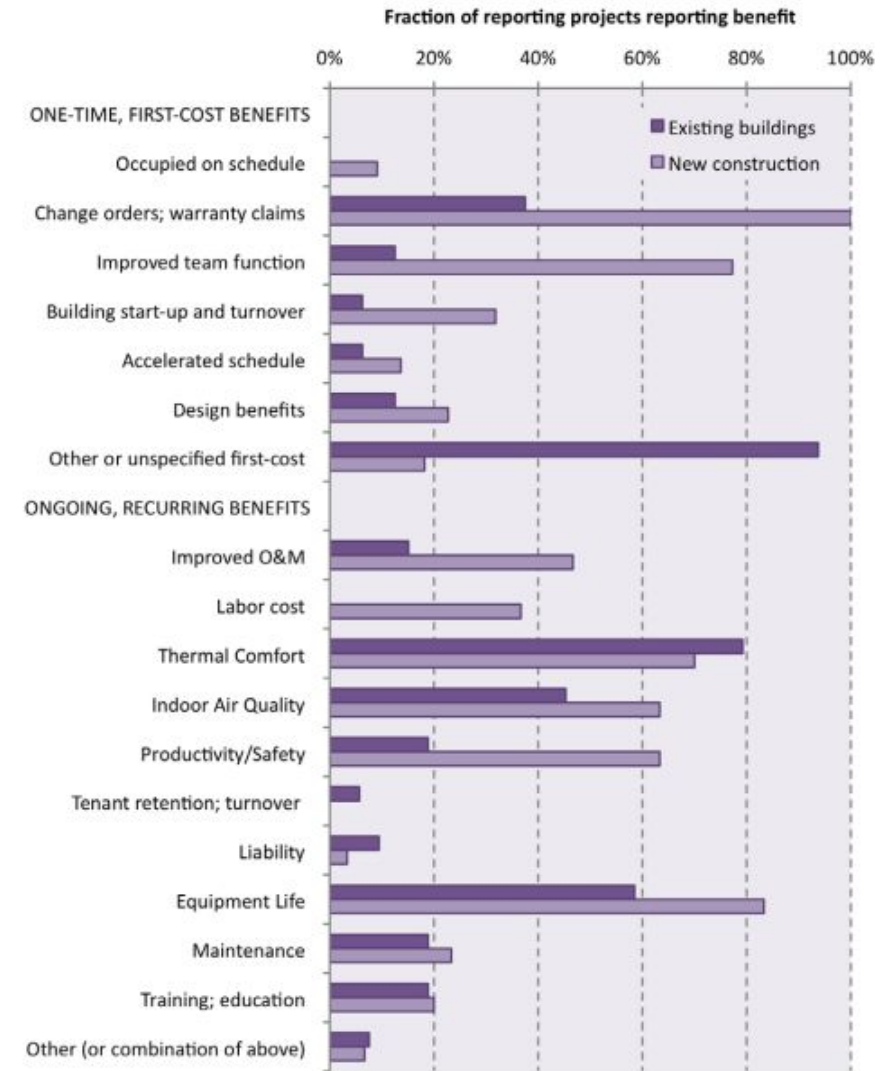
- Creating a comprehensive building model (Digital Twin) and comparing it to real-world operation

Why Commissioning?

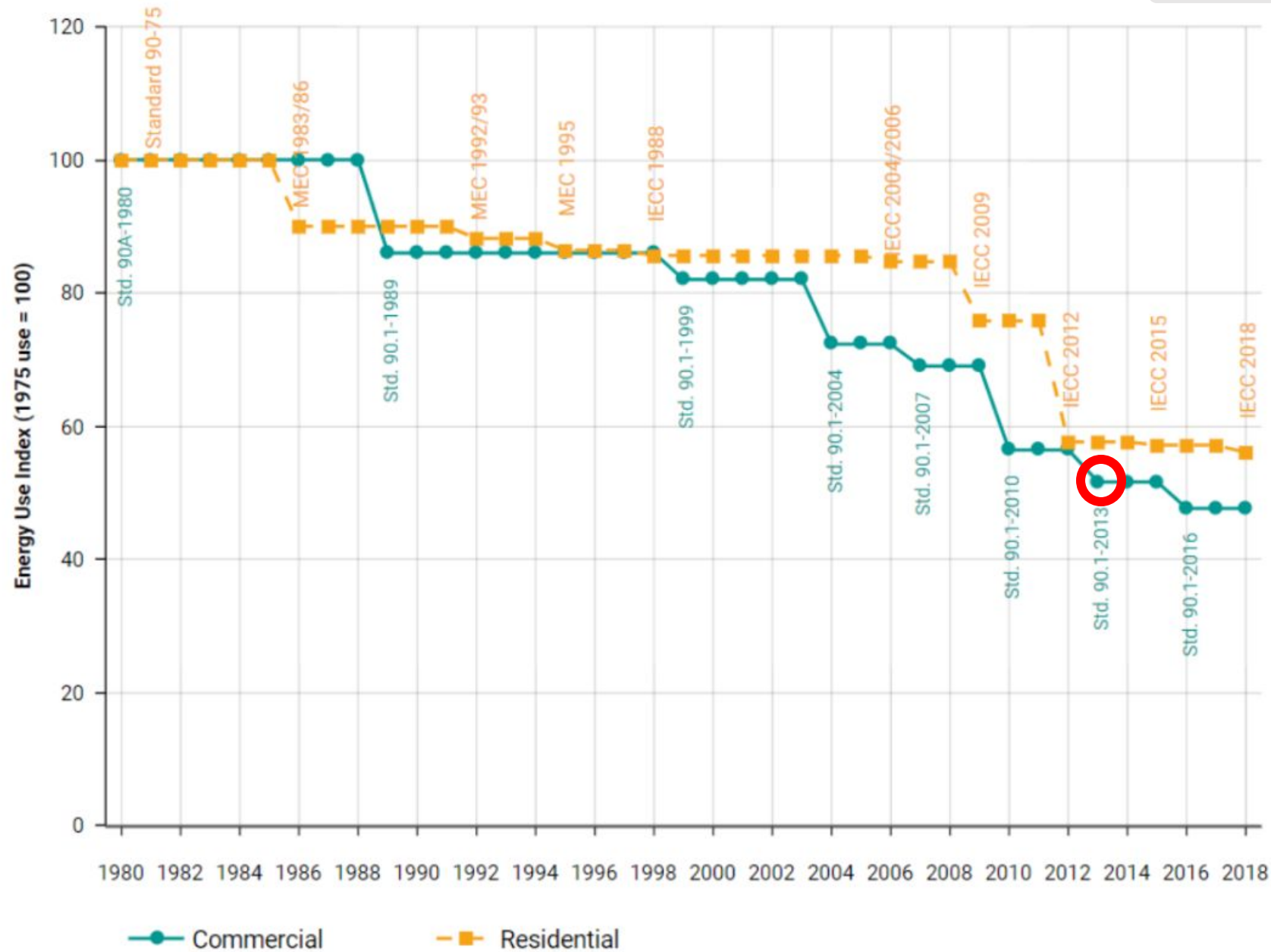
Building Performances Effect Students

- Thermal Comfort
- Lighting Levels
- Indoor air quality
 - Ventilation
 - Filters
 - Electronic air cleaner operation
- Less mystery and more trust that systems and components are working properly.
- Ease of operation and maintainability
- Money saved by energy reductions can then be invested into the education process
- Code Compliance is just the minimum

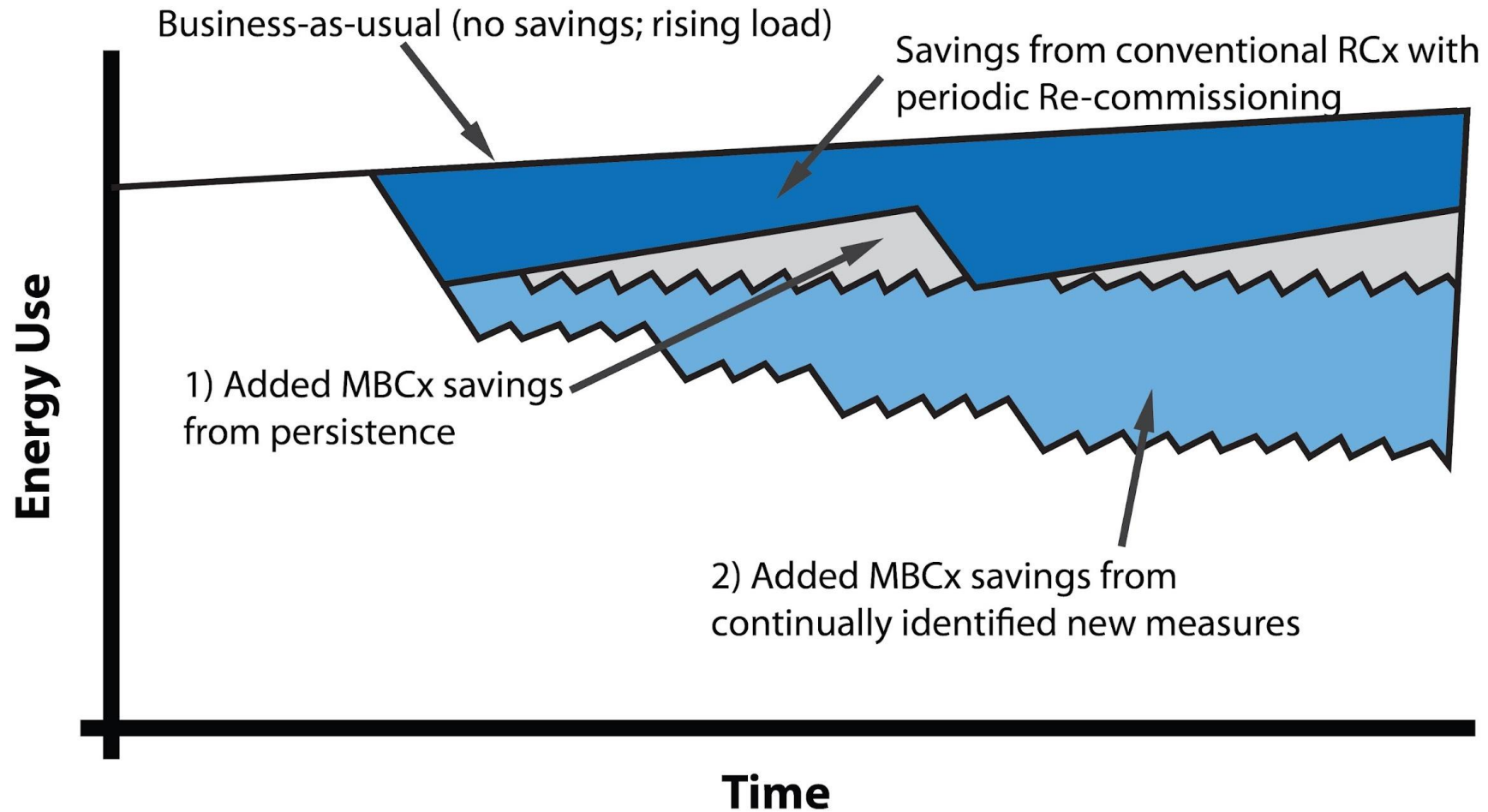
Figure 16. *Non-energy benefits observed following commissioning.*



Energy Use of Model Building Energy Codes Over Time

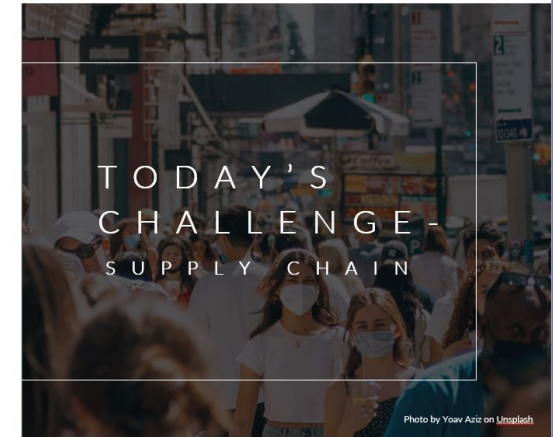
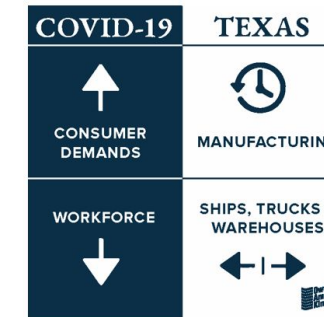


On-Going Commissioning



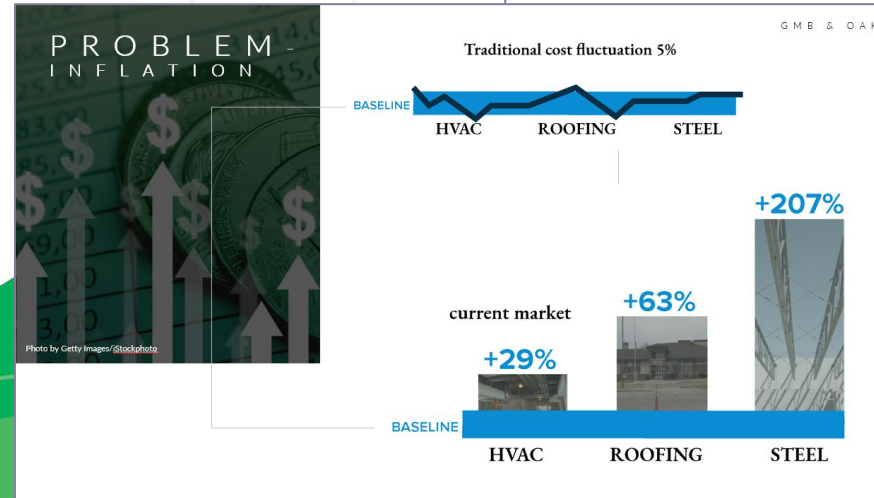
State of Facilities

- Preventative Maintenance
- Replacement Planning
- Capital Investment with Operating Savings



Market Dynamics

- Supplies
- Bid Market





Questions?

Finalize Credit for Attendance

NEW PROCESS!

The MSBO Evaluation is your record for attendance

Please complete by February 15

- Receive an email from Survey Monkey for the MSBO evaluation. Your evaluation will be your record for attendance.
- Receive email from MOECS-noreply@michigan.gov to fill out an evaluation for SCECHs.

Thank You!



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