APPA U

Commissioning - An O&M Perspective

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What are the biggest issues that your campus is dealing with related to HVAC systems and Indoor Air Quality?

Issues with HVAC System on Campus

- Cost
  - Energy and Maintenance
- Reliability/failures
- Mold
- Customer Complaints
  - Too Cold/Too Hot
- Tight Temp/%RH limites (labs, clean rooms)

Commissioning is a way to help

What is Commissioning?

Commissioning - Systematic process to ensure new system installation is installed and operating according to original design criteria.

Re-Commissioning - Process to test a system that was commissioned previously.

Retro-Commissioning - Testing system that has been repaired or upgraded and/or that has never been commissioned to ensure that it meets designer/owner requirements

Continuous Commissioning - Ongoing commissioning that uses extensive monitoring to collect and analyze use and operations over time

Terms of Commissioning

- Cx = Commissioning
- Owner
- Operator/User
- Contractor
- Designer
- Commissioning Authority
- Commissioning Agent

Terms of Commissioning

- CxA = Commissioning Agent
- OPR = Owner's Project Requirements
- BAS = Building Automation System
- CCP = Certified Commissioning Provider
- TAB = Testing and Balancing

Terms of Commissioning

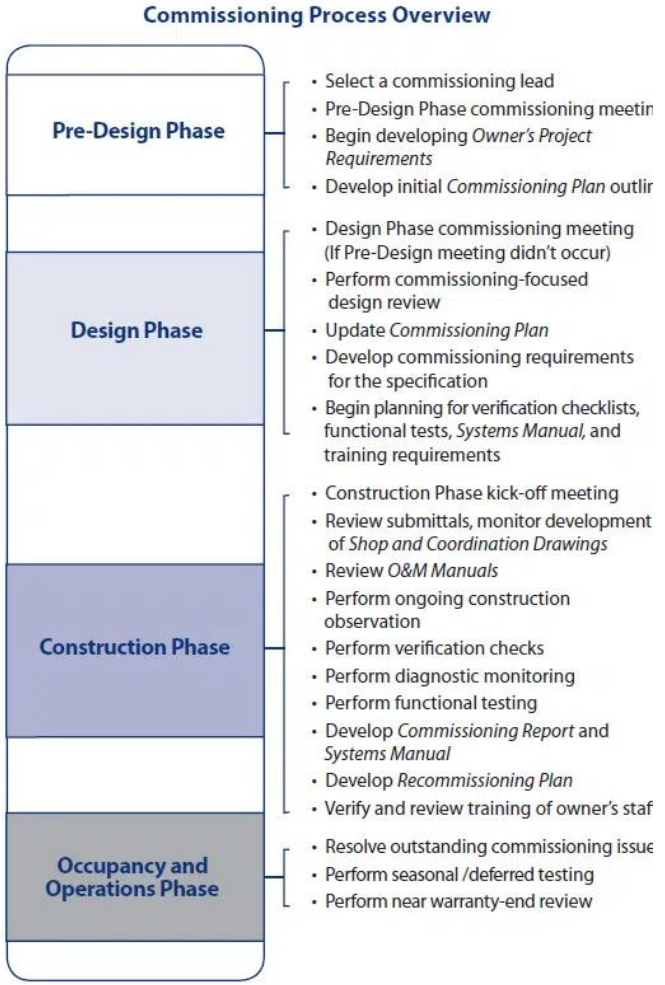
- **Fundamental Commissioning** - Process to ensure all facility systems perform interactively in accordance with the design documentation and intent, and in accordance with the owner's operational needs

- **Enhanced Commissioning** - Includes the additional tasks of: conducting design review; reviewing contractor submittals for energy-related systems; developing commissioning manual; and inspecting operation of energy-related systems within 10 months of final acceptance and develop plan to resolve outstanding issues.

What is Commissioning?

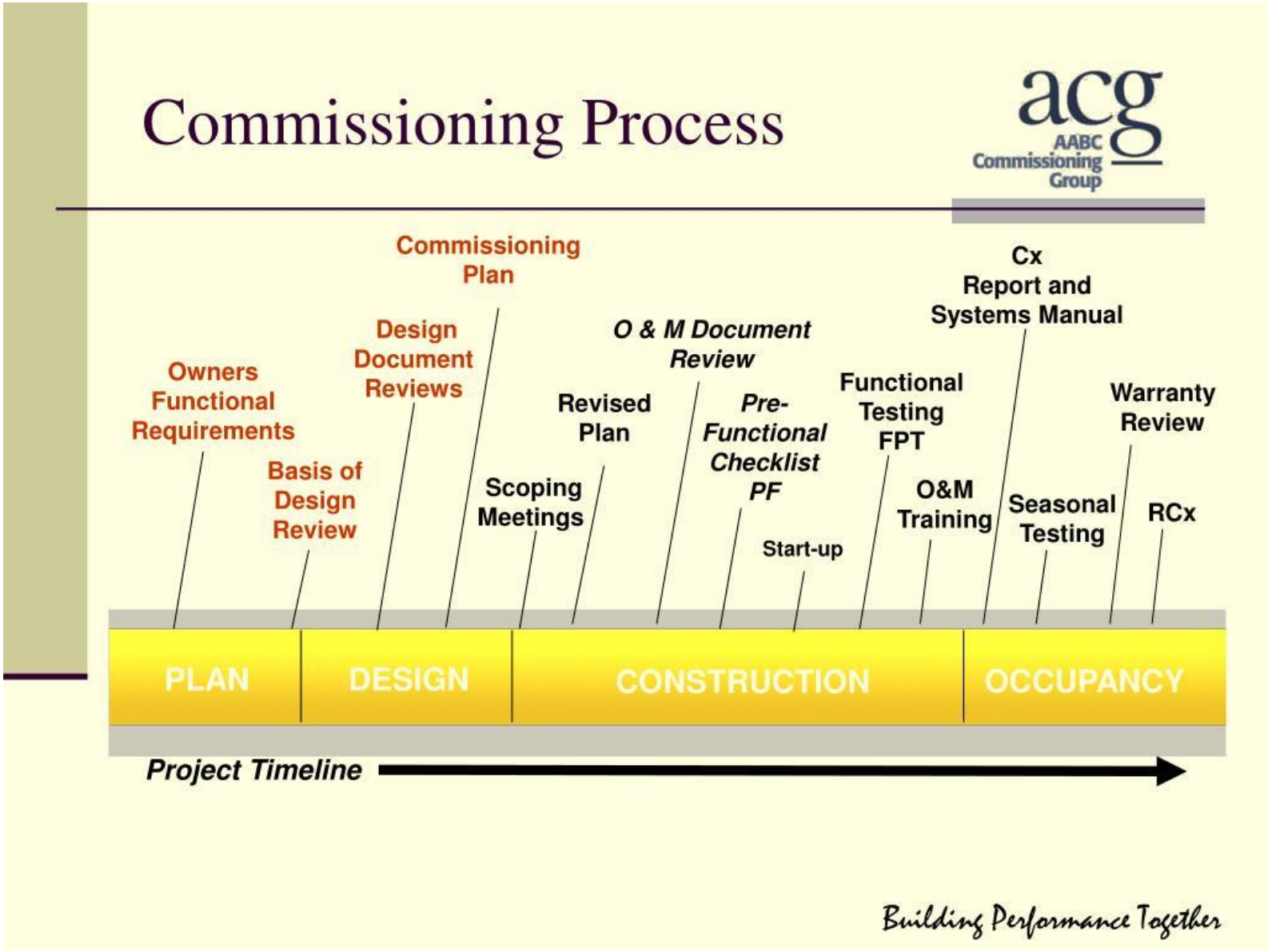
Commissioning - Systematic process to ensure new system installation is installed and operating according to original design criteria.

- New building/major renovation
- Starts in design phase
- Construction inspections/verifications
- Diagnostic monitoring
- Functional testing
- Verify/review owner training
- Resolve outstanding issues
- Perform seasonal testing
- Warranty-end review



Source: California Commissioning Guide: New Buildings

Commissioning




COMMISSIONING
ENGINEER
noun.[kuh-mish-uh n en-juh-neer]
Someone who does precision guesswork based on unreliable data provided by those of questionable knowledge.
See also wizard, magician

Response from Contractors to Commissioning Team

Re-Commissioning & Retro-Commissioning

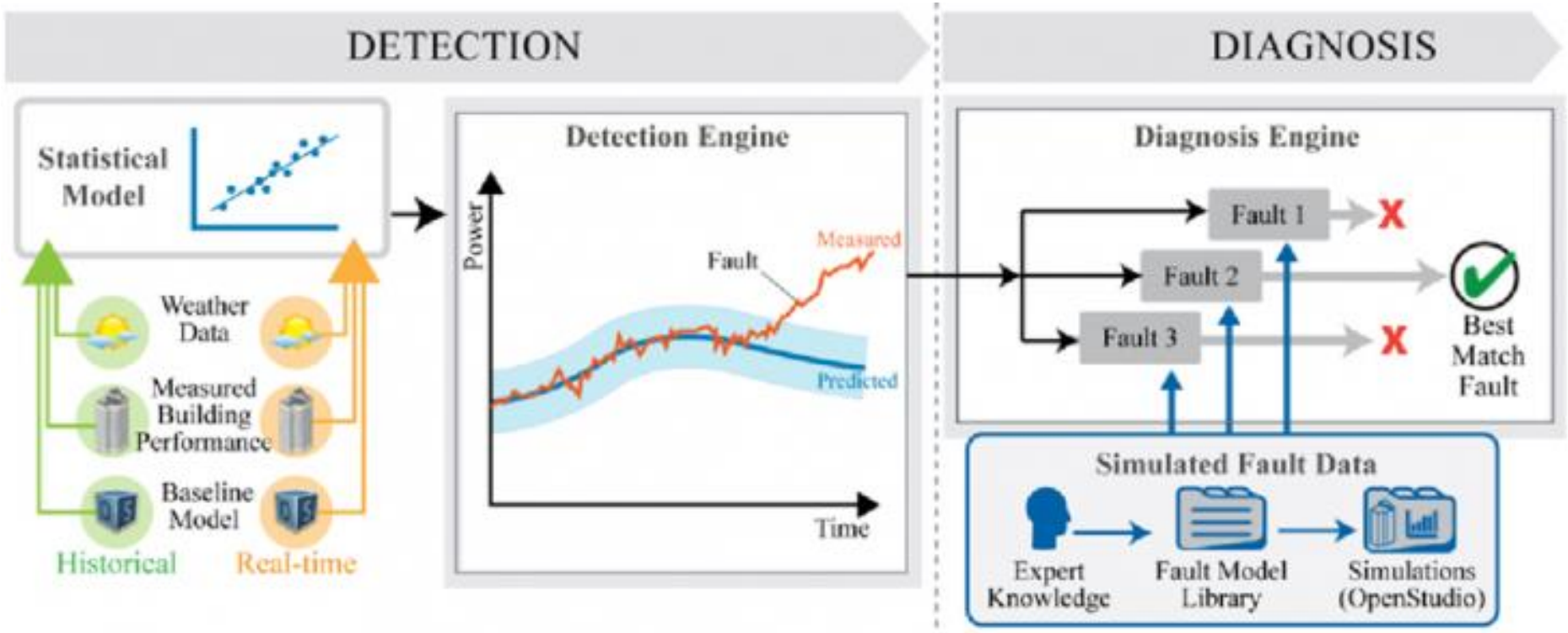
Re-Commissioning - Process to test a system that was commissioned previously.

Retro-Commissioning - Testing system that has been repaired or upgraded and/or that has never been commissioned to ensure that it meets designer/owner requirements

- **Basically, commission after building has been operating for a while.**

Continuous Commissioning

Continuous Commissioning/Monitoring-based Commissioning - Ongoing commissioning that uses extensive monitoring to collect and analyze use and operations over time



Why Commissioning???

- **Systems are more complex than past**
  - Contractors are more specialized
- **Construction Project**
  - Connection of equipment from multiple manufacturers
  - Installed by a team that has never worked together
  - Installed by a team that was selected based on low bid
  - Designed by engineer that has never actually seen it before
  - Fit into a space that the architect decided was all the space that the engineer was going to get
  - Designed and installed by a team that has to make it work ***once*** to pass initial inspection

- What could go wrong???

Why Commissioning???

"*The first 90% of a project takes 90% of the time, the last 10% takes the other 90%.*"

Why Commissioning?

- Method to obtain LEED points
  - Enhanced Commissioning
- Required by some building codes
  - HVAC to meet energy efficient standards
- Recommended by ASHRAE
- Recently recommended by CDC (ventilation rates based on COVID)
- Things ‘Drift’ over time
  - Either by automation or by manual override

What to Commission?

- HVAC System
- Electrical System
- IT System
- Automation System
- Building Envelop
- Fire Alarm System
- Speciality Process

Single manufacturer’s acceptance testing verses a complex ‘system’ with many manufacturers.

What to Commission?

- Not going to commissioning a window unit!

Benefits of Commissioning

- System operates as design
- System operates more efficiently
  - Less energy usage/Lower GHG emissions
  - Lower operating costs
- Ensure Safety of system

Benefits of Commissioning

- Occupants/customers more satisfied
  - Works better and less disruptions
- Operations staff better understand how it works
- If it doesn’t end up perfect, there is a record of what the issues were

Commissioning from M&O perspective

Initial Construction - Have to get it correct once

M&O Team - Get it correct every day after acceptance

Steps in Initial Commissioning

- Planning
  - Owner Project Requirements
  - Cx Agent part of design process
  - Include Operating Staff
  - Develop Cx plan/procedures
- Construction
  - Inspections (installed per design)
  - Operator Training
- Factory Acceptance Testing
  - Each individual component operates correctly

Steps in Initial Commissioning

- Systems Test of sequence of operations
- Identify issues/assign responsibility to resolve
- Retest as required
- Generate commissioning report
- Test during alternative season (Heat and Cool)

Approaches to Re-Cx for Existing Facilities

- Continuous Commissioning
- 3rd Party Cx Agent
- In-House Cx Team

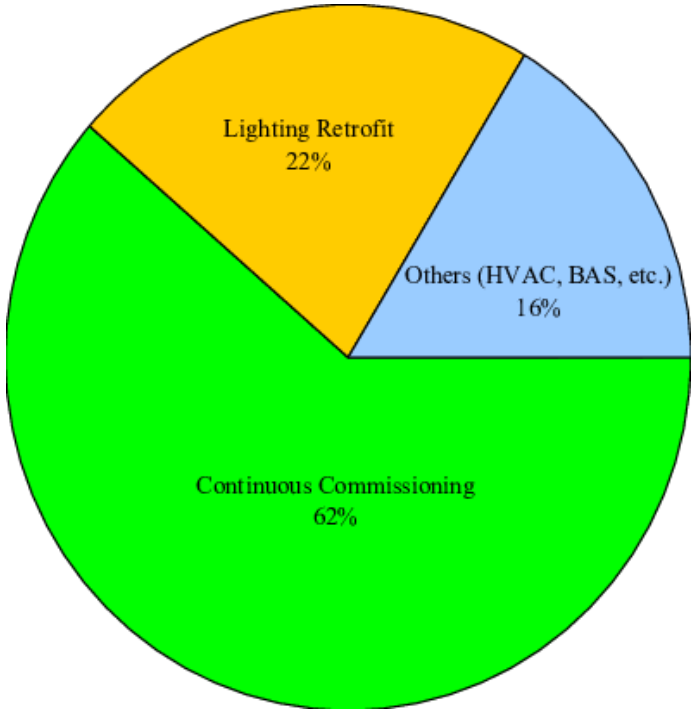
Not mutually exclusive

Continuous Commissioning

- Ongoing commissioning
- Continuous Commissioning - Ongoing commissioning that uses extensive monitoring to collect and analyze use and operations over time
- EcoStruxureBuilding Advisor
- Generates issues/alarms
  - Can include estimate of wasted energy
- Still requires troubleshooting/repair/maintenance

Continuous Commissioning Case

- Alamo Community College District (2.3 Million GSF)
- Reduce risk
- Enhanced occupant comfort & productivity
- Retrofit identification
- $3.5 Million/Short Payback (2 yrs continuous CX)



Continuous Commissioning Case

- Boston Scientific Corporate HQ (5 Bldgs/645K GSF)
- Pinpoints issues, trends, averages
- Prioritizes issues and suggested actions
- Assigns dollar value to energy opportunities
- Tracks and validates energy metrics
- 40% reduction in avoidable cost related to faults

Continuous Commissioning Case

- Helps identify issues
- Helps prioritize issues
- Maintenance Tech still has to take action to correct

Re-Commissioning Approach

- Treat like a project
- Develop general scope (building, systems, goals, timeframe, etc.)
  - Building selection based on energy and/or operational issues
- Select Cx Agent
  - 3rd Party Cx Agent = Cx Engineers
  - In-House Cx Team
- Develop plan, work through details

Re-Commissioning Options

- Full commissioning
  - Every component/system
  - Point to point check out

- Commissioning “Lite”
  - Select components - Example: AHUs only

Re-Commissioning Approach

- Can be complex
  - Check everything
  - Change/update Sequences of operation
  - Reprogram Controllers

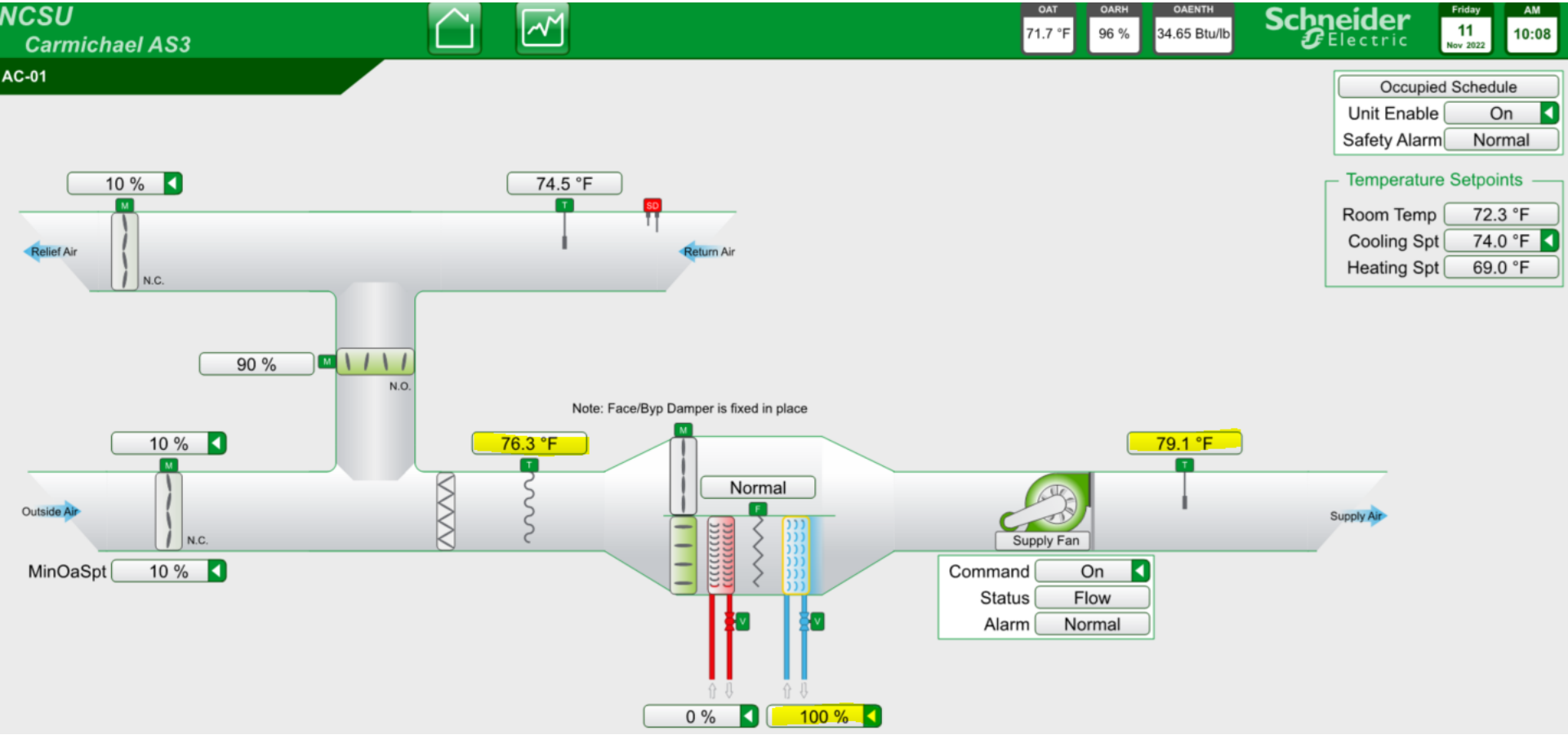
- Can be as simple as "***let's check out this AHU operations***"

Re-Commissioning Approach

- How manage?
  - Through separate project management group, through M&O Staff or energy management
- Owner's Technicians and/or BAS Technicians support
- Complete Commissioning checks
- Develop list of issues
  - Can include estimated energy costs
- Develop plan to resolve
  - In-house can resolve as they go

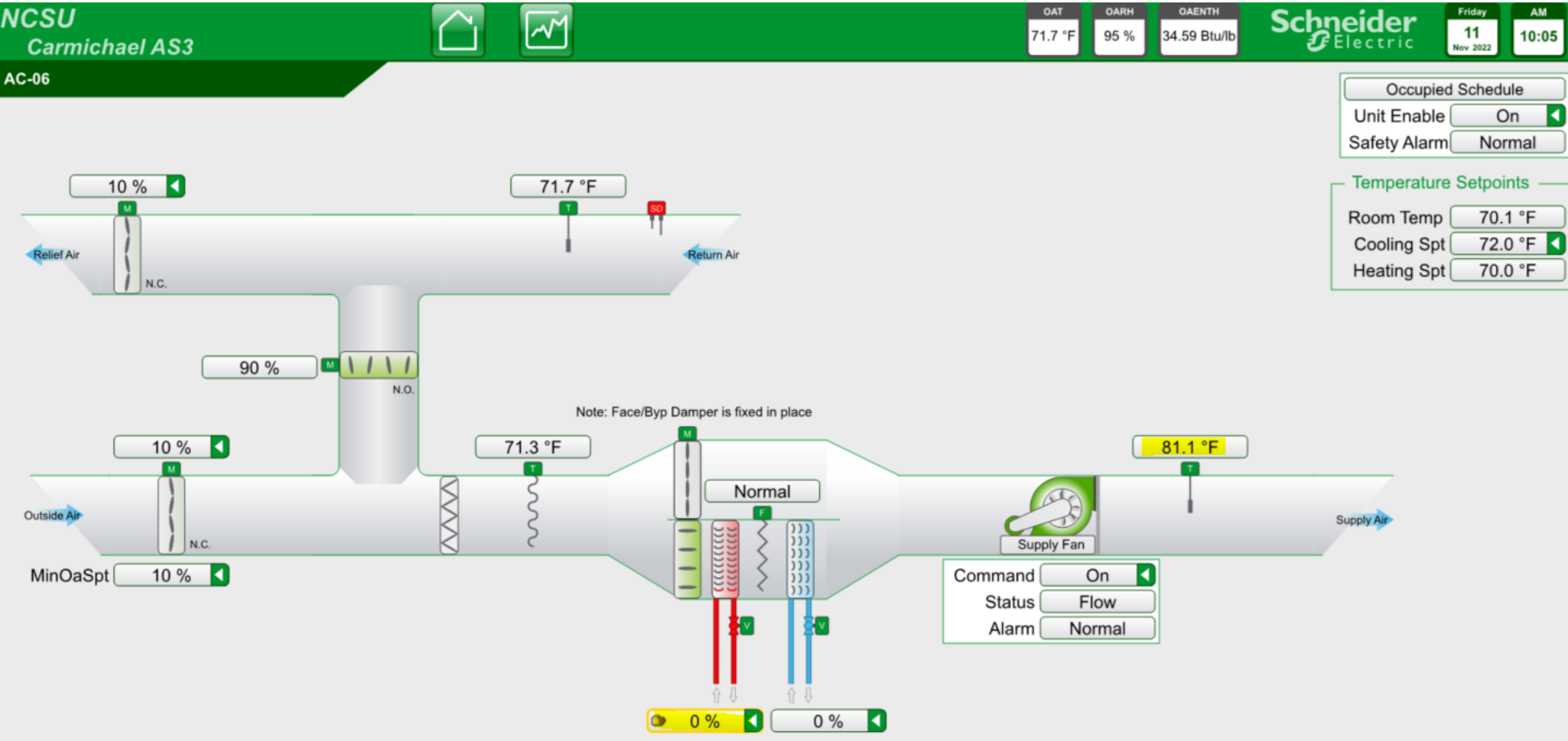
Re-Cx Example

- Cooling Valve not working Properly



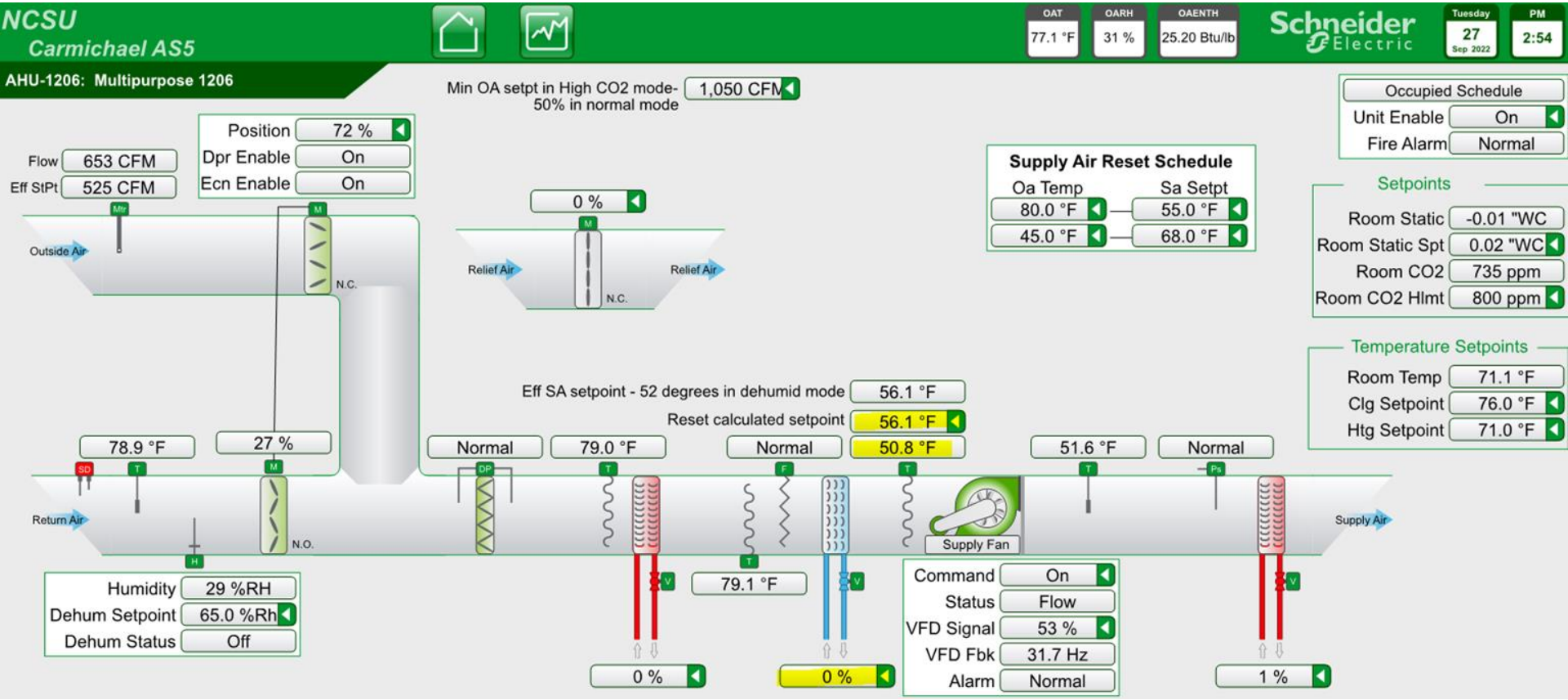
Re-Cx Example

- Preheat valve failed in open position (or leaking)



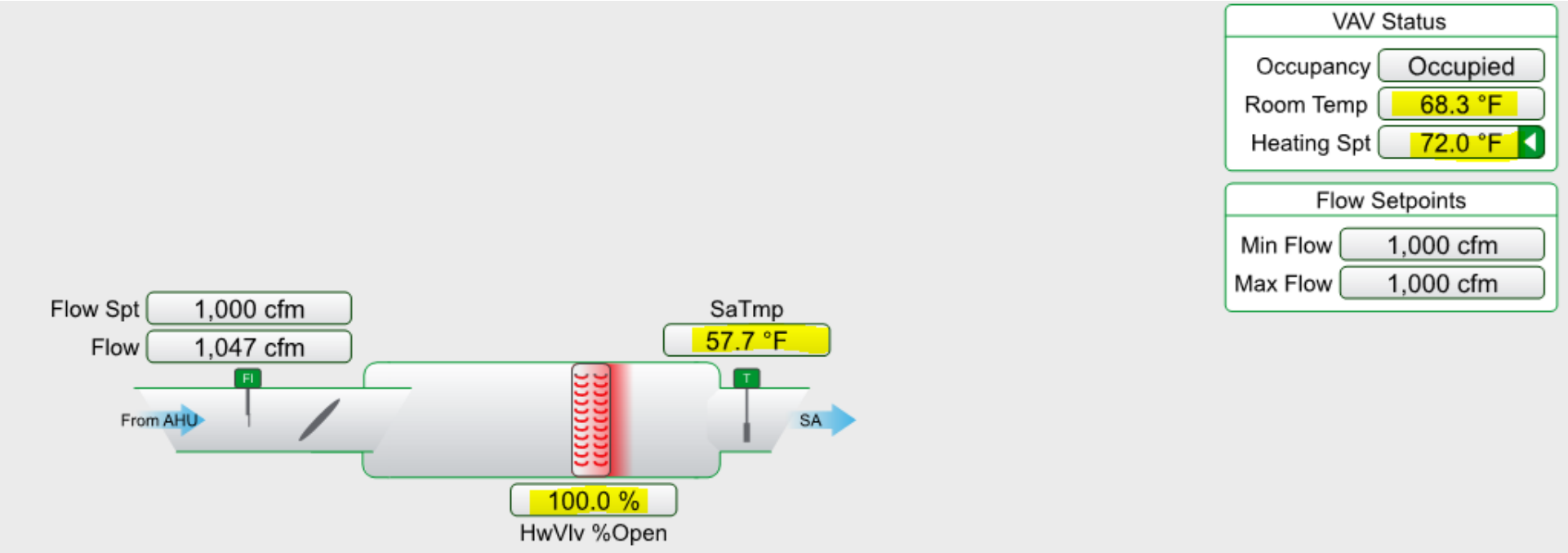
Re-Cx Example

- Cooling Valve not correct



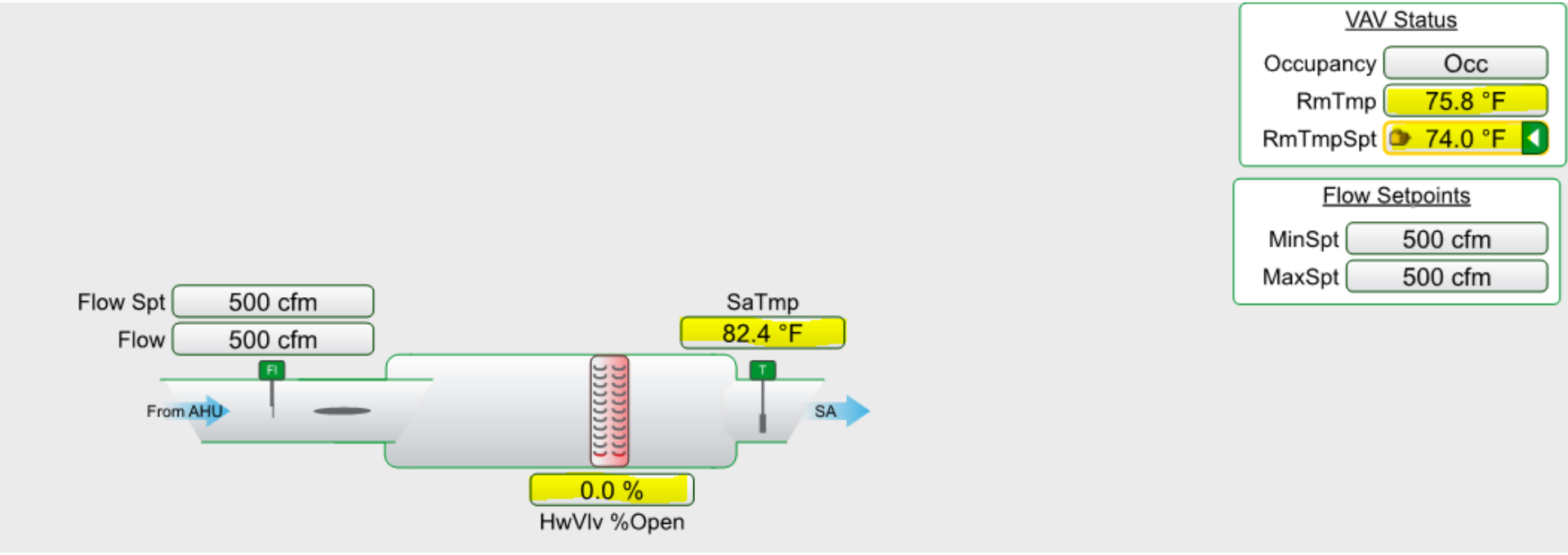
Re-Cx Examples

- Hot Water Valve on VAV Box not working Properly(Too Cold)



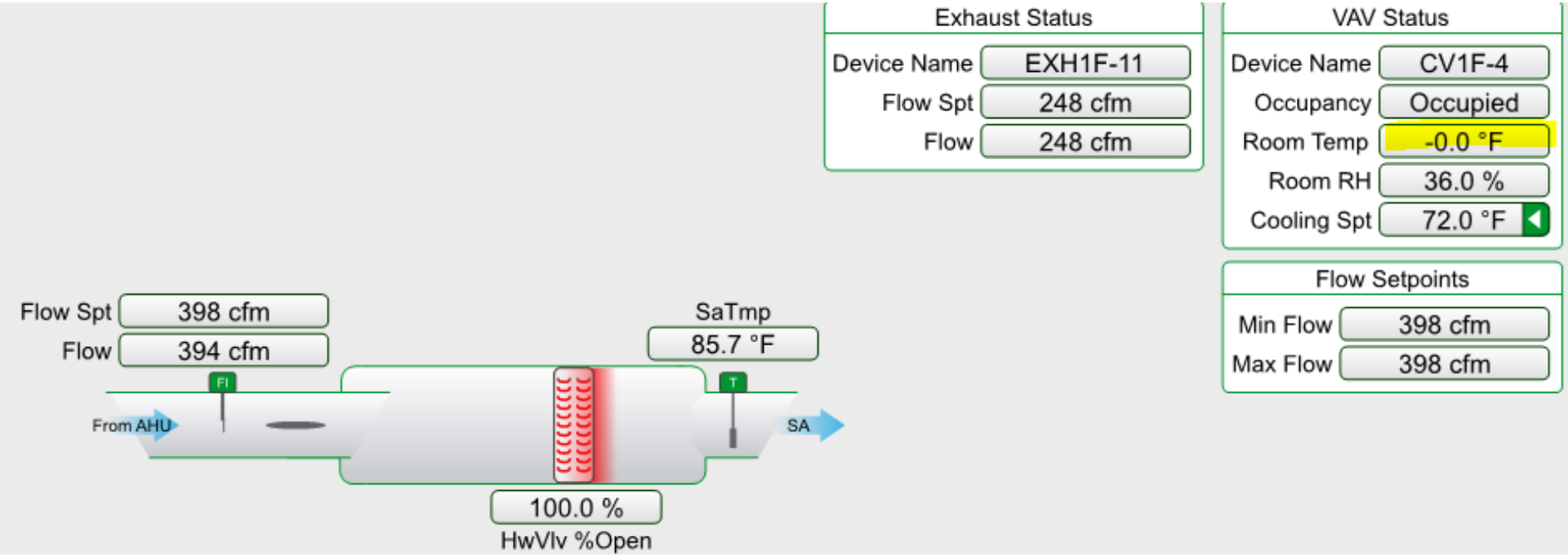
Re-Cx Example

- Hot Water Valve not working Properly on VAV Box (Too Hot)



Re-Cx Example

- Room T-Stat not working (Uncomfortably Hot)



Re-Cx Examples

- Clogged OA Damper

Re-Cx Examples

- Holes in AHU
  - Pressure concerns
  - Air Leak around coils

Examples of Re-Commissioning

- Actuator Linkage failed

Actuator Linkage failure

- AHU Condensate Drain

AHUDrainNot plumbedProperly

Moistureinpnuematic

Controllerchattering

NegativeBuilding

Re-CX Case study
Combined BAS upgrade with Cx

Bio-Tech Training & Education Center

For more information

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(919) 513-2000
btecinfo@lists.ncsu.edu

Please visit the BTEC website to learn more about its academic and professional development programs, analytical and bioprocess services, and its research activities.

Welcome to BTEC

Delivering world-class education and training, engaging in novel research, and providing custom contract services

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Biomanufacturing Training and Education Center

1000 copies of this public document were printed at a cost of 76¢ per copy.

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About BTEC

The Golden LEAF Biomanufacturing Training and Education Center (BTEC) develops skilled professionals for the growing biomanufacturing industry. BTEC also helps support and grow this important sector of North Carolina's economy through its education and training programs, its research endeavors, and the contract services it provides. BTEC —

- Is part of NC State University's College of Engineering and is located in the Centennial Campus research park
- Provides degree opportunities for both undergraduate and graduate students
- Offers a wide range of education and training courses for working professionals
- Supports clients from academia and industry by delivering bioprocess and analytical services
- Creates and participates in innovative research collaborations that aid and grow the industry

BTEC's highly qualified scientists, engineers, and operations staff carry out the center's programs in two facilities. The main building features 43,700 gross square feet of laboratory space, which includes a simulated-GMP (Good Manufacturing Practice) pilot plant, and 7,200 gross square feet devoted to classrooms. The nearby BTEC Annex offers an additional 4,000 gross square feet of laboratory space. Together, the two facilities boast more than $18 million of industry-standard equipment. The center is capable of producing biological products using cell growth and expression, recovery, and purification processes.

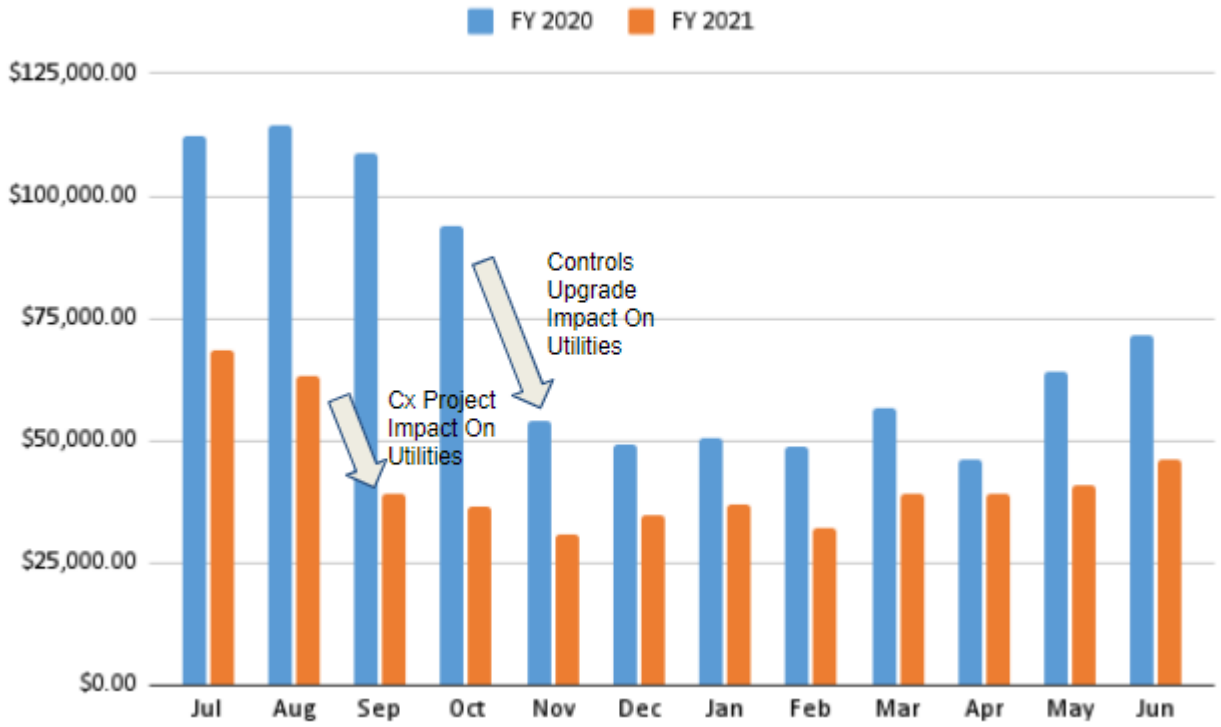
An important resource for the 700+ life science companies in North Carolina and their more than 64,000 employees, BTEC provides support and services to foster innovation and job creation. Since opening in 2007, BTEC has been helping to position the state as a leader in biomanufacturing workforce development.

Through its various academic programs and professional development opportunities, BTEC equips individuals with the knowledge and skills needed to pursue or advance a career in biomanufacturing.

Examples of Re-Commissioning

BTEC INET Upgrade to BACnet

- Upgrade started: Jun 2019
- July 2020: NCSU CX team goes behind upgrade.
- FY 2019 Total: $814,031
- FY 2020 Total: $870,327
- **FY 2021 Total: $507,237**
- **1 year savings: $363,089**
- 41% reduction within a year!



Operations Team Perspective

- Really should get involved with commissioning for new construction and major renovations
  - Project Team focused on completing task
  - Operations team focused on what happens after project ends and everyone leaves
- Collaboration for Re-Cx project
  - Include occupants, maintenance staff, EH&S
- Just identifying the issue is not enough
  - If you don’t correct the issue, then operations will not improve

Operations Team Perspective

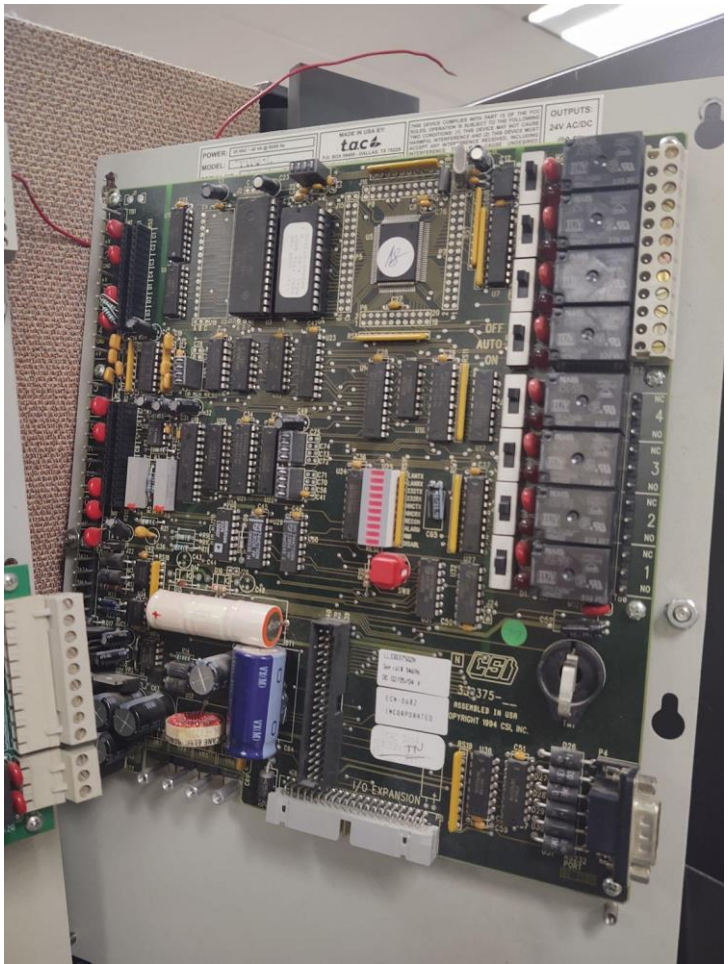
- Training staff is important
  - We all simplify things to our level of understanding
- There are simple things that can be done to improve performance/reduce costs
  - Calling it Cx/call it good maintenance
- Having a good/functioning Schedule in the BAS is one of the simplest methods to reduce Energy
- Calibration - Prioritize the AHU over the VAV box

Operations Team Perspective

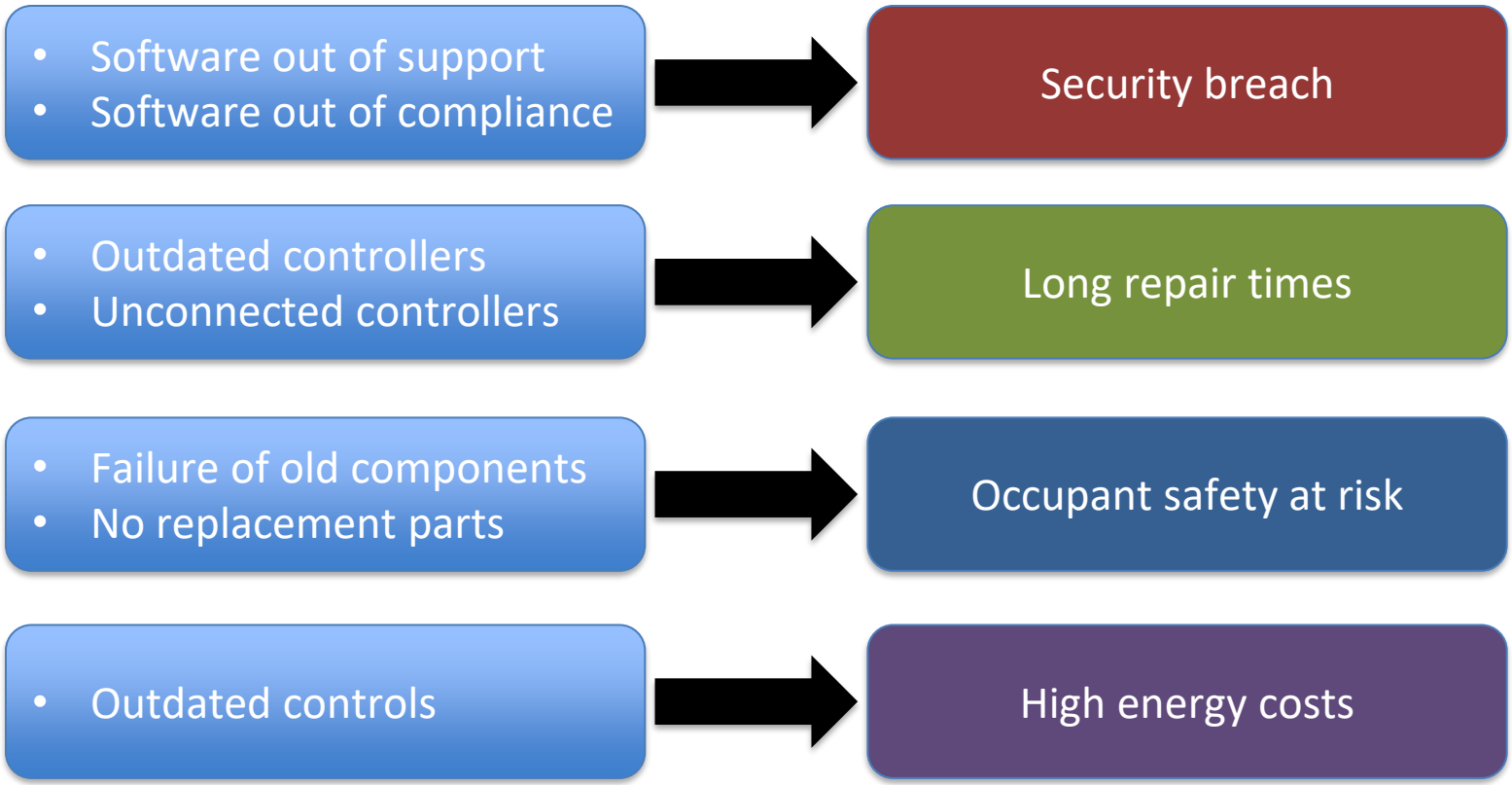
- Every Air Monitoring Station that you have is wrong (need a maintenance program)

Current Controls Challenges Concerning Campus

- How many electronic devices do you have in your house that are >20 years old???



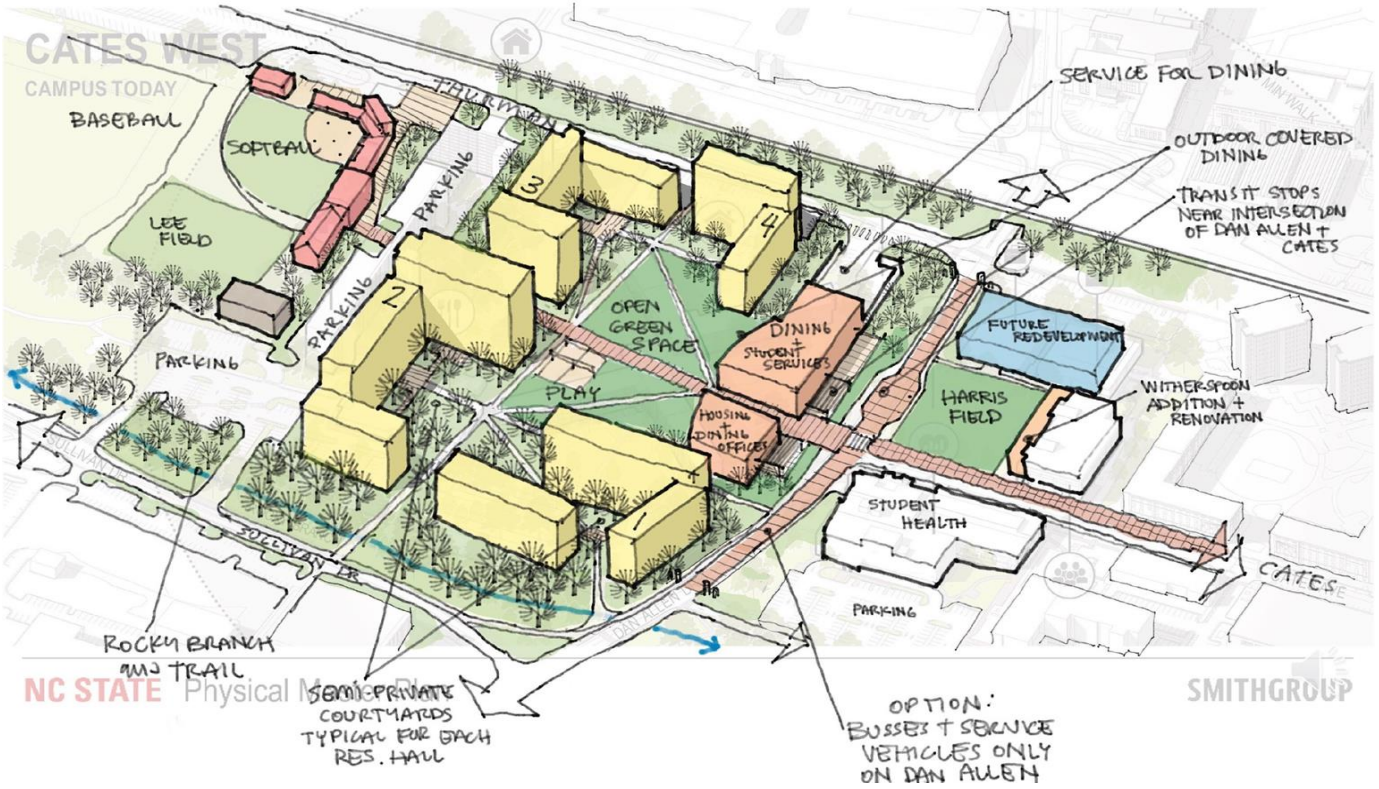
Current Controls Challenges Concerning Campus



A Method for HVAC Projects

- BAS Upgrade followed by Cx
  - BAS aging out
  - New hardware & new software
  - Complete check/correcton of System functions
- Update Sequences of Operations
  - Potentially reduce ventilation rate for labs
  - Economizer mode
    - Air-Side and/or water side
- Can combine with lighting upgrade (use one occupancy sensor for HVAC and lights)

Questions


CATES WEST
CAMPUS TODAY
BASEBALL
SOFTBALL
LEE FIELD
PARKING
PARKING
PARKING
PARKING
1
2
3
4
OPEN GREEN SPACE
PLAY
DINING + STUDENT SERVICES
HOUSING + DINING OFFICES
FUTURE REDEVELOPMENT
HARRIS FIELD
WITHERSPOON ADDITION + RENOVATION
STUDENT HEALTH
CATES
SERVICE FOR DINING
OUTDOOR COVERED DINING
TRANSIT STOPS NEAR INTERSECTION OF DAN ALLEN + CATES
ROCKY BRANCH GREENWAY TRAIL
SEMI-PRIVATE COURTYARDS TYPICAL FOR EACH RES. HALL
OPTION: BUSSES + SERVICE VEHICLES ONLY ON DAN ALLEN
NC STATE Physical Master Plan
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