



Make Your Building Sing!: Building Re-tuning to Reduce Energy Waste

September 2, 2014
3:00-4:00 PM EDT



Overview and Agenda

- Welcome and Overview
- Building Re-tuning Introduction: U.S. Department of Energy
- Re-tuning Program at Las Colinas Tower II: Parmenter Realty Partners
- Center for the Arts Building Re-tuning: Towson University
- Building Re-tuning Training Partnership: Consortium for Building Energy Efficiency (CBEI)
- Additional Resources
- Question & Answer Session

Today's Presenters

Name		Organization
Benjamin Goldstein	 A portrait of Benjamin Goldstein, a man with dark hair, wearing a dark suit, white shirt, and patterned tie, smiling.	U.S. Department of Energy
Steve Harrison	 A portrait of Steve Harrison, a man with white hair, wearing a dark suit, white shirt, and patterned tie, smiling.	Parmenter Realty Partners
Dennis Bohlayer	 A portrait of Dennis Bohlayer, a man with grey hair, wearing a dark suit, white shirt, and red tie, smiling.	Towson University
Lisa Shulock	 A portrait of Lisa Shulock, a woman with short brown hair and glasses, wearing a dark top, smiling.	Consortium for Building Energy Innovation



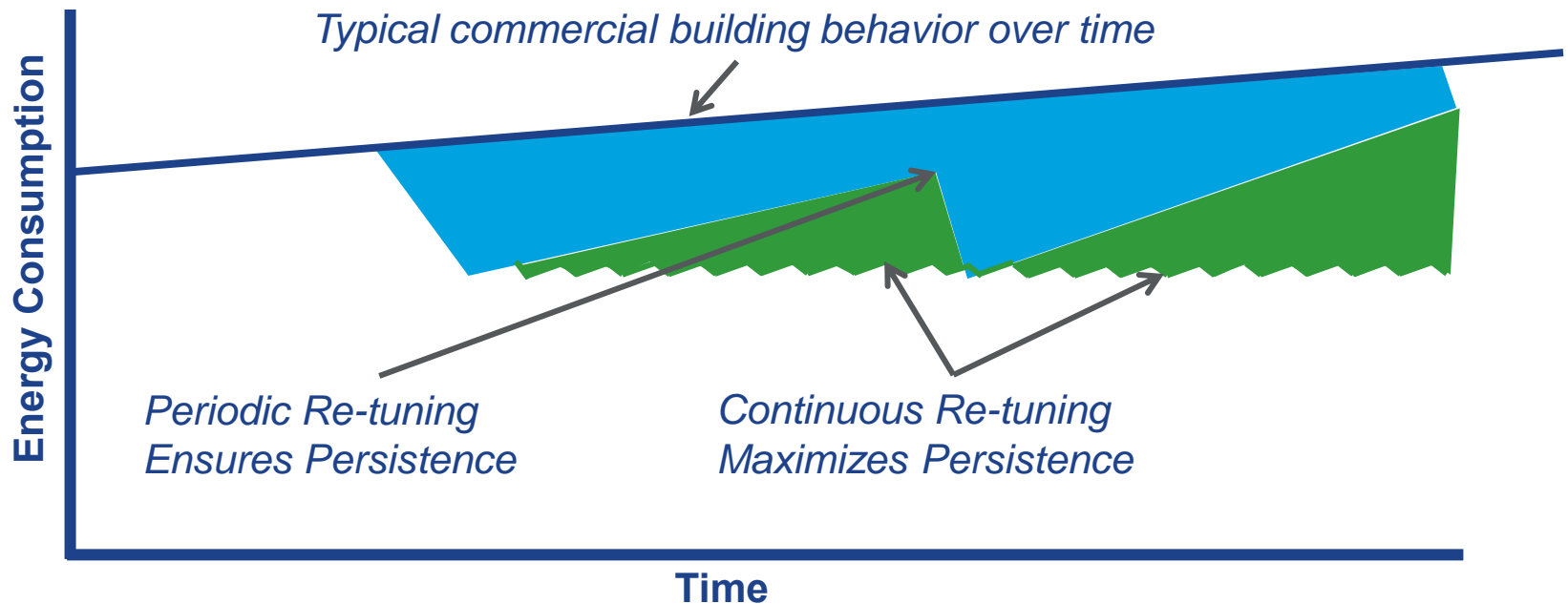
Benjamin Goldstein

Better Buildings Workforce Program

U.S. Department of Energy



Building Re-tuning: No/Low-Cost Operational Measures to Save Energy



- Building re-tuning is a systematic process to identify and correct building operational problems that lead to energy waste
- No- and low-cost savings opportunities include: replacing faulty sensors, adjusting set-points and Building Automation System (BAS) schedules, utilizing variable speed fans and economizers, insulating pipes, adding CO2 sensors, widening thermostat dead bands, and sealing building envelope leaks

How the Re-tuning Training Works

Classroom Training



Experts teach the classroom lecture portion, delving into all aspects of the re-tuning process such as efficiency in data collection, optimize AHUs, economizers, zone conditioning, central plants, meter profiles, analyze BAS graphs, and conduct building walk-downs

Building Walk-Down



Trainees thoroughly walk down the building including review of electrical/mechanical prints, envelope, roof, air handlers, plant area, and BAS front end to get an in-person understanding of building conditions, design, and operations



Steve Harrison, Managing Director of Facilities and Sustainability

Parmenter Realty Partners

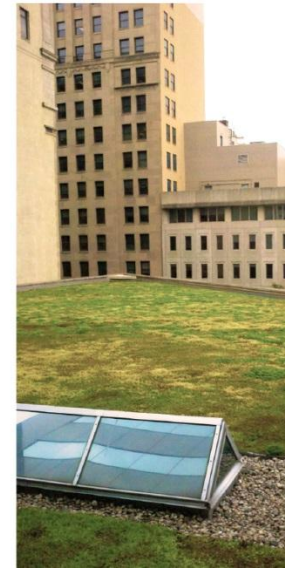


Parmenter**GREEN**

HIGH PERFORMANCE BUILDINGS



RE-TUNING PROGRAM AT LAS COLINAS TOWER II



CELEBRATING 25 YEARS
OF EXCELLENCE

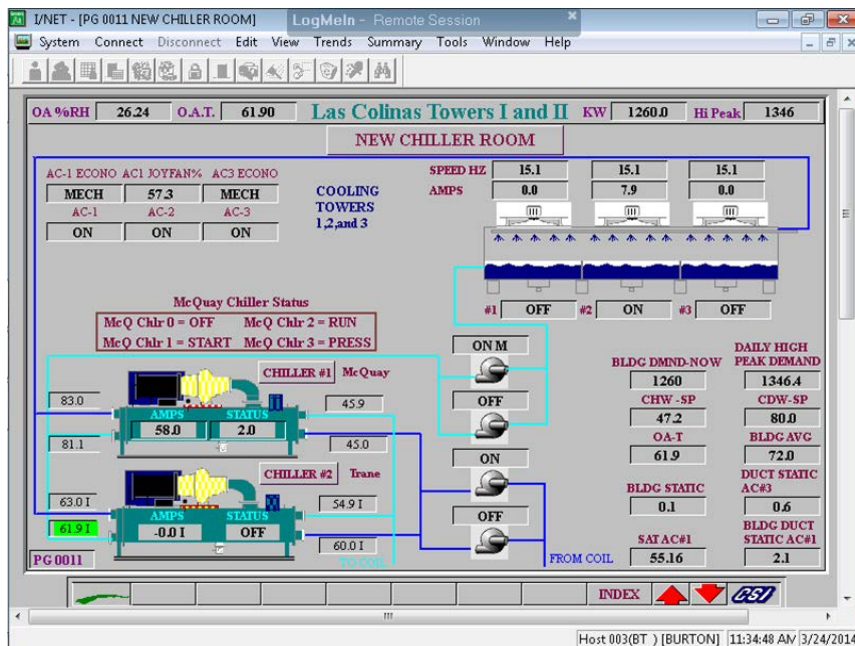
RE-TUNING PROGRAM AT LAS COLINAS TOWER II

- Parmenter Realty Partners
 - Own and operate buildings throughout the Southeast region
 - Value add business model: purchase underperforming buildings and turn them around
 - ParmenterGREEN division focuses on every aspect of sustainability, energy performance
- Why Re-Tuning program was right for us
 - Focus on low and no cost solutions
 - Had one property consistently underperforming
 - Struggled with staffing at this property



RE-TUNING PROGRAM AT LAS COLINAS TOWER II

- Our Preparations
 - Identified Las Colinas Towers II as primary target
 - Start trending a list of 200 recommended points
 - Gave PNNL team remote access to BAS
 - First indication of a problem – trying to grant access
 - EMS wasn't set up to trend yet – turned out to be a company-wide problem
 - Made Las Colinas Towers an open book, access to all records, let them see all the warts



RE-TUNING PROGRAM AT LAS COLINAS TOWER II



- Our Training Days
 - Gathered Parmenter Engineers from all over Texas to participate
 - Classroom session
 - Live BAS review
 - Examined trends in detail
 - Walk down of interior and exterior spaces, roof, central plant
 - Very low temperatures on the walk down day 30 degrees, gave us the opportunity to watch lack of economizer function, saw stack effect in action
 - Review of mechanical plans
 - Equipment: Infrared scanner and temperature gun
 - Air infiltration
 - Surface temperatures
 - First experience with opening up operations to outside entities non-vendors – showed commonalities with other building engineers
 - City of Dallas
 - JC Pennys
 - Open communication leads to healthier dialogue & education



RE-TUNING PROGRAM AT LAS COLINAS TOWER II

- What we found
 - Not having a qualified Chief Engineer is a huge handicap
 - Education for Owners and Asset Managers, highly trained staff is worth the investment
 - Junior engineers were chasing their tails, did not have enough experience to draw larger conclusions/big picture, only able to deal with one problem in front of them
 - Improperly positioned or not calibrated sensors (OA) significantly impact EMS operations – became very evident
 - Onsite engineer needs to have EMS programming working knowledge
 - Needs to be able to direct vendor rather than depend on the vendor
 - PRP has stepped up EMS training for all Engineer levels
 - Sparked conversation about original design intent (sometimes from the 80s) vs. modern technology and new systems
 - Let's make what's there work properly
 - Original design intent in office buildings needs to be really understood before you can upgrade systems
 - Vendors often try to push sales and don't focus on making existing system work better
 - Need to have a mechanical engineer they trust to guide through retrofit options

RE-TUNING PROGRAM AT LAS COLINAS TOWER II

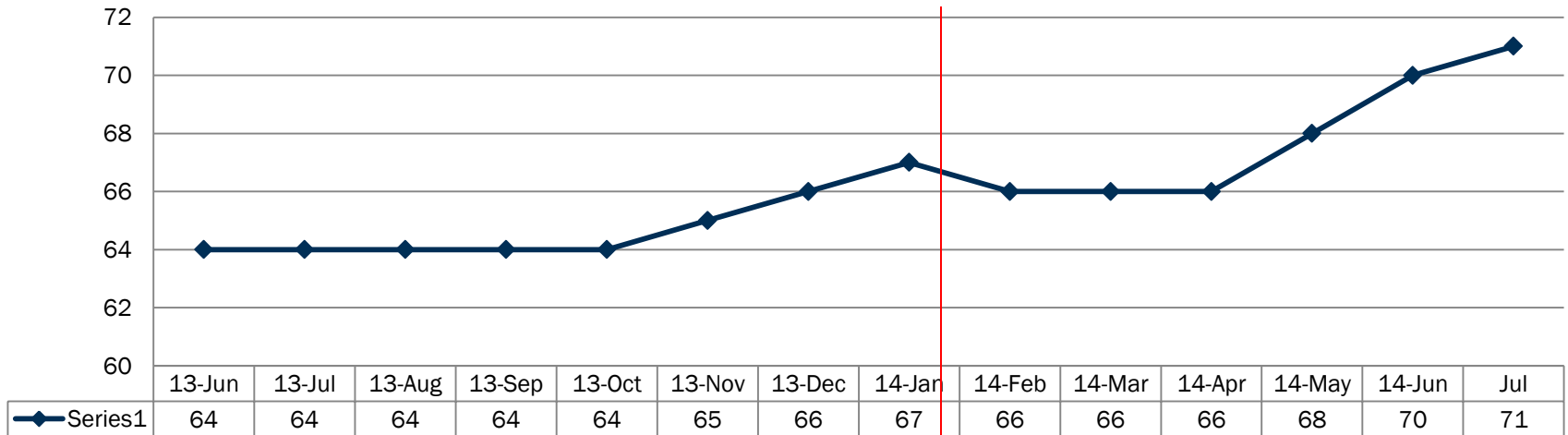
- The results
 - Process engaged us in more in depth investigation of the systems at the building (can of worms)
 - Really engaged us in the building and all aspects of the operations
 - Prioritized hiring a qualified Chief Engineer
 - Called a meeting to review the issues brought up from re-tuning
 - An army of vendors
 - Mechanical Engineers
 - Asked everyone to identify issues that fell into their scope from a list we provided to them
 - 3-4 days, testing all systems
 - Vendors came back with a list of repairs, and also list of systems that were working correctly



RE-TUNING PROGRAM AT LAS COLINAS TOWER II

- Improvements
 - ENERGY STAR score trending up
 - Consumption improved by at least 10% every month compared to previous year
 - Tenant HVAC complaints have dropped

Las Colinas Tower II ENERGY STAR score



Dennis Bohlayer
Director, Energy Engineering and Conservation

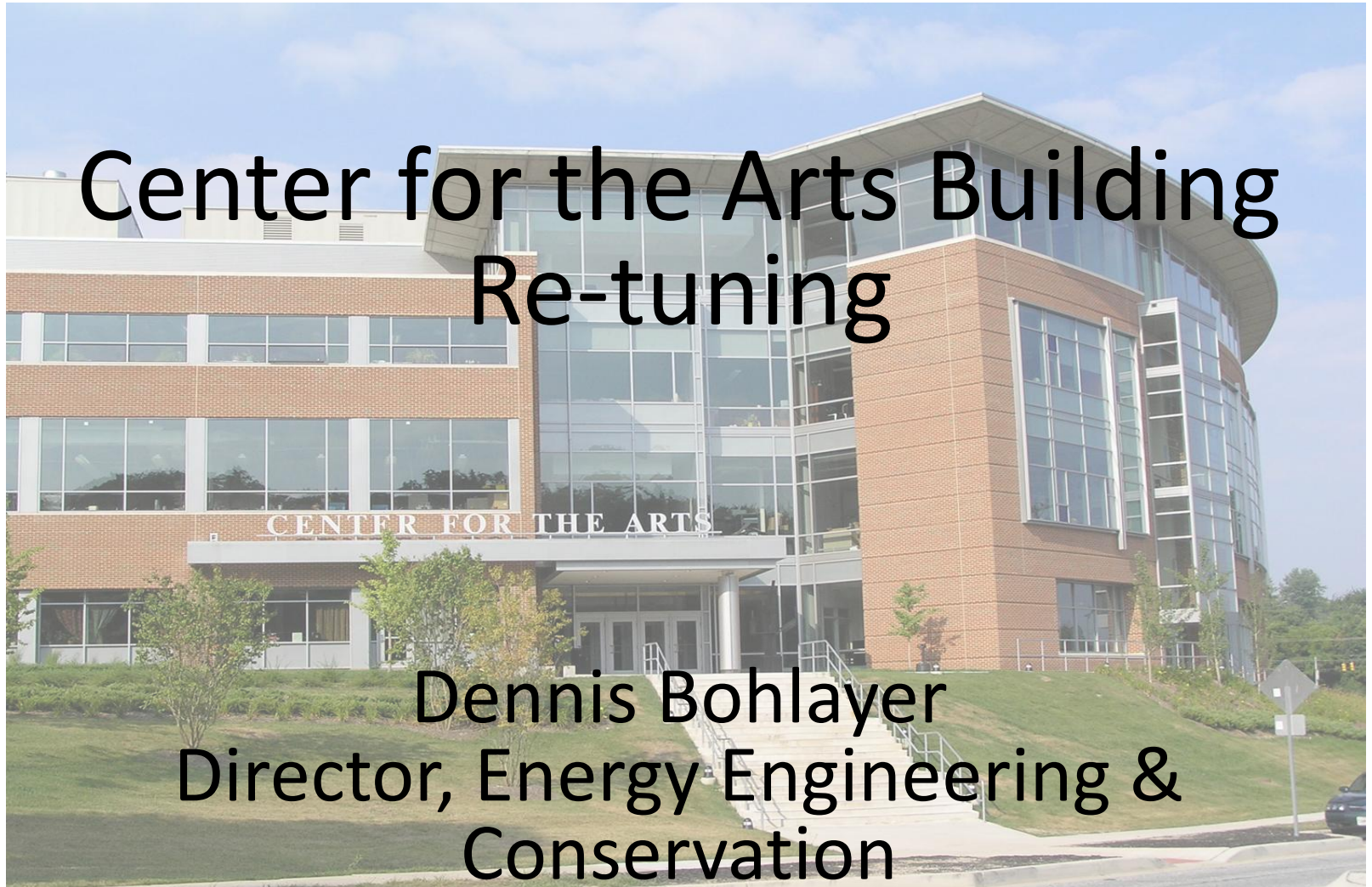
Towson University





Center for the Arts Building Re-tuning

Dennis Bohlayer
Director, Energy Engineering &
Conservation



Towson University Utilities

Fiscal Year 2014

Campus building square footage: 5.6 million

Electricity

- 77 million kilowatt-hours consumed
- \$8.5 million

Natural Gas

- 2,200,000 therms consumed
- \$1.7 million

Water/Sewerage

- \$1 million

State of Maryland Mandates

- Energy Reduction—15% reduction by end of 2015 based on 2007 baseline
- Renewable Energy—20% of Maryland energy from renewable sources by 2022 (2% solar)
- Climate Action—reduce green house gas emissions 25% by 2020 based on 2006 baseline

Towson University Commitments

- American College & University Presidents' Climate Commitment (signed 2007)
- U.S. Dept. of Energy's Better Buildings Challenge—reduce energy/square foot 20% by 2023 from a 2010 baseline (signed 2013)

Building Re-tuning Training

- Held June 17-18, 2014 at Towson University
- 25 State Agency Building Operators
- 1st Day Classroom
 - Re-tuning Basics
 - Introduction of Energy Charting and Metrics (ECAM) Tool—Microsoft Excel add-on
 - Controls Analysis of Selected Building
- 2nd Day Field Work
 - Building walk-down of Selected Building



Center for the Arts

300,850 Gross Square Feet

Original construction – completed 1972

Additions/Renovation – completed 2006



EXIT

2000 - 2000
2000 - 2000
2000 - 2000



← 1001 - 1012
Restrooms & Elevator ↑
↑ 2000 - 4000





Building HVAC Equipment

- 19 Rooftop and Penthouse Air Handling Units
- AHUs ranging from 2,000 to 48,000 CFM; 14 are 10,000 CFM and higher
- AHU-16/16E – 48,000 CFM 100% Outside Air
- 3 chillers – 1-500 ton and 2-250 ton
- 2 boilers – 10,000 MBH each
- 16 humidifiers
- 17 pumps (excl. preheat circulation pumps)
- About 300 supply air terminal units

Reasons for selection of Center for the Arts as our re-tuning class “patient” ?

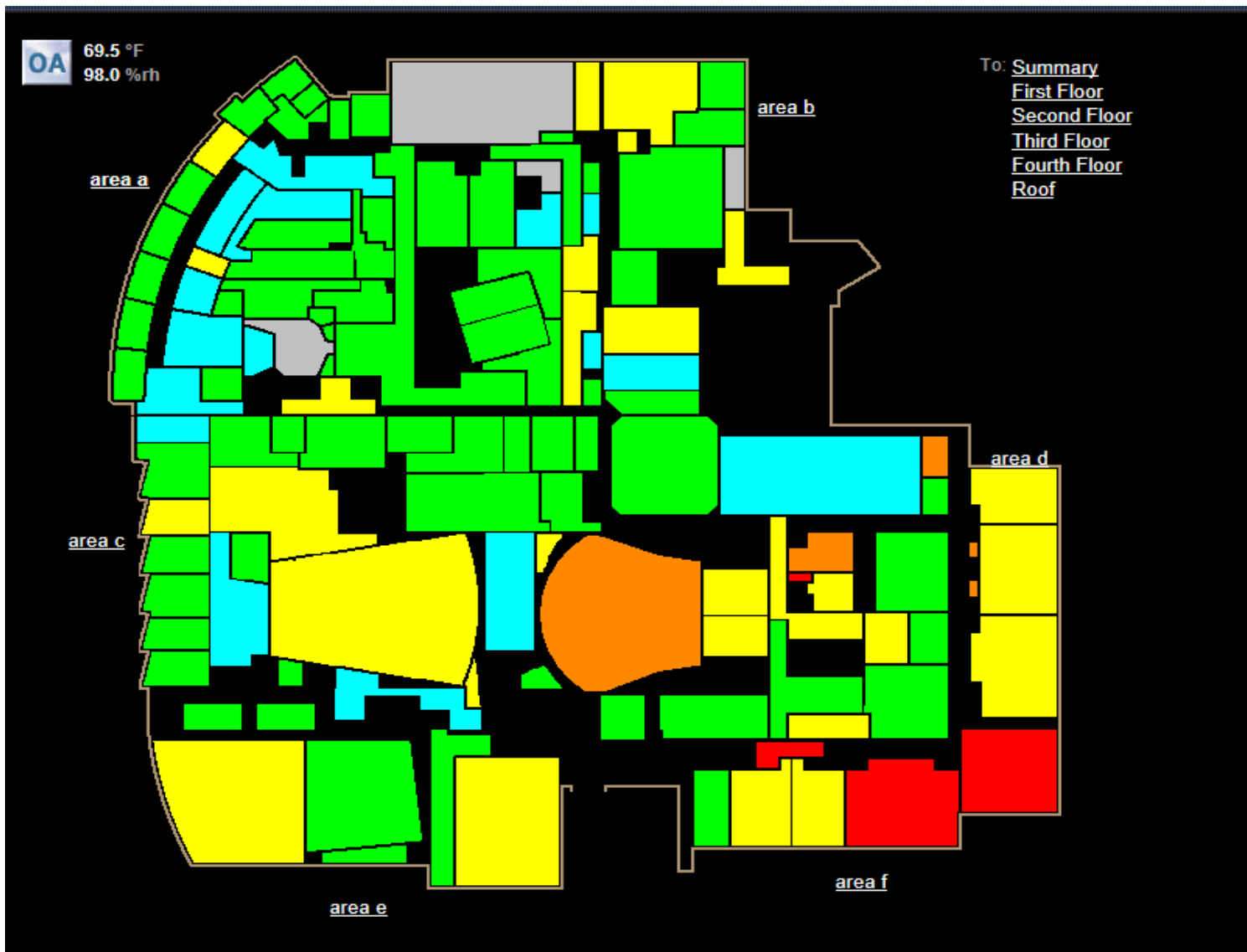
- HVAC Supervisor: “We’ll probably find some things there.”
- Large, complex building with large AHUs serving wide variation of spaces
- Diverse functions, e.g., dance studios, music practice rooms, & faculty offices, all on same AHU.
- Known comfort and special equipment issues
- Known design-related issues from 2006 construction
- Known high value energy conservation opportunities
- My thought: “Start with something hard and everything later will seem easy.”

Things in our favor for re-tuning

- In-house controls expertise – HVAC supervisor and 1 experienced controls technician
- Excellent Building Automation System (BAS) with Automated Logic's WebCTRL
- Real-time metered utilities through BAS
- University leadership commitment to energy conservation through BBC and PCC

Automated Logic's WebCTRL

- Web-based
- Excellent graphics
- User friendly with graphical function block programming logic
- Graphical trending capability
- Time-lapse tool for reviewing building/equipment behavior for past 24 hours

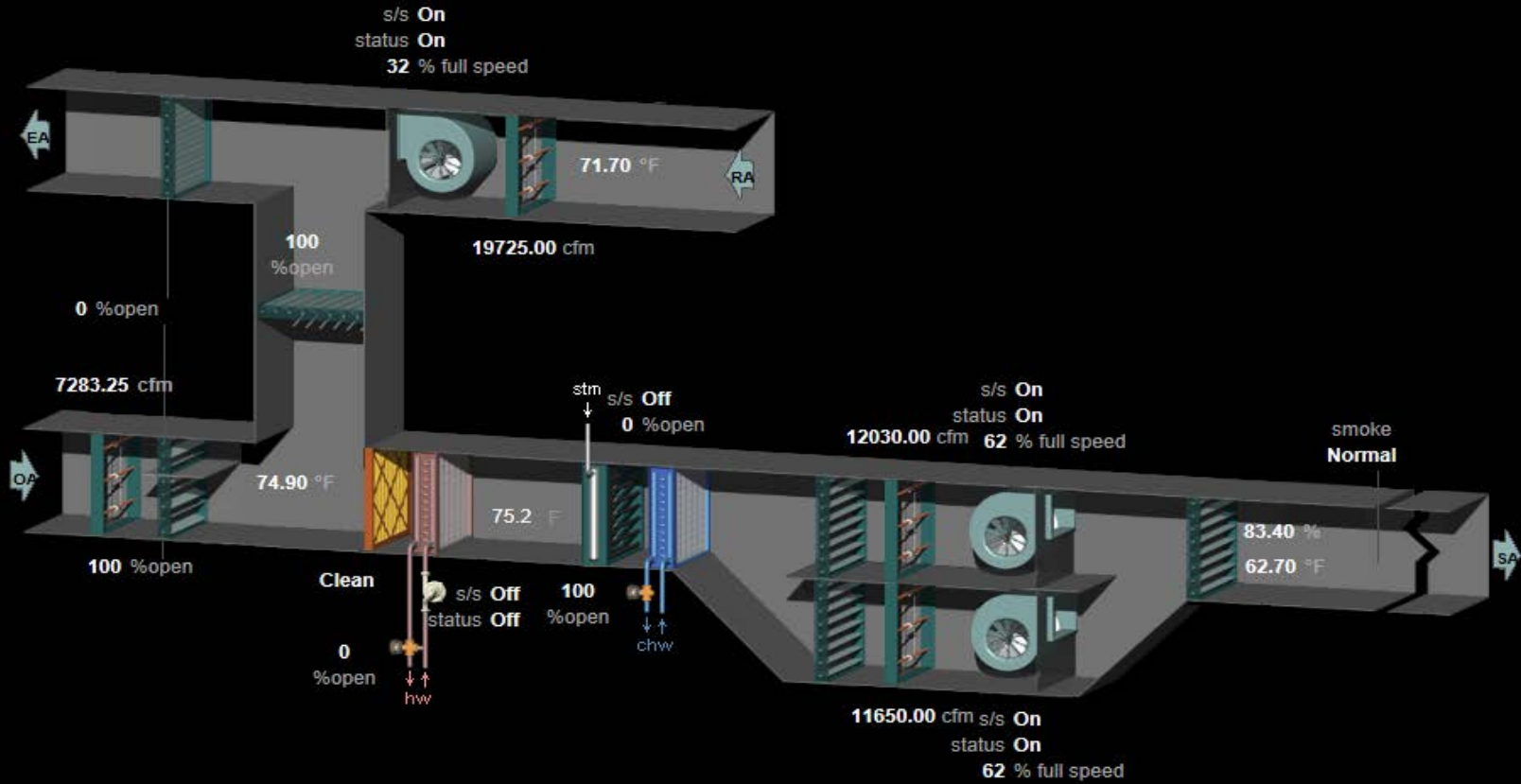


Automated Logic Screenshot—Center for the Arts 3rd Floor

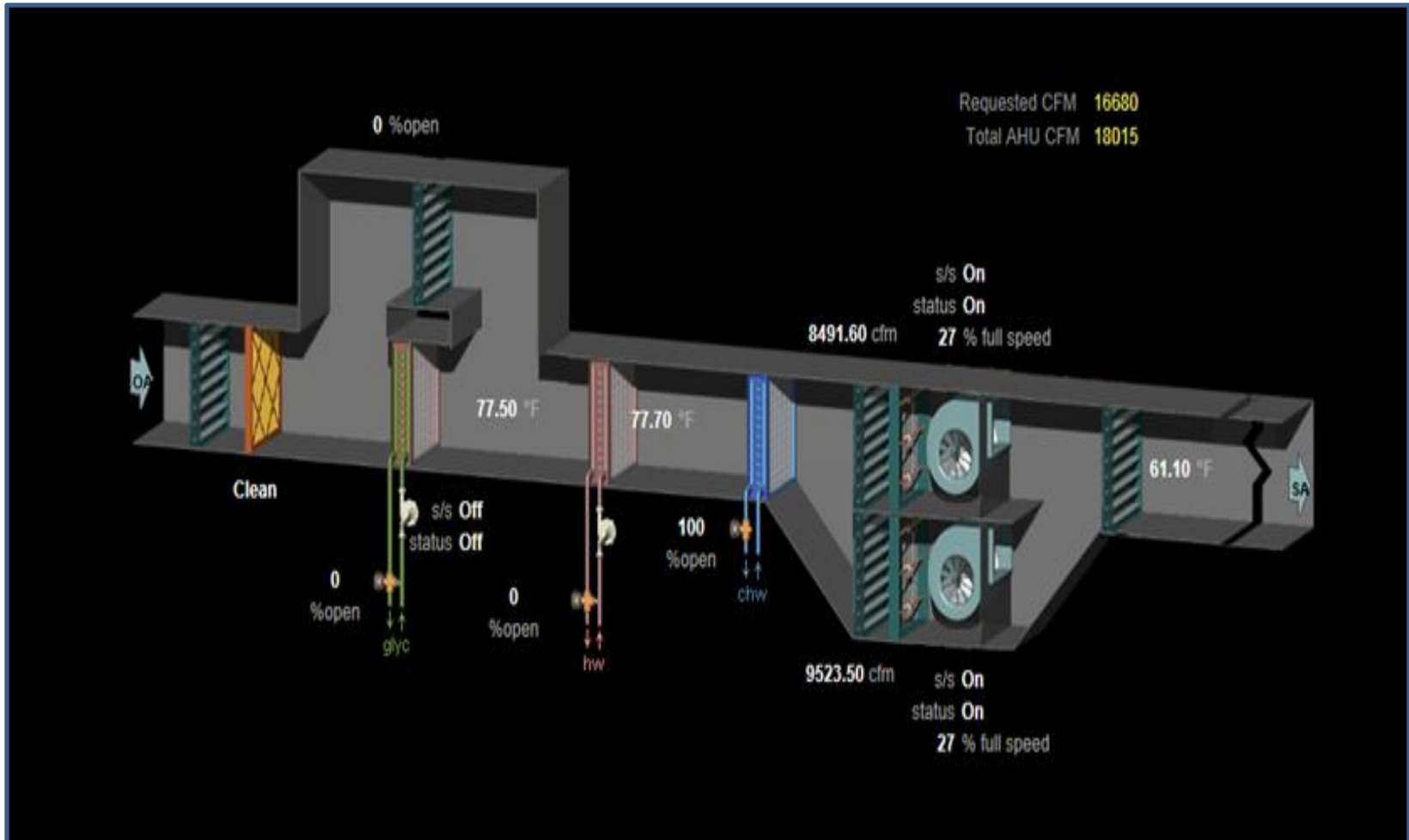
OA

AHU 18

71.0 °F
2.0 %rh



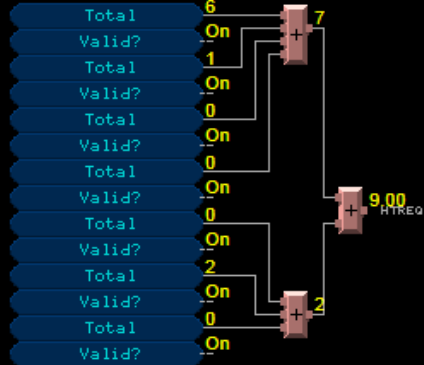
Air Handling Unit 18 – 43,000 CFM



Air Handling Unit 16 -- 48,000 CFM 100% Outside Air
 (16E is companion exhaust fan)

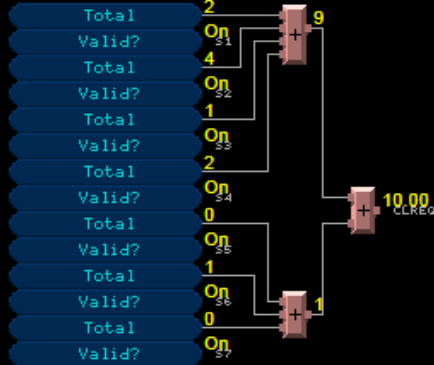
Run Conditions

Zones requiring heating



HTREQ = 9 AV Zones requiring heating
 HTREQ = T: Ht Req

Zones requiring cooling



CLREQ = 10 AV Zones requiring cooling
 CLREQ = T: Cl Req

Any zones occupied?



BN1 Occupancy Over Off OVER
 OCC = Yes BV Any zone occupied?
 OCC = T: Occ Mode
 FOR = 7.78 AV Run for at least ____ minutes.
 FOR = T: Run Time

Run When ...

Run when ...

1. Any zone is occupied by schedule or override.

2. Or when > 15 zones require heating
 or when > 15 zones require cooling
 When zones unoccupied.

Unoccupied runtime: Run for ____ minutes

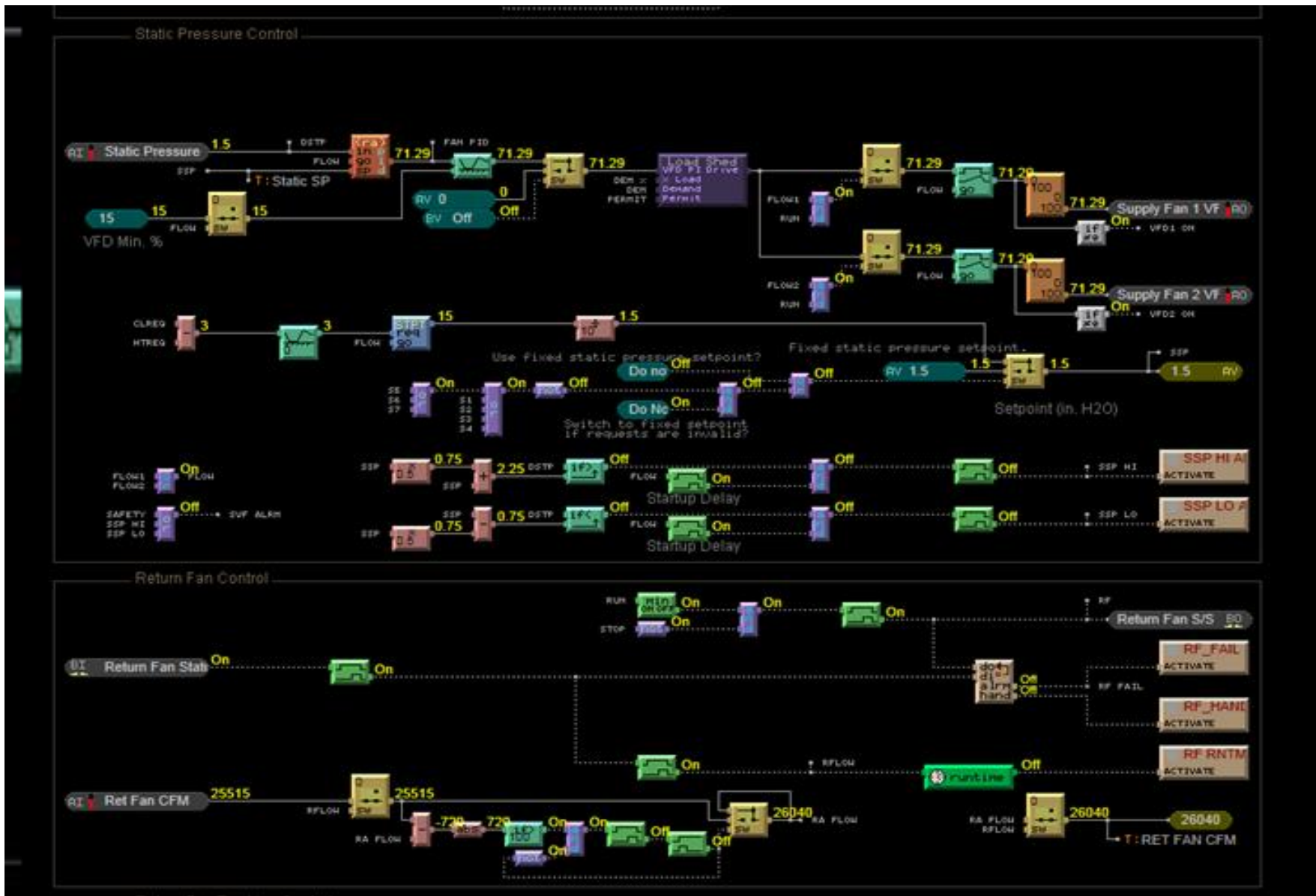


OCC On Yes BV
 FLOH On
 BV In Aut Off
 BV Off Off
 Locked State Equipment H-O-A

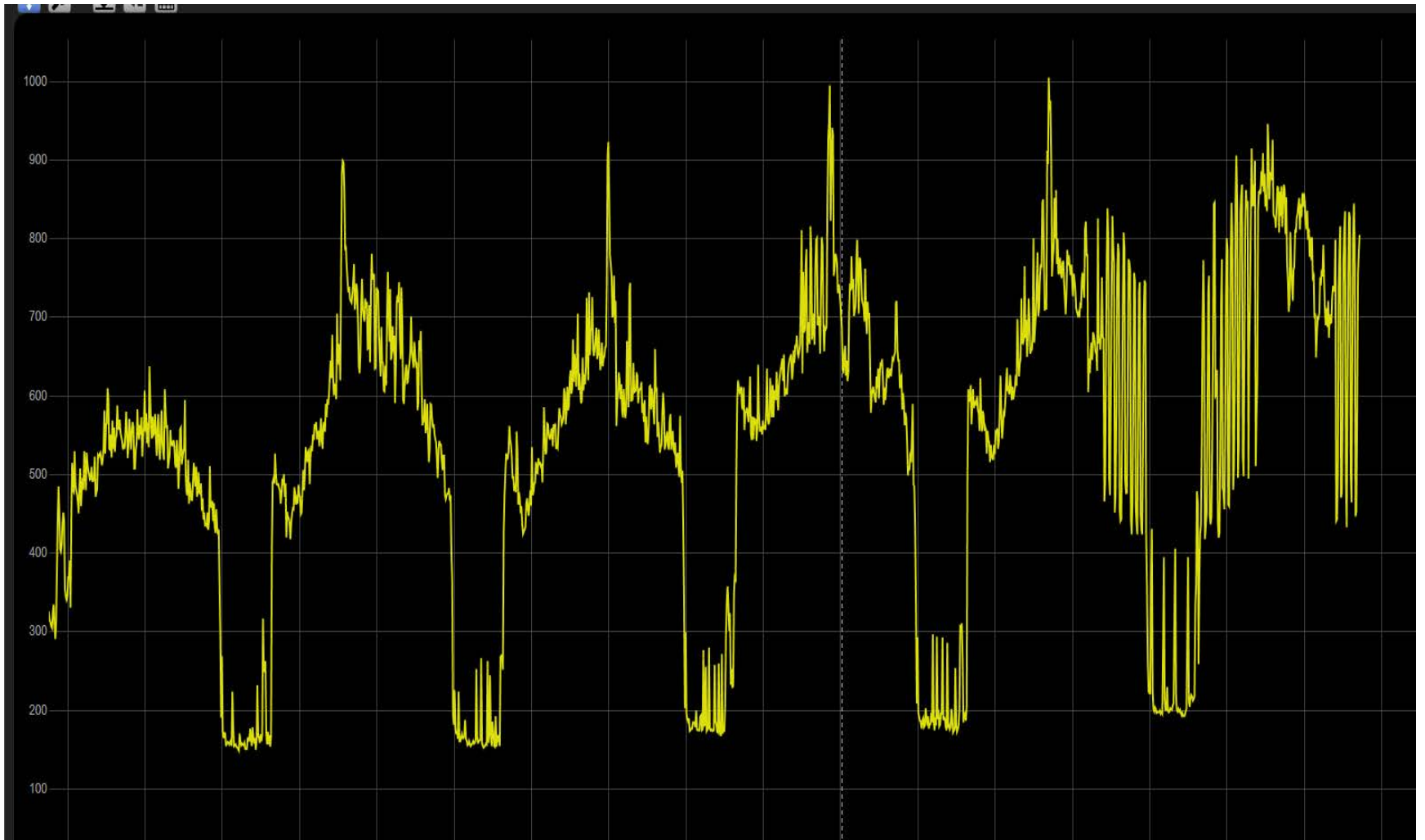
Outside Air Temperature and Equipment Alarm Status



Typical Automated Logic's Graphical Programming Logic Page



Typical Automated Logic's Graphical Programming Logic Page



Center for the Arts Electrical Demand
Saturday, August 17 to Thursday, August 21



Center for the Arts Electrical kWh
Month of July 2014

Building Walk-down Observations

- Open windows and skylights
- Exterior light fixtures on during daytime
- Hundreds of lighting fixtures in large halls and lobbies not on occupancy sensors or controls
- Daylighting and light dimming control opportunities abound
- Lighting retrofit opportunities, e.g., halogen to LED, etc.

Building Walk-down Observations, con't

- HVAC
 - Empty classrooms, theatres, concert halls, etc. with temperatures of 68-69 degrees
 - Building occupancy schedule unchanged from spring academic semester (6:30 a.m to 11:30 p.m.) though we were in summer mode.

Building Walk-down Observations, con't

- Building Chilled Water and Heating Plant
 - Though VFD-driven, chilled water pumps were being throttled by isolation valves at 50% open (continuous pressure drop on pumps)
 - Boilers operating with leaving water temperatures of 170 degrees F during summer.
 - Heating loop differential pressure too high causing hot water valves to be pushed off their seats and leaking through hot water coils

Building Re-Tuning Report

- Energy Conservation Measures (ECMs) classified as to “Effort” and “Potential Savings”
- “Effort” and “Potential Savings” broken down into “Low-Medium-High” sub-classifications
- Definitions of each provided in report, e.g.,
 - Low effort—a few hours
 - High savings—20-30% at system/component level

Center for the Arts Re-Tuning Report

HVAC ECMs (19 total)

POTENTIAL SAVINGS				
Low	Medium	High		
*	*	*	High	EFFORT
*	7	1	Medium	
*	2	9	Low	

Center for the Arts Report, con't

- Envelope ECMs (3)
 - 2 “Low Effort” with “Low Potential Savings”
 - 1 “Medium Effort” with “Low Potential Savings”
- Lighting ECMs (4)
 - 1 “Low Effort” with “High Potential Savings”
 - 2 “Medium Effort” with “High Potential Savings”
 - 1 “High Effort” with “Medium Potential Savings”

#1 Opportunity Uncovered



HVAC Scheduling!!

Building was still operating in normal spring/fall academic schedule of 6:30 a.m. to 11:00 p.m. Sunday through Saturday!

A Roundup of the Usual Suspects

- Meeting held with multiple levels of Facilities Department leadership and building operators
- Force field diagram used as facilitation tool (next slide)
- Revelations:
 - Keeping academic year scheduling was intentional
 - Building equipment, zones served, and controls not well understood
 - Design-related issues from 2006 project still exist
 - Widespread fear of upsetting occupants and adversely affecting pianos, organs, art gallery artwork in making any changes
 - Confusion as to who should make BAS scheduling changes and what setpoints and schedule should be
- Outcomes:
 - No leadership direction (other than be careful if you do anything)
 - HVAC Shop Supervisor (by default) was appointed building scheduler
 - Implemented a 4th of July holiday schedule (Friday through Sunday)

FORCE FIELD ANALYSIS

HVAC AND LIGHTING SCHEDULING THROUGH AUTOMATED LOGIC BUILDING AUTOMATION SYSTEM (BAS)

<p>CURRENT STATE:</p> <p>Buildings are being left unscheduled as to occupied or unoccupied state consistent with use.</p>	<p>DESIRED STATE:</p> <p>A sustainable process whereby buildings are scheduled consistent with occupancy and use.</p>
<u>DRIVING FORCES</u>	<u>RESTRAINING FORCES</u>
Facilities Management professionalism—doing the right thing	Facilities Management Leadership
Stewardship of university resources (\$, equipment wear/tear, maintenance labor/materials, etc.)	Question/confusion as to who should implement schedules. And if it should be a centralized vs. decentralized role(s). And where authority should come from.
University 2020 Plan	VPs/Deans/Building Coordinators concerned about impact and upsets.
President’s Climate Commitment	Building occupants
Constrained energy budget	Knowledge of building HVAC and lighting systems, i.e., what AHU feeds what area/zone.
University Commitment to Better Buildings Challenge	Knowledge of scheduling function within Automated Logic software
	Knowledge of building functions and schedule
	Fear of incurring occupant wrath if mistakes are made.
	Specialized equipment requiring special environmental conditions.
	Time/effort to keep pace with building functions and schedule and to implement same within ALC.



Center for the Arts Electrical kWh
Month of July 2014

Things not in our favor for re-tuning

- With respect to scheduling and setpoint changes:
 - Fear!!
 - Fear of upsetting occupants
 - Fear of adversely affecting special equipment, e.g., organs, pianos, percussion, artwork
 - Uncertainty as to what environmental requirements really should be
 - Organizational confusion as to who is responsible or empowered to do what
 - Uncertainty as to leadership backing our conservation measures vs. occupant “requirements”

...things not in our favor, continued....

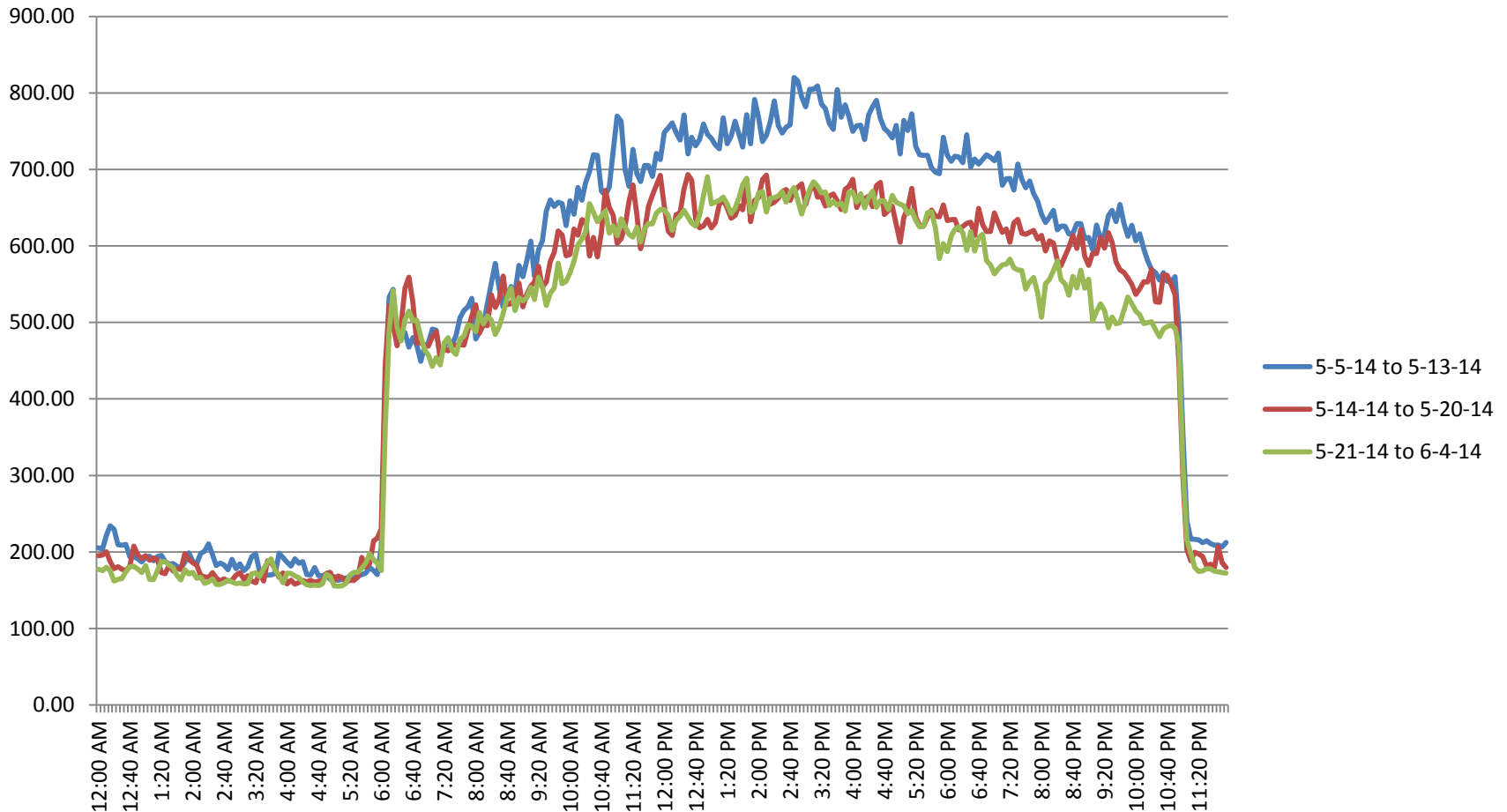
- With respect to systems, equipment, etc.
 - Not enough eyes on controls data, i.e., drinking from firehose
 - Lack of focused effort on walk-downs of buildings, controls monitoring and analytics, and ECM implementation
 - Not enough technical resources to implement corrective controls measures

Actions since Re-tuning Training

- Reprogrammed 6 single zone AHUs and 2 small multi-zone AHUs
 - Done to gain better operational performance of the hot water, chilled water, economizer cycles, humidity control and CO2 control (where applicable)
- Restored many of the zone heating and cooling setpoints to the original settings (70/74 degrees respectively) Setpoints had been changed by building operators (?)
- Began using ECAM for building analysis

ECAM Graph of Average Daily Electrical Demand at Center for the Arts

Periods of time before, during, and after Final Exams



Benefits of Re-tuning Training

- Focused search for the simple, obvious things
- Focused review and analysis of HVAC controls, finding little effort opportunities which have high value benefits
- Awareness of the ECAM analytical tool:
<http://buildingretuning.pnnl.gov/ecam.stm>
- Provided that stimulus needed to move forward and overcome “at rest” inertia, i.e., how to you eat an elephant? ..one bite at a time.

Some Lessons Learned (Thus Far)

- Plenty to see just by walking the building – chances are you will be surprised!
- Collect data and work off the facts, especially if occupant engagement is necessary. Do your research. Remember you are dealing mainly with perceptions.
- Realize that there will always be a percentage not comfortable (review ASHRAE Standard 55-2010)
- Make setpoint adjustments gradually
- The initial re-tuning task can seem overwhelming—establish a game plan with specific tasks and milestones and celebrate progress one step at a time.

Contact

Dennis Bohlayer

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Facilities Management

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(Center for the Arts re-tuning report available upon request)



Lisa Shulock
Research Project Manager

Pennsylvania State University
Consortium for Building Energy Efficiency

Building Re-Tuning Training Partnership

BOMA International

The Consortium for Building Energy Innovation
DOE, Building Technology Office

Presented by Lisa Shulock, CBEI



**CONSORTIUM for
BUILDING ENERGY
INNOVATION**



Consortium for Building Energy Innovation (CBEI)

Mission

To transform the energy efficiency market for existing small- and medium-sized commercial buildings

Vision

Be recognized as the leader in creating vibrant ecosystems to identify and apply integrative technologies and innovative practices in existing buildings

Goals

1

Develop market-tested pathways to 50% energy reduction in existing buildings

2

Demonstrate and deploy solutions at a regional scale to push out nationally

3

Accelerate adoption of energy efficient retrofit solutions at the national scale

*Funded by the Department of Energy, Buildings Technology Office
Located in the Philadelphia Navy Yard*

Context/Background

- ▶ DOE funded Pacific Northwest National Lab (PNNL) to develop curriculum for Building Re-Tuning Training
 - First for large buildings with BAS
 - Followed by training for small-medium size buildings without BAS
- ▶ CBEI received funding from NIST MEP (DOE funds) (along with 2 other MEP centers) to pilot the curriculum
- ▶ We have focused on small-mid sized buildings without BAS
- ▶ To date, we've trained 114 people and done “walk-downs” of 32 buildings
 - Commercial, Schools, Government, Industrial



Next Phase of Work – Partnership with BOMA International

- ▶ Prepare for large-scale dissemination of Building Re-Tuning Training
 - Develop & pilot Train-the-Trainer model
 - Focus first on commercial buildings without BAS
 - CBEI: curriculum development; create online learning management system; create guide for BOMA for delivering BRT
 - BOMA: focus on deployment through network of local associations

Next Phase of Work – Partnership with BOMA International

- ▶ Long-term goal of the BOMA roll-out: re-tuning training course available for any and all local BOMA associations to offer to their members
- ▶ Two BOMA associations have been selected to pilot the train-the-trainer model
 - BOMA Wisconsin (Milwaukee) in October 2014
 - BOMA San Diego in February 2015
- ▶ If interested in attending either of these sessions, contact
 - Scott Morris Smorris@boma.org or
 - Lisa Shulock Lshulock@engr.psu.edu

Additional Resources

Re-tuning Resources Online and More in Development

Re-Tuning Resources on CBRD and PNNL websites

Interested parties can visit the Commercial Buildings Resource Database (CBRD) for free Re-tuning Resources such as:

- Re-tuning Training: Instructors Manual
- Large Building Re-tuning Training
- Small Building Re-tuning Training
- ECAM Tool User's Guide & Interval Data Analysis
- Primer on Building Systems for Re-tuning Training
- Case Study: Vornado
- Coming soon: Additional case studies

Free Online Re-Tuning Training Available

PNNL offers two free interactive Re-tuning e-learning courses to anyone interested in improving a building's energy performance and the comfort of the building's occupants

(<http://retuningtraining.labworks.org/training/lms/>)

- *Re-tuning for Building with Building Automation Systems* (CEUs available from the Building Operator Certification Program)
- *Re-tuning for Buildings without Building Automation Systems*

DOE Commercial Buildings Resource Database (CBRD)

CBRD: Resources to support the adoption of energy-saving building technologies

The screenshot displays the DOE Commercial Buildings Resource Database (CBRD) search interface. At the top, the U.S. Department of Energy logo and navigation links are visible. The main heading is "Commercial Buildings Resource Database". Below this, the search results for the term "retuning" are shown, indicating 30 resources found. The search filter "resource type" is active, and "retuning" is highlighted in a blue circle. The results list three presentations related to large building re-tuning training.

Resource Type	Title	Description	Actions
Presentation	Large Building Re-Tuning Training: Re-Tune Based on Findings	Re-tune the building based on specific findings. Building re-tuning maxims, assumptions, and conclusions.	Download Read more
Presentation	Large Building Re-Tuning Training: Introduction	Understand the purpose of re-tuning, definition of building re-tuning, and what to expect from the training class	Download Read more
Presentation	Large Building Re-Tuning Training: Air-Handling Units	Learn how to re-tune air-handling units (AHUs)	Download Read more

Upcoming Re-tuning Training Opportunities

■ In Person Training Courses

- CBEI BOMA Collaboration for Local Association Pilots
- Proactive Private Market Uptake (e.g. NYSERDA Subsidized Re-tuning Training Courses)



■ Online Training & Resources

- Free PNNL Online Interactive Training Courses
- YouTube Video from Towson University Re-tuning Training
- DOE Training Slides, Guides, Case Studies, Etc.



Question & Answer Session

Join Us for the Next Better Buildings Webinar

PACE Financing for Energy Efficiency

Tuesday, October 7, 2014
3:00-4:00 PM EST

John Kinney, Clean Fund
Eric Shambarger, City of Milwaukee
Steve Thompson, Hilton Los Angeles/Universal City

Property Assessed Clean Energy (PACE) financing is a vehicle to pay for energy efficiency improvements or renewable energy installations on private property. Local or state governments or other entities fund the upfront costs of the improvements which are paid back over time through property assessments added to the owner's property tax bills. Better Buildings Challenge partners describe their successful experiences with PACE financing as program developers, city administrators, and property owners.

[Register here](#)

Additional Questions? Feel Free to Contact Us

betterbuildingswebinars@ee.doe.gov

Today's Presenters	Dennis Bohlayer Towson University dbohlayer@towson.edu Steve Harrison Parmenter Realty Partners sharrison@parmco.com	Benjamin Goldstein DOE, Better Buildings Workforce Program benjamin.goldstein@ee.doe.gov Lisa Shulock Pennsylvania State University lshulock@engr.psu.edu
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