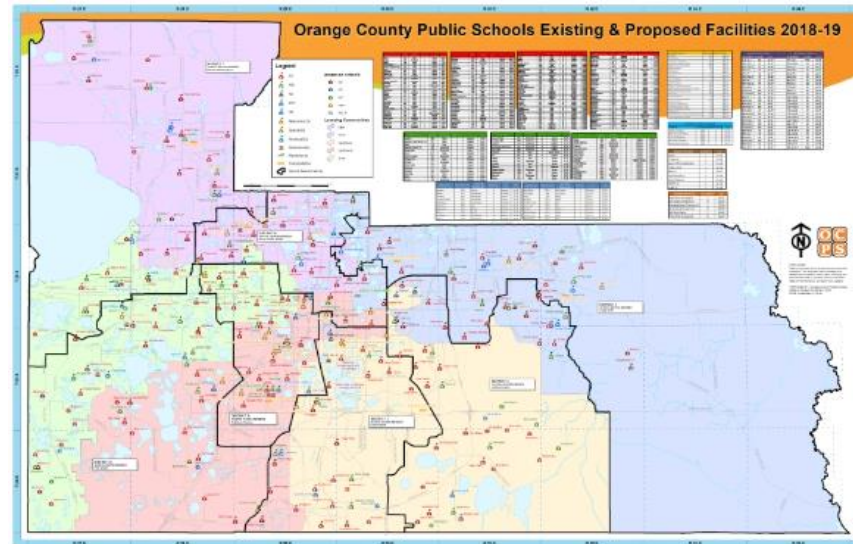




# Evolution & Benefits of a District-wide Commissioning Program



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AIA Provider Number 50111116

## Evolution and Benefits of a District-wide Commissioning Program

Course Number: CXENERGY1913

*Drew Daly, Jonathan Noordzy & Bill Bradford,  
Hanson Professional Services, Inc.*

July 16, 2019

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

This course is registered with **AIA CES**



# Learning Objectives

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At the end of the this course, participants will be able to:

1. The organization and reporting structure between the Cx Provider and Owner when commissioning multiple projects (schools) concurrently; all scheduled for delivery at the start of the school year in August.
2. The evolution and expansion of the commissioning scope, as benefits of design and submittal reviews were identified; and how some of these have impacted District guidelines.
3. Use of a cloud-based Cx web application with dedicated project sites to collect and disseminate Cx documentation, including tracking Contractors' progress on checklists and resolution of issues.
4. Lessons learned and benefits (quantitative and qualitative) identified from commissioning over 50 schools over a five year period for this customer.



# Presenters



Drew Daly  
Hanson



Jonathan Noordzy  
Hanson



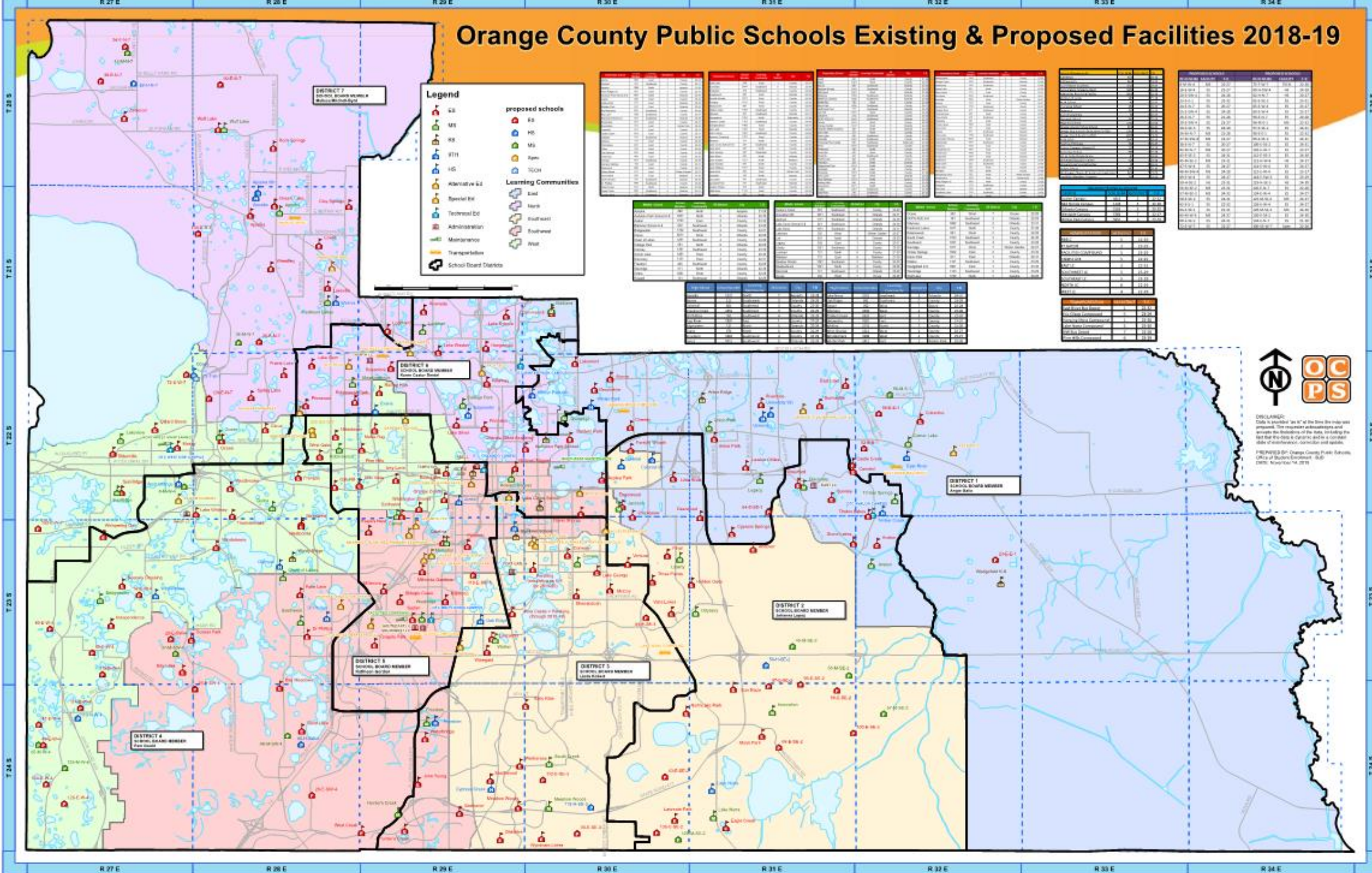
Bill Bradford  
Hanson

# Overview of Orange County Public Schools (OCPS)

OCPS is the 9th largest Public School System in the United States and the 4th largest Public School System in Florida

School Type	Number	Students	
Elementary	124	85,083	(includes pre-K)
Middle	37	41,759	
K-8	7	6,255	
High	20	58,507	
Except/Alternative	8	4,398	
Charter	—	15,683	
<b>Total</b>	<b>196</b>	<b>211,685</b>	(does not include Except/Altern. & Charter)

# Orange County Public Schools Existing & Proposed Facilities 2018-19



**Legend**

- Existing Schools:
  - ES
  - MS
  - HS
  - STH
  - HS
  - Alternative Ed
  - Special Ed
  - Technical Ed
  - Administration
  - Maintenance
  - Transportation
  - School Board Districts
- Proposed Schools:
  - ES
  - HS
  - MS
  - Ann
  - SOCH
- Learning Communities:
  - East
  - North
  - Southwest
  - West

Facility Name	Location	Year	Status
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Facility Name	Location	Year	Status
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**DISCLAIMER:**  
 This is provided "as is" of the time the original prepared. The preparer assumes no liability and accepts the responsibility of the user, including the user that the data is complete and accurate and a complete table of maintenance, correction and update.  
 PREPARED BY: Orange County Public Schools, Office of Facilities Management, 10/18/18, November 14, 2018

# Overview of OCPS Construction Program

- 2018-2019 Budget - Capital Projects Fund \$1,858,305,493 (used for new construction, land, renovation and remodeling)
- **Sales Tax**
  - Half-penny sales tax capital campaign passed in 2002, reapproved in 2014 and is funded through 2025.
  - It pays to renovate or replace aging schools, build new schools to accommodate growth, pays for site acquisition, new digital technology in classrooms and capital renewal.
  - **From January 2003 through June 2018, sales tax collections totaled \$2.8 billion**



# Overview of OCPS Construction Program

- During FY 2019, the district will have more than:
  - \$617 million in budgeted school projects under construction (e.g., more than \$158 for new projects and \$459 million for replacement projects)
- Since 2003 OCPS has:
  - Opened 50 new schools
  - Replaced or renovated 118 schools
- Over the next five years, OCPS plans to open 14 new schools:
  - 10 elementary schools,
  - 2 middle schools, and
  - 2 high schools

# Overview of the OCPS Cx program

- Advertised Scope of Services:
  - *“Provide professional Cx services as directed by the School Board in order to verify and document that a facility and all of its systems and assemblies are and /or were planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements”*
- Specific notes:
  - Hanson helped develop the “template scope of Cx services”
  - OCPS has a higher sampling rates for testing
  - Expectation that Hanson will follow-up through closure of every issue
  - OCPS upper management (e.g., Supt. of Schools, CFO, etc.) appear to walk-thru every school prior to occupancy

# Year 1 - Cx included at end of construction

- Brookshire ES – 54 total issues
- Hackney Prairie ES – **129 total issues**
- Sun Blaze ES – 44 total issues



# Year 1 - what we found

- # of issues varied from 44 to 129
- Wide space temperature gradients in classrooms
- TAB reports could not be duplicated
- Chiller control issues
- Secondary CHW pump issues
- Various AHU control issues



# Year 1 - how we improved our process

- Conducted seminars for OCPS PMs explaining Cx and its benefit for the overall construction process
- Pushed hard to have Cx begin earlier
- Adopted red light/ green light status report for OCPS management



## Orange County Public Schools Commissioning Project Status

8/23/2013

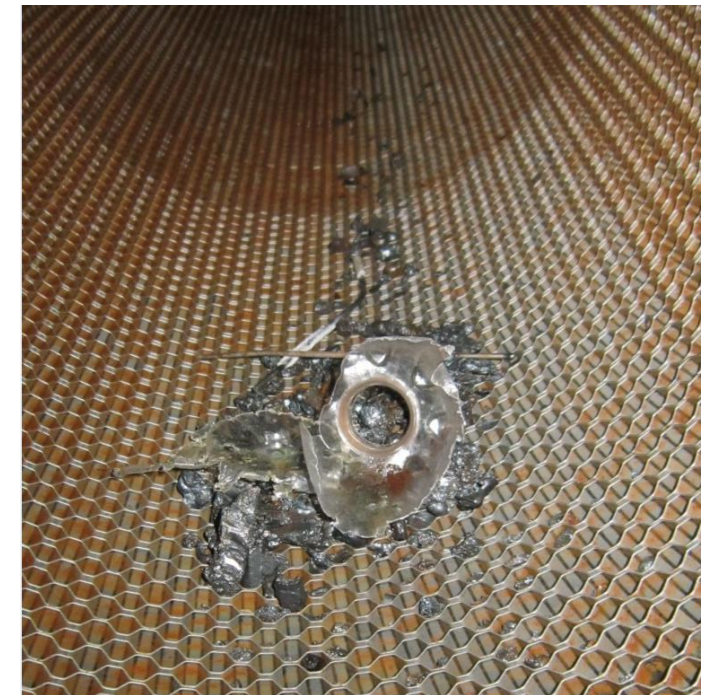
Status	Project Name	OCPS Project No.	Hanson Project No.	Rec'd NTP	OCPS PM	Current Phase/ Milestone	Substantial Completion	Contract Completion	GC	Pool Visits		Status/Comment
										Total	Remaining	
Green	Brookshire ES	C-0062	13G0016	7/25/2013	Tim Gough	Acceptance - Testing (FPT)	6/28/2013	6/28/2014	Skanska	15	7.5	FPT week of 8/12 & 8/19 - VAV boxes; remaining FPT week of 8/26 and 9/2. 7.5 visits used as of 8/21.
Yellow	John Young ES	C-0072	13G0095	7/30/2013	Curtis Stulting	Construction	6/30/2014	6/30/2015	Walbridge	25	25	Waiting for conformed documents to review. When available, review CDs, schedule kickoff, develop Cx plan and specs.
Yellow	Shingle Creek ES	C-0065	13G0096	7/30/2013	Curtis Stulting	Construction	6/30/2014	6/30/2015	Walbridge	25	25	Waiting for conformed documents to review. When available, review CDs, schedule kickoff, develop Cx plan and specs.
Green	Ocoee ES	C-0069	13G0097	8/6/2013	Brian Smith	Construction	6/30/2014	6/30/2015	McCree	25	25	Review 100% conformed construction documents. Develop Cx Plan and specs. Schedule kickoff once subcontractors have been hired.
Green	Pineloch ES	S-0052	13G0098	8/6/2013	Brian Smith	Construction	6/30/2014	6/30/2015	McCree	25	25	Review 100% conformed construction documents. Develop Cx Plan and specs. Schedule kickoff once subcontractors have been hired.
Green	Wheatley ES	S-0056	13G0104	7/30/2013	James Beusse	Design?/ Construction?	7/30/2014	7/30/2015	Gilbain	25	25	Design is ~ 30%. Review OPR and BoD. Develop Cx Plan. When documents are complete, review 100% and develop Cx Specs.
Red	Hackney Prairie ES		13G0122		Mike Lennon	Construction Complete			Walbert Co.			Signed agreement returned to OCPS 8/15/13. Waiting on NTP. Upon receipt of NTP, review TAB report, schedule kickoff meeting, prepare FPT forms.
Red	Sun Blaze ES		13G0121		Curtis Stulting	Construction Complete			Welbro			Signed agreement returned to OCPS 8/15/13. Waiting on NTP. Upon receipt of NTP, schedule kickoff meeting, prepare FPT forms.
Red	Waterford Lakes ES		13G0120		Tim Gough	Bidding			McCree (NTP 9/5)			Signed agreement returned to OCPS 8/15/13. Waiting on NTP. Waiting for conformed drawings to review. Construction has not started; subs are not contracted.
Green	Dr. Phillips HS Bldg 18 HVAC Eval.	C-0059	13G0127	8/13/2013	Mahendra Setaram	Investigation	N/A	10/10/2013	N/A	N/A	N/A	Kickoff and Site visit scheduled for 8/28. (Luis Linares/Sai Perez)
Red	Dr. Phillips HS Cx		13G0105		Mahendra Setaram	Construction - Phase 1 is complete			James Cummings			Proposal resubmitted 8/8/13 for OCPS review. Meeting 8/29 w/ OCPS and Hanson to review phasing.

## Year 2, Cx included at end of design phase

- John Young ES – 72 total issues (26 design, 46 construction)
- Shingle Creek ES – 67 total issues (26 design, 41 construction)
- Ocoee ES – **266 total issues** (27 design, 239 construction)
- Pineloch ES – **119 total issues** (27 design, 92 construction)
- Wheatley ES – 74 total issues (29 design, 45 construction)
- Waterford Lakes ES – **131 total issues** (45 design, 86 construction)
- Doctor Phillips HS – **287 total issues**
- Cypress Creek HS – **202 total issues** (16 design, 186 construction)

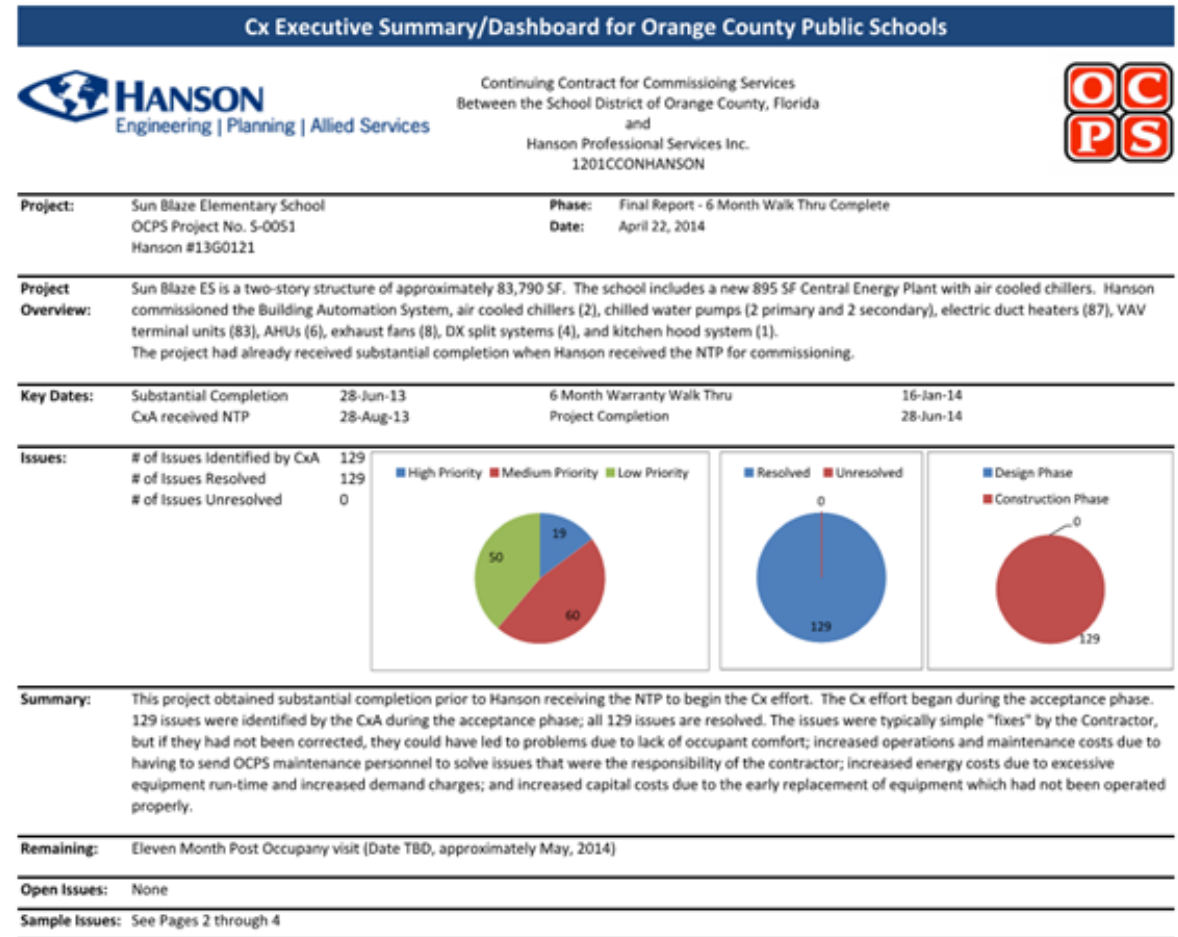
## Year 2, what we found

- Inadequate pipe flushing
- Incomplete test & balance
- BAS issues
- Relief fans running backwards
- Low VAV minimum settings
- Classroom AC unit controls not coordinated with BAS



# Year 2, how we improved our process

- Pushed hard to have Cx begin earlier
- Added pipe flushing meetings
- Added controls coordination meetings
- Implemented periodic update meetings with OCPS
- Incorporated graphic dashboard of issues found & resolved with final Cx reports





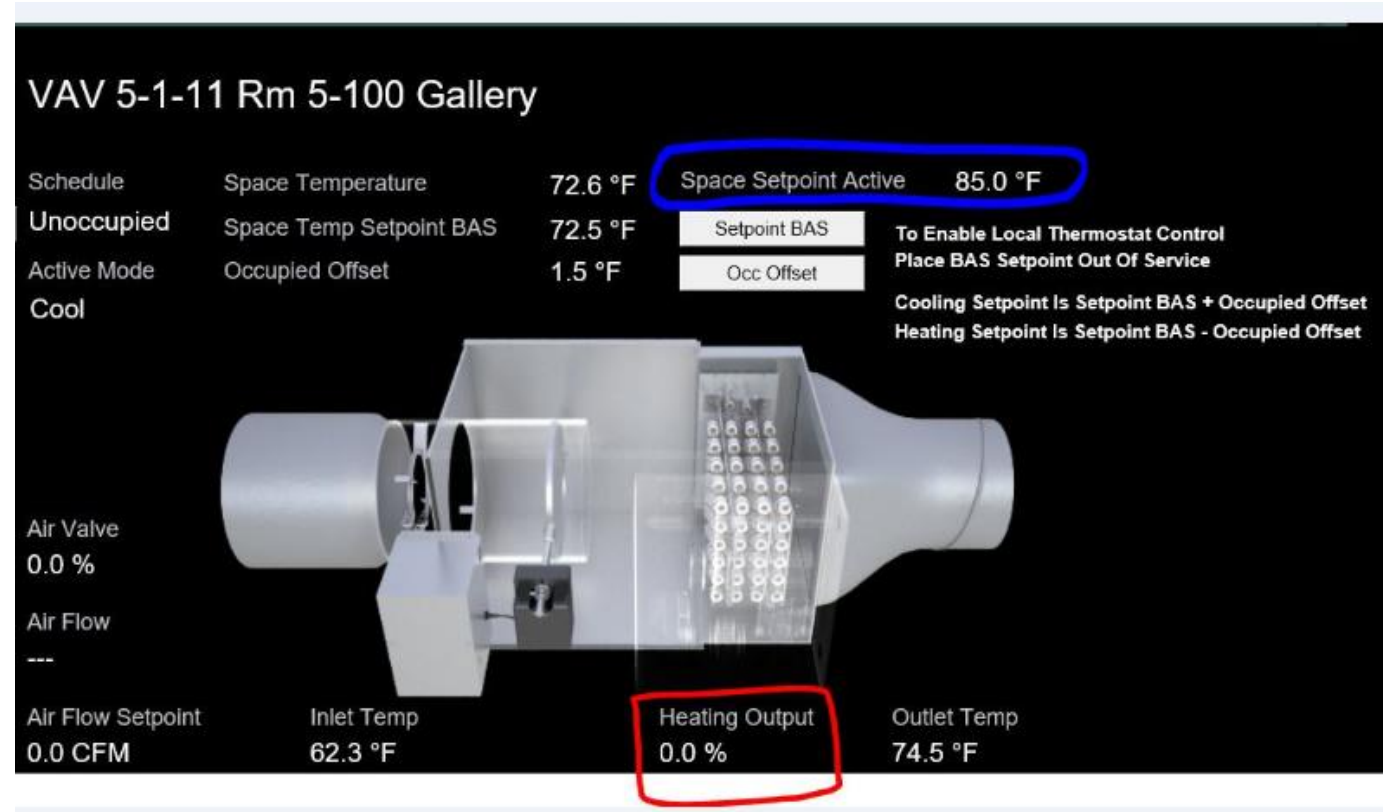
## Year 3, Cx included at end of design phase

- Lake Weston ES – 70 total issues (42 design, 28 construction)
- Clay Springs ES – 88 total issues (50 design, 38 construction)
- Lovell ES – 77 total issues \*
- Independence Area ES – 78 total issues (27 design, 51 construction)
- Eagle Creek Area ES – 71 total issues \*
- Apopka ES – 51 total issues (27 design, 24 construction)
- Lake Whitney ES – **108 total issues** (69 design, 39 construction)

(\* prototype of the school listed above, so only provided one design review)

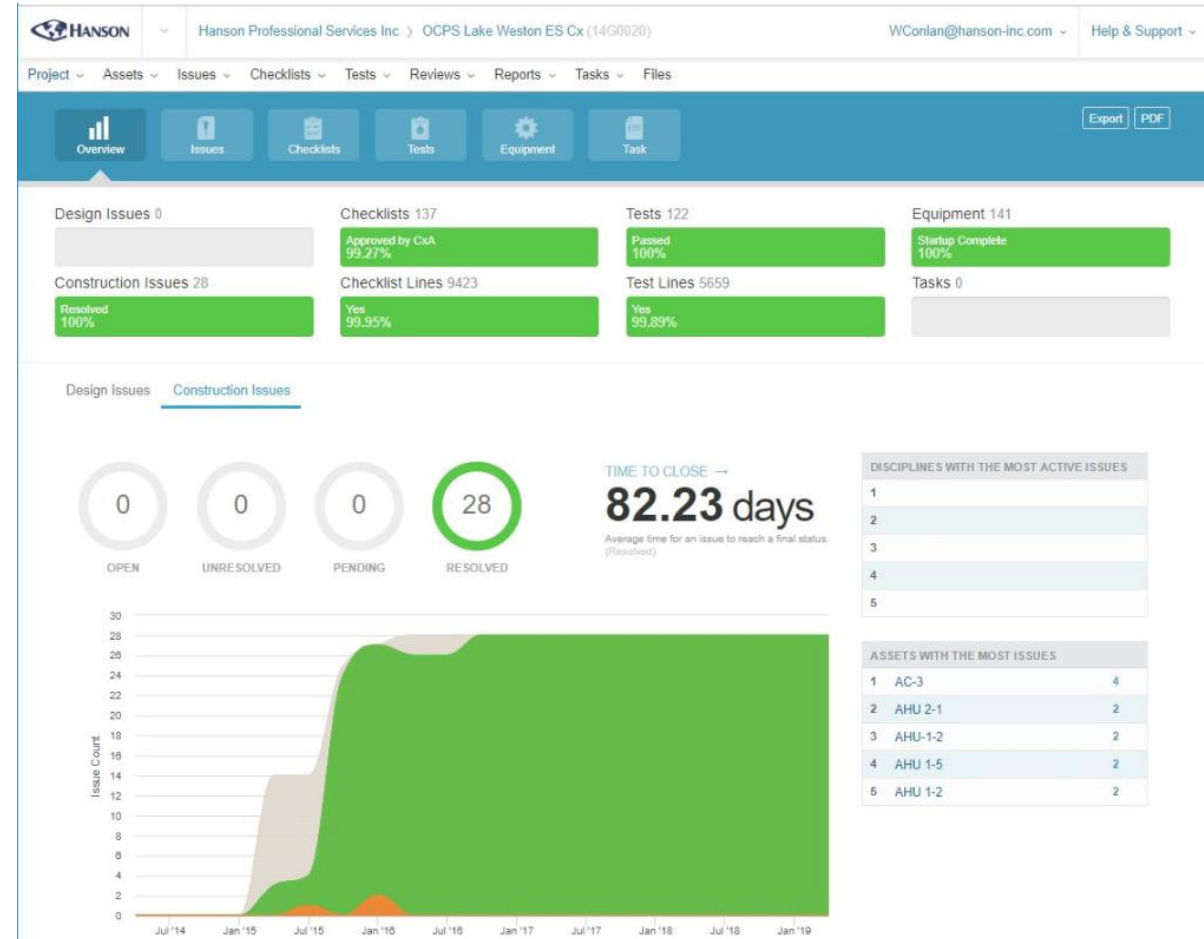
# Year 3, what we found

- Low VAV minimum settings
- VAV diffuser incorrect application
- Heater issues
- Electrical subs went out of business on multiple schools



# Year 3, how we improved our process

- Piloted cloud-based commissioning application (CxAlloy)
- Conducted CxAlloy training sessions for OCPS PMs
- Provided “lessons learned” for OCPS to share with design & construction teams

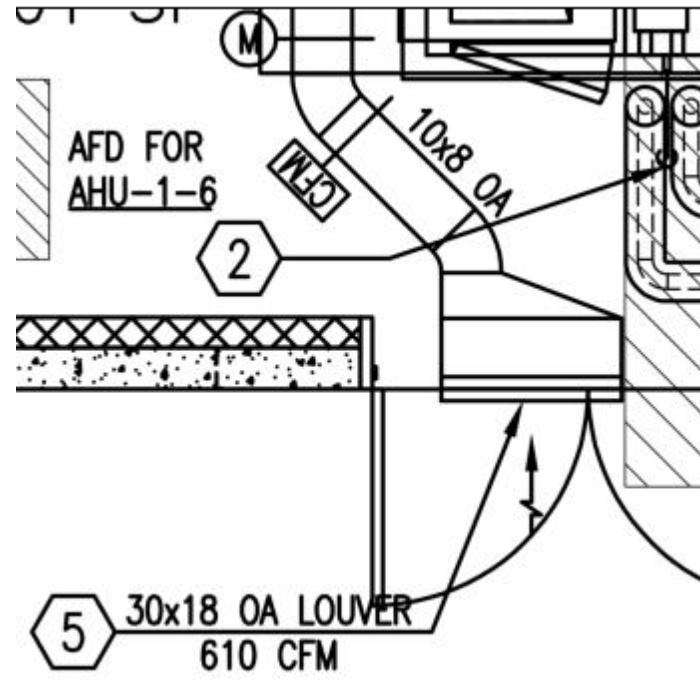
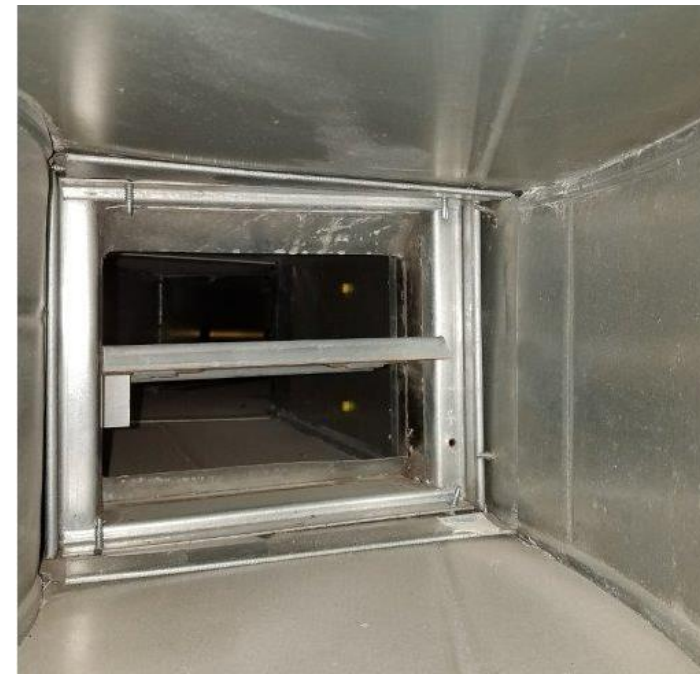


# Year 4, Cx included Full Design through Post Acceptance phases

- Wedgefield Area K-8 – **235 total issues** (97 design, 138 construction)
- Dream Lake ES – **203 total issues** (56 design, 147 construction)
- Lockhart ES – **113 total issues** (41 design, 72 construction)
- Riverside ES – **105 total issues** (38 design, 67 construction)
- Tangelo Park ES – **117 total issues** (39 design, 78 construction)
- Millennia ES – **140 total issues** (71 design, 69 construction)
- Bay Lake ES – **160 total issues** (19 design, 141 construction)
- Ventura ES – 49 total issues (19 design, 30 construction)

# Year 4, what we found

- Incomplete BAS programming
- TAB incomplete
- Condensation problems in kitchens
- Classroom AC controls not coordinated with BAS
- Chilled water piping to AHUs reversed
- Low VAV minimum settings
- Outdoor air intake duct not sized for partial load conditions
- Issues with bi-polar ionization



## Year 4, how we improved our process

- Coordinated with bi-polar ionization manufacturers and contractors
- Conducted CxAlloy training sessions for all parties
- Conducted lessons learned workshop for OCPS and EORs
- Discussed how designs from different Engineers could be made more consistent to facilitate OCPS Maintenance.



Orange County Public Schools

Cx Lessons Learned Meeting  
June 2, 2017



## Intent and Desired Results

- Openly discuss items to avoid issues from arising
  - Design Review items on multiple projects
  - BAS Issues on multiple projects
  - Design Approach differences between EoRs
- Determine a Path Forward on these items
  - Incorporate into OCPS standards
  - Exclude the items from the OCPS standards
  - Leave as currently being done

## Lessons Learned Items

- Application of Therma-Fuser diffusers
- VAV Minimum CFM Settings
- Classroom Temperature Gradient Impact on Occupant Comfort
- Outside Air Quantity and CO2 relationship
- Air Flow Measuring Station (AFMS) Location
- Controls Interoperability: Freeze Protection Sequence with CGAM Chillers and AHU
- Differential Pressure Sensor for CGAM chillers
- Controls Interoperability: BAS integration with Packaged Equipment
- Single Zone AHU: CAV vs. VAV

# Typical issues identified: Design Reviews

- Ambiguous or confusing diagrams and details
- Airflow CFM shown on plans did not maintain proper (slightly positive) building pressurization
- VAV minimum settings too low
- Specification sections could be made stronger
- Outdoor air intake duct sizing
- Incorrect use of VAV diffusers
- Controls issues



# Typical issues identified: Submittal Reviews

- Incorrect HP on EFs – i.e., motors over-amped
- Issues with sequences of operation – “copy and paste” carries design issues into submittals
- Missing energy meters which are not included in the Controls submittals
- Coordination of sequences between the BAS and the chiller

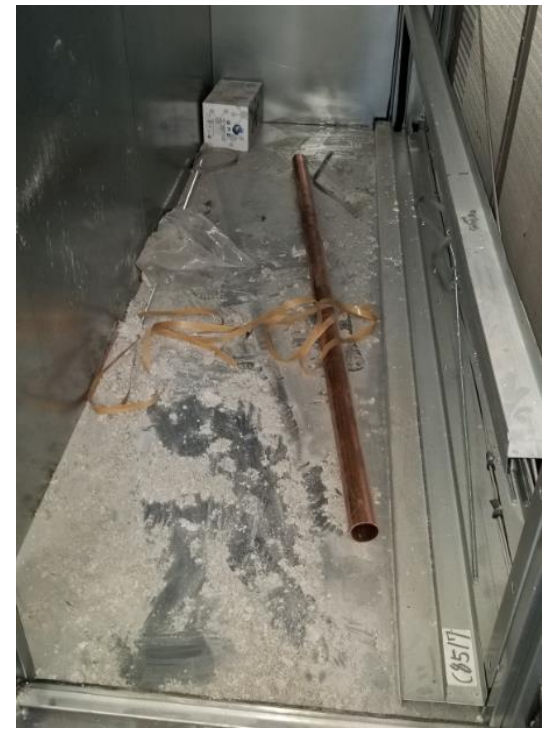
# Typical issues identified: Field

- Faulty or incomplete sequences of operation
- Inaccessible valves and filters
- Need appropriately sized access panels in hard ceilings
- Bi-polar sensor installation errors



# Typical issues identified: Field

- Gauges and local displays mounted where they are difficult (or impossible) to read
- Openings in equipment, piping and ductwork, which are not sealed from construction dust and debris
- Missing air vents on chilled water piping



# Issues from Contractors

- Complaints of insufficient funds to assist with testing
- Insufficient technical support for testing
- Called to the site to test equipment which is not ready
- TAB contractor unable to duplicate airflow readings from TAB report in field.

# Overall process improvements we implemented

- Developed and conducted Cx training sessions for the OCPS PMs, along with the benefits it provides
- Implemented informational review meetings with the OCPS Program Management Team
- Developed "red light/green light" summary of projects to provide OCPS with a quick look at which projects "need attention"
- Developed summary "dashboard" which provided a quick way of looking at the individual project progress

# Overall process improvements we implemented

- Developed and conducted a "lessons learned" session for all of the design engineers to resolve continuing issues and gain “buy-in” to all use a standardized approach
- Increased staffing level (with CxAs with > 10+ years of Cx experience) to properly serve our OCPS’ increasing workload
- Adopted CxAlloy in 2015 for all of the OCPS project to provide constant (and real time communication to OCPS about their projects)

# Overall process improvements we implemented

- Proactive in getting issues submitted via CxAlloy and tracked to resolution
- Share occupant complaints with engineer to get them resolved, which has led to updates in the OCPS design standards
- Successfully implemented proper pipe flushing procedures and early AHU start-up procedures

# Benefits to OCPS

- Issues tracking provides feedback on how specific contractors performed overall on individual projects
- Ability to track when specific contractors fell behind and when they need increased attention
- Reduction in energy
- Reduction in number of “callbacks” during the warranty period
- Increased occupant comfort
- Ability to identify and follow issues to resolution prior to warranty period expiration



# Steps OCPS has taken to improve the process

- Placed increased emphasis on Cx
- Modified design guidelines to include proper pipe flushing
- Raised minimum airflows
- Modified design guidelines for better overall comfort
- Required contractor's support throughout the Cx process
- Implemented a form of RCx program

# Analysis – Elementary Schools

School	Year	Avg # design issues	Range design issues	Avg # const issues	Range const issues	Avg. # total issues	Range total issues
ES	2013	NA	NA	76	44-129	76	44-129
ES	2014	30	26-45	92	41-239	122	67-266
ES	2015	31	27-69	46	24-77	79	51-108
ES	2016	40	19-71	86	30-147	127	48-203
ES	2017	23	19-30	65	14-113	85	37-143
ES	2018	57	22-113	64	40-107	122	62-169

# # of Participants (a.k.a. “variables”) in the program (through 2018)

- Total # of CM's = 14
- Total # of BAS Subcontractors = 4
- Total # of Mechanical Subcontractors = 8
- Total # of TAB Subcontractors = 10

**TOTAL # OF DIFFERENT COMPANIES = 36**

- Total # of OCPS PMs assigned = 25
- Hanson # of lead CxA's assigned = 4

# Analysis – OCPS kWh/SF

Schools	Avg. kWh/SF
Non Cx Schools	14.53
<b>OCPS Sustainability Target</b>	<b>13.10</b>
Year 1 Schools	11.41
Year 2 Schools	12.03
Year 3 Schools	10.67
Year 4 Schools	10.44

# How can this type of program be improved going forward:

- Formalize RCx program
- Develop a district-wide ongoing re-commissioning program
- Develop a comprehensive measurement & verification program
- Develop a district-wide Energy Roadmap
- Implement a program of Facility Condition Assessments
- Implement a district-wide Monitoring Based Cx program
- Implement a "Smart Schools" program

# Summary

## **A district-wide commissioning program:**

- Requires education of all parties involved
- Works best when the number of variables is reduced
- Saves energy and money
- Reduces callbacks during the warranty and post-warranty periods
- Is a good first step for your school district!



**Questions?**



This concludes The American Institute of Architects  
Continuing Education Systems Course

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