AABC Commissioning Group



Evolution and Benefits of a District-wide Commissioning Program

Course Number: CXENERGY1913

Drew Daly, Hanson Professional Services, Inc. <u>Speaker TBD,</u> Orange County Public Schools

April 18, 2019





Evolution of a District-wide Commissioning Program for Orange County Public Schools



AABC Commissioning Group AIA Provider Number 5011116



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Learning Objectives

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.



Presenters









Tom Goodman OCPS

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	
Total	196	211,685	(does not include Except/Altern. & Charter)



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 have been replace or renovated.
- 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 it 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

	HANSON			Orange County Public Schools Commissioning Project Status					8/23/2013			
							9 ,		atuo	P	ool Visits	1
Status	Project Name	OCPS Project No.	Hanson Project No.	Rec'd. NTP	OCPS PM	Current Phase/ Milestone	Substantial Completion	Contract Completion	GC	Total	Remaining	Status/Comment
	Brookshire ES	C-0062	13G0016	7/25/2013	Tim Gough	Acceptance - Testing (FPT)	6/28/2013	6/28/2014	Skanska	15	i 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.
	John Young ES	C-0072	13G0095	7/30/2013	Curtis Stulting	Construction	6/30/2014	6/30/2015	Walbridge	25	5 25	Waiting for conformed documents to review. When available, review CDs, schedule kickoff, develop Cx plan and specs.
	Shingle Creek ES	C-0065	13G0096	7/30/2013	Curtis Stulting	Construction	6/30/2014	6/30/2015	Walbridge	25	5 25	Waiting for conformed documents to review. When available, review CDs, schedule kickoff, develop Cx plan and specs.
	Ocoee ES	C-0069	13G0097	8/6/2013	Brian Smith	Construction	6/30/2014	6/30/2015	McCree	25	5 25	Review 100% conformed construction documents. Develop Cx Plan and specs. Schedule kickoff once subcontractors have been hired.
	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.
	Wheatley ES	S-0056	13G0104	7/30/2013	James Beusse	Design?/ Construction?	7/30/2014	7/30/2015	Gilbain	25	5 25	Design is ~ 30%. Review OPR and BoD. Develop Cx Plan. When documents are complete, review 100% and develop Cx Specs.
	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.
	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.
	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.
	Dr. Phillips HS Bldg 18 HVAC Eval.	C-0059	13G0127	8/13/2013	Mahendra Setaram	Investigation Construction -	N/A	10/10/2013	N/A	N/A	N/A	Kickoff and Site visit scheduled for 8/28. (Luis Linares/Sal Perez) Proposal resubmitted 8/8/13 for OCPS
	Dr. Dhilling U.C. Cu		1200105		Mahendra	Phase 1 is			James			review. Meeting 8/29 w/ OCPS and Hanson

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 <u>266 total issues (</u>27 design, 239 construction)
- Pineloch ES <u>119 total issues</u> (27 design, 92 construction)
- Wheatley ES 74 total issues (29 design, 45 construction)
- Waterford Lakes ES <u>131 total issues</u> (45 design, 86 construction)
- Doctor Phillips HS <u>287 total issues</u>
- Cypress Creek HS <u>202 total issues</u> (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

	Cx Exect	utive Summ	nary/Dashboard for Orange	County Public Schoo	ls	
S?	HANSON Engineering Planning Al	lied Services	Continuing Contract for Commissis Between the School District of Orange and Hanson Professional Service 1201CCONHANSON	oing Services : County, Florida :s Inc.		
Project:	Sun Blaze Elementary School OCPS Project No. S-0051 Hanson #13G0121		Phase: Final Report - 6 Date: April 22, 2014	Month Walk Thru Complete		
Project Overview:	Sun Blaze ES is a two-story st commissioned the Building A terminal units (83), AHUs (6), The project had already recei	ructure of appro- utomation Syster exhaust fans (8) ved substantial o	kimately 83,790 SF. The school includes a m, air cooled chillers (2), chilled water pu , DX split systems (4), and kitchen hood s completion when Hanson received the NI	a new 895 SF Central Energy Plan mps (2 primary and 2 secondary ystem (1). IP for commissioning.	t with air cooled chillers. Hanson), electric duct heaters (87), VAV	
Key Dates:	Substantial Completion CxA received NTP	28-Jun-13 28-Aug-13	6 Month Warranty Walk Thru 16-Jan-14 Project Completion 28-Jun-14			
issues:	# of issues identified by CxA # of issues Resolved # of issues Unresolved	129 129 0	Priority Medium Priority Low Priority	Resolved Unresolved	Design Phase Construction Phase	
Summary:	This project obtained substan 129 issues were identified by but if they had not been corre having to send OCPS mainten	tial completion p the CxA during t ected, they could ance personnel	prior to Hanson receiving the NTP to begin the acceptance phase; all 129 issues are no f have led to problems due to lack of occu to solve issues that were the responsibilit	in the Cx effort. The Cx effort be esolved. The issues were typicall upant comfort; increased operati ty of the contractor; increased en	gan during the acceptance phase y simple "fixes" by the Contracto ons and maintenance costs due lergy costs due to excessive	

properly

aining: Eleven Month Post Occupany visit (Date TBD, approximately May, 2014)

Open Issues: No

ample Issues: See Pages 2 through 4

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 <u>108 total issues</u> (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 <u>203 total issues</u> (56 design, 147 construction)
- Lockhart ES 113 total issues (41 design, 72 construction)
- Riverside ES <u>105 total issues (38 design, 67 construction)</u>
- Tangelo Park ES <u>117 total issues (39 design, 78 construction)</u>
- Millennia ES <u>140 total issues (71 design, 69 construction)</u>
- 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 <u>Therma</u>-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
- Pipe and 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	Range design	Avg # const	Range const	Avg. # total	Range total
		issues	issues	issues	issues	issues	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			
OCPS Sustainability Target	13.10			
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 your customer and 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

Contact Information



