

Evolution of Commissioning within a School District: Provider and Owner/Operator Perspectives

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Synopsis

Enovity has been involved in commissioning of 10 school campuses (more than 500,000 sq. ft.) for the Folsom Cordova Unified School District (FCUSD) in the Sacramento, California Metro area over the last three years. Campuses range from 45,000 sq. ft. to more than 175,000 sq. ft. and the scope of work includes commissioning of projects ranging from major bond-funded improvement projects (new HVAC and controls) to ground-up construction of new campuses.

This paper discusses the evolution of commissioning within a District that is currently responsible for 35 campuses in a fast-growing suburb of Sacramento. The paper will focus on the perceived value of commissioning within the District by project managers, construction managers, A&E team members, and local contractors. A comparison of two nearly identical projects – one that benefitted from commissioning and one that did not, illustrates some of the positive impacts of commissioning.

Along with the Enovity commissioning project manager (commissioning authority), this paper is co-written by FCUSD's facility/energy manager (Owner), who has been instrumental in promoting "commissioning as usual" for District projects. He shares his personal experience on how his role as an owner/operator has evolved since commissioning has become required for all new construction and major renovation projects. In addition to providing an insight into some of the challenges faced while integrating commissioning with their design/construction process, he will also share some of the benefits realized by the District since adopting the commissioning process. The study also describes how commissioning has changed the stakeholders' perception of major construction projects.

About the Authors

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Systems from Arizona State University; and his B.S. in Architecture from School of Architecture, Delhi, India.

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FCUSD Overview

The Folsom Cordova Unified School District is located approximately 20 miles east of Sacramento, California. The District encompasses an area northeast of downtown Sacramento and consists of 22 elementary schools, four middle schools, three high schools, two continuation high schools, adult education and other service centers. Many of the buildings were constructed more than 50 years ago. The HVAC equipment at these facilities varies from chilled/hot water loops on the older campuses to package rooftop DX units with gas fired furnaces on the newer construction. The District primarily utilizes two major controls systems across the different schools which are connected over the District network with a central EMS workstation located at the facilities maintenance office.

As most of the equipment on older campus is reaching the end its life, the District has been implementing various modernization projects that range from minor valve replacements to the complete teardown and replacement of the mechanical systems. The growth in this region has also required the construction of three new ground-up schools.

The Initial Perception

As with majority of owner/operators, the concept of commissioning was fairly new to the District. Prior to implementation of commissioning, any construction activity undertaken by the District was approached as a stand-alone project with intent to keep the initial cost low. Not much consideration was given to the long term impacts of the decisions taken during design and construction. This resulted in schools with different equipment and control standards that created problems for the maintenance staff. This approach was also echoed by the rest of the team on any construction project that includes:

- Construction managers – Their primary goal was to get the implementation completed as quickly as possible while meeting the design requirements (which may or may not be exactly the same as the owner’s project requirements).
- Architect & Engineers (A&E) – They would design the mechanical systems using standard design guidelines. During the design process, although the owners’ requirements for the new buildings were considered, there was a lack of information about the past performance of existing buildings. This led to inefficient use of the installed equipment and even over-sizing in some cases due to built in redundancy. For modernization projects, assessing existing conditions was not always consistently and thoroughly performed.
- Contractors – They believed in completing the installation and turning over the building as quickly as possible and that any issues that came up during construction could be addressed during the warranty period even if it involved replacing a whole AC unit after the building was operational.

School districts are a small community and word, good or bad, spreads quickly. The experiences resulting from any construction project are quickly disseminated to other campuses and set a level of expectation for future projects. To minimize disruption to the school operation, the majority of the construction projects are implemented over the summer break, the short duration of which brings a greater challenge to the team's goal of delivering a quality project. The commissioning of projects were not always seen by the staff as a means to streamline operation and improve conditions on site but as a disruption to a seemingly normal building operation that will result in some of the heating/cooling control being taken away from them.

The general perception about commissioning was that it added to the cost of implementing any project and duplicated activities performed by the Inspector on Record (IOR), A&E and the contractors. Commissioning engineers were perceived as mere inspectors and were generally unwelcome on job sites. The general feeling was that commissioning leads to unnecessary delay by requiring certain tasks to be performed in a specific order and also requiring inspections at various stages.

The Need

There were many factors that led the District to consider commissioning for its construction projects. The nature of the bid process allowed for the lowest bid contractor to be selected for the job, making it difficult to ensure a consistent level of quality on every project. During construction, different contractors did not “play well together” leading to lack of cooperation and finger pointing which meant constant rework or deviation from design to meet the as-built conditions. Once the installation was completed, there were no adequately qualified personnel that could inspect and approve the completed system. The level of inspection that was carried out during construction was mainly aimed at verifying code compliance and installation of individual pieces of equipment without considering the interaction between them. The District realized that it was the little things which went unnoticed and were costly to them in higher energy bills. In most case it was found that systems were not functioning or started malfunctioning soon after project was said to be completed, at a time when the contractor had no incentive to be back on site to address any issues.

The District also realized that the commissioning authority's expertise can be utilized not only during and after construction but during the design phase as well. Also, since the commissioning engineers review and conduct a point-by-point inspection of an operating system from an energy efficiency standpoint, their review can highlight additional measures which may have been overlooked during the design phase.

Having the commissioning engineers involved in the warranty phase to conduct a final inspection prior to expiration of warranty phase can potentially save negative comments coming from the maintenance department staff members who inherit the system.

Initial Approach and Process of Change

Although the District Board had agreed to implement commissioning on at least one of its projects, there was still some skepticism about the value that it would bring to the District facilities. The first project that required commissioning was a large modernization project in 2005. At that time, the concept of commissioning was still fairly new to the District and it was being treated as a task at the end of the construction phase rather than being a part of the whole design and construction process. Enovity was hired only three weeks prior to building occupancy and was asked to commission HVAC systems that involved various pieces of equipment including: multiple air handlers, VAV boxes, reheat coils and unit ventilators. During the course of commissioning, more than 300 separate issues were identified, a majority of which could have been prevented had the commissioning process been initiated earlier. Prior to this process being performed, the District had no other means to confirm if the equipment was installed and operating as specified and primarily had to rely on the contractor's word and IOR and A&E's inspection report before accepting turnover of the buildings. The commissioning issues list for this project provided the District ammunition to challenge the claims of the contractors and also get a higher level of confidence about the mechanical systems before occupancy. Adding the commissioning issues to the project 'punch list,' the District was able to seek resolution on a majority of the items before formally accepting the building turnover.

Based on the positive experience of this first project, the District has since incorporated commissioning as part of all its new construction and major retrofits involving HVAC work. To date, commissioning has now been implemented on a total of 10 Schools Campuses (approx 500,000 sq.ft.). Three of these schools were new constructions and seven were major modernization projects.

The scope of these projects required enhanced commissioning for HVAC systems and controls, and included:

- Development of Commissioning Plans
- Use of Commissioning Specifications during bidding
- Submittal Reviews
- Development of Startup Checklists
- Development of Functional Performance Tests
- Coordination Meetings with CM and Contractors
- Development of Ongoing Issues Lists
- Back-checks of incomplete/deficient work
- Certification of Systems
- Warranty Phase Trend Analysis and Back-checks

The Impact

During the commissioning of these projects more than 700 issues were noted, which can be broadly categorized into the following:

Operational & Maintenance - 32% - These included issues that would have required additional overhead to the District's operation and maintenance staff. If not addressed in a timely manner, these issues can potentially lead to equipment failure.

- Excessive play or gap in dampers
- Overly noisy & vibrating equipment
- Improper / unsafe installation; not code compliant
- Equipment poorly labeled
- Missing covers & fasteners
- Incomplete training
- Loose wires
- As-built and Operations Manual incomplete or missing
- Condensate piping improperly installed
- Incomplete/incorrect mapping of points at the console

Comfort & Indoor Air Quality – 37% - These issues impact occupant comfort and can lead to unhealthy space conditions if not addressed in a timely manner. Examples of some of these issues include:

- Improper setpoints
- Overly noisy equipment
- Dirty filters / coils
- Malfunctioning exhausts fans
- Improper flue exhaust
- Improper CO₂ based purge operation
- Improper air balance
- Unapproved relocation of supply grills

Energy – 26% - These issue result in inefficient operation of the equipment leading to excessive energy use. Examples of some of the issues found include:

- Excessive play or gap in dampers
- Equipment interlock not working
- Malfunctioning power exhausts
- Inoperative dampers/actuators
- Malfunctioning economizer controls
- Incorrect programmed sequence of operations / control wiring
- Oversized fans (design)
- Field modifications made without approval.
- Direct wired exhaust fans – Always ON

Safety – 6% - These issues could lead to potential dangerous conditions that could lead to injury to the occupants or the maintenance staff. Examples include:

- Water leakage on electrical equipment
- Unsecured/improperly mounted equipment
- Unsealed roof openings/electrical conduits

- Improper switching of exhaust fans
- Flue exhaust proximity to air intake
- Construction debris left on/around units.
- Unsecured exposed wires inside the unit

New Benefits Being Realized by the District

The commissioning process has resulted in many benefits, some immediate and some long term. The outcomes of this process has been positive not only for the owners/operators but also the other stakeholders in the process. The benefits include but are not limited to:

- Satisfied building staff – Better temperature control and indoor air quality conditions leads to less discomfort situations.
- Satisfied maintenance personnel – Minimal hot/cold calls and reduced rate of equipment failure requires lesser site visits. Also, since the contractor is required to provide training on the HVAC and controls before the formal turnover of the buildings, the maintenance staff is less likely to have any surprises during maintenance.
- Increased level of confidence among school sites after building turnover – Better occupant comfort and reduced maintenance calls assures the occupants that the building will perform as intended which allows them to focus on their primary objective of providing education.
- Smoother transition for the contractors – They are able to leave a site and focus on their next project knowing that warranty calls will be at a minimum.
- Improved energy efficiency – Ensuring that the HVAC systems are operating normally and at the highest level of efficiency.
- Fewer change orders and construction litigation –The construction manager, architects and owners have to deal with fewer change orders and there is no “fine-tuning” during the warranty period.
- Minimize dependence on contractors for ongoing maintenance – A documented sequence of operation eliminates guesswork during troubleshooting and minimizes loss of proprietary knowledge after contractor’s departure.
- ‘Lessons learned’ – The detailed testing and review of the as-built system provides critique that can be used for improving future projects including:
 - Better assessments of existing conditions for retrofits
 - Optimization of equipment sizing/design for new installations
 - Improved controls strategies for HVAC operation

A Tale of Two Projects, One Commissioned and One Not

To validate some of the benefits realized due to commissioning, the performance of two elementary school campuses, Sandra Gallardo and Navigator Elementary, was compared. The two schools have exactly the same Architectural and Mechanical design but were constructed at different times. Sandra Gallardo Elementary was not commissioned while Navigator Elementary, which was constructed a year later, had completed commissioning of the HVAC and

control system. To keep the comparison as subjective as possible, it was limited to the performance of the schools during the warranty period of one year and was evaluated using the number of HVAC related warranty call backs to each school.

The results were surprising but not completely unexpected. Sandra Gallardo Elementary had a total of 19 warranty requests over a period of a year. These 19 requests were related to 38 issues of which eight were recurring issues. In comparison, Navigator Elementary only had 4 warranty requests related to 4 issues – none of which were repeats.

The Transformation

Commissioning has made a significantly positive impact on the end results of these projects while adding value at each step. The success has led to a positive change in perception about commissioning among the stakeholders, including:

- **Owner-Facilities / Operator-School Staff** – They now require the commissioning authority's involvement during the design, development, and construction documents review phases, as it was clearly highlighted in prior projects that having the commissioning authority involved as early as possible can prevent many of the oversights during design and implementation that can lead to costly repairs/modifications and cause disruption to the building operation. The owner now seeks input from the commissioning authority and relies on them to provide objective advice on any HVAC issues that arise.
- **Construction Managers** – They now consider the commissioning authority as an owner representative and require contractors to provide a satisfactory resolution on any issues that are raised until a resolution is reached, even though it may involve halting or delaying progress on a construction task.
- **Architect & Engineers** – They consider the feedback and resolution on issues identified in prior projects valuable input in designing new / retrofit projects. They also actively participate and provide input on issues identified and reported by the commissioning authority.
- **Contractors** – Their primary objective is still to complete the installation and turn over the building as quickly as possible. However, they now realize that the commissioning authority actually assists them in providing a quality installation. Some even leverage the commissioning authority's knowledge and experience to their advantage by utilizing their assistance during initial testing of equipment.

The District has realized that informing site staff of construction schedules, project completion milestones and commissioning benefits goes a long way in calming fears and receiving cooperation from all the stakeholders. An effective strategy in this regard has been to involve the principal at weekly meetings in order to keep him/her apprised of the changes in the schedule/progress. Also, providing written documentation regarding the condition of the systems

in each room along with a formal response process leads to a much smoother building operation during the post occupancy period.

Conclusion

Commissioning has significantly impacted the design and construction process at the FCUSD. While encountering many hurdles along the way, the authors have demonstrated its value for all projects. While working through initial resistance and challenges it was demonstrated that commissioning actually helps ensure coordination, not duplication, between the duties performed by the various members of the design team. The commissioning authority is now seen as a partner during the construction process, one who also facilitates communication between the various members of the team and offers objective advice on technical matters by understanding both the basis of owner's requirements and the technological solutions that are specified to meet those requirements.

The Future

Based on the success of HVAC commissioning on the various school projects, the District is now considering expanding the scope of commissioning to also include high and low voltage electrical systems and some plumbing systems. It is also looking into other innovative delivery methods for new construction / modernization projects. The District is now mandating that all school sites are designed and constructed to meet California High Performance Schools (CHPS) guidelines. Finally, the District is looking to implement a broader sustainability initiative by pursuing a LEED[®] Silver rating for their new District office.