

Evolution of Commissioning at the Chicago Public Schools: from Concept to Commitment

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Synopsis

The Chicago Public Schools (CPS) educates over 400,000 students in over 600 school buildings with energy bills over \$70,000,000 per year. In order to improve project delivery, support better operation and maintenance, and increase energy efficiency – all in service of the primary mission of education – CPS looked to commissioning as a tool to reach these goals. Over the past three years, as the local industry has become more mature, and the district has become more experienced, commissioning as a concept has evolved into commissioning as a commitment. This has not been without some growing pains. The presentation will review the evolution of commissioning as it is incorporated into the workings of a big city school system, highlighting the obstacles and pitfalls, but also the successes and opportunities. Coming from this discussion will be concrete examples and recommendations for the end-user implementing commissioning on either a programmatic or single-project level, as well as tips for providers and participants (from designers to contractors) on how to serve customers while participating in the commissioning process.

About the Author

Joseph F. Clair serves as the Managing Engineer for the Chicago Public Schools. Prior to his service to the Board of Education, during which he has participated in all facets of construction, design and utility costs, Joseph spent 10 years in the construction industry. His focus has always been energy efficiency, sustainability and high performance buildings, and he brings that passion to all of his work. Through energy management system design, MEP coordination, commissioning and energy efficiency analysis, Joseph has contributed to the elimination of over 250 MWh of electricity consumption and 10,000 therms of natural gas usage. Joseph lives in Chicago with his family, and has for his entire life.

Introduction

Commissioning is a process. To succeed, it requires clearly defined goals, structure, and a champion or champions willing to make adjustments or directives that keep the process moving.

Since 1995, the Chicago Public Schools has maintained a significant capital improvement program, simultaneously renovating existing school buildings and creating new ones at a significant rate. Just prior to this time, the first direct digital control systems had been installed at school buildings and as part of the capital improvements, several more were added yearly. In addition, new mechanical technologies were coming into the marketplace and were applied on the school projects. Add to this a population of building engineers of varying abilities and experiences, more used to straightforward boiler/radiator buildings than computer-controlled, multiple-mechanical system buildings, and what results is the dangerous potential for poor performance. This poor performance can manifest itself in the most benign state as inefficient energy use, and in the most destructive state as poorly ventilated, and poorly conditioned, spaces where learning is difficult.

In order to avoid and combat these potential conditions, the Chicago Public Schools, through an agreement with Commonwealth Edison (ComEd), adopted commissioning of its control systems on every mechanical renovation or new construction project. Concurrently, the City of Chicago adopted the Chicago Standard for Green Buildings, requiring LEED® certification of all new buildings built by the City; this included new school buildings. The Chicago Public Schools became one of the largest consumers of commissioning services in the region. This presented great opportunity, but as CPS was soon to learn, it also posed great difficulty to reaching its ultimate goal of efficient, maintainable designs, constructed with quality, and turned over completely to operations staff.

Phase I: Concept

The initial implementation of commissioning was provider-centered, and focused on fixing problems. Because of the nature of public work and procurement, and the approach CPS has taken to it, the district had little control over the which contractors performed the most important work associated with facility operations: HVAC piping and sheet metal, electrical, and especially controls and testing/balancing. In addition, because of the volume of work done, several different design teams (all of varying skill) were needed. Even with centralized oversight and program management (by a consultant team), the quality of design from one project to the next varied greatly. These constraints hampered the effectiveness of commissioning during this phase, but through the problems encountered, long-term solutions were found.

Design Phase

Mechanical and electrical building systems are experiencing growth and changes in technology at a rate faster than at any time in their history. With competing firms approaching effectiveness, efficiency and innovation in so many different ways, staying current from a design standpoint

has become increasingly difficult. Architects have become more reliant on engineers, and engineers subsequently have become more reliant on suppliers and manufacturers. For specialty systems, such as controls (or building automation systems), this situation is more pronounced. Local distributors (branch offices or system integrators) constantly push the “latest and greatest”, even when development is incomplete, because stagnation in that technology market results in lost share. Most engineering firms can stay current only to a certain level, and even those that choose to retain professionals experienced in the field, have to devote significant resources to that end. For a school district with fixed cost structures, and accelerated delivery timelines, designers’ ability to deliver high quality, highly efficient buildings suffers.

To understand the role of commissioning in CPS work, one must first understand the structure of the design delivery method used to combat the issues related to design quality. Currently, the program management consultant scopes a project and then directs an owner’s representative to manage the project from design through construction. That owner’s representative consultant begins by taking the general scope and producing a more detailed scope (through schematic design), which is reviewed by the program manager. Once the design is deemed ready by all involved, an architect of record is brought on board to take the design through completion, with subsequent reviews by the owner’s representative at two completion milestones, and by the program manager prior to bid.

Given the quality control process already in place, commissioning during the design phase should focus on operational, accessibility, and quality control issues. A design team or owner expects that coordination issues will be encountered, or that maintenance concerns will arise. How well the project team tracks and addresses these issues, defines the success of the design phase commissioning process. Unfortunately, due to the increased level of complexity in technology-based systems, the presence of three different professionals and one owner on each project requires the commissioning authority to spend more time as traffic cop, trying to glean the true intention of the owner (as stated through its various representatives and agents), and negotiating a common ground among the professionals involved. On top of this, because of the limited capacity of the design professionals related to controls and balancing, they also end up providing significant guidance on the design for these areas. This results in an inefficient process.

Construction Phase

Recognizing that design-related issues affect construction quality heavily, construction issues arise independent of design, and affect the efficacy of commissioning to an equal extent. General contractors, in the low bid environment, seek out the lowest prices for the designed work. Project specifications typically required competition for each product or system installed (i.e. no sole sourcing of products), and could not limit the participation of providers. The market of mechanical and electrical contractors who can perform this work within the constraints of the cost structure, coupled with the “open” nature of the public bid meant that companies with questionable competency could, and did, participate in the process. The tight margins associated with the work further exacerbated the design issues, and resulted in projects with significant operational issues, contentious change orders, and untimely project completion.

As an organization, CPS addressed these possible complications by focusing heavily on enticing quality from the general contractors. CPS established a list of pre-qualified general contractors, bringing them into a “program.” This facilitated lines of communication, created an environment of familiarity, and formed a solid foundation for quality work. In addition, the program manager implemented weekly review of project issues, resulting in quicker resolution of changes and claims, and allowing for faster processing of payments. The combination of these two processes, coupled with a dedicated project manager from the owner’s representative consultant, allowed the project-initiation-to-completion process to move relatively smoothly, however issues of project turnover and closeout persisted.

Commissioning in the construction phase should focus heavily on progress review, pre-functional requirements, and support of submittal reviews. On all projects, but even more so on projects with relatively inexperienced design teams, commissioning authorities spent significant time performing compliance reviews of submittals and installation. Additionally, due to the third-tier nature of the control contractors and testing agencies, and the lack of limitations on who could participate, commissioning authorities required more field time addressing problems of contract performance that often were not found during construction administration by the designer. With the pressure of project schedules, commissioning work often started before verification of contract compliance, and resulted in a continually expanding list of issues, frustrating contractors, complicating turnover, and adding to the cost of commissioning.

Lessons Learned

Commissioning is a process for delivering quality, and for increasing the maintainability of systems. The commissioning authority serves as the facilitator and overseer of that process, and coordinates among all of the project team members. From the initial implementation of commissioning, CPS realized that several structural issues prevented successful, cost effective implementation of commissioning. These were:

1. Lack of a single, consistent source for owner’s requirements
2. Miscommunication that resulted in the placing of too much of the quality control responsibility on the commissioning authority
3. Contractual issues related to procurement and closeout

If CPS was going to realize the promises of increased project quality and improved facility operation, solutions to these issues were needed, culminating in a clear but comprehensive approach to commissioning. The steps required to deliver on this need were started, and the road to improved commissioning is well underway.

Phase II: The Commitment

Through implementing commissioning, the Chicago Public Schools took a big step toward improving the quality and maintainability of its mechanical/technical systems. However, just

adding commissioning to the process of project delivery was not enough. Adding commissioning highlighted the issues within CPS that make it difficult to obtain quality project delivery, and provided the foundation for the Chicago Public Schools to turn the concept of commissioning to a true commitment to commissioning.

Developing Standards

A complete, well-thought owner's project requirements document provides the foundation for solid commissioning implementation. For an owner like the Chicago Public Schools, with as many as one hundred concurrent projects of various scope and scale, developing this document on each project, and maintaining quality and consistency, proves difficult. Prior to two years ago, the only true standards implemented across the CPS asset portfolio rested in the institutional knowledge of the designers, building engineers and consultants working for the Board, or in the buildings themselves. Working with this lack of written direction required individual commissioning authorities to make judgment calls, sometimes contrary to specific project specifications, so that consistency could be obtained.

In order for the commissioning program to work successfully, standards were developed across all of the technical disciplines. These standards included not only the technical specifications and standard contract document details and language, but also narrative design guidelines for architects and engineers to follow so that consistency of application and sizing is maintained. Additionally, design review processes now focus on standards implementation and coordination, allowing for consistency in the design review process. This provides for a more straightforward design process, and removes some of the arbitrary ambiguity that can result when different reviewers look for different issues. Developed standards focus on three areas of project technologies: MEP (mechanical, electrical and plumbing/fire protection), controls and commissioning.

Controls

Separating controls from the rest of traditional MEP technologies reflects the importance of the control systems to an owner with hundreds of different buildings. Building engineers tend to spend 3-5 years, on average, at their building, and with only one hundred currently functioning direct, digital control systems, most of the engineers serving CPS have little to no experience with the technology. Even those who do have experience may only have seen one or two different manufacturer's systems. By focusing extra attention to the controls, CPS developed not just product requirements and design guidelines, but standards for the look, feel and operation of the system. Building-specific troubleshooting guides, "cheat sheets" and online video guides are only some of the operation documentation that are now required of controls installations, with examples residing in the standards. This allows a new engineer to come up to speed quickly on what the system in their building does, and relieves the engineer of having to deal with too many idiosyncrasies of varying systems.

Commissioning

As was noted earlier, contractors have difficulty dealing with unknowns, and commissioning (especially of control systems) became a significant unknown. With unknowns comes added cost, with no added value. Realizing that not only contractors needed to focus on the consistency and quality of the projects, CPS began standardizing the method of delivery of commissioning. This focused on standardizing the contractual role of commissioning as support of, but not a replacement for, the role of the engineer of record, and providing consistent message of what is required. Contractors are held to high standards of performance, but either through allowances or breakouts, commissioning costs at the contractor level are identified and managed so that the ambiguity does not cloud the overall project cost.

Getting Buy-in

Without acceptance of commissioning at every level of project delivery, success comes infrequently in a large-scale program. Building engineers and district management buy-in because contractors are held to high standards and project turnover is more thorough and timely. Owner's representatives, project managers and design teams buy-in because they have third-party reinforcement for their efforts, and because project close-out phases can be significantly reduced freeing teams for work on other projects. Buy-in from contractors is the most difficult to obtain. Another set of eyes on a project introduces another layer of subjectivity, but it also provides an independent supporter for the knowledgeable contractor. The key to getting contractor buy-in lay in maintaining consistency in what is asked for, having a clear process that leaves all direction in one entities hands, and formulating a transparent line of communication for resolution of issues. Contractors want jobs to close out quickly, but cannot operate under a situation where they are forced to listen to many different voices. Next to operations staff, contractors are the most important player in successful commissioning, and their buy-in is essential.

Developing Champions

The most important step in the positive evolution of the commissioning process at the Chicago Public Schools is the hiring and assigning of staff working directly on commissioning. CPS created a managing engineers position, one of whose duties is to oversee, develop and improve commissioning practices. In addition, retired building engineers have been assigned to provide additional interface between and among the commissioning authorities, the contractors and the school. Instead of relying solely on commissioning consultants and contractors for technical expertise, these CPS employees have the knowledge base to not only understand the process, but to drive it and better it. Of the actions presented here, building an internal base of commissioning knowledge has provided the greatest strides toward quality project delivery.

Finding Partners

Along with developing the internal staff necessary to affect quality project delivery, owners must have strong partnerships with commissioning providers and industry experts. These partnerships can take many forms. Owners can establish lists of qualified providers through a request for qualifications process, thus ensuring a certain level of quality and expertise. These qualified

providers can then be approved for multiple years so that they can build institutional knowledge. By repeating this process at regular intervals, owners can ensure competitive pricing, while developing a strong, customized base of providers. Another option is the development of a managing commissioning authority that would be responsible for the implementation of standards and processes, as well as direct oversight of project-by-project work. Project-by-project commissioning can then be performed by a more diverse group of smaller providers, thus expanding the base of providers without compromising experience. For owners with diversity goals and neighborhood hiring requirements, this scenario can provide a means for meeting those goals.

In addition to the providers, it is important to work with outside entities that can bring resources and insight to the program. Foundations, trade organizations and governmental agencies all have experiences and resources that allow owners to learn from each other, to find new approaches to commissioning, and to expand commissioning programs within their limited resources. For example, the Chicago Public Schools partnered with the Illinois Clean Energy Community Foundation to pilot a retro-commissioning program to drive building performance improvement. The foundation sought some commitment that the district would pursue the recommendations of the providers as part of the funding for the program. This challenge heightened the role of CPS in the project, and increased the results that the program could achieve.

Developing Tools

In order to maintain consistency and quality in the commissioning process, especially when many different providers may be part of a program, well-developed, online tools improve the chances for success. The development of these tools is as important as the tools themselves, for it forces the owner and contributing providers to focus on how the process should work to meet institutional goals, thus furthering the commitment to the process. By making it available online, all participants in the commissioning process can have access in real time to the information. This promotes a transparency, and forces all parties to be clear and concise in their communication. With many problems of commissioning coming from the perception of the process, increasing the objectivity and consistency goes a long way to getting complete buy-in.

Phase III: The Future

As with any process, there is no end, only a series of beginnings. The new beginnings at the Chicago Public Schools revolves first around the completion of process and tool development, then on the further institutionalizing of the commitment. The current staff is the first wave of committed professionals directly managing the process, and developing tools and processes that can transition to the next wave of managers and administrators is crucial to future success. In addition, expansion of the commissioning process beyond construction and capital projects provides the opportunity for additional involvement and greater knowledge of the process and benefits. The next wave of implementation will focus on continual commissioning and retro-commissioning.

Continual Commissioning

A natural extension of commissioning on new projects, continual commissioning provides building operators and managers with tools to continue reaping the benefits realized in quality project commissioning. As managers and operators change, there is a tendency to lose knowledge and therefore, lose efficiency. Implementing a program that can prompt and lead personnel to maintain efficiency allows for easier transition throughout building life. By linking the program to the design and project commissioning, institutional knowledge can reside in a process instead of in people, reducing the impact of transience and turnover on building operation. Long-term commitment to continual commissioning will extend the benefits realized in project commissioning, increase asset life, and improve the dissemination of knowledge. Engaging operators on a regular basis with measurable performance metrics not only increases the efficiency of the building, but it provides excellent opportunities for ongoing training. The resultant upward spiral builds success on success and stabilizes the building portfolio.

Retro-Commissioning

In order to address the quality of systems in facilities where new construction or renovation is not occurring, retro-commissioning can be employed to identify operational and system application issues, and develop recommendations. Starting with facility assessments to determine the relative value of the commissioning process, and proceeding through documentation, testing and recommendations of the providers, retro-commissioning provides a framework not only for determining the physical needs in a space, but also the opportunities for improvement. This improvement can be functional, but more likely results in improved energy performance and increased maintainability.

Conclusion

Given the constant struggle to balance the use of resources in planning and execution, change often comes of necessity rather than intention. CPS started commissioning reactively in response to low project quality resulting from structural issues. By refusing to stand pat, and by choosing to adapt as needed, the foundation laid by adopting and implementing commissioning has blossomed into a full-blown commitment to commissioning as a part of project delivery. Building on this commitment, to the point where commissioning is assumed instead of discussed, will be the challenge of the next three years.