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Pushing the envelope

The Need for Enhanced Commissioning

Set goals, check goals, meet goals. This is the backbone of commissioning, although like many other things, the devil is in the details.

BY JEREMY CARKNER AND JAMIE MCKAY

Commissioning of building systems has become a routine practice in new building construction and major renovations, particularly with the advent of newer requirements arising from LEED® and other green building rating systems. The process for commissioning mechanical and electrical [M&E] systems has been refined over the last 30 years, and applied to a wide variety of infrastructure, with strong guidance from ASHRAE since the 1980s. The National Institute for Building Sciences [NIBS] began to formalize the Building Envelope Commissioning [BE Cx] process under the “whole building commissioning” concept in 1998. In 2006 NIBS released Guideline 3 - Exterior Enclosure Technical Requirements for the Commissioning Process and updated this document in 2012.

Building upon the established processes developed for M&E commissioning, BE Cx provides an effective means of:

- Planning,
- Delivering, and
- Operating building systems.

PROJECT TIMELINE SOURCE: MARK LEAFSTEDT, WHAT IS COMMISSIONING, TESTMARC COMMISSIONING SOLUTION, PRESENTATION FOR AABC COMMISSIONING GROUP [1].

So, what is BE Cx?

In the case of BE Cx, the process hones in on the building envelope as its area of focus, e.g., walls, roofs, windows, and below-grade systems. The guidelines listed above are helpful in defining the roles and considerations of BE Cx but provide a wide range of concepts and implementation options to address varying project types. Within this framework practitioners of BE Cx in North America have responded to the market with dramatically different interpretations and approaches to BE Cx, and as such, variation and confusion exists on the level of scope required and delivered. This has left owners, as well as practitioners, asking for a level playing field and a better defined scope of work.

Regardless of interpretation, there are some fundamental aspects to successfully delivering BE Cx, as shown with the following timeline, and discussed in more detail below.



Owner's Project Requirements

The BE Cx Authority [BE CxA] acts as the Owner's advocate throughout all stages of the building's design and construction, and is a key resource in identifying and addressing performance issues during the first year of occupancy. Owner's Project Requirements [OPRs] are a critical task in establishing performance goals and expectations and ideally are developed during the pre-design stage. OPRs establish performance and functional requirements for the passive building envelope systems, and allow design activities, material selections, and construction sequencing the opportunity to respond against an understood baseline.



Similarly to M&E OPRs, the BE Cx OPRs can be developed by the owner in isolation, however the involvement of a BE CxA in OPR development will enable the owner to evaluate their priorities and requirements. Unfortunately, not all owners are equipped to develop a thorough and balanced OPR; considering the cost, time, and quality triangle, plus the principles of building science. A knowledgeable BE CxA can also help integrate the project's sustainability initiatives into the OPR, including: daylighting strategies, passive energy optimization, service life determination and building durability planning.

This being said, OPRs are inherently a dynamic set of parameters that can evolve and respond to design options and construction considerations. OPRs will also be tested during the Integrated Design Process [IDP] and this is an opportunity for the BE CxA to demonstrate their role and value to the full team, where their experience in a wide variety of building envelope systems and also understanding of building envelope failure mechanisms can be brought to bear as a means of evaluating trade-offs and changes in OPR philosophy. Functional characteristics for building envelope systems must be used as the starting point for BE Cx OPR development, with a dedicated focus on energy [i.e. heat and air flow] and durability since these are essential considerations for a high-performance building. These characteristics also influence the M&E OPRs and M&E system functional performance, and as such, BE Cx and M&E Cx OPRs must be well-coordinated.

Role of IDP

Although BE Cx focuses primarily on building envelope systems, the process follows a distinct and defined track in the design and construction process. Incorporating the BE CxA in an IDP allows a multitude of perspectives, priorities, specialties, and experts to discuss and arrive at whole building solutions. The BE CxA's engagement during pre-design is helpful in these instances since a greater degree of owner understanding and perspective has been collected, thus solidifying the BE CxA's position as an independent advisor all throughout the process. Unfortunately, the current trend in the industry is to engage the services of a BE CxA into design development or later in design, and hence the early goal setting and independent advocacy for the building envelope systems is more difficult to achieve.

"The Plan"

While most project teams are familiar with a M&E Cx plan and Cx specifications, the BE Cx plan and associated specifications are equally important and must be integrated into the overall Whole Building Cx plan. The BE Cx plan is intended to outline primary roles and responsibilities as well as the general process and timeline for BE Cx. The plan is contractually implemented via BE Cx specifications where the following typical requirements are outlined:

- Shop drawing submittals and review process;
- BE Cx Forms and Checklists for completion by the Constructor's BE Cx Agent;
- Material sample submittals;
- Pre-installation meetings;
- Installation forms and checklists;
- Mandatory mock-ups;
- Mandatory manufacturers' site visits, testing and reporting;
- Sample removals and replacements;
- Independent testing requirements and functional performance checklists; and
- Seasonal/post-occupancy functional testing

What is "included"?

Once key goals are identified within the OPRs and the BE Cx plan and specifications have been established, the task must begin to define the building envelope and establish the performance characteristics for the various components and systems in terms of function[s], construction trade involvement and overall responsibility [e.g., cross-over work]. Performance of the building envelope should be evaluated on the following functions [from Canadian Building Digest document #48 - Requirements for Exterior Walls, originally published in December 1963]:

- Heat flow control;
- Air flow control;
- Water vapour flow control;
- Rain penetration control;
- Control of light, solar and other radiation;
- Noise control;
- Fire control;
- Provision of strength and rigidity;
- Durability;
- Aesthetics; and
- Economics

COLLABORATIVE LIFE SCIENCES BUILDING, OREGON STATE UNIVERSITY SYSTEM/OREGON HEALTH & SCIENCE UNIVERSITY. IMAGE COURTESY OF CO ARCHITECTS AND SERA ARCHITECTS [2].

Building envelope systems are typically multi-layered, multi-component systems that require the installation of components in an overlapping sequence; which in many instances conceal the underlying layers. For this reason, it is imperative that effective and targeted design reviews, shop drawing reviews and construction mock-ups/site [manufacturing plant] reviews be undertaken. The importance of early integration and review cannot be stressed enough – without a properly designed assembly, no quantity of testing can make the system meet its initial goals.

Design Review and System Execution

Material selection, compatibility, constructability, and system continuity are each important elements to address during design reviews, particularly as the design phases progress into increasing levels of completion. Independent design reviews are best implemented with coordination and continued dialogue and feedback from the designers of record, such that issues or gaps are eliminated prior to the tendering stage.

To add to the complexity, component materials have evolved over time requiring an increased level of knowledge of fundamental building science principles. This requires a consistent and robust process to evaluate operational performance of the passive building systems [envelope], which BE Cx affords via its focus on OPRs and design reviews as critical steps prior to construction.

As construction begins, the Constructor's BE Cx Agent needs to organize and implement the required BE Cx activities and coordinate sub-trades and testing agencies. The interaction between the BE Cx Agent [retained by constructor] and BE CxA [retained by owner] is such that BE Cx tasks and requirements are executed as defined and on schedule, while overseen to minimize gaps in delivery and functional performance.

The material and installation verification phase will identify and document that the correct materials have been installed, in the correct sequence and in accordance with the applicable design details. The performance verification phase will then effectively "test" the in-situ elements to confirm the installation and identify any deficiencies.

At the completion of the project, the BE Cx Final Report provides a record of the installed materials, and mock-ups and tests completed. The report is a valuable piece of information for diagnosing and addressing any post-construction issues that might arise.

BE Cx "In Practice"

CASE STUDY: COLLABORATIVE LIFE SCIENCES BUILDING, OREGON STATE UNIVERSITY SYSTEM/OREGON HEALTH & SCIENCE UNIVERSITY

Size 650,000 ft²
Project Value \$211 M [USD]

Scheduled Completion 2014
Target LEED Platinum NC

General Contractor JE Dunn



- **BE CxA Role:** To provide technical feedback, review and keep the ownership group informed whether the design meets the OPRs.
- **Key BE CxA Activities:** Review shop drawings and submittals; mock-up review/testing; fabrication shop visits; periodic field reviews during installation.
- **Timing/Coordination:** OPRs written by architect in CD phase; BE CxA engaged late in CD phase.
- **Key Challenges:** BE CxA vs. BE Consulting role definition; technical solutions and specific details; value-engineering process and compliance with OPRs; revisions to OPRs during CD phase.
- **Lessons Learned:** Earlier involvement of BE CxA is warranted; clear definitions of roles and responsibilities; linkage of OPRs and consequences for end-users if OPRs compromised; documentation plan and buy-in by owner team; owner budget for BE Cx activities must be balanced against key expectations and areas to provide value to project team.

Conclusion

Using the framework outlined above, the BE Cx approach can be tailored to suit the specific needs for each project, owner and project team members. While the aim of industry may be to "push the envelope" with new systems, design configurations, and enclosures, the primary desires of high-performance, efficient buildings and long-term durability must remain. It is against this mandate that the BE Cx process functions most effectively.

Although there are many possible paths to commission the building envelope, the emphasis should be placed on well-developed OPRs, early design review and an integrated commissioning plan. Understanding and communicating owner goals and intentions enables the team [design and construction] to align commissioning activities with project timelines and assign responsibilities, ultimately dispelling scope confusion while achieving lasting value. ◀

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