Commissioning: What Architects Need to Know

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Commissioning: What Architects need to know.

- What is Commissioning (Cx)?
- How did it originate?
- Why is it relevant today?

- What are the different types of Cx?
- What’s the difference between Re-Cx vs. Retro-Cx?
- What is Whole Building Cx?
- What’s the difference between a Cx Authority and a Cx Agent?

- What is the Architects role in the Cx process?
- What elements of Cx are most pertinent to an architect?
- How should Architects budget for and manage the Cx process?
What is Commissioning?

Simply...

Set goals, check goals, meet goals
Commissioning (Cx) A Quick History.

- M&E systems
- Testing, Adjusting, Balancing (TAB)
- Occurs towards end of construction phase
“The Commissioning Process is a quality-focused process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.”

Translation:
The Owner gets what they want and paid for.
What did the Owner pay for?

- How the customer explained it
- How the project leader understood it
- How the engineer designed it
- How the programmer wrote it
- How the sales executive described it
- How the project was documented
- What operations installed
- How the customer was billed
- How the helpdesk supported it
- What the customer really needed
What is it really?

**Commissioning is an end-to-end process that follows a plan**

- A well executed commissioning plan will:
  - Satisfy the Owner’s Project Requirements
  - Ensure that individual systems operate properly
  - Integrate these systems efficiently
  - Provide Operations Staff with the training & tools necessary to operate and maintain the facility as intended
What else is there to Commissioning?

- Commissioning is not simply:
  - The last step in construction
  - Simple equipment start-up
  - Limited to Testing, Adjusting & Balancing (M&E)
  - Observing just one operating scenario
  - Assembling a set of typical Project Close-out Documents

_There’s more to commissioning than just the “traditional activities”. _
Modern Commissioning

- Re-defined by ASHRAE, LEED®, CSA, et al
- Whole building approach, includes M&E, BE, IT, security etc.
- Starts at project concept and is a team effort.
- Process extends through warranty period into occupancy and beyond
- Goal is to satisfy Owner’s Project Requirements (OPR’s)
## Design & Construction Timeline

### Traditional Timeline:

<table>
<thead>
<tr>
<th>PRE-DESIGN</th>
<th>DESIGN</th>
<th>Coord. &amp; Peer Rev.</th>
<th>CONSTRUCTION</th>
<th>OCCUPANCY</th>
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**Project Timeline**

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**Today’s Timeline:**

**Project Timeline**

- **COORDINATION & PEER REVIEW**
- **COMMISSIONING**
Construction and Cx Timeline

**Project Timeline**

- **PRE-DESIGN**
  - Owner’s Project Requirements
  - Design Document Reviews
  - Basis of Design Review
- **DESIGN**
  - Commissioning Plan
  - Revised Plan
  - Scoping Meetings
  - Design Document Reviews
- **CONSTRUCTION**
  - O&M Document Review
  - Construction Checklists
  - Pre-Func. Test
  - Start-up
- **OCCUPANCY**
  - Functional Tests
  - O&M Training
  - Seasonal Testing
  - Warranty Review
  - Cx Report and Systems Manual
  - RCx

**COMMISSIONING**

*Source: Mark Leafstedt, What is Commissioning, TestMarc Commissioning Solutions, presentation for AABC Commissioning Group.*
LEED Fundamental & Enhanced

**Fundamental**
- Prepare the OPR’s
- Prepare the Cx Plan including EIVF’s and PVF’s
- Incorporate the Cx Plan into the CD’s.
- Site reviews, witness tests & training plan
  - Review the BOM for completeness
- Prepare the Cx report.

**Enhanced**
- Review the schematic / BoD for OPR compliance
- Review construction drawings near completion
- Review the contractors submittals (shop dwgs.)
- Development of a Systems Manual for re-Cx.
- Near warranty end or post-occupancy review.
Re-Commissioning (R-Cx) vs. Retro-Commissioning (Retro-Cx)

Re-Commissioning
An application of the commissioning process requirements to a project that has already been delivered using a proper commissioning plan and where we are able to use the documentation created during the previous process.

Retro-Commissioning
The Commissioning Process applied to an existing facility that was not previously commissioned and where documentation does not exist.

ASHRAE Guideline 0 – 2005
NRCAN Re-commissioning Guide for Building Owners and Managers
CSA Z320-11, Section 3: Definitions
Retro-Cx Objectives:

• Optimize Buildings Operations:
  • Energy Consumption (direct $$$)
  • IAQ (Occupant satisfaction, standards: indirect $$$)
  • Add Market value of property asset based on retro-Cx being completed

• Optimize Maintenance
  • The objective is to capitalize on the investments made to achieve the above
Definition of Roles

Cx Authority (CxA):
- Responsible for guiding the Cx process
- Reports directly to the Owner.

**Duties:**
- Preparation of forms
- Supervision and Leadership of the Cx process
- Final approval of the documentation

Cx Agent:
- Executes the Cx field duties.
- Typically the lead constructor.

**Duties:**
- Provide labour and technical skills
- Completion of forms
- Overall scheduling during the construction phase
- Preparation and delivery of the documentation
“The Checklist Manifesto”
Whole-Building Commissioning

- Team effort – Design team, construction team, independent CxA, Owner, Facility Manager, equipment manufacturer
- Starts at project concept
- Process extends through warranty period into occupancy and beyond
- Includes systems other than M&E such as telecom, security, BE, etc.
- Goal is to satisfy Owner’s Project Requirements (OPR’s)
There’s more than just M&E...

- IT / Voice
- Security (including Door Hardware)
- Fire Alarm / Fire Protection
- Audio Visual / Wayfinding
- Landscaping
- Building Envelope
BE Cx - Scope of Work

- Owner’s Project Requirements
- Design Reviews
- BE Commissioning Plan
- BE Commissioning Specification
- On-Site Review & Testing
- Cx Report + Re-Cx Plan

ASHRAE Guideline 0-2005, The Commissioning Process
Used as the foundation for Cx process

ASHRAE
Guideline 1-2007,
HVAC&R
Technical
Requirements for the
Cx Process

NIBS
Guideline 3-2012,
Exterior Enclosure
Technical
Requirements for the
Cx Process

Guidelines
2-200X and 4-200X through
14-200X, Technical Cx
guidelines dealing with
structure, electrical, lighting,
interiors, plumbing, etc.
NIBS Guideline 3

- Guideline 3 is a big document of what can be done
- Covers wide range of tasks
- Includes lots of supporting documentation and sample formats

“The commissioning objectives ... can vary tremendously...”
NIBS Guideline 3

Annex C  Costs and Benefits
Annex D  Documentation and Responsibilities
Annex E  Commissioning Process Request for Qualifications *(Not used in Guideline 3. See Guideline 0.)*
Annex F  Roles and Responsibilities - Commissioning Team Members
Annex G  Commissioning Plan *(Not used in Guideline 3. See Guideline 0.)*
Annex H  Acceptance Plan *(Not used in Guideline 3. See Guideline 0.)*
Annex I  Owner’s Project Requirements Workshop Guidance *(Not used in Guideline 3. See Guideline 0.)*
Annex J  Owner’s Project Requirements
J.1 - OPR Checklist
Annex K  Basis of Design
K.1 - BOD Checklist
NIBS Guideline 3

Annex L- Specifications

L.1 Preliminary Table Of Contents of Specification Sections that may include Building Exterior Envelope Commissioning Requirements

L.2 Exterior Enclosure Specifications

L.3 Example Draft Specification, Section 01811 - Building Exterior Enclosure Commissioning

L.4 Example Specification 01810 of General Requirements for a Recent Project

L.5 Example Specification 01811 of Fenestration System Testing Requirements for a Recent Project

Annex M Construction Checklists

Annex O Systems Manual

Annex P Training Manual and Training Needs (*Not used in Guideline 3. See Guideline 0.*).

Annex R Integration Requirements

Annex S Interference and Coordination with other Systems (*See Annex R*)

Annex T Communications: What, When and Who (*Not used, see Annex R*)
NIBS Guideline 3

Annex U

Exterior Enclosure Testing Procedures

Sub-Annex U.1: Laboratory Testing

Sub-Annex U.1a: Laboratory Testing Case Study Example

Sub-Annex U.2: Field Testing

Sub-Annex U.2a: Field Testing Case Study Example

Sub-Annex U.2b: Recommended Practice for Incremental Field Water Testing

Sub-Annex U.2c: Example Doors and Windows Functional Test for a recent project

Sub-Annex U.2d: Example Mock up Window Functional Test for a recent project

Sub-Annex U.2e: Example Exterior Wall Drainage Plane System Functional Test for a recent project

Sub-Annex U.3: Resources for Testing

Sub-Annex U.3a: Reference Standards for Field Testing

Sub-Annex U.3b: Technical information

Sub-Annex U.3c: Testing Resources by wall Assembly

Annex V

Pre-Design Phase Commissioning Process Specific Needs (Not used)

Annex W

Design Phase Commissioning Process Specific Needs (Not used)

Annex X

Construction Phase Commissioning Process Specific Needs (Not used)

Annex Y

Constant Commissioning of the Building’s Exterior Enclosure

Annex Z

Example Calculation Procedures and Tools
“The commissioning objectives ... can vary tremendously...”

Do you have to do it all??

- Historical Assemblies (Mass masonry)

- New to market

- Unique and Untested
BE Cx - Construction

- Process Follows BECx Specifications:
  - Testing requirements (manufacturer or on-site)
  - Shop drawing submittals
  - Material submittals
  - Mock-ups
  - Manufacturer’s site visit
  - Sample removals/renewals

- Mock-ups:
  - Workmanship & Transitions
  - Quality Assurance

- BE Cx Report
- Re-Cx Plan → Warranty & Maintenance Period
How is BECx Different?

Follow the same steps as Cx but:

• Systems are different

• More passive than active

• More often "site-built" assemblies …

• … Often in problematic weather

• Multiple manufacturers and trades at one location

• Building Science is the blend of Architecture with Mechanical and Materials Engineering
Architects Role in Cx

The Architect leads the design team and is required to complete or coordinate the following:

- Identifying Cx activities in their project schedule,
- Providing a written *Basis of Design* prior to the start of Construction Document preparation,
- Providing single line system schematics with general description of sequence of controls with the 50% construction drawing submissions,
- Provide drawings (i.e., plans, elevations, sections and details) to clearly illustrate each material within an assembly and the connections of adjacent assemblies,
- Provide off-site and on-site testing requirements for the building envelope assemblies,
• Advising the CxA of acceptable tolerances for equipment performance for aspects such as provided capacity, measured efficiency or phase current balance,

• Respond to the CxA’s design and construction document reviews,

• Coordinate the testing and training requirements in their specifications with the CxA’s commissioning specifications section and Commissioning Forms,

• Reviewing and commenting on draft Commissioning Forms, paying particular attention to issues highlighted by the CxA,

• Providing required information to permit preparation of the Commissioning Forms by the CxA,

• Attend Building Envelope mock up verification activities

• Attend commissioning meetings as required by the CxA,
Architects Role in Cx

• Copying the CxA on all SIs and CCNs and site reports

• Selective witnessing of testing in conjunction with the CxA

• Review and address issues identified on the completed Commissioning Forms,

• Review contractor submitted marked-up record drawings for accuracy,

• Coordinate the mechanical engineers review TAB reports and providing necessary instructions to the contractors to address any balancing deficiencies.

• Review Architectural, Building Envelope Consultant, Independent Testing/Inspection agent, and/or material/manufacturer’s’s representative’s site visit reports,
Architects Role in Cx

- Provide summary descriptions and expected conditions to be provided of each system for incorporation into the Building Operations Manual. (Highly recommended)

- Provide descriptions of emergency operating and post emergency start-up procedures for the building for incorporation into the Building Operations manual

- Partake in staff training including providing an overview of systems design intent,

- Address warranty period user issues.

And you’re done!
Commissioning Economics

- Cx is not an additional layer of construction or project management.
- Its purpose is to reduce the cost of delivering construction projects and increase value to owners, occupants, and users.

Source: ACG CxA Webinar.
Estimates of Construction Phase Commissioning Costs
(Costs for the commissioning authority in new construction, per square foot)

Source: Establishing Commissioning Costs, PECI, revised 02/14/2002.
The cost of reviewing a project design (per device): $10

The cost of finding an error before a device is purchased: $100

The cost of restocking and replacing a device once it is installed during the construction phase: $1,000

The cost of replacing a device after a building is occupied: $10,000
Cx Examples

• Fast food client, “cookie cutter” buildings.
• 2,500 sq. ft., based on standard details.
• Over 100 sites were visited in one year.
• Basic operation Cx was completed.

• Results: Over 60% of the sites visited had significant construction issues that required a return visit to verify proper basic construction.
• Mission Critical Facility (MCF).
• 100% reliability of M/E systems was demanded.
• Contractor absolutely assured us that emergency power systems were functional, no need to test.
• One basic test was requested and granted.

• It failed.
• 11 times.
• The twelfth time was successful.
Building Envelope Cx (BECx).

Shop drawings for window assemblies were reviewed and accepted.

Contractor installed the window correctly, inspected by team.

In the first year severe HVAC issues were occurring.

Issue: the glass film was installed on the wrong side of the pane at the factory.
Designers and constructors are moving away from an adversarial relationship…

Towards a more cooperative relationship.
In Summary...

What should architects always remember:

• Commissioning is not just simple M/E start up
• BECx is specialty work
• Commissioning is not a commodity.
• Architects play a leadership role in Cx.
• Commissioning reduces problems, but nothing beats a good design combined with qualified construction.
A typical project…
Questions?
Thank you!