BUILDING COMMISSIONING

What's it all mean, what does code require, and what's the best approach for my facility?

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Agenda

- The various Cx terms and definitions
- Details on the process
- City of Fort Collins requirements
- Utility rebates and programs

Commissioning

The Terms and Definitions

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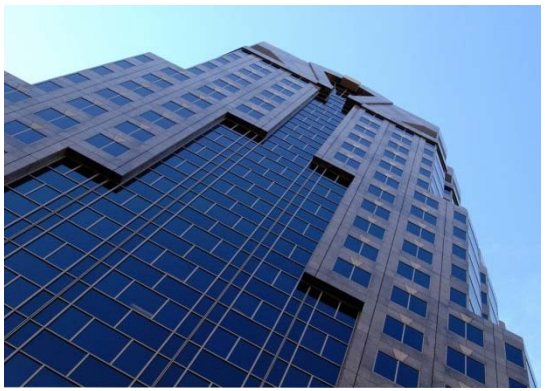
Commissioning Goal

- Commissioning concept comes from shipbuilding: “A ship manned and in condition for active service.”
- Out of commission – not in working order
- **Goal of commissioning in buildings**: get a building in good working order and keep it there



Commissioning Goal

- **Working order can mean a few different things:**
  - As designed
  - Owners requirements
  - Energy efficiency
- **Want to keep all these items in mind!**

Single Instance/ Periodic Commissioning

New-Construction Commissioning (NC Cx):

- Commissioning applied from project design to initial occupancy
- Can include review of HVAC systems, lighting, envelope, and other building systems.

Single Instance/ Periodic Commissioning

NC Cx - Focus and Deliverables:

- Design reviews through the design process
- Development of owner's project requirements (OPR)
- Development of test plans and checklists
- Equipment testing and site observations → punch list
- Training evaluation
- Development of system manuals
- Warranty phase review

Single Instance/ Periodic Commissioning

NC Cx - Drivers:

- USGBC - Leadership in Energy & Environmental Design (LEED) – NC or BD+C
  - EAp Fundamental Cx of Building Energy Systems
  - EAc Enhanced Cx
- City Codes

LEED

Single Instance/ Periodic Commissioning

NC Cx - Benefits:

- Ensure that the building is in good working order before it is turned over - catch contractor mistakes like missing or incorrectly installed equipment – this will reduce:
  - Occupant complaints and callbacks
  - Indoor air quality and thermal comfort problems
  - Premature equipment failure
  - Litigation
- Likely to reduce your operational costs by yielding 5%–10% improvements in energy efficiency
- Ensures facilities personnel know how to operate key building systems

Single Instance/ Periodic Commissioning

Existing Building Commissioning (EB Cx)

- **Retro-commissioning (RCx)**:
  - Commissioning systems in an existing building; assumes no prior commissioning activity
- **Re-commissioning (RCx):**
  - Commissioning systems in an existing building; assumes there has been prior commissioning activity and this is a checkup

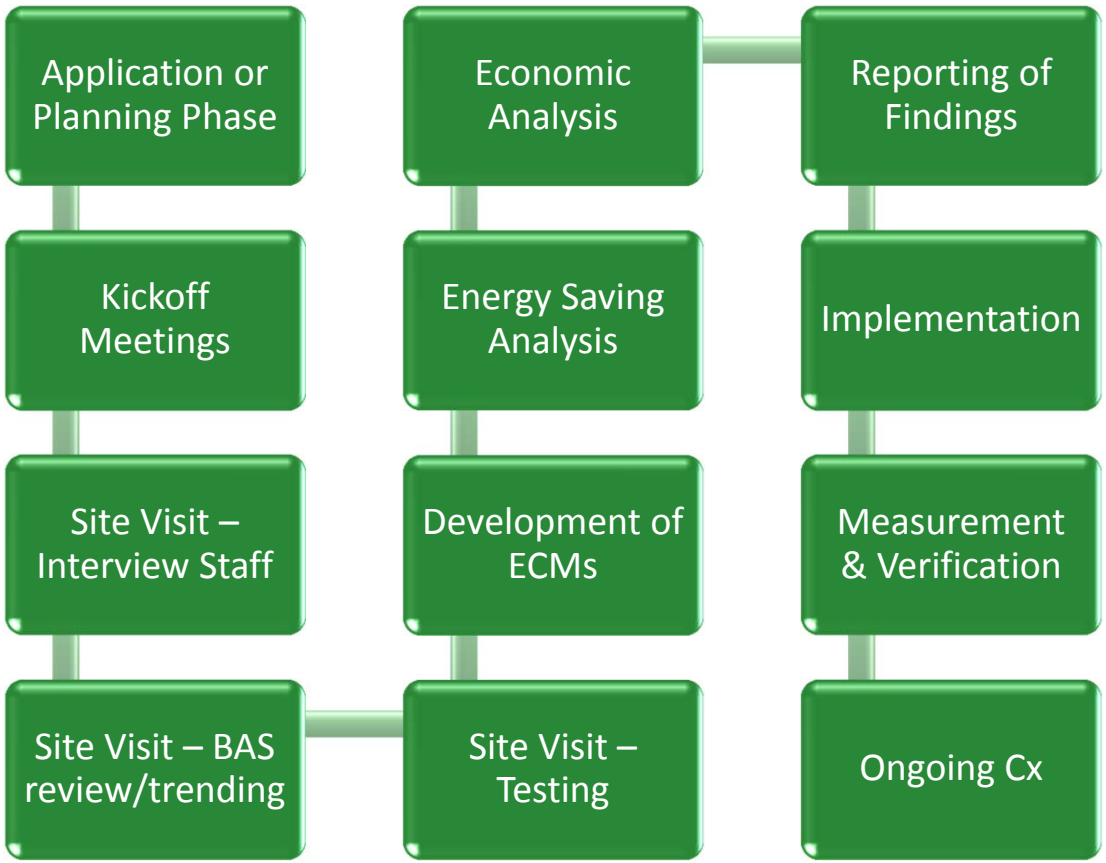
Single Instance/ Periodic Commissioning

EB Cx - Focus and Deliverables:

- Utility bill analysis
- Energy disaggregation of major end uses
- Review of equipment operation and efficiency
- Review of building control sequences
- Report summarizing findings and recommendations
- Assistance through implementation
- Verification of implementation

Single Instance/ Periodic Commissioning

EB Cx – the Process



Single Instance/ Periodic Commissioning

EB Cx - Drivers:

- Utility programs
- USGBC LEED - EB or O+M
  - EAc EB Cx: Investigation and Analysis
  - EAc EB Cx: Implementation
- Energy Codes

Single Instance/ Periodic Commissioning

EB Cx - Benefits:

5-20% Energy Savings Potential

- Reduce energy use, peak demand, energy costs
  - RCx type of measures typically provide a 6 month to 2 year payback
- Improves system performance and occupant comfort
- Reduces maintenance issues and costs
- Higher energy score and increased ability to market building as “green” or achieve certifications

Ongoing Commissioning

Continuous Cx™ (CCx):

- Term registered by Texas A&M University that applies to their ongoing optimization process

Monitoring-Based Cx (MBCx):

- Term often used by utility programs for focus on collecting monitored data and utilizing building staff to diagnose problems
- Steps include: 1) install BAS 2) RCx 3) OCx with measured savings

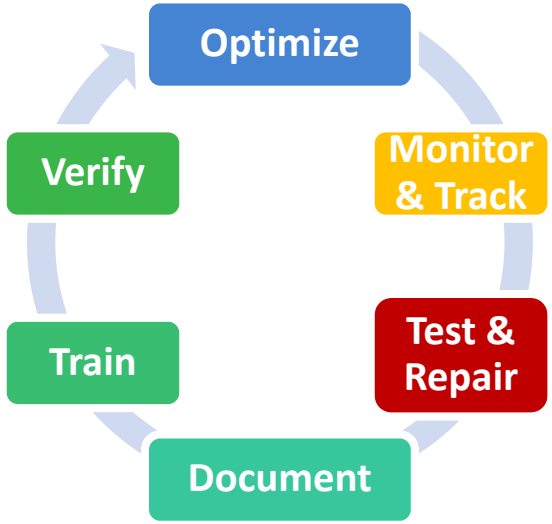
Ongoing Cx (OCx):

- General term to summarize services related to providing continuous review and improvement in the operation of building systems; includes documentation and training updates

Ongoing Commissioning

Focus and Deliverables:

- Optimize operation with multiple season review
- Monitor and track performance over time along with notification of equipment malfunction or if items are manually controlled



- Typically collect BAS (trend) data to review equipment operation and building performance
  - Manual process (facility staff or energy consultants)
  - Software diagnostic tools can automate this process

Ongoing Commissioning

Focus and Deliverables (cont):

- Test equipment and identify cause
- Feed information into Work Order systems
- Repair issues
- Update documentation and staff training
- Verify energy savings

Ongoing Commissioning

Approach:

- **Manual OCx**
  - Deeper operational review can be triggered by a specified time period, increase in energy usage, or increase in occupant complaints
  - Set up of “smart alarms”
  - “Human Analytics”
- **Fault Detection and Diagnostics Software**
  - Monitors system performance – immediate identification of issue
  - Software tool notes when operational parameter is different than specified (normal) operation by using “rule based approach”
  - Can identify duration of fault and associated cost (prioritization!)

Ongoing Commissioning

Fault Detection and Diagnostic Software Services:

- Many offering Software as a Service (SAAS) - software and associated data centrally hosted on the cloud
- Variety of depth and features
  - Live connection to the BAS or exported trend data
  - Quantify energy/cost impacts
  - Connection with work order systems
  - Most tools do not have active control functionality

Sample of Software Products

Company	Product	Key Features
Ezenics	Optimized Operational Readiness™	SAAS packaged offering – built in rules with option to write, emphasis on fine tuning, standardized naming conventions, mobile app with QR codes
KGS Buildings	Clockworks™	SAAS packaged offering – quantifies costs (prioritizes on multiple criteria), gives possible causes of faults, built in rules, modules for custom analysis
SCIEnergy	SCIwatch™	SAAS packaged offering - designed for larger buildings, built in rules, pushes data nightly, ranks faults by equipment type
SkyFoundry	SkySpark™	Software license (can be setup on cloud) – flexible customization for systems and rules; scalable; requires detailed knowledge to integrate, connect systems, and write rules

And several more…

Ongoing Commissioning

Drivers:

- USGBC LEED - EB or O+M - EAc : Ongoing Cx
- Building staff has limited time and resources – systems get out of tune over time and issues can be hard to identify.
- Operational issues have a large impact
- Four years after RCx was completed, it was found that energy savings dropped by 25% (~ 6%/yr average)

**Study by Texas A&M Energy Systems Lab for the US DOE and IEA (IEA Annex 47 Subtask C Final Report, 2009)*

Ongoing Commissioning

Benefits:

- Continuously improve equipment operation and occupant comfort (prevents building drift) and continues to identify new optimization opportunities over time
- Keeps building documentation up to date
- Keeps staff adequately trained
- Protect the initial investment in commissioning and achieve additional energy savings over time

Ongoing Commissioning

Benefits (continued):

- Drive towards predictive maintenance practices rather than reactive or time based maintenance
- Best practices in building maintenance and operations were found to **reduce energy use 10-20%;** poor maintenance practices can increase use 30-60%

**Frankel, M., Heater, M. and Heller, J. "Sensitivity Analysis: Relative Impact of Design, Commissioning Maintenance and Operational Variables on the Energy Performance of Office Buildings" New Buildings Institute. August 2012.*

Details on Each Process

The When, Why, and How

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What to Expect (What Will You Find)?

NC Cx

- Design selected will be a balance between initial and ongoing operating costs (Cx agent represents energy and operating perspective)
- Ensure drawings provide necessary detail and content matches specifications
- Site observations at various stages of construction ensure that the correct equipment and components are installed properly

What to Expect (What Will You Find)?

NC Cx

- Selected equipment will be functionally tested (at specified sampling rate)
  - Piping correct and insulation adequate
  - Valves wired properly, dampers/actuators stroke
  - BAS points mapped correctly, sequences optimized
  - Oversee test and balance work

What to Expect (What Will You Find)?

NC Cx

- An ongoing issues log (punch list) is maintained until items are corrected
- Ensure contractors provide adequate training to the staff on operation of the systems
- System manuals are developed/left for staff to reference
- Ensure issues are addressed through the warranty phase

What to Expect (What Will You Find)?

NC Cx

- Duration depends on the design process, construction, and occupancy period
- Cost depends on: size of project, complexity of systems, systems to be Cx, when Cx begins, level of detail provided
    - Rule of thumb: 1-6% of construction costs

What to Expect (What Will You Find)?

RCx

- Utility bill analysis will provide
  - Calculated energy use index (EUI) and benchmarked
  - Identify building load profiles and seasonal abnormalities
  - Identify demand limiting opportunities
  - Energy Star score

What to Expect (What Will You Find)?

RCx

- Functional testing will identify component functionality
- Trend data review will identify operational functionality
- BAS review will identify control sequence, set point, and mapping issues

What to Expect (What Will You Find)?

RCx – Common Measures

1. Scheduling of equipment
2. Outside air optimization and economizer operation
3. Temperature resets
4. Set point optimization and resets
5. Simultaneous heating and cooling
6. Sensor calibration
7. VFD retrofits
8. Lighting Control
9. Control loop tuning
10. Maintenance items

5-20%
Initial Energy
Savings Potential

What to Expect (What Will You Find)?

RCx

- Energy saving and economic analysis pill provide simple payback or ROI
- Report will summarize findings and spell out recommendations
- Implementation assistance or verification is needed for ensuring proper installation/operation and fine tuning (optimization)

What to Expect (What Will You Find)?

RCx

- Duration is typically 8-12 weeks for primary investigation; the full scope (from planning to verification phase completion) can be close to a year depending on implementation time
- Cost depends on: number and complexity of systems, level of detail provided
    - Rule of thumb: $0.15-1.00/sf

Pro/Cons for Various Scope Items

- **Equipment Review**
  - Typical RCx reviews major HVAC equipment operation; balance 'fee versus scope' for small equipment and other systems
  - Consider capital items?
- **Level of Testing**
  - Determine appropriate level of functional testing, point to point testing, and trend analysis → deficiency log

Pro/Cons for Various Scope Items

- **Energy Savings Analysis**
  - Estimate of savings potential (lo/med/high)
  - Spreadsheet analysis
  - Energy model
- **Economic Analysis**
  - Engineers estimation, vendor pricing
  - Simple payback, ROI, or LCCA

Pro/Cons for Various Scope Items

- **Reporting**
  - Deficiency log
  - Detailed report
- **Implementation Roles**
  - Advisory, assistance, management (turn-key)
- **Post Implementation**
  - Verification services
  - Staff training
  - Ongoing Cx

When To Do Commissioning

- **NC Cx**
  - During early design phase
- **Re- or Retro- Cx**:
  - On a periodic basis
  - Energy use changes
  - Increase in comfort problems or maintenance issues
  - Change in building use/design
  - Change in facility staff
- **Ongoing Cx:**
  - Ongoing basis or at specified time intervals

Who is the Team

- **Utility:**
  - Account rep or program manager
- **Client**:
  - Facility team lead (technical and building knowledge)
  - Preferred vendors (controls, service, mechanical)
- **Service Provider:**
  - Someone you trust with technical knowledge
  - Approved program service providers
  - Certifications
    - Professional Engineer (PE)
    - Certified Energy Manager (CEM)
    - Cx Certifications: CxA by ACG (AABC Commissioning Group), CBCP by AEE (Assoc of Energy Engineers), CPMP by ASHRAE, CCP by BCA (Building Commissioning Assoc), CxAP/CAP/CxM/GcxP or GCP by Univ of Wisconsin Madison

City of Fort Collins

The Energy Code Requirements

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As Required by City Energy Codes

New Buildings or Additions:

- 15,000 sf or larger
- Requirements akin to LEED EAp - Fundamentals Cx
- Not required to have Cx agent involved in design - however there are several Cx deliverables associated with design phase commissioning (OPR, BOD)
- Light envelope Cx required (this is in conjunction with building air tightness requirements)
- Includes some sound testing
- Service provider must have Cx credentials; for a list of Cx agents email Building Department or Gary Schroeder GSchroeder@fcgov.com

As Required by City Energy Codes

Renovations:

- Major alterations (greater than $50,000) are required to get an energy assessment
- This is a free service from the utility

As Required by City Energy Codes

Cooling Rebates:

- If receive a cooling rebate for cooling equipment
- That specific system needs to be commissioned
- Commissioning form on Efficiency Works website

Utility Programs

The Information

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Efficiency Works

Website:

- http://efficiencyworks.prpa.org/for-business/

- **Building Tune-up Program Requirements:**
  - Receive electricity by Estes Light & Power, Fort Collins Utility, Longmont Power & Communications, Loveland Water & Power
  - Programs are customized for every building size and type
- **Program Cost**:
  - Free RCx study and assistance with energy measure implementation obligations

Efficiency Works

- **Process:**
  - Participant completes and submits application
  - Select a service provider
    - *A list of approved service providers are on the website*
  - Service provider schedules, preforms, and completes the RCx study


Energy Saving
just ahead

HERE TO ANSWER YOUR QUESTIONS

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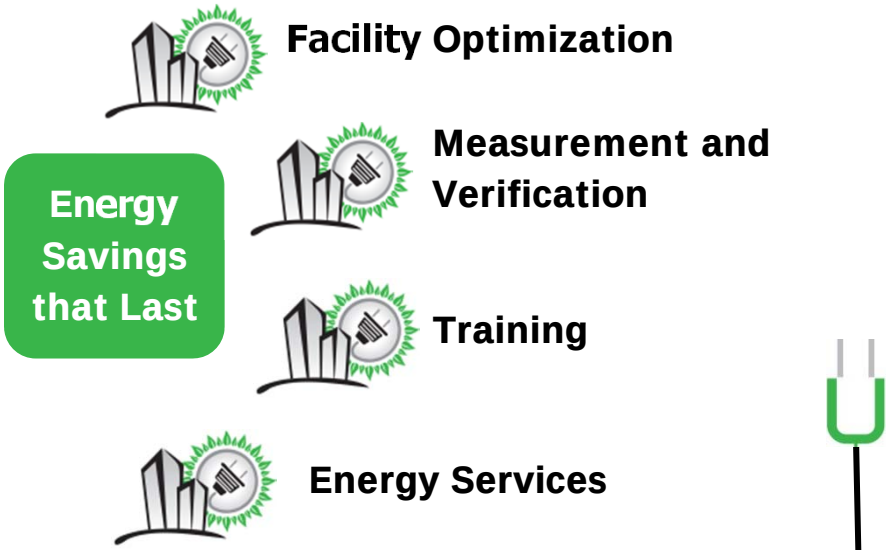

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