Case study: Re-commissioning a high-performance building findings and lessons learned.

David H. Hill  
Chief Engineer, CalSTRS  
Cullen H. Choi, PE, CEM, LEED AP O+M  
Senior Manager, Architectural Energy Corporation

- Introduction  
  - Unique opportunity to hear a building that was commissioned during construction and commissioned again during operations  
  - Building characteristics (age, size, construction specifics)  
  - What the objectives of each of these activities were  
  - What the activities were and how the Cx and RCx activities differ

- Team members  
  - Owner  
    - Facility Management & Operations  
    - Cx Consultant

- Scope  
  - NC Cx  
    - Approach  
    - Findings, including deficiencies  
    - Issue resolutions (obstacles and benefits/impacts)

- EB Cx  
  - Approach  
    - Findings, including deficiencies  
    - Enhancements to original Cx design/controls strategies  
    - Issue resolutions (obstacles and operational, monetary, and energy savings)

- Findings and lessons learned

- Additional information
Why CalSTRS?
A unique opportunity to examine a building that was commissioned during initial construction, and re-commissioned during operations.
Why CalSTRS?

A unique opportunity to examine a building that was commissioned during initial construction, and re-commissioned during operations...
building
Not just any building...

- Structure Height: 277’ 4” P2 to top of upper parapet wall; add 12’ 0” from P1 = 289’ 4”
- Main Lobby Height: 43’ 4”
- Structure Gross: 766,412 square feet
- Tower Gross: 323,596 square feet
- Podium Gross Total: 442,816 square feet
- Podium 1 – 5 Ozz Total: 46,046 square feet
- Podium 2 Public Area: 16,972 square feet
- Podium Lobby: 2782 square feet
- Podium P2 Café: 6970 square feet outdoor patio 2625 square feet
- Podium Fitness Center: 3032 square feet
- Podium Parking: 322,035 square feet
- Server Room: 4422 square feet
- T1P: 24,175 square feet T1B: 5383 square feet T1 Mechanical: 27,558 square feet
- Garage: 1112 parking stalls (two spaces eliminated on P1 in 2010 / 2011)
- Lighting Controls: Lutron (dimmable), Watt Stopper (ON/OFF)
- HVAC Controls: Staefa / Talon
- Tower Supply Fans: (4) 75 HP fans, 320KCFM
- Tower Return Fans: (2) 100 HP fans
- Min Outside Air Station: 30KCFM
- Heat Pumps: 48 Florida Heat Pump
- Split Systems: 9 Daiva
- Exhaust Fans: 3B Greenheck
- Fan Terminal Units: 355 Price
- Chillers: (2) York Chillers 375 ton
- Boilers: (3) Bryan Boilers, 3500 MBH Input, 2940 MBH Output
- HVAC Pumps: Bell & Gossett
- Generator: Cummins 2000Kw, 2922HP, 650 gal belly tank
- Generator: 138gph @ full load
- Fire Pump: John Deere, 75HP, 1000GPM @ 275psi, 150 gal transfer tank
- Fire Pump: 12.7gpm @ full load, pump: 1000gpm @ 212psi, engine: 240BHP @ 2600RPM
- Sprinkler Reservoir: 37,000 gal
- Diesel Fuel Storage Tank: 3000 gal, effective storage capacity: 2700 gal
- Electric mains: (2) PG&E transformers at 480V, 3 Ph, 4000A each
- Gas Main: 2” line
- Domestic Water Main: 8”
- Fire Water Main: 6”
- Irrigation Water Main: 2”
- Domestic Water Booster: Grundfos, 376 gpm @ 232psi max, normal operate at 145psi
examine a building, financial construction, and operations...
Commissioning: [kuh-mish-uh-ning] (v)

The process of ensuring that systems are designed, installed, functionally tested and capable of being operated and maintained according to the owner’s operational needs.
- California Commissioning Collaborative

The Commissioning Process is the Owner’s quality-oriented process for achieving, verifying, and documenting that the performance of buildings, systems, and assemblies meets defined objectives and criteria.
- ASHRAE Guideline 0 & Standard 202

To verify that the project’s energy-related systems are installed, and calibrated to perform according to the owner’s project requirements, basis of design and construction documents.
- LEED BD&C V3 EAp1
A unique opportunity for re-commissioned dual
Re-Commissioning: An application of the Commissioning Process requirements to a project that has been delivered using the Commissioning Process. This may be a scheduled re-commissioning developed as part of an Ongoing Commissioning Process, or it may be triggered by use change, operations problems, or other needs.

- ASHRAE Guideline 0
... is a systematic method for investigating how and why an existing building’s systems are operated and maintained, and identifying ways to improve overall building performance.

- CCC California Commissioning Guide: Existing Buildings
Building's systems are optimized for high building performance.
initial constructing operations...
New Building Cx:
- Inform design to meet OPR
- Functionally test to verify performance
- Document deficiencies & issues
- Ensure proper turnover & training
Existing Building Cx (RCx):
- Investigate operational performance
- Identify opportunities for optimization
- Implement changes & recommendations
- Verify, re-assess, & repeat
Important to make sure all team members have the same expectations of the process, activities, timeline, and deliverables!
Team members:

- Owner
- CalSTRS
  - Principle Real Estate Investment
  - Pannatoni Development Company
- Facility Management & Operations
  - Jones Lange LaSalle
  - Able Engineering
- Commissioning Provider
  - Architectural Energy Corporation
  - Independent Consultants
New Building Commissioning = United Nations
NC Cx UN Member States:
- Owner
- Architect
- Architect of Record
- Design Engineer
- Engineer of Record
- GC/CM
- Civil
- Structural
- Electrical
- MEP
- Controls
- Commissioning
- Etc...

UN Headquarters

NC Cx Concerns & Approach:
- Equipment needs to be designed, installed, and tested to meet Cx goals.
- No major issues with design review and alterations to meet intent of building space-use.
- Project team members performed admirably and were responsive, reliable during construction.
- Cx issues were minimal, and included small controls items, piping, and damper operations...

At the end of the day, the building was delivered as a building that was designed...
NC Cx Concerns & Approach:
- Equipment needs to be designed, installed, and tested to meet OPR
- No major issues with design revisions and alterations to meet intent of building space-use
- Project team members performed well and were responsive, responsible, and reliable during construction
- Cx issues were minimal, and isolated to small controls items, piping details, damper operations...

At the end of the day, the building that was built and delivered matched the building that was designed...
The day, the building that was built and delivered matched the plan as designed...

**Results of NC Cx:**

All issues with design & construction activities had to be addressed to deliver a functional building - but the major emphasis was on delivering the building as designed - that was a problem.
We delivered a high-performance building, can't we just leave now?
We delivered a high-performance building, can't we just leave now?
Entitlement Planning

2005
Construction Commissioning & Turnover
2009

2010

2045

Operations
RCx
& Renovations
Continued Operation
Renovations
Building Upgrades
Adaptive building reuse and re-purposing
Is there a strategic plan for the building, or just leave now?

- 2005: Entitlement Planning
- 2007: Construction, Commissioning, & Turnover
- 2009: SD, DD, CD
- 2010: Continued Operation, Renovations, Building Upgrades
- 2045: Adaptable, Resilient

2-4% of the building life span
Focus change from Design & Construction to Operations

- EB Co Concerns & Approach
  - Building needs to be comfortable
  - Reduce energy consumption
  - Provide enhanced control and operation
  - Identify and correct operational issues
  - Measure building performance

- Transition the building from the theoretical world of design, into the practical world of operations

- Post Co Improvements and results of EB Co (RC)
  - Automation of the wast shaft supply air damper to direct the main air supply to load areas
  - Resetting of the main air handling unit pressure set point
  - Resetting of chilled water temperature set point
  - Resetting of under floor air damper set points
  - Fan terminal unit output set points to match local load conditions
  - Modification of cooling tower operation on cooler days to minimize fan power
  - Increased load monitoring for proper monitoring
  - Boiler firing optimization to reduce short cycling
  - Occupancy tuned return fan staging
  - Building pressurization control optimization
  - Morning warm up sequence optimization and equipment staging (FTUs vs AHU)
  - Abandonment of non-chemical water treatment
  - and many more...
Transition the building from the theoretical world of design, into the practical world of operations.

EB Cx Concerns & Approach:
- Building needs to be comfortable
- Reduce energy consumption
- Provide enhanced control and operation
- Identify and correct operational issues
- Measure building performance
**operations**

RCx Team (a.k.a. UN Security Council)
- Facility Manager & Staff
- Building Engineering
- RCx Provider

**Focus:**
- continued operational refinements based on actual day-to-day activities
- establish pride of ownership
- engage in continued education to constantly provide expertise
- identify building modifications reflective of operational problems

More focused, streamlined, cooperative
*still have different perspectives*

**Focus:**
- integrate building systems that were designed separately to operate more efficiently together
- create opportunities for overall energy efficiency and savings
- recommend cutting edge strategies for equipment, systems, and controls
- provide high-level direction on energy performance
Post Cx Improvements and results of EB Cx (RCx)

- Automation of the west shaft supply air damper to direct the main air supply to load areas
- Resetting of the main air handling unit pressure set-point
- Resetting of chilled water temperature set-point
- Resetting of under floor air damper set-points
- Fan terminal unit output set-points to match local load conditions
- Modification of cooling tower operation on cooler days to minimize fan power
- Increased sub-metering for power monitoring
- Boiler firing optimization to reduce short-cycling
- Occupancy based return fan staging
- Building pressurization control optimization
- Morning warm up sequence optimization and equipment staging (FTUs vs AHU)
- Abandonment of non-chemical water treatment
- and many more...
Optimized building operation simply wasn't achieved through NC Cx...however designed operation was

The ongoing teamwork of Owner, Management, Engineer & Operations, and Consultants helped achieve a building that informed its operation and provided the team members with the appropriate perspectives to achieve all goals.
The Big Picture
Build a Building
Commission it...
**Design & Construction**
- Stop designing buildings so that they can be constructed
- Prioritize operations in design
- Focus on Integrated Design with O&M input

**Owner & Facility Management**
- Exempt sustainable expectations
- Emphasize long-term perspective
- Develop pre- and post-occupancy
- Provide teams with the needed tools
- Contribute early in NC Cx process
- Participate in D&C with the perspective of operations
- Use NC Cx as a time to think "big picture" prior to operations
- Continue development, training and education

- Establishing
- Emphasis
- Development of teams
- Provide tools
Owner & Facility Management

- Establish reasonable expectations
- Emphasize long-term perspective
- Develop pre- and post-occupancy teams
- Provide teams with the needed tools
Design & Construction

- Stop designing buildings so that they can be constructed
- Prioritize operations in design
- Focus on Integrated Design with O&M input

Commissioning Provider

- Establish reasonable expectations
- Emphasize long-term perspective
- Develop pre- and post-occupancy teams
- Provide teams with the needed tools

- Provide big picture support on an ongoing basis
- Consider effects of recommendations on large scale
- Support day-to-day operations with recommendations, don’t hinder them
Commissioning Provider

- Provide big picture support on an ongoing basis
- Consider effects of recommendations on large scale
- Support day-to-day operations with recommendations, don’t hinder them
Why CalSTRS?
A unique opportunity to examine a building that was commissioned during initial construction, and re-commissioned during operations...
Why CalSTRS?
A unique opportunity to examine a building that was commissioned during initial construction, and re-commissioned during operations...

Because we can learn how to save the world. - one building at a time.
Why CalSTRS?
A unique opportunity to examine a building that was commissioned during initial construction, and re-commissioned during operations...

Because we can learn how to save the world.
- one building at a time.

Dave Hill
david.hill3@am.jll.com

Cullen Choi
cchoi@archenergy.com