Commissioning Cx
High Performance Facilities
Green Projects-LEED

15-or-so-Best Practices
Thoughts & Ideas

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Characteristics of High Performance Buildings
- Lower Energy Use
- Reduced Environmental Impacts
- Improved Productivity
- Increased Life Cycle Value
- Sustainable O&M Programs

Current Impacts of Facilities
- On the Environment
  - Buildings use 40% of the worldís energy, 75% of the worldís wood, and 16% of the worldís water
- On the Economy
  - About 20% of a buildingís Life Cycle Costs are due to design & construction, 80% for O&M (excluding occupant costs)
- On People
  - US EPA finds that people spend 90% of their time indoors
  - 30% of new and renovated buildings have IAQ problems

In the Life Cycle of a facility, 80% of the buildingís cost occurs after construction and user occupation.

What If you had aÖ
- Ö better process for designing, constructing, commissioning, operating, maintaining and sustaining new and existing buildings?
- Ö improved methodology to increase and maintain the facility asset value?
What if it resulted in Ø

- Ø improved sustainable designs
- Ø better construction / hand-off
- Ø systems working correctly the first time
- Ø smoother turnovers
- Ø improved operator (O&M) training

What if it resulted in Ø

- Ø lower operating costs
- Ø reduced energy consumption
- Ø improved building environments
- Ø extended life cycle asset value
- Ø increased productivity of the people utilizing the facility / environment

7th Generation Law

"In every deliberation, we must consider the impact of our decisions on the next seven generations."

7th Generation Law

Native American Law (Chief Seattle & Iroquois Confederacy)

Commissioning (Cx)

Commissioning is Ultimate Goals

- All components function as per design intent.
- All components function together as an INTEGRATED SYSTEM.
- All integrated building systems function interactively.
- Energy utilization is efficient and quantified.
- Smooth transition / hand-off from contractor to user.
- FM O&M can sustain an efficient Ops Model.

What Is Commissioning?

Systematic process of assuring by verification and documentation, from the design phase to a minimum of one year after construction, that all building facility integrated systems perform interactively in accordance with the “Owners Intent” Design Intent, Constructed Intent and in accordance with the owner’s operational needs, including preparation of O&M personnel.
Commissioning

Cx
Green ñ LEED

Top Line: What is Commissioning's Ultimate Goal?

To insure that the owner receives a:
1. Well designed, coordinated
2. Better constructed
3. Functional performing
4. Sustainable
5. Maintainable
6. High performance facility

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So why Commission?

- More Complex & iSMARTi Building Systems
- Complex Environmental Control Systems
- Indoor Air Quality Requirements
- Distribution & outside air
- Energy Efficiency Issues
- Increasing Costs of Operation and Maintenance
- Project / Building Turn-Over from Contractor to Owner
- Designer and Contractor iCall Backs After Construction

Sound Bite Definition of Commissioning

- Formalizes the iQuality! portion of iBudget, Schedule and Quality for Scope of Work.
- NOT just a istart-up! activity
- Most important components:
  - Documentation of Intent
  - Verification of Performance Functionality
  - Training of O&M Personnel
- Process to verify functionality of operations, enhance contractor turn-over to owner, avoid O&M problems, improve O&M operating budgets.
Where Does Commissioning Fit In?

BUDGET

Scope of Work

QUALITY

SCHEDULE

Benefits of Commissioning

- Eases Building Turn-Over from Contractor to Owner
- Reduces "Call Backs" After Construction
- Designer
- Contractor
- Improved Environmental Controls
- Energy Savings
- Increased O & M Staff Knowledge
- Persistence of Energy Savings

What Systems are "Generally" Commissioned?

- HVAC
- Plumbing
- Fire Protection
- Controls
- Electrical
- Lighting
- Emergency Power
- EMCS

When Is the Commissioning Process Started?

- Pre-Design
- Design
- Construction
- Post Construction
- Post Warranty
- Existing Buildings

The Earlier, the Better!

When Performed → Type of Commissioning

- New Project Commissioning
- Retro / Post-Commissioning
- Re-Commissioning
- Continuous Commissioning
Who Performs Commissioning?

Commissioning Team

- Cx leading O
  - Designers
  - Contractors
  - Owner

How is Commissioning Performed?

- Develop a Commissioning Plan for the Specific Project
  - Define Team Members
  - Define Roles & Responsibilities
  - Define Systems to be Commissioned

Design Phase Commissioning Activities

- Commissioning Plan
- Design Intent Document
- Design Reviews
- Commissioning Specification

Construction Phase Commissioning Activities

- Schedule Commissioning Activities
- Shop Drawing Review
- Operations and Maintenance Documentation Preparation
- Training Plan Review
- Regular Coordination Meetings / Site Visits

Training and Testing

- Contractor Training
- Systems Training
- Testing
- Final Commissioning Report
- Deficiency Correction
How is Commissioning Performed?

Warranty Period Commissioning

- Deferred Testing
- 10-Month Check-up
- Amend Final Commissioning Report

Final Commissioning Report

- Completed Commissioning Plan
- Updated Design Intent Documentation
- Certified Contractor Required Testing Results
- Contractor Training Plans & Materials
- Cx System Wide Training Plan & Materials
- System Readiness Checklists
- Documentation of each Verification Testing Procedure Performed
- Functionality Documentation

Bottom Line: What is Commissioning's Ultimate Goal?

To insure that the owner receives a:
1. Well designed, coordinated
2. Better constructed
3. Functional performing
4. Sustainable
5. Maintainable
6. High performance facility

Cost Factors

Depending on the process, but some “rules-of-thumb” for full commissioning services:
1. 2 - 4% of construction costs for systems commissioned.
2. Ω% - 2% of overall project construction cost.

Factors Impacting Cost of Commissioning
- Number of different systems
- Complexity of systems
- When commissioning starts & stops
- Project delivery method
- What commissioning includes

Project Cost Savings

Pentagon facility O&M staff have quantified a cost savings ratio of:
- $1.40 savings return for every $1.00 invested in commissioning.
- Successful contractor & O&M hand-off
- Things worked from day-one
- Minimized contractor call backs
- Systems are easier to maintain
- Addressed equipment issues prior to termination of Warranty period

Commissioning to Support

Green Buildings
Sustainable Designs
LEED Certifications
Overview

- Green Buildings & LEED & Cx
  - What is it?
  - How is it done?
  - What does it mean for the Owner?
  - Benefits
- US Green Building Council
- LEED Certification/Rating System

Some Definitions

US GBC

Green Buildings

(AKA High Performing)

- Create a healthy and comfortable environment;
- Reduce operation and maintenance costs;
- Built in flexibility
- Responsive to local community
  - historical preservation,
  - access to public transportation
  - other community infrastructure systems.

Green Buildings

(AKA High Performance)

- Create healthy, environmentally-sound & resource-efficient buildings
  - integrated design approach
- Promote resource conservation,
  - energy efficiency, renewable energy, and water conservation features;
- Consider environmental & health impacts and waste minimization

Green Buildings

- The entire life-cycle of the building and its components is considered, as well as the economic, health and environmental impact and performance.

“We shape our buildings, and after that our buildings shape us.”

Winston Churchill

What is Green Design?

Design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in five broad areas:

- Sustainable sites
- Water efficiency
- Energy efficiency and renewable energy
- Conservation of materials and resources
- Indoor environmental quality (IEQ)
Leadership in Energy & Environmental Design
A leading-edge system for designing, constructing, operating and certifying the world’s greenest buildings.

Sustainability
- To keep in existence; maintain.
- To keep up competently.
- **Green** = the sustained reduction in the use and conservation of non-renewable resources.

Sustainable Design
- **Green** = the practice of reducing the content and utilization of non-renewable resources in the design, construction and operation of buildings and interiors.
- Reduce, Reuse, Recycle

Sustainability
- "Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs."
  United Nations World Commission on Environment and Development.
- "Then I say the earth belongs to each . . . generation during its course, fully and in its own right, no generation can contract debts greater than may be paid during the course of its own existence."
  Thomas Jefferson, September 6, 1789

Sustainable Design
- **High Performing ñ Best Value**
- Green Design
- Whole Building Design
- Environmentally Responsible
- Enhance health & productivity
- Life Cycle Perspective
How is it Done?

Green Design ñ LEED Certification

Yes

Can a Building be Designed and Constructed without being ìGreenî?

Yes

Can a Building be Designed and Constructed ìGreenî be LEED Certified without some level of Commissioning?

Yes & No

LEED Certification Process
A three step process:
- Step 1: Project Registration
  - Welcome Packet and on-line project listing
- Step 2: Technical Support
  - Reference Package
  - Credit Rulings
- Step 3: Building Certification
  - Upon final documentation submittal and USGBC review - approval

How is it Done?

First:
ñ the owner must make a committed decision to sustain the green process for the project.
How is it Done?

Second:
- the architectural design group generally registers the project (w/USGBC) for one of the four levels of LEED Certification. Certification, Silver, Gold, Platinum
- the design team must sustain the green design process for the project.

LEED Levels of Achievement

Total Available Points: 69

Four Levels of Achievement:
- Certified Level (26-32 points)
- Silver Level (33-38 points)
- Gold Level (39-51 points)
- Platinum Level (52+ points)

How is it Done?

Third:
- the engineering design group conducts and develops an energy model of the support systems.
Sixth:
ñ As a required Prerequisite for LEED Certification, the owner must hire an independent third party Ö Commissioning (Cx) Group ...to verify through documentation and Functional Performance Testing, the building systems meet Design Intent.

Fifth:
ñ Fourth: ñ Project is constructed green by all levels of contractors.
ñ As a required Prerequisite for LEED project is constructed green by all levels of contractors.
ñ Project is constructed green by all levels of contractors.

Sixth:
ñ Sixths: ñ Facility operations and maintenance personnel are trained in green design, construction, operations and maintenance.
ñ O&M personnel sustain the green project with maintenance procedures that do not negate the green process.

Seventh:
ñ Seventh: ñ STRONGLY recommended that every 24-months the main environmental support systems be RETRO-COMMISSIONED to insure that systems are sustaining the green intent and LEED Certification.
Benefits of Green Building

- Environmental benefits
  - Reduce the impacts of natural resource extraction, manufacturing, operations and disposal
- Economic benefits
  - Improve the bottom line
- Health and safety benefits
  - Enhance occupant comfort, health & productivity
- Community benefits
  - Minimize strain on local infrastructures and improve quality of life

Economic Benefits

- Competitive first costs
  - Integrated design allows high benefit at low cost by achieving synergies between disciplines and between technologies
- Reduce operating costs
  - Lower utility costs significantly
  - High durability & low maintenance
- Optimize life-cycle economic performance

Through Commissioning

- All components function as per design intent.
- All components function together as a SYSTEM.
- All systems function interactively.
- Energy utilization is efficient and quantified.
- Smooth transition / hand-off from contractor to user.
- Minimize contractor call-backs!!

LEED Certification Benefits

- Recognition of Quality Buildings and Environmental Stewardship
- Third party validation of achievement
- Qualify for growing array of state and local government incentives
- Contribute to growing knowledge base
- LEED certification plaque to mount on building
- Official certificate
- Receive marketing exposure through USGBC Web site, case studies, media announcements

Websites of interest

- [www.usgbc.org](http://www.usgbc.org)
- [www.eren.doe.gov](http://www.eren.doe.gov)
  - Federal Energy Management Program (FEMP)
  - Buildings for the 21st Century
- [www.wbdg.org](http://www.wbdg.org)
  - Whole Building Design Guide (NAVFAC)
- [www.bcx.org](http://www.bcx.org)
  - Building Commissioning Association

And many more links at sites listed above
**Why Cx?**

Systematic process of assuring by verification and documentation, from the design phase to a minimum of one year after the project, that all resources perform interactively in accordance with the design documentation and intent, and in accordance with the owner’s operational needs, including preparation of operation personnel.

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**Energy & Atmosphere**

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Commissioning</td>
</tr>
<tr>
<td>5.2</td>
<td>Continuous Building Cx and Maintenance, Maintenance Contracts</td>
</tr>
<tr>
<td>5.3</td>
<td>Continuous Building Cx and Maintenance, Comprehensive</td>
</tr>
<tr>
<td>5.4</td>
<td>Preventive Maintenance Program</td>
</tr>
<tr>
<td>5.5</td>
<td>Measurement &amp; Verification, M&amp;V for Equipment - First Grouping</td>
</tr>
<tr>
<td>5.6</td>
<td>Measurement &amp; Verification, M&amp;V for Equipment - Second Grouping</td>
</tr>
<tr>
<td>5.7</td>
<td>Measurement &amp; Verification, M&amp;V for Equipment - Third Grouping</td>
</tr>
<tr>
<td>5.8</td>
<td>Measurement &amp; Verification, Emission Reduction Reporting</td>
</tr>
<tr>
<td>6</td>
<td>Green Power</td>
</tr>
</tbody>
</table>

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**Commissioning Ultimate Goals**

- All components function as per FINAL design intent.
- All components function together as a SYSTEM.
- All systems function interactively.
- Energy utilization is efficient and quantified.
- Smooth transition / hand-off from contractor to user.
- Minimize contractor call-backs!!
- Improve O&M costs.
Basic Project Life Cycle (3-hexagonal boxes)
- Owner Determines Need
- Design (assessment / programming)
- Construction
- Hand-off to Owner
- User fit up
- Utilization of Facility
- Operations & Maintenance
- Disposition of Facility

Green ñ LEED
Commissioning ñ Cx
15-or-so Best Practices
Thoughts and Ideas

Project Owner
ï is committed to Green / LEED Certification

Green / LEED / design & Cx process
ï are implemented during Discovery

Design Phase Commissioning Activities

Energy Modeling
ï is utilized to quantify sustainable energy management
Design Intent Document
ï is developed in design and upgraded throughout construction

Design Documentation
ï is reviewed by Peer / Cx / CM / O&M groups

Green / Cx Contractor Training
ï Is conducted at Pre-Bid meeting to help understanding of sustainable component impacts

Cx is responsible for
ï Commissioning
ï As-Built document monitoring
ï Q/A
ï TAB

O&M Documentation is
ï Submitted just after approved submittals

Cx develops & implements
ï Pre-functional checklists
ï Functional Performance tests
Construction Phase Commissioning Activities

- Preconstruction Meeting
- Kick Off Meeting
- Submittal Review
- Contractor Progress Meetings
- Commissioning Meetings
- Shop Drawing Review
- Project Schedule Review
- Site Observation Visits
- Manager LEED Documentation
- O&M Manuals
- Witness Testing
- Equipment Checklists

Testing/Training Phase Commissioning Activities

- Submit LEED Documentation
- Punchlist
- Verification Testing
- Corrective Action Reports
- Operations Maintenance Training
- O&M Manuals
- Warranty Information
- Re Commissioning Manual
- Owner Occupancy
- Project Closeout

Energy Modeling baseline is

- Re-confirmed at conclusion of Cx / TAB

Energy Modeling

- Model the energy and water systems to predict savings.
  - Design the building with equipment to measure energy and water performance.
  - Draft a Measurement & Verification Plan to apply during building operation that compares predicted savings to those actually achieved in the field.
  - Provide fundamental systems Commissioning

Cx assists with population & helps implement

- Computerized Maintenance Management System

CMMS

- Computerized Maintenance Management System
- Work order processing
  - Requested
  - Run-to-failure
- Preventive maintenance scheduling
- Predictive maintenance monitoring
- Operational (energy) monitoring
Value of Commissioning integrated with implementation of CMMS programs
- Obtain / load the data for all systems / components
- Asset Tag all components
- Conduct and Develop an asset condition assessment report
- Commission system readiness and functionality

Cx develops & implements
- System Wide Training for O&M personnel

Cx is responsible for
- Assembly & submission of all project closure documentation
- System manual

Cx is responsible for
- Monitoring
  - Cx system warranties for first year

Warranty Phase Commissioning Activities
- Deferred Testing
- 10 Month Warranty Meeting
- Final Commissioning Report
- Lessons Learned

Cx is responsible for
- Monitoring
  - Sustainable components each quarter for first year
Green ñ LEED

Commissioning

Cx