The Value of Building Commissioning Study (NCCx Results)

Tom Poeling, PE, CEM, CCP
2019 BCxA President
Director – U.S. Engineering Construction

Learning Objectives

1. Present the results of a joint BCxA/LBNL study that provides updated metrics on the value of (NCCx) commissioning.

2. Provide data that can be used by commissioning stakeholders to promote the industry.

3. Understand market opportunities to improve the commissioning industry.

4. Understand Cx scope of work improvements to improve delivery process.
Prior LBNL Studies – Cost Effectiveness of Commercial Building Commissioning

The Cost-Effectiveness of Commercial Buildings Commissioning
A Meta-Analysis of Existing Buildings and New Construction in the United States

Evan Mills
Hannah Friedman
Teresia Powell
Norman Boursakis
David Clevidence
Tux Haas
Mary Ann Petitt

1 Lawrence Berkeley National Laboratory
2 Portland Energy Conservation Inc.
3 Energy Systems Laboratory, Texas A&M University

November 23, 2004
LBNL - 56637

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(2004)
Value of Commissioning Study - Goals

• Refresh the LBNL 2009 survey
  • Maintain consistency in the dataset
  • Reflect changes to the industry due to maturity
  • Define effects of changes to Cx approach (such as Ongoing Cx)
  • Include economics for Cx of new and additional systems
  • Expand database for different building types, markets

• Establish new baseline for Cx metrics
• Identify appropriate level of data to gather
• Create an iterative process for data gathering
• Engage industry to provide more feedback over time on project level and market level trends
Value of Commissioning Study

Data Survey - LBNL (NCCx, EBCx, OCx)
- Project Specific Description
- Reason for Cx
- Deficiencies & Measures
- Cx Cost Data
- Scope of Cx
- Baseline Energy Use & Savings
- Non-Energy Impacts

Market Survey - BCxA
- Company information
- Certification
- NCCx Market Factors
- NCCx SOW Tasks
- EBCx Market Factors
- EBCx Economics
- EBCx SOW Tasks
- OCx Economics
- OCx SOW Tasks
BCxA / LBNL Roles

BCxA
- Research Market Databases
- Created Market Survey
- Review Market Survey
- Market Survey sent to BCxA Members
- "Gimme Five" Campaign
  BCxA Members
  Utility Providers
- Organize/QC Data Survey
- Create Data Graphs
- Create Preliminary Presentation

LBNL
- Coordinated scope/grant with DOE
- Provide Data Survey
- Reviewed Data Survey
- Data Survey Form sent to Utility Providers
- Create Data Graphs
## Data Survey Statistics

### New Construction Cx

<table>
<thead>
<tr>
<th></th>
<th>2009 Study</th>
<th>2018 Study</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Buildings</td>
<td>82</td>
<td>101</td>
</tr>
<tr>
<td># of Projects (w/cost data)</td>
<td>74</td>
<td>71</td>
</tr>
<tr>
<td>Floor Area (SF)</td>
<td>8,813,925</td>
<td>22,217,059</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>$2.2B</td>
<td>$10.1B</td>
</tr>
<tr>
<td># of States Represented</td>
<td>10</td>
<td>18</td>
</tr>
</tbody>
</table>

### Existing Building Cx

<table>
<thead>
<tr>
<th></th>
<th>2009 Study</th>
<th>2018 Study</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Buildings (total)</td>
<td>562</td>
<td>738</td>
</tr>
<tr>
<td># of Projects (w/energy savings data)</td>
<td>300</td>
<td>705</td>
</tr>
<tr>
<td>Floor Area (SF)</td>
<td>90,410,884</td>
<td>252,159,847</td>
</tr>
<tr>
<td># of States Represented</td>
<td>21</td>
<td>18</td>
</tr>
</tbody>
</table>
Discussion Topics

• Building data: Preliminary narratives regarding Cx Value metrics
  1. NCCx – Cost Summary
  2. NCCx – Market Demand Factors
  3. NCCx – Scope of Work Observations

• Review Data Survey Results
  ▪ What’s Changed?
  ▪ Check Calibration
  ▪ Market Drivers & Issues
Value of Cx (NCCx) Study Results

Cost Summary

Market Demand Factors

Scope of Work Observations
NCCx Cost per Square Foot

New Construction Commissioning Cost
($2018/sq.ft.) (n=67)

<table>
<thead>
<tr>
<th>Percentile</th>
<th>2018</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>25th Percentile</td>
<td>$0.40</td>
<td>$0.59</td>
</tr>
<tr>
<td>Median</td>
<td>$0.82</td>
<td>$1.16</td>
</tr>
<tr>
<td>75th Percentile</td>
<td>$1.36</td>
<td>$2.14</td>
</tr>
<tr>
<td>Mean</td>
<td>$1.06</td>
<td>$1.94</td>
</tr>
</tbody>
</table>

NCCx Cost/SF Comparison (2009 to 2018)
Building Size Distribution: NCCx

NCCx Building Size Distribution - 2018 (n=71)

- Min: 2,700
- Median: 115,908
- Mean: 232,409
- Max: 3,500,000

NCCx Project Size Distribution – 2009 (n=77)

- Min: 1,227
- Median: 69,500
- Mean: 114,467
- Max: 685,000
NCCx Cost by Building Type

Market Segment Breakdown (Projects with Cost Data)

Percent of total projects with cost data

- 2009
- 2017

Chart showing the percentage of projects by market segment for 2009 and 2017.
NCCx Cost by Building Type

Market Segment Breakdown (Projects with Cost Data)

- 2009
- 2017

Percent of total projects with cost data

<table>
<thead>
<tr>
<th>Building Type</th>
<th>2009</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>HE</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>O</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>HI</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>K12</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>PA</td>
<td>0%</td>
<td>0%</td>
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<td>I</td>
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<td>LLOD</td>
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<td>W</td>
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<td>HO</td>
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<tr>
<td>W</td>
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<td>0%</td>
</tr>
<tr>
<td>FSA</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>POS</td>
<td>0%</td>
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# NCCx Cost by Building Type

## New Construction Commissioning Cost

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<th>2009</th>
<th>2018</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n=</td>
<td>% total # of projects</td>
</tr>
<tr>
<td>Higher Education</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Office</td>
<td>10</td>
<td>14%</td>
</tr>
<tr>
<td>Healthcare – Inpatient</td>
<td>9</td>
<td>12%</td>
</tr>
<tr>
<td>K12 Schools</td>
<td>7</td>
<td>10%</td>
</tr>
<tr>
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NCCx Cost by Building Type

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NCCx Cost: Qualifications vs. Price Based Selections

Question: How many projects are chosen on qualifications vs. price?

Weighted Avg. = 43%
Question: Cx is increasingly profitable?

- Strongly Disagree: 3%
- Disagree: 15%
- Neutral: 47%
- Agree: 31%
- Strongly Agree: 4%
1. Overall **NCCx costs/SF** appear lower, but…..
2. 2018 data field contains 2X more **SF per building**
3. **Building type** mix is different. Less data for Public Assembly, Laboratories, and Public Safety (higher $/SF in 2009).
4. NCCx fee ranges for higher education and healthcare are less volatile than 2009. NCCx fee ranges for office and schools are more stable (and increasing).
5. Over 40% of NCCx work is selected based on qualifications vs. price
6. Cx firms are reporting stable/increased **project profitability**
7. **Be very careful to qualify NCCx costs using other metrics than just overall $/SF**
8. **Use a range to report NCCx costs**
Value of Cx (NCCx) Study Results

Cost Summary

Market Demand Factors

Scope of Work Observations
Reasons for Executing NCCx

Factors that Drive Cx? (Out of 5.0)

- Owner Awareness: 3.82
- Building Codes: 3.74
- Voluntary Rating Programs: 3.65
- Public Policies: 3.54
- Utility Programs: 3.11
- Other: 2.92
- Trade Associations: 2.75
Reasons for Implementing NCCx

Fraction of reporting projects with reason (New Construction)

- Ensure system performance (energy and non-energy-related) (79%)
- Comply with LEED or other sustainability rating system (65%)
- Smoother process and turnover (new construction) (55%)
- Ensure or improve thermal comfort (53%)
- Train and increase awareness of building operators or...
- Comply with organizational mandate/policy (50%)
- Ensure adequate indoor air quality (48%)
- Extended equipment life (34%)
- Obtain energy savings (34%)
- Increase occupant productivity (32%)
- Reduce liability (11%)
- Qualify for rebate, financing, or other services (6%)
- Participation in utility program (5%)
- Research/demonstration/pilot (3%)
- Comply with existing buildings ordinance (0%)
- Other (3%)
## Reasons for Implementing NCCx

### Reasons that Increased (2009 to 2018)

<table>
<thead>
<tr>
<th>Fraction of reasons to embark on NCCx</th>
<th>2009</th>
<th>2018</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comply with LEED or other sustainability rating system</td>
<td>15%</td>
<td>65%</td>
<td>50%</td>
</tr>
<tr>
<td>Comply with organizational mandate/policy</td>
<td>0%</td>
<td>48%</td>
<td>48%</td>
</tr>
<tr>
<td>Smoother process and turnover (new construction)</td>
<td>26%</td>
<td>55%</td>
<td>29%</td>
</tr>
</tbody>
</table>
## Reasons for Implementing NCCx

### Reasons that Decreased (2009 to 2018)

<table>
<thead>
<tr>
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<th>2009</th>
<th>2018</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensure adequate indoor air quality</td>
<td>75%</td>
<td>34%</td>
<td>-41%</td>
</tr>
<tr>
<td>Participation in utility program</td>
<td>42%</td>
<td>3%</td>
<td>-39%</td>
</tr>
<tr>
<td>Obtain energy savings</td>
<td>65%</td>
<td>32%</td>
<td>-33%</td>
</tr>
<tr>
<td>Ensure or improve thermal comfort</td>
<td>72%</td>
<td>53%</td>
<td>-19%</td>
</tr>
<tr>
<td>Train and increase awareness of building operators or occupants</td>
<td>61%</td>
<td>50%</td>
<td>-11%</td>
</tr>
</tbody>
</table>
## NCCx: Projects Reporting Non-Energy Benefits

### First Cost Savings
- Project on schedule, problems detected and corrected earlier: 90%
- Occupied on schedule: 79%
- Improvements to system design, equipment sized correctly: 77%
- Improve construction team coordination, reduce disagreements: 74%
- Building occupied sooner, call-backs reduced, TAB costs reduced: 62%
- Fewer change orders; warranty claims: 56%
- Other or unspecified first-cost: 18%

### Ongoing (Recurring) Improvements
- Thermal Comfort: 95%
- Maintenance: 90%
- Improved O&M: 87%
- Training; education: 87%
- Indoor Air Quality: 72%
- Equipment Life: 69%
- Liability: 21%
- Tenant retention; turnover: 13%
- Productivity/Safety: 10%
- Other (or combination of above): 3%

*(n=39)*
Activities included in New Construction Commissioning Scope (n=62)

- Commissioning provider development of design intent: 43%
- Write specifications: 76%
- Develop commissioning plan: 98%
- Develop sequences of operation (if not well-developed by...): 23%
- Review submittals: 90%
- Construction observation: 98%
- Verification checks/prefunctional testing: 97%
- Functional testing; use of diagnostic tools: 98%
- Commissioning provider significantly involved in issue...: 87%
- Oversee training: 90%
- Review O&M manuals: 79%
- Develop systems manual/recommissioning manual: 75%
- Perform trend analysis, modeling, or benchmarking: 55%
- Evaluate energy cost savings: 6%
- Final report: 98%
- Ongoing commissioning, or other ongoing related...: 33%
Activities included in New Construction Commissioning Scope (n=62)

- Commissioning provider development of design intent: 43%
- Write specifications: 76%
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- Review O&M manuals: 79%
- Develop systems manual/recommissioning manual: 75%
- Perform trend analysis, modeling, or benchmarking: 55%
- Evaluate energy cost savings: 6%
- Final report: 98%
- Ongoing commissioning, or other ongoing related...: 33%
NCCx Market Factors

1. Owner awareness – highest driving factor
2. NCCx demand driven by regulation and codes
3. Several non-energy benefits obtained thru NCCx
   a) Schedule improvement
   b) Smooth turnover
   c) Training
4. Building performance metrics (energy, IAQ) has lost some emphasis
5. Core Cx scope of work is performed on each project
6. Opportunity to improve frequency of scope items:
   a) OPR/Design Intent document
   b) Controls sequence development
   c) Energy cost calculations
   d) Post-occupancy tasks
Value of Cx (NCCx) Study Results

Cost Summary

Market Demand Factors

Scope of Work Observations
Percentage of NCCx Projects include Design Phase Cx Services?  (26)
Percentage of NCCx Projects where OPR is Developed for Owner? (30)

- Less than 20%: 31%
- 20-40%: 15%
- 40-60%: 10%
- 60-80%: 20%
- Greater than 80%: 5%

Weighted Avg. = 47%
Percentage of Cx Issues Discovered during Design Phase? (33)

- Weighted Avg. = 25%
How often are Cx Review Comments in Design Phase are incorporated in Contract? (43)

- Never: 0.0%
- Rarely: 5.0%
- Sometimes: 25.0%
- Often: 46%
- Always: 84%

NCCx SOW Observations
How often were control sequences created without collaboration between design and Cx? (39)

67%
How often does NCCx meet with facility personnel during design? (41)
How often is detailed Cx schedule integrated with construction schedule? (42)
How often do controls coordination meetings occur (engineer, contractor, Cx)? (45)
How often are equipment startups well coordinated ahead of time? (49)
How often do Cx issues remain open after Beneficial Occupancy? (52)

- Never: 0.0%
- Rarely: 5.0%
- Sometimes: 34%
- Often: 37%
- Always: 10.0%
- Don't know: 15.0%
How often is a Post-turnover occupant survey of satisfaction conducted? (53)

- Never: 0.0%
- Rarely: 5.0%
- Sometimes: 10.0%
- Often: 15.0%
- Always: 20.0%
- Don't know: 25.0%

33% and 34% respectively for Sometimes and Rarely.
How often are OCx tasks included after Warranty is complete? (54)
NCCx Market Survey – SOW Takeaways

1. Design phase Cx services are included in over 60% of NCCx projects.

2. Design phase Cx review comments are incorporated in contract documents over 80% of the time.

3. Design phase issues constitute ≈ 25% of all NCCx issues.

4. Opportunity to improve frequency of NCCx scope items:
   a) OPR/Design Intent document
   b) Controls sequence development/Controls coordination meetings during submittals
   c) Scheduling/Equipment startup coordination
   d) Collaboration with facility personnel/Follow-up with occupants

5. OCx SOW is included more often (44% = “sometimes” or better)
Additional Information

Deliverables will be posted to website,

https://www.bcxa.org/knowledge-center/

• Technical Narratives
• Blogs
• Presentations
• Data, Research
• Related Surveys

Questions?

tom.poeling@usengineering.com