Utility Savings Initiative

Existing Building Commissioning

New Hanover County Area
December 7, 2015
• **Commissioning (Cx)** – Systematic process of ensuring that new building systems perform interactively according to documented design intent and owner’s operational needs.

• **Existing Building Commissioning (EBCx)** – Application of the Cx process to existing buildings to improve building performance. Successful implementation can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building’s life.
Varieties of Existing Building Commissioning

- The Deep Dive
- Rapid Implementation and Payback
- Building Controls Tune-Up
- Third Party Commissioning

Department of Environmental Quality
General Benefits:

- Improved occupant safety
- Improved occupant comfort
- Reduced energy / water costs
- Reduced maintenance costs
- Reduced repair / replacement costs
- Increased building value
- Advanced staff skills
Generally Accepted Industry Numbers

Cost: $0.05 to $0.40 per sq. ft.

Energy Savings: 15% - 30% commonly realized (up to 40% possible)

Cost Savings: 0.7 year payback
Deep Dive
What Is It?

• HVAC optimized to current use of the building

• Defective or improperly installed equipment is repaired or replaced

• Replace aged or malfunctioning equipment with more efficient equipment
• Results in optimally performing building
• May be performed in-house or combination of in-house and outside consultants
• Requires the most resources
Deep Dive

Cost:

- $1.00 to $2.00 per sq. ft.
  (includes ~25% labor, ~75% equipment)

Energy Savings:

- 10% - 40% commonly realized
  (dependent on condition of building)

Cost Savings:

- Less than 2 year payback

Department of Environmental Quality
• In-house staff possess high level expertise
• Project has institutional commitment
• Staff has passion and time available
• Building contains digital controls
• Funding is available for commissioning and equipment upgrades
• Results in comprehensive whole building improvement
• Increases capability for continued optimal performance
• Extends life of the equipment
• In-house staff brings institutional knowledge
Individual Project Costs: Fox Labs

Example 1: Mary Anne Fox Labs (70,700 SF)
- Commissioning performed by outside contractor and NCSU Staff
- Building consists of teaching labs and professor offices

<table>
<thead>
<tr>
<th>EXPENSE (BY PROVIDER)</th>
<th>COST ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning (Consultant)</td>
<td>48,500</td>
</tr>
<tr>
<td>Facilitate Contractors (NCSU)</td>
<td>14,052</td>
</tr>
<tr>
<td>Repair Work (Zone 7)</td>
<td>2,696</td>
</tr>
<tr>
<td>Parts &amp; Components</td>
<td>1,300</td>
</tr>
<tr>
<td>Lab Airflow Contractor</td>
<td>12,000</td>
</tr>
<tr>
<td>Major Projects (NCSU/Contractor)</td>
<td>24,500</td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>103,048</td>
</tr>
</tbody>
</table>

COST PER SQUARE FOOT: $1.46
Individual Project Costs: Fox Labs

Example 1: Mary Anne Fox Labs (70,700 SF)

- Energy savings for Fiscal Year 2014 (as compared to FY 2013).

<table>
<thead>
<tr>
<th>ENERGY CATEGORY</th>
<th>SAVINGS ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>17,854</td>
</tr>
<tr>
<td>Steam</td>
<td>23,548</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>41,455</td>
</tr>
<tr>
<td>Domestic Water</td>
<td>1,230</td>
</tr>
<tr>
<td><strong>TOTAL SAVINGS</strong></td>
<td><strong>84,087</strong></td>
</tr>
</tbody>
</table>

EUI dropped from 528 to 468
Example 2: Leazar Hall (57,027 SF)

- Commissioning performed by outside contractor & NCSU staff
- Building consists of teaching labs, classrooms and professor offices

<table>
<thead>
<tr>
<th>EXPENSE (BY PROVIDER)</th>
<th>COST ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning (Consultant)</td>
<td>34,900</td>
</tr>
<tr>
<td>Facilitate Contractors (NCSU)</td>
<td>14,652</td>
</tr>
<tr>
<td>Repair Work (Zone 1)</td>
<td>4,900</td>
</tr>
<tr>
<td>Parts &amp; Components</td>
<td>483</td>
</tr>
<tr>
<td>Major Projects (NCSU/Contractor)</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL COST</strong></td>
<td><strong>54,935</strong></td>
</tr>
</tbody>
</table>

COST PER SQUARE FOOT: $0.96
Individual Project Costs: Leazar Hall

Example 2: Leazar Hall (57,027 SF)
  • Energy savings for Fiscal Year 2014 (as compared to FY 2013).

<table>
<thead>
<tr>
<th>ENERGY CATEGORY</th>
<th>SAVINGS ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>7,308</td>
</tr>
<tr>
<td>Steam</td>
<td>19,255</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>19,045</td>
</tr>
<tr>
<td>Domestic Water</td>
<td>333</td>
</tr>
<tr>
<td><strong>TOTAL SAVINGS</strong></td>
<td><strong>45,941</strong></td>
</tr>
</tbody>
</table>

EUI dropped from 157 to 103
**Example 3: Withers Hall (71,144 SF)**
- Commissioning performed by NCSU Commissioning Team
- Building consists of classrooms and professor offices

<table>
<thead>
<tr>
<th>EXPENSE (BY PROVIDER)</th>
<th>COST ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning (NCSU)</td>
<td>29,630</td>
</tr>
<tr>
<td>Repair Work (NCSU Cx Team)</td>
<td>16,387</td>
</tr>
<tr>
<td>Repair Work (Zone 1)</td>
<td>6,207</td>
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<tr>
<td>Parts &amp; Components</td>
<td>3,956</td>
</tr>
<tr>
<td>Major Projects (NCSU/Contractor)</td>
<td>19,008</td>
</tr>
<tr>
<td><strong>TOTAL COST</strong></td>
<td><strong>$75,188</strong></td>
</tr>
</tbody>
</table>

**COST PER SQUARE FOOT: $1.06**
Example 3: Withers Hall (71,144 SF)

- Energy savings for Fiscal Year 2014 (as compared to FY 2013).

<table>
<thead>
<tr>
<th>ENERGY CATEGORY</th>
<th>SAVINGS ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>15,193</td>
</tr>
<tr>
<td>Steam</td>
<td>6,262</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>20,195</td>
</tr>
<tr>
<td>Domestic Water</td>
<td>356</td>
</tr>
<tr>
<td><strong>TOTAL SAVINGS</strong></td>
<td><strong>42,006</strong></td>
</tr>
</tbody>
</table>

EUI dropped from 110 to 77
## NCSU First Four Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Size (SF)</th>
<th>Project Cost</th>
<th>Cost / SF</th>
<th>Annual Savings</th>
<th>ROI (Years)</th>
<th>Decrease in EUI</th>
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</thead>
<tbody>
<tr>
<td>Mary Anne Fox Labs</td>
<td>70,700</td>
<td>$103,048*</td>
<td>$1.46</td>
<td>$84,087</td>
<td>1.2</td>
<td>528 to 468</td>
</tr>
<tr>
<td>Leazar Hall</td>
<td>57,027</td>
<td>$54,935*</td>
<td>$0.96</td>
<td>$45,941</td>
<td>1.2</td>
<td>157 to 103</td>
</tr>
<tr>
<td>David Clark Labs</td>
<td>93,181</td>
<td>$148,830*</td>
<td>$1.59</td>
<td>$334,131</td>
<td>0.5</td>
<td>594 to 371</td>
</tr>
<tr>
<td>Withers Hall</td>
<td>71,144</td>
<td>$75,188</td>
<td>$1.06</td>
<td>$42,006</td>
<td>1.8</td>
<td>110 to 77</td>
</tr>
<tr>
<td>Totals</td>
<td>292,052</td>
<td>$382,001</td>
<td></td>
<td>$506,165</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Includes cost for consultant
Rapid Implementation and Payback

Department of Environmental Quality
Rapid Implementation and Payback

What Is It?

• Focus primarily on HVAC controls, maintenance and operations
• Target measures with one year payback or less
• Low cost, low risk, high reward alternative
• Requires minimal capital, but high level of in-house expertise
Rapid Implementation and Payback

Cost:
- $0.10 to $0.25 per sq. ft. (includes ~90% labor, ~10% equipment)

Energy Savings:
- 10% - 30% commonly realized (dependent on condition of building)

Cost Savings:
- Less than 1 year payback
Rapid Implementation and Payback
When to Use It

• In-house staff possess high level expertise
• Project has institutional commitment
• Staff has passion and time available
• Building contains digital controls
• **Major building systems are functional**
Rapid Implementation and Payback

Other Factors and Benefits

• Primarily labor costs
• Less effort in building & faster payback
• Significant deficiencies are resolved later
• In-house staff brings institutional knowledge
**Program Savings for 10 million Sq. Ft.**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Savings</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>$ 4.3 m</td>
<td>$822,000</td>
</tr>
<tr>
<td>2011</td>
<td>$ 5.3 m</td>
<td>&lt; $75,000</td>
</tr>
<tr>
<td>2012</td>
<td>$ 5.9 m</td>
<td>&lt; $75,000</td>
</tr>
<tr>
<td>2013</td>
<td>$ 6.0 m</td>
<td>&lt; $75,000</td>
</tr>
<tr>
<td>2014</td>
<td>$ 6.6 m</td>
<td>&lt; $75,000</td>
</tr>
</tbody>
</table>

$28.1 m ~ $1.1 million

- Link to UNC Chapel Hill’s Retro-commissioning white paper
  [http://save-energy.unc.edu/Projects/EnergyConservationMeasuresProgram](http://save-energy.unc.edu/Projects/EnergyConservationMeasuresProgram)
Performance vs Time

- **Rapid Payback**
- **Cx + EBCx**
- **No Cx**

**Department of Environmental Quality**
NC State Approach

~ $2.00 / sq. ft.  
2.5 year payback

Current condition

UNC Chapel Hill Approach

~ $2.00 / sq. ft.  | 3 – 10 year payback
~ $.25 / sq. ft.  | 6 month payback
Department of Environmental Quality

Campus EBCx Program Start
## Program Savings for 10 million Sq. Ft.

<table>
<thead>
<tr>
<th>Program Year</th>
<th>GSF</th>
<th>Cost (Thousands)</th>
<th>Cost / GSF</th>
<th>Energy Savings (MBtus)</th>
<th>Water Savings (MGals)</th>
<th>MTCO2E Reduction</th>
<th>Energy Savings (Millions)</th>
<th>ROI (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>10M</td>
<td>$822</td>
<td>$0.08</td>
<td>439,600</td>
<td>27.2</td>
<td>41,419</td>
<td>$4.3</td>
<td>2.3</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td>&lt;$75</td>
<td>&lt;$0.01</td>
<td>532,500</td>
<td>30.5</td>
<td>43,865</td>
<td>$5.3</td>
<td>&lt;1</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>&lt;$75</td>
<td>&lt;$0.01</td>
<td>558,500</td>
<td>36.0</td>
<td>41,313</td>
<td>$5.9</td>
<td>&lt;1</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td>&lt;$75</td>
<td>&lt;$0.01</td>
<td>611,500</td>
<td>31.9</td>
<td>52,407</td>
<td>$6.0</td>
<td>&lt;1</td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td>&lt;$75</td>
<td>&lt;$0.01</td>
<td>618,000</td>
<td>33.9</td>
<td>51,196</td>
<td>$6.6</td>
<td>&lt;1</td>
</tr>
<tr>
<td>5 year Total:</td>
<td>10M</td>
<td>$1,122</td>
<td>$0.12</td>
<td>2,760,100</td>
<td>160</td>
<td>230,200</td>
<td>$28.1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
Building Controls Tune-Up

What Is It?

- Vendor analyzes HVAC controls system and proposes changes for improvements based on current building and space use

- Vendor performs agreed upon improvements to reduce energy use as budget allows

- Minor repairs performed by either vendor or in-house staff

- Staff is trained by vendor as part of service
• In-house staff lacks expertise / resources
• To provide training to in-house staff
• Project has institutional commitment
• Building contains digital controls
• Building is metered
• Can have major impact on cost savings by controlling demand charges
• Can easily lose the gains if staff do not provide ongoing monitoring of the system
• Deficiencies found during system analysis are put on list to be resolved later
NCCU Pilot Project

Pearson Dining Hall
Year Built: 2008
Floor Area (GSF): 58,000
No. of Floors: 3
Hrs. Occupied per Week: 84

Miller-Morgan Health Sciences
Year Built: 1982
Floor Area (GSF): 47,000
No. of Floors: 2
Hrs. Occupied per Week: 46 (approx.)
Building Controls Tune-Up

Cost:

• ~$ 0.25 per sq. ft.

Energy Savings:

• 6% - 10% in electrical consumption
• 22% – 30% reduction in electrical demand
• Heating from steam not yet available

Cost Savings:

• $11,300 in electrical consumption alone

Miller Morgan: 58 measures identified. 50 being implemented.
Pearson Cafeteria: 43 measures identified. 40 being implemented.
Third Party Commissioning
What Is It?

- Consultant assists the owner in developing the EBCx scope of work.
- Consultant manages the EBCx process on behalf of the owner.
- Consultant investigates, analyzes, and provides recommendations for optimizing the performance of existing building systems, which will include payback analysis.
Cost:

- $0.25 to $0.75 per sq. ft.
  (does not include implementation costs)

Energy Savings:

- 10% - 35% commonly realized
  (dependent on condition of building and measures from report selected for implementation)

Cost Savings:

- Payback typically 2 years or less
- In-house staff lacks the expertise or time
- To provide training to in-house staff
- Project has institutional commitment
- Building contains some digital controls
- Knowledge of the building systems is limited
• To develop comprehensive list of building needs

• Assist in capital planning needs

• To gain expertise of independent consultant

• Implementation by contractor, in-house staff or combination (additional $ 0.50 - $1.25 per sq. ft.)
• Analytics phase provides a report only, but no implementation

• Can provide implementation project management

• Wider range of services are available (such as energy modeling)

• Access to wide range of testing equipment
Third Party Commissioning

Results: Avoided Utility Cost

C-2219 Annual Energy Cost

- Baseline: $19,296
- Return to Design Conditions: $15,265
- ECM 1: Occupancy Schedule: $8,718
- ECM 2: Occupancy Schedule and Remove Inlet Vanes: $7,801

Department of Environmental Quality
## Comparing Retro-Commissioning Options

<table>
<thead>
<tr>
<th></th>
<th>Potential Amount of Energy Savings Realized</th>
<th>Cost to Implement</th>
<th>Skill Level of Owner Staff Required</th>
<th>Time Commitment of Owner Staff Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Dive (Submersible)</td>
<td>$$$</td>
<td>$$$</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Rapid Implementation / Payback (Snorkel)</td>
<td>$$</td>
<td>$</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Controls Tune-Up (Swimming)</td>
<td>$ to $$</td>
<td>$</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Third Party (Scuba Dive)</td>
<td>$ to $$$</td>
<td>$ to $$$</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Potential Funding Sources

- House Bill 1292 Carry Forward (like)
- Maintenance and Operations Budget
- Repair and Renovation Funds
- Existing Utility Budget
- Grants
- Student Sustainability Funds
- Receipts Generated Funds
- Lapsed Salary
- Part of a Performance Contract
JUST SO YOU KNOW

Though in most cases, the building owner will see improvements in energy performance by retro-commissioning, in few cases, where buildings are not providing proper space conditioning, an increase in energy consumption may be seen. However, the building will provide an improved indoor environment and occupant comfort.
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We can't solve problems by using the same kind of thinking we used when we created them.

Albert Einstein
Any Questions?

The Deep Dive

Rapid Implementation and Payback

Building Controls Tune-Up

Third Party Commissioning

Department of Environmental Quality