Building Performance Data for Operators: What Can Work

Michael Bobker
Building Performance Lab, City University of New York

Robert Berninger
Memorial SloanKettering Cancer Center, NYC

Tim Angerame and Rick Seppa
Utility Programs and Metering Inc., NYC

ASHRAE Winter Meeting
New York City, January 23, 2008
Seminar 89, sponsored by TC 01.05 Computer Applications
Feedback Concepts
Man-Machine Interaction in Building System Monitoring and Performance Improvement

• Human Factors engineering – operating a building becoming more like flying a plane
• Provide an effective supervisory function over automated processes
• Avoid Information Overload
• Use Energy as a Key Success Factor
• Enable “drill-down” and multi-variate analysis
Changing Landscape of Metering and Data Acquisition

- Digitalization
- Data interoperability
- Wireless
- Web-based viewing

- New technology makes new forms of data acquisition and monitoring feasible
Case Study of a Chiller Plant

- Memorial SloanKettering Cancer Center in New York City
- Multi-building campus, 1.17 million square feet
- 6,000 ton steam-turbine chiller plant
  - Primary, secondary and tertiary pumped loops
  - > $4 million in annual steam cost
- Operational Improvement from a retrofitted Monitoring System that makes Key Performance Data available to Operators
Monitoring System Overlay

- Added flow points (13)
- Temperatures from BAS
- Stand-alone monitoring system
- Remote support with full viewing
- $167,000 in capital cost + $50,000 annual
Entry Screen - Key Data Impossible to Miss

Key current performance data in easy format

New reads: tons and steam flow, steam rate

Operators readily see key performance outcomes – gain new awareness of priorities
Easy “drill-down” to next level

- Click on icon to select component for further data
Again, key data in easy format

- Pre-configured data output
- Next level allows configurable data
“Drill-down” via Selectable Multivariate Data

- Easy selection from drop-down "pick-list"
- Allows specification of time period for review
## Selectable Multivariate Data

- Rich data available for "drill-down"
Selectable Multivariate Data – Automatic Graphing

- Multi-variate graphing as a standard presentation format
- Powerful for operators to see relationships
- Develop and test hypotheses
Another example of significant multivariate observation

- Chiller 4 more efficient at light load
- Control upgrade issue

Chiller 1 vs Chiller 4 Efficiency Data at Varying Loads
Operator Response

• High degree of involvement, use, and learning
• Communication between operators
• Remote support encourages interactivity
• Improved job satisfaction and performance
• Identification of needs for new controls
Early Operator-driven Operational Improvements

- Refrigerant Charge
- Chiller Staging
- Individual Chiller Efficiencies
- Condenser Temperatures
- Water-side Economizer
Data Availability: Immediate Impacts

- Having performance data resulted in immediate actions and impacts
- Numerous operator stories
- $100,000 / mo savings

### Memorial Sloan Kettering - Chiller (Mechanical Cooling) Performance Report 2007

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th># Days</th>
<th>Chiller Output Ton-Hrs</th>
<th>Steam Usage Milbs</th>
<th>Chiller Efficiency lbs/Ton</th>
<th>Baseline Efficiency lbs/Ton</th>
<th>Average Cost $/Mlb.</th>
<th>Chiller Operating Cost $</th>
<th>Baseline Operating Cost $</th>
<th>Savings $</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/26</td>
<td>1/26</td>
<td>13</td>
<td>962,205</td>
<td>12,897</td>
<td>13.404</td>
<td>15.440</td>
<td>$17.23</td>
<td>$222,215.31</td>
<td>$255,976.55</td>
<td>$33,761.24</td>
<td>13.2%</td>
</tr>
<tr>
<td>1/26</td>
<td>2/26</td>
<td>13</td>
<td>2,400,368</td>
<td>30,556</td>
<td>12.730</td>
<td>15.440</td>
<td>$17.54</td>
<td>$535,876.23</td>
<td>$649,966.74</td>
<td>$114,090.51</td>
<td>17.6%</td>
</tr>
<tr>
<td>2/26</td>
<td>3/27</td>
<td>13</td>
<td>2,291,842</td>
<td>26,753</td>
<td>11.673</td>
<td>15.440</td>
<td>$14.86</td>
<td>$397,556.05</td>
<td>$525,845.12</td>
<td>$128,289.07</td>
<td>24.4%</td>
</tr>
<tr>
<td>3/27</td>
<td>4/25</td>
<td>13</td>
<td>1,930,290</td>
<td>22,973</td>
<td>11.902</td>
<td>15.440</td>
<td>$17.61</td>
<td>$404,573.12</td>
<td>$524,856.44</td>
<td>$120,283.31</td>
<td>22.9%</td>
</tr>
<tr>
<td>4/25</td>
<td>5/25</td>
<td>13</td>
<td>588,241</td>
<td>5,484</td>
<td>9.323</td>
<td>15.440</td>
<td>$23.60</td>
<td>$129,418.98</td>
<td>$214,324.20</td>
<td>$84,905.22</td>
<td>39.6%</td>
</tr>
<tr>
<td>5/25</td>
<td>6/26</td>
<td>13</td>
<td>682,405</td>
<td>12,897</td>
<td>13.404</td>
<td>15.440</td>
<td>$17.23</td>
<td>$222,215.31</td>
<td>$255,976.55</td>
<td>$33,761.24</td>
<td>13.2%</td>
</tr>
<tr>
<td>6/26</td>
<td>7/26</td>
<td>13</td>
<td>2,400,368</td>
<td>30,556</td>
<td>12.730</td>
<td>15.440</td>
<td>$17.54</td>
<td>$535,876.23</td>
<td>$649,966.74</td>
<td>$114,090.51</td>
<td>17.6%</td>
</tr>
<tr>
<td>7/26</td>
<td>8/24</td>
<td>29</td>
<td>2,400,368</td>
<td>30,556</td>
<td>12.730</td>
<td>15.440</td>
<td>$17.54</td>
<td>$535,876.23</td>
<td>$649,966.74</td>
<td>$114,090.51</td>
<td>17.6%</td>
</tr>
<tr>
<td>8/24</td>
<td>9/25</td>
<td>32</td>
<td>2,291,842</td>
<td>26,753</td>
<td>11.673</td>
<td>15.440</td>
<td>$14.86</td>
<td>$397,556.05</td>
<td>$525,845.12</td>
<td>$128,289.07</td>
<td>24.4%</td>
</tr>
<tr>
<td>9/25</td>
<td>10/25</td>
<td>32</td>
<td>1,930,290</td>
<td>22,973</td>
<td>11.902</td>
<td>15.440</td>
<td>$17.61</td>
<td>$404,573.12</td>
<td>$524,856.44</td>
<td>$120,283.31</td>
<td>22.9%</td>
</tr>
<tr>
<td>10/24</td>
<td>11/27</td>
<td>34</td>
<td>588,241</td>
<td>5,484</td>
<td>9.323</td>
<td>15.440</td>
<td>$23.60</td>
<td>$129,418.98</td>
<td>$214,324.20</td>
<td>$84,905.22</td>
<td>39.6%</td>
</tr>
<tr>
<td>11/27</td>
<td>12/26</td>
<td>13</td>
<td>682,405</td>
<td>12,897</td>
<td>13.404</td>
<td>15.440</td>
<td>$17.23</td>
<td>$222,215.31</td>
<td>$255,976.55</td>
<td>$33,761.24</td>
<td>13.2%</td>
</tr>
</tbody>
</table>

Total Average: 137 days, 8,172,946 Ton-Hrs, 98,664 Steam Usage Milbs, 19,733 Chiller Output lbs, 12,072 Baseline Output lbs, $1,689,639.70 Chiller Operating Cost, $2,170,969.05 Baseline Operating Cost, $481,329.35 Savings, 23.5% Savings.
Interpreting Early Results

• Conjoint Man-Machine Systems provide superior results

• Short, fast feedback loops that incorporate Operators
  – “trim” system for dynamic operating conditions
  – Find improved operating points
  – Better decision-making about equipment starts and sequencing

• Powerful learning with documentation of results
Questions?

Michael Bobker
michael_bobker@baruch.cuny.edu