Example graphs

Features:

- System data
- Component data
- Hierarchies
- Hierarchy – data links
- Comment (about function)
- Status

5/10/2011
Example graphs

Missing

• Operating modes annotated w/comments on intent for modes
• Traffic lights for each mode
• Explanation of traffic light

No difference between measured and simulated data during occupied hours
→ no performance problem

Occupied: Air flow increased

Un-Occupied: low air flow to many zones

Simulation approximation
Active chilled beam is constant volume (not two speed)

Is this a performance problem? NO
Example graphs

Consistencies? Inconsistencies? Improvements?

Features; Implication(s)?
Example graphs

1. Water running throughout the night (faucet left on)
2. Water used at regular intervals at 8pm and 10pm
3. Missing data
4. Water usage follows occupancy trends
5. Water usage drops during holidays

Features of data
5/10/2011
Example graphs

1. Annotate!
2. Provide operational status – suggestions here?

Features; Implication(s)?
Figure 2 – Scatter Plot of Relationship between Chilled Water Consumption and Exterior Temperature of Y2E2 Building for the 2010 Year

Features; Implication(s)?
1. Baseline chilled water usage
2. Direct relationship between chilled water consumption and OAT
3. Slope slightly decreases for OAT > threshold (region 3)
Indoor Lighting

Consistencies? Inconsistencies? Improvements?
Indoor Lighting

1. Missing data
2. High unoccupied power usage compared to occupied usage and other floors
Outdoor Lighting

Consistencies? Inconsistencies? Improvements?

Features; Implication(s)?
1. Drop in unoccupied power usage
2. Missing datum
3. Outside lighting usage higher in the daytime than at night
Outside Air Temperature vs Steam Flow Rate

Consistencies? Inconsistencies? Improvements?

Features; Implication(s)?
Outside Air Temperature vs Steam Flow Rate

Consistencies? Inconsistencies? Improvements?

Features; Implication(s)?
1. Anomaly
2. Steam flow inversely proportional to dry-bulb Outside air temperature (good!)
3. Second trend line for same outside temperature range: occupied vs. unoccupied?
4. Baseline steam flow
Handheld vs. BMS Measurements
<table>
<thead>
<tr>
<th>Location of Measurement</th>
<th>Fancy Thermometer (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling</td>
<td>71.6</td>
</tr>
<tr>
<td>Middle</td>
<td>72.6</td>
</tr>
<tr>
<td>Ground</td>
<td>70.7</td>
</tr>
</tbody>
</table>

**Figure 9 - Space 293 Temperature Measurements**

![Graph showing temperature measurements over time](image)

Data Points fairly consistent with BMS measurements. The values are very close to each other at the time of measurement (2:10 PM).

**Figure 10 - Space 293 BMS Measurements Graph with Manual Points Plotted**
Features; Implication(s)?
Features; Implication(s)?
CO2 Concentration

Features; Implication(s)?
Carbon Dioxide Status?

Variation from Handheld Device and Building Monitoring System

Features; Implication(s)?
<table>
<thead>
<tr>
<th>Location of Measurement</th>
<th>Fancy Thermometer (°F)</th>
<th>Cheap Thermometer (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling</td>
<td>74.5</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>75.6</td>
<td>73.4</td>
</tr>
<tr>
<td>Ground</td>
<td>75.1</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 7 - Space 292A Temperature Measurements**

![Temperature Measurements Graph](image)

**Figure 8 - Space 292A BMS Measurements Graph with Manual Points Plotted**

Data Points fairly consistent with BMS measurements. The values are very close to each other at the time of measurement (2:00 PM).
<table>
<thead>
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<th>Fancy Thermometer (°F)</th>
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</thead>
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</tr>
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</table>

**Figure 9 - Space 293 Temperature Measurements**

![Graph showing temperature measurements over time](image)

Data Points fairly consistent with BMS measurements. The values are very close to each other at the time of measurement (2:10 PM).

**Figure 10 - Space 293 BMS Measurements Graph with Manual Points Plotted**
Room 293 & 292A Measured vs. Recorded Space Temperature

<table>
<thead>
<tr>
<th></th>
<th>Room 292</th>
<th>Room 293</th>
<th>OAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>74.5</td>
<td>71.6</td>
<td>58.7</td>
</tr>
<tr>
<td>Sensor Level</td>
<td>75.6</td>
<td>72.6</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>75.1</td>
<td>70.7</td>
<td></td>
</tr>
<tr>
<td>Furthest Wall</td>
<td>73.5</td>
<td>72.3</td>
<td></td>
</tr>
</tbody>
</table>

Features; Implication(s)?
Outdoor Air Temperature Measured vs. Recorded

Features; Implication(s)?
Space Temperature Status?

Features; Implication(s)?
Current Draw (Rm 292 Handheld vs Rm 341 BMS)

1. Five devices (lamp, 2 computers, 2 monitors)
2. One computer unplugged

Features; Implication(s)?
Supply/Outside Air Temperatures

We have chosen to assign this system a green status. The supply air temperature stays within one degree of the setpoint and is never closer than 5°F from the dewpoint temperature. Since the daytime temperatures never exceeded 68°F, morning warmup mode would be allowed to occur throughout the entire two weeks. However, the outdoor temperature was cooler than the supply temperature so we would not expect the temperature to drift upwards.

- Rationale for identifying any green, yellow or red data regions;
- Modes of operation in functional intent
Supply/Outside Air Temperatures

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- Relative fraction of energy use of system re building as a whole?
- Energy simulation exercise to confirm or disconfirm your intuition.
This is a comparison of the different load draws in the representative office 341 for plugs, lighting and ceiling fan. When someone is occupying the room, we expect these loads to fluctuate at different parts of the day (plug load - all day, lighting load - when lighting is needed, ceiling fan - when circulation is needed). We used a carpet plot so we can easily determine which plug loads are the largest, and therefore, be able to make recommendations on how to reduce energy. As seen below, there isn’t much data for these three points. Point 1 represents the time when some plug load (i.e. laptop, lamp, etc.) is turned on and used. During section 2 for plug load, this electronic stays on in sleep mode and therefore draws less amps. At point 3, the electronic is used again and shut off. The graphs for lighting and ceiling are outlined with a yellow line because it is unclear whether or not that data is good. From those graphs, you can see that no amps are being drawn at any point in the 2 week period. This means that either the sensors are broken or that they are never used. It is difficult to put a traffic light on this type of data because there is a large range of data that is appropriate for these sensors and that these loads are driven by the occupant solely, not by outside/inside conditions.
Plug Load Current Draw, Lighting Load Current Draw, Ceiling Fan Load Current Draw

2. this electronic in sleep mode and therefore draws less amps.

1. time when some plug load (i.e., laptop, lamp, etc.) is turned on and used.

3. electronic is used again and shut off.
   • graphs for lighting and ceiling outlined with a yellow line because unclear whether data are good.
     – no amps drawn in 2 week period... either sensors broken or load never used.
   • difficult to put traffic light on this type of data ..
     – large range of data appropriate for these sensors
     – loads driven by occupant, not outside/inside conditions.

Features; Implication(s)?
Plug Load Current Draw, Lighting Load Current Draw, Ceiling Fan Load Current Draw

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- Graphs for lighting and ceiling outlined with a yellow line because unclear whether data are good.
  - No amps drawn in 2 week period...
  - Either sensors broken or load never used.

- Difficult to put traffic light on this type of data...
  - Large range of data appropriate for these sensors
  - Loads driven by occupant, not outside/inside conditions.

- Modes?
- Why 24 hour/day plug load draw (region 2)?
- Status (green/yellow/red)
- Relative fraction of energy use of components re building as a whole?
- Energy simulation exercise to confirm or disconfirm your intuition.

5/10/2011