Enhancing Building Maintenance Practices with Data Analytics

Katie Rossmann
Manager of Data Analytics and Commissioning
UI Facilities Management FDD Program
Enhancing Building Maintenance Practices with Data Analytics

• Why do we use data analytics?
• What is Fault Detection and Diagnostics?
• High-level overview of the Uiowa FDD Program
• Introduction to key players involved in the FDD response team
• Walk through an example of a typical fault response workflow
• Illustration of benefits
• What’s next?
Weak Signals

“The intuition about how a machine is operating on a factory floor used to come from working there thirty years and being able to detect a slightly different sound signature emanating from the machine, telling us something is not exactly right. That is a weak signal. Now with sensors, a new employee can detect a weak signal on the first day of work – without any intuition.”

Thank You for Being Late
An Optimist’s Guide to Thriving in the Age of Accelerations
Thomas L. Friedman
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2003

Typical Room Comfort Control Operation Parameters in 2003

1. Terminal Air Box Control with Hot Water Reheat (Type A):
   a. Each zone has a TAB with a hot water reheat coil, reheat coil control valve, and DDC controller. Install a single point temperature sensor 2'-6" downstream of the reheat coil. Install a wall mounted temperature sensor to maintain space temperature of 72°F (adj.). See drawings for temperature sensor requirements.
   b. Terminal air boxes shall be set in occupied or unoccupied control via a space occupancy sensor. If the TAB is in occupied mode, the box shall open to at least minimum air flow. Space temperature shall be maintained as described herein. If the TAB is in unoccupied mode, it shall be allowed to modulate closed. The box and valve shall only modulate open to maintain a minimum winter setback temperature of 65°F (adj.), and a maximum summer set up temperature of 80°F (adj.).
   c. The occupancy sensor shall set the TAB to unoccupied after fifteen minutes (adj.) to avoid "false-offs."
   d. At full cooling, the TAB shall be fully open. The reheat coil control valve shall be closed.
   e. On a fall in space temperature, the TAB shall modulate closed until space setpoint is maintained, or until it reaches its minimum position. The reheat coil control valve shall be closed.
   f. On a further fall in space temperature, the TAB and the reheat coil control valve shall modulate open in unison until setpoint is maintained or until specified maximum heating airflow is reached.
   g. If heating water system temperature is 5°F (adj.) below setpoint, on a call for heating, the TAB shall remain at its minimum airflow setting.

Three modes of operation-room for intuition
More modes of operation, more data points, more "weak signals"
“Experienced workers knew how to process weak data. But now with Big Data, with a much finer grain of fidelity we can make finding a needle in the haystack the norm - not the exception. And we can augment the human worker with machines so they work as colleagues and enable them to process weak signals together and overnight become like a thirty year veteran.”

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Understanding what has happened in the past, what is happening now, and what will probably happen is foundational for predictive analytics.

We already have the data and the expertise!

Predictive analytics is bridging the gap traditionally provided by Institutional Knowledge.
Early warning signs, often in the form of “Weak Signals” provides the basis for predicting impending system failure.

Predicting impending failure, and preventing that failure, mitigates business continuity risk and financial risk.

The dollar outlay shifts from productivity losses, repair costs and wasted energy to investments in infrastructure and technology and active monitoring.
Managing Risk & Costs

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Fault Detection and Diagnostics

What is it?

Fault Detection and Diagnostics (FDD) is a software tool used to **PROACTIVELY** discover building system problems and identify optimization opportunities…

**BEFORE** they lead to alarms, excessive waste of resources, occupant discomfort or system failure.
Fault Detection and Diagnostics

Key Tenants of Uiowa’s FDD Program

• We leverage our internal expertise to prioritize and perform the majority of the work.
• We use existing data infrastructure, mostly through our Building Automation Systems, OSISoft Pi and our Computerized Maintenance Management System (AiM).
• Compliments overall FM goal to support proactive and predictive maintenance.
Fault Detection and Diagnostics

Program Timeline

1. September 2014
   Started a pilot to self-perform an on premises FDD implementation in a newly constructed lab building

2. September 2015
   Investigated working with an integrator for a campus-wide FDD solution

3. February 2016-June 2016
   Issued an RFP to select an FDD solution for 20 General Fund Buildings

4. October 2016-January 2017
   Selected an FDD solution and on-boarded 20 buildings with a software as a service, cloud-based solution.
20 Buildings
Academic, Lab, Office, Recreational, etc.

KGS Buildings Clockworks FDD Software

49,000 Points
5 min interval collection

All Major HVAC Equipment
AHUs, HW/CHW Systems, Pumps, VAVs

4 Building Automation Systems
Andover Continuum, Schneider StruxtureWare, JCI Metasys, Pi OPC

Onboarding time
3 months for all buildings to be live and performing fault detection
Fault Detection and Diagnostics

Buildings currently online

<table>
<thead>
<tr>
<th>College of Medicine Administration Building</th>
<th>Biology Building East</th>
<th>Adler Journalism Building</th>
<th>Campus Recreation and Wellness Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>College of Public Health Building</td>
<td>Blank Honors Center</td>
<td>Boyd Law Building</td>
<td>Chemistry Building</td>
</tr>
<tr>
<td>Pappajohn Biomedical Discovery Building</td>
<td>Voxman Music Building</td>
<td>Spence Laboratories of Psychology</td>
<td>Pomerantz Center</td>
</tr>
<tr>
<td>Dental Science Building</td>
<td>Hancher Auditorium</td>
<td>University Services Building</td>
<td>Trowbridge Hall</td>
</tr>
<tr>
<td>Carver Biomedical Research Building</td>
<td>Stuit Hall</td>
<td>Medical Laboratory</td>
<td>Calvin Hall</td>
</tr>
</tbody>
</table>
Fault Detection and Diagnostics

Work order automation helps facilitate the work and “tell the story”
### Analytic Response Group

Multidisciplinary team  
Meets 4 mornings per week  
Prioritizes, plans & coordinates response

#### First Responders
- Experienced HVAC technicians  
- Interact with tool full time  
- Field troubleshoot and point person for maintenance fixes

**2 FTE**

#### Controls Support
- Experienced controls programmers (1 point person)  
- Assist with analytics issues & troubleshooting, adjust programming as needed

**1 FTE**

#### Analytics
- BLS Managers  
- Technical support for FDD  
- Review metrics and report successes

**As Needed**

#### Priority and Planning
- BLS Managers  
- Prioritize and plan ARG activities  
- Coordinate and plan FDD projects

**As Needed**
First Responders do a quick “desktop” validation of the fault using software

~7° drop across coil

Cooling Valve Closed
Fault Response Workflow

Direction given and work order generated 10/13/17

Notes entered in Clockworks are pushed to the work order description within AiM

The technician initiates a request for a work order within Clockworks, which generates a work order in the CMMS (AiM)
Fault Response Workflow

Work completed and Work Order closed 11/9/17

Analytic is no longer flagging

<table>
<thead>
<tr>
<th>Building</th>
<th>Equipment</th>
<th>Analysis</th>
<th>Start Date</th>
<th>Notes Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyd Law Building</td>
<td>BLB-AHU-3 (Air Handler)</td>
<td>AHU Coils</td>
<td>11/13/2017</td>
<td>Adjusted cooling valve and replaced heating valve from pneumatic to electric.</td>
</tr>
<tr>
<td>Boyd Law Building</td>
<td>BLB-AHU-3 (Air Handler)</td>
<td>AHU Coils</td>
<td>11/14/2017</td>
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<td>BLB-AHU-3 (Air Handler)</td>
<td>AHU Coils</td>
<td>11/15/2017</td>
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<td>Boyd Law Building</td>
<td>BLB-AHU-3 (Air Handler)</td>
<td>AHU Coils</td>
<td>11/16/2017</td>
<td></td>
</tr>
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<td>Boyd Law Building</td>
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UI Facilities Management FDD Program

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Institutional Benefits

• **Proactive Maintenance**: Our team has greater visibility into hidden equipment issues, and receives an automated, prioritized “to do” list.

• **Prioritized Insights**: Greater direction for completing work due to prioritization metrics. We now perform root-cause analysis to determine the necessary resolution for each fault—maximizing time and resources.

• **Measured Impact**: We now can track our success and justify our internal staffing and vendor support. Our work, now captured through AiM, illustrates impact, and is one more piece of the puzzle to identify time and resource needs.
UI Facilities Management FDD Program

Enhancing Building Maintenance Practices with Data Analytics

Data is captured in our CMMS for enhanced KPI Measurement

Show progress in starting and closing out issues

Communicate time and resource needs

Illustrate a transformation to more planned and scheduled, less reactive work
UI Facilities Management FDD Program

Enhancing Building Maintenance Practices with Data Analytics

Data is captured in AiM to help with Measurement & Verification

Boyd Law Building – 4 year Energy Analysis

12 kbtu/sqft in energy savings to date

Boyd Law Building - Steam Performance Verification

Boyd Law Building - Chilled Water Performance Verification

The University of Iowa
What’s Next?

• Onboarding 29 additional buildings over the next 5 months
• Expanding the FDD response process to include more frontline staff involvement
• Investigating the use of the tool for new construction commissioning
Questions?

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