SAVING ENERGY AND IMPROVING BUILDING PERFORMANCE THROUGH FAULT DETECTION & DIAGNOSTICS

LOCATION

The University's Health Sciences E Wing was constructed as an extension to an existing building on campus. This wing comes fully equipped with various labs, teaching spaces, and a learning resource centre for the Health Sciences department.

THE CHALLENGE

The primary challenge presented to us involved the implementation of an Energy Management Information System (EMIS) for the electricity, chilled water, steam, and water consumption meters on campus using our Kaizen software. The secondary challenge involved identifying issues that the Facilities Management team was not aware of, using Kaizen’s Fault Detection and Diagnostics (FDD) feature. This report focuses on the findings from the Fault Detection and Diagnostics rules that were implemented in Kaizen.

KAIZEN BENEFITS

$50,000
Potential estimated cost savings in annual utility costs

Roughly $10,000
In realized savings year-to-date from AHU fan electricity savings alone

120/lbs hour
Estimated energy savings from closing just one isolation valve that was manually overridden

OUR FINDINGS

Here are some of the major findings uncovered by the Fault Detection and Diagnostics rules in Kaizen. We were able to uncover a few areas of improvement that weren’t previously known to Facilities Management, using the generated insights from Kaizen (our analytics software).

1. **Air Handling Units (AHU1 through AHU6)**
   Kaizen identified six Air Handling Units (AHU), each with varying combinations of issues:
   - All AHUs were running 24 hours a day, 7 days a week regardless of building occupancy.
   - Some Heating and Cooling Coil Valves were open to 100% with no modulation throughout the heating and cooling seasons respectively.
**What is Fault Detection and Diagnostics (FDD)?**

Kaizen provides a simple way to see inside your building automation system (BAS). Our Fault Detection and Diagnostics (FDD) system can reduce the amount of time spent diagnosing system faults in your facility, and increase the number of issues that can be fixed with the same resources.

Logic rules can be customized to fit the exact needs of your facilities management plan, including weather, occupancy schedules, and more to determine when and how the BAS should perform. With Kaizen, your building becomes more efficient and cheaper to operate.

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**Fig. 1: AHU SAT Fluctuations due to poor Heating Coil Valve control.**

- Most of the Variable Frequency Drive fans were running at speeds closer to 100% due to the Supply Static Pressure Set Points (SSP SP) not being reset based on actual demand for air from the terminal units.
- The Supply Air Temperature (SAT) for several AHUs displayed significant fluctuations.
- One AHU was shown to have issues with a Mixed Air Damper (MAD) being 100% open without any modulation for several days (Fig. 1).

2. **Improving Occupancy Comfort and Wellness**

Kaizen was applied to improve occupant comfort and wellness, in addition to improving building and energy performance. Using a total of 55 zones with heating and cooling set points as test candidates, Kaizen monitored and analyzed temperature control, ventilation control, and humidity control within the building.

3. **Steam Isolation Valve**

Kaizen’s Building Operator Report showed a Steam Isolation Valve serving Forced Flow Units and Unit Heaters left open during the summer, which resulted in wasted steam.
CopperTree Analytics provided the following recommendations to improve the operation of the six AHUs in the building:

1. **Air Handling Units (AHU1 through AHU6)**
   A schedule was recommended for the AHUs that were operating 24/7. This would reduce the run time of the fans, and more significantly, reduce the demand for heating, cooling, and humidification in the building.
   - **Supply Static Pressure SP reset strategy**
     A close-to-real time SSP SP reset strategy was recommended for the AHUs. This would allow the SSP SP to be reset based on actual demand for air in the terminal units. If the zone air flows are above the flow set point, then the dampers would close, and this would then reset the SSP SP, reducing the fan speed. This would allow for the fans to operate at lower speeds when there is less demand for air flow from the terminal units.
   - **The Supply Air Temperature (SAT) fluctuations indicated an opportunity to improve the control on the heating and cooling control valves, which would lead to the SAT control being more stable.**

   - **Improved control strategies were recommended for Heating and Cooling Control Valves that were operating at 100% all the time (Fig. 2)**

   As of December 2017, the six affected AHUs have undergone Scheduling and Fan Speed Optimization implementation. The supply and return fan savings have been measured and verified using Kaizen, and the corrective measures applied to the AHUs during the summer of 2017 has saved approximately $10,000 in AHU fan electricity savings in just 6 months (Fig. 2).

2. **Improving Occupancy Comfort and Wellness**
   To address the occupant comfort issues in the zones, a custom rule was written in Kaizen to calculate the hours of operation when the room temperature was outside of acceptable limits. Out of the 55 zones used for testing, 11 zones were identified that required investigation first. Investigation of these zones helped identify the broken Radiation and Chilled Beam Valves. These are currently in the process of being repaired or replaced.

   ![Fig. 2: Electricity Cost Savings Meters for AHUs in Kaizen as of Dec 15, 2017 (AHU fan electricity savings only).](image-url)

   **Air Handling Units**

   - AHU3, 260.61 $
   - AHU4, 346.77 $
   - AHU5, 1,579.67 $
   - AHU1, 1,531.43 $
   - AHU2, 1,252.20 $
   - AHU6, 5,098.50 $
3. **Steam Isolation Valve**

CopperTree Analytics advised the client that the Steam Isolation Valve needed to be shut off. Once the valve was shut off, it resulted in energy savings of approximately 120lbs/hour (Fig. 3).

If optimization measures are taken, we estimate the potential cost savings to be approximately $50,000 annually in utility costs for this building.

This figure has been estimated and quantified through the Measurement and Verification rules in Kaizen during our pilot project phase, though it should be noted that the potential for more savings can be realized through further optimization measures.

**Fig. 3:** Steam consumption graph showing consumption before and after the Steam Isolation Valve was shut off by the building operator.

**Fig. 4:** A sampling of some of the insights generated by the Golden Standard feature in Kaizen.

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**THE GOLDEN STANDARD FOR OPTIMIZATION**

In addition to fault detection and providing actionable insights, Kaizen is able to capture changes in your BAS on an ongoing basis, and measure it against an optimized baseline for the BAS called the Golden Standard. Any positive changes captured by Kaizen can be promoted to be part of the new Golden Standard while flagging any negative changes for further review (Fig. 4).

The Golden Standard allows your facilities management team to take proactive measures to prevent your building from drifting away from the desired baseline. For example, Golden Standard Insights can capture any equipment changed to manual control from automatic control.

**KAIZEN FOR TODAY AND THE FUTURE**

CopperTree Analytics believes in providing actionable insights for building automation and energy management professionals. Learn more about what we can do for you and your business at www.coppertreenalytics.com.