Recommissioning of the Figge Art Museum

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Figge Art Museum Recommissioning

How it came to pass
Recommissioning process
Ongoing performance
History leading to Recommissioning

Participation in MidAmerican Energy Company’s Commercial New Construction program during design and construction (2002 to 2005)

- Efficiency program offered by MidAmerican Energy Company
- Energy modeling to predict building performance
- Incentives provided for savings vs. state energy code
- Incentives are contingent upon measurement and verification findings

Diagram:
- Information Gathering
  - Energy Modeling
  - Cost Analysis
- CD Review
- M & V
Findings of Measurement and Verification

- M&V process occurred after building had been operating for several months
- Building was using significantly more energy than predicted by the model
- Some measures were not functioning properly
What to do?

The utility-supported M&V process was limited in scope

- Checking specific measures
- Not checking basic model assumptions

MidAmerican Energy Company agreed to fund a recommissioning study

- Understand how energy is used in building
- Explore further energy savings options
Recommissioning Team

Figge Art Museum
- Provide history of operational issues
- Provide direction regarding acceptable solutions to energy issues

ENTEC Solutions
- Provide assistance to owner in operation of building
- Provide design services for solutions to energy issues
- Implement new building control sequences

The Weidt Group
- Collect building performance data
- Identify operational issues
- Conduct energy analysis
Recommissioning Process

Data Collection
Analysis
Implementation
Verification
Data Collection – Operator Interview

- Revealed problem with preheat coil freeze-up
- Control sequences were modified to prevent recurrence
- Also recurrent freeze-stat trips during economizer operation due to stratification of mixed air
Data Collection – Plan Review

- Humidification air compressors larger than expected
- Chiller and boiler efficiencies lower than expected
- Lighting power density higher than expected
- Fan size in TAB reports similar to model
Data Collection – Spot Measurements

Electrical current measurements at panels were used to estimate key energy loads

<table>
<thead>
<tr>
<th>End Use</th>
<th>Measured kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior Lighting</td>
<td>140</td>
</tr>
<tr>
<td>Exterior Lighting</td>
<td>6</td>
</tr>
<tr>
<td>Fans</td>
<td>173</td>
</tr>
<tr>
<td>Kitchen Equipment</td>
<td>94</td>
</tr>
<tr>
<td>Big Elevator</td>
<td>3</td>
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<tr>
<td>Humidifiers</td>
<td>65</td>
</tr>
<tr>
<td>Chillers - Dehumidification</td>
<td>95</td>
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<tr>
<td>Cooling Towers</td>
<td>11</td>
</tr>
<tr>
<td>Pumps</td>
<td>27</td>
</tr>
</tbody>
</table>
Portable Data Loggers – Gallery Lighting

- Building operator has manually dimmed lights to 65%
- Daylighting control provides additional reduction mid day
- Similar datalog results for other zones led to improved assumptions for lighting schedules

**Second Floor Gallery Skylights Lighting Circuit**

![Graph showing percent full load over time](chart.png)
Portable Dataloggers – Kitchen Equipment

80% during daytime
20% at night
Energy Management System Review

The Weidt Group was set up with remote access to Energy Management System (EMS)

Lots of information
- Air handler data
- Zone VAV box data
- Central plant data

Graphic Data Screen Review
- Point in time operation

Trend Log Charts
- 15 minute time interval
- Multiday trends
EMS Graphic Data Screen

Air Handling Unit 3 (AHU-3)

- OA Humidity: 45.7% OAA Temp: 24.6°F
- MAX VAV DMND: 55% GEN BLDG SCHEDULE: OFF
- DEHUM CALL: OFF AHU-3 SCHEDULE: ON
- TIMED FILTER RESET: OFF AHU-3 MODE: Occupied

Exhaust Air
- AHU-1 EAD: 0%
- HRU EAD: 100%
- P-16: 100%

Outside Air
- HRU OAD: 100%
- PHC SAT: 49.6°F
- AHU-1 OAD: 0%
- PHC VALVE: 65%

Return Air
- RA Damper: ON
- ENB: ON
- Airflow: 18126 cfm

Supply Air
- TO RETURN AIR CHAMBER
- TO SUPPLY AIR CHAMBER
- AHU-1, AHU-2, AHU-4, AHU-6, AHU-7/8

Click HERE for area served

18th National Conference on Building Commissioning
February 4, 2006
Toa = 25°F dry bulb

Excessive Preheat:
Design intent is 30°F to prevent frost on heat wheel

Chiller is dropping supply air temp by 6 degrees F

50°F
67°F
61°F
57°F

Heat Wheel is off
No discharge air temperature reset
EMS Graphic Screens – Discharge Temp Reset

- AHU Discharge Temp = 57 F
- All zones in heating mode
- Discharge Temp should be reset upwards

![EMS Graphic Screens Image]
Additional Findings from EMS Trend logs

- Fan Static Pressure Reset – trend log of set point showed it did not change with time
- Demand controlled ventilation – Zone CO\textsubscript{2} levels did not rise significantly above outdoor levels
- Outside air damper open at night – trend log of damper position
Calibration of model for recent operation
Update of code baseline model
Modeling of measures identified by Recommissioning
Calibration of Model for Recent Operation

- Remove economizer
- Remove discharge air temperature reset
- Increase outside air preheat
- Increase humidification compressor power
- Remove scheduled outside air
- Remove demand controlled ventilation
- Remove heat recovery
- Remove fan static pressure reset
- Update lighting power
- Reduce chiller efficiency
- Adjust operating schedules
Updates to Code Baseline Model

Adjust operating schedules
Increase kitchen equipment loads
Add exterior lighting and elevators
- Audit period was Nov 2005 to Feb 2006
- Based on ReCx data, we were unable to explain the high electric use in summer of 2005
- May have been building startup issues that were resolved before the start of ReCx
ReCommissioning Measures

Bundle 1: Restore economizer and heat recovery, reduce preheat set point to 30 F

Bundle 2: Bundle 1 + scheduled outside air and demand controlled ventilation

Bundle 3: Bundle 2 + duct static pressure reset
## Modeled Measure Savings

Incremental savings for each bundle of measures

<table>
<thead>
<tr>
<th>Bundle Description</th>
<th>Energy $</th>
<th>Electric MWH</th>
<th>Gas Therm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundle 1: Add economizer and heat recovery, reduce preheat</td>
<td>$69,061</td>
<td>584</td>
<td>42,171</td>
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<tr>
<td>Bundle 2: Add sched OA &amp; CO2 control</td>
<td>$3,603</td>
<td>20</td>
<td>1,498</td>
</tr>
<tr>
<td>Bundle 3: Add fan static pressure reset</td>
<td>$7,630</td>
<td>163</td>
<td>-490</td>
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<tr>
<td>Total Bundle 3 Savings vs Calibrated Model</td>
<td>$80,294</td>
<td>767</td>
<td>43,179</td>
</tr>
<tr>
<td>Total Percent Savings</td>
<td>33%</td>
<td>30%</td>
<td>48%</td>
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</tbody>
</table>
Figge Art Museum chose to implement all measures

- New glycol heating loop was added to prevent freeze problem on preheat coils
- Glycol added to chilled water loop to allow economizer operation
- New control sequences were implemented by ENTEC Services with input from Figge Art Museum and The Weidt Group
Verification of ReCx Measures

Checks via EMS
Site visit with entire team for spot checks
Final meeting to review verification findings
Verification – Heat Recovery, Preheat & SAT Reset

Toa = 38 F dry bulb
Verification – Economizer

Toa = 45°F dry bulb
Verification – Static Pressure Reset

Air Handler 1 Static Pressure Reset

Static Pressure

Other Measures Verified

Outside air dampers closed a night
Demand controlled ventilation
Ongoing Performance – Monthly Electric

![Graph showing annual electric MWh consumption over months from January to December for different models and utility bills.]

Legend:
- Code Model
- Calibrated Model
- 2005 Utility Bill
- 2006 Utility Bill
- 2007 Utility Bill
- 2008 Utility Bill
- 2009 Utility Bill
- Bundle 3 Model
Ongoing Performance – Monthly Gas

- **Annual Gas Thems**
- **Code Model**
- **Calibrated Model**
- **Utility Bill**
- **Bundle 3 Model**

**Calibration Period**

**Implementation Period**
Ongoing Performance – Annual Gas

Annual Gas Therm - Code Model, Calibrated Model, Utility Bill, Bundle 3 Model

2005: 15% Savings, 42%, 33%, 18%
2006: 42%
2007: 33%
2008: 18%
2009: 18%
Ongoing Performance – Annual $
Building use has increased in recent years so energy increase is expected

- Especially due to demand controlled ventilation
Conclusions

- Detailed data collection and review identifies operational problems
- Modeling shows value of fixing problems and provides baseline for ongoing performance
- Involvement of building owner and operators is critical to:
  - Understand history of changes
  - Keep improvements in place over time
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