

Turning data into action: framing BAS data for end-users

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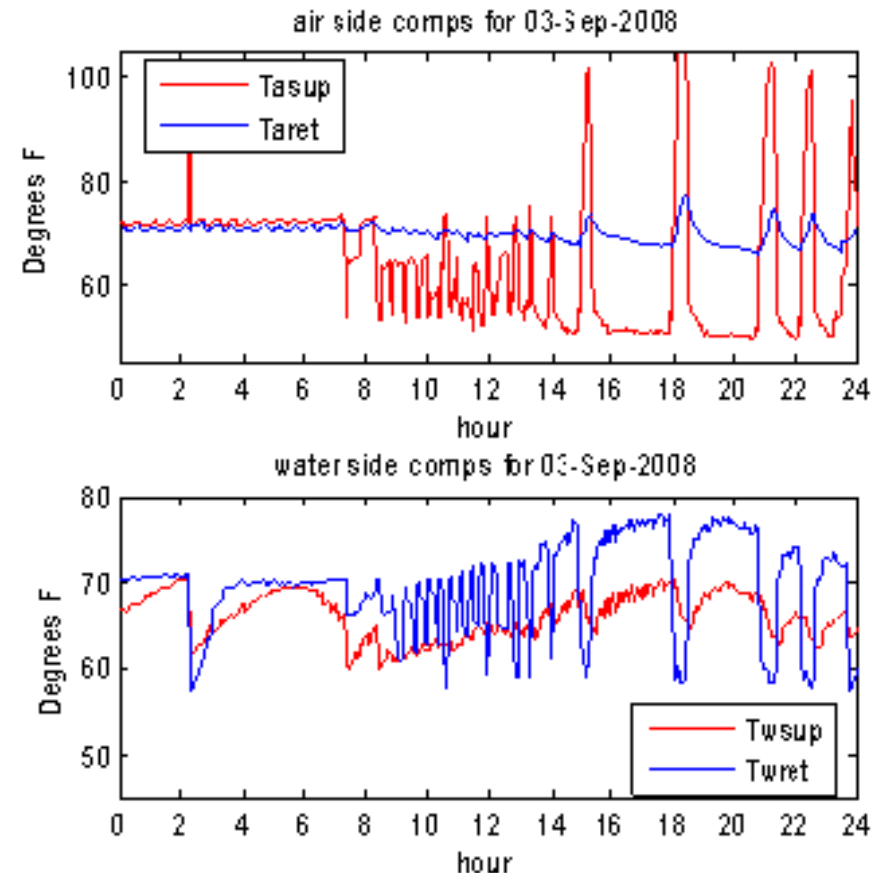
Contents

- Introduction
- Acquiring and using data from large BAS:
the case at MIT
- Managing and extracting information
- Some useful outputs
- Where things can go

Data, Data, Everywhere

- Many measurements in today's BAS
- More coming with required PMV and FDD
- More complex systems, more things to manage, less time for analysis

Time series for a water cooled heat pump

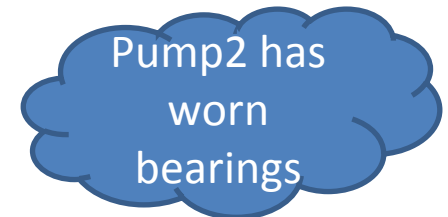


Less Data, More Information

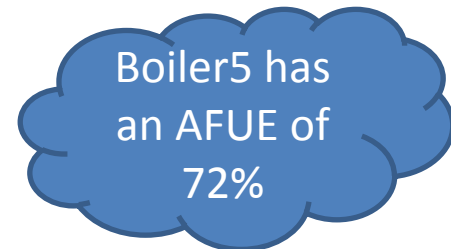
- Convert data into tangible and useful information
- Communicate information to enable action
- Provide tools to fix problems; not an engineer in a box



AHU1 has
faulty
economizer



Pump2 has
worn
bearings



Boiler5 has
an AFUE of
72%

Case Study

- Case studies at MIT on getting, using and managing BAS data
- 100,000+ devices over 2 Msf; largest of its kind from Schneider Electric (TAC)
- Typical BAS measurements

The screenshot displays the Andover Controls Continuum software interface. The top window shows the main dashboard with a photo of the MIT dome and navigation options like 'Main Page', 'Reports', and 'System & Status'. The bottom window shows a detailed 3D schematic of an N42 RTU (Return Air Handling Unit) with various components and their real-time data.

Component	Parameter	Value	
Outside Air	Temp	84.2	
	Humidity	33.7%	
	Exhauster	OFF	
Mixer 1a	Temperature	72.5	
	Set Point	33.7	
	Status	Enabled	
Fan 1a	Speed	67.0%	
	Status	Enabled	
	Filter PC-A1	COF	1/1/2009
Mixer 2a	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Fan 2a	Speed	64.7%	
	Status	Enabled	
	Filter PC-A2	COF	1/1/2009
Cooling Stages	Stage 1	COF	1/1/2009
	Stage 2	COF	1/1/2009
	Stage 3	COF	1/1/2009
	Stage 4	COF	1/1/2009
Supply VA20A1	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A2	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A3	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A4	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A5	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A6	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A7	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A8	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A9	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A10	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A11	Temperature	53.6	
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	Status	Enabled	
Supply VA20A12	Temperature	53.6	
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	Status	Enabled	
Supply VA20A13	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A14	Temperature	53.6	
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	Status	Enabled	
Supply VA20A20	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A21	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A22	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A23	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A24	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A25	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A26	Temperature	53.6	
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	Status	Enabled	
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	Status	Enabled	
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	Status	Enabled	
Supply VA20A60	Temperature	53.6	
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	Status	Enabled	
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	Set Point	57.7	
	Status	Enabled	
Supply VA20A77	Temperature	53.6	
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	Status	Enabled	
Supply VA20A78	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A79	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A80	Temperature	53.6	
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	Status	Enabled	
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Supply VA20A98	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A99	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	
Supply VA20A100	Temperature	53.6	
	Set Point	57.7	
	Status	Enabled	

Extraction from MIT BAS

- Data logging through Continuum software
- 1 minute polling on preset groups of points
- Scheduled daily task for report compilation
- Extraction via email or workstation login

The screenshot displays two windows from a BAS control system. The top window, titled 'List View - Groups', shows a table of system groups:

DeviceId	Name	Description
MITN42_C012N42_RTU1	Air Handler Fan 1 Group	Air Handler Fan 1 Group
MITN42_C012N42_RTU1	Air Handler Fan 2 Group	Air Handler Fan 2 Group
MITN42_C012N42_RTU1	Chilled Stages Group	Chilled Stages Group
MITN42_C012N42_RTU1	Fan/Filter	Fan/Filter
MITN42_C012N42_RTU1	JackData	RTU1
MITN42_C012N42_RTU1	Mixing/Da	Mixed Air Damper Group
MITN42_C012N42_RTU1	High/FieldGr	Data Collection
MITN42_C012N42_RTU1	DiscOveride Gr	Data Collection
MITN42_C012N42_RTU1	Optchar Gr	Optimum Start Group

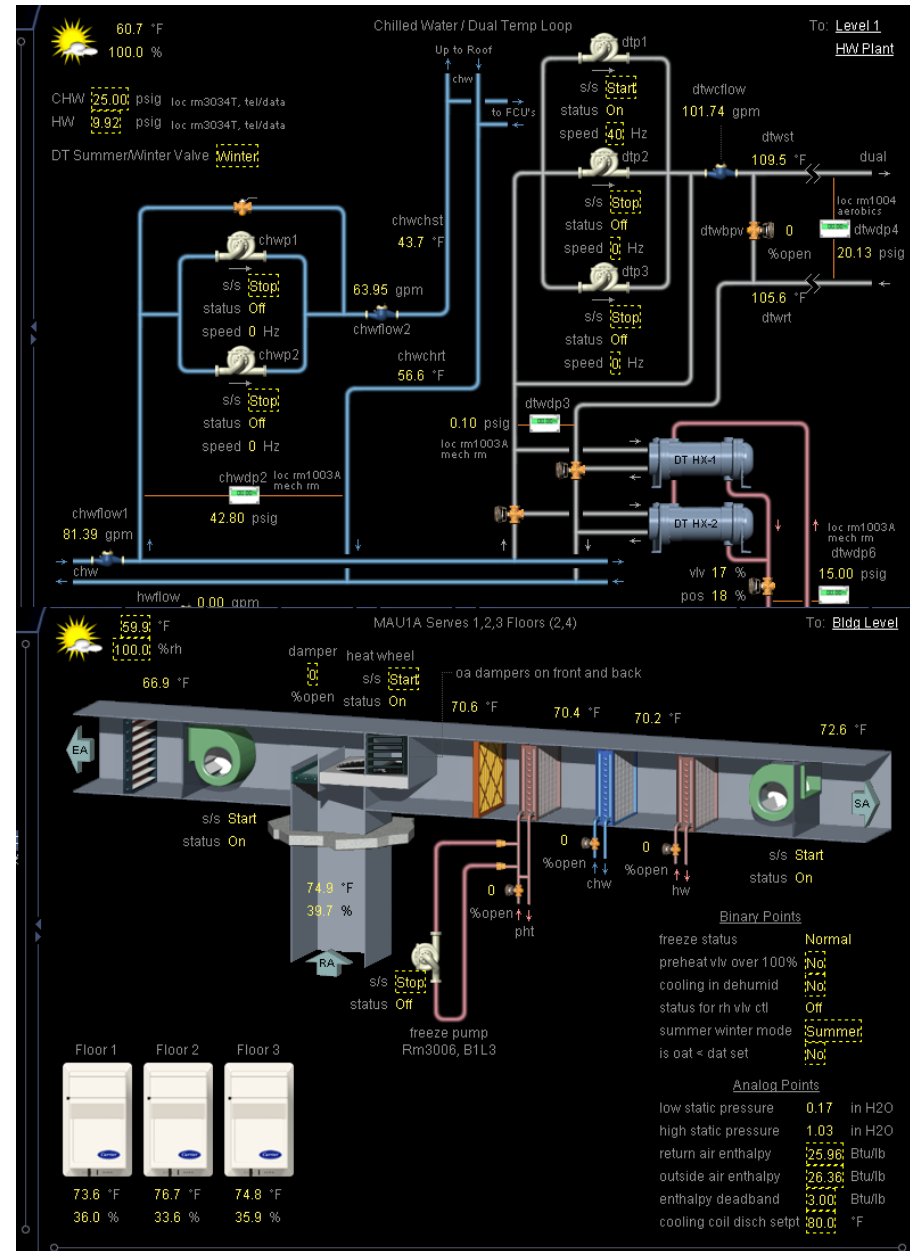
The bottom window, titled 'AirHandler1.Gr - Log View [Member List]', shows a table of data points:

Name	Alias	Value	Type	Owner	DeviceId
FFanRt_A1	FFanRt_A1	Off	InfraOutput		MITN42_C012N42_RTU1
HighGrnd	HighGrnd	Off	InfraName		MITN42_C012N42_RTU1
DiscOveride	DiscOveride	Off	InfraName		MITN42_C012N42_RTU1
Occupancy	Occupancy	On	InfraName		MITN42_C012N42_RTU1
Supply_SP	Supply_SP	1.02	InfraOutput		MITN42_C012N42_RTU1
Supply_SP_2a	Supply_SP_2a	1.0	InfraName		MITN42_C012N42_RTU1
SupplyFan	SupplyFan	On	InfraOutput		MITN42_C012N42_RTU1
SupplyFan_2a	SupplyFan_2a	18.2	InfraOutput		MITN42_C012N42_RTU1
SupplyFanSp	SupplyFanSp	42.6%	InfraOutput		MITN42_C012N42_RTU1

The bottom window also displays a text-based log or control strategy document with sections such as 'RTU FANS', 'MIXED AIR DAMPERS', 'TEMPERATURE SETPOINTS', 'REHEAT COIL CONTROL', 'NIGHT SET-UP', and 'NIGHT SET-BACK'. The 'RTU FANS' section states: 'The supply fan shall modulate to maintain a dust static pressure setpoint in the main supply duct. The return fan shall follow the supply fan speed offset by as much as 10% to maintain a space pressure...'. The 'MIXED AIR DAMPERS' section describes the logic for when outside air enthalpy is less than or greater than the return air enthalpy. The 'TEMPERATURE SETPOINTS' section defines supply air temperature setpoints based on VAV box flow rates. The 'REHEAT COIL CONTROL' section describes the logic for when outdoor air temperature is above 40°F. The 'NIGHT SET-UP' section describes the logic for when space temperature rises above the unoccupied high limit. The 'NIGHT SET-BACK' section describes the logic for when space temperature drops below the unoccupied low limit. The 'Optimum Start' section describes the logic for when RTU's will be optimally started.

Notes on Extraction

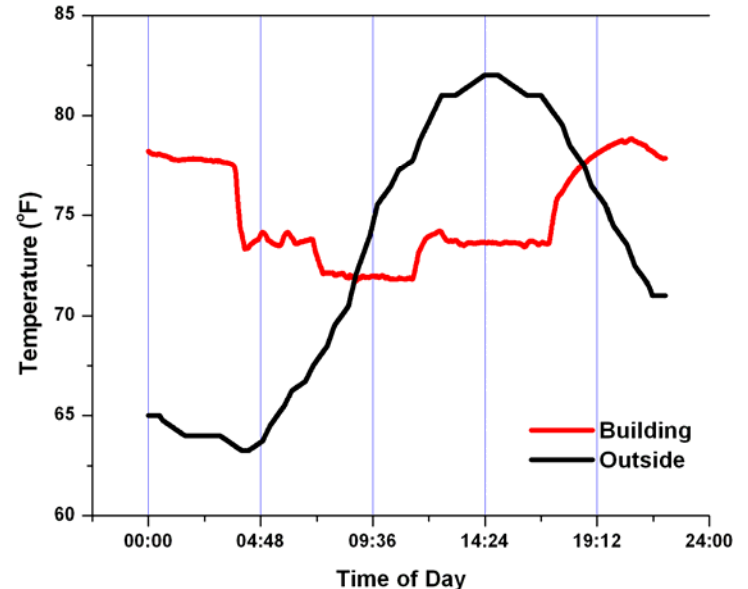
- Web-based “scraping” from any web interface, e.g. Carrier’s I-Vu
- Multi-source input, stored in standard XLS format, per day
- 3rd party polling programs can drag a network down!



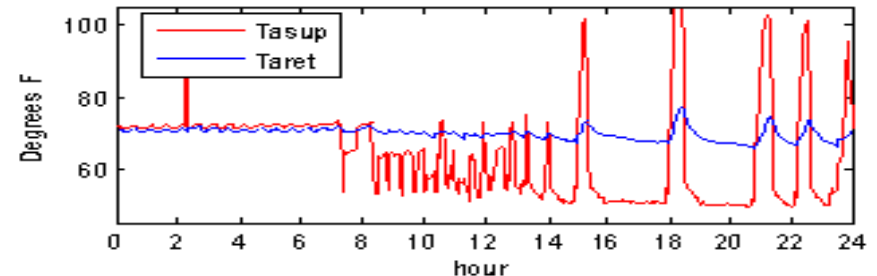
Experience in Using Data

- Lots of data clean up
- Data is only as useful as the information it provides
- Value of analysis is the utility of information
- Decision makers don't care about *raw* or *interesting* data

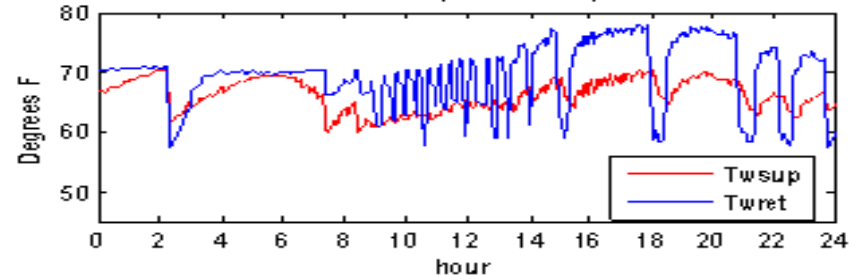
Temperature Data for 6/25/08



air side comps for 03-Sep-2008




waterside comps for 03-Sep-2008

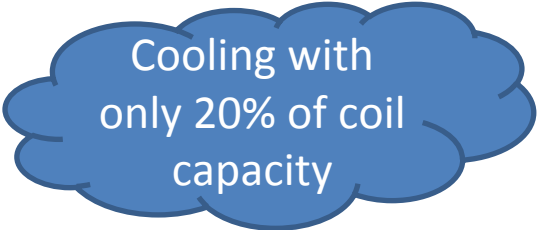


Making Data Useful

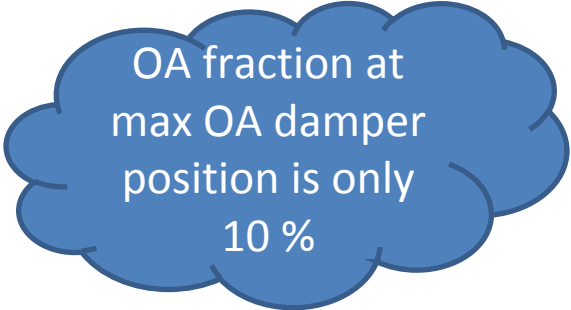
- Assume we can organize lots of data into one manageable structure
- What do decision makers want to know?
- What would engineers like to know?



New steam traps = 50% savings



Cooling with only 20% of coil capacity



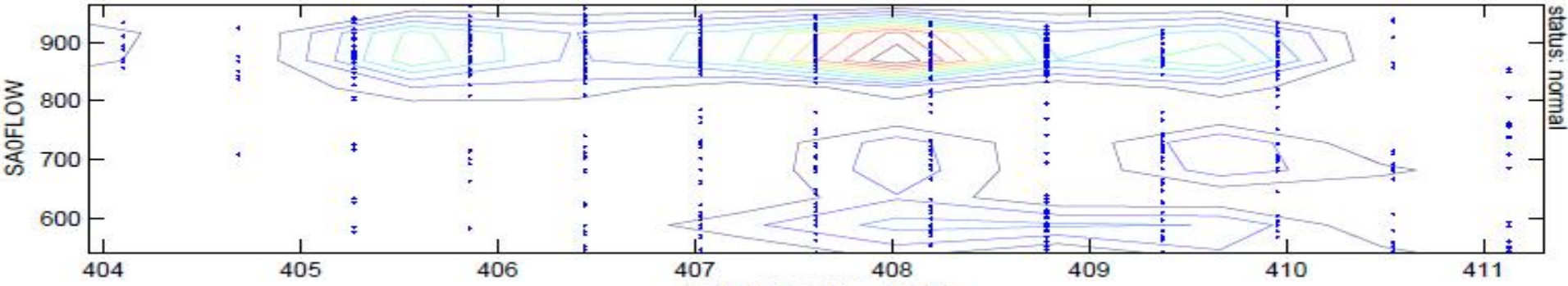
OA fraction at max OA damper position is only 10 %

Accounting for Uncertainty

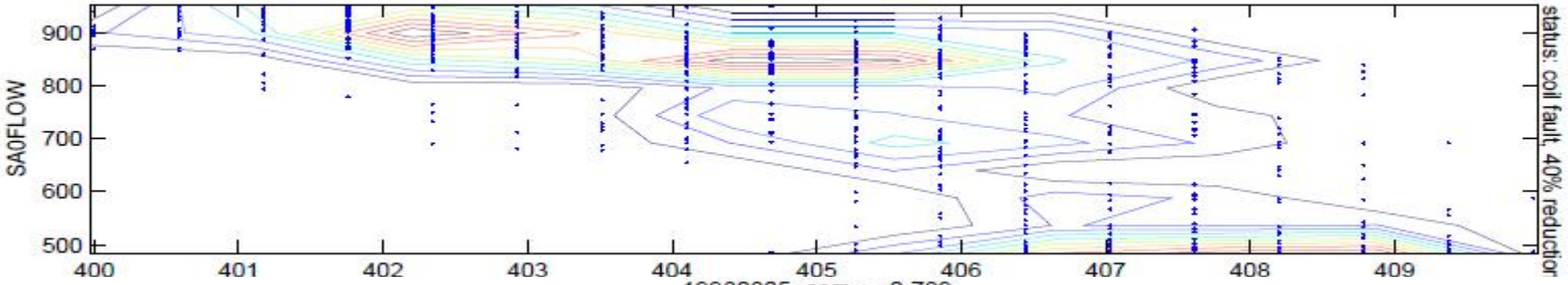
- Uncertainties from sensor placement, measurement, fault state etc
- Uncertainties about system status
- Raw data can come from anything...
- **Need robust, yet simple models: not everything to everyone**

Variability in SA flow vs. VLV pos

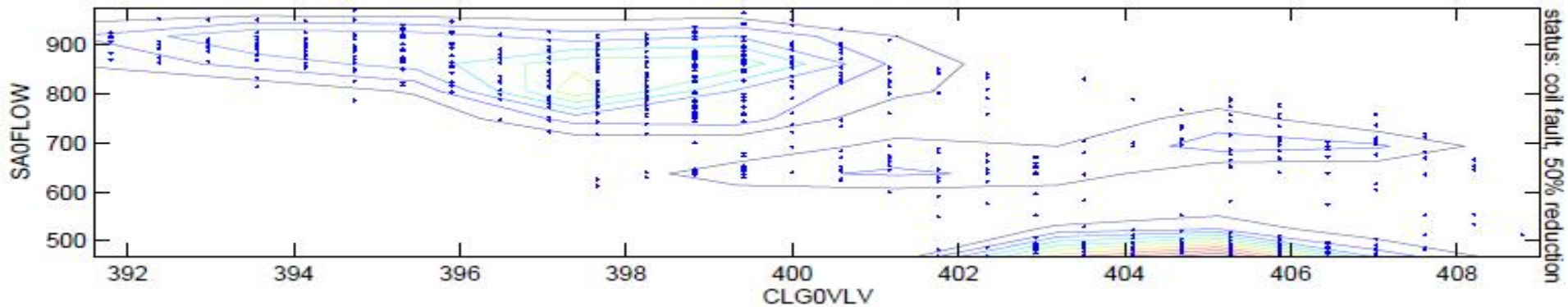
19980807, corr = -0.279



19980804, corr = -0.723

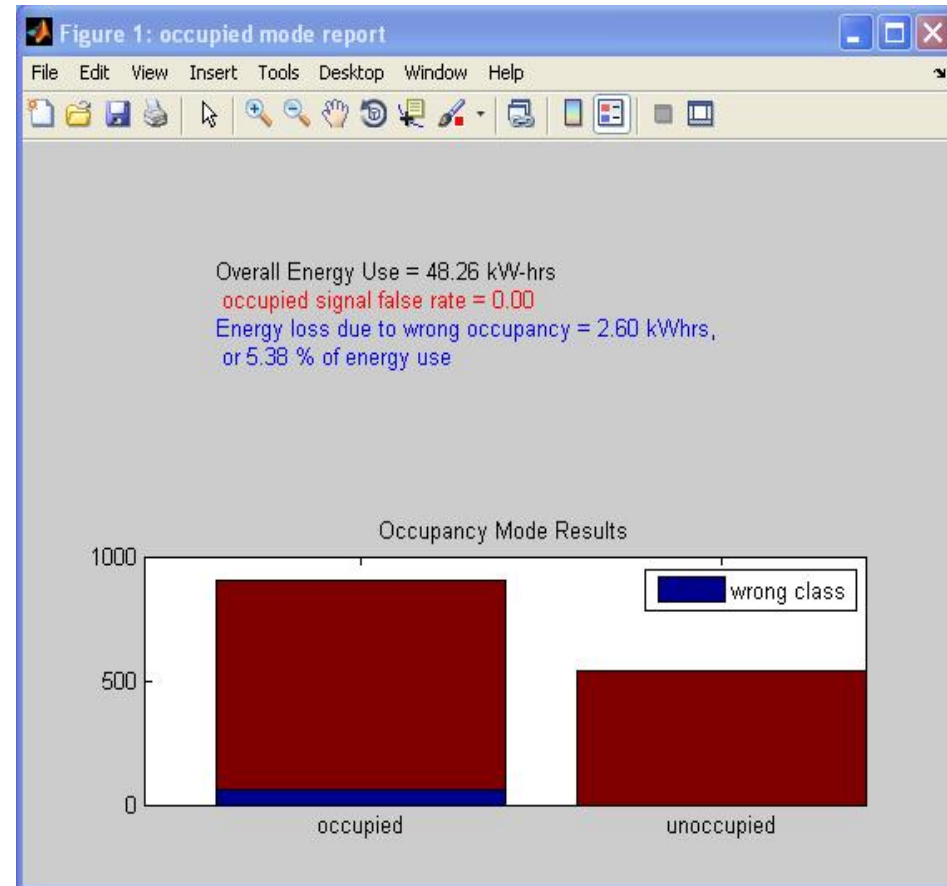


19980805, corr = -0.789



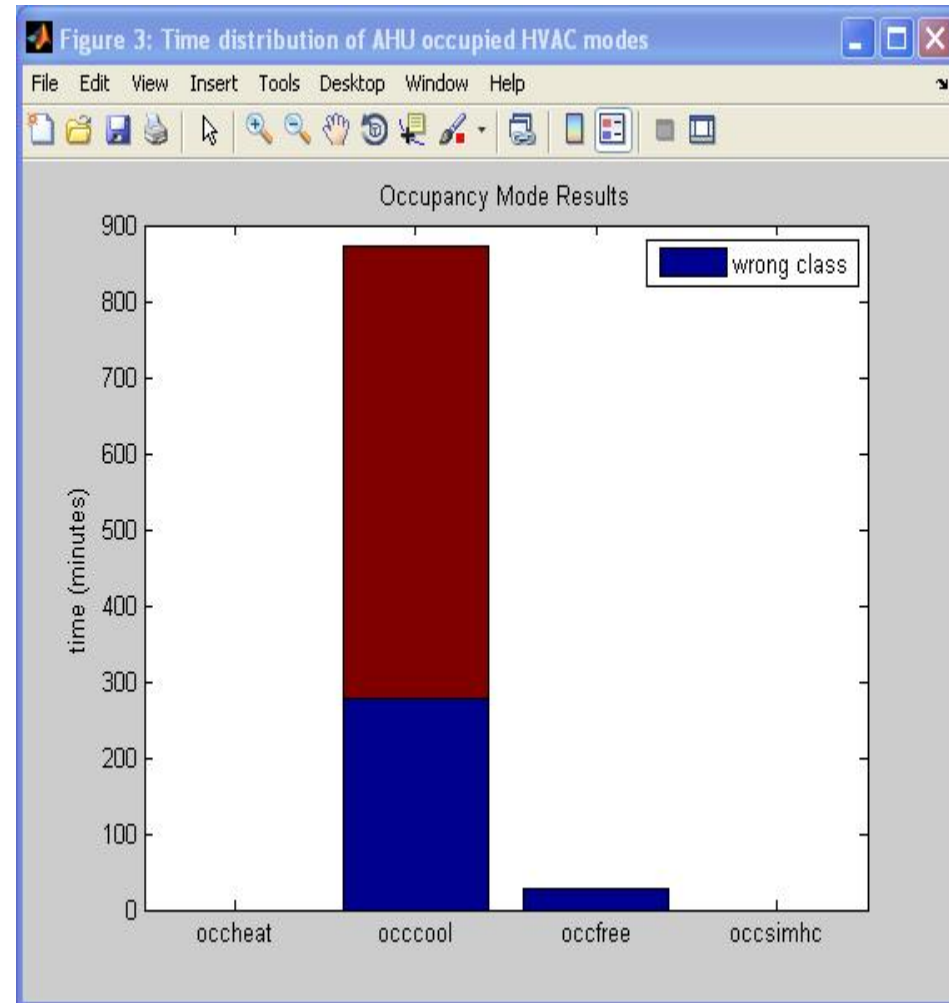
How We've Made It Work

- MIT's engineers just needed a few tools:
- What does the AHU do all day?
- Anything important I should know?



Simple, Useful, Actionable

- Equipment only does certain jobs
- How often does it do them?
- How often *it should not* be doing them?



Philosophy at MIT

- People fix buildings – not computers or networks
- Machines outperform people on quality control measurement for diverse equipment operations
- People can use quality control tools to streamline operations and save money

Where things can go

- Plenty of technology for getting and storing volumes of data from many disparate sources
- Intelligent systems that help define what you want from data, and then find it for you
- Robust analytical tools that deliver actionable information to help you get things done