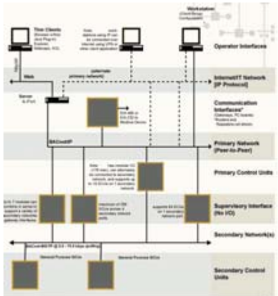

DDC Systems as Tools in a Retro-Commissioning Application

Reinhard Seidl, P.E.
Taylor Engineering

Overview

- Goals for today
- What is retro-commissioning (RCx) ?
- What value does RCx bring?
- What challenges are different for RCx than for regular commissioning in new construction?
- What is the payback you can expect?
- How can you implement RCx?
- Wrap up

1

Overview

What is retro-commissioning
↓
What value does RCx bring
↓
RCx Challenges
↓
Payback for RCx
↓
How to implement

2

Overview

- What is retro-commissioning
- What value does RCx bring
- RCx Challenges
- Payback for RCx
- How to implement

3

What is Commissioning

- Why do we have to perform separate commissioning? Didn’t have to do this in the past to get a working building
- The owner paid for a complete working building !

4

Overview

- What is retro-commissioning
- What value does RCx bring
- RCx Challenges
- Payback for RCx
- How to implement

- Commissioning (Cx)
- Recommissioning (ReCx)
- Retro-commissioning (RCx or Retro-Cx)
- On-going commissioning

5

Flavors of Commissioning

- Commissioning: getting the building to perform as intended first time round.
- Re-commissioning: getting a building that was previously commissioned back into original operational state.
- Retro-commissioning: take a building that was never commissioned correctly, and never operated correctly, to operate better.
- Continuous commissioning: detect faulty operation and energy waste continuously, perform corrective measures immediately.

6

Commissioning evolution

- Focus on control systems
- Commissioning as a separate activity is a fairly recent phenomenon
- Systems are getting more complex
- Controls used to be scope of mechanical engineer / mechanical installer / mechanical startup personnel
- Now some or all of these are separate controls-oriented people.

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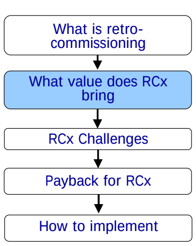
Overview



8

Value of RCx

- Specially aimed at older buildings that never got commissioned
- At best: get building to operate as originally
- At least: operate to minimum requirements
  - Meet code and standards of care
  - Improve comfort and reduce complaints
- Save energy, water

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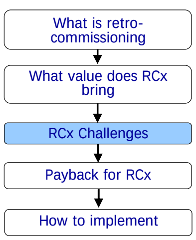
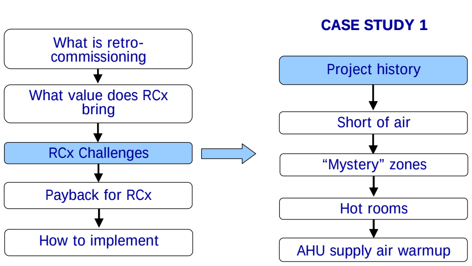
Overview



10

Overview



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Case Study 1

- University Campus Building
- 200,000 sqft, 8 stories
- Seismic Retrofit
- Add'l money – use for building upgrades – new control system and air handlers

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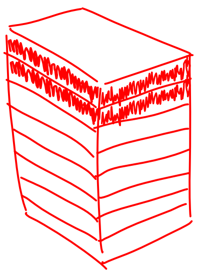
Case Study

- Problems:
- General Contractor out of business after 2 top floors
- Controls contractor gone after 2 top floors
- Do remainder of building (6 bottom floors) with new team – and new controls system



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Case Study

- Building flooded ½ way through 2nd phase. Bottom floors need complete overhaul- budgets gone
- Controls systems top 2 floors don't match bottom 6 floors. Never commissioned.
- HVAC doesn't work – now what?

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Overview

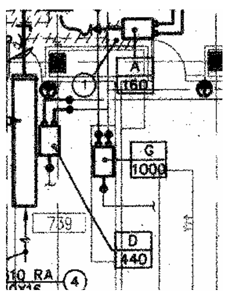
What is retro-commissioning → What value does RCx bring → RCx Challenges → Payback for RCx → How to implement

CASE STUDY 1

Project history → Short of air → "Mystery" zones → Hot rooms → AHU supply air warmup

Case Study – short of air

- Problems:
- After turning on system, don't get enough air
- Initial balancing report suggest all is fine, but subsequent report shows large shortages from cfm's shown on 30-year old design drawings

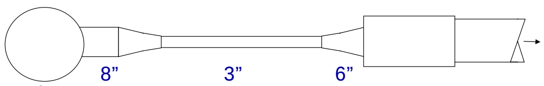


Case Study – short of air

- No initial air balance was made pre-construction, so don't know if air flows shown on drawings were ever met.
- Probably, the airflows shown on drawings were NEVER met (new fans are larger than the originals) but there is no way to know.

Case Study – short of air

- Trying to explain low airflow – find 3” ductwork !
- Creates tremendous losses on VAV inlet sides

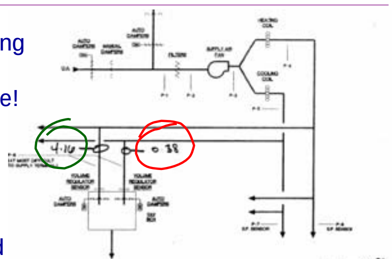


- Speed up fans?

18

Case Study – short of air

- Already running at > 5” ext. static pressure!
- Note large difference in pressures between hot deck and cold deck



Dampers	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8
	0.29	7.18	5.68	4.15	5.38	1	1.79	4.18

MOTOR AMPS
42.8/44.3/43.4

BHP
38.16

19

Case Study – short of air

- Solution: new control sequence that uses both hot deck and cold deck to supply air to spaces.
- Turn off heat whenever possible
- Use “full cooling” mode with both decks
- Result: increased airflow between 15%-20% per floor.

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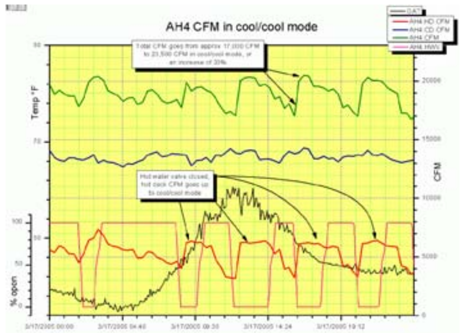
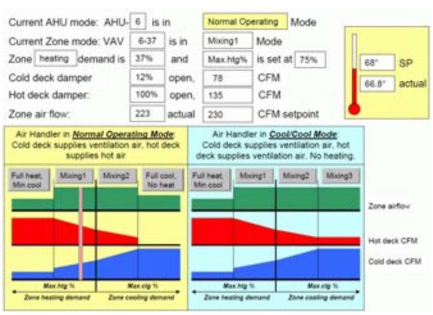
Case Study – short of air

- Increased airflow



Case Study – short of air

- Fairly complex VAV and AHU operating modes



Overview

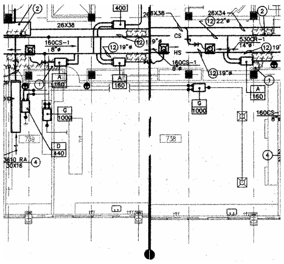
- What is retro-commissioning
- What value does RCx bring
- **RCx Challenges**
- Payback for RCx
- How to implement

CASE STUDY 1

- Project history
- Short of air
- **"Mystery" zones**
- Hot rooms
- AHU supply air warmup

Case Study – Mystery Zones

- Some zones just not “behaving right” – heating rooms when in cooling mode; checked all actuators and wiring



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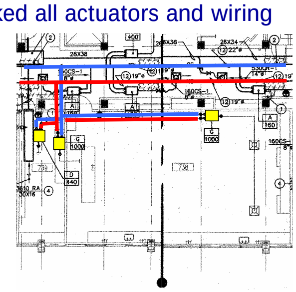
Case Study – Mystery Zones

- Some zones just not “behaving right” – heating rooms when in cooling mode; checked all actuators and wiring



CD, HD and 3 VAV terminals

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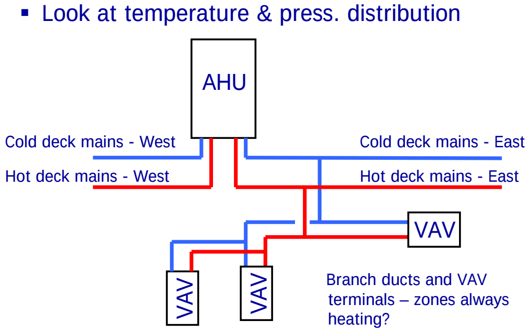
Case Study – Mystery Zones

- Look at temperature & press. distribution



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Case Study – Mystery Zones

- Look at temperature & press. distribution

27

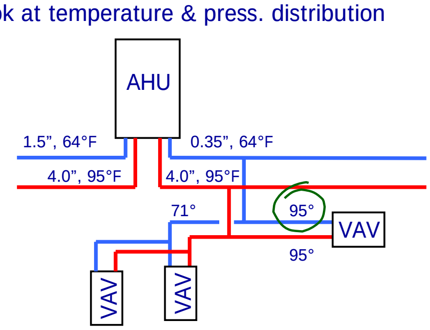
Case Study – Mystery Zones

- Look at temperature & press. distribution

28

Case Study – Mystery Zones

- Look at temperature & press. distribution



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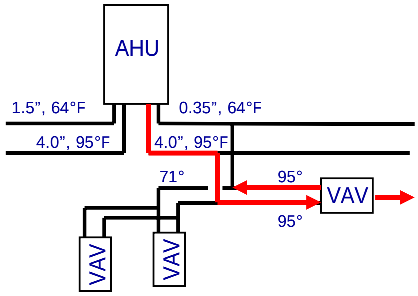
Case Study – Mystery Zones

- CV damper in VAV box has high press. drop

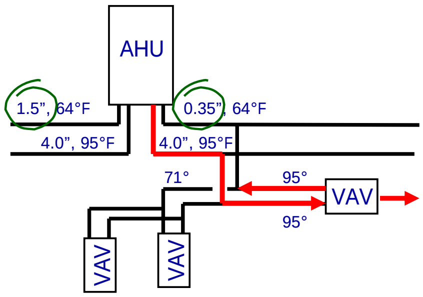
Case Study – Mystery Zones

- Actual airflow direction is as follows:



Case Study – Mystery Zones

- Why are pressures at AHU so different (left/right)?



Case Study – Mystery Zones

- Never did original commissioning and checkout!
- Picture shows perforated plate at AHU duct connection (from inside AHU)

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Overview

What is retro-commissioning → What value does RCx bring → RCx Challenges → Payback for RCx → How to implement

RCx Challenges ⇒ CASE STUDY 1

CASE STUDY 1

Project history → Short of air → "Mystery" zones → Hot rooms → AHU supply air warmup

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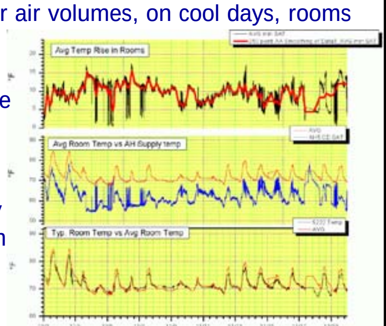
Case Study – Hot rooms

- Even with larger air volumes, on cool days, rooms still too hot ?
- Average room temperature rise shows between 5° and 15° difference between supply temp. and room temp.
- Looks normal



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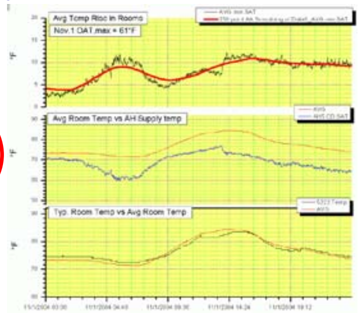
Case Study – Hot rooms

- Check particularly hot room – rises to 85°F on cool day
- Outside air is max. 61°F.
- AH supply air temperature is 78°F, or 17°F warmer!



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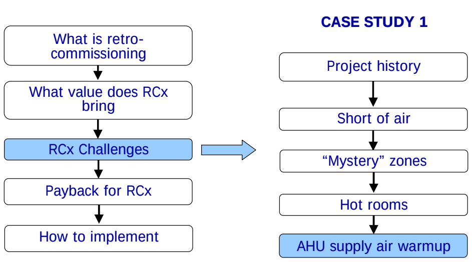
Overview



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Case Study – AH warmup

- Cold deck (=neutral deck) warms up by as much as 17°F without apparent cause ?

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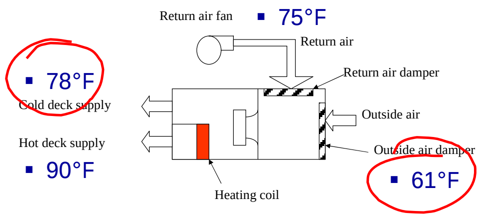
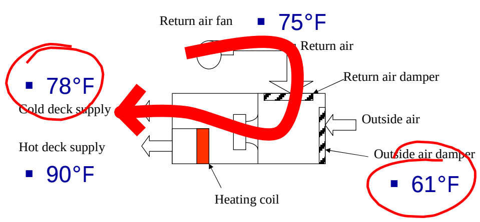
Case Study – AH warmup

- Dual Deck AHU – new as part of retrofit



Case Study – AH warmup

- Dual Deck AHU – new as part of retrofit



- Economizer stuck?

Case Study – Hot rooms

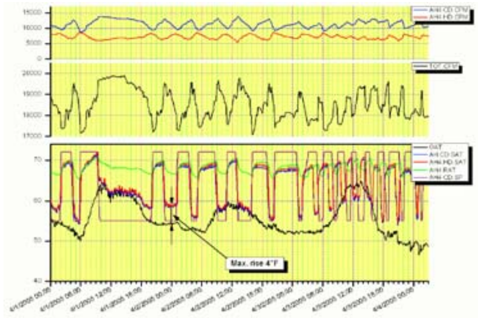
- Make test protocol with technician watching economizer dampers.

5. FIRST TEST : To determine if the effect does indeed come from the damper, we will shut off all heat to the coil for 3 days, and continue trending. If the cold deck still heats up, the only possible heat source will be return air. We'll also be trending return air temperature, to determine how much return air is being mixed.

6. SECOND TEST : After this, we will put heating back into automatic operation, and manually lock the return damper 100% closed and the outside air damper 100% open. If the heating effect on the cold deck does not occur, and supply air tracks outside air, we'll know for sure it's not coming from the heating coil. By elimination therefore, the effect will be from the return damper.

Case Study – Hot rooms

- Hot water valve shut – motor heat rise only



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Case Study – Hot rooms

- Note: cycling in previous slide is due to cold deck temperature reset when building gets too cold. Reset loop not tuned correctly, so
  - Cold deck setpoint rises full range in 5 minutes
  - Economizer closes
  - Hot deck and cold deck warm up
  - Cold deck setpoint resets back down

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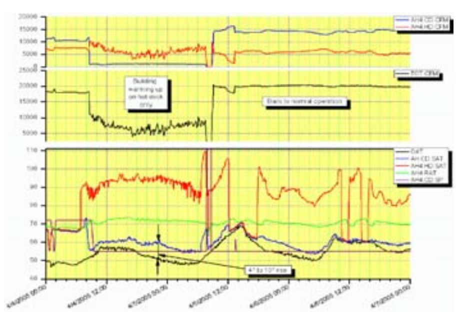
Case Study – Hot rooms

- Economizer locked open – cold deck temp. rise is back!



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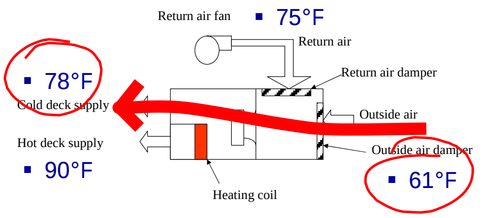
Case Study – AH warmup

- Dual Deck AHU – new as part of retrofit



- Definitely looking at an effect within the AHU

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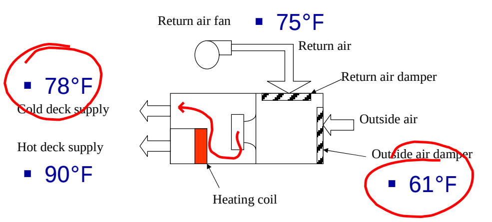
Case Study – AH warmup

- Dual Deck AHU – new as part of retrofit



- Supply air heating up along coil ??

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Case Study – AH warmup

- Coil compartment of AHU with plug fan

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Case Study – AH warmup

- Added baffle plates to AH coil to prevent air flowing “along face of coil”

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Case Study – AH warmup

- Results: some slight improvement, but not really solution to the problem
- Tried many different ways of looking at problem to find correlation of factors

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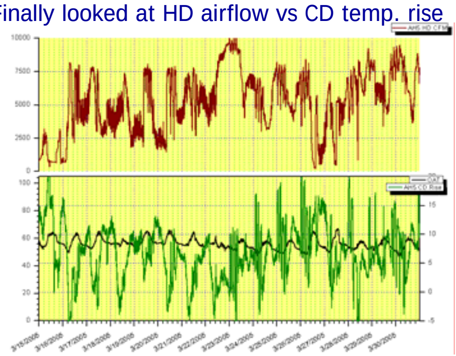
Case Study – AH warmup

- Finally looked at HD airflow vs CD temp. rise



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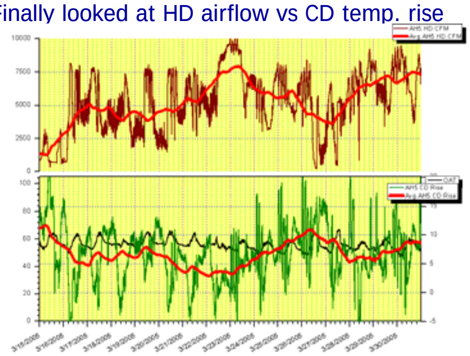
Case Study – AH warmup

- Finally looked at HD airflow vs CD temp. rise



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Case Study – AH warmup

- As hot deck airflow decreases, cold deck warms up!
- Solution: Lock out hot water valve if
  - HD airflow is too low
  - Outside air temp too high
  - Cold deck temperature rise too high

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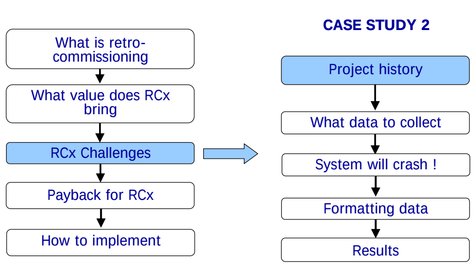
Overview



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Case Study 2

- Medical Campus
- 680,000 sqft, 4 stories
- Investigation into operating conditions
- Suspect energy waste and chiller staging issues, but not sure

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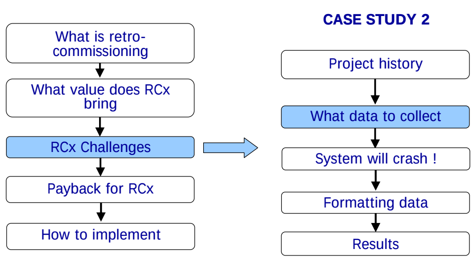
Overview



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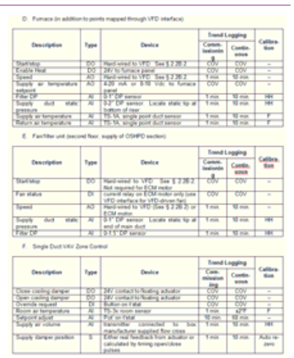
Defining data to collect

- No points list
- No Floor plans in DDC



D. Furnace (in addition to points mapped through VFD interface)

Description	Type	Device	Trend Logging		Calibration
			Commissioning	Continuous	
Start/stop	DO	Hard-wired to VFD. See § 2.28.2	COV	COV	–
Enable Heat	DO	24V to furnace panel	COV	COV	–
Speed	AO	Hard-wired to VFD. See § 2.28.2	1 min.	10 min.	–
Supply air temperature setpoint	AO	4-20 mA or 0-10 Vdc to furnace panel	COV	COV	–
Filter DP	AI	0-1" DP sensor	1 min.	10 min.	HH
Supply duct static pressure	AI	0-2" DP sensor. Locate static tip at bottom of riser	1 min.	10 min.	HH
Supply air temperature	AI	TS-1A, single point duct sensor	1 min.	10 min.	F
Return air temperature	AI	TS-1A, single point duct sensor	1 min.	10 min.	F

E. Fan/filter unit (second floor, supply of OSHPD section)

Description	Type	Device	Trend Logging		Calibration
			Commissioning	Continuous	
Start/stop	DO	Hard-wired to VFD. See § 2.28.2. Not required for ECM motor	COV	COV	–
Fan status	DI	current relay on ECM motor only (use VFD interface for VFD-driven fan)	COV	COV	–
Speed	AO	Hard-wired to VFD (See § 2.28.2) or ECM motor	1 min.	10 min.	–
Supply duct static pressure	AI	0-1" DP sensor. Locate static tip at end of main duct	1 min.	10 min.	HH
Filter DP	AI	0-1.5" DP sensor	1 min.	10 min.	HH

F. Single Duct VAV Zone Control

Description	Type	Device	Trend Logging		Calibration
			Commissioning	Continuous	
Close cooling damper	DO	24V contact to floating actuator	COV	COV	–
Open cooling damper	DO	24V contact to floating actuator	COV	COV	–
Override request	DI	Button on Tstat	COV	COV	–
Room air temperature	AI	TS-3x room sensor	1 min.	±2°F	F
Setpoint adjust	AI	Pot on Tstat	10 min.	10 min.	–
Supply air volume	AI	transmitter connected to box manufacturer supplied flow cross	1 min.	10 min.	HH
Supply damper position	S	Either real feedback from actuator or calculated by timing open/close pulses	1 min.	10 min.	Auto re-zero

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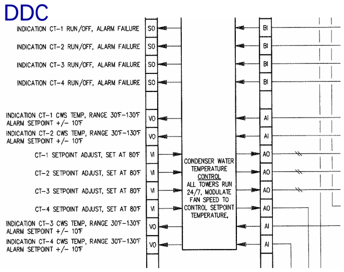
Defining data to collect

- No points list
- No Floor plans in DDC



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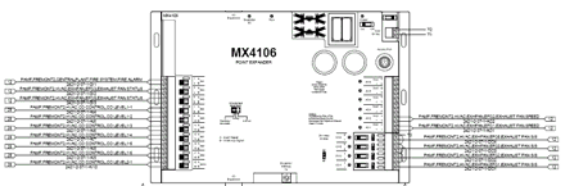
Defining data to collect

- No points list
- No Floor plans in DDC



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Defining data to collect

- How to know what to trend when system has no record drawings with points lists, and all point names are 6 letter codes?
  - W11210
  - VC1LO
  - VHX1SY

Any Guesses?

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Defining data to collect

- How to know what to trend when system has no record drawings with points lists, and all point names are 6 letter codes?
    - VF01WR – EXH HUM

Some points have descriptors – but still not enough information

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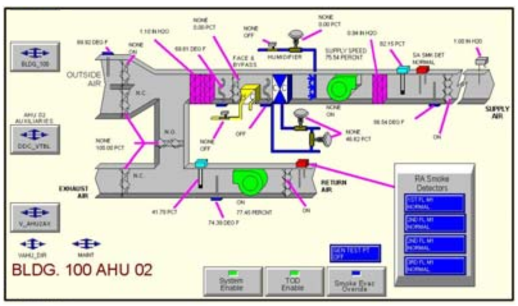
Defining data to collect

- Record screenshots – build database of points



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Defining data to collect

- Note that the user interface shown is a modern version of the DDC software, but the underlying network and controllers are 10 years old
- The problems being described here will not occur for new systems, installed in current projects.

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Defining data to collect

- Record screenshots – build database of points

ROOM/UNIT	POINT DESCRIPTION	PT. VALUE/UNITS
A4.117A A4.76B	CFM PT.35	0.00 CFM
V25302	DMP POS.PT49	0.00 PCT
A4.127B A4.77	CFM PT.35	0.00 CFM
V25303	DMP POS.PT49	100.00 PCT
A4.115 A4.78	CFM PT.35	144.00 CFM
V25305	DMP POS.PT49	30.40 PCT
A4.115A A4.79A	RTMP PT.04	74.50 DEG F
V25306	RM STP 92	74.00 DEG F
	DSCH T PT.15	67.50 DEG F
	CFM PT.35	248.00 CFM
	DMP POS.PT49	0.00 PCT
	RHVLV PT.53	27.20 PERCNT
A4.115A A4.79B	CFM PT.35	64.00 CFM
V25307	DMP POS.PT49	78.00 PCT
A4.115B A4.80	CFM PT.35	32.00 CFM
V25308	DMP POS.PT49	100.00 PCT

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Defining data to collect

- Record screenshots – build database of points

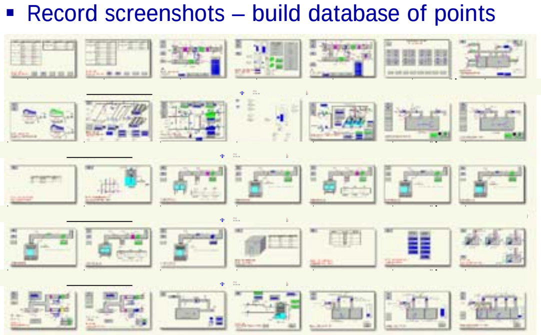
ROOM/UNIT	POINT DESCRIPTION	PT. VALUE/UNITS
A4.117A A4.76B	CFM PT.35	0.00 CFM
V25302	DMP POS.PT49	0.00 PCT
A4.127B A4.77	CFM PT.35	0.00 CFM
V25303	DMP POS.PT49	100.00 PCT
A4.115 A4.78	CFM PT.35	144.00 CFM
V25305	DMP POS.PT49	30.40 PCT
A4.115A A4.79A	RTMP PT.04	74.50 DEG F
V25306	RM STP 92	74.00 DEG F
	DSCH T PT	DEG F
	CFM PT.35	CFM
	DMP POS	CT
	RHVLV PT	PERCNT
A4.115A A4.79B	CFM PT.35	CFM
V25307	DMP POS.PT49	67.60 PCT
A4.115B A4.80	CFM PT.35	32.00 CFM
V25308	DMP POS.PT49	100.00 PCT

Point: T25306
Desc.: RTMP PT.04
Status: NORMAL
Priority: NONE
Value: 74.50
Ex-State: N/A
Total: Total

64

Defining data to collect

- Record screenshots – build database of points



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Defining data to collect

- Record screenshots – build database of points
- About 200 user screens
- About 3,000 points
- Send to DDC service contractor and ask for trend setup

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Defining data to collect

Orig row	Screen	Point name	Description	Units	Point count	Subtot
					Total point counts	3006
4	Bldg 100 Heating water system		HX 100 C1 leaving water temp	°F	1	
5			HX 100 C1 iso valve	Open/Closed	1	
6			HX 100 C2 leaving water temp	°F	1	
7			HX 100 C2 iso valve	Open/Closed	1	
8			100 HWP 1 speed	%	1	
9			100 HWP 1 power	kW	1	
10			100 HWP 2 speed	%	1	
11			100 HWP 2 power	kW	1	
12			100 HWP 3 speed	%	1	
13			100 HWP 3 power	kW	1	
14			HW flow	GPM	1	
15			HWS temp	°F	1	
16			HWR temp	°F	1	
17			B04 C07 HW DP	psi	1	
18			B04 C02 HW DP	psi	1	
19			B04 C03 HW DP	psi	1	
20	HW System totals					16
21	Bldg 100 AC-07		AC7 Steam VLV EP	Open/Closed	1	
22		VFA7DS	AC7 supply air temp setpoint	°F	1	
23		VFA7DS	AC7 supply air temp	°F	1	
24		AC7 FB DMPR	AC7 face and bypass damper	psi	1	
25			AC7 Compressor	On/Off	1	
26			AC7 Room temp	°F	1	
27			AC7 Room temp setpoint	°F	1	
28	AC7 totals					7
29	Bldg 100 zone 1 tables		16 zones - room temp	°F	16	
30			16 zones - dmpr pos	%	16	
31			2 zones - room temperature	°F	2	
32			2 zones - room temperature setpoint	°F	2	

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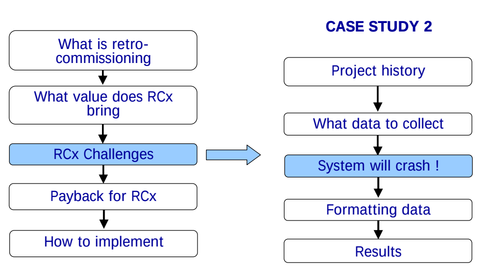
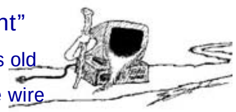
Overview



68

“Can’t trend that much”

- Kick-off meeting reveals that
  - Hardware around campus looks to be in good shape and well maintained overall
  - But operation hard to verify because systems are partly pneumatic, partly DDC
- “Can’t do the trends you want”
  - DDC Legacy system ~10 years old
  - Running on 9,600 baud phone wire



69

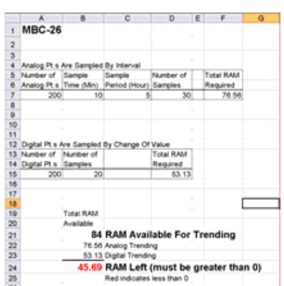
“Can’t trend that much”

- Contractor says:
- System will crash, not enough memory in modules
- Network won’t handle traffic
- Will interrupt normal operations
- All sounds rather dire

70

“Can’t trend that much”

- Try to figure out how much memory is actually needed to trend a point and store a number
- Come back with spreadsheet showing what can be stored.



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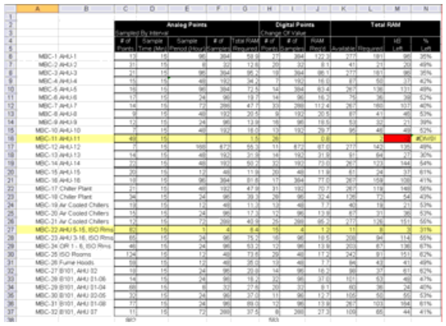
“Can’t trend that much”

- Choose points per module to trend



72

“Can’t trend that much”

- Selected ~1,600 points out of 3,000 that can be trended without causing network problems
- Set up one controller first and trial-run to prevent crashes
- Then, set up remaining trends
- Takes 2 men about 2.5 days

73

“Can’t trend that much”

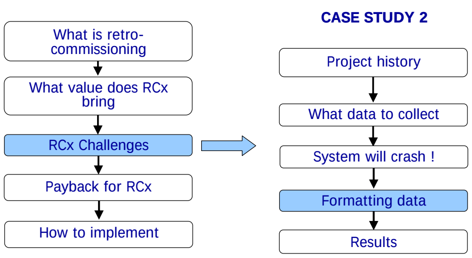
- After 2 weeks, extracted trends (takes ~1 whole day on site)
- Post-processing: 1,696 trends recorded, 668 were empty.
- Of the 1,028 trends containing data, 584 were recorded at 15 minute intervals, the rest at 5, 10, 11, 29, 40 or 57 minutes.
- 766 trends contained data over the 14 day test period. 211 trends contained 5 days or less.

74

"Can't trend that much"

- Entire exercise of figuring out how to get trends, and how to set up controllers, took about 3 months.

Overview



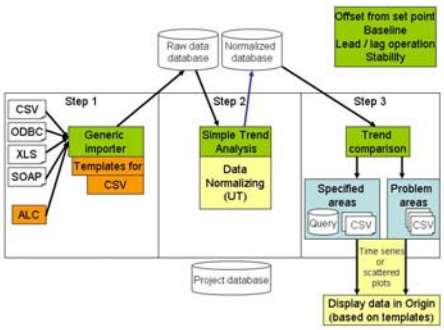
Formatting data

- TrendAnalyzer (TA) – developed to deal with legacy system trend review
- Is being merged with PG&E's Universal Translator (UT) and will be posted on PG&E website for free.

- http://www.utonline.org/

Formatting data

- Data conversion in TA / UT:



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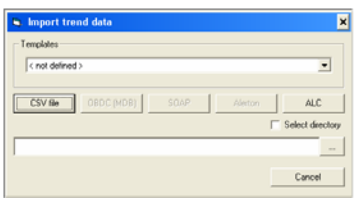
Formatting data

- Step 1: import data (csv, ODBC, custom DDC formats)



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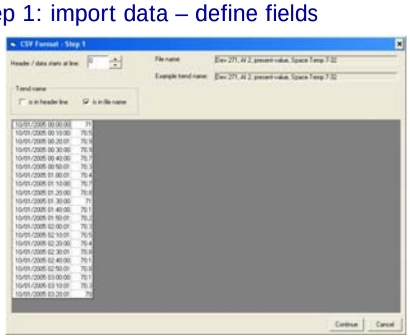
Formatting data

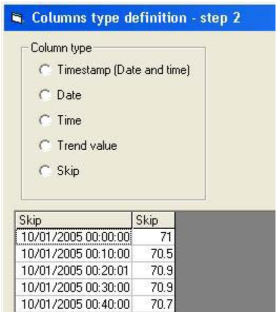
- Step 1: import data – define fields



80

Formatting data

- Step 2: import data – define fields



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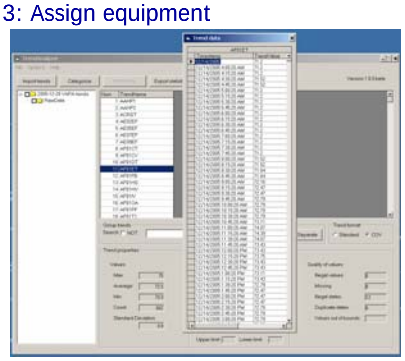
Formatting data

- Step 3: Assign equipment



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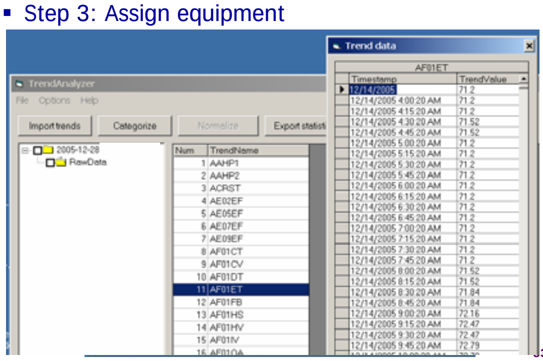
Formatting data

- Step 3: Assign equipment



83

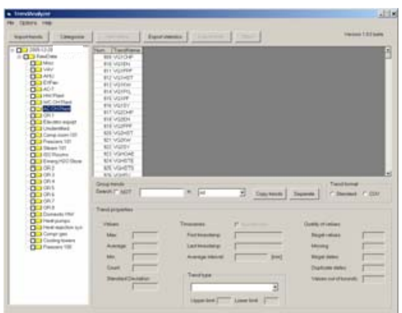
Formatting data

- Step 3: Assign equipment

84

Formatting data

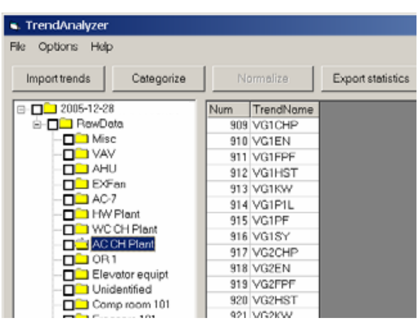
- Step 3: Assign equipment



85

Formatting data

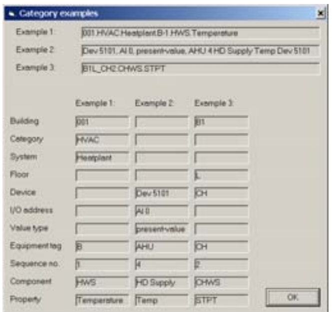
- Step 3: Assign equipment



86

Formatting data

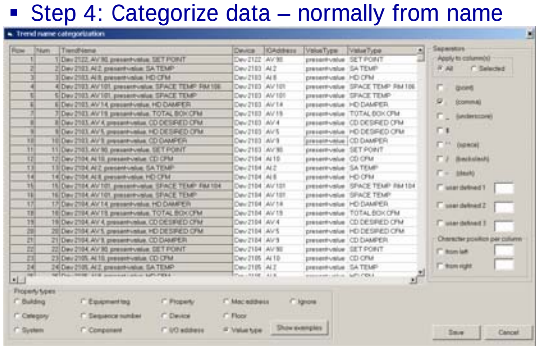
- Step 4: Categorize data



87

Formatting data

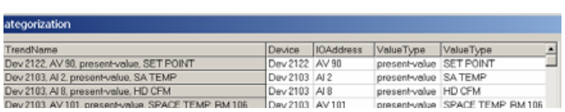
- Step 4: Categorize data – normally from name



88

Formatting data

- Step 4: Categorize data – normally from name



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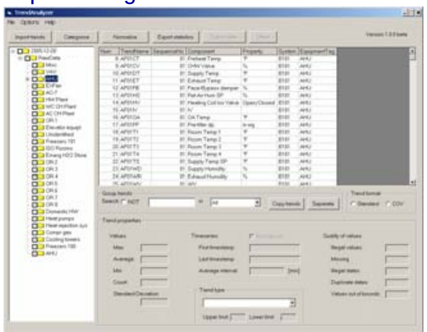
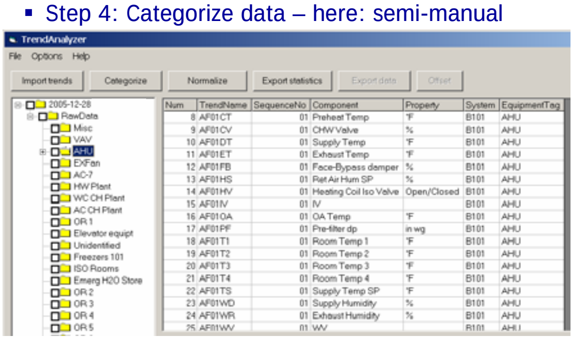
Formatting data

- Step 4: Categorize data – here: semi-manual



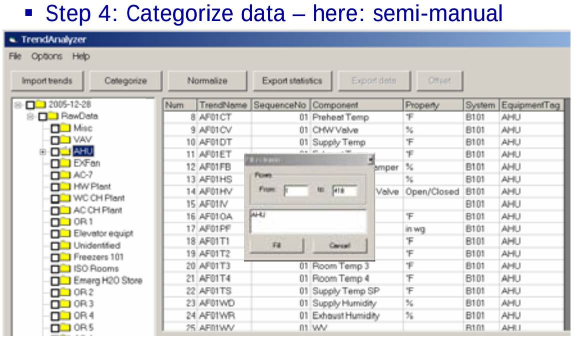
Formatting data

- Step 4: Categorize data – here: semi-manual



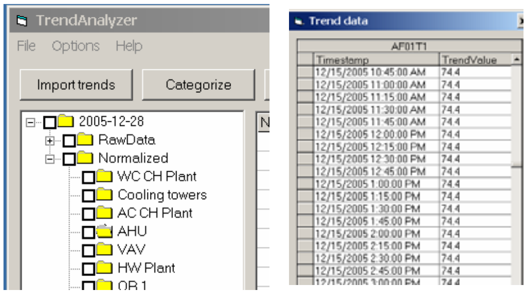
Formatting data

- Step 4: Categorize data – here: semi-manual



Formatting data

- Step 5: Normalize data – all on same timestamps



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Formatting data

- Step 6: Separate similar data, example: VAV's

EquipmentTag	Sequence No	Component	Property
VAV	1	damper pos	%
VAV	1	zone temp	°F
VAV	1	Setpoint	°F
VAV	2	damper pos	%
VAV	2	zone temp	°F
VAV	2	Setpoint	°F
etc			

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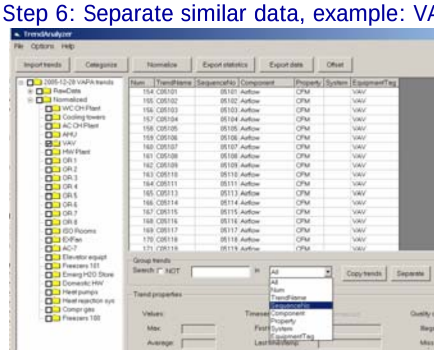
Formatting data

- Step 6: Separate similar data, example: VAV's



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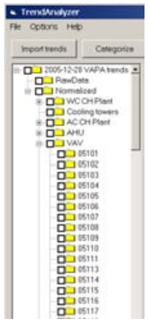
Formatting data

- Step 6: Separate similar data, example: VAV's
- Automatic subdirectories



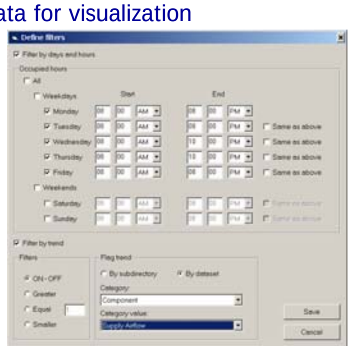
Formatting data

- Step 7: Export data statistics

Trend Num	Name	Value Maximum	Average	Minimum	StdDev	Count	Illegal	Missing	OutOfBoun	Timestamp StartDate	EndDate	Avg.Interva	Illegal	Duplicate
1	AAHP1	93.2	80	65.5	7	1252	0	0	0	12/13/2005 15:15	12/26/2005 15:59	15	0	0
2	AAHP2	84.9	79.4	76.3	1.8	1253	0	0	0	12/13/2005 15:01	12/26/2005 16:00	15	0	0
3	ACRST	74.4	73.9	73.4	0.1	2801	0	0	0	12/13/2005 0:04	12/27/2005 6:09	7	27	0
4	AE02EF	1	0.5	0	0.5	18	0	0	0	12/13/2005 4:20	12/23/2005 15:15	836	0	0
5	AE05EF	1	1	1	0	18	0	0	0	12/13/2005 4:20	12/23/2005 15:15	836	0	0
6	AE07EF	1	1	1	0	2	0	0	0	12/26/2005 1:49	12/26/2005 1:49	0	0	0
7	AE09EF	1	1	1	0	2	0	0	0	12/14/2005 16:52	12/14/2005 22:50	179	0	0
8	AF01CT	73.8	60.6	51.8	3.6	662	0	0	0	12/14/2005 3:43	12/26/2005 15:57	27	12	0
9	AF01CV	100	38.4	0	23.9	662	0	0	0	12/14/2005 3:43	12/26/2005 15:57	27	12	0
10	AF01DT	65.8	59.5	51.1	1.5	662	0	0	0	12/14/2005 3:43	12/26/2005 15:57	27	12	0
11	AF01ET	75	72.5	70.9	0.8	662	0	0	0	12/14/2005 3:45	12/26/2005 15:59	27	12	0
12	AF01FB	64.5	9.7	0	20.7	662	0	0	0	12/14/2005 3:42	12/26/2005 15:56	27	12	0
13	AF01HS	40	40	40	0	662	0	0	0	12/14/2005 3:45	12/26/2005 15:59	27	12	0
14	AF01HV	1	0.5	0	0.5	10	0	0	0	12/13/2005 17:54	12/17/2005 21:51	600	0	0
15	AF01IV	1	0.4	0	0.5	5	0	0	0	12/17/2005 21:55	12/20/2005 6:14	676	0	0
16	AF01OA	73.8	57	38.4	7.2	662	0	0	0	12/14/2005 3:41	12/26/2005 15:55	27	12	0
17	AF01PF	0.4	0.4	0.4	0	662	0	0	0	12/14/2005 3:42	12/26/2005 15:56	27	12	0
18	AF01T1	75.4	74.2	73.4	0.4	441	0	0	0	12/14/2005 7:48	12/26/2005 15:48	40	12	0
19	AF01T2	77.4	71.2	67.4	2.8	441	0	0	0	12/14/2005 7:48	12/26/2005 15:48	40	12	0
20	AF01T3	70.9	69.5	68	0.7	662	0	0	0	12/14/2005 3:34	12/26/2005 15:48	27	12	0
21	AF01T4	74.4	73.5	72.8	0.3	662	0	0	0	12/14/2005 3:34	12/26/2005 15:48	27	12	0
22	AF01TS	60	59.2	57.5	0.5	279	0	0	0	12/13/2005 9:25	12/26/2005 12:13	68	1	0
23	AF01WD	94.2	77.1	36.4	12.6	662	0	0	0	12/14/2005 3:44	12/26/2005 15:58	27	12	0
24	AF01WR	52.2	40.8	16.1	9.1	662	0	0	0	12/14/2005 3:45	12/26/2005 15:59	27	12	0
25	AF01WV	100	6.8	0	20.3	662	0	0	0	12/14/2005 3:43	12/26/2005 15:57	27	12	0
26	AF02CV	40.9	2.2	0	7.1	1252	0	0	0	12/13/2005 15:08	12/26/2005 15:53	15	0	0
27	AF02DS	2.5	2	1.4	0.1	1252	0	0	0	12/13/2005 15:12	12/26/2005 15:57	15	0	0
28	AF02DT	67.4	63.3	57.5	1.4	1252	0	0	0	12/13/2005 15:07	12/26/2005 15:52	15	0	0
29	AF02DY	1	0.5	0	0.5	19	0	0	0	12/13/2005 6:00	12/26/2005 6:00	985	0	0
30	AF02FB	0	0	0	0	1252	0	0	0	12/13/2005 15:04	12/26/2005 15:49	15	0	0

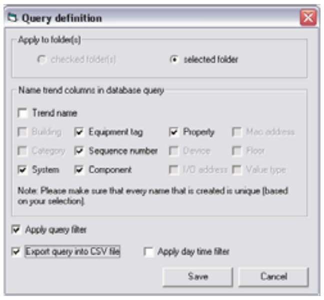
Formatting data

- Step 7: Export data for visualization
- Use filters to look only at data during occupied schedule (time-based)
- Use filter to only look at VAV data when fan is running (using flag trend)



Formatting data

- Step 7: Export data for visualization
- Export data into queries that can be read by database or as comma separated file (CSV) that can be read by spreadsheet



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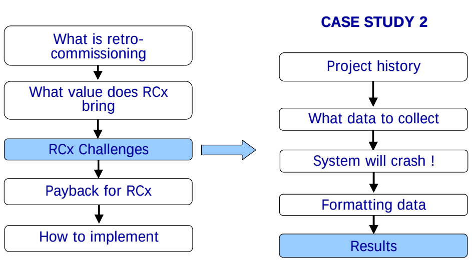
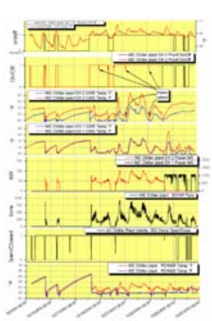
Overview



100

Results

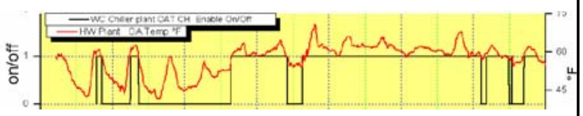
- Chiller plant
- Chiller plant lockout set too high (58°) – prevents cycling but starves air handlers.



101

Results

- Chiller plant
- Chiller plant lockout set too high (58°) – prevents cycling but starves air handlers.



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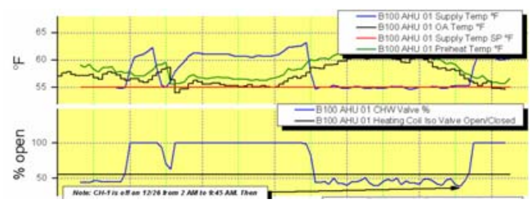
Results

- AHU supply temp high with AHU chw valve open



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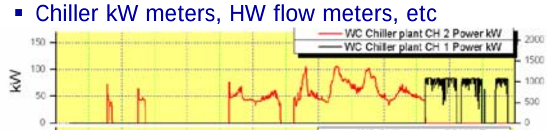
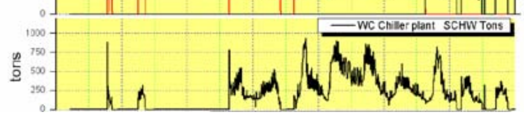
Results

- Several meters out of calibration or broken
- Chiller kW meters, HW flow meters, etc





- CH-1: 1,000 kW/750 tons = 1.3 kW/ton ??
- CH-2: 100 kW/800 tons = 0.13 kW/ton ??

104

Results

- Variety of items for Air handlers

a. B100 AHU-1: Calibrate OA/Pre-heat sensor, or fix HW iso valve leaking HW into pre-heat coil.

b. B100 AHU-2: Humidifier is not working. Possibly main steam shut-off, see § 5 above.

c. B100 AHU-2: Unit runs at 25% above design cfm and should be rebalanced (zones are supplying more air than designed for).

d. B100 AHU-3: Economizer damper linkage needs to be adjusted, or economizer section examined for other problems. Large fluctuations in return fan speed occur during economizer closure.

e. B100 AHU-3: Unit runs at 35% above design cfm and should be rebalanced (zones are supplying more air than designed for).

f. B100 AHU-4: Pre-heat setpoint needs to be set to same temperature as WC chiller lockout set point.

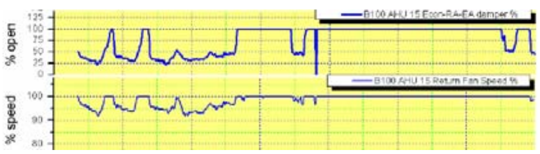
g. B100 AHU-5: Humidifier does not work – when control valve opens fully, no change in humidity occurs. Possibly main steam shut-off, see § 5 above.

h. B100 AHU-6: Economizer damper linkage needs to be adjusted, or economizer section examined for other problems. Large fluctuations in return fan speed occur during economizer closure. Mixed air temperature stays above outside air temperature in full economizer mode, indicating that return air damper does not close completely.

105

Results

- Economizer problems – large fan speed fluctuations show either outside air, return air or exhaust air dampers not operating correctly



106

Results

- Some typical damper problems

Damper A4.75 is starved and unable to maintain set point.

Damper A4.76A is stuck open and maintaining high airflow while being commanded shut.

Damper A4.77 is starved and unable to maintain set point.

107

Results

- Some damper problems -100% open dampers

Trend Num	Name	Value Maximum	Average	Minimum	StdDev	Count	Timestamp StartDate	EndDate
314	E11104	100	100	100	0	288	12/26/2005 18:04	12/27/2005 17:59
321	E22306	100	100	100	0	1372	12/13/2005 11:14	12/27/2005 17:58
331	E25129	100	100	100	0	11	12/13/2005 15:51	12/13/2005 18:20
336	E25214	100	100	100	0	11	12/13/2005 15:59	12/13/2005 18:29
338	E25224	100	100	100	0	11	12/13/2005 15:58	12/13/2005 18:27
339	E25229	100	100	100	0	11	12/13/2005 15:57	12/13/2005 18:26
340	E25304	100	100	100	0	11	12/13/2005 15:56	12/13/2005 18:26
354	E26108	100	100	100	0	50	12/13/2005 6:09	12/13/2005 18:24
355	E26109	100	100	100	0	50	12/13/2005 6:09	12/13/2005 18:24
356	E26110	100	100	100	0	50	12/13/2005 6:10	12/13/2005 18:25
364	E26118	100	100	100	0	50	12/13/2005 6:11	12/13/2005 18:26
365	E26119	100	100	100	0	50	12/13/2005 6:11	12/13/2005 18:26
366	E26120	100	100	100	0	50	12/13/2005 6:11	12/13/2005 18:26
377	E31104	100	100	100	0	74	12/13/2005 0:07	12/13/2005 18:22
287	E05110	100	99.8	0	4.2	1372	12/13/2005 11:16	12/27/2005 17:59
285	E05108	100	99.8	5.2	4	1372	12/13/2005 11:15	12/27/2005 17:59
302	E09102	100	99.8	14.4	4	700	12/13/2005 14:36	12/27/2005 17:50
307	E09107	100	99.8	23.2	3.9	700	12/13/2005 14:37	12/27/2005 17:50
316	E19101	100	99.8	27.2	3.9	705	12/13/2005 13:27	12/27/2005 17:56
289	E05112	100	99.7	0	3.7	1416	12/13/2005 0:05	12/27/2005 17:49
299	E05123	100	99.7	0	4.2	1417	12/13/2005 0:02	12/27/2005 18:01
288	E05111	100	99.7	3.2	4.2	1417	12/13/2005 0:04	12/27/2005 18:03
295	E05119	100	99.7	7.6	4.2	1374	12/13/2005 10:36	12/27/2005 17:50
380	E31107	100	98.5	27.2	9.6	75	12/13/2005 0:00	12/13/2005 18:30
376	E31103	94	89.2	85.6	2.3	74	12/13/2005 0:06	12/13/2005 18:21
351	E26105	99.6	87.8	73.6	11	50	12/13/2005 6:09	12/13/2005 18:24
292	E05116	86.4	84.9	2.8	3.4	1417	12/13/2005 0:04	12/27/2005 18:03
341	E25309	84	83.3	82.4	0.4	11	12/13/2005 15:56	12/13/2005 18:25
359	E26113	84.4	79.4	74.4	2.8	50	12/13/2005 6:11	12/13/2005 18:26

108

Results

- Possible savings –
  - Run Air Handlers with supply static pressure reset, order of magnitude savings around $75 K / year
  - Prob. < 1 year payback
  - Run air-cooled smaller chillers instead of large water cooled chillers for better efficiency. Hard to tell exact difference in possible change, because chiller kW meters need to be replaced.
  - Possible savings on secondary chwp speeds and cooling towers, although trends were missing, need to re-trend

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Results

- Typical savings on chiller plants:
  - Turn down SCHWP speeds, raise chw dT
  - 75 Hp pump running full speed 24/7 costs $92,000 at 14 cents/kWh
  - Reducing static pressure setpoint by 25% reduces pump speed 15%, but power by 35%. That means a reduction of $32,000 per year.

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Results

- Current report contains approx. 200 corrections, suggestions etc on 230 pages of data, charts, screens etc.
- More data needs to be obtained, specifically on pumps and cooling towers.
- Decisions about possible fixes or upgrades have not yet been made.

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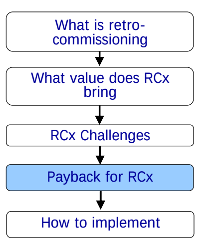
Overview



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Payback

- As seen in previous examples, payback varies.
- First case study was not oriented toward payback, but toward making building inhabitable
- Second case study was aimed at finding out operational status of building, but savings are possible and probably < 1 year payback
- Typical payback almost always less than 2 years.
- See report by LBnL study with Portland Energy Conservation Inc. and Texas A&M at
- http://www.peci.org/ncbc/proceedings/2005/19_Piette_NCBC2005.pdf

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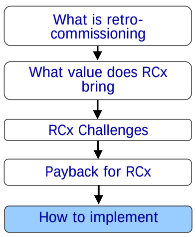
Overview



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Payback

- Full-fledged RCx requires engineer with experience
- But many (maybe most?) problems on site are just invisible. With better tools, these can be brought to light much easier.
- UT should provide some help in taking “unruly” data and looking for errors in performance
- Automatic fault detection and diagnosis is also making inroads (FDD) and will shortly be applicable in many systems

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TA details

References, Sources

- California Commissioning Collaborative www.cacx.org
- TIAX Report for DOE – Impact of DDC on commercial building energy use http://www.tiaxllc.com/aboutus/abo_newsviews_bytypeind.php?type=reports&ind=ABS
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