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> AIA Continuing Education

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Course Description

Discover how Big Data is finding its way into the facilities management profession and how our industry is increasingly positioning itself to harness and leverage the explosion of data collection and processing. At the center of this facilities-related Big Data revolution is the deployment of Fault Detection and Diagnostics or FDD. FDD holds the promise of moving our profession from a reactive service model to more of a predictive service model. Learn how employing a monitoringbased commissioning model, built on data analytics, holds the promise of providing more efficient building operations, retaining energy conservation gains, and lowering the risks to business continuity by using a predictive maintenance approach.



Learning Objectives

- · Define "Big Data" and the benefits in Facilities Management
- The future of smart buildings
- Define Fault Detection and Diagnostics and how this technology leverages
 investing over spending with COVID-19 and new construction examples
- · Case Study: University of Iowa's Fault Detection and Diagnostics Program
- · How to get started on your campus and measure success
- Questions and Answers

























Fault Detection and Diagnostics

What is it?

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.

Not QUITE there on a scalable solution to Building IoT using machine learning...but it's coming and FDD gets us close

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 2005

 • The Good Ol' Days"
 • Three modes of operation
 • Three modes of operation
 • Limited data points
 • Limited data points
 • More room for intuition and
 institutional knowledge
 • The state and the











FDD During COVII)-19
Ventilation qua successful return	ity is a key component to a to campus during COVID-19.
Sample of IAQ issues in individual rooms Supply/Exhaust flow lower than setpoint Supply/Exhaust flow higher than setpoint Zone dar More than Air Chan 9,000 rooms! Room CO2 lugter than maximum	Sample of IAQ issues at the central Air level Mixed Air Temp lower/higher than setpoint Dampers stuck closed Outdoor air Mixed Air T More than 408 Stuck Damp Damper short cycling
Many weak signals!	Minimum outdoor air damper closed CO2 sensor error

Durations Constraints Constraints

hide recommendations Check damper, no air flow, heat valve

hide recommendations Check damper, no air flow, heat valve could also be leaking, hide actions found damper set screw was lose reset and put box thru rec





Case Study: University of Iowa's Journey into FDD

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FDD at the University of Iowa

Key Tenants

- Important that we leverage our internal expertise to prioritize and perform the majority of the work.
- Important that we use existing data infrastructure, mostly through our Building Automation Systems or OSISoft Pi.
- Always want to be good stewards of University money and resources.
- Must compliment overall FM goal to be more efficient with our work and support proactive and predictive maintenance.

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	(Air Handler)		1.000000000	cooling element. Supply air temperature short cycling			0	12.33		1000
Voxman School of Music	VOX-HRC Loop (Heating System)	HW Loop	11/6/2019	Low loop temp difference. Diff pressure lower than setpoint. Flow sensor miscalibration.	1	\$31	10			
Visual Arts Building	VAB-Stab HW Loop (Heating System)	HW Loop	11/0/2019	Minimal load across loop. High supply temp.	1	\$28	10			4
Medical Education Research .	MERF-GEN AHU-2 (Air Handler)	AHU Colts.	11/8/2019	Simultaneous heating and cooling.	1	\$27	10		1	
Eckstein Medical Research	ault Det	ectior	า อเ	nd Diagnostics	s [)e	m	no		
Medical Education Research	(Air Handler)	NOV MIRE	19/0520-10				W		1	
Wendell Johnson Speech and	SHC-WJSH-HW System Loop (Heating System)	HW Loop	11/6/2019	Minimal load across loop. Supply temp higher than setpoint.	2	\$17	0			
Van Allen Hall	Well-Penthouse AHU (Air Handler)	AHU Colla	11/6/2019	Possible simultaneous or excess heating and cooling. Retruin RH lower than minimum. Supply temp higher than setsors: Supply temp reset error: Out of range sensor error (high).	2	\$14	5	1	0	
Medical Education Research	MERF-LAB AHU-1 (Air Handler)	AHU Colts	11/8/2019	Simultaneous beating and cooling.	1	\$14	1			8
Eckatein Medical Research B.	EMRB-CHWS (Cooling System)	CHW Loop	11/0/2019	Low loop temp difference.	2	\$14	5			9
Medical Laboratories	+M_AR_AH01_Supply (Air Handler)	AHU Colls	11/6/2019	Excess heating. Supply temp higher than setpoint. Leaking heating value.	1	\$12	9	2	101	1
Chemistry Building	CB-AHU-4 (Air Handler)	AHU Collis	11/5/2019	Simultaneous heating and cooling. Bluck cooling coll valve.	2	\$12	-			
Medical Research Center	MRC-ERU-1 (Air Handler)	AHU Heat Recovery	11/6/2019	Unused free heating available.	2	\$12				13
Iowa Mémorial Union	MU-Chilled Water East (Cooling System)	CHW Loop	11/5/2019	Low supply temp. Diff pressure not tracking setpoint.	9.	\$11	4			
	WOX-ERU 01						-			

2	2
З	2

	Issue	identifie	ed and t	roubleshooting begins 11/2	1/2019)				
Building	Equipment	Analysis	Start Date	Notes Summary	Tasks	Cost	E	C	M	Actions
Hancher Auditorium	HA-AHU-8 (Air Handler)	AHU Coils	11/17/2019		1	\$0	0			~
Hancher Auditorium	HA-AHU-8 (Air Handler)	AHU Coils	11/18/2019		1	\$0	0			~
Hancher Auditorium	HA-AHU-8 (Air Handler)	AHU Coils	11/19/2019		1	\$0	0	2		~
Hancher Auditorium	HA-AHU-8 (Air Handler)	AHU Coils	11/20/2019		1	\$0	0			~
Hancher Auditorium	HA-AHU-8 (Air Handler)	AHU Coils	11/21/2019	Simultaneous heating and cooling. Supply temp lower than setpoint. Leaking cooling valve.	1 (\$93	20	*	6	~
						\sim				















Closing the Loop Work completed and Work Order closed 11/9/17 AiM 🔳 Notes Log KATHLEEN About Logou BRAD DAMERON Nov 22, 2019 02:30 PM DAMRON GENERAL Found cooling valve actuator failed. Replaced actuator. BD, RM 11/22/19 Analytic is no longer flagging Start Date Equipment Analysis Tasks Cost Taska Cost E C M HA-AHU-8 AHU Coils 11/19/2019 (Air Handler) AHU Coils 11/19/2019 HA-AHU-8 (Air Handler) AHU Coils 11/20/2019 \$0 📀 1 HA-AHU-8 (Air Handler) AHU Coils 11/21/2019 Simultaneous heating and cooling. Supply temp lowe than setpoint. Leaking cooling valve. H4-AHU-8 (Air Handler) AHU Colls 11/22/2019 Simultaneous heating and cooling. Supply temp lower than setpoint. Leaking cooling valve. Hancher Auditorium HA-AHU-8 AHU Colls 11/23/2019 (Air Handler) 1 \$0







B	lssue ide	ntified a	and tr	oubles	shooting begins					
	Building	Equipment	Analysis	Start Date	Notes Summary	Tasks	Cost E	C	M	Actions
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problem	Biology Building	BB1-AHU-1 (Air Handler)	AHU Coils	6/16/2019	Excess heating.	2	\$3 🜗		-	~
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dicator increased	lology Building	BB1-AHU-1 (Air Handler)	AHU Colls	6/18/2019	Simultaneous heating and cooling. Leaking heating valve.	2	\$981 19		6	~
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	Biology Building	BB1-AHU-1 (Air Handler)	AHU Coils	6/20/2019	Simultaneous heating and cooling. Leaking heating valve.	0	\$1,736 10			~

FDD Response Workflow First Responders do a quick "desktop" validation of the fault using software Pre-heating coil 150 A.A. erature (F) 50 degree rise in temperature across the heating coil! Air temp 70 07/14 00:00 07/14 12:00 Time Heating Valve Closed HR discharge air temp ----Face damper – Valve por Facilities Man THE U

















What's Next?

Current State...

- Now have 52 buildings on Schneider Building Analytics platform.
- Two new construction buildings were onboarded this year and using the platform for warranty item identification and ongoing commissioning.

Ongoing improvement...

- Always improving our processes to build Fault Detection into our existing maintenance practices through expanded training and workflow improvement.
- Looking at ways to utilize the tool to identify larger capital investment projects and the associated workflow for implementation
- Utilizing the tool to help identify potential IAQ issues in classroom spaces

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Implementation Tips & Measuring Success



FDD Implementation Tips



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FDD Implementation at Ulowa

Pappajohn Biomedical Discovery Building FDD Pilot



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Key Performance Indicator Examples

- Most costly equipment and/or buildings
- Number of items addressed/quarter
- Total avoidable energy cost available Percent reduction in corrective work
- Total avoidable energy cost addressed
- Number of comfort issues and response rateNumber of maintenance issues and

· Most uncomfortable buildings

response rate



Ratio of reactive to predictive work

Repeat Offenders

orders

orders





























11/1 1 1 1 1 1		Building Name	Building Name		Start Date	
What types of issue	s are found?	All	\sim	12/1/2019	12/9/201	
Common Air Handler Faults	Common Zone Faults					
asult Air Handler	A Result Zone Eq	sipme. Bruit	Boller	Heating System	1	
outdoor air damper below minimum	Room air temp higher than setpoint				1	
apply static pressure smaller than setpoint 186	Room air temp lower than setpoint	Missing Information: utility rates		61		
apply temp higher than setpoint 100	Occupancy sensor on longer than expected	23 Supply temp not tradiing setpoint		58		
ut of range sensor error (low) 157	Leaking heating valve	19 Low loop temp difference		39		
sitive temp difference across cooling element. 123	Flat sensor error	18 Pamp status data meimatch		27		
ssible simultaneous or excess heating and cooking 117	Zone supply air temperature short cycling	Missing Information: utility rates, pump HP, rated HW fic	w	24		
n status data mismatch 108	Zone occupied, AHU off	10 Supply temp reset error		23		
essure sensor drift 106	Supply air flow lower than setpoint.	9 Missing Information: pump HP, rated HW flow		20		
and air temp higher than setpoint 102	Out of range sensor error (low)	g Diff pressure lower than setpoint		15	~	
issing informations rated flow 60	Heating coll value short cycling	9 Pump(s) on, bollers off		15		
ut of range sensor error (high) 56	Stuck zone supply clamper	Common Cooline Cool	-			
tuck cooling coll volve 55	Setpoint was zero	Common Cooling Syste				
upply temp reset error 94	Stack heating valve	S Result	Chiller	Cooling System	~	
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pply air temperature short cycling 84	Zone on while unoccupied	4				
in on while unoccupied 75	Supply fan short cycling	Surply temp		24 24		
	Supply air velocity pressure sensor drift	3 Out of range secure amore thinks		25		
R effectiveness info available 75				20		
R effectiveness info available 75 uck pre-heating coll valve 66	Out of range sensor error (high)	2 Oriberbilis on Olivinumer all				
Reflectiveness info available 75 uck pre-heating coil valve 66 ow initialance 60	Out of range sensor error (high) Jumping sensor error	2 Chiller/HPs on, CHW pumps off		25		
R effectiveness info analiable 75 suck pre-heating coll valve 66 ow imbalance 60 supply tomp reset 60	Out of range sensor error (high) Jumping sensor error Stuck cooling valve	Chiller/HPs on, CHW pumps off CHW pump(s) on, chillen/tips off		25		
R effectiveness info available 75 ock pie-heating coli valve 66 ow imbalance 60 o supply tomp reset 60 more rent or flow revenal 60	Out of range sensor error (high) Jumping sensor error Stuck cooling where Cooling coil wheeshort cycling	Chiller/HPS on, CHW pumps off CHW pump(s) on, chiller/tps off Diff pressure higher than setspoint.		25		
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lefterSieners Wo analole 15 do per betring col valve 16 ou apply tomp frast over and an error of flow revenued 16 many laternative fast 19 19 ou error of more than opected 20 ou error of more than opected 20 ou error of more 18 ou branding col valve 18 ou branding col	Out of range sensor even of high Juning justees ennor Statut cooling can be also that of the sensor HPU for Cooling can be also that of the cooling of Mining information - HPU for exemption Sensor ennor or their wervanal Sensor ennor or the wervanal Sensor ennor or the memory anapper Taplated Teleforms (Wer Abert Cooling	Childer/HS on, CHV purps off CHV purps on childer/ps off DIT pressure higher than stephon Low toop temp difference Making Information CHV pump HP Child or timps menner enror (bio) Pump Status dida mismatch Homes CHV pump Ling and CHV pump		25 22 19 18 16 10		

Resources

- Department of Energy Smart Energy Analytics Campaign https://smart-energy-analytics.org/
- COGfx Study on the Impact of Green Buildings on Cognitive Function

http://naturalleader.com/thecogfxstudy/why-you-should-care/

• Your peer institutions!

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Recommended Reading/White Papers

- Accenture Energy Smart Buildings:
- czgbc.org/energy-smart-buildings-whitepaper
- Forbes article on Data Scientists:
- https://www.forbes.com/sites/gilpress/2016/03/23/data-preparationmost-time-consuming-least-enjoyable-data-science-task-surveysays/#67d4e2et6f63
- IBM research on Machine Learning:
- http://www.research.ibm.com/labs/ireland/#project
- Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations Thomas L. Friedman





