Automation Controls and Energy & Maintenance Savings at UNL

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Building Automation

System Development

Construction

Operation

Controller Manufacturing Controller and Software Development

Design

Install

Maintain

Monitor

Operate





UNL BAS History

- Early era Johnson Controls T6000
- 1978 Visit to UCSD (Cal San Diego)
- 1979 EMS I
- 1980 First Hardware
- 1996 First Microprocessor Thermostat
- 2000 Y2K Compliant System
- 2006 Linux/Java/TCPIP

Today 220+ Buildings, 650,000+ I/O objects





The What?

- Mechanical System Controls
- Room Temperature Controls
- Fume Hood Controls
- Laboratory Pressurization Controls
- Greenhouse Temperature Controls
- Building Utility Metering
- Lighting Controls





The Why?

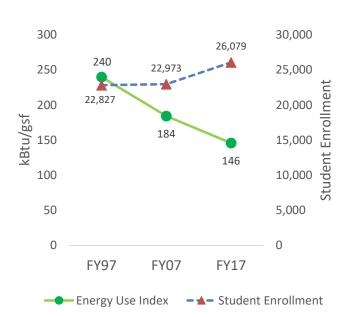
- Non Proprietary
- Standardization
 - One System
 - One User Interface
 - One Set of Spare Parts etc.
- Proven Success and Innovation
- Flexibility
- Save Energy



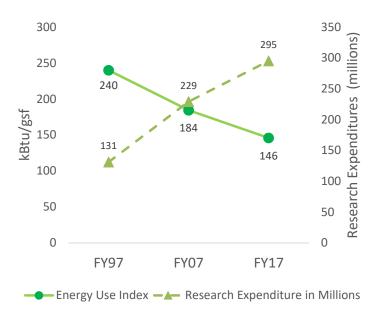


20-year Energy Use Index (EUI) **UNL State Buildings**

EUI and Enrollment



EUI and Research





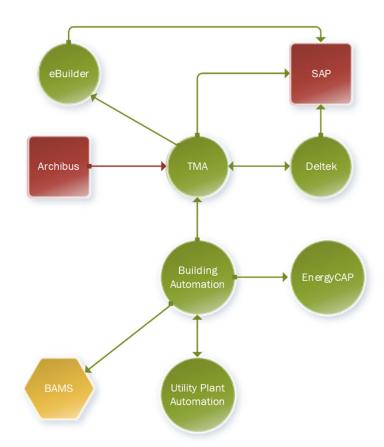


Integrated Systems





System Integrations









IoT in Action

Through Integration

- Semi-annual Fan, Pump, and Motor PMs
- Average frequency reduced from 6 to 10.5 months
- 30% operational savings versus calendar-based PMs

January	February	March	April	May	June
MIWIFSS	MIWIFSS	MTWTFSS	MIWIFSS	MTWTFSS	MIWIFS
123416	123	1.2	123411	1234	
7 8 9 10 11 12 15	4 5 4 7 1 5 12		T 8 9 10 11 12 11	8 4 7 8 8 10 11	2 2 4 5 6 7
14 15 15 17 18 19 20	11 12 13 9 15 16 17	10 11 12 13 14 15 18	14 15 15 17 18 19 20	12 12 14 15 16 17 18	9 10 11 12 13 14
24 22 29 24 25 26 27	18 19 26 21 22 23 24	17 18 19 20 21 22 23	21 22 29 24 25 26 27	19 20 21 22 23 34 25	18 1T 10 19 20 21 2
26 29 30 31	25 26 27 28 29	24 25 26 27 26 29 30	26 29 30	26 27 28 29 30 31	23 24 25 26 27 28 3
		31			30
July	August	September	October	November	December
MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFS
122456	123	1224507	12345	1.2	122450
7 6 9 12 11 12 12 15	4 5 6 7 8 9 12	8 9 10 11 12 13 14	8 7 8 9 15 11 12	2450700	8 8 10 11 12 13
H 15 19 17 18 19 20	11 12 13 14 15 10 17	15 16 17 10 19 20 21	12 14 15 16 17 16 19	12 11 12 15 16 15 16	15 10 17 18 19 20
21 22 20 24 25 26 27	18 19 20 21 22 23 24	22 23 34 25 39 27 28 29 30	20 21 22 23 24 25 20	17 18 19 20 21 22 23	22 23 24 25 29 27 29 30 31
26 29 30 31	25 28 27 28 20 30 31	3.30	27 26 29 30 31	24 25 28 27 25 29 30	29 30 31
					05.1
January	February	March	April	May	June
MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFS
1 2 2 4	1	1	12343	1 2 3	122458
5 6 7 8 8 10 11	2 2 4 5 5 7 8	2 3 4 5 6 7 8	6 7 8 9 15 11 12	4 5 4 7 6 9 10	8 8 10 11 12 13
S 12 19 18 12 18	9 10 11 12 15 14 15	9 10 11 12 15 14 15	15 14 15 16 17 18 19	11 12 10 14 15 16 17	15 16 17 15 19 20
10 20 21 22 23 24 26	16 17 18 19 20 21 22	18 17 96 19 20 21 22	20 21 22 20 24 28 26	18 19 29 21 22 23 24	22 25 24 25 26 27
26 27 28 29 30 31	29 24 25 26 27 26	29 24 28 26 27 28 28 30 31	27 28 29 30	25 26 27 28 29 30 38	29 30
July	August	September	October	November	December
MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFS
12345	1.2	123454	1214	1.	12345
6 7 6 9 18 11 12	3458709	7 8 9 10 11 12 13	5 6 7 6 9 16 11	2 3 4 5 6 7 6	7 8 9 10 11 12
13 14 15 18 17 19 19	10 11 13 13 14 15 18	14 15 16 17 19 19 29	12 13 14 15 16 17 10	9 12 11 12 13 14 15	14 15 10 17 18 19
2011221242520	17 10 19 20 21 22 23	21 22 25 34 25 26 27	19 20 21 22 23 34 25	16 17 16 19 30 31 32	21 22 23 24 25 26
27 28 29 30 31	26 29 29 27 28 29 30	28 29 20	26 27 28 29 30 31	23 24 25 26 27 28 29	28 29 30 31
January	February	March	April	May	June
MTWTFSS	MIWIFSS	MTWTFSS	MIWIFSS	MIWIFSS	MIWIFS
111	1234507	1 2 3 4 5 0 7	1214	1.2	12245
45071110	0 9 15 71 12 13 14	8 9 10 11 12 13 14	5 6 7 8 9 10 11	3 4 5 6 7 8 9	7 1 9 10 11 12
11 12 13 14 15 16 17	15 16 17 18 19 20 21	18 16 17 18 19 22 21	12 19 14 19 18 17 16	12 11 12 13 14 15 16	14 19 16 17 18 19
18 19 20 21 22 23 24	22 23 24 28 26 27 28	22 23 24 25 25 27 28	10 20 21 72 73 24 25	17 18 19 20 21 22 29	21 22 25 24 25 26
29 26 27 28 29 30 31		29 30 31	26 31 38 39 30	24 29 28 27 28 29 30 30	28 20 30
July	August	September	October	November	December
MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFSS	MTWTFS
1 2 3 4		12545	1 2 3	1234567	1234
		6 7 8 9 10 11 12	45676810	8 9 10 11 12 15 14	8 7 6 9 10 11
5 6 7 6 9 10 11	2345676				
5 6 7 8 9 10 11 12 13 14 15 18 17 18	9 10 11 12 13 14 15	10 14 15 16 17 18 18	11 12 13 14 15 46 17	15 18 17 16 19 20 21	
5 6 7 6 9 10 11			91 12 13 14 15 16 17 16 19 20 21 22 23 24 25 28 27 28 29 20 21	15 18 17 16 19 20 21 22 23 24 25 26 27 26 29 30	13 54 15 15 17 18 20 21 22 23 24 25 2 27 20 29 20 21

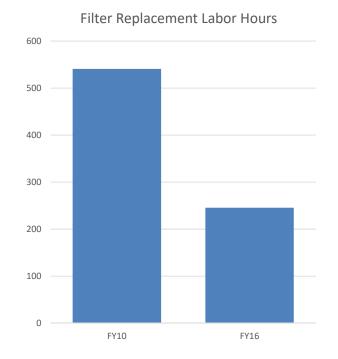




IoT in Action

Through Integration

- 55% reduction in labor hours
- 50% fewer filters
- Reduced energy consumption
- Reduced environmental impact
- Improved Indoor Air Quality



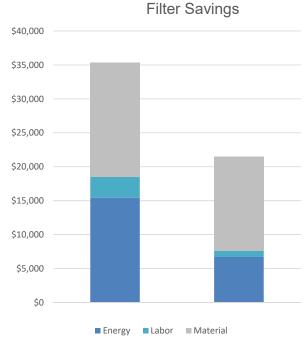




IoT in Action - Example

Chemistry Building









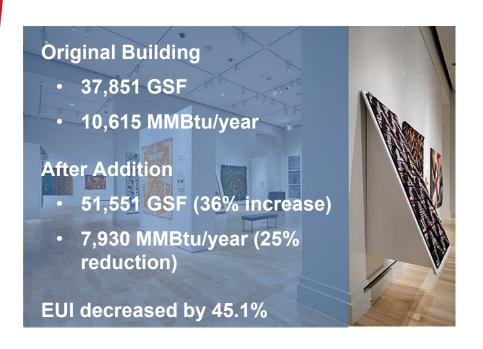
Continuous Commissioning

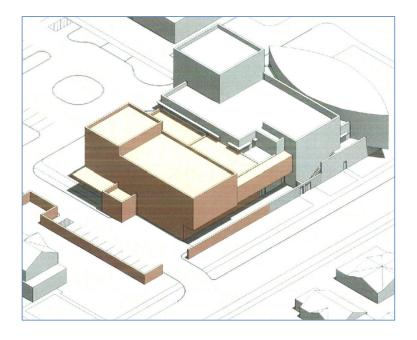




Recommissioning - Example

International Quilt Museum









Recommissioning Savings

Cumulative Energy Savings

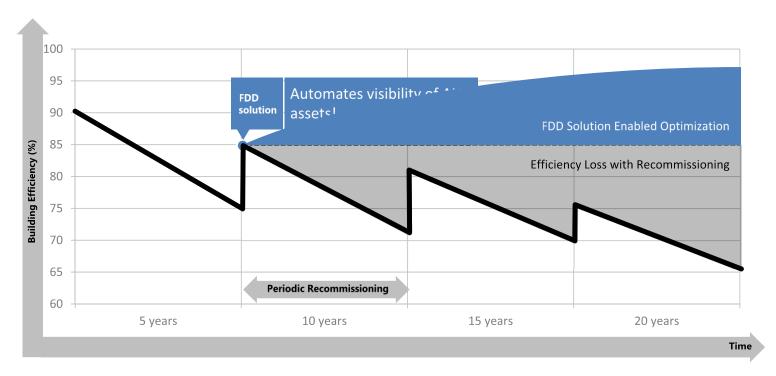
University of Nebraska-Lincoln Recommissioned Buildings	Baseline Cost	Actual Cost	Avoided Cost	Avoided Cost %	Months Elapsed	Avoided To-Date
ALEX - Alexander Building	\$5,747	\$5,373	\$374	6.5%	4	\$374
ANDN - Andersen Hall	\$26,470	\$26,957	(\$487)	-1.8%	22	(\$892)
ANSC - Animal Science Complex	\$312,359	\$306,899	\$5,460	1.7%	15	\$6,825
AVH - Avery Hall	\$83,390	\$87,742	(\$4,351)	-5.2%	28	(\$10,153)
ENTO - Entomology Hall	\$35,944	\$35,589	\$355	1.0%	13	\$384
FMS - Facilities Management Shops	\$59,802	\$57,945	\$1,857	3.1%	30	\$4,643
HARH - Hardin Hall	\$84,461	\$80,338	\$4,123	4.9%	21	\$7,215
KCR - Kiesselbach Crops Research Lab	\$16,390	\$12,771	\$3,619	22.1%	13	\$3,920
KEIM - Keim Hall	\$71,877	\$76,143	(\$4,266)	-5.9%	26	(\$9,243)
MOLR - Morrison Center	\$83,706	\$77,917	\$5,789	6.9%	9	\$5,789
OTHM - Othmer Hall	\$135,133	\$128,950	\$6,182	4.6%	6	\$6,182
QH - Quilt House	\$325,220	\$185,747	\$139,473	42.9%	40	\$464,910
RVB - Mary Riepma Ross Media Arts	\$144,818	\$112,711	\$32,107	22.2%	33	\$88,294
SHEL - Sheldon Museum of Art	\$49,575	\$35,153	\$14,423	29.1%	23	\$27,643
TEAC - Teachers College Hall	\$9,881	\$9,881	\$0	0.0%	4	\$0
Totals	\$1,444,774	\$1,240,117	\$204,657	14.2%		\$595,891



14% reduction in annual energy costs (average)



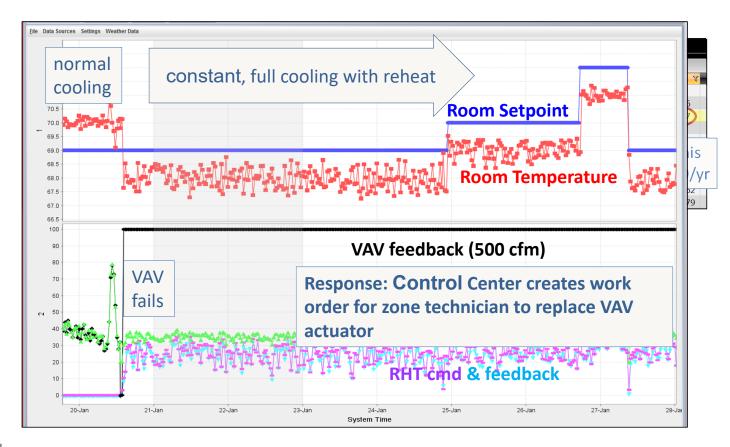
Continuous Commissioning with FDD







Example Fault







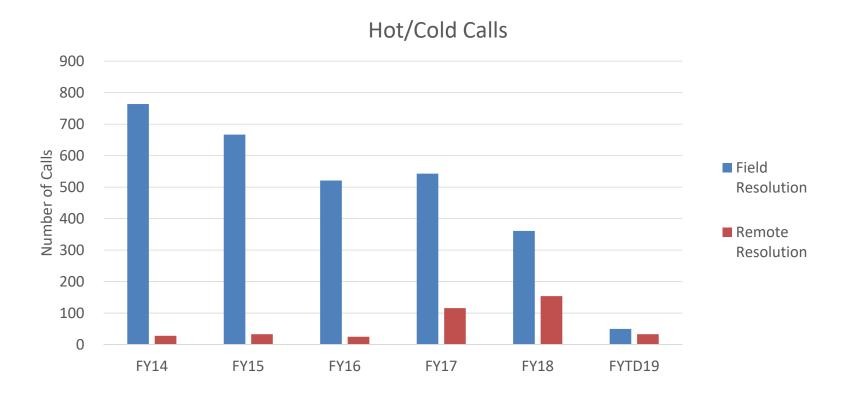
FDD Identified Cost Avoidance

	2016	2017	2018
Cost if Uncaught	\$5,274	\$30,188	\$146,066
Fault Actual Cost	\$209	\$936	\$7,952





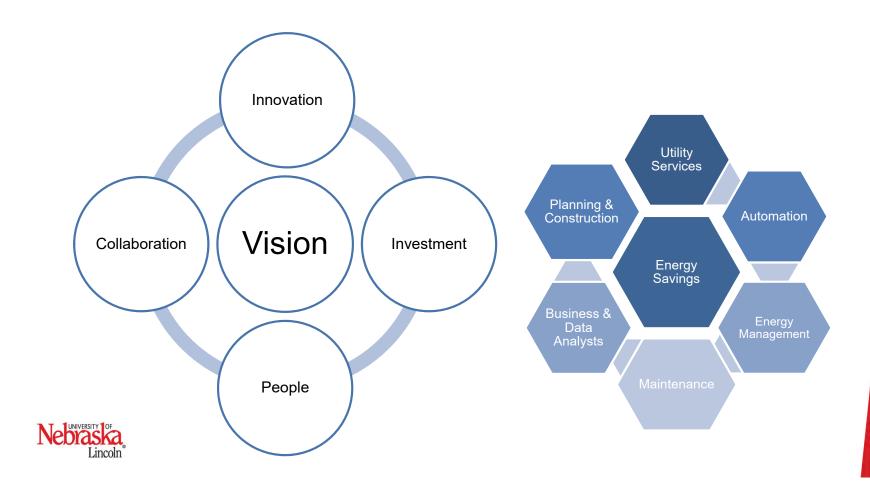
Reducing Technician Labor







What makes our program possible?





Questions?





