Leveraging Big Data at University of Nebraska-Lincoln

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Presentation Objectives

- How Big Data can be used to improve the operational efficiency of assets to reduce energy and maintenance costs and improve occupant comfort
- How to develop data collected by Building Automation Systems (BAS) into actionable knowledge
- How to prepare and implement a system to leverage Big Data

Outline of Presentation

- Big Data and Strategic Goals
- Big Data and the Maintenance Maturity Continuum
- Harnessing Big Data using Fault Detection and Diagnostics (FDD)
- FDD Implementation and Results at UNL
- Wrap up:
  - Lessons Learned
  - Conclusions
  - Questions

Big Data and Strategic Goals

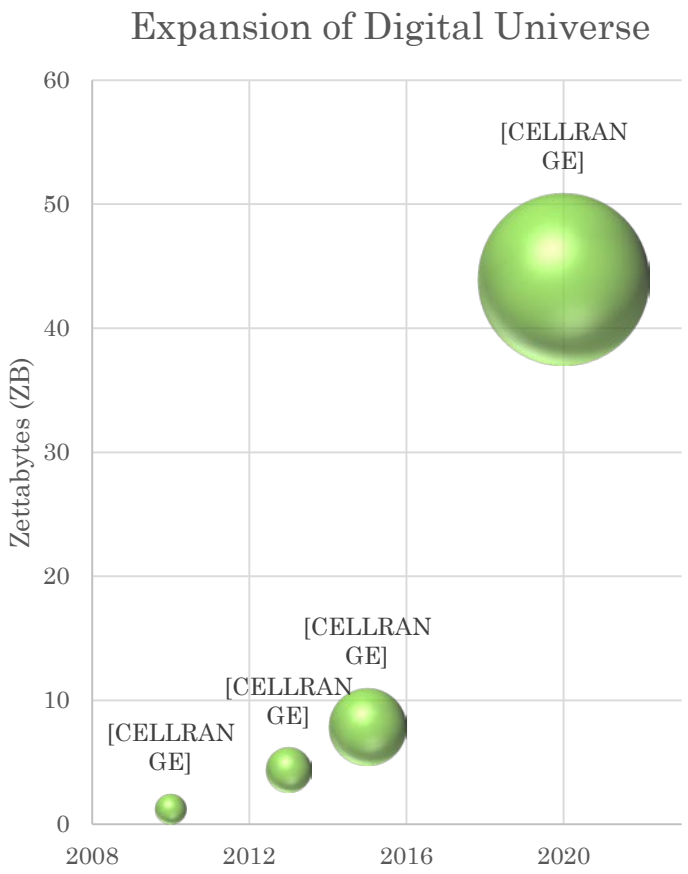
What is Big Data?

- Big data is a term for data sets that are so large or complex that traditional data processing applications are inadequate

– Wikipedia

Big Data in Perspective

- If the Digital Universe were represented by the memory in a stack of iPads:
  - In 2013 the stack would have reached 2/3 of the way to the moon
  - In 2020, the stack is projected to reach the moon 6.6 times



1 ZB = 1 trillion GB

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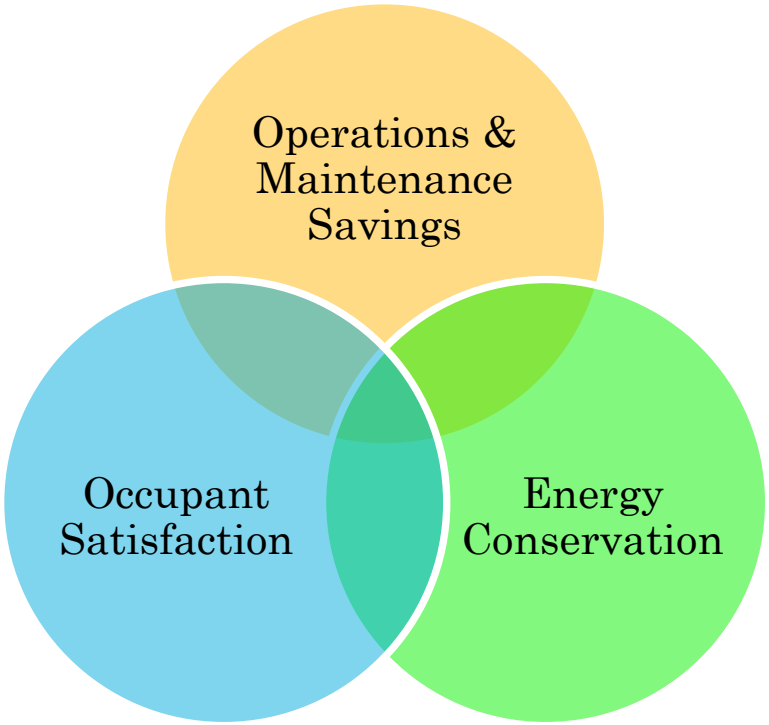
Big Data At UNL Facilities

- 60,500 connected sensors and control devices
- 7.4 million new records collected *every day*
- Total volume of 7.2 billion records
- Most data is purged without ever being used

A clear picture of our facilities' performance is obscured by the sheer volume of records

Why is Big Data Important?

- Big Data can be utilized to address Operations & Maintenance (O&M) costs
  - Typically the 2nd largest cost category in an institutional budget (after people costs)
- Big Data can be used to support the strategic goals of the institution



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Asset Degradation is the Key

- The performance of campus assets (building equipment and infrastructure) will degrade over time
- As performance degrades, assets will typically:
  - Experience reduced useful life and may suffer catastrophic failure
  - Use more energy
  - Provide less reliable facility conditions
- Assets connected to the Building Automation System (BAS) can signal a change in condition and the need for a maintenance response

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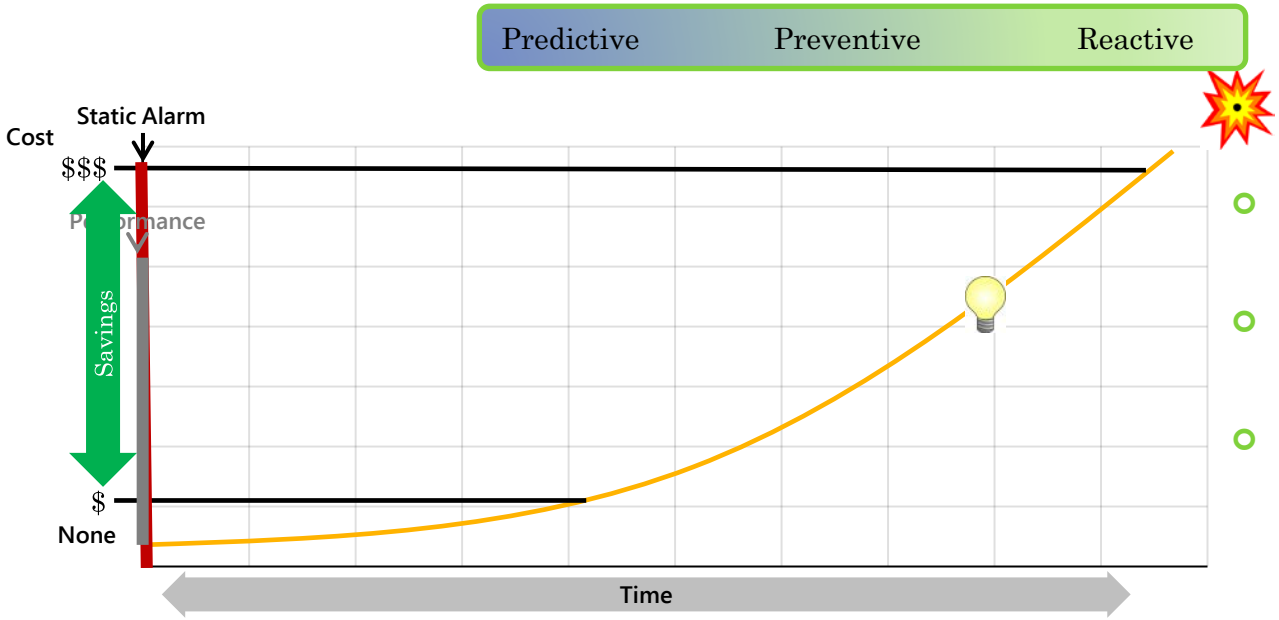
Focus on Asset Performance For Cost Savings



Degradation Curve

- Reduce Energy Consumption
- Avoid catastrophic breakdowns
- Resolve issues before occupant awareness

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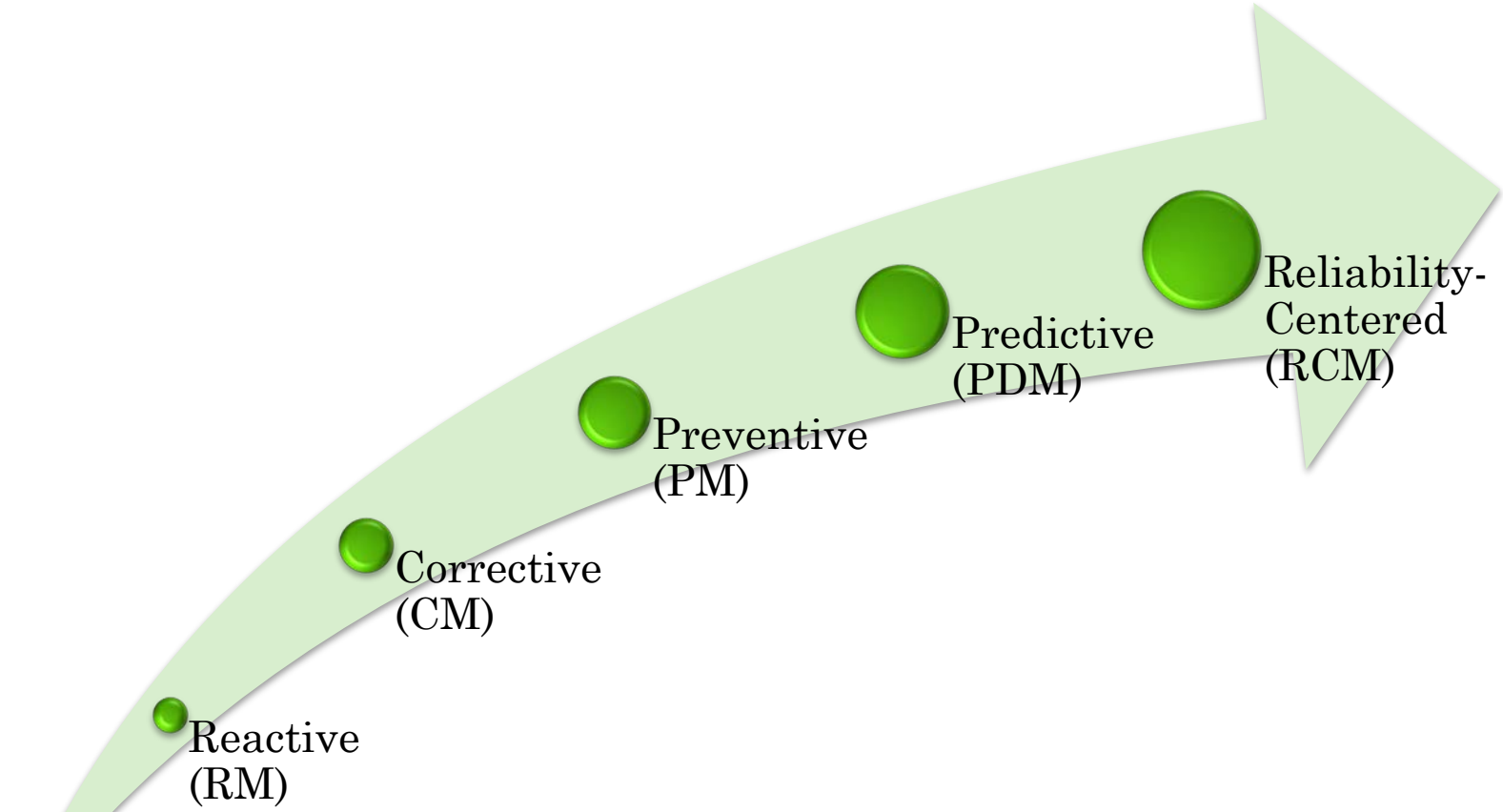
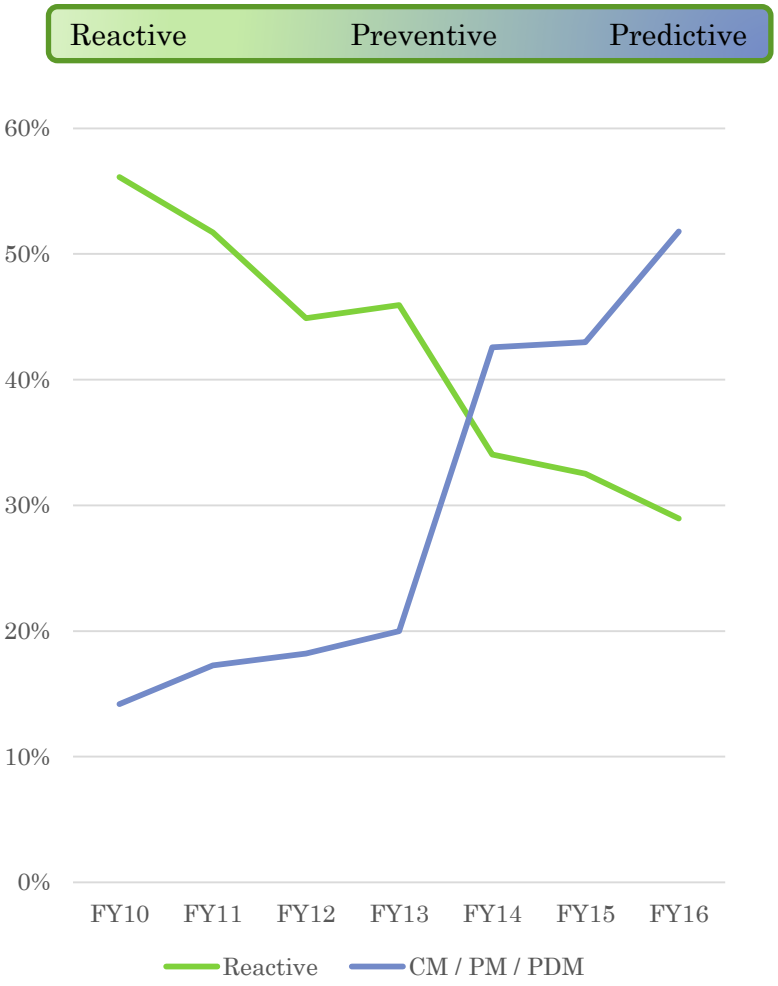
Maintenance Maturity Continuum at UNL

Maintenance Maturity Continuum



Timeline of Maintenance Maturity at UNL

- Moved from centralized to zone-based shops
- Added sensors to collect equipment data
- Implemented calendar-based PM program
- Implemented Computerized Maintenance Management System (CMMS)
- Integrated CMMS and BAS



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Data-Driven PM Drives Cost Savings

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

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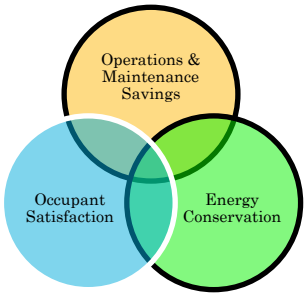
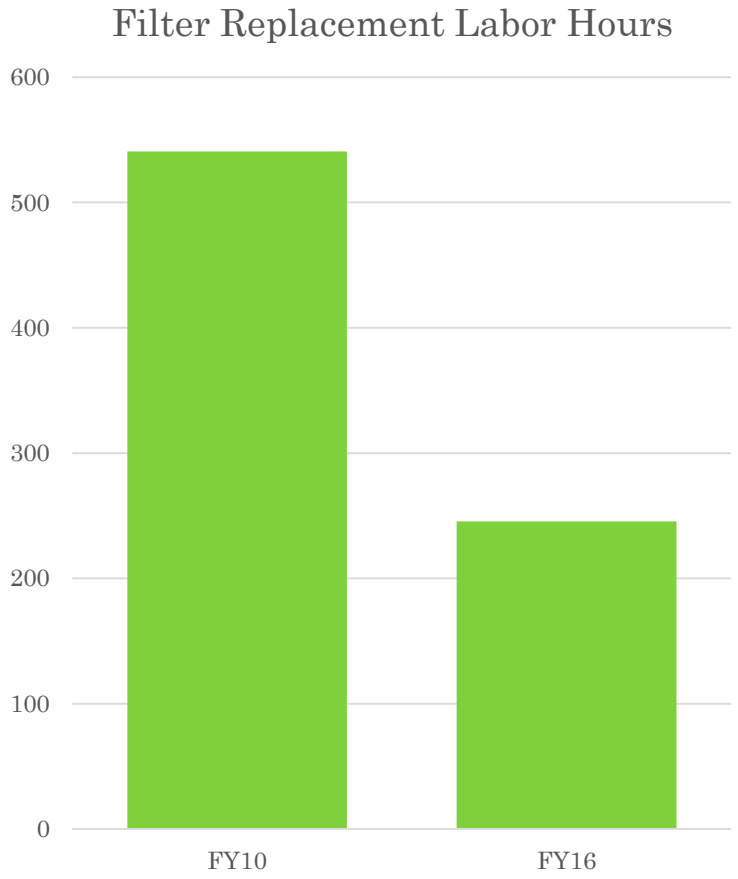
Data-Driven Filter PDM Drives Cost Savings



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



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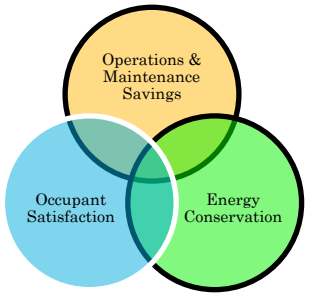
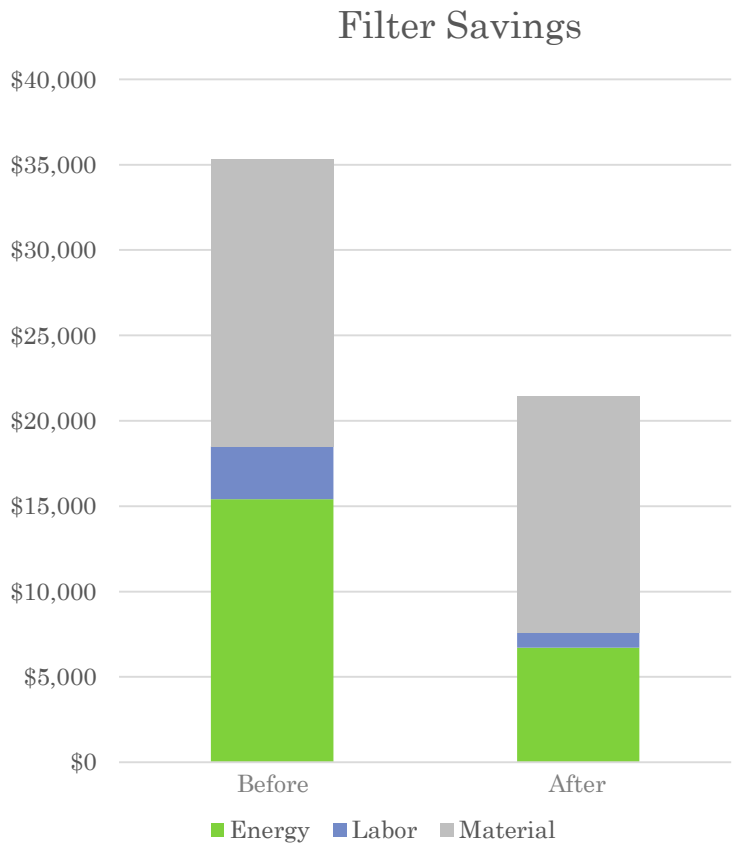
Hamilton Hall Chemistry Lab Filter Savings



- Energy Savings: $8,700/year
- Labor Savings: $2,200/year
- Material Savings: $2,900/year



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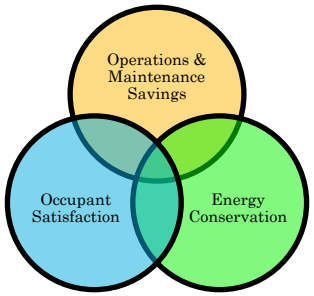
Approaching RCM



- Reduced energy costs and consumption
- Operational improvements
- Improved environmental footprint
- Improved occupant comfort

*However… we're not yet **leveraging** Big Data*

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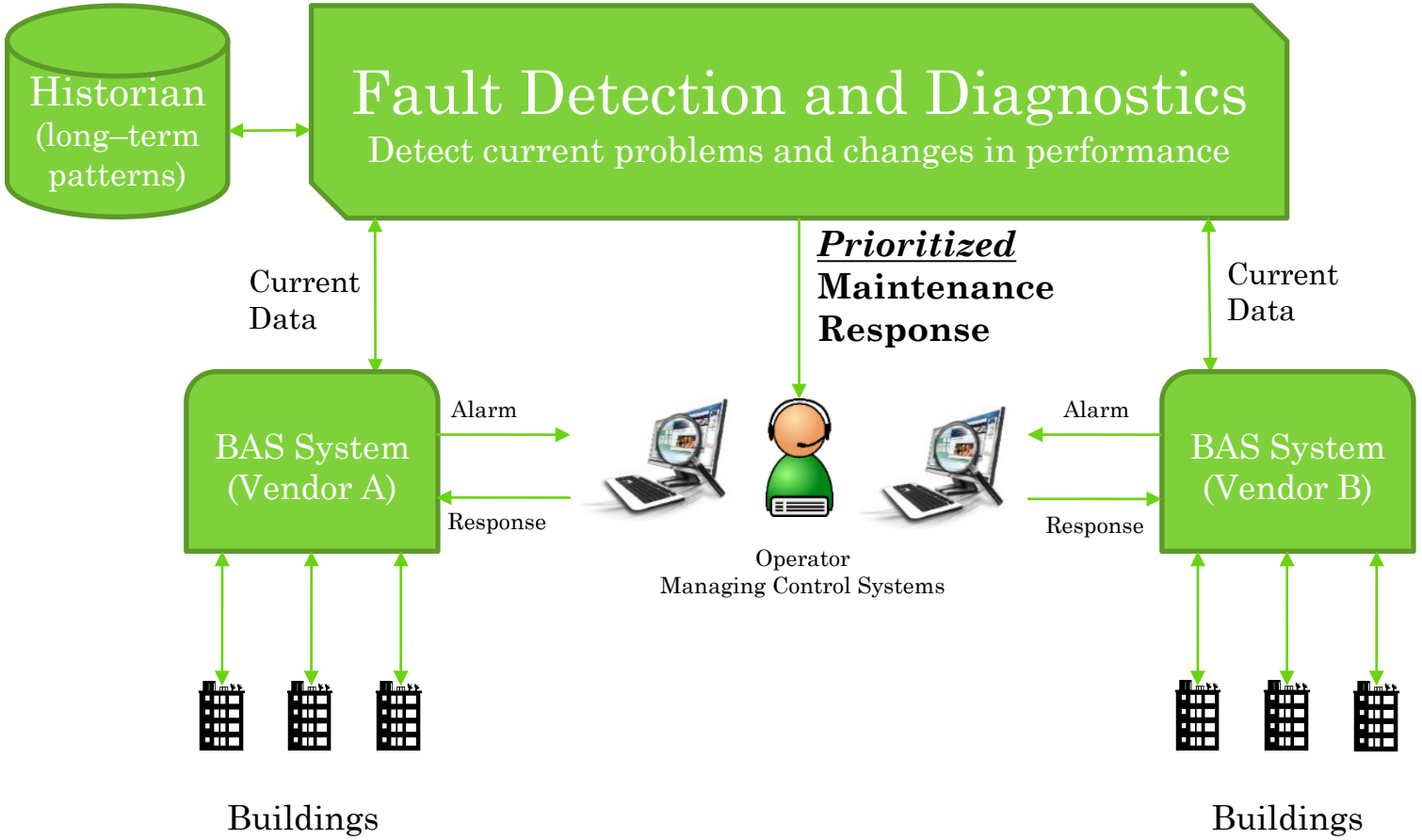
Fault Detection and Diagnostics (FDD)

FDD Leverages Big Data

- FDD aligns specialized algorithms and Big Data
  - Identifies asset degradation
  - Prioritizes maintenance response
  - Records the asset's performance over time

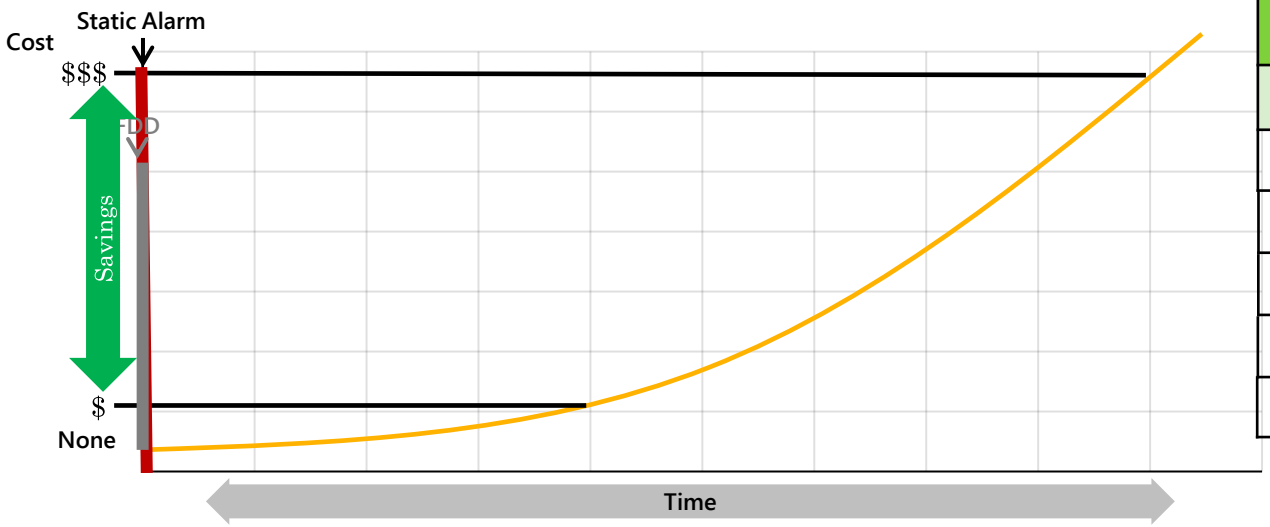
FDD provides real-time actionable knowledge

Building Automation and FDD



Fault Detection versus Alarm Management

Air Handler Unit (30,000 CFM)



Monetizing Fault Savings	
Heating Energy Cost /year:	
Optimal:	2,130 $/year
Alarm Status:	30,300 $/year
Fault Detected:	4,880 $/year
Fault Savings:	25,420 $/year
Fault vs Alarm:	84%

Degradation Curve

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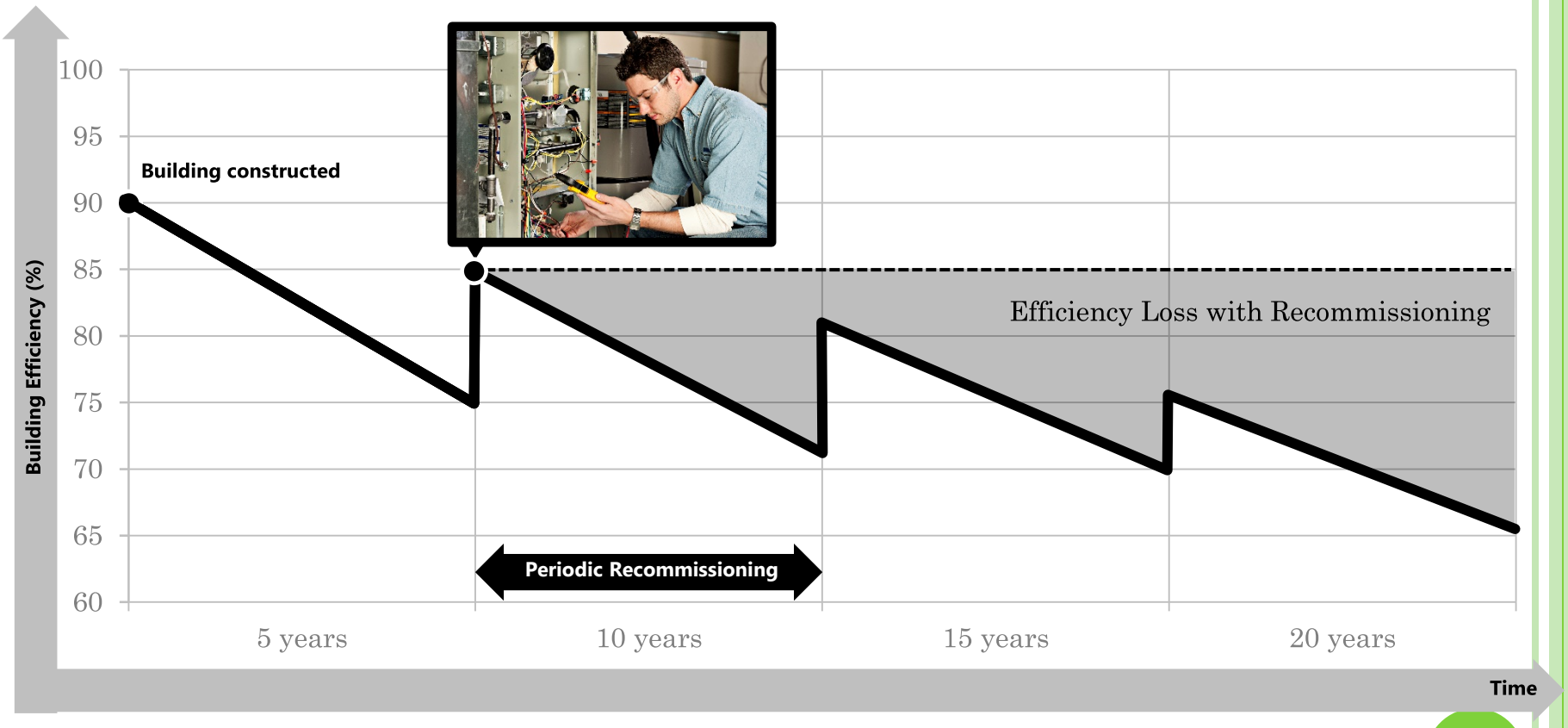
Periodic Recommissioning (RCx)



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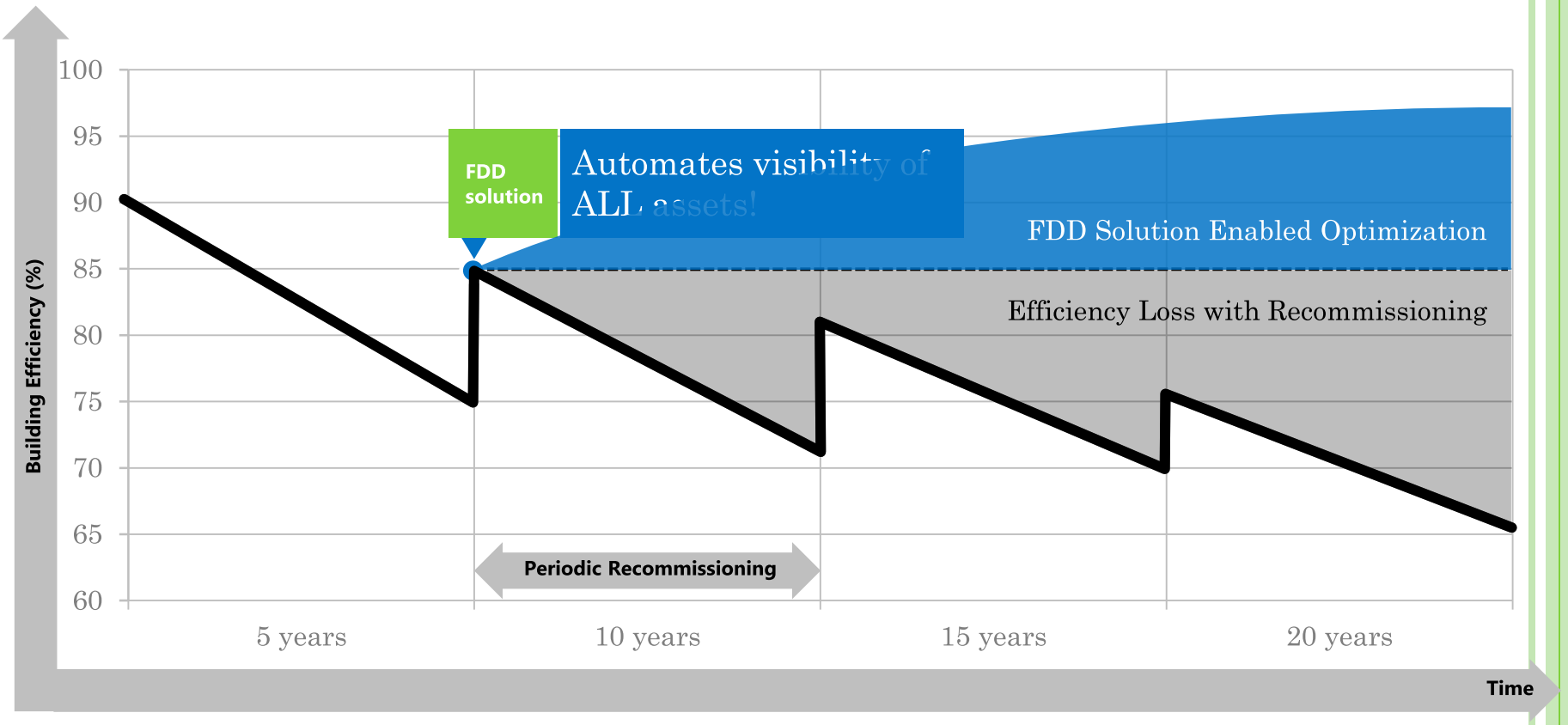
Continuous Commissioning with FDD



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FDD at Microsoft Campus Redmond, Washington

FDD saved **10%** of annual energy costs

45% of faults fixed within **30** seconds

ROI in less than **24** months

- In four years, this solution saved Microsoft $4.5M
- Microsoft projects $100M global savings in ten years

ROI Analysis for UNL

- Projected payback in 10 years based on energy savings alone
- Anticipated 5% annual energy savings
- O&M savings will accelerate our payback
  - Reduced labor hours
  - Reduced material cost

FDD Implementation and Results at UNL

FDD Implementation – FY16

- Align BAS assets and integrate with ICONICS software
- Establish recommissioning program
  - Six buildings each year
  - Concurrent FDD development
- Develop fault prioritization algorithms
  - Cost
  - Criticality

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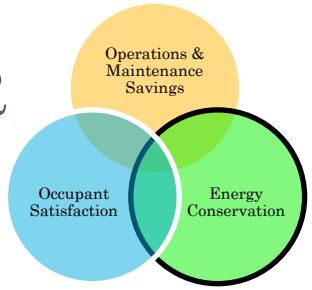
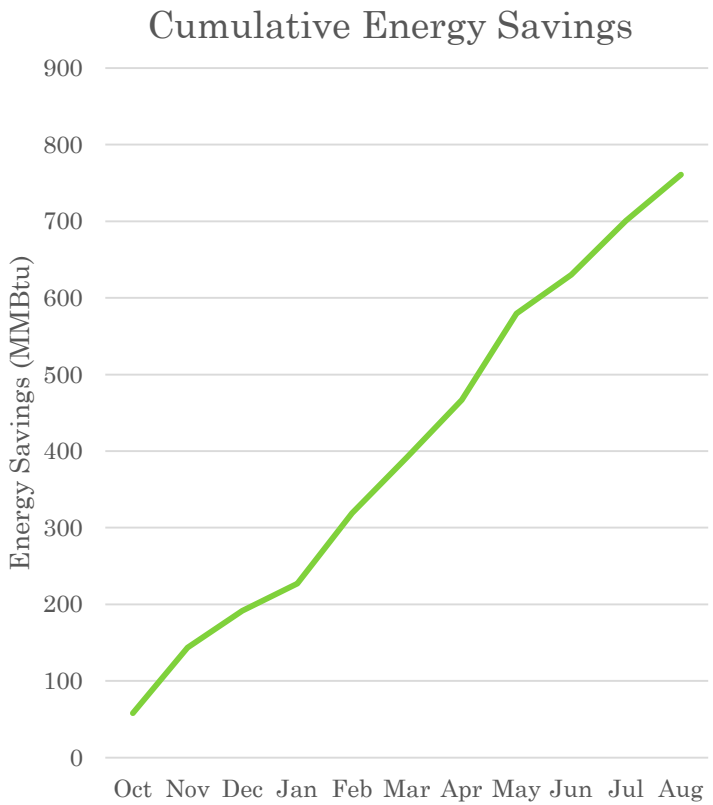
Fault Response

- Dashboards prioritize faults
- Control Center triage
  - Identify root cause using BAS
  - Resolve issues remotely if possible
  - Dispatch field technician when necessary

Ross Van Brunt Visitors Center RCx Energy Savings



- Energy Use Index (EUI) decreased by 15.5%
- Identified additional energy conservation projects



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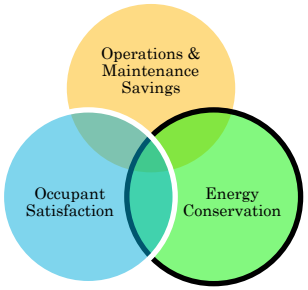
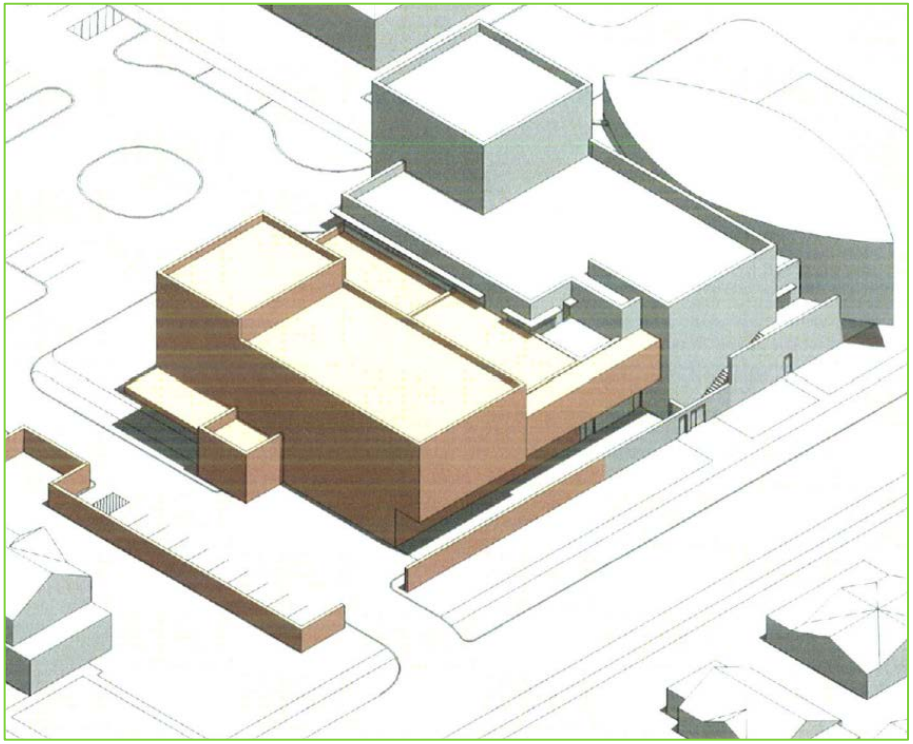
Intl. Quilt Museum RCx Energy Savings



- Original Building
  - 37,851 GSF
  - 10,615 MMBtu/year
- With Addition
  - 51,551 GSF (36% increase)
  - 7,294 MMBtu/year (31% reduction)
- EUI decreased by 45.1%



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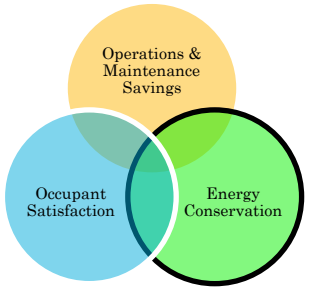
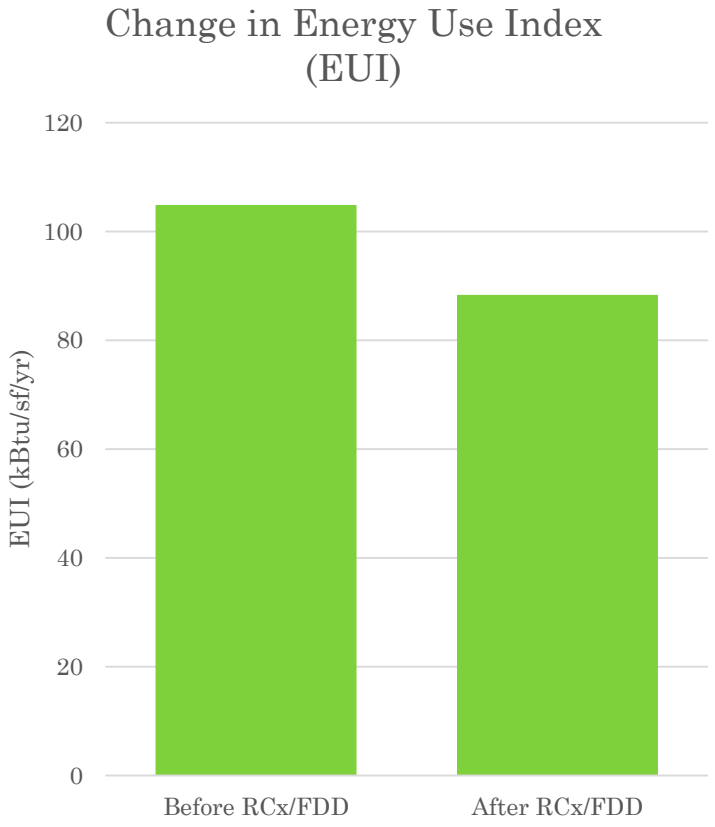
Cumulative RCx Energy Savings



- 11.8% reduction in EUI for buildings with at least 6 months of data
- Not every building will realize energy savings



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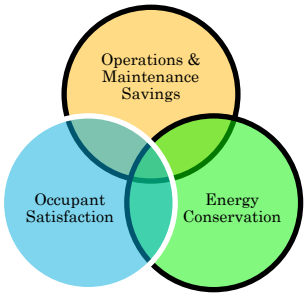
FY17 FDD
Detected Fault Costs



- 19 Buildings currently being monitored by FDD
- 259 unique faults reported in first 2 months of FY17
  - If left uncorrected for a year, these equate to $50,000 in wasted energy
- Many faults are resolved remotely at no/low cost

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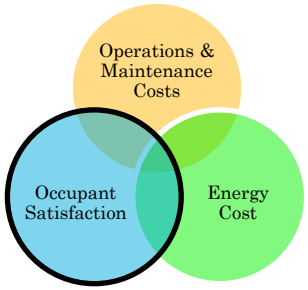
Occupant Satisfaction



- Improved temperature control
- Reduced air handler noise
- Mitigated safety concerns

"We have noticed the noise in the air handler is gone! The offices in the south wing have been much more comfortable – they have been cooler. The Great Hall has been cooler as well."

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Lessons Learned, Conclusions And Questions

Lessons Learned

- Select a good business partner
- Use FDD to help target recommissioning efforts
- Seek feedback from building occupants and maintenance staff to direct recommissioning efforts
- Leverage FDD for warranty oversight of construction and renovation projects

Future Enhancements to UNL's FDD Program

- Extend FDD enrollment to
  - Approximately 100 campus buildings
  - Five campus utility plants
  - All new buildings
- Integrate FDD with Computerized Maintenance Management System (CMMS) to automatically generate work orders for specific fault types
- Implement mobile notification for field and on-call personnel

Conclusions

- Big Data can be used to improve asset performance, reduce energy and maintenance costs, and improve occupant comfort
- FDD translates Big Data into actionable information that can help institutions meet strategic goals and move toward RCM
- Alignment of a Recommissioning program with an FDD program will enhance the benefits of both programs

Questions?

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