DATA INTEGRATION FOR UTILITIES AND ENERGY

APPA INSTITUTE FOR FACILITIES MANAGEMENT
INDIANAPOLIS, IND
SEPTEMBER 12, 2023

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PURPOSE OF TODAY'S PRESENTATION

- To provide a broad understanding of:
  - Data Warehouses/Data Marts
  - How to collect the data
  - How to convert data into information
  - Examples

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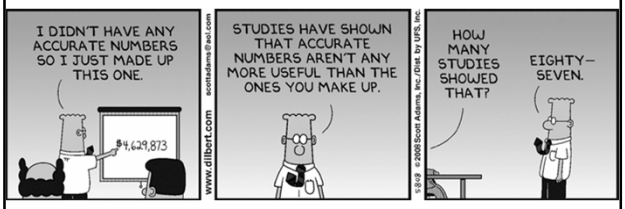
WORDS OF WISDOM



If you torture the data enough, it will confess to anything.

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DISCUSSION

- Create a report of energy consumption and cost for each building owned by your institution:
  - If served by a District Energy System or local system(s):
    - Chilled Water
    - Steam or Hot Water
    - Electricity
    - Water
    - Fuel-Gas/Oil/Coal
  - If served by the local utility
    - Electricity
    - Fuel-Gas/Oil/Coal
    - Water
  - This year versus last year information:
    - Consumption and cost
    - Hours used and weekly schedule
    - Average number of occupants, i.e. staff, students, faculty
    - Square footage of building including classification(s), i.e. instructional space, administrative, research, housing, etc.
    - Departmental ownership
    - Weather, e.g. average temperatures, % sun, etc.
    - HVAC system type

WHERE WOULD YOU GET THE INFORMATION TO PRODUCE THIS REPORT?

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THE DATA PROBLEM

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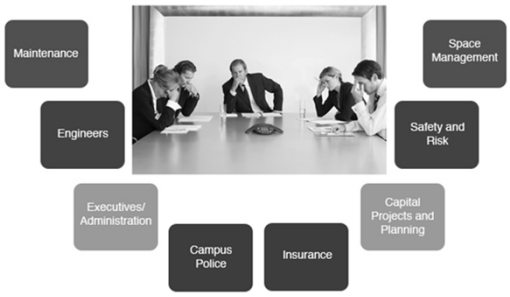
THE PEOPLE PROBLEM



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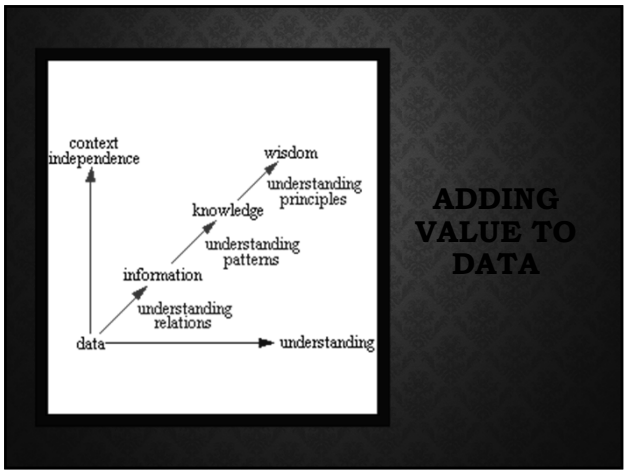

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How do you get there?

Best Practices in Data Management
Five Elements for Success

Asset Inventory	Data Access	Tools and Analytics	Organizational Structure	Engagement Communication
Comprehensive	Comprehensive	Flexible	Integrated	Targeted
Centralized	Streamlined	Secure	Centralized	Clear
Verified	Automatic	Accessible	Dedicated Staff	Transparent
Up to Date	Prompt	QA/QC	Streamlined	Mission-focused

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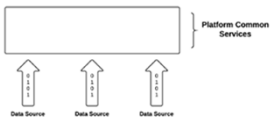
Platform Concept



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Platform Concept

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Platform Concept

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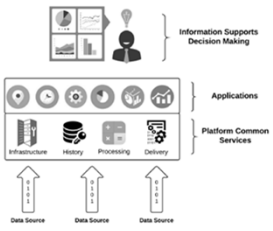
Platform Concept



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INTEGRATE THE DATA

Data Warehouse operates on an enterprise level and contains all data used for reporting and analysis, while **Data Mart** is used by a specific business department and is focused on a specific subject (business area).

- Aggregate data into a single centralized repository available to all authorized stakeholders
- Integrate the data into consistent subject categories based on how users refer to them
- Apply consistent value representation, units, and descriptors to the data

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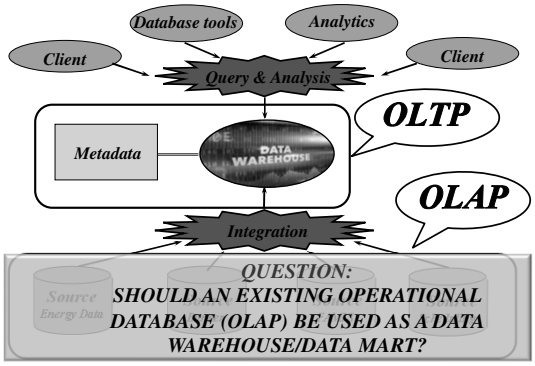
DATA WAREHOUSE/DATA MART ARCHITECTURE



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QUERY THE DATA

- Use IT database management tools to create "views" of data organized for use by reporting software (clients).
- Apply analytics, e.g. machine learning methods, artificial intelligence (AI), etc. to extract information from data subsets

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HOW IS MACHINE LEARNING RELEVANT TO FACILITIES MANAGEMENT?

Pattern recognition is a key part of machine learning: delving deep into data sets to identify recurring patterns and adapting to suit them. Facilities managers can't just dig into those numbers on their own — in most operations, the information sets are just too vast. However, the patterns they display are real, and extremely relevant in cases such as these.

Predicting Problems

When a facility manager tracks operations with machine learning, the disruptions in normal patterns are just as relevant as the consistencies. For example, if a process suddenly fails to meet its routine performance levels, it's possible to isolate and replace a failing part — before it becomes a problem. Smart technology can be programmed to set alerts when the facility displays inconsistencies, all through self-monitoring data collection.

Tracking Usage

By establishing operational patterns, it's easy for facilities managers to develop proactive system scheduling: parts ordering, cleaning, routine shutdowns, and equipment replacement can all be arranged at the most cost-effective and efficient times.

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HOW IS MACHINE LEARNING RELEVANT TO FACILITIES MANAGEMENT?

Optimizing Energy Efficiency

A recent study investigated deep learning for asset optimization throughout a regular office building. The vast system of sensors tracked 35,000 measured data points per minute and drew insights on everything from prioritized elevator scheduling to kitchen odors, automated temperature adjustments, and lighting controls.

While this project proves an elaborate example, smart tech systems can outpace static programs in balancing building load. For example, most usage — even in HVAC and lighting alone — goes beyond the binary weekday/weekend or workday/holiday schedule. Weather events, holidays, and even major sporting events routinely alter attendance levels, and a smart system can mine historical performance data and respond accordingly.

Savvy Storage

In addition to predicting patterns for real-time applications, machine learning tech can also help to sort, prepare, and store data — suddenly, all this information can be significantly more useful to a manager.

For example, the tech can automatically group and sort data according to time of year, a particular machine performance, or even a type of maintenance. These analyzed, categorized data sets prepare the foundation for smart, organized action.

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CONVERT DATA TO INFORMATION

- Microsoft Office
- Third party reporting tools and applications
- Analytics, AI
- Web applications

Knowing that a tomato is a fruit?
That's Data.

Knowing not to put one in a fruit salad?
That's Useful Information.

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GROUP DISCUSSION

- What are our FM functions?
- What data is collected by other functions in your organization that you can/want to use?
- What data is collected institutionally that can be used to meet your needs?
- What formats does the data require, i.e. spreadsheet, dashboard, formal reports, etc.?
- Can you currently convert the data into information in the required format(s)? How?

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EXAMPLE APPLICATIONS

- Convert INFORMATION into KNOWLEDGE
  - Energy Management
  - Operational and Decision Support
  - Maintenance Management
  - Analytics, AI, Fault Detection
  - Reporting

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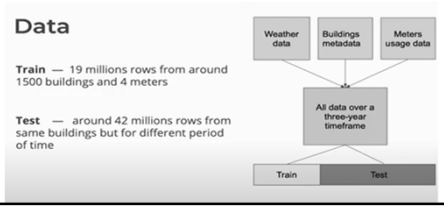
ASHRAE- Great Energy Predictor III- A Machine Learning Case Study

The competition focused on predicting the energy savings of a retrofit in the measurement and verification (M&V) process. Assessing the value of energy efficiency improvements can be challenging as there's no way to know how much energy a building would have used without the improvements.

Competitors were challenged to build counterfactual models across four energy types based on historic usage rates and observed weather. The dataset includes three years of hourly meter readings from over one thousand buildings, extensive characterization of the various buildings, and comprehensive weather data at over a 1,000 different sites around the world.



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AUTOMATED LOGIC
BUILDING UTILITY METERING PANEL
Centennial_Engineering
VALUES
SETPOINTS
ALARMS
Go To:
Chilled Water
Natural Gas & Dom. Water
Steam & Condensate
Elec. Pumps
All Alarms
Main BUMP Front
Utilities Map

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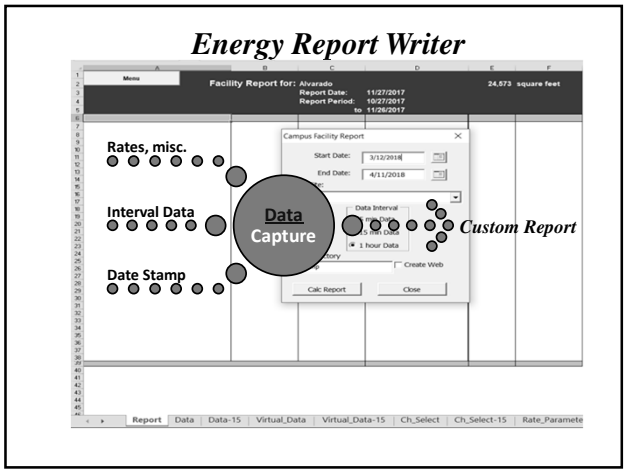
Energy Report Writer
Facility Report for: Alvarado
Report Date: 11/27/2017
Report Period: 10/27/2017 to 11/26/2017
24,573 square feet
Campus Facility Report
Start Date: 3/12/2018
End Date: 4/11/2018
Data Interval
1 hour Data
Create Web
Calc Report
Close
Rates, misc.
Interval Data
Date Stamp
Data Capture
Custom Report
Report
Data
Data-15
Virtual_Data
Virtual_Data-15
Ch_Select
Ch_Select-15
Rate_Paramete

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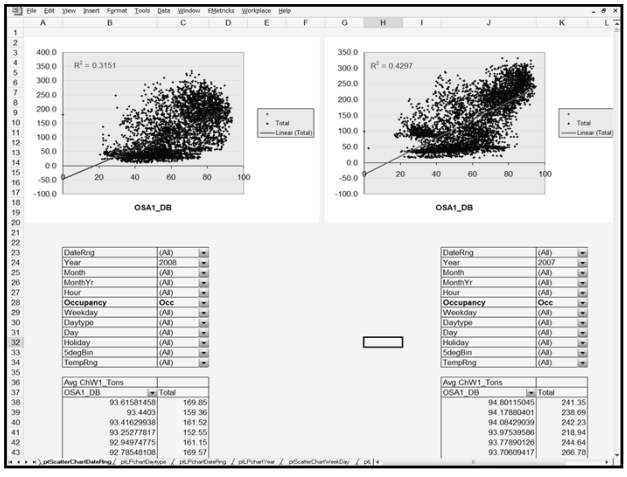
R² = 0.3151
R² = 0.4297
OSA1_DB
Total
Linear (Total)
DateRng (All)
Year 2008
Year 2007
Month (All)
MonthYr (All)
Hour (All)
Occupancy Occ
Weekday (All)
Daytype (All)
Day (All)
Holiday (All)
5degBin (All)
TempRng (All)
Avg ChW1_Tons
OSA1_DB
Total

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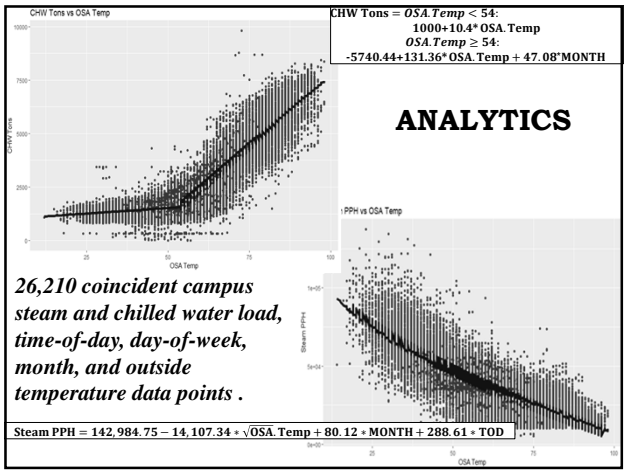

CHW Tons $= \begin{cases} OSA.Temp < 54: \\ 1000+10.4*\text{OSA.Temp} \\ OSA.Temp \geq 54: \\ -5740.44+131.36*\text{OSA.Temp}+47.08*\text{MONTH} \end{cases}$

ANALYTICS

26,210 coincident campus steam and chilled water load, time-of-day, day-of-week, month, and outside temperature data points .

$$\text{Steam PPH} = 142,984.75 - 14,107.34 * \sqrt{\text{OSA.Temp}} + 80.12 * \text{MONTH} + 288.61 * \text{TOD}$$

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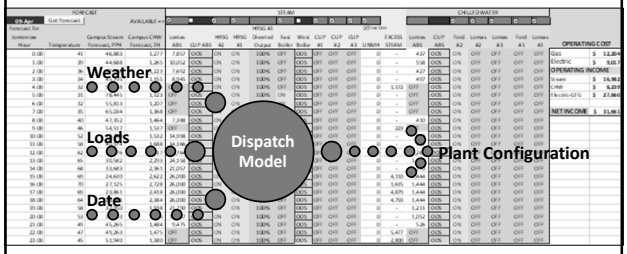
Operational and Decision Support



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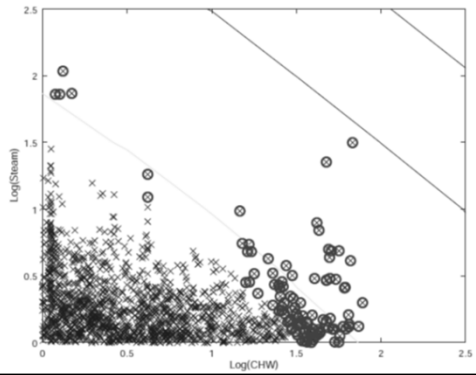
ANALYTICS
FAULT DETECTION AND DIAGNOSTICS



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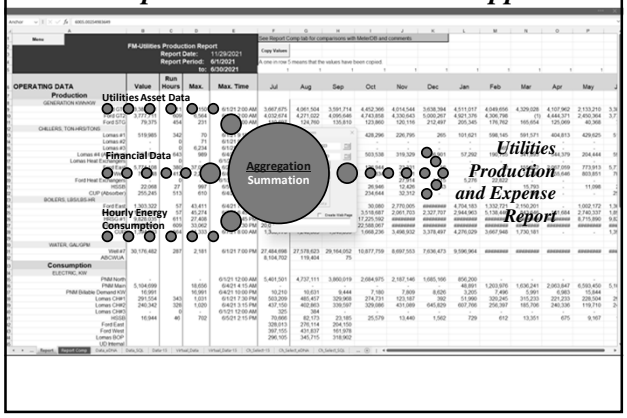
Operational and Decision Support



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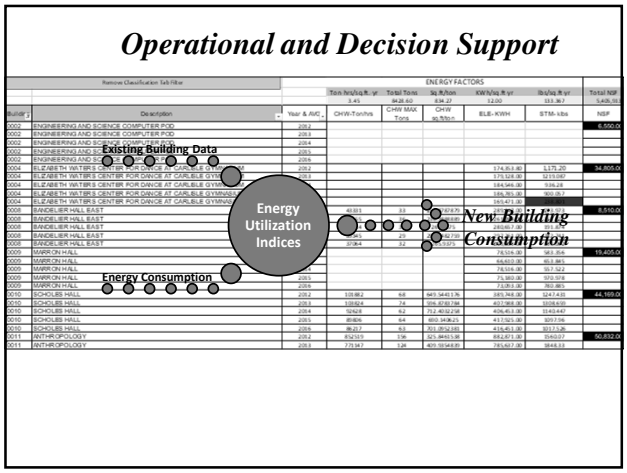
Operational and Decision Support



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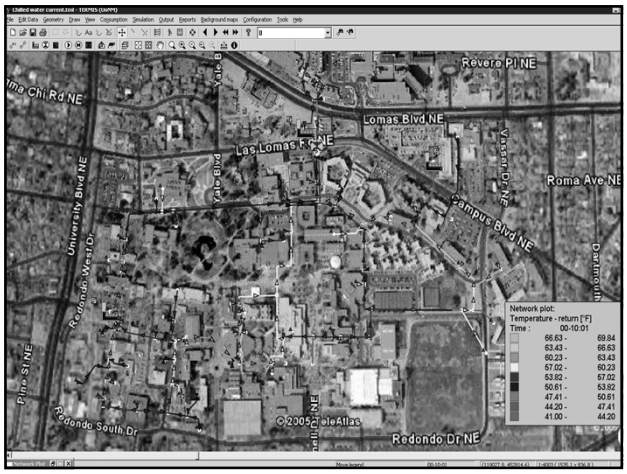

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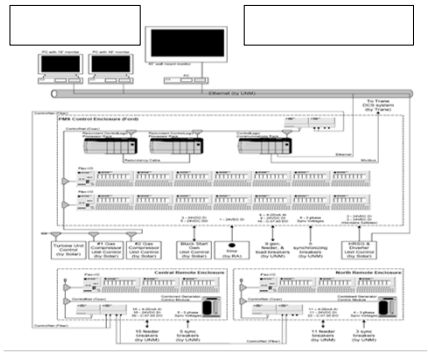
QUESTIONS & ANSWERS

Thank You!



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THIS CONCLUDES THE AMERICAN INSTITUTE OF ARCHITECTS CONTINUING EDUCATION SYSTEMS COURSE

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