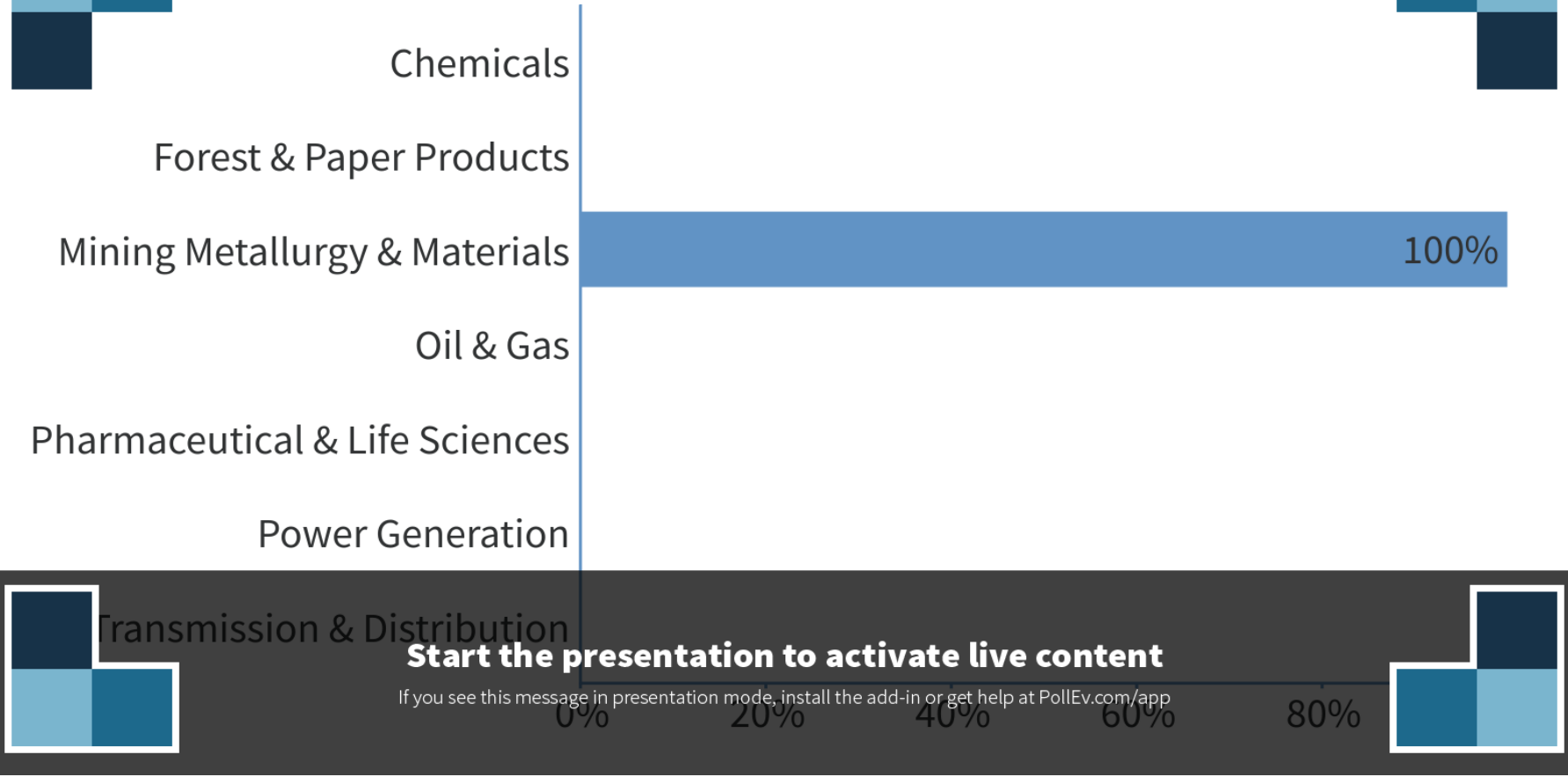
# Introduction to Asset Monitoring and Condition-based Maintenance with the PI System


Presented by
- Michelle Kuiee – Product Marketing Manager
- Thibaud de Rouzé – Systems Engineer

# What industry do you represent?

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# How much do you know about the PI Systen

Nothing, I've only heard of it

I am using Data Archive as a data historian

I am using Asset Framework to structure my data sets

I am using traditional tools -PI DataLink and PI Processbook

I am using PI Vision

I am using Advanced Integrations (Business ytics, Esri, Microsoft Azure, SAP HANA)

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# PI System Basics journey

# Where are we in our PI System Basics Journey ?


## Getting Started

My operational data, the PI System and the greater technology landscape

## Asset Health

Introduction to asset monitoring & CBM with the PI System

## Process Optimization

Intro to process optimization & analytics with the PI System

## Tools for Visualization

Introduction to visualizing data with the PI System

# Equipment failures

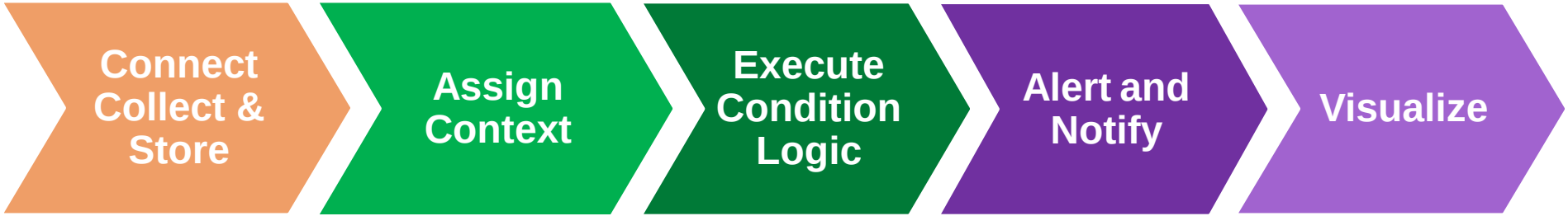
© Modern Pumping Today

https://sites.google.com/site/metropolitanforensics/cause-and-contributing-factors-of-failure-of-wind-turbines

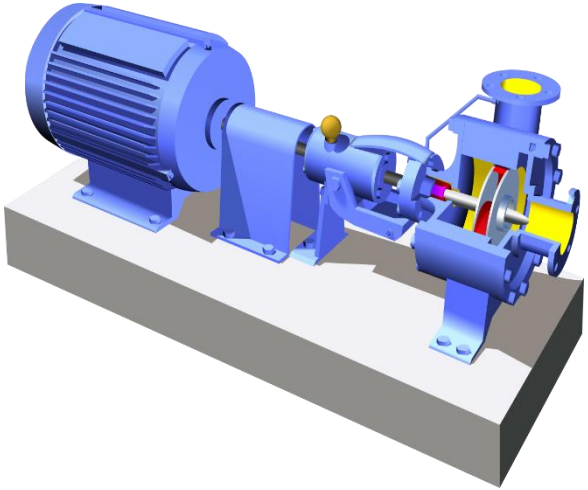
© Michael Sheffielt

Alphaspirit © 123rf.com

# How do we do it?

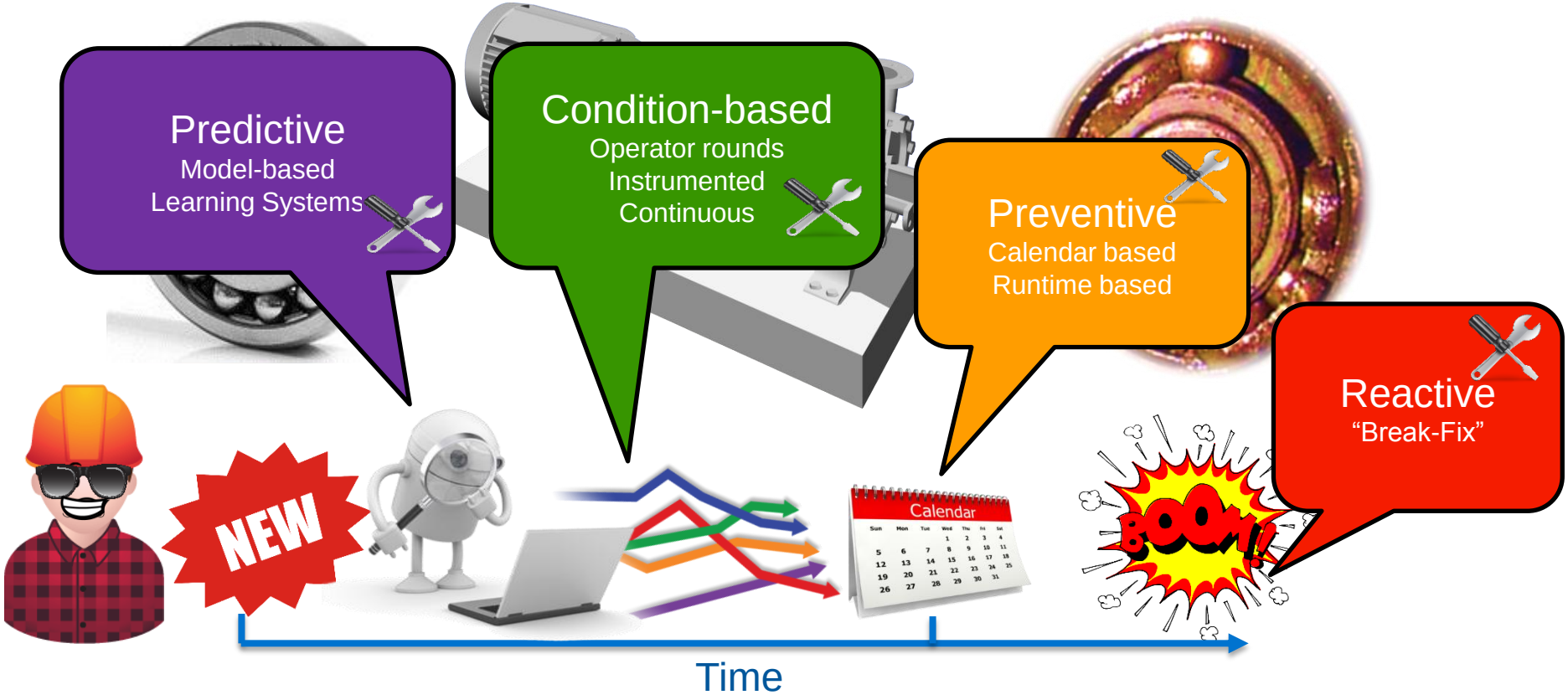


# Asset Monitoring and Maintenance Strategies

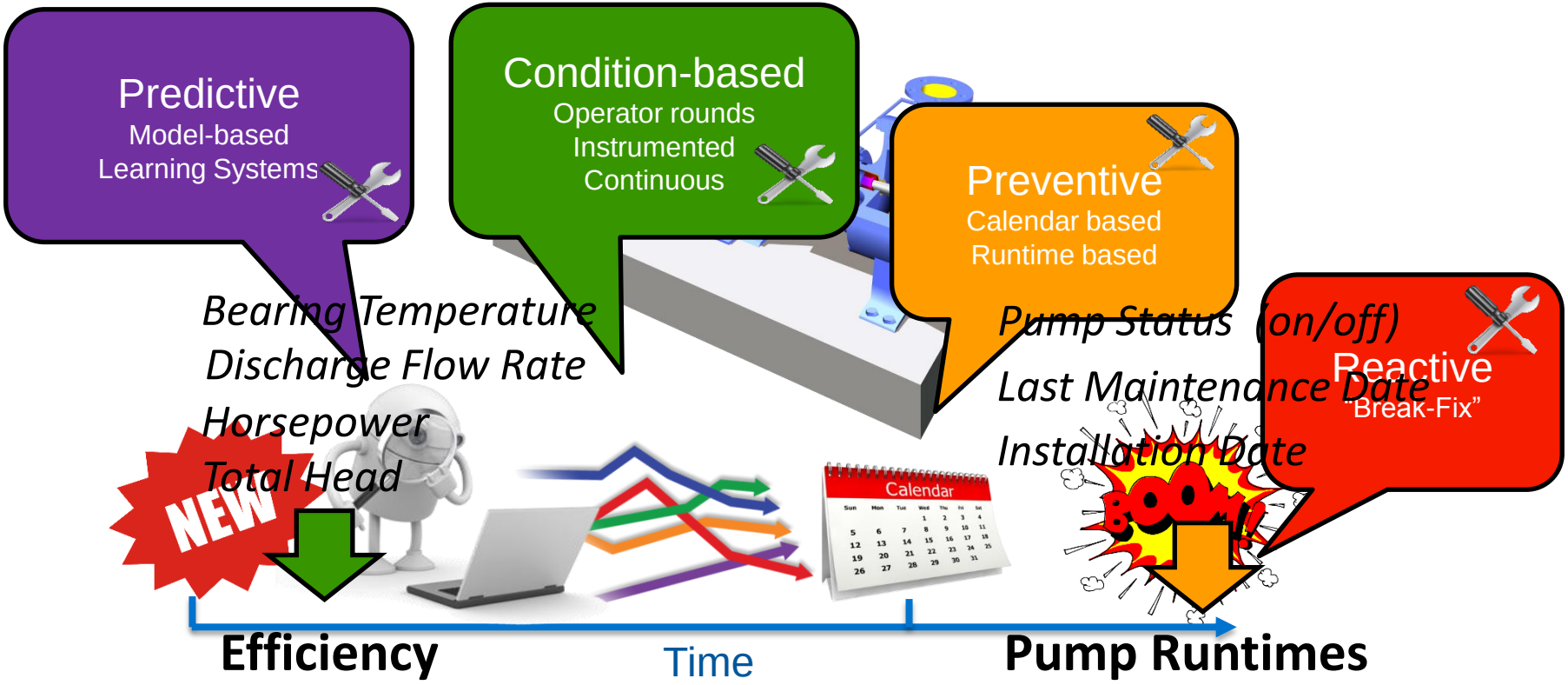



Time

# Asset Monitoring and Maintenance Strategies



# Asset Monitoring and Maintenance for Pumps



# 5 Steps of CBM


PI Interfaces
PI Connectors

Collect

PI Server
- Data Archive
- Asset Framework
- Asset Analytics
- Event Frames

Manage & Enhance

PI Vision
PI DataLink
PI ProcessBook
Notifications

Deliver

# Connect, Collect and Store

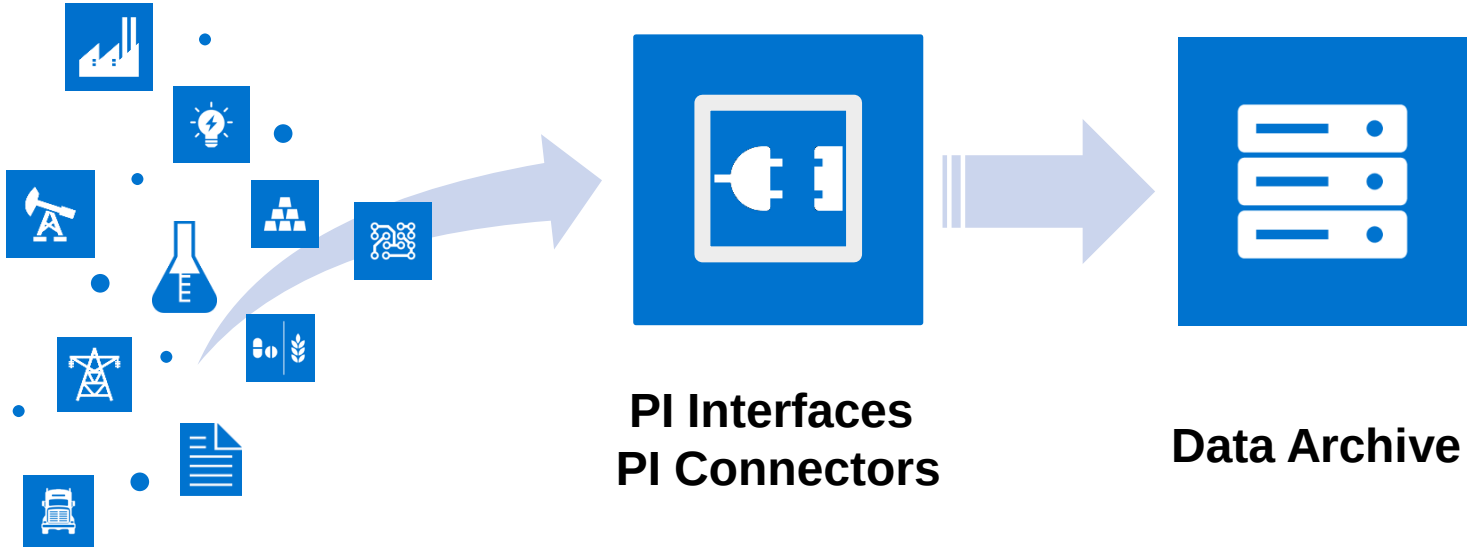
Connect
Collect & Store

Assign Context

Execute
Condition Logic

Alert and Notify

Visualize



**PI Interfaces**
**PI Connectors**

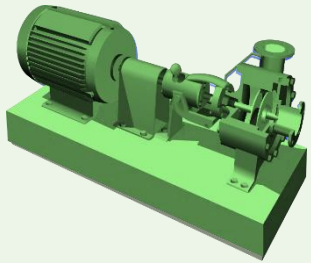
**Data Archive**

# Assign Context – the simplicity of AF

Connect Collect & Store | **Assign Context** | Execute Condition Logic | Alert and Notify | Visualize

**Element Template**

Pump

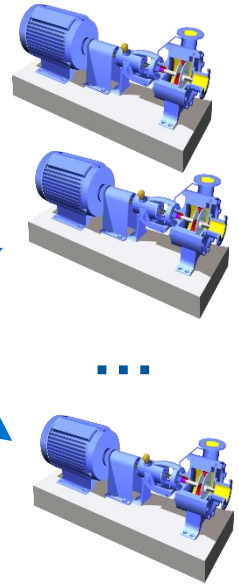


**Attributes**

- Pump Status
- Last Maintenance Date
- Installation Date
- Bearing Temperature
- Discharge Flow Rate
- Horsepower
- Total Head

**Calculations with Asset Analytics**

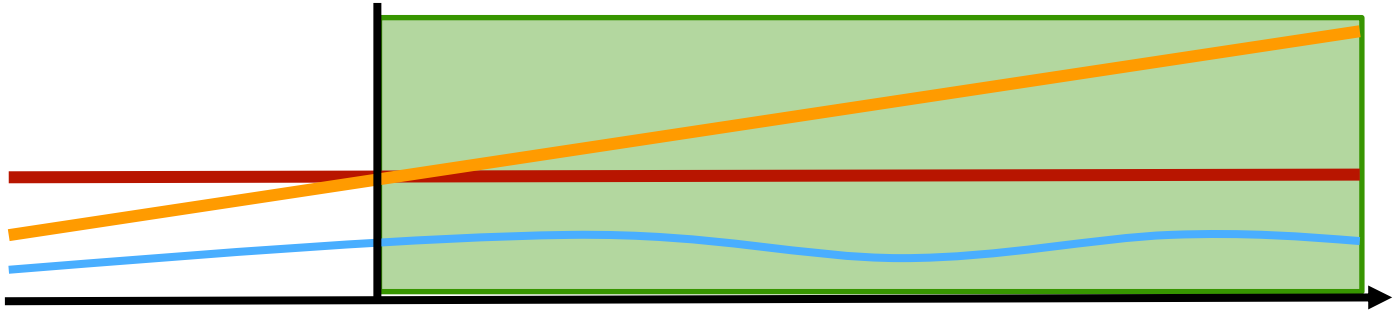
- Pump Runtimes (or)
- Number of Starts (or)
- Efficiency (or)



# Execute Condition Logic

Connect Collect & Store | Assign Context | **Execute Condition Logic** | Alert and Notify | Visualize

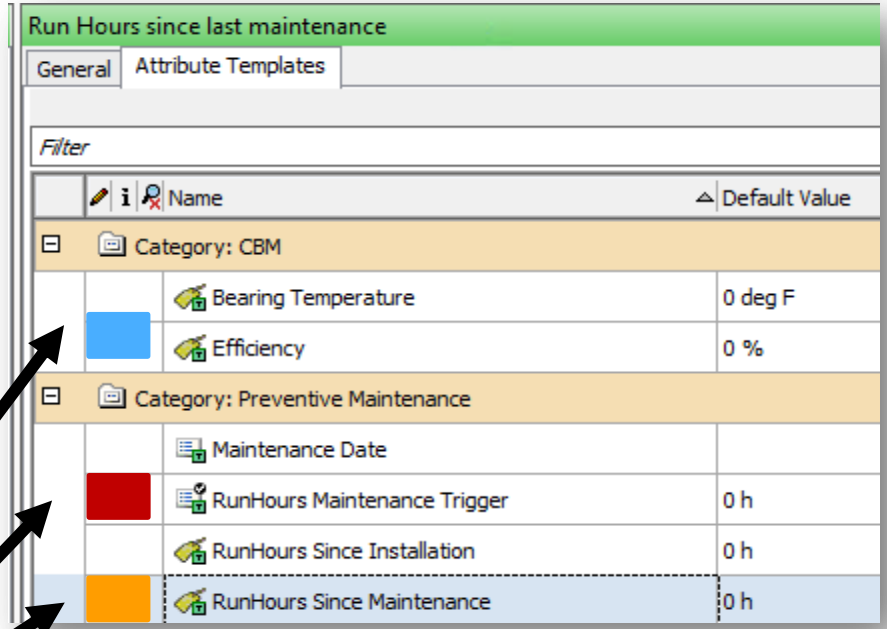
**Run Hours Since Last Maintenance > Run Hours Maintenance Trigger**

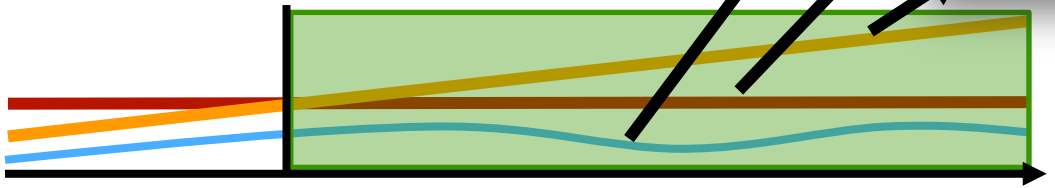


**PI Event Frames**

# Execute Condition Logic

**Event Frame template - what to monitor ?**



# Execute Condition Logic

Analysis Type: Expression Rollup Event Frame Generation SQC

Event Frame Template: Run Hours since last maintenance

Evaluate

| Name | Expression | True for | Severity | Value at Evaluatio | Value at Last Trig |
|---|---|---|---|---|---|
| Start triggers | | | | | |
| StartTrigger1 | if 'RunHours Since Maintenance'> | Set (optional) | None | | |

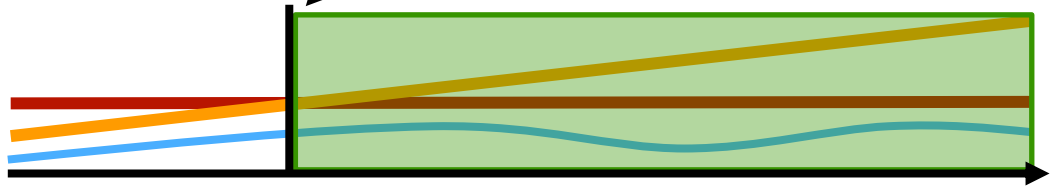
```
if 'RunHours Since Maintenance'>'RunHours Since Installation|RunHours Maintenance Trigger'
then TRUE else FALSE
```

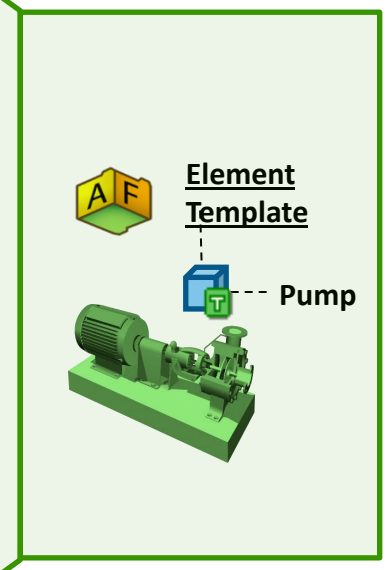
Add a new variable Add a new start trigger

Advanced Event Frame Settings...

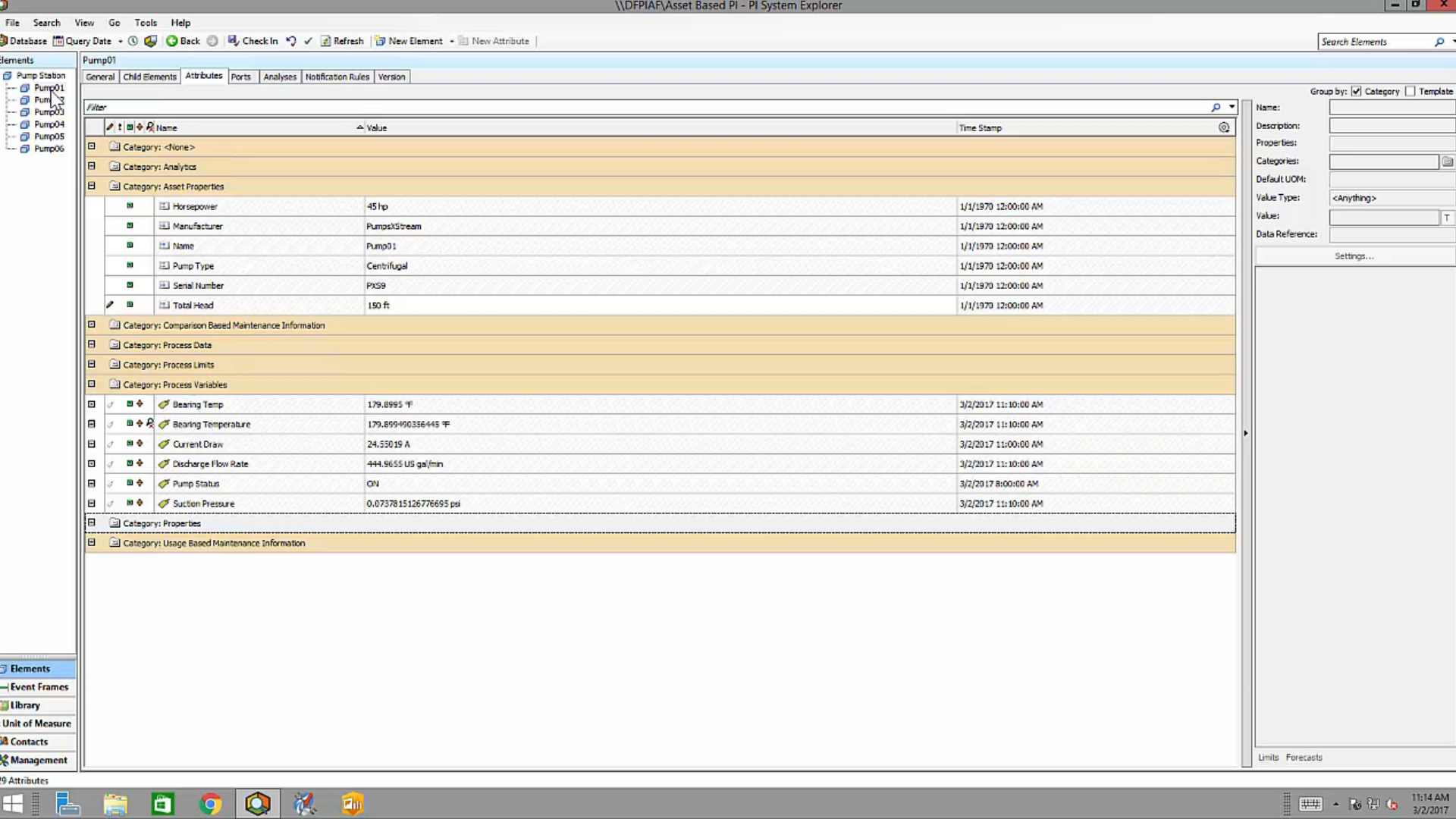
Scheduling: Event-Triggered Periodic

Trigger on Any Input






**AF Analysis – when to trigger?**


\\DFPIAF\Asset Based PI - PI System Explorer
File Search View Go Tools Help
Database Query Date Back Check In Refresh New Element New Attribute
Search Elements
Elements
Pump Station
Pump01
Pump02
Pump03
Pump04
Pump05
Pump06
Pump01
General Child Elements Attributes Ports Analyses Notification Rules Version
Group by: Category Template
Filter
Name Value Time Stamp
Category: <None>
Category: Analytics
Category: Asset Properties
Horsepower 45 hp 1/1/1970 12:00:00 AM
Manufacturer PumpsXStream 1/1/1970 12:00:00 AM
Name Pump01 1/1/1970 12:00:00 AM
Pump Type Centrifugal 1/1/1970 12:00:00 AM
Serial Number PXS9 1/1/1970 12:00:00 AM
Total Head 150 ft 1/1/1970 12:00:00 AM
Category: Comparison Based Maintenance Information
Category: Process Data
Category: Process Limits
Category: Process Variables
Bearing Temp 179.8995 °F 3/2/2017 11:10:00 AM
Bearing Temperature 179.899490356445 °F 3/2/2017 11:10:00 AM
Current Draw 24.55019 A 3/2/2017 11:00:00 AM
Discharge Flow Rate 444.9655 US gal/min 3/2/2017 11:10:00 AM
Pump Status ON 3/2/2017 8:00:00 AM
Suction Pressure 0.0737815126776695 psi 3/2/2017 11:10:00 AM
Category: Properties
Category: Usage Based Maintenance Information
Name:
Description:
Properties:
Categories:
Default UOM:
Value Type: <Anything>
Value:
Data Reference:
Settings...
Limits Forecasts
Elements
Event Frames
Library
Unit of Measure
Contacts
Management
9 Attributes
11:14 AM
3/2/2017

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All Places > All Things PI - Ask, Discuss, Connect

# Asset Based PI Example Kits

https://pisquare.osisoft.com/all-things-pi/asset-based-pi-example-kits

er your questions here and we'll address them throughout our sess

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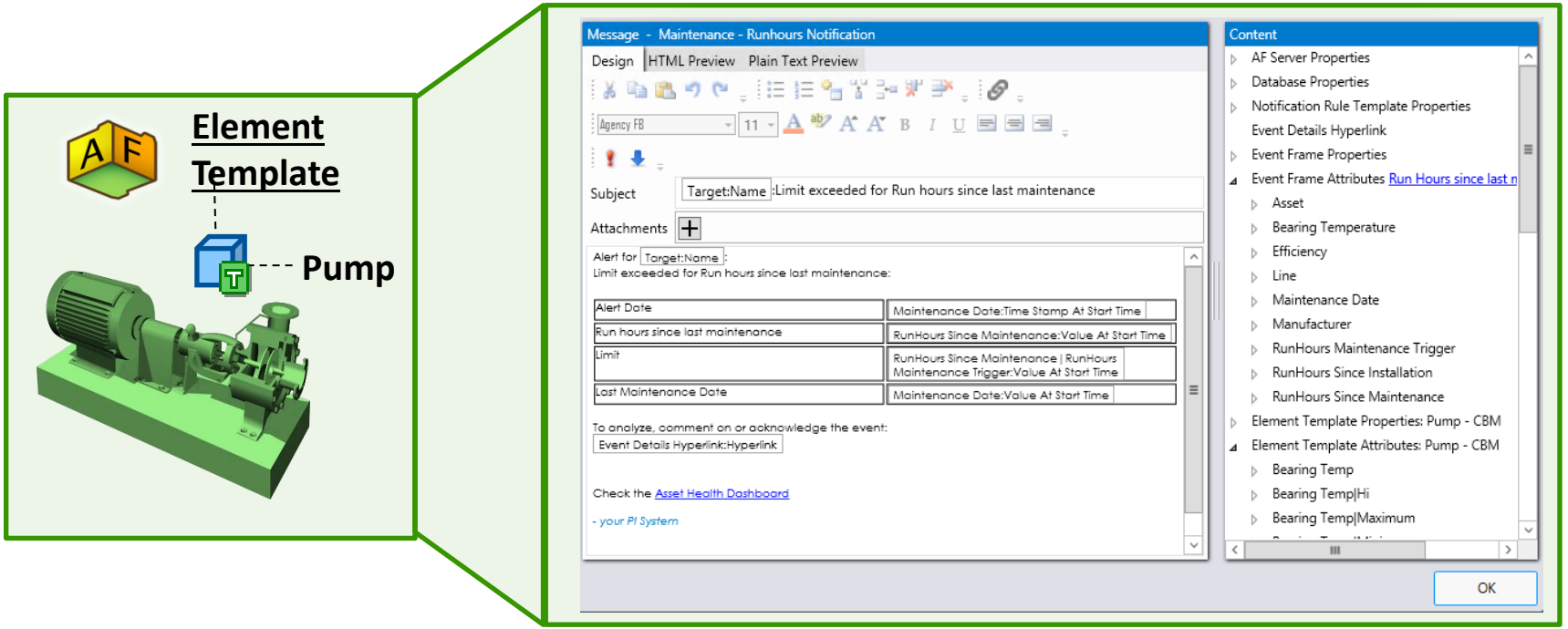
# Alert and Notify

Connect Collect & Store | Assign Context | Execute Condition Logic | **Alert and Notify** | Visualize

# Alert and Notify

## PI Notification



# Visualize

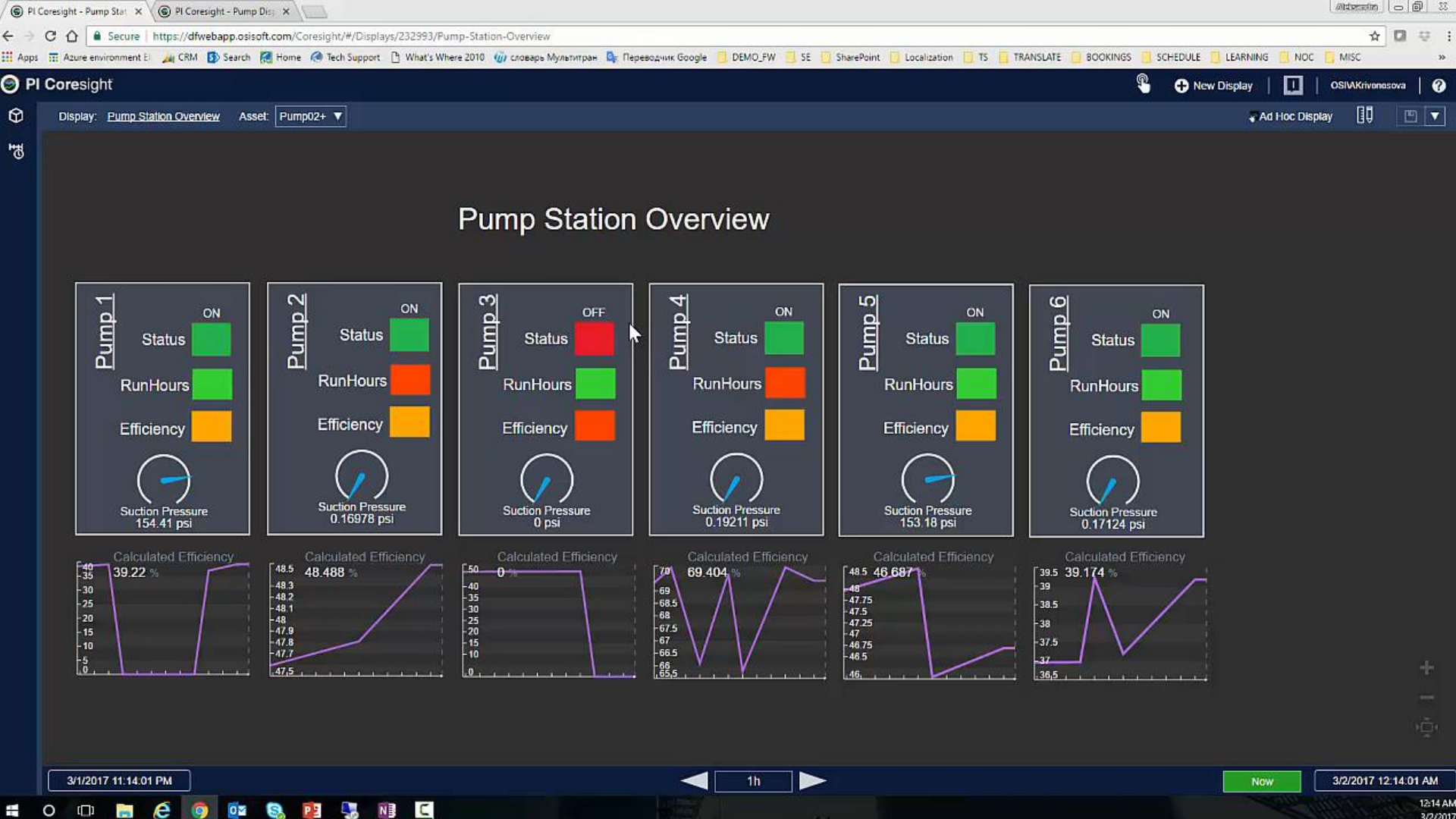
Connect Collect & Store → Assign Context → Execute Condition Logic → Alert and Notify → **Visualize**

**PI DataLink**

**PI ProcessBook**

**PI Vision**

**Esri Map**


PI Coresight - Pump Stat
PI Coresight - Pump Dis
Secure
https://dfwebapp.osisoft.com/Coresight/#/Displays/232993/Pump-Station-Overview
Apps
Azure environment E
CRM
Search
Home
Tech Support
What's Where 2010
словарь Мультитран
Переводчик Google
DEMO_FW
SE
SharePoint
Localization
TS
TRANSLATE
BOOKINGS
SCHEDULE
LEARNING
NOC
MISC
PI Coresight
New Display
OSIVAKrivonosova
Display:
Pump Station Overview
Asset:
Pump02+
Ad Hoc Display
Pump Station Overview
Pump 1
ON
Status
RunHours
Efficiency
Suction Pressure
154.41 psi
Pump 2
ON
Status
RunHours
Efficiency
Suction Pressure
0.16978 psi
Pump 3
OFF
Status
RunHours
Efficiency
Suction Pressure
0 psi
Pump 4
ON
Status
RunHours
Efficiency
Suction Pressure
0.19211 psi
Pump 5
ON
Status
RunHours
Efficiency
Suction Pressure
153.18 psi
Pump 6
ON
Status
RunHours
Efficiency
Suction Pressure
0.17124 psi
Calculated Efficiency
39.22 %
Calculated Efficiency
48.488 %
Calculated Efficiency
0 %
Calculated Efficiency
69.404 %
Calculated Efficiency
46.687 %
Calculated Efficiency
39.174 %
3/1/2017 11:14:01 PM
1h
Now
3/2/2017 12:14:01 AM
12:14 AM

# 5 Steps of CBM


PI Interfaces
PI Connectors

PI Server
- Data Archive
- Asset Framework
- Asset Analytics
- Event Frames

PI Vision
PI DataLink
PI ProcessBook
Notifications

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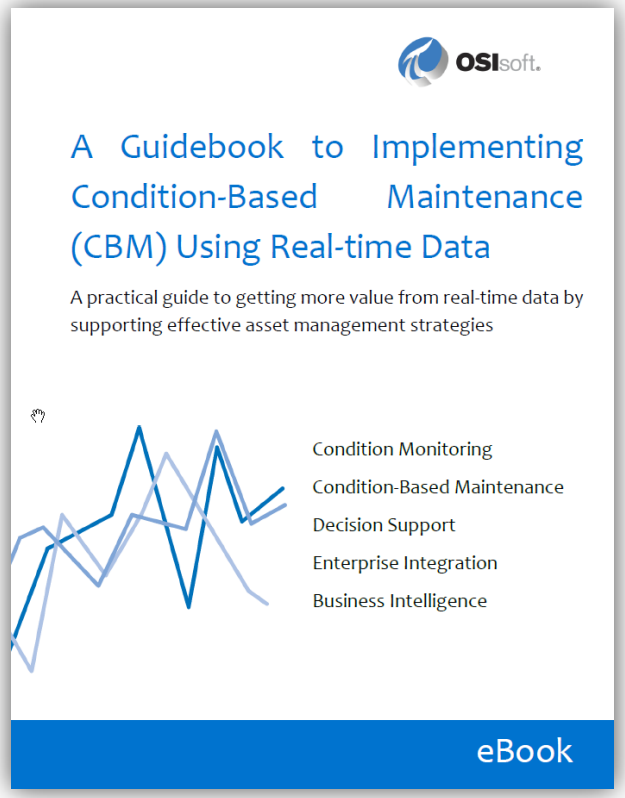
# Asset Based PI Example Kits

https://pisquare.osisoft.com/all-things-pi/asset-based-pi-example-kits

# CBM Prescriptive Guidance




- Enabling Condition Based Maintenance (CBM) Online Course
- CBM Guidebook
  https://pisquare.osisoft.com/community/Learn-PI/enabling-condition-based-maintenance
- Enabling CBM in Power Generation with the PI System
  http://www.osisoft.com/corporate/power-cbm/

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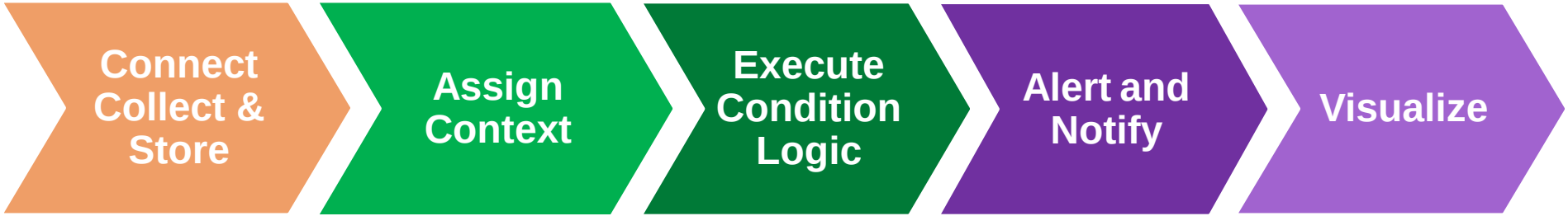
# More about the products

# Products and Components Used



# Products and Components Used

# Day 3 – PI Interfaces & PI Connectors

| Room | Time | Title |
|---|---|---|
| Arora 17 | 11:15 | Connectivity from A to Z - Roadmap for PI Connectors and PI Interfaces |
| Arora 16 | 14:30 | Data Collection at the Edge - OSIsoft Message Format |
| Arora 17 | 15:25 | Pervasive Data Collection for Industry 4.0 |

# Day 3 – PI Server and its Components

| Room | Time | Title |
|---|---|---|
| Arora 11 | 10:10 | Enterprise PI System Deployment: Rapidly adopting Asset Framework |
| Arora 11 | 11:15 | PI Server 2017 |
| Arora 11 | 14:30 | Best Practices for Implementing PI AF - Customer Testimonials |

# Day 3 – PI Integrators and PI Vision

| Room | Time | Title |
|---|---|---|
| Arora 17 | 12:15 | Streaming Analytics, Data Lakes and PI Integrators |
| Arora 11 | 12:15 | PI Vision 2017 |

# More from our customers

# O&G Customer Presentations at UC London 2017

| Room | Time | Company | Title |
|---|---|---|---|
| Arora 15 | 9:45 | TransCanada | How TransCanada uses SQC Analytics in AF to build and grow their Enterprise Anomaly |
| Arora 15 | 10:30 | Abu Dhabi Company for Onshore Petroleum Operations Ltd | Improving Equipment Reliability and Availability through Real-time Data |
| Arora 15 | 14:30 | PETRONAS Carigali Sdn. Bhd | PETRONAS Rotating Equipment Analytics |

# Other Customer Presentations at UC London 2017

| Room | Time | Company | Title |
|---|---|---|---|
| Arora 11 | 09:45 | EDF | EDF eMonitoring for Thermal Power Plants |
| Arora 17 | 09:45 | TransCanada | Going Long: Enabling Expansion of TransCanada’s Enterprise Analytics Program |
| Arcadia 1 | 10:30 | MPWiK Wroclaw | Wroclaw Water and Sewage Authority's (MPWiK's) OT - IT convergence |

# Other Customer Presentations at UC London 2017

| Room | Time | Company | Title |
|---|---|---|---|
| Catty Sark | 10:30 | SUBNET Solutions | Data Concentration for 6,000 Distribution Devices to Facilitate Asset Optimization with the PI System |
| Arcadia 2 | 11:15 | SNCF RÉSEAU | Using Operational Data for the Future Maintenance of the French Rail Infrastructure |
| Arcadia 1 | 15:15 | Klabin/IHM Engenharia | Puma Project: Transforming Data to Information for Operational Intelligence |

# Customer Examples


Chemicals


Mining, Metallurgy & Materials


Oil & Gas


Pharmaceutical& Life Science


Pulp & Paper


Power Generation


Transmission & Distribution


Other

## Have an idea how to improve our products?

## OSIsoft wants to hear from you!

https://feedback.osisoft.com/

# Contact Information

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Product Marketing Manager
OSIsoft LLC

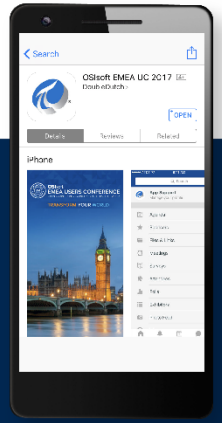
# Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

# Please remember to…

Complete the Online Survey for this session

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감사합니다

Danke

谢谢

Merci

Gracias

# Thank You

ありがとう

Спасибо

Obrigado

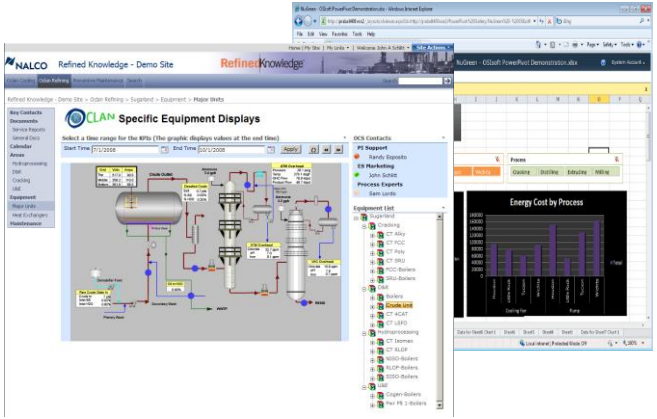
# Appendix

# Nalco: Knowledge Platform

CHEMICALS & PETROCHEMICALS

The Nalco Refined Knowledge offering combines the best of the three industry leaders:

- OSIsoft's Operational Infrastructure
- SharePoint and PI System
- Nalco as the Solutions Provider




**John Schlitt - Business Manager**

**Automation COE, Nalco**

## Customer Business Challenge

- Process data held in various "islands of information"
- Performance data was collectedly manually
- Personal Service Reports (PSRs) were time-consuming
- The goal: centralize data collection to bring greater value to the service Nalco provides

## Solution

Used OSIsoft's Operational Infrastructure

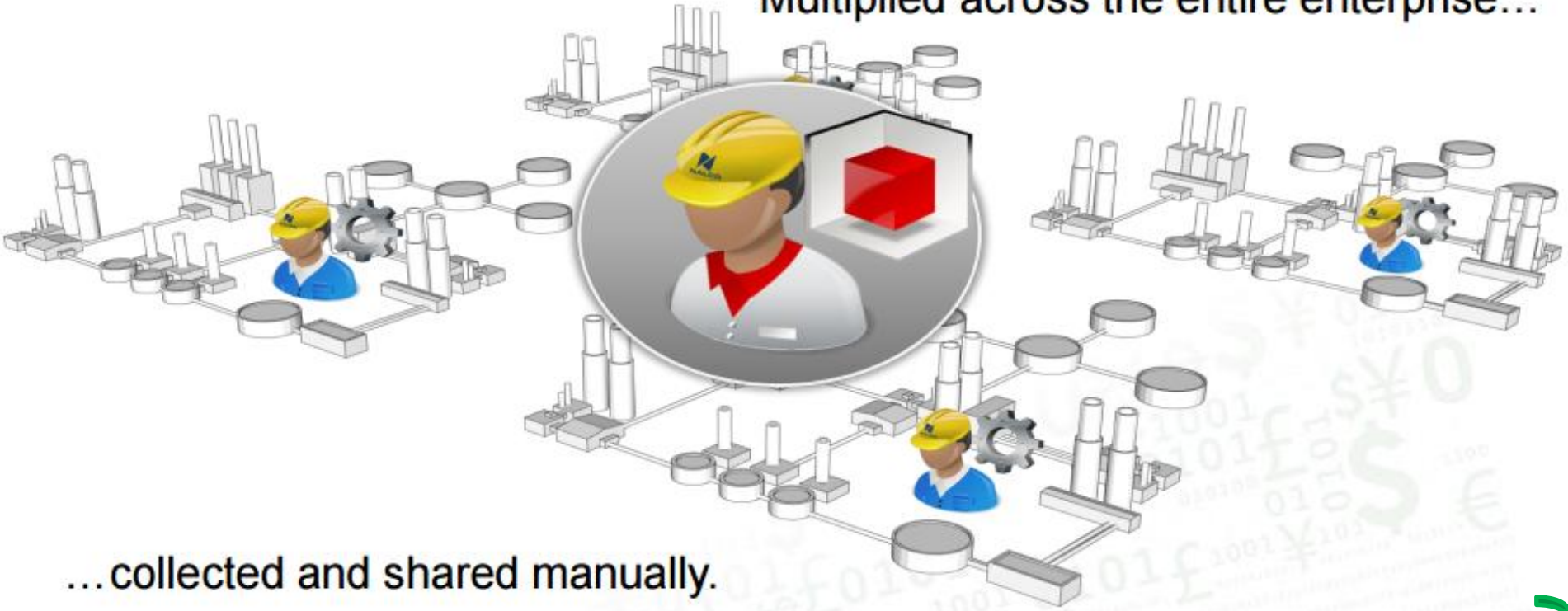
- Central Data Collection
- Tech View & Analysis
- Calculation Engine
- Value Generation Tool
- PI Notifications/OCS = real-time alerting

## Customer Results / Benefits

- Centralized data collection
- Condition based maintenance and performance optimization
- Role-based visibility into plant operations and performance
- On-demand Summary and KPI info to customers and Nalco
- Actionable data now at customer's fingertips

# Challenge: Islands of Information

Multiplied across the entire enterprise…

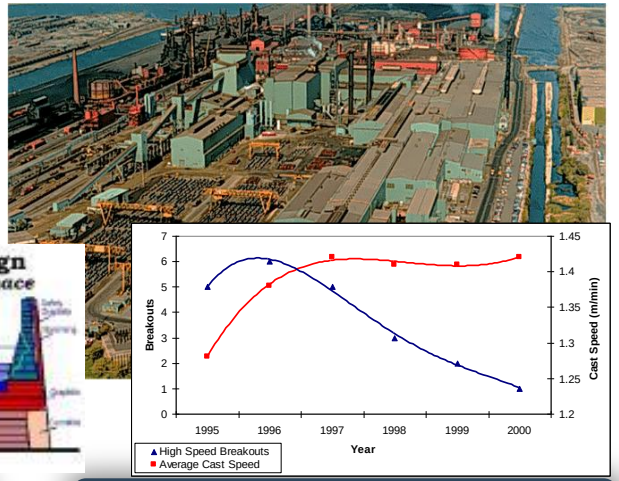


…collected and shared manually.

# Arcelor Mittal -Dofasco: From Repair Mode to Operational Failure

MATERIALS, MINES, METALS & METALLURGY

*"We're using OSIsoft's PI System platform to change the maintenance culture from Repair mode to Operational Failure. We have increased Average Equipment Availability from 78% to 91 %. We have increase the proactive maintenance of equipment from 30% to 70%."*
***Vlad Juric**, **Arcelor Mittal**, Hamilton*




## Customer Business Challenge

- Plant floor and business users needed one version of the truth for all facets of Steel Mill operations
- Needed real-time Data for alarming to monitor equipment status and quality
- Needed automatically generated maintenance notifications into Dofasco CMM.
- Needed to reduce caster break outs due to nonlinear nature of the process.

## Solution

- Implemented the PI System as real time data historian and analytical engine and visualization.
- Implemented connectivity to Dofasco CMMS or automated work order creation
- Implemented data analysis strategy to identify best operation pattern and alert when the pattern changed from normal.

## Customer Results / Benefits

- Increase Equipment Availability from 78% to 91%.
- Extend Life Cycle of all BFs more than 20 Years saving $ 19 millions in BFs campaigns.
- Statistical detection of hot spots improved BF hearth life.
- Reduction total energy consumption
- Users see profitability and growth historically and in real-time
- Increased Production
- Reduced caster breakouts from 7 to ZERO. Savings 2,5 million per year per caster.

http://www.osisoft.com/Presentations/Slab-Casting-Automation-%E2%80%93-Contextualize-Raw-Data-into-Operational-Intelligence/

# Business Challenge

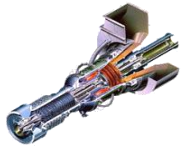
- Modelize Level 2 process in an **open** and **reliable** architecture driven by data and events.
- Empower **production** people to access all **system** data for process analytics and real-time decision making.
- **Control** the process events to define **the product quality**.

# Saved over 220K BOE in Lost Production in <6 months

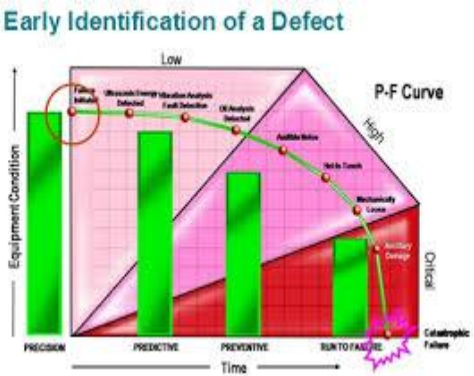
Talisman Sinopec

"A Management Process designed to **improve the reliability and integrity of rotating equipment** across all Talisman UK assets through effective monitoring & maintenance."

Sam Scott, Rotating Equipment Engineer



TALISMAN ENERGY




## CHALLENGES

- SME's work on shore, and while dedicated to improving production, struggle with seeing and monitoring the full operation of the equipment from different vendors
- Inability to capture and leverage knowledge of subject matter experts
- Inconsistency in analytics, visualization/KPIs, and reporting

## SOLUTION

Implemented a Rotating Equipment Excellence Program (REEP), leveraging a PI System-based solution called SPOTLIGHT to monitor their 2,900 pieces of critical rotating equipment

- SME's look at the operating envelope of the individual pieces of equipment to determine how to optimize and reduce failures
- Continuous monitoring of values against alarm limits

## RESULTS

Data is presented in a consistent manner across all equipment

- Reduced the amount of critical rotating equipment failures, saved about 220K BOE in 6 months
- Early detection of performance problems with equipment
- Reduced maintenance costs by >10%

http://www.osisoft.com/Presentations/Proactive-Critical-Rotating-Equipment-Monitoring-for-Upstream-Safety-and-Production-Operations/

# Business Challenge

## Safety Critical Equipment

- 39 Diesel Drive Fire Pumps
- 6 Electric Drive Fire Pumps
- 8 Hydraulic drive fire pumps
- 15 Emergency Power Generation Packages
- 26 Bilge / Ballast Pumps
- 53 Other Safety Critical Pumps

## Production Critical Equipment

- 56 Gas Turbines
- 40 Gas Compressors
- 9 Diesel Engines for Main Power Generation
- 27 Main Water Injection, P.W. & Artificial Lift Pumps
- 35 Main Oil Line Pumps
- Circa 2711

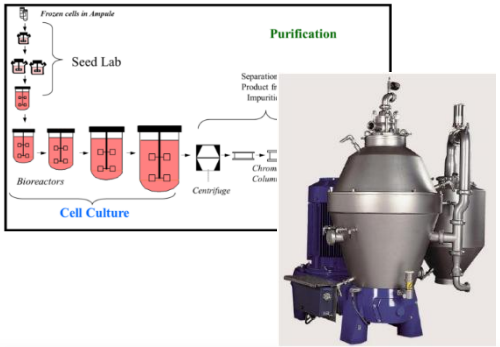
A total of 2831 pieces of Major Rotating Equipment

# Genentech: Summary Statistics Analysis

*Considered the **founder of the biotechnology industry**, Genentech has been delivering on the promise of biotechnology for more than 30 years, using human genetic information to discover, develop, manufacture and commercialize medicines to treat patients with serious or life-threatening medical conditions.*


Presentation by **Craig William Taylor**
**Sr. Data Systems Engineer**
**Genentech, Inc** *(A Member of the Roche Group)*


Genentech
*A Member of the Roche Group*




## Customer Business Challenge

- Need to organize data so that it's 'Analysis Ready'
- Want enhanced process understanding (multivariate analysis)
- Standardize complex calculations
- Enable flagging and commenting of significant operational excursions or anomalies

## Solution

- Implementation and Testing of the PI System in stages.
- Defining individual summary statistics.
- Coding summary statistics and going through the PI SDK to reach data.

## Customer Results / Benefits

- Gained better process understanding and defined causes for abnormal process behavior
- System saves engineering time and allows for efficient process monitoring for each process step
- Increased our staffs depth of knowledge
- Without the PI System, our staff would not be reviewing these detailed summary statistics during normal process monitoring

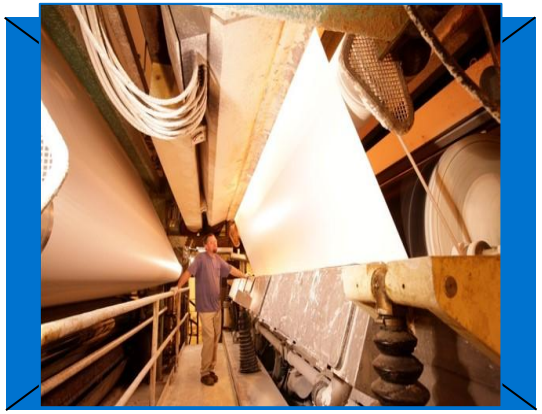
# Summary Statistic Example 1: Filter Fouling Issue

## Centrifuge Unit Effect:

- An investigation into the differences observed between our 2 different centrifuges revealed equipment was piped slightly differently
- The piping difference allowed increased water to enter the system diluting the centrate, contributing to filter fouling in both the centrifuge and chromatography process steps
- This understanding allows engineers to correct the process and reduce filter fouling

http://www.osisoft.com/Presentations/Enabling-Manufacturing-Summary-Statistics-Analysis-Using-the-PI-System/

# Achieving an Enterprise View of Asset Efficiency with Asset Framework



## COMPANY and GOAL

Clearwater Paper is a young company made up of mills who developed their own operational reporting. It wanted to find a way to standardize Enterprise OEE reporting, across all sites, based on real-time data.

## CHALLENGE

A myriad of different systems and pre-existing OEE reports made an “apples to apples” comparison between sites impossible.

- In many cases real-time data was not recorded for Clearwater’s converting assets.

## SOLUTION

Standardize on a system that makes use of PI System data to detect downtime events. Use the PI System to tie the data together.

- New OPC interfaces to pull in real-time data.
- Asset Framework to build the enterprise hierarchy
- PI OLEDB Enterprise to feed the data to BI tools.

## RESULTS

For the first time Clearwater is able to measure the performance of all its assets using identical metrics.

- OEE baselines established.
- Performance goals based on this solution.
- Data sets actively being used by several Six Sigma projects

# The Challenges

- Between 2012 and 2014 most mills had already developed location specific OEE metrics
- There were 5 distinct systems in use for recording downtime
- Only 4 mills used real-time data for OEE, most relied on manual entry, after the fact
- Less than 10% of Clearwater's Converting assets were hooked into a historian
- Change in project sponsorship halfway through

http://www.osisoft.com/Presentations/Asset-Framework-Ties-Together-Enterprise-OEE/

UniEnergy Technologies

# UniEnergy Technologies: Actionable Health and Performance Parameters


## Business Challenges

A. Remote monitoring for long-term health and performance

B. Minimize service costs by predicting service needs

C. Ensure contractual performance compliance

D. Design, operations, and marketing direction

## Solution

A. Implement PI System – Notifications and PI DataLink reports for automated alerts to low, medium, and high priority issues

B. Automate monitoring and response

C. Automate asset utilization and performance reports.

D. Facilitate management feedback

## Results and Benefits

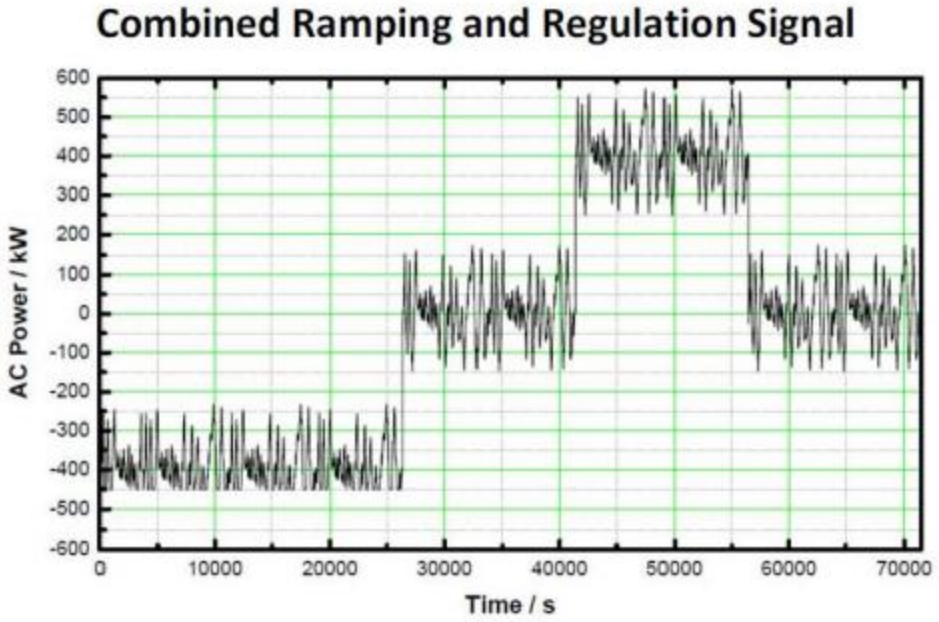
A. Publish six weekly health reports for each 0.5MW/ 2MWh battery, and issue alerts for higher priority items

B. Offer 12 PI Vision displays for in-depth analysis for efficient in-depth study

C. Improved service resu!ts at a lower cost

# Uni.System – 4 Hour Integrated AC Battery

- Energy Battery with Power Battery Capabilities
- Prime Applications
  - Micro-Grids especially for renewable integration
  - Transmission or Generation Deferral
  - Peak Shaving
  - Layered Applications
    - Backup Power
    - Frequency Regulation



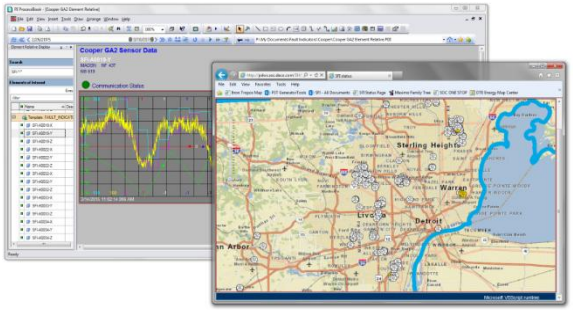

http://www.osisoft.com/Presentations/Monitoring-Health-and-Performance-of-MW-Scale-Battery-Installations/

# DTE Energy: Reliability Through Innovation

"As an innovative utility, we were looking for solutions to get more real-time reliability data out of our distribution grid, particularly on older legacy and poorly performing circuits."

"Now that we have better real-time visibility into our grid, we can safely restore power faster and better plan our capital investments around aging assets before they cause outages."

Vince Dow
Vice President, Distribution Operations, DTE Energy




## Business Challenges

- Determining where to send crews during outages to minimize patrol time
- Integrating data from different types of sensors with multiple backend systems
- Allow crews to visualize real-time sensor data in the field and engineers to visualize historical data in the office

## Solution(s)

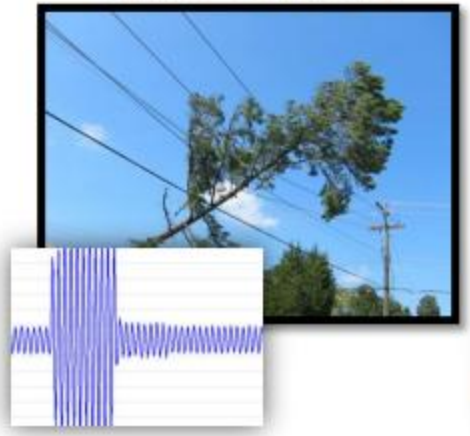
- Feed all sensor data into PI System using PI Interface for DNP3
- Utilize Asset Framework and Notifications to push events to field and DMS
- PI Vision and PI ProcessBook to visualize historical data
- Utilize PI integrator for Esri ArcGIS

## Results and Benefits

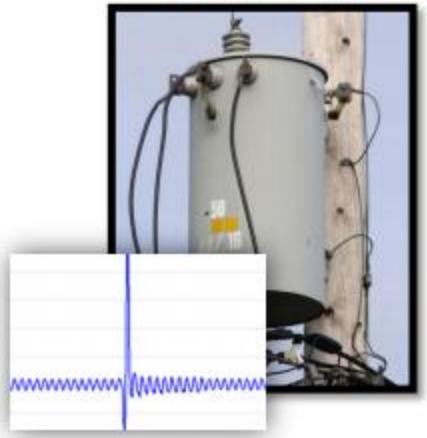
- Visualization of sensor status on circuit map allows crews to divide circuit into segments and narrow search for faults. Expecting to eliminate at least 500k customer outage minutes annually
- History of device operation and circuit data gives valuable visibility into legacy parts of the system. Savings estimated at $25k per circuit.

# Fault Locating

## Wire Contact

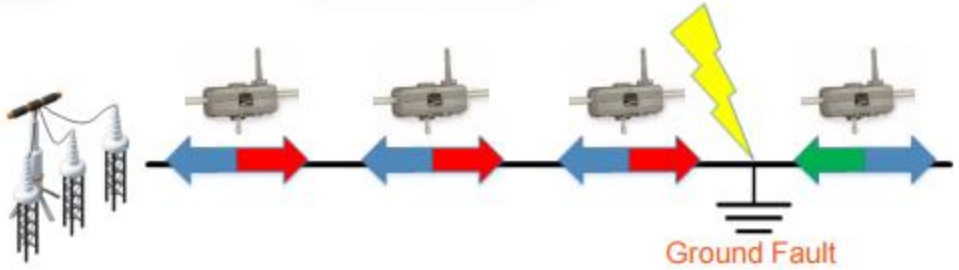


## Failing Pole Top Transformer



## Failing Underground Cable

Minimizing patrol distances can improve restore time




http://www.osisoft.com/Presentations/Distribution-Fault-Location-with-PI-at-DTE/

# Condition Monitoring

## Marathon Petroleum

Continually looking for ways to **increase supply chain awareness** and **reduce operating costs**.

### CHALLENGES

Shore-side staff lacked visibility into their marine assets to ensure consistent product flow.

- Slow reaction time to unplanned events
- The volume and diversity of maritime data sources was hard to integrate
- Marine assets are mobile

### SOLUTION

Remote monitoring collects marine asset data and transmits to central support offices for analysis and recommendations.

- Real-time visibility into events
- Connected to a wide range of sources on diverse fleet
- Securely connected wireless with no data loss

### RESULTS

Reduced repair and service costs across the entire fleet.

- Improved on-time arrival performance
- Reduced unplanned down time
- Shared data improved communication and scheduling

# Marine

- Large private inland petroleum products barge fleet
- Operations include 18 owned/leased inland waterway towboats and 184 owned and 16 leased barges
- Charters additional equipment for brown and blue water movements
- Transports crude, light products, ethanol, feedstocks, and other specialty chemicals

# Business Challenge / Project Overview

- Condition Based Monitoring:
  - This effort is expected to reduce extended downtime of equipment due to equipment failure, reduce costs for failure by having better information available, increase mechanical availability, enable a safer working environment, and improve efficiency of the Marine work force.

- Project Scope
  - Marine vessels
    - Engines
    - Gears
    - Generators
    - Steering
    - Ship Service
    - Tank Alarms
  - Marine Repair Facility
    - Waste Water Treatment Plant
    - Thermal Oxidizer
    - Maintenance Float
    - Tank Farm
    - Boiler house

http://www.osisoft.com/Presentations/Marine-Fleet-Condition-Based-Monitoring-@-Marathon-Petroleum-Company/

# Fleet Condition-Monitoring

Large Latin American Freight Railway

Goal to reduce operations and maintenance costs on their mixed manufacture (GE, Siemens, EMD) fleet of 700 locomotives.

## CHALLENGES

Lacked the network and systems to continually collect data from fleet in the field.

- Ability to provide consistent service across all locomotives
- Short Implementation timeline
- No additional infrastructure costs
- Support system expansions in the future.

## SOLUTION

Collected VR Data using Wi-Fi transfers into a real-time infrastructure supporting CMMS

- Used WAN connections at Signal Stations as hotspots
- Leveraged existing on-board VR data
- Unified data sets from all makes and models

## RESULTS

Completed transition to CBM within a year  expanding network to support streaming data

- Minimize Maintenance Costs
- Increase availability
- Provide consistent support across 700 locomotives