Moving Beyond the Spreadsheet

Use of PI AF to Standardize Calculations and Analysis

Stephen Reynolds
SunCoke Energy

Abstract

SunCoke Energy

- SunCoke Energy operates six sites in the US and Brazil for the conversion of metallurgical coal into metallurgical coke used in the manufacture of steel.
- The core technology used across the coke, steam, and power sections has remained consistent across the sites leading to common analytical concepts.
- However, people change, systems change, needs change. Analytical tools evolve. Variations begin.
- By using PI AF and Asset-Based Analytics, we begin to bring the calculations back to standard, automate repetitive system tasks, and allow our people more time for performance improvement rather than spreadsheet improvement.
- The PI System now feeds our Business Intelligence.

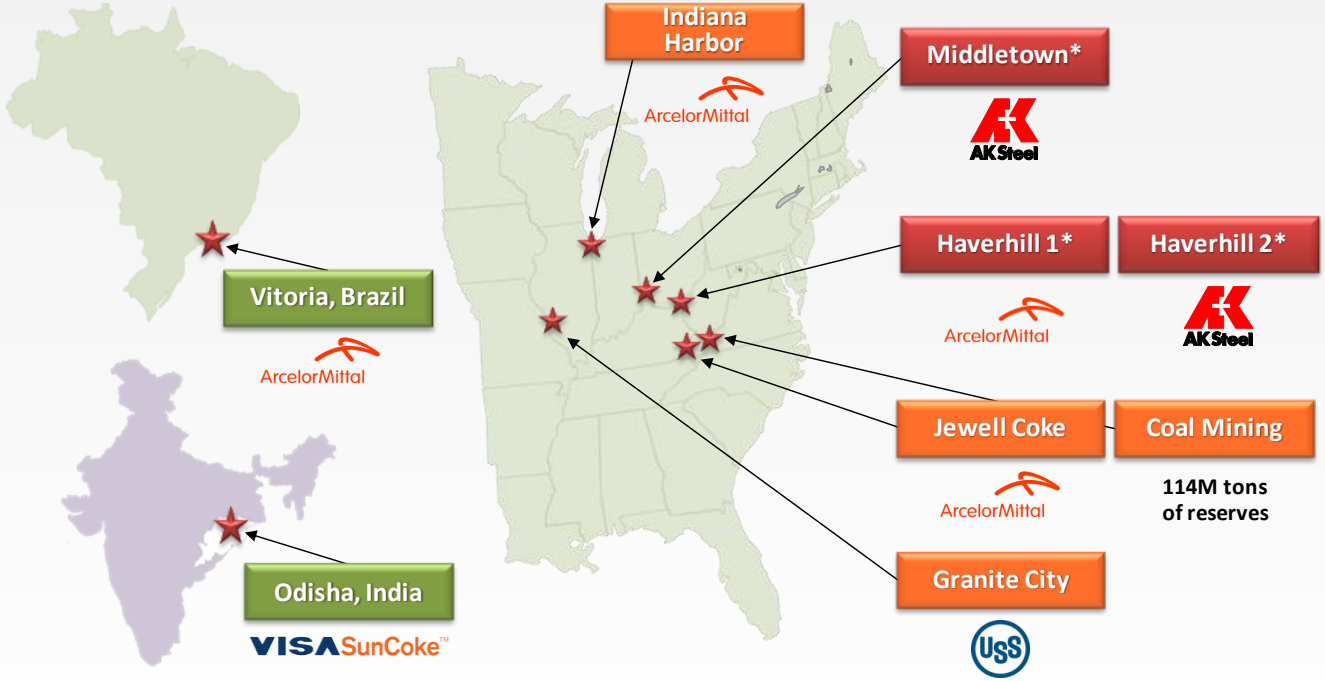
Topics

- SunCoke and the SunCoke Way
- Oven Inspections
- Maximo Work Order Interface
- Template Calculations
- Preparing for Business Intelligence

SunCoke Operations

SunCoke Energy

Our cokemaking operations are strategically located in proximity to our customers' integrated steelmaking facilities



*65% owned by SXCP

SunCoke History

SunCoke Energy

- 1960's – Jewell prototype oven design
- 1998 – First commercial expansion, Indiana Harbor, IN
- 2005 – Expansion with first internally owned process for steam generation, Haverhill, OH (HHO 1)
- 2007 – First international expansion with power generation, Vitoria ES, Brasil
- 2008 – Expansion with first domestic power generation, Haverhill, OH (HHO 2)
- 2009 – Expansion to Granite City, IL
- 2009 – SunCoke Way initiated to standardize operating processes and metrics
- 2011 – First start-up under the SunCoke Way, Middletown, OH
- 2012 – PI Enterprise Agreement established
- 2013 – Visa SunCoke partnership, Odisha, India (not included in PI System)

Coking and Heat Recovery

- Metallurgical coal mined and supplied to ovens
- Coal charged / coke pushed from ovens on 48 hr cycles
- Coke process operates at >2000 deg F (MACT)
- Flue gas processed in Heat Recovery Steam Generators (HRSG)
- High pressure steam supplied to customers or used to drive turbine generators
- Coke provides heat and structural support as well as reducing agent in blast furnace

The SunCoke Way

SunCoke Energy

The way we work, everyone, everyday, to continuously improve results.

Critical Processes

Safety and Environmental	Operational Control	Maintenance / Reliability	Quality Management	Asset Management

Critical Systems

Critical systems drive the work within each process. Each system defines the metrics, roles and responsibilities, reviews, events, and action plans to achieve success in the critical process.

Metrics	Identify key performance indicators to measure performance
Roles and Responsibilities	Identify roles and personnel accountable and responsible for results
Events	Define event and exception criteria to trigger analysis
Action Plans	Define and implement the improvement action plan
Sequential Review	Determine sequential review structure to drive communication and accountability

Organizational Capabilities — Develop skills and attributes required to execute critical systems and drive continuous improvement

System Tools — Used to implement and manage the SunCoke Way.

Oven Inspections

SunCoke Energy

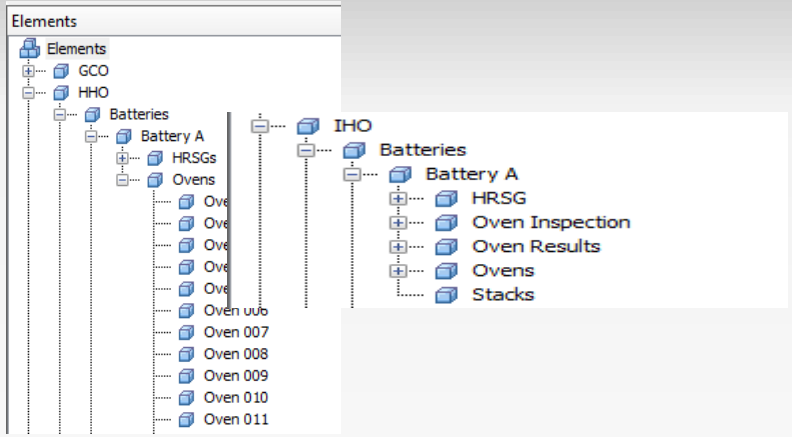
Problem Statement:

- Over 130 inspection points per oven
- Over 1000 ovens fleet wide
- Single corporate inspection team
- Inspections captured and communicated through extensive paperwork
- Inspections tied to performance data through oral history and complex spreadsheets
- How to quickly identify, prioritize, communicate required repairs?

Solution:

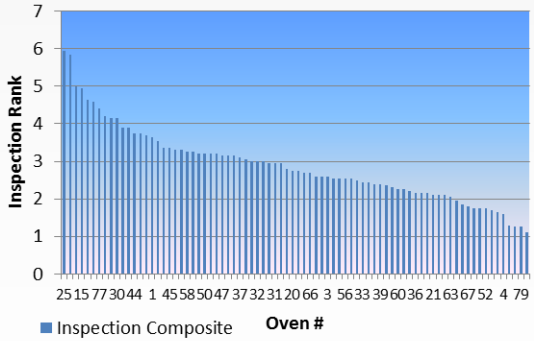
- Data captured using PI Manual Logger
- Context added through PI AF
- Visualization added through existing PI Visualization tools

Using PI AF

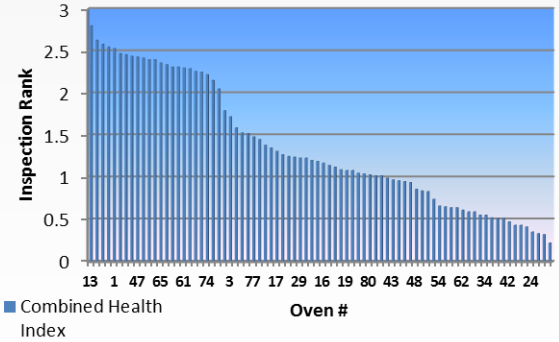


- Moving Inspections to Oven Templates in PI AF
- Combining inspection data with performance data for health index calculation and analysis
- Utilizing roll-up functionality of PI AF to prioritize sites, batteries, specific ovens.

Inspection Composite Only



Combined Health Index



Maximo Interface

SunCoke Energy

Problem Statement:

- Work orders are people driven.
- Preventative maintenance (PM) is calendar based.

Solution:

- PI can identify failures through instrument readings
- Equipment in-service time can be tracked
- PI Notifications can route to Maximo

Meter Based PM – Coal Crusher

SunCoke Energy

- PI Notifications sends PI data into Maximo via web service
- Triggers PM work orders based on machine run hours
- Reduces administrative steps in workflow
- Optimizes PM scheduled work

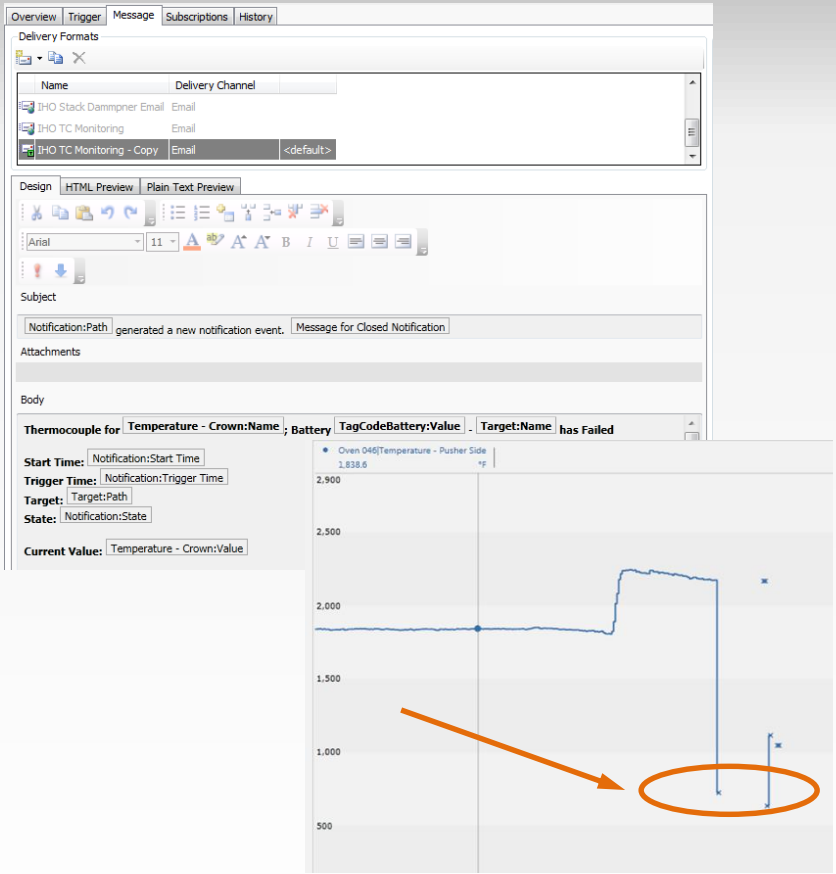
PM	Service Life (h)
Grease Feeders	400
Precision Grease Crusher Bearings	720
Inspect Breaker Plates	2200
Inspect Coupling	2200
Change Motor Bearing Oil	2200
Clean/Overhaul Motor	17000

PM	Description	Location	Loca
8668	GREASE CRUSHER FEEDER #1	FD-26-07	FEEDER¿#1
8669	GREASE CRUSHER FEEDER #2	FD-26-08	FEEDER¿#2
8670	GREASE CRUSHER BEARINGS #2	CU-2302	COAL CRUSHER #2
8671	GREASE CRUSHER BEARINGS #1	CU-2301	COAL CRUSHER #1
8672	INSPECT CRUSHER #1 & QTRLY CHECKS	CU-2301	COAL CRUSHER #1
8673	INSPECT CRUSHER #2 & QTRLY CHECKS	CU-2302	COAL CRUSHER #2
8674	CLEAN AND INSPECT CRUSHER MOTOR #1	MT-23-01	MOTOR, AC, CRUSHER #1
8675	CLEAN AND INSPECT CRUSHER MOTOR #2	MT-23-02	MOTOR, AC, CRUSHER #2

Select Records

Instrument Based WO - Thermocouples

- PI Notification triggers based on established conditions
- Eliminates “awareness” timing
- Interface checks for redundant WO’s and enters new WO’s as needed
- Utilizes standard WO description and job plan
- PI Notification timing allows plant first response



Template Calculations

SunCoke Energy

Problem Statement:

- Over 80% of our ovens have consistent instrumentation
- Over 90% of our steam and power equipment have consistent instrumentation
- Every plant has a different analysis

Solution:

- Utilize PI AF templates to push single analytical solutions

Current Solutions

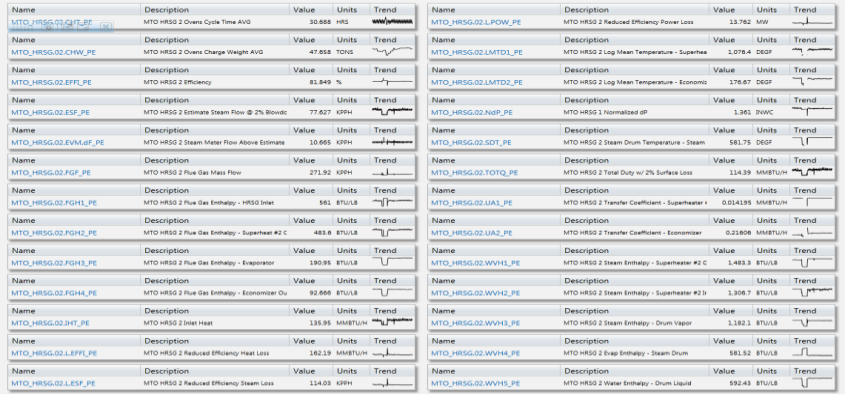
SunCoke Energy

Not To Exceed Limits	Analyze specific indicators for operating limit violations, count occurrences, roll up across hierarchy
Coking Rate	Analyze specific ovens for production rate using multiple data points, roll up across hierarchy
Oven Health Score	Combine oven performance with oven inspection, calculate for oven, roll up across hierarchy
HRSG Efficiency	Complete multiple mass / energy calculations to determine HRSG efficiencies and output, roll up across hierarchy
HRSG Leak Detection	Utilize water balance to calculate leak risk and trigger early notification
And Counting…	SunCoke is just beginning to scratch the surface

Standard Analyses

- Boundary limits checked against targets
- Temperature crosses and other process checks are analyzed
- Watch tag given a “0” or “1” to facilitate count and roll up

- Engineering calculations added to PI AF hierarchy for visualization



Preparing for BI

SunCoke Energy

Problem Statement:

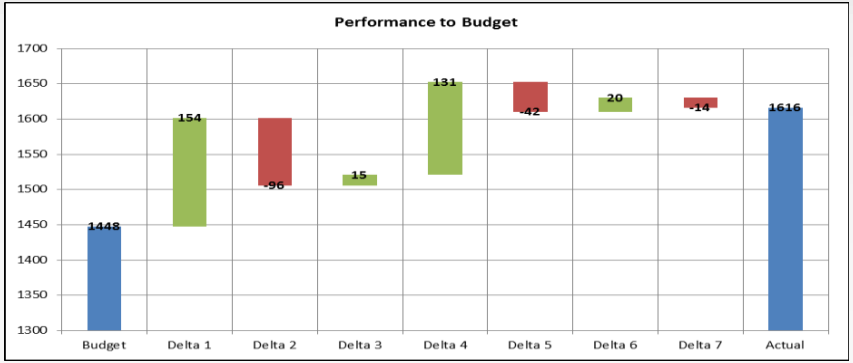
- Preparing Business Intelligence platform to consolidate plant metrics calculations
- Not all data is metered, routinely measured, or routinely recorded
- Manually entered data must satisfy design standards for data architecture
- Granularity of data is used for broad time analyses (weekly, monthly, yearly…)

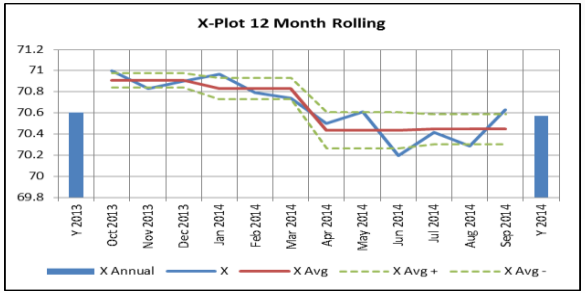
Solution:

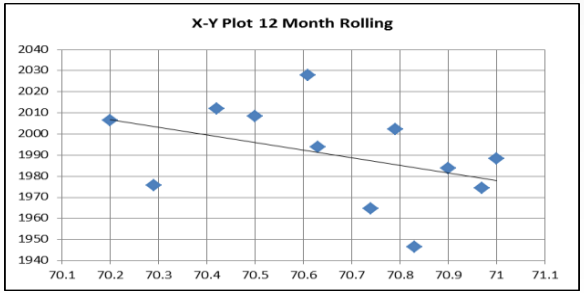
- Utilize PI Manual Logger and Excel interface to input data
- Structure data through PI AF
- Prepare data for data model

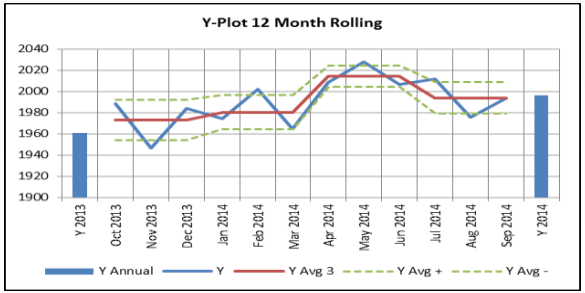
Production Metrics

- Less than 10 actual values combine to generate roughly 25 distinct metrics (and counting)
- Scale measures can be metered (PI Data Archive) or tracked by weight tickets (shoebox historian)



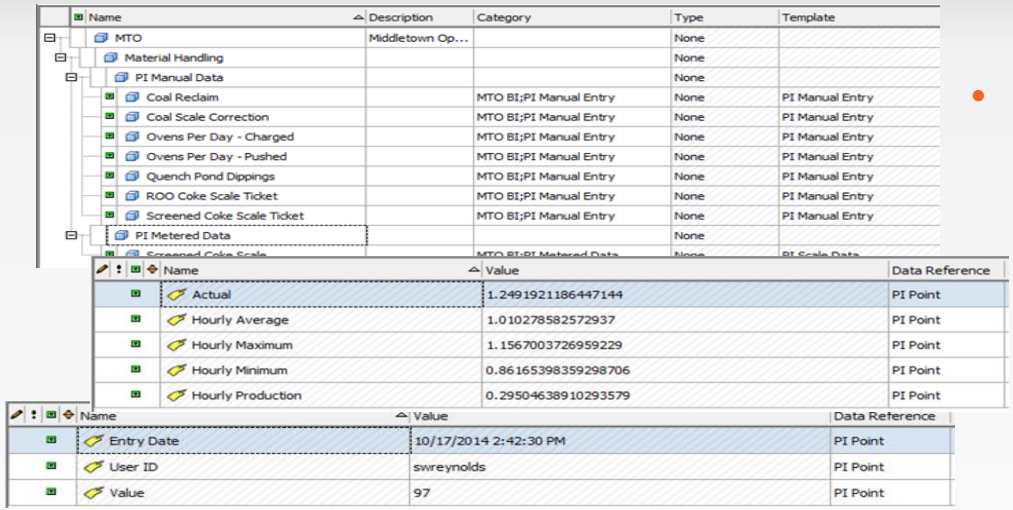






Solution Design

SunCoke Energy



Name	Description	Category	Type	Template
MTO	Middletown Op...		None	
Material Handling			None	
PI Manual Data			None	
Coal Reclaim		MTO BI;PI Manual Entry	None	PI Manual Entry
Coal Scale Correction		MTO BI;PI Manual Entry	None	PI Manual Entry
Ovens Per Day - Charged		MTO BI;PI Manual Entry	None	PI Manual Entry
Ovens Per Day - Pushed		MTO BI;PI Manual Entry	None	PI Manual Entry
Quench Pond Dippings		MTO BI;PI Manual Entry	None	PI Manual Entry
ROO Coke Scale Ticket		MTO BI;PI Manual Entry	None	PI Manual Entry
Screened Coke Scale Ticket		MTO BI;PI Manual Entry	None	PI Manual Entry
PI Metered Data			None	

Name	Value	Data Reference
Actual	1.2491921186447144	PI Point
Hourly Average	1.010278582572937	PI Point
Hourly Maximum	1.1567003726959229	PI Point
Hourly Minimum	0.86165398359298706	PI Point
Hourly Production	0.2950463891029357	PI Point

Name	Value	Data Reference
Entry Date	10/17/2014 2:42:30 PM	PI Point
User ID	swreynolds	PI Point
Value	97	PI Point

- Build separate BI Hierarchy in protected PI AF database
- Structure data and context to simplify E-T-L process
  - Use categorization to improve query processing
  - Prepare data using analytics – hourly averages, minimums, maximums, production deltas, etc.
  - Use templates for scalability and standardization
- Manual entry requires three attributes sharing common timestamp
  - Actual value
  - Entry timestamp
  - User ID

Quick Benefits

HRSG Notifications:

- Captured 70% tube leaks with early warning
- Saved 6-8 hours each on permitted venting and steam sales

Oven Inspections:

- Saving hours on paperwork
- Continuing to develop optimization

T/C Notifications:

- No missed WO's
- Theft deterrent

Cycle Time Improvement:

- Consistent temperature measurement
- Cycle time optimization
- An improvement in cycle time by 2 hours results in average of 7 more pushes per oven annually
- Roughly $70K more revenue per oven

Conclusion

SunCoke Energy

In Conclusion:

- Recruit a willing internal business partner
- Find the common elements
- Structure the context
- Build the analytics
- Get help
- Deploy

Acknowledgements:

- Wes Alderman
- Bruno Bachiega
- Trevor Bell
- Jamilly Brito
- James Butler
- Tamalyn Ennis
- Glenn Hummel
- Bob Johnson
- Matthew Keen
- Anand Kshatriya
- Scott Larson
- Nicholas Thorson
- Andre Zardini
- OSIsoft
- Process Innovations
- Rovisys

End of Presentation – Questions?