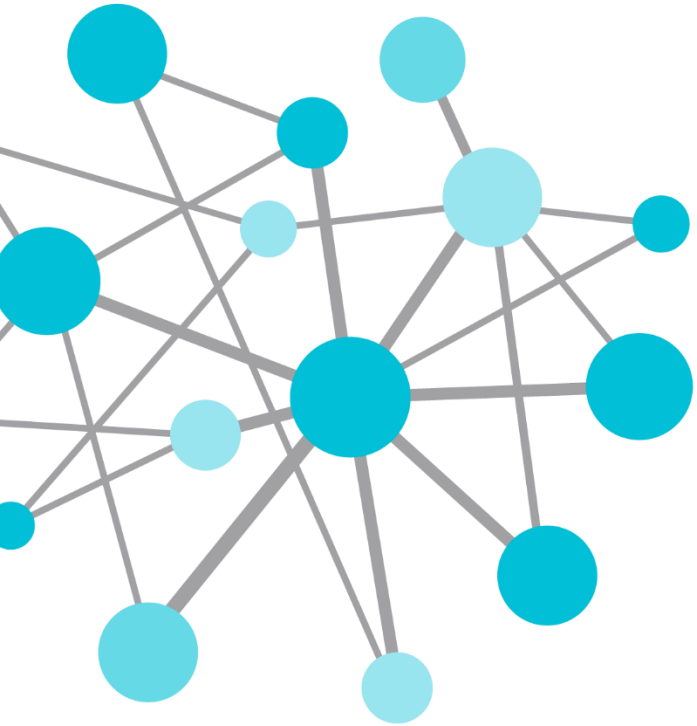

Asset Health Indexing using PI System Integration

Predictive Steps to Monitoring Asset Health

Presented by **Scott Larson**
Wes Alderman
Jason Crum

SunCoke Energy™

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Agenda

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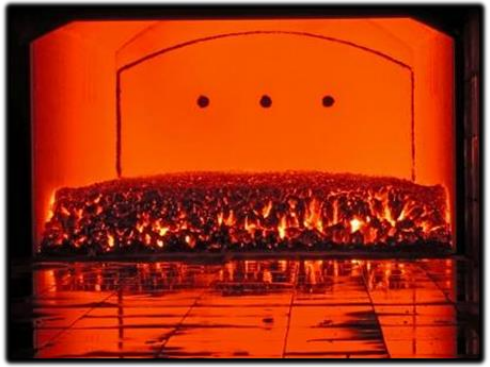
- SunCoke Energy at a Glance
- Our History with the PI System
- Process Overview
- Inspection Process
- Asset Health Program
- Questions



Largest Independent Metallurgical Coke Producer in the Americas

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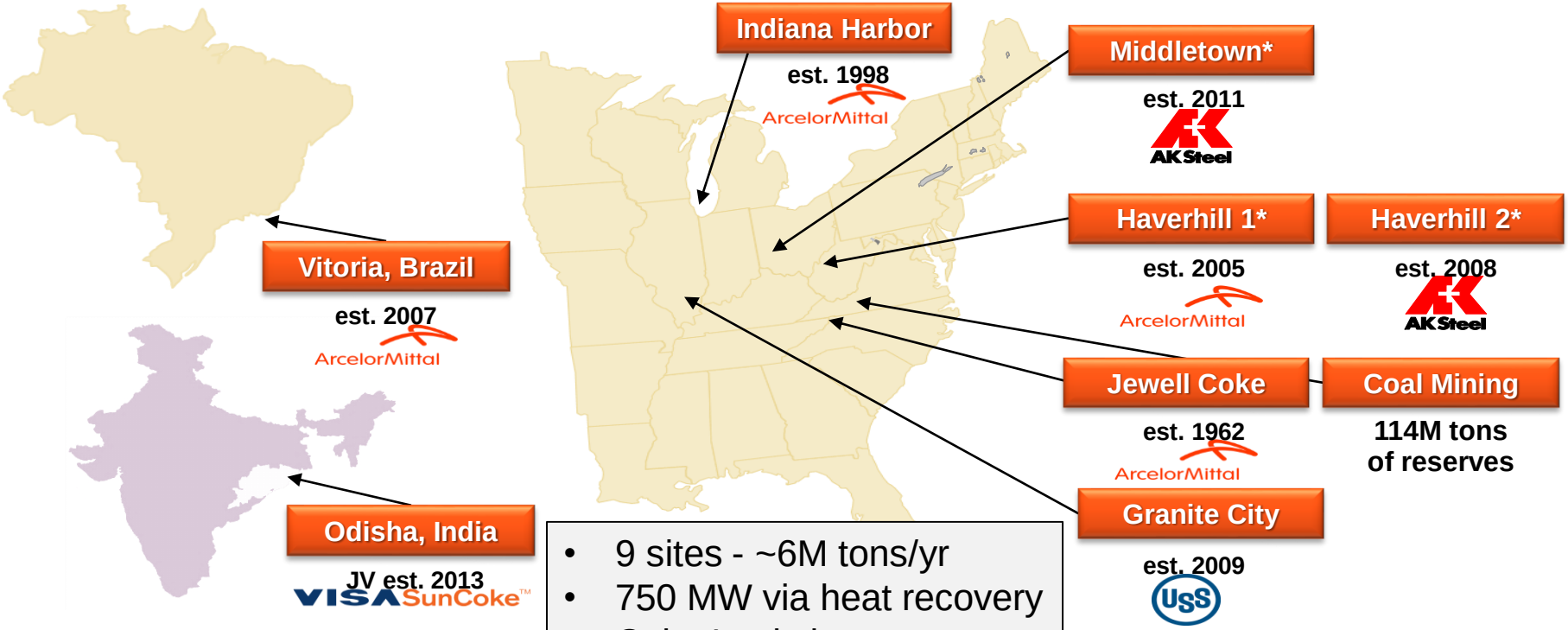

- 9 sites - ~6M tons/yr
- 750 MW via heat recovery
- Coke Logistics

Note: what is the typical MW generation

Value Now, Value over Time with the PI System

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- First Installation at Haverhill Operations in 2009
- All Plants installed October 2011
- Increasing use and value 2009-2011
- Enterprise Agreement (EA) signed in 2012
- Perspective on the EA
  - Supported a refocus on "value from vs the cost of" the PI System
  - Helped Reduced the cost of curiosity
  - Enabled quicker development and rollout of applications broadly
  - Accelerated value realization and sustainment
  - Enabled normalization and simplification of data – securely & broadly
  - Supported SunCoke Energy's vision of the importance of information

The Making of Coke…and Energy

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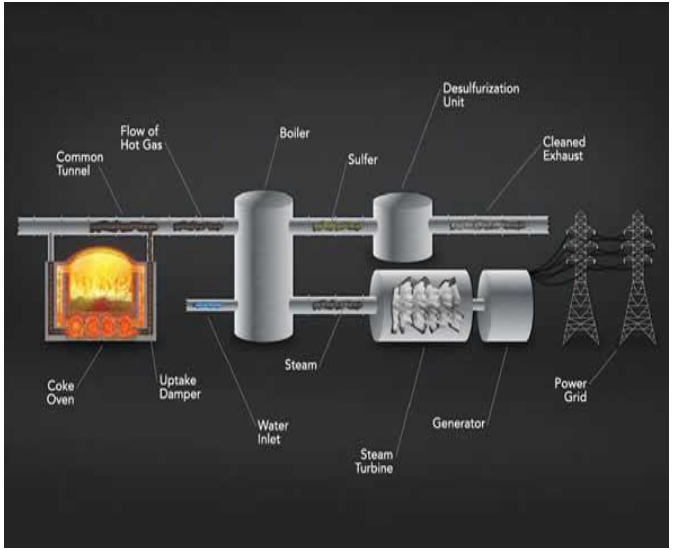
- Thermal Decomposition of Coal
- Heat Recovery from Flue Gas
- Power Generation
- Coke Logistics
- Safety & Efficiency are paramount



SunCoke Process Flow

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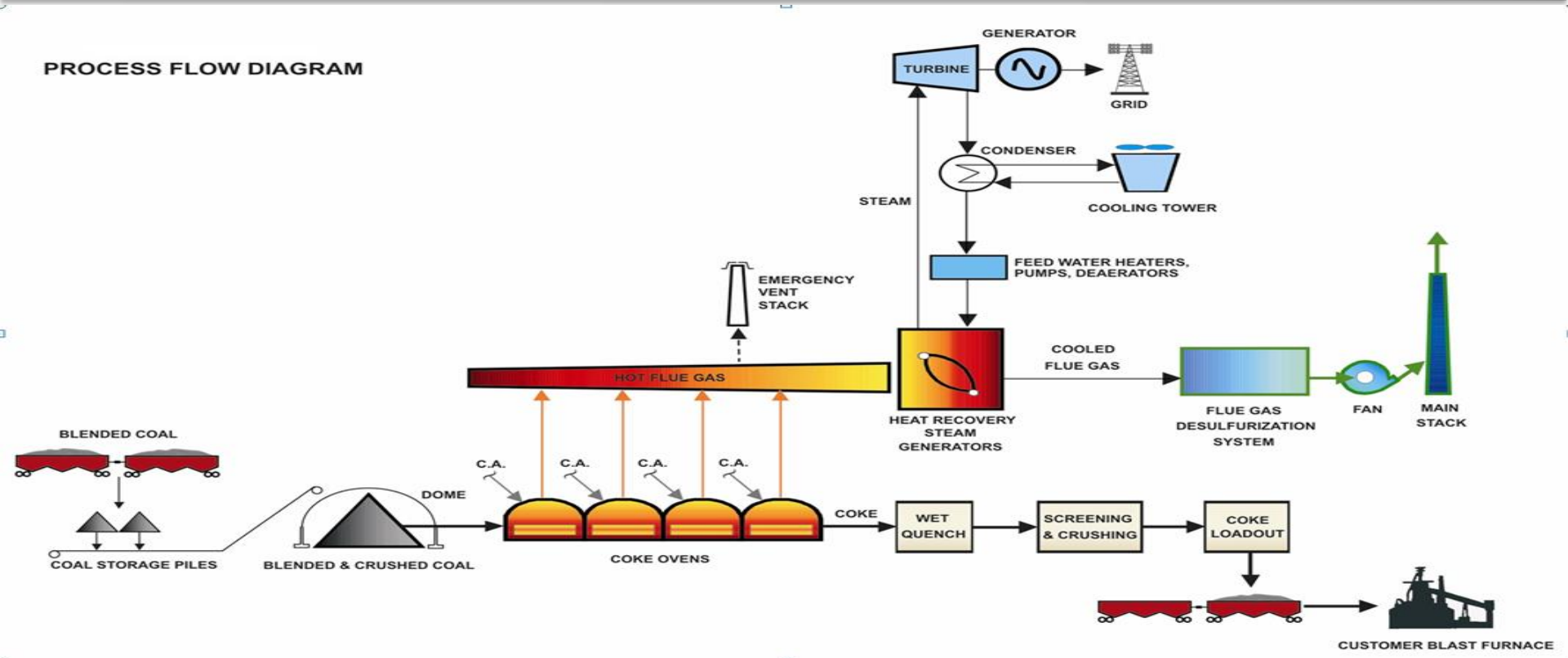

Coke Oven Overview

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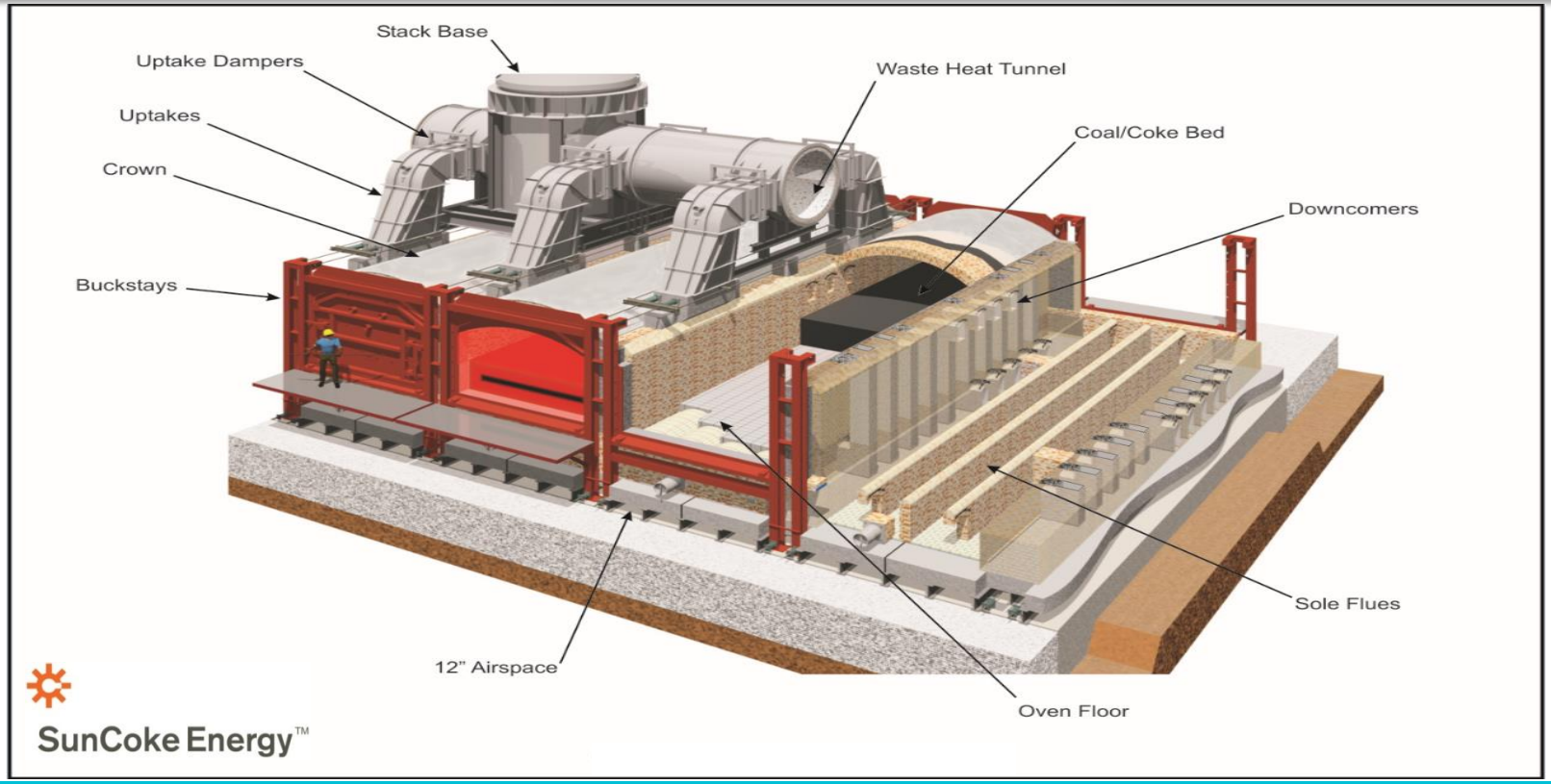

Coking Chamber

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Health Indexing System

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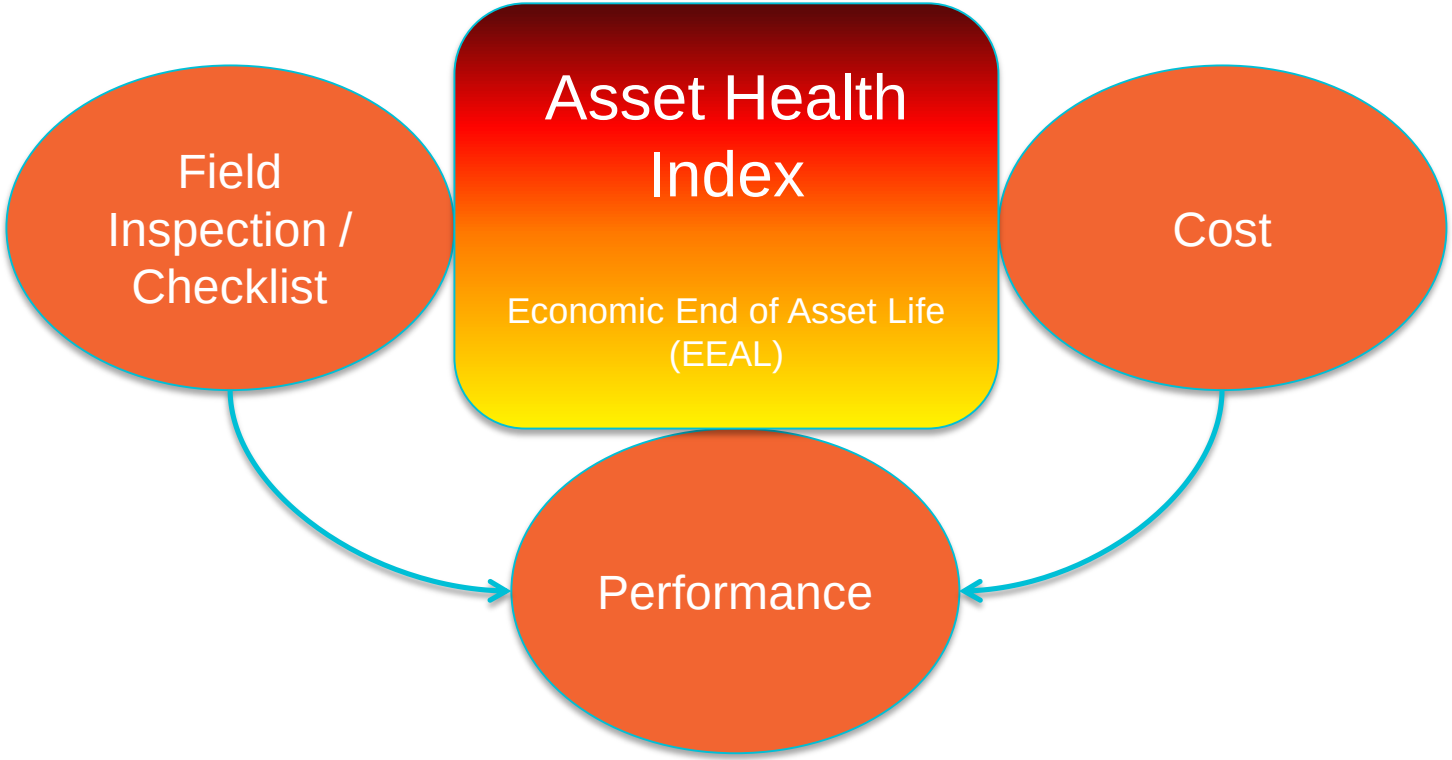

Setting up the monitoring / recording inspection path…..

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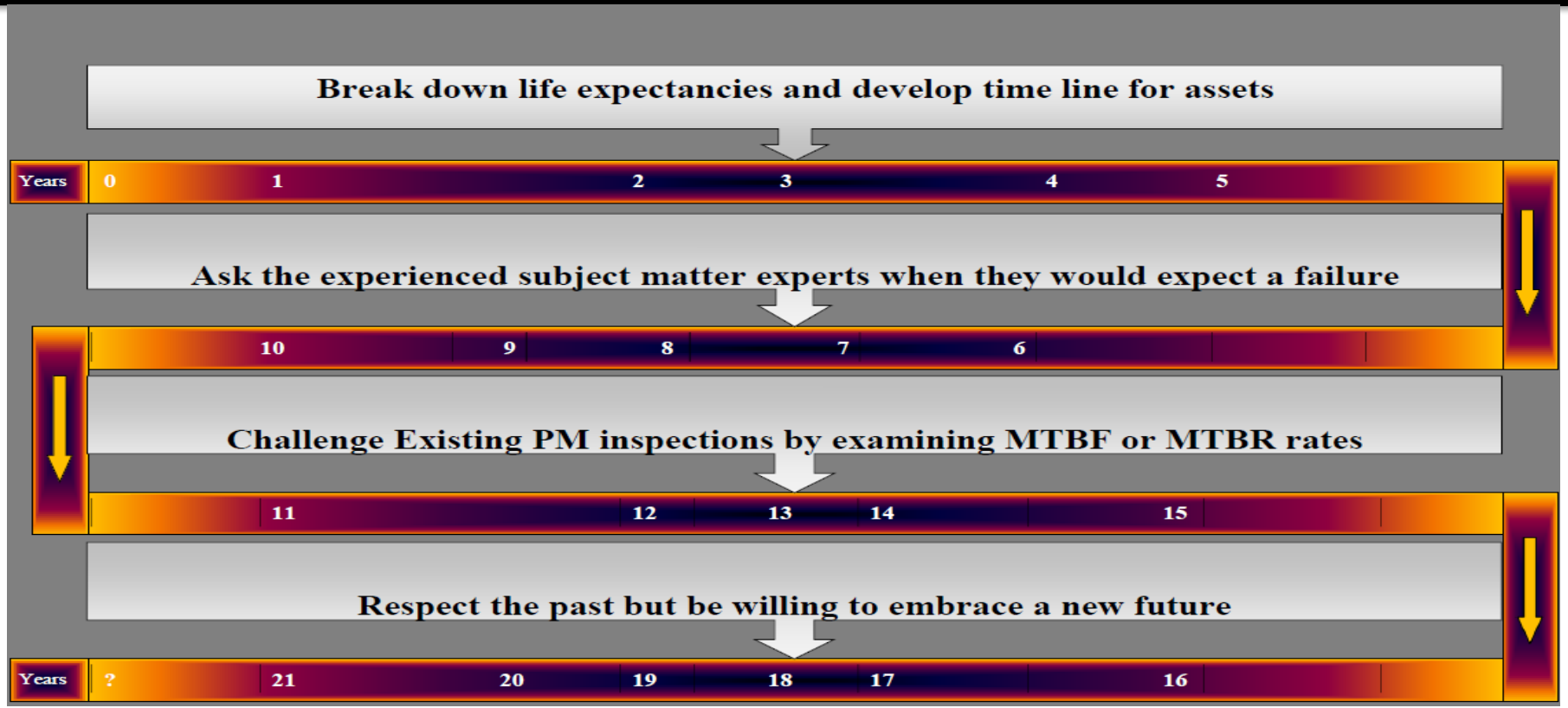
- Clearly define digital data states for asset conditional recording and identify all component areas of asset deemed important / critical.
  - Inspection granularity can vary.
    - Example: Good or Bad / On or Off type input
      - Pros--Applicable in many cases where asset condition is simply functioning properly or not
      - Cons--Not a good digital state for age related conditional failure and where health indexing prioritization could be needed
    - Expanded Example: No Damage, Minimal, Moderate and Severe
      - Applicable when asset age related failures occur.
      - Enables health analysis for work order prioritization

Develop maintenance timelines for your process to understand where you are currently, where you will be, so you can steer where you want to go.

Maintenance Timeline



Paper inspection migration to electronic entry with analysis….

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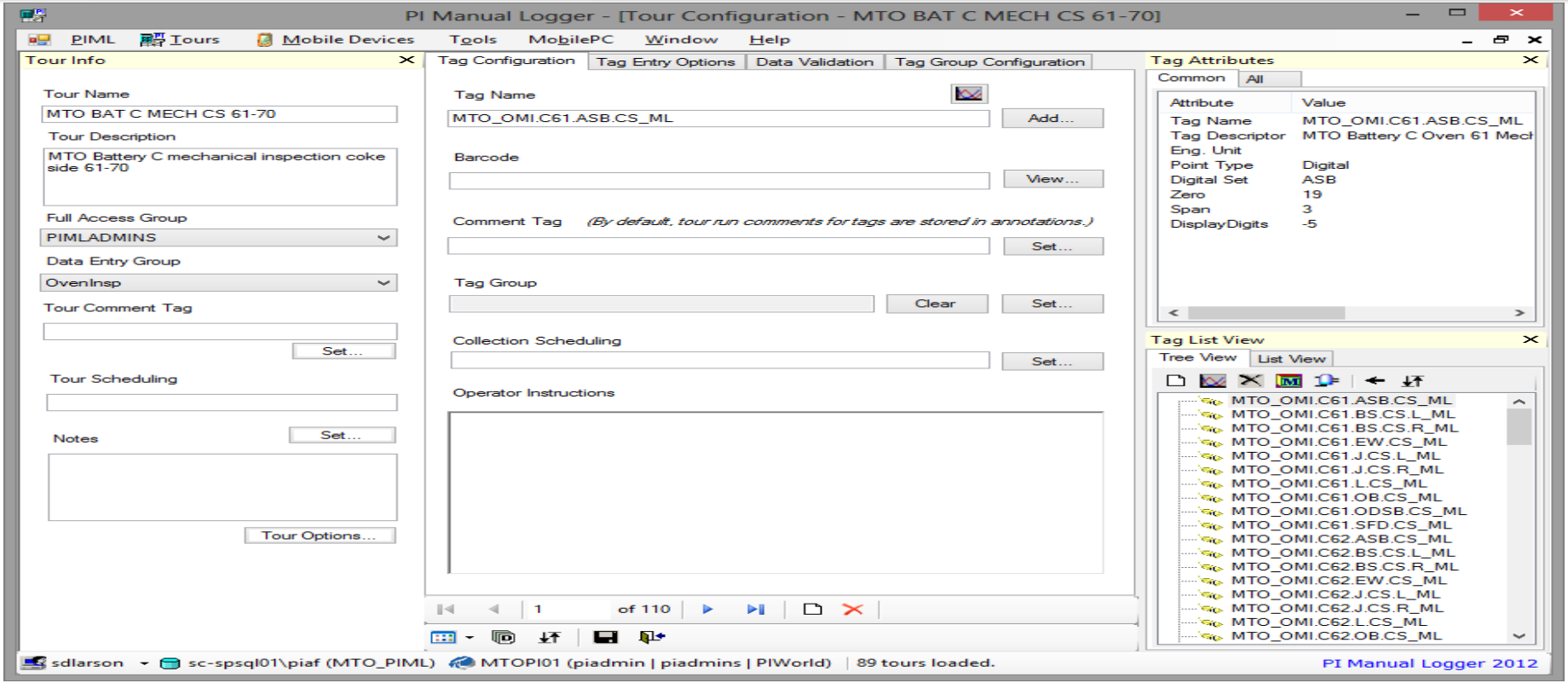
- All PM inspections were transitioned from paper / excel type entry and captured through electronic data field entry.
- Data logger tours were copied from paper inspection programs and recreated using corresponding digital states within the PI System.
  - These PI Tags were created for each identified condition that could exist.
- Over 30,000 tags were created per operating site for oven battery assets.

PI Manual Logger Tour Creation



Define performance…
What is considered good???

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- Important to define process characteristics that accurately depict good performance
  - Example(s):
    - Coke Ovens—Temperature, Coking Rates, Charge Weight….
    - Steel Caster—Metal in Mold, Thru Put, Quality data
    - Chemical Plant—Stock Feed Rates, Catalyst Performance,
    - Your Plant—What metrics define your process????
- Most of the time these metrics are the backbone of dashboard creation—good visual aid for that day.
- By integrating PI System and using an Asset Health Index ranking system, it becomes possible to predict failure, reduce downtime and cost in order to manage assets more effectively.
- Decisions become based on predictive measures / data versus reactive break-ins.

Performance Example:

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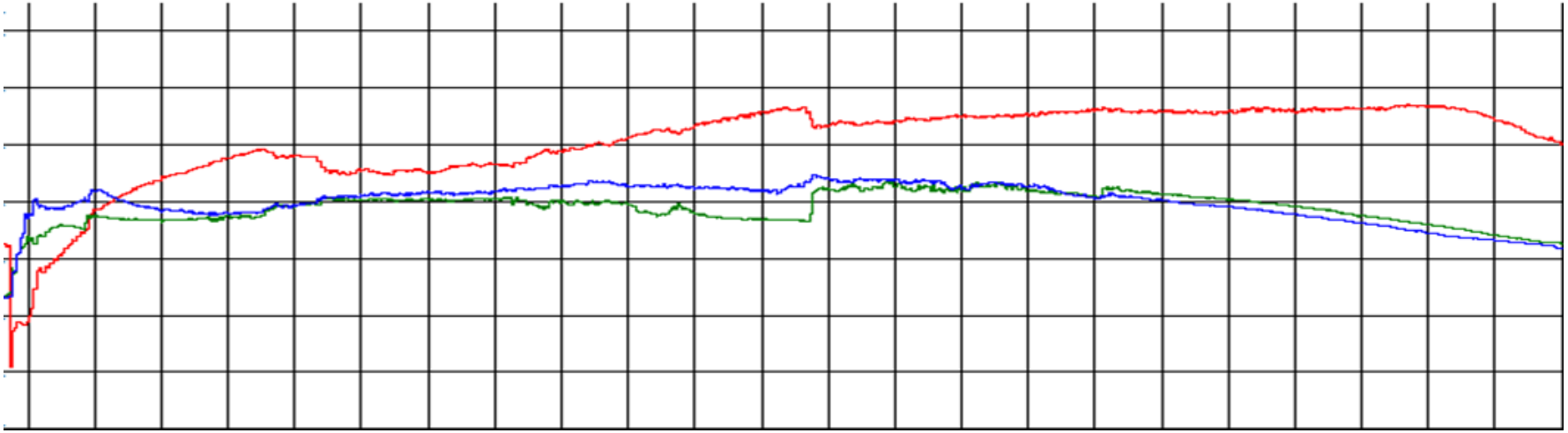
- Temperature Performance Profile—Optimum defined—Others???
  - Feed Rates
  - Hydraulic pressure
  - Lbs / Hr
  - Feet / sec
  - L / min



Maintenance Cost
Predicting the Economic End of the Asset Life

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- Define accepted or “good” cost for asset.
  - Maintenance spend on asset will be categorized according to industry standards, historical data, company feedback, or published data.
  - Digital State set for each condition as defined by process experience and / or budget controls.

- Final Plot for Health Indexing comprised of:
  - Spend Index
  - Performance Index
  - Inspection Index
  - Others????

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Composite the System that works for you….

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- A Weighting System can be applied to reflect proper influence of each individual component to best formulate your process
- **Index Example:** ∑ C1 x W1 + C2 x W2 +C3 x W3+…Cn x Wn… where C is defined as the Condition Rank and W is defined as the associated Weighting within that category.
- Example:
  - Performance was considered to be the most important piece, followed by Inspections and then Cost
  - Category / Condition can be anything—Just define it!!
- *The tracking and collection of this data will build the database needed to predict the EEOL or Economic End of Oven Life and control to a specified delta between oven performance and cost*.

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Health Index Prioritization for Asset Repair Prioritizatoin Example…

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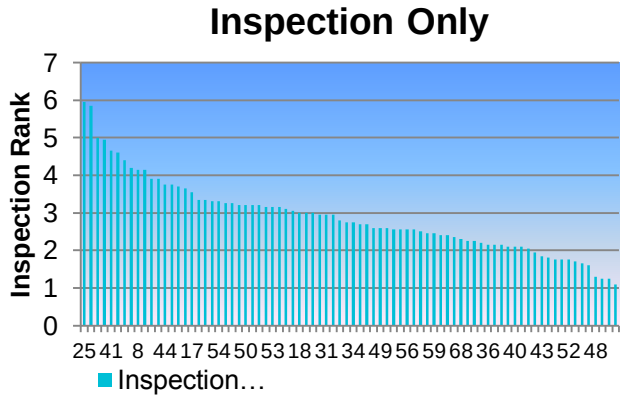
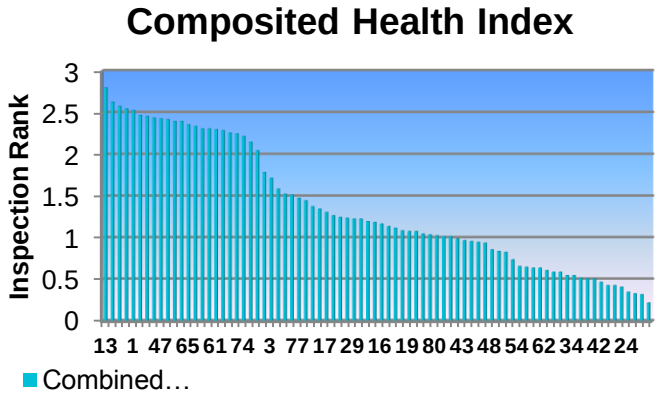
- Lower Left Chart—Portrays asset prioritization analysis based on inspection data only. The first (10) assets prioritized for repair according to Figure 6.29(ac) would be:
  - **25,16,13,15,41,5,77,10,8,and 30**
- Lower Right Chart—Portrays the asset prioritization according to the Composited Health Index which includes Performance / Inspection and Cost
- According to this chart, the first (10) assets prioritized for repair would be:
  - **13,30,78,44,1,11,28,51,47 and 37**
  - ***Note: Only (2) assets appeared in the same list. Performance / Risk is vital to prioritizing repair.***
- ***Compositing key data sources, only assets above a defined rank prioritization will require repair. By executing the revised repair plan, a 34% reduction in cost was realized.***





Program Development -Purpose

- To record, analyze and prioritize repair in order of severity
- All Data both real time (Performance) and periodic (Inspection / Cost) will feed the Health Ranking System database that will offer quick analysis of inspection data overlaid against performance data.
  - Data will enable planning and budgeting of future repair activities
  - Data offers a more focused approach to needed repairs or will trigger additional inspection as performance begins to drop.
  - Reduces the number of inspections and therefore can reduce resource needs
  - Predict Failure and Monitor Asset Health to better control process.

Integrating the PI System by assigning digital states to all conditions—Performance, Asset Health, and Financial—We have been able to better guide our business model to make the most informed decision as we keep a finger on the pulse of our process.

Contact Information

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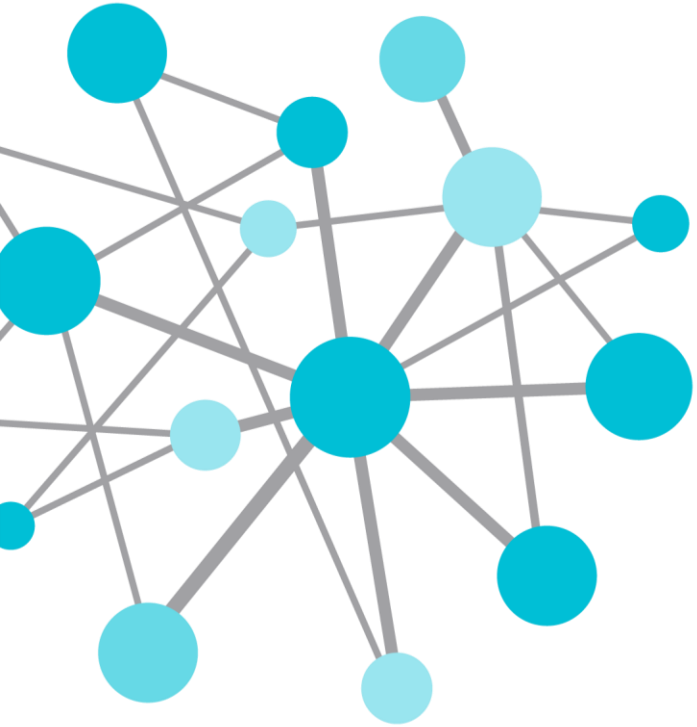

THANK YOU

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