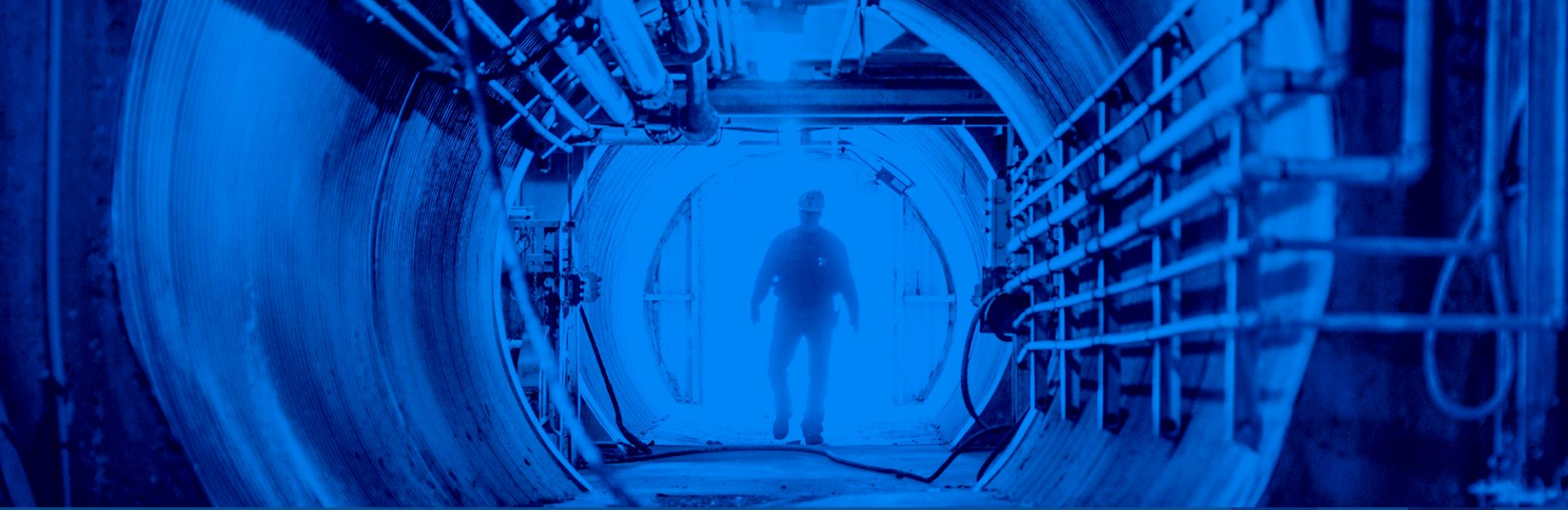
Vertimill Predictive Analytics

Presented by **Scott Schemmel, Jolene Baker and Wyatt Keller**



Vertimill Predictive Analytics

CINER

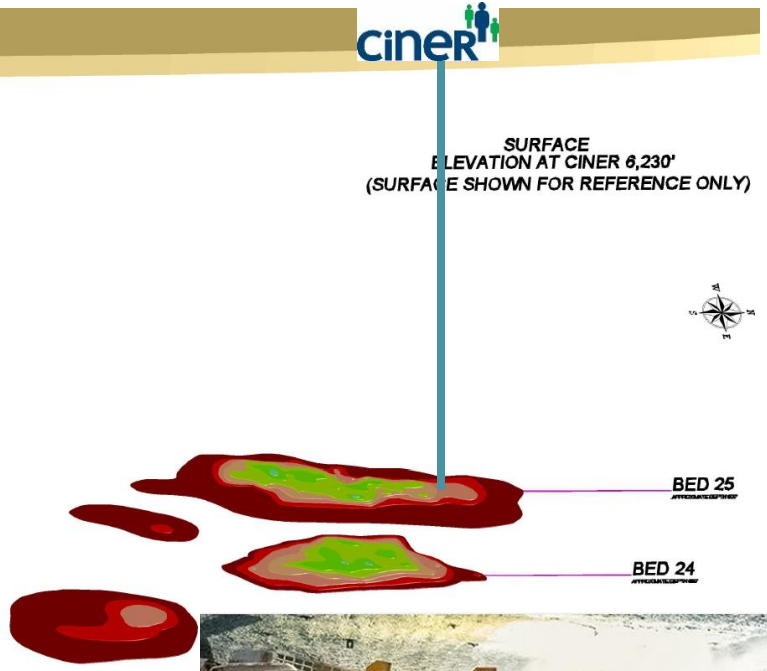
Soda Ash 101

- Ciner Wyoming, LLC (pronounced jin-ner) is a natural soda ash producer in the Green River basin in Wyoming
- We refine soda ash from a natural feedstock of sodium sesquicarbonate (Trona)
- Trona was deposited in the basin over a million year period when 4 million year old Lake Gosiute(\ˈgō¸shüt\ ) became closed off from a freshwater source and the alkali concentration increased
- To produce soda ash, Trona is mined and calcined to remove water and CO_2 to convert the Trona ore to sodium carbonate aka Soda Ash

$$2(Na_2CO_3 \bullet NaHCO_3 \bullet 2H_2O) \rightarrow 3\ Na_2CO_3 + CO_2 + 5H_2O$$

- Used in
  - Glass – 49%
  - Chemicals – 27%
  - Soap and detergents – 11%
  - Flue gas treatment – 3%
  - Pulp and paper – 2%
  - Water treatment – 2%
  - Misc. – 6%

Problem Overview



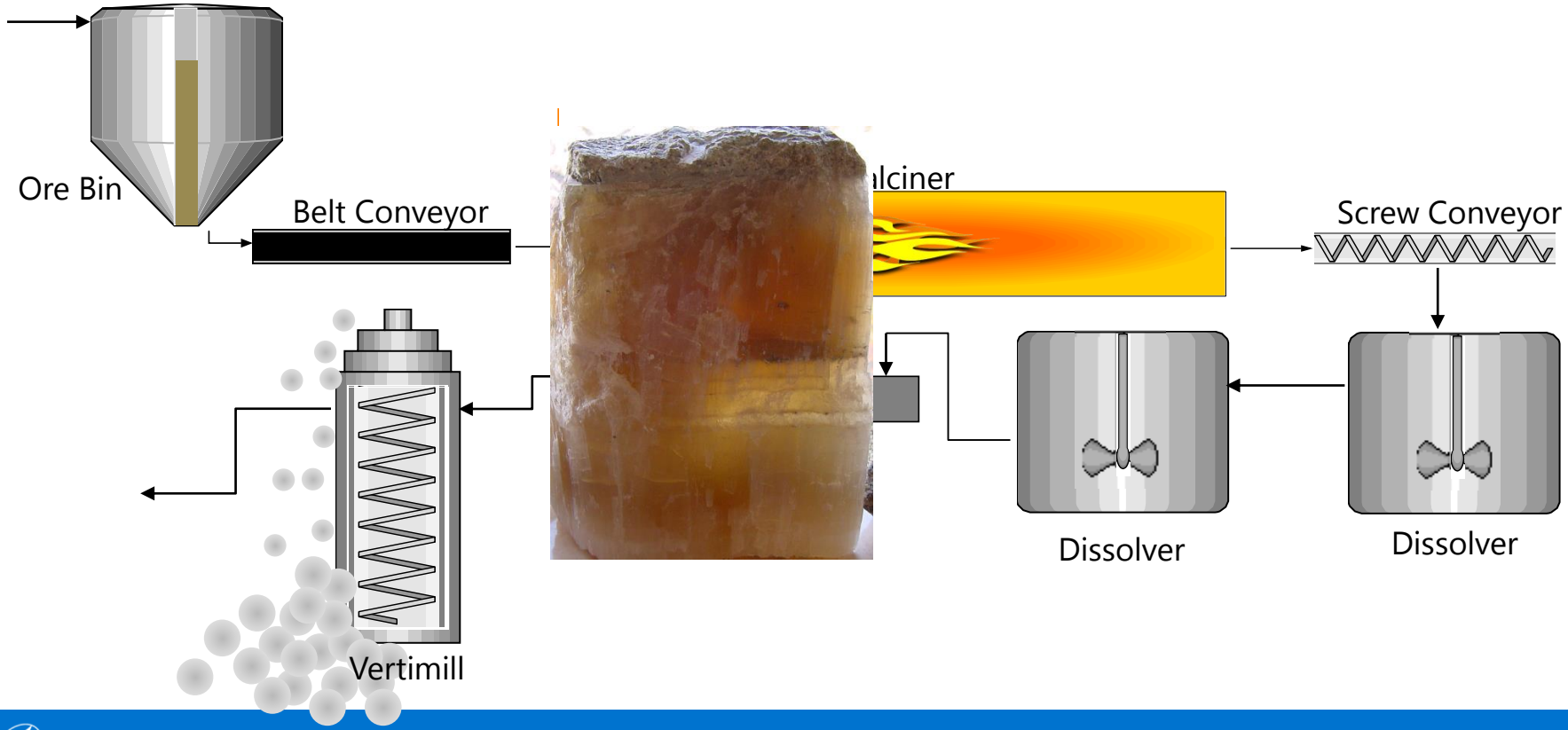
- Continuous Drum Miners mine Trona ore
- Ore Grade varies throughout different areas in the beds
  - Low Ore Grade, below 83%, is referred to as “Bad Ore”
  - Variances in Ore Grade can lead to process upsets and unplanned downtime
- Lab analysis provides ore grade after the fact - no real time ore analysis
  - Process Operators are “blind” to sections of “Bad Ore”

Problem Overview in Detail

- Trona ore is calcined and then dissolved to separate the desired soda ash from the insoluble impurities
- Insoluble impurities are ground to recover any trapped soda ash and produce a PSD that generates a paste for disposal of the tailings
  - The amount and type of insolubles are a direct function of ore rate & grade
  - The Vertimill is capable of handling a fixed amount of insolubles
  - Variations in ore grade can send too many insolubles to the Vertimill
- The Vertimill can be overloaded when…
  - There is too high of a insoluble loading, and/or
  - Larger PSD of the insoluble, or
  - Inadequate loading of grinding media in the Vertimill
- …reducing grinding effectiveness and ultimately spilling over the top of the Vertimill

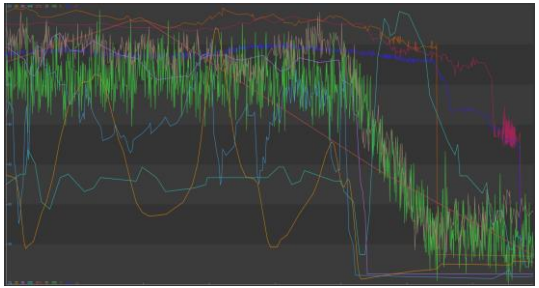
When the Vertimill is down 60% of total production is lost

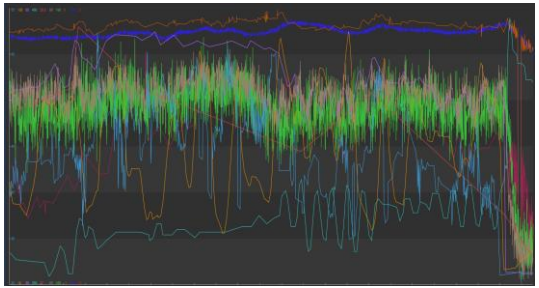
Problem Overview (2 hour processing time)

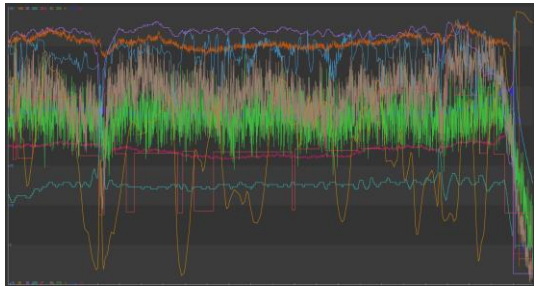


Existing Signals

- Existing real-time data showed that the process was affected by Bad Ore or the Vertimill was not properly loaded with grinding media prior to a process upset
  - 10 process data streams presented the best pre-upset visibility
- Patterns in the 10 data streams immediately around upset conditions were not consistent enough from upset to upset.
  - Varied in frequency, consistency, and magnitude





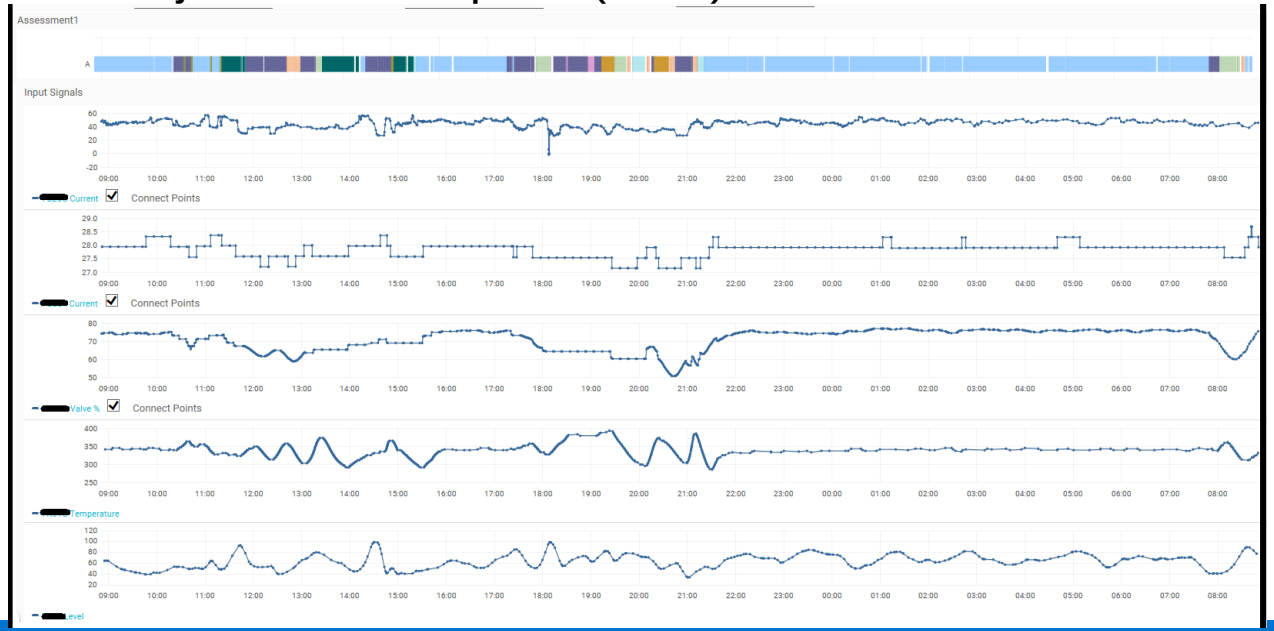


- Conventional analytics were not good as preventative warning
  - Time consuming application of statistical analytics to filter and refine the data did not work
  - Some other method or tool was needed…

Enlightenment

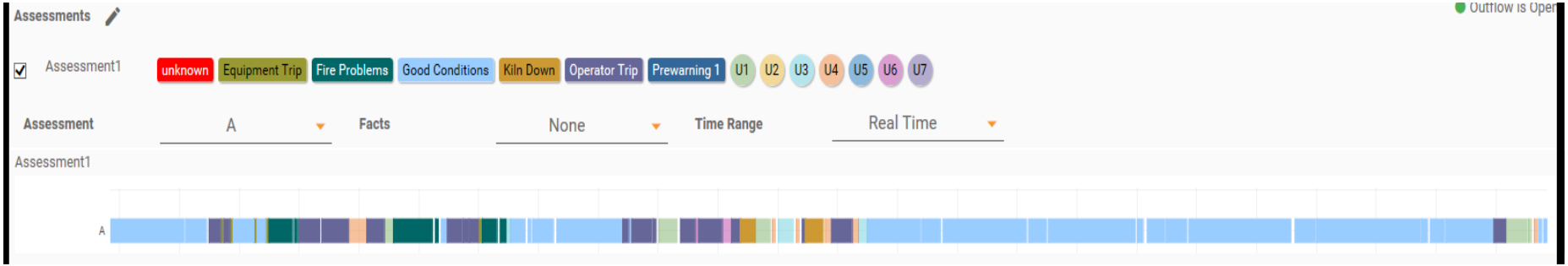
- By chance, we met Crick Waters from Falkonry at a regional OSIsoft event
  - Falkonry provides a Pattern Recognition software designed for use by front line process experts or Subject Matter Experts (SME)

- Trial run POV
  - 2 months to repeatable insightful patterns for all 10 data streams
- Falkonry “crunched” our data streams
  - Similar operating conditions were grouped and color coded
  - No context…yet



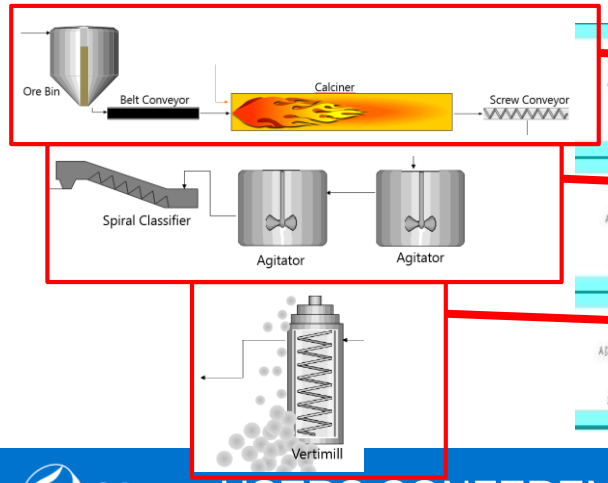
Existing signals – New Tools & How They Work

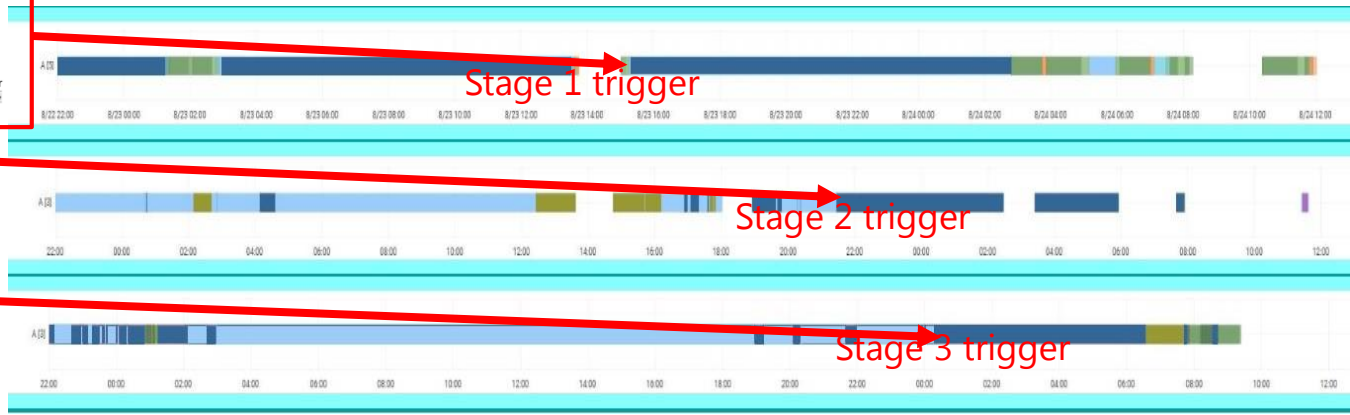
- Adding context - time periods defined for Good and Bad Ore events or inadequate grinding media charge
  - Software found similar patterns to create Bad Ore or Media Charge prediction model
  - Ran multiple iterations and tests on the models to confirm validity
- Post validation, applied the model to real-time data flow
  - Ever improving predictive model
  - Able to be adjusted anytime there are new events



Combining Learned Models

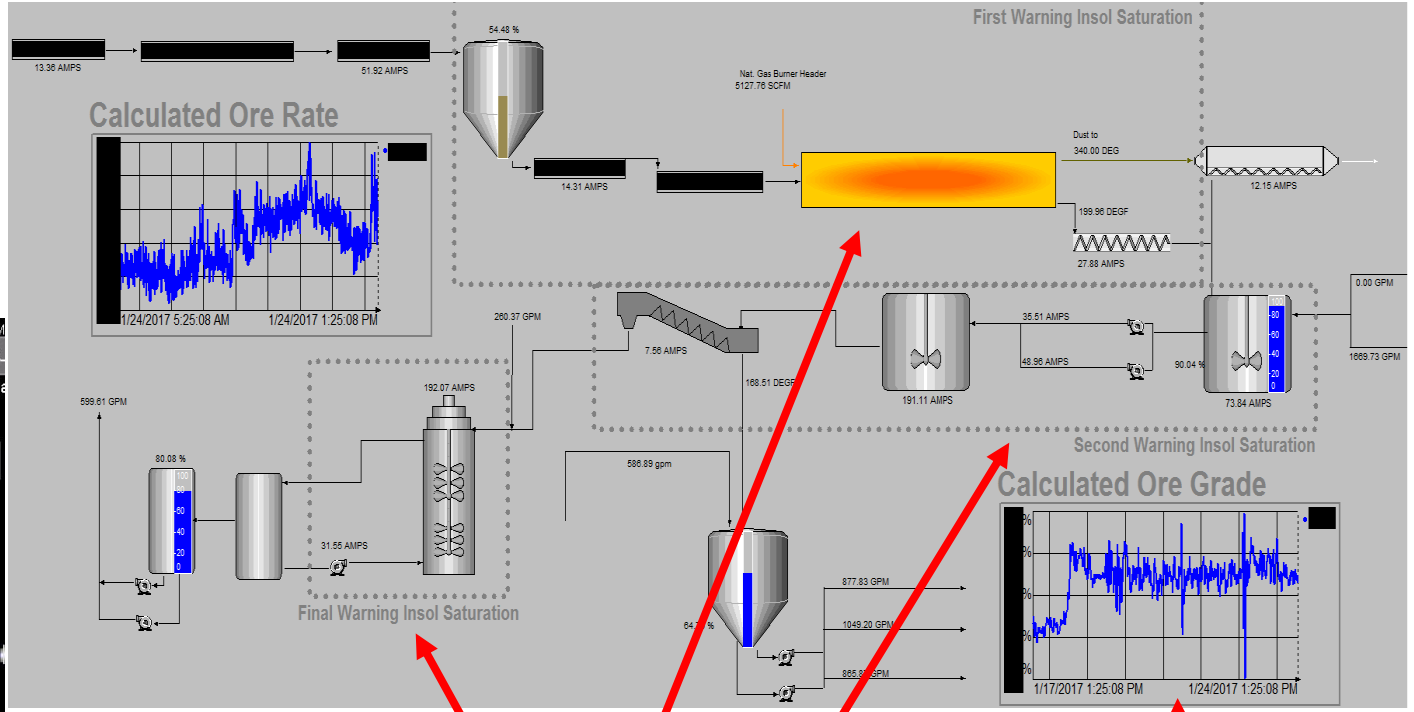
- Best Solution? All 10 data streams in one model (pipeline)…
  - Expected to see Bad Ore move through the system in an hour or two…not the case…
- Broke 10 data streams into 3 like process pipelines
  - Dry-Burner/Calcining, Wet-Dissolving, and Grinding/Milling-Vertimill
  - Detectable Variations
- Insolubles from Bad Ore actually buildup hours before Vertimill affected
  - Patterns show buildup of Bad Ore cascading from calcining to dissolving to the Vertimill
  - Plenty of time for corrective response versus reactive response



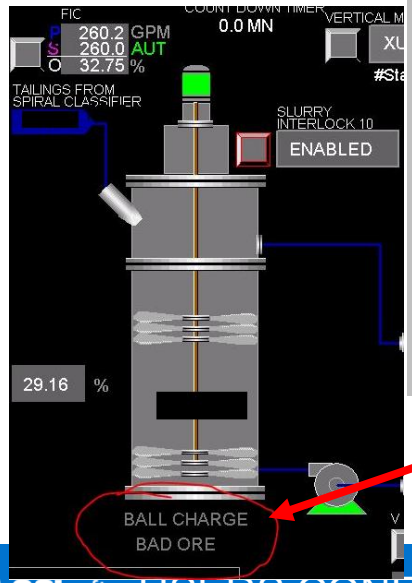


Operationalize

PI Coresight™ Dashboard



DCS Alarm



Alarm

3 Stage Alarm

Real time Ore Grade Prediction

Benefits

- Operations
  - Alarms provide visibility for operators where they were “blind” before
  - Confidence to make decisions regarding tonnage flow to run at optimal state
- Business
  - Reduce lost tons of production
  - Benefits are measurable and significant!
- Technical
  - No time spent teaching outside parties process details
    - Subject Matter Expert (SME) is directly involved
    - “Data science in software” significantly reduces time spent performing data analysis
  - Visual Pattern Recognition is relatable and easily interpreted
    - Models are easily modified to meet current conditions
  - Reduced development and deployment time leads to quicker realization of Revenue Growth and Cost Savings

Lessons Learned

- More than one problem may be revealed
- Iterative process requiring input from many areas of the process
- Opportunity is knocking…

Predictions with the PI System and Falkonry's Pattern Recognition

COMPANY and GOAL

Ciner Resources is a leading natural soda ash producer, and wanted to **predict and reduce** process downtime.

CHALLENGE

Difficult to find patterns to use for alarms when combining multiple data sources.

SOLUTION

Required a more advanced pattern recognition solution.

- Recognized upset using PI Coresight
- Unable to capture all instances using tools in PI Asset Framework
- Leveraged Falkonry with PI to identify meaningful patterns

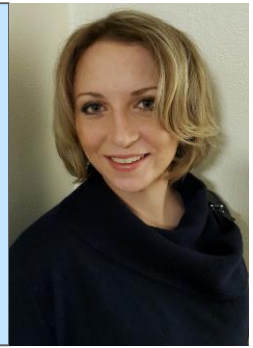
RESULTS

More detailed insight into current operation conditions.

- Detect Bad Ore Grade, Mechanical issues and Process Anomalies
- Generated Calculators using PI AF Analytics based on new insights
- Justified hypothesis around abnormal events

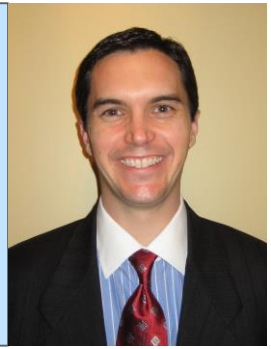
Contact Information

Jolene Baker
jbaker@ciner.us.com
SMART Plant Lead
Ciner Wyoming LLC



Wyatt Keller
wkeller@ciner.us.com
Process Engineer
Ciner Wyoming LLC

Scott Schemmel
sschemmel@ciner.us.com
Head of IT (CIO)
Ciner Resources



Questions

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谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado