Metallurgy Analytics
Transforming Plant Data to Actionable Insights

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Conference Theme & Keywords

Barrick Gold Corporation

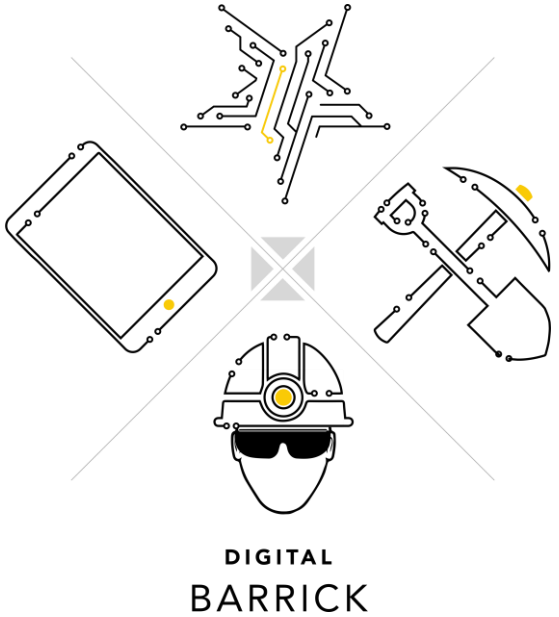
- Barrick Gold is the world's largest gold producer
  - Head-Quartered in Toronto, ON, Canada.
  - Worldwide company with a focus on the Americas.
  - More than 75% of our gold production comes from the Americas region, including Argentina, Canada, Dominican Republic, Peru and the United States.
  - Barrick also has mining operations and projects in Australia, Chile, Papua New Guinea, Saudi Arabia, and Zambia.
  - At the end of 2017, Barrick had proven and probable gold reserves of 64.4 million ounces.

Barrick Nevada – Cortez Ops.

- 100 kilometers southwest of Elko, Nevada, in Lander and Eureka counties.
- Cortez Mining District mining since 1862.
- Proven and probable gold reserves at Cortez as of December 31, 2017, were 10.0 million ounces.
- One of the early adopters of OSISoft PI infrastructure, within Barrick.

Digital Transformation journey

- Barrick Gold, like many world-class companies today, has embarked on a Digital Transformation journey:
  - Harness the transformational potential of digital innovation across the whole enterprise.
  - Strategic Intent is to transform Barrick into a Digital Enterprise.
  - “A productive, safe, environmentally friendly, socially responsible low cost digital enterprise that leverages technology and data as a competitive advantage.”



Transforming Plant Data into Actionable Insights

Barrick Gold Corporation is undergoing a major **digital transformation**, and needs to draw **actionable insights** from its volumes of data in a **quick**, effective and **scalable** manner.

CHALLENGE

- Process data was raw, poorly labelled, and didn't contain any context, making analytics inefficient and time-consuming.
- Engineers' ad-hoc analyses effected by slow data collection and processing methods
- Lack of process-type structure to data made data navigation challenging.

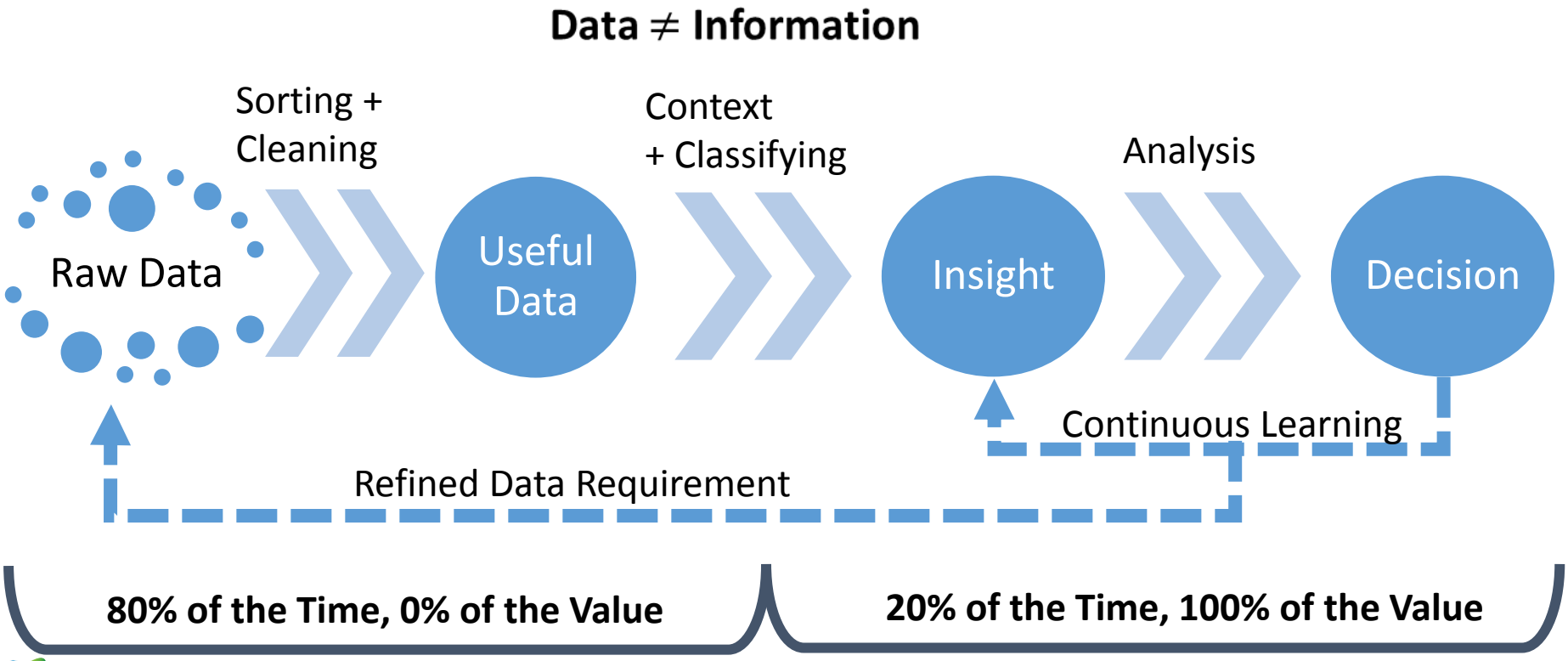
SOLUTION

RESULTS

Agenda

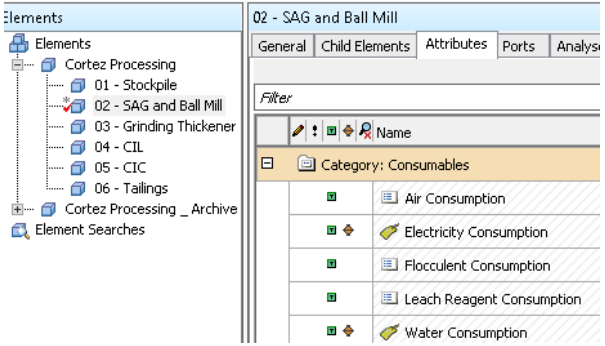
- Data Assembly and Preparation
- Data Contextualizing and Classifying
- Putting Data to Work – Predictive Modeling
- Enhancing Process Transparency – Communicating Insights

The Challenge with Big Data

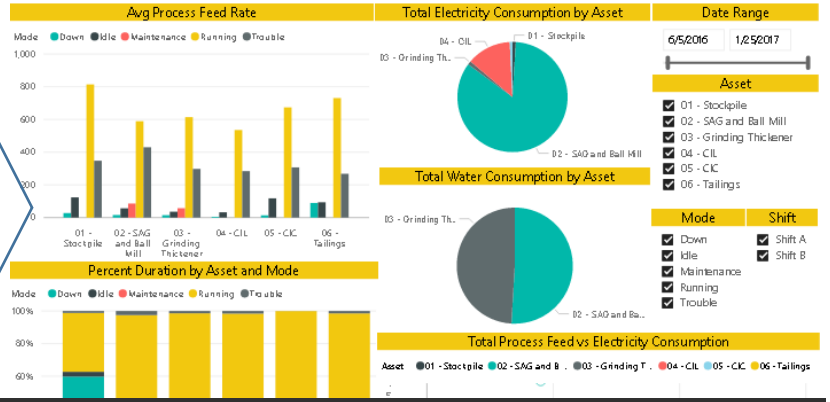


Metallurgy Analytics – PI System as Foundation

Process Unit Template (PI Asset Framework)

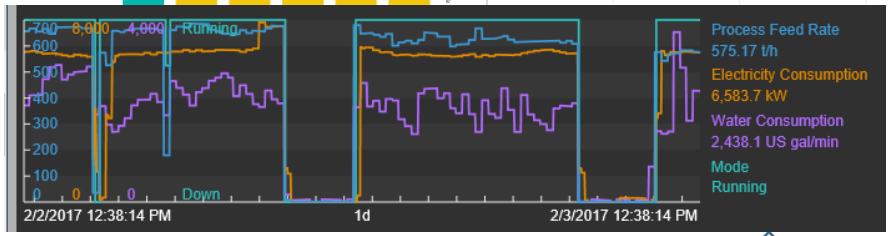


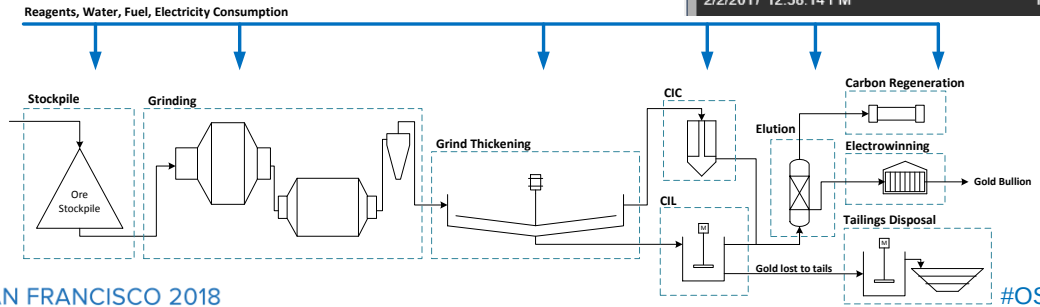
Classified Data Aggregation To Business Intelligence and Visualization Tools (PI Event Frames)



Targeted Personnel Event Notifications

Classified Data Extraction and Process Modeling (PI Analyses and Event Frames)





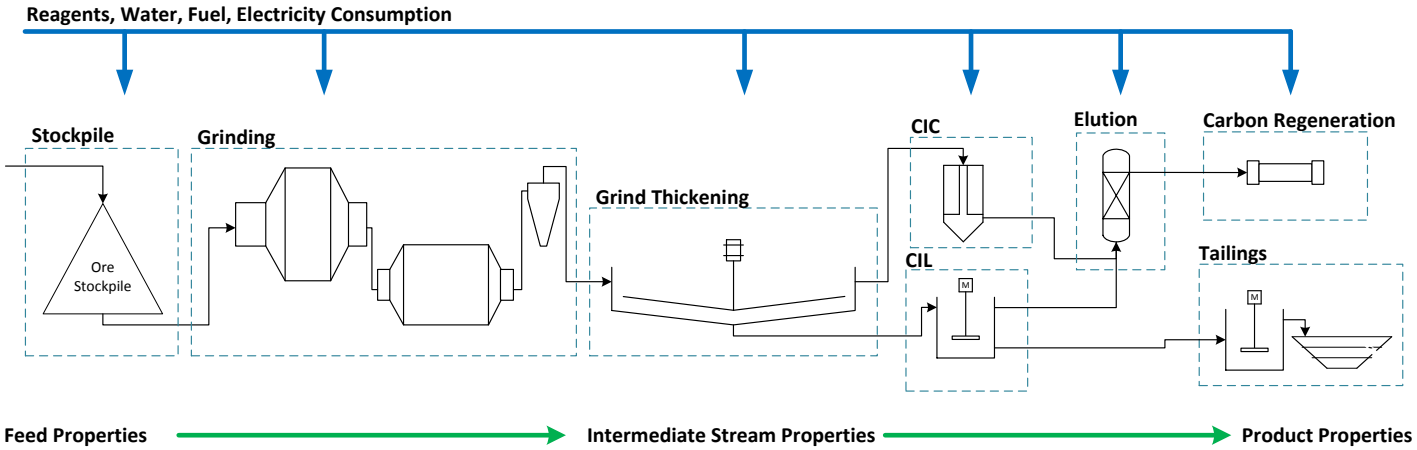
Results reflected in data visualization and analysis platforms.

Unit Process Element Templates

Method
High-Level PI AF Element Templates applied to Process Sections

Reason
Implement a Standard, Scalable form for comparison.

Result
- Quickly compare cost drivers between sections.
- High-level sectional process models using key inputs.



PI Event Frames for Data Classification & Context

Classified by

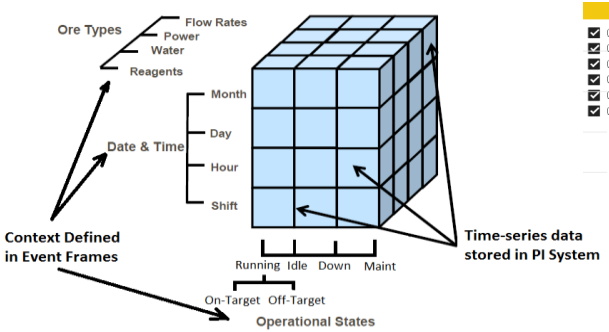
- Operating Modes
- Operating Shifts / Crews
- Feed Types

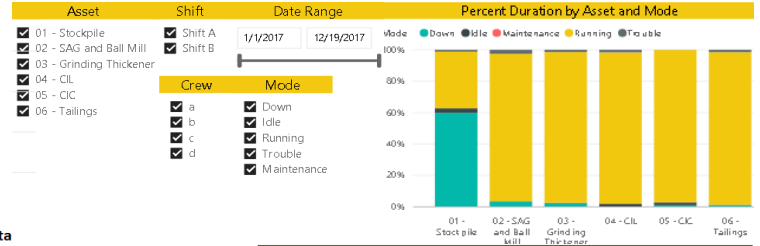
Reason

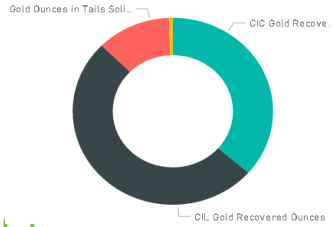
Aggregation by classification / context in BI Tools.

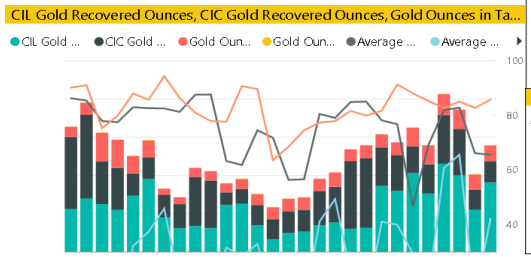
Result

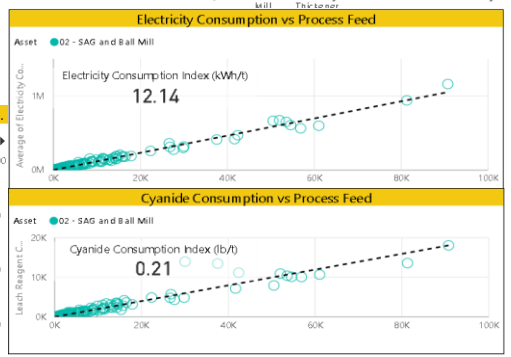
- Highlight opportunities by operating mode.
- Clean, contextual data for Process Modeling











Data Driven Analytics – Machine Learning

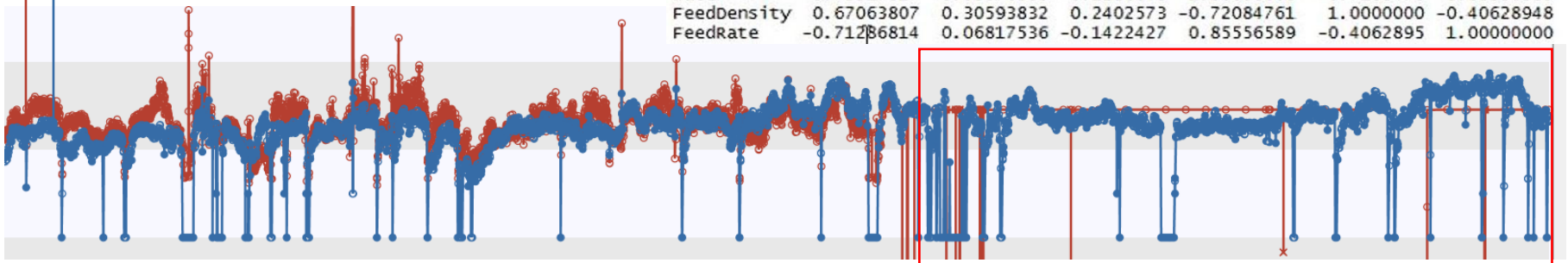
Method

- PI Event Frames as sources of high-quality, cleansed, and contextualized modeling data sets.
- Model development in specialized 3rd party advanced analytical toolkits.

Result

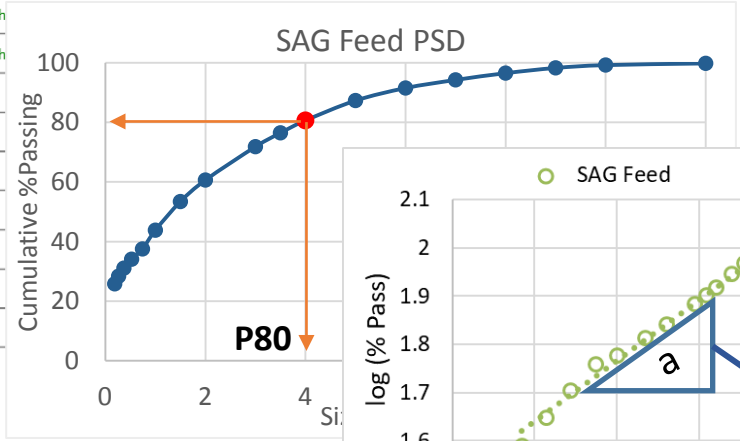
- Significantly reduced time in data preparation and pre-processing for modeling purposes.
- Operating mode specific model deployment, e.g. predict only during running OK states.

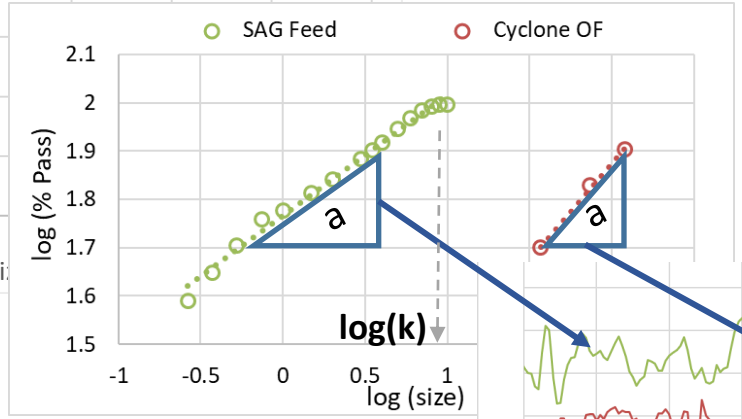

```
  (Intercept)   Electricity    Production         Water   FeedDensity      FeedRate
126.252670862 -0.010720738  0.057221350  0.008232462  3.235241354 -0.022375382
> cor(P80_Nov)
                    P80 Electricity Production       Water FeedDensity    FeedRate
P80          1.00000000 -0.03155779  0.3898828 -0.75927817   0.6706381 -0.71286814
Electricity -0.03155779  1.00000000 -0.2936733 -0.05576389   0.3059383  0.06817536
Production   0.38988279 -0.29367334  1.0000000 -0.22806480   0.2402573 -0.14224269
Water       -0.75927817 -0.05576389 -0.2280648  1.00000000  -0.7208476  0.85556589
FeedDensity  0.67063807  0.30593832  0.2402573 -0.72084761   1.0000000 -0.40628948
FeedRate    -0.71286814  0.06817536 -0.1422427  0.85556589  -0.4062895  1.00000000
```



PI Analysis to Gain Deeper Insights

Name	Expression
X1	LOG10(37)
X2	LOG10(74)
X3	LOG10(TagAvg('Discharge Properties|Particle Size Distribution|Size P80','*-5m','*'))
Y1	LOG10(TagAvg('Disch
Y2	LOG10(TagAvg('Disch
Y3	LOG10(80)
SumX	X1+X2+X3
MeanX	SumX/3
SumY	Y1+Y2+Y3
MeanY	SumY/3
SumXY	X1*Y1+X2*Y2+X3*Y3
SumXSumYDivn	SumX*SumY/3
SumX2	X1^2+X2^2+X3^2





Result

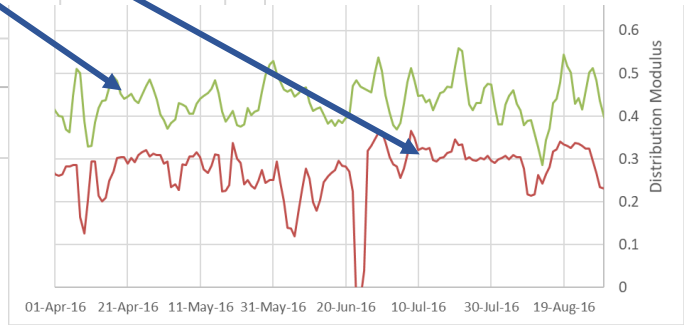
- Building on existing process measurements to enhance insights, e.g. online-calculation of PSD shape parameters to detect possible ore property changes.

Gaudin-Schumann

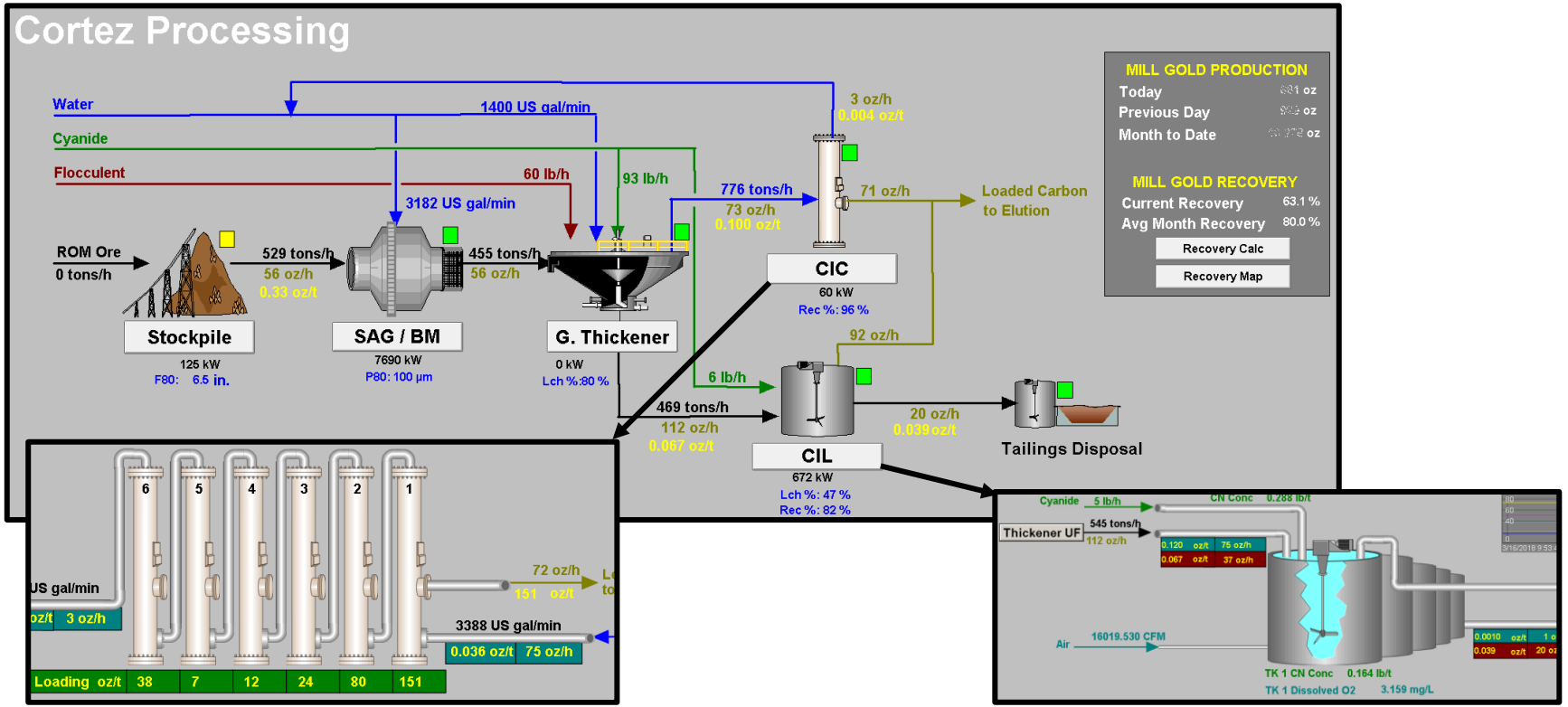
$$y = 100\left(\frac{x}{k}\right)^{a}$$

a - Distribution Modulus

k - Size Modulus



PI Vision for Operations Transparency



MS Power BI for Visual Analytics

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BARRICK

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CHALLENGE

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SOLUTION

PI Asset Framework employed as the foundation for data preparation, classification, and exposure to advanced analytical tools

- PI Event Frames used to build context layers onto high-level process sections.
- PI EF classified data as cleansed and prepared data sets directly used in Machine Learning tools

RESULTS

Enhanced understanding of major gold recovery drivers.

Rapidly scalable configuration of process sections to track major process consumables and cost drivers.

Questions

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

State your **name & company**

Please remember to…

Complete the Online Survey for this session

Speakers

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Merci

谢谢

Danke

Спасибо

Gracias

Thank You

감사합니다

ありがとう

Grazie

Obrigado