Mine Haul Truck Health Monitoring System with PI System

Presented by

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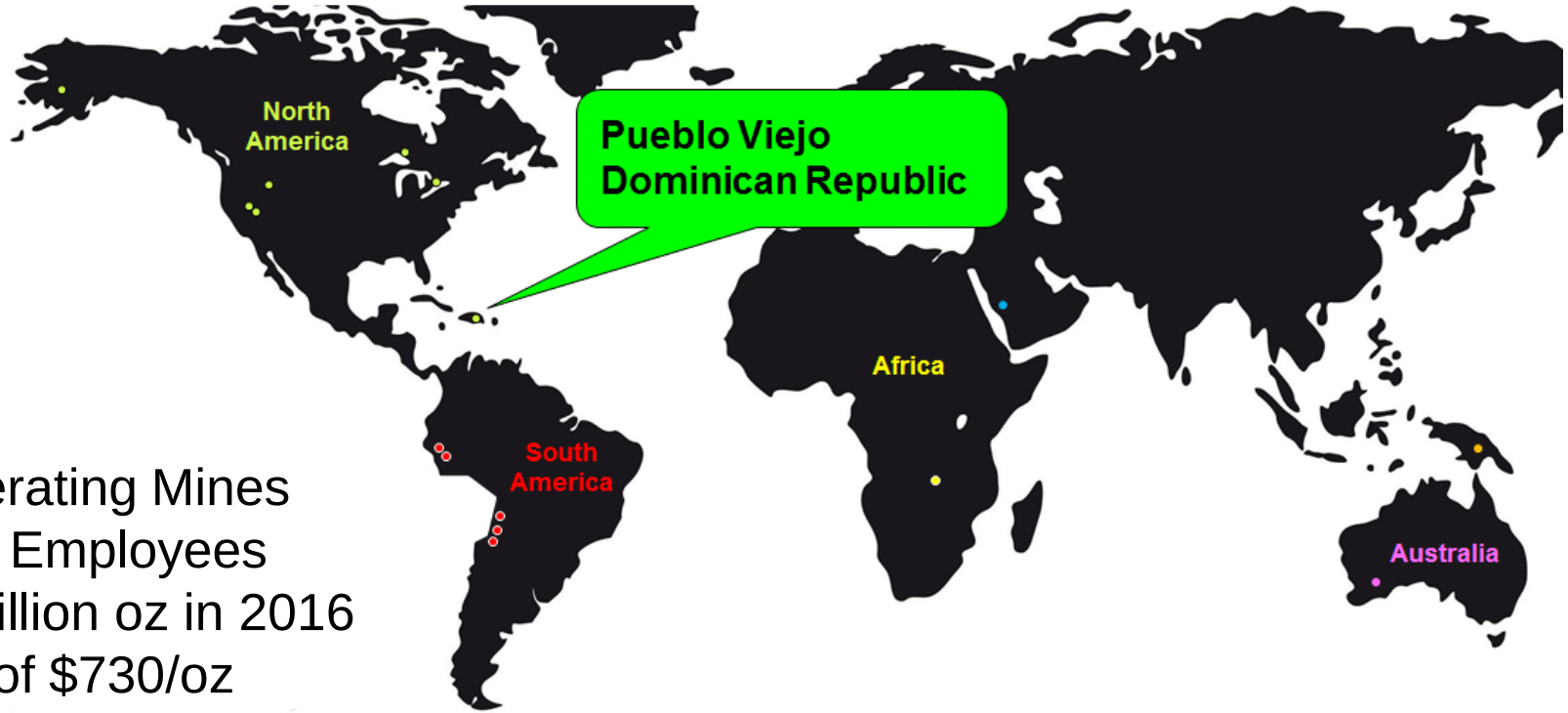
Agenda

- Introduction
- Company Background
- Business Drivers
- Implementation Details
- Results Obtained and Business Impact
- Summary
- Conclusion

Barrick Gold Corporation



- 16 Operating Mines
- 17,500 Employees
- 5.52 Million oz in 2016
- AISC[1] of $730/oz

1-Express in Press Release — Feb 15, 2017

Barrick Gold Pueblo Viejo

- More than 2,000 Employees
- Production of 1,165,645 oz. in 2016
- 150,000 Tons mined and moved per day

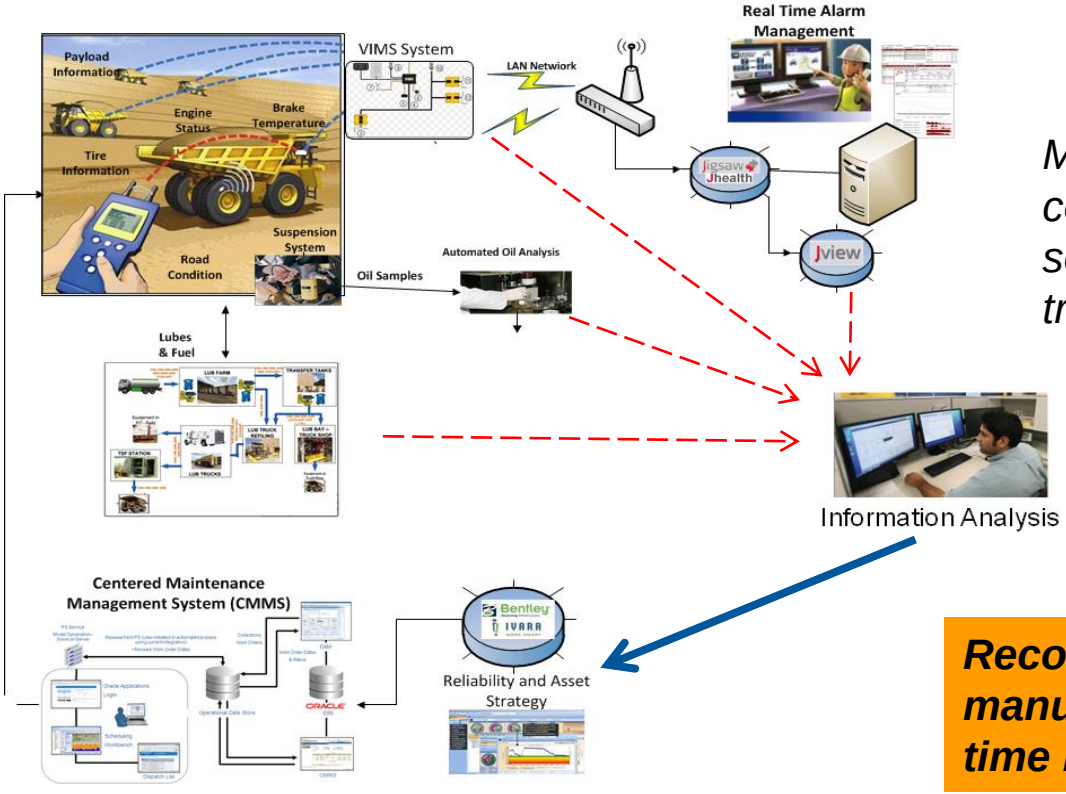
The Mining Fleet

- Mining equipment:
  - 34 CAT789 Haul Trucks
  - 2 Hitachi 3600 Shovels
  - 3 CAT 994F Front Loaders
  - Other: 30 Support equipment
- Annual production target for 2017 is 45 Million tons
- Maintenance Annual Budget $56 Million
- Truck Fleet
  - Budget: 32% of Annual Maint. budget ($17.8 Million) allocated to Haul Truck fleet
  - Truck Down Time cost is **$700/Hr**

Business Drivers

- Contribute to Safety
- Improve Productive Availability
- Increase Operational Efficiency
- Reduce Scheduled & Non-Scheduled Downtime
- Improve Asset Life Cycle Cost and meet Annual Budgets
- Support Corporate Digitization Strategy

How we monitor health in mining?



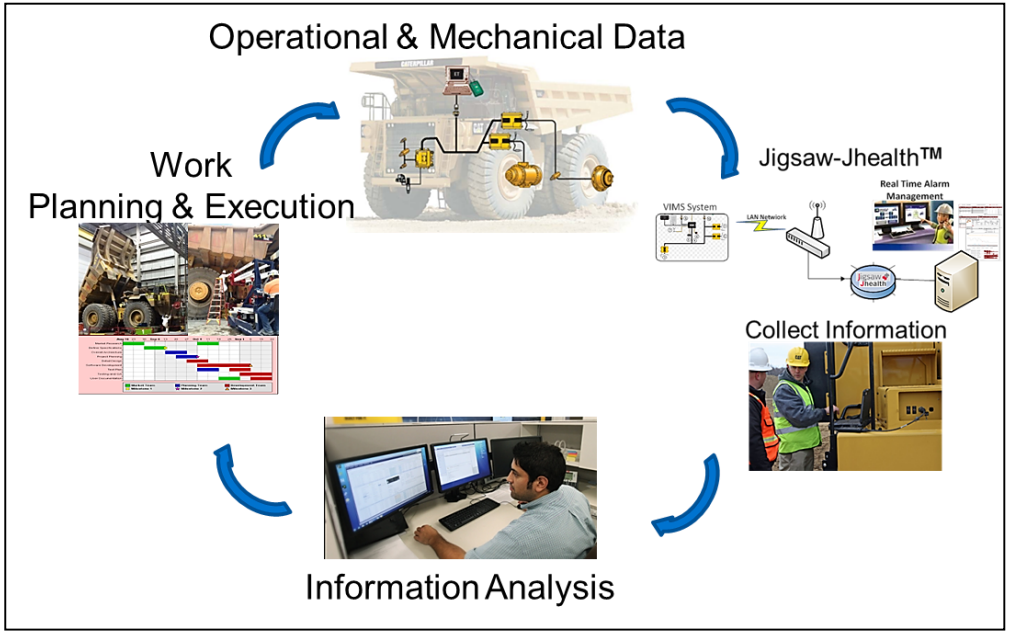
Monitoring Technician and Engineers, collect information from different sources, to trend and investigate why a truck could fail or had failed.

Recommendations to take action is manual, time consuming task and some time late on time.

Finding Improvement opportunities on this traditional model

1 Improve Safety

6 Reduce Down-Time Cost



5 Ability to predict potential failures

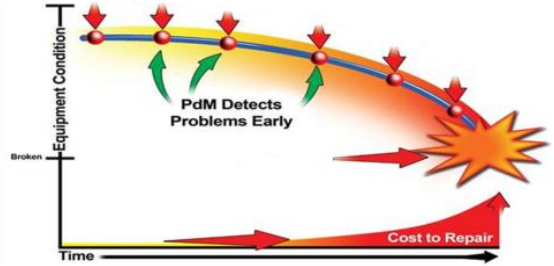
2 Reduce time to collect or analyze information

3 Visibility and ability to convert valuable data into Information

4 Enable the processing of high volumes of information

The Challenge

- To **monitor** and **manage the Asset Health of the Haul Truck Fleet,** in **Real Time**, using **available** Installed **Technologies,** at a **minimum investment** to**:**
  - **Digitize** the on board **information**
  - **Turn** Information **into Action**
  - Produce **faster analysis** of more data, **delivering more accurate** results
  - Achieve the strategic **Operational and Maintenance goals**



DIGITAL
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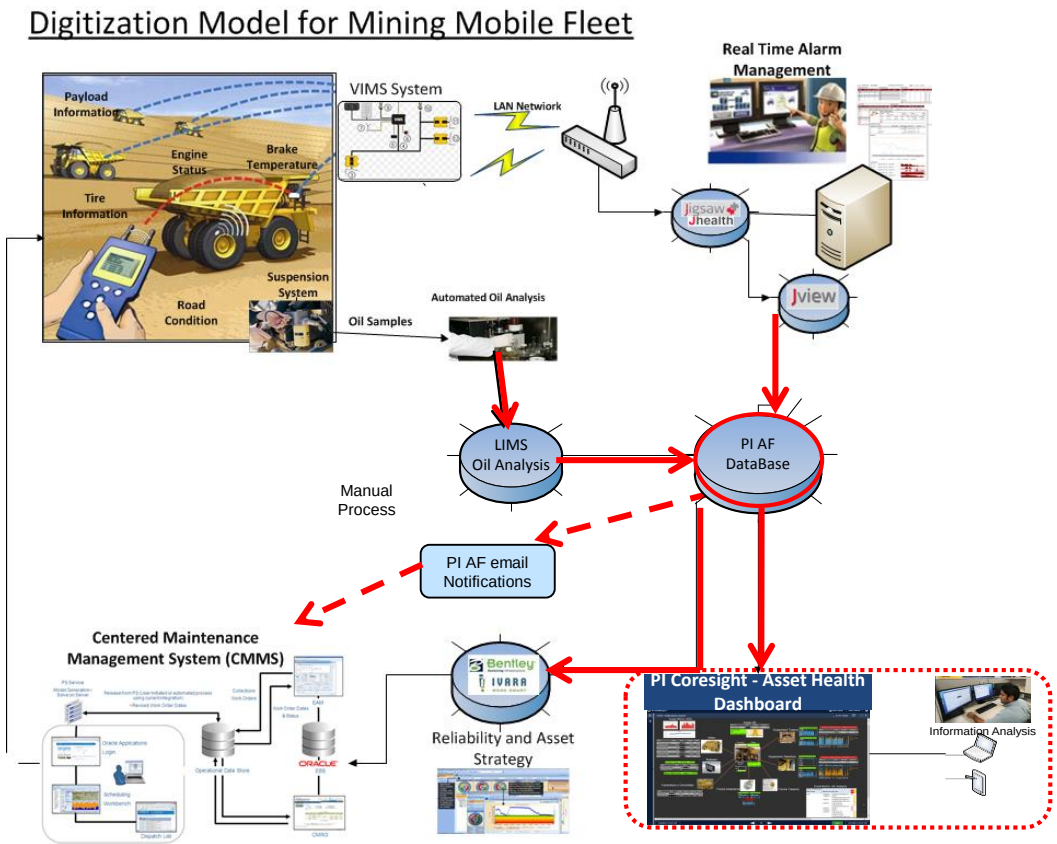
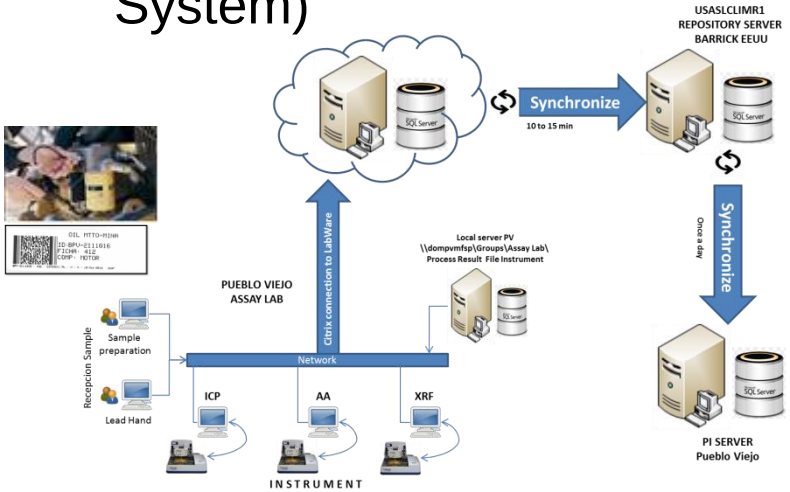
Solution



- Interface Jhealth & LIMS to PI System
- Develop calculations for predictive analytics
- Create dashboards
- Convert Analyses into Action, sending Notifications to end users.
- Trigger Work Orders in CMMS

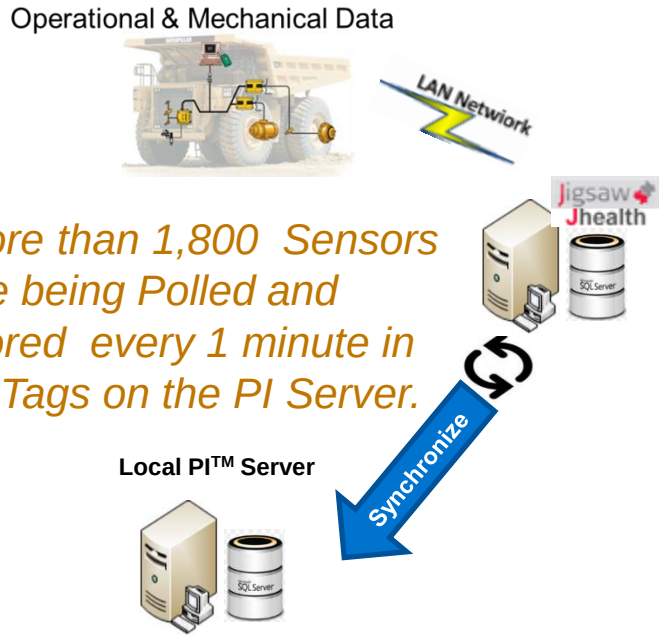
Interfaces

- LIMS - PI System™ (Laboratory Information Management System)



More than 3,000 PI tags are collecting Oil data to do Analysis of Information of the haul truck fleet systems.

- Jigsaw-JHealth™ – PI System™



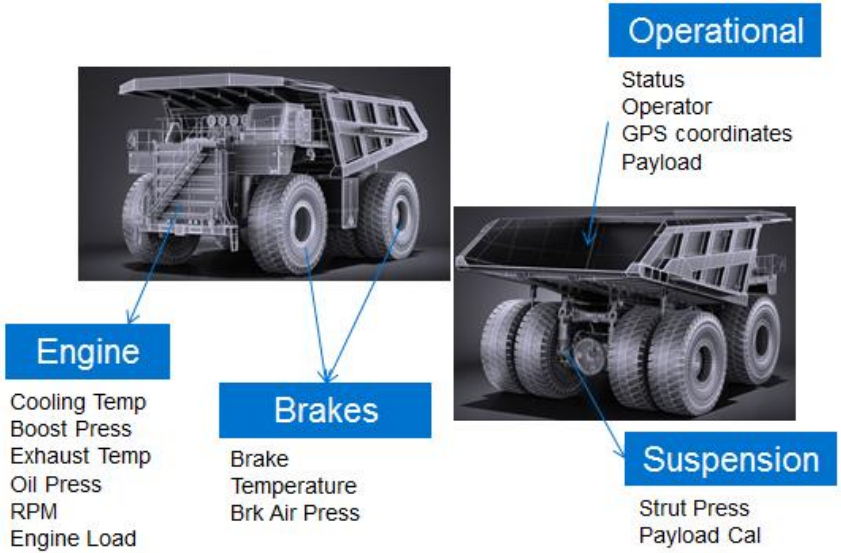
More than 1,800 Sensors are being Polled and stored every 1 minute in PI Tags on the PI Server.

What to do with all this data?

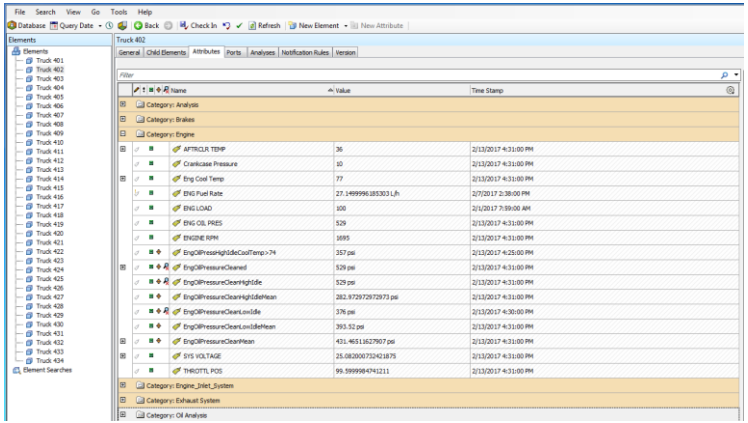
A large amount of data is being collected and stored every minute 24x7.

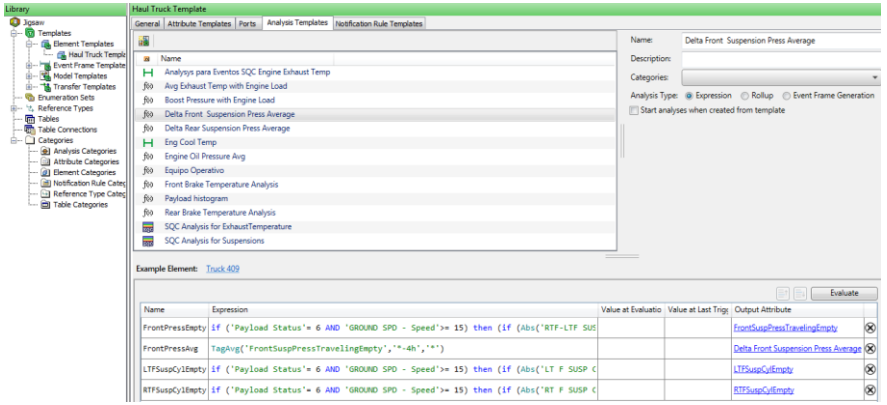
but….

How are we going to make sense of it ??



Asset Framework™ Structure

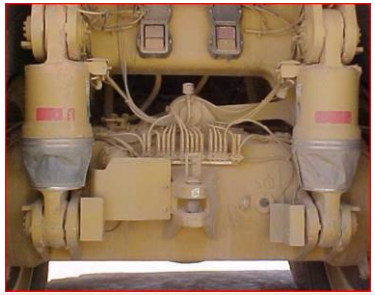




Predictive analyses and calculations are performed on the PI Server, in Real Time for all 34 Trucks

Example: Monitoring Suspension System

- Components to analyze:
  - Rear Suspension Struts
- Variables:
  - Left Rear Pressure
  - Right Rear Pressure
  - Ground Speed
  - Payload Status
- Condition for Analysis: Trend Front and Rear Suspension Cylinder differential pressures (RH minus LH) when truck is traveling empty.
- Expected Values should remain constant around 50psi.

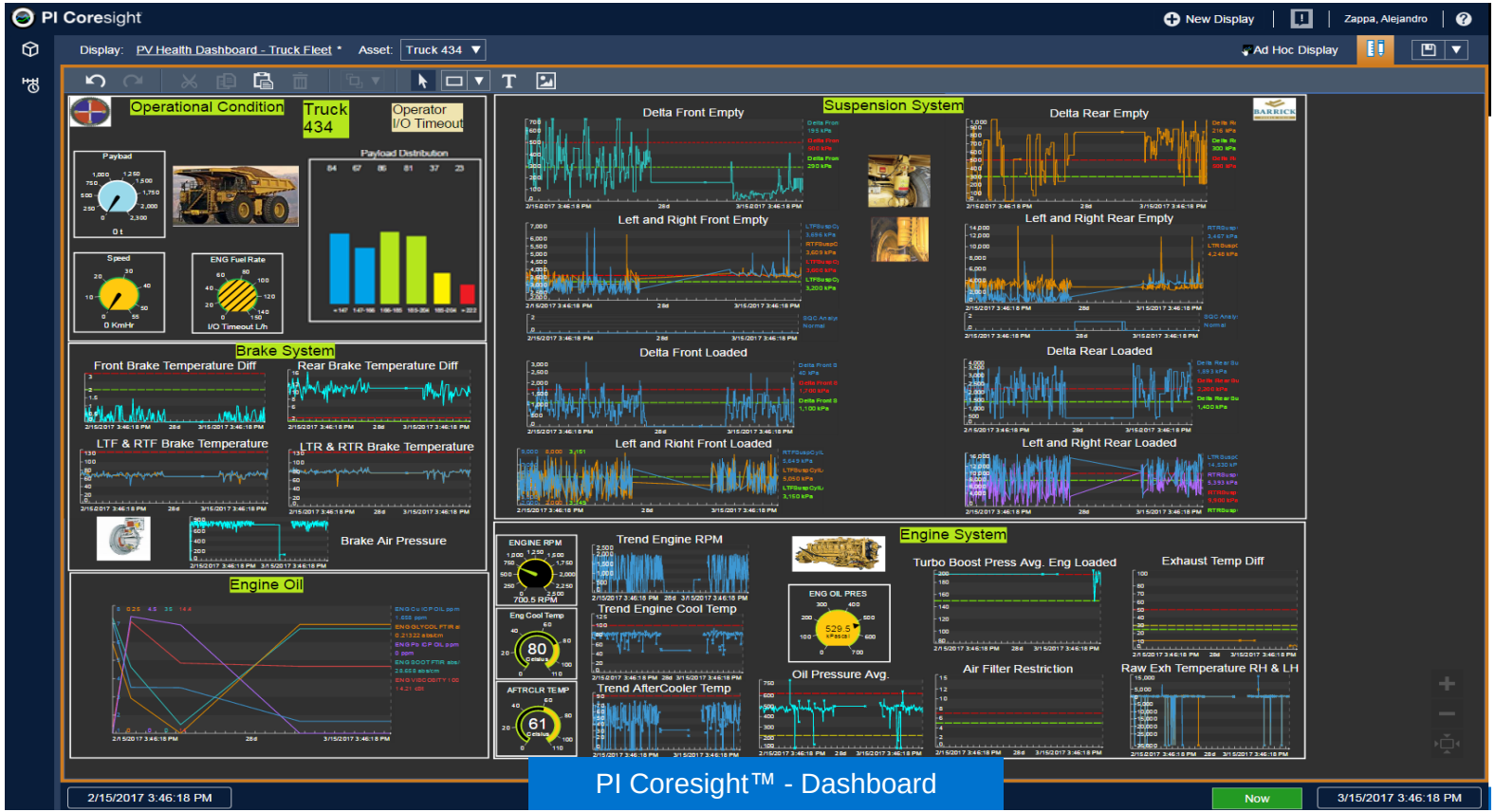


Evaluate

Name	Expression	Value at Evaluatic	Value at Last Trigger	Output Attribute
RearPressEmpty	if 'Payload Status'= 6 AND 'GROUND SPD - Speed'>= 12 t			RearSuspPressTravelingEmpty
	if 'Payload Status'= 6 AND 'GROUND SPD - Speed'>= 12 then (if Abs('RTR-LTR SUSPCYL') > 8000 then NoOutput() else Abs('RTR-LTR SUSPCYL')) else NoOutput()			
RearPressAvgEmpty	TagAvg('RearSuspPressTravelingEmpty','*-4h','*')			Delta Rear Suspension Press Average Empty

Benefits on this Analysis:
- To Schedule Down Time for suspension cylinders pressure adjust.
- Cost Un-schedule vs Schedule is 2:1

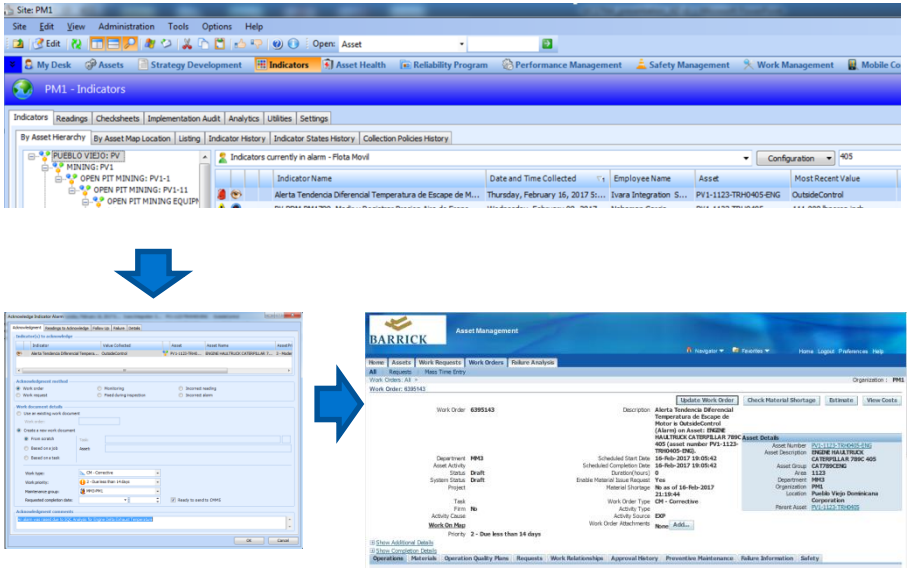
Displaying the data



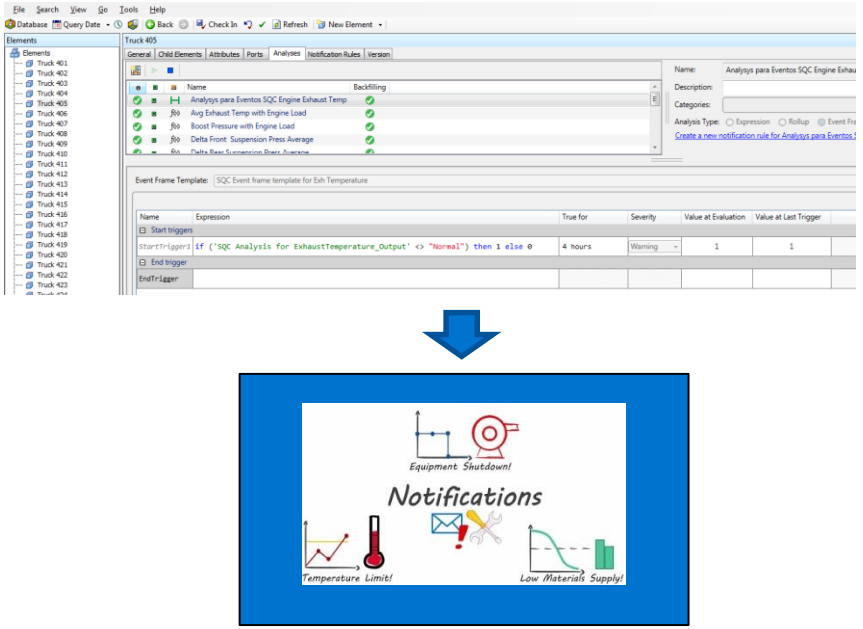
PI Coresight™ - Dashboard

Sending Alerts to End Users and triggering Work Orders

- Using PI System to APM Plug-in to trigger WOs in Oracle eAM



- Triggering Event Alerts using Notifications



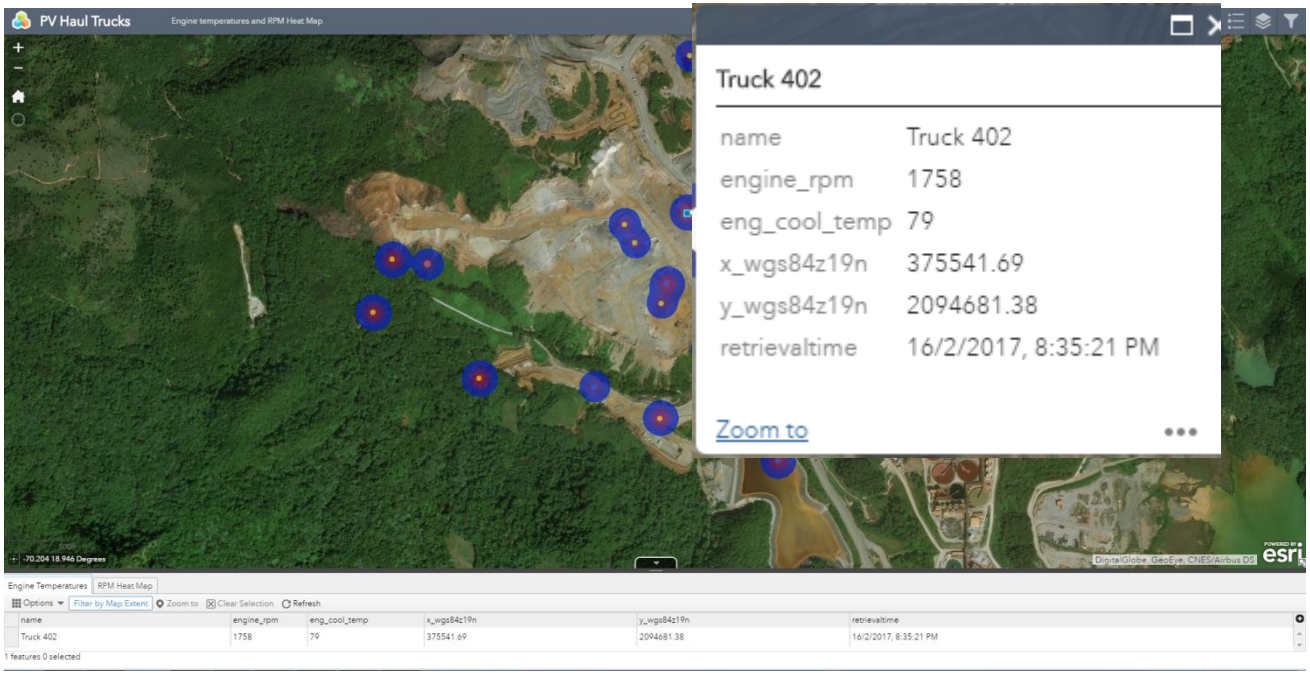
Change Management

- Maintain communication with stakeholders.
- Involve end users and subject matter expert during the development.
- Showing the end users the benefits in real time.
- Collecting and adjusting information to eliminate false positives.
- Develop a formal process for decision making.
- Tracking and communicating realized benefits.

Future

- Esri ArcGIS and PI System integration will enable us to do Operational Performance Analysis in real time.

Example: Monitoring Engine Temperature to detect Where and Why and check if they are related to certain operational behaviors

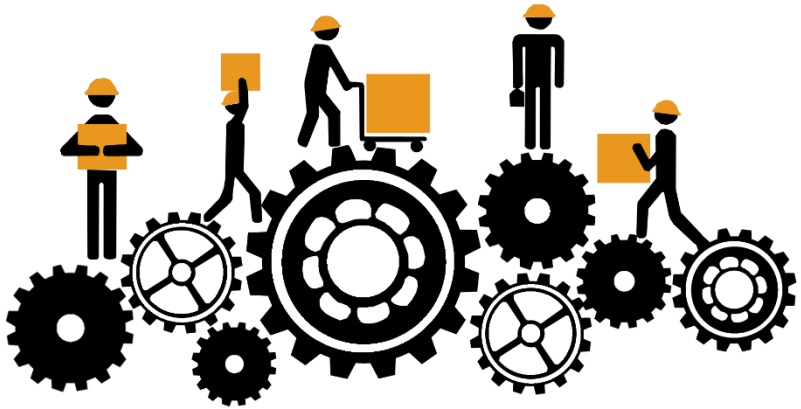


Benefits so far

- Reduced Risk. Less people exposed to hazards in the field.
- Improved information quality and data analysis.
- Faster analysis of large amounts of data and more accurate results.
- Increased capacity for early detection of potential failures.
- Reduced number of potential failures (increased) MTBF.
- Reduced response time (reduced MTTR).
- Contributed to improved Reliability and Availability.
- Contributed to Maintenance and Downtime Cost reduction.

It’s a Team Work

- Field Maintenance Team
- Reliability Engineering
- Fleet Management Dispatch
- Mining Information Technology
- Vendors (OSIsoft ™, Caterpillar™, HexagonMining™, Bentley™)



Using PI System for Real-Time Haul Truck Health Monitoring

COMPANY and GOAL

Barrick Gold Pueblo Viejo, the largest producer of gold in the Caribbean, wanted to improve the Asset Health Monitoring system for the Haul Truck fleet using real-time information to Improve Maintenance Efficiency and Costs.

CHALLENGE

To provide real-time information of 34 Haul Truck using the installed systems & minimum Investment.

- Reliability, Monitoring Condition, Maintenance and Planners often relied on incomplete or delayed information to make decisions rather than on real time data.

SOLUTION

On-board sensor information of haul truck are processed in real-time Using PI System, notifying about potential failures in real-time .

- "We used to use the in-vehicle sensors to investigate, post-mortem, why a truck failure had happened"
- “Now We can be one step ahead of a failure and be more proactive”

RESULTS

Reliability was increased, maintenance and availability were optimized and capacity to detect potential failures was improved.

- Able to detect & address failures
- Scalability to other fleet and sites
- Cost avoidance over $ 500,000 (Estimate in 2nd half of 2017)
- Reduce # of failures by 30% in Engine, Suspensions and Brakes

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Questions

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谢谢

Danke

Merci

Gracias

Thank You

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Спасибо

Obrigado