

About SSR Mining



Our Operations

PRODUCTION

Marigold Mine	
United States	т
Seabee Gold Operation	1.0
Canada	т
Puna Operations	
Argentina	т

DEVELOPMENT

San Luis Peru	+
Pitarrilla Mexico	+

EXPLORATION

Amisk	+
Canada	•
Candelaria	
United States	
Maverick Springs	1
United States	Т
San Marcial	
Mexico	-
Sunrise Lake	
Canada	т



Mid tier Precious metals producer with operations and exploration projects throughout North and South America

2017 Gold Equivalent Production +370,000 oz AuEq

Strong focus on improving throughput while reducing cash cost



The Mine where we want to make the changes





Marigold Mine



- Marigold is located 3 hours drive east of in Nevada
- Open pit, run-of-mine heap leach gold operation
- Produced 200,000+ gold ounces per annum
- ~200,000 tonnes of material moved per day
- Mine operates a mixed fleet of haul trucks, shovels, drills and support equipment
- Shovels and production loader:
 - P&H 4100 XPC (Joy Global) Electric Shovel (343)
 - 2 Hitachi EX5500 Diesel Shovel (340, 341)
- Haul trucks:
 - 6 Hitachi EH5000 ACI (470, 471, ..., 475)
 - 6 Hitachi EH5000 ACII (476, 477, ..., 481)
 - 9 Komatsu 930E (482, 483, ..., 491)
- Drills:
 - 2 Atlas Copco DML45, 2 Pit Viper drills



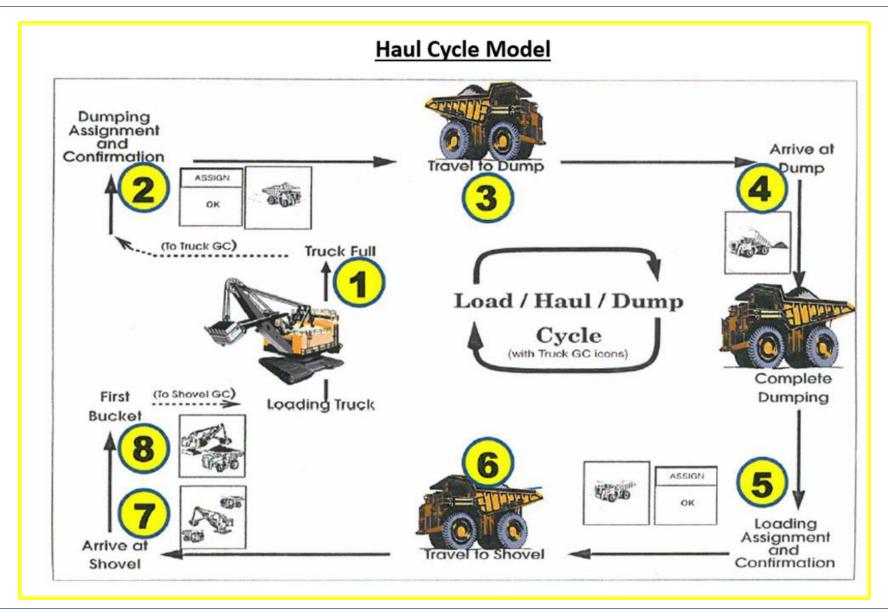
What do you think happens when a truck breaks down.. SSR





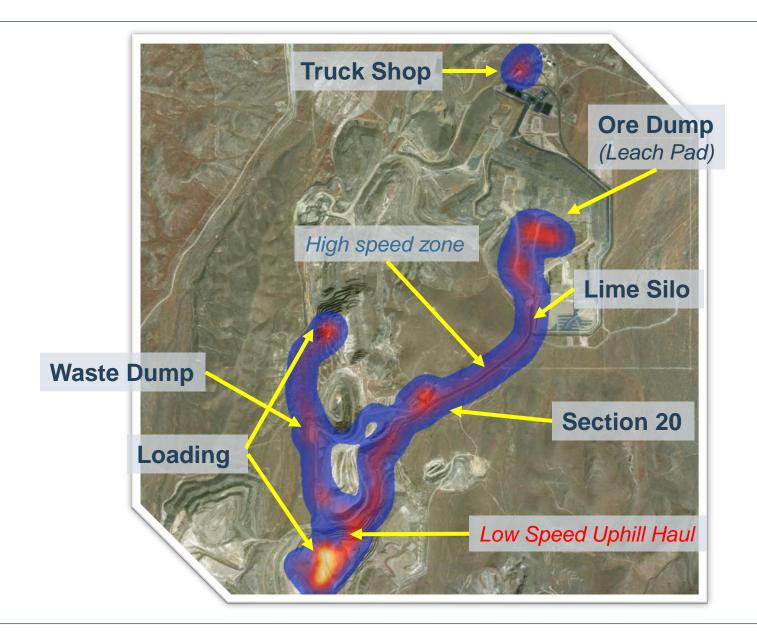
Marigold Mine Mining Process





Plan View of the Mine – How the mining cycle works





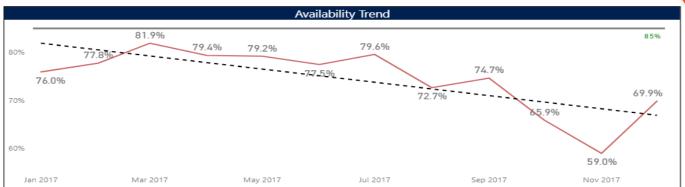


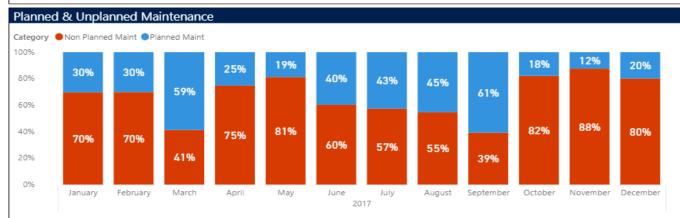
Predictive Maintenance Challenge

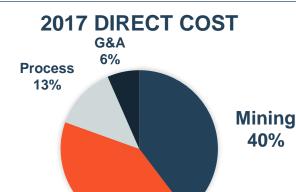
Why Predictive Maintenance is important



- In 2017, 41% of Marigold total direct cost went toward equipment maintenance
- Haul truck availability is decreasing due to high unplanned downtime



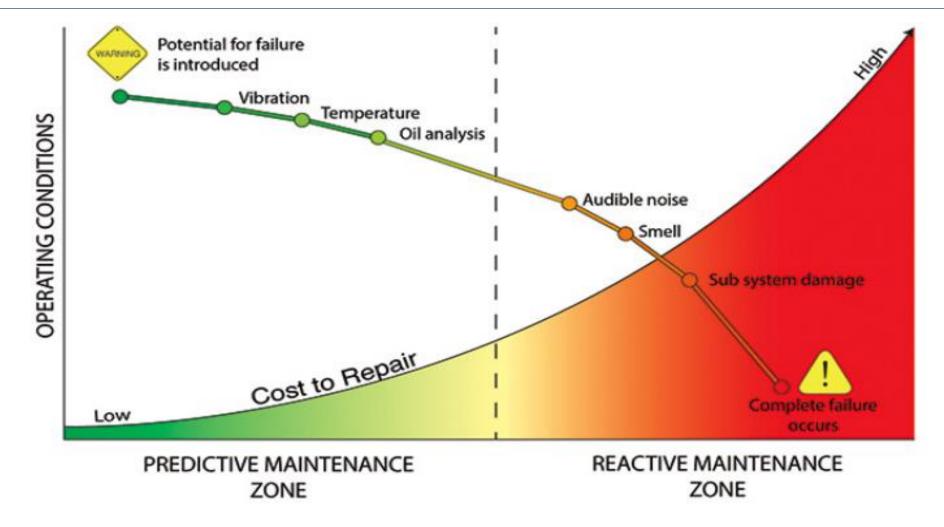




Maintenance 41%

Why Predictive Maintenance is important





- ✓ Predictive is proactive
- ✓ Safety, certainty, planning, production, cost, right place right time in the cycle.

Dataset – Where are the data coming from



The dataset covers 12 months (May 2017 – Apr 2018) worth of equipment identifiers, time profiles, production, performance, alarms and work order history. The 3 systems used are:

- Dispatch: This dataset contains haul truck production summary (Equipment IDs, Tons moved, distance traveled and cycle time) and equipment time profile (operative, delays, downtime, idle time, and standby) along with downtime reasons and comments
- Minecare: This data set contains haul truck sensors data, alarms and alerts history
- eMaint: Maintenance Work order history which includes work order time, downtime type, work type, equipment and components and parts usage

We've made some improvements since the Hackathon..

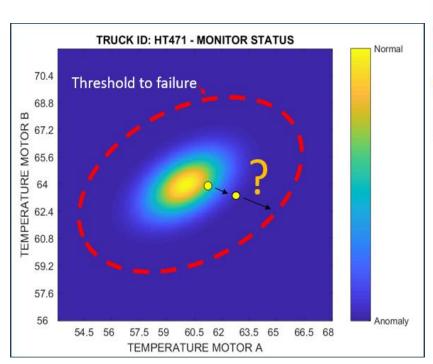


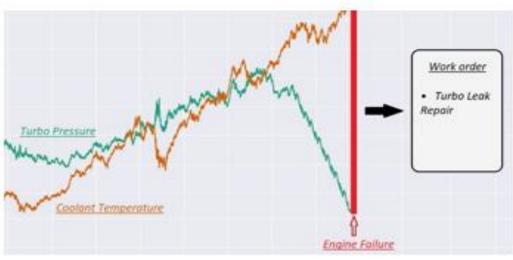
- Updated dataset from May 2017 April 2018
- Narrowed dataset to just one haul truck fleet (i.e. Hitachi EH5000 ACII)
- More sensors data due to better connectivity and higher usage of the Minecare software. However, the sensor data is not continuous and is event triggered
- Clean up the dataset by removing unnecessary columns
- Added more details on the Work Order file of sub components and failure modes for non-PM and non-routine work
- Better able to explain data connection among data sources

Potential Areas to Explore



Predict the failure type and the specific parts need to be repaired.



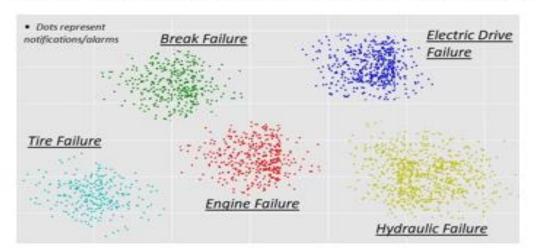


https://docs.microsoft.com/en-us/azure/machine-learning/team-data-science-process/cortana-analytics-playbook-predictive-maintenance

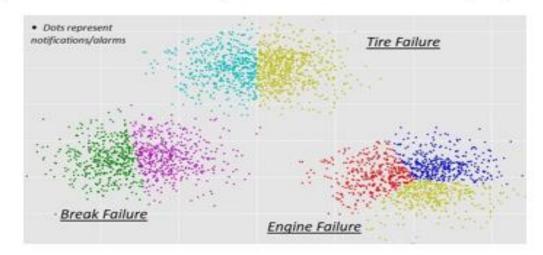
Potential Areas to Explore



- Cluster the notifications / alarms to match with the equipment failures.
 - Single notification / alarm causes the failure event. (One to one mapping)



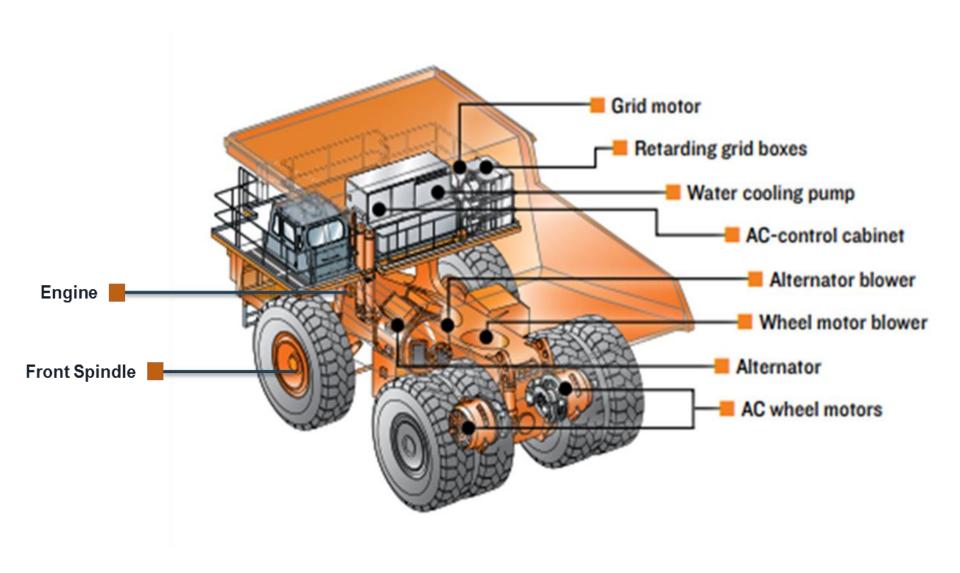
Multiple notifications / alarms together cause a failure event. (Multiple to one mapping)



Predict how many hours / days before a specific part of the truck fails.

Haul Truck Components

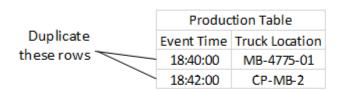




Known Challenges



Connecting data from different data sources with different time frame.





Production Table		
Time	Truck Location	
18:40:00	MB-4775-01	
18:41:00	MB-4775-01	
18:42:00	CP-MB-2	
18:43:00	CP-MB-2	

Engine Speed
1361.375
1361.375
1361.375
1348.875
1349.25
1266.375
972.375
761.375

Group each and Calculate the averages

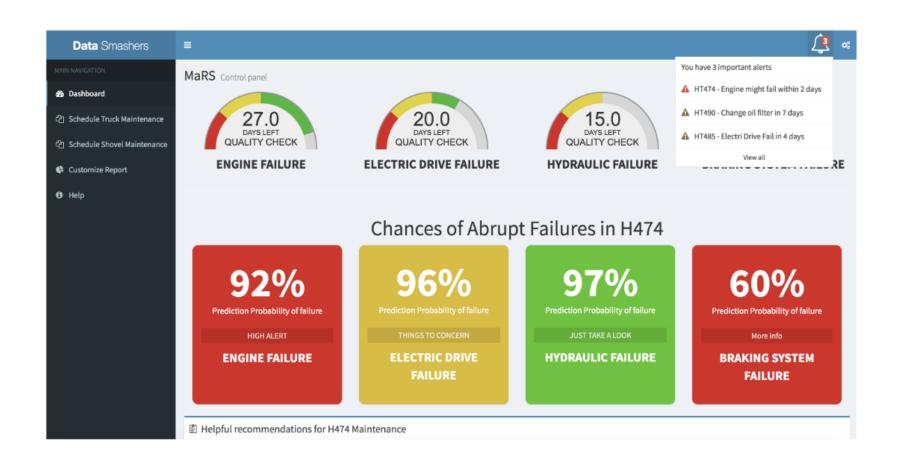
Machine Data Table		
Time	Average Engine Speed	
18:40:00	1361.375	
18:41:00	1355.125	
18:42:00	1307.8125	
18:43:00	866.875	

Join Together

Joined Table		
Time	Truck Location	Average Engine Speed
18:40:00	MB-4775-01	1361.375
18:41:00	MB-4775-01	1355.125
18:42:00	CP-MB-2	1307.8125
18:43:00	CP-MB-2	866.875

Sample Results







Thank you

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