MOBILE EQUIPMENT DATA ANALYTICS
CMIC National Mining Innovation Summit
June 4th 2019
<table>
<thead>
<tr>
<th>SURFACE MINING ROADMAP</th>
<th>IMPROVE PREDICTIVE ANALYTICS OF EQUIPMENT AND MINING PROCESS PERFORMANCE</th>
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<tbody>
<tr>
<td><strong>1. Improve ore body knowledge</strong></td>
<td>Adopt coiled drill techniques</td>
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<td><strong>2. Integrated mine design, planning and scheduling</strong></td>
<td>Integrate all ore body data into one common spatial database &amp; planning platform</td>
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<td><strong>3. Selective mining</strong></td>
<td>Explore continuous cutting machines for bulk mining</td>
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<td><strong>4. Alternative hauling technologies</strong></td>
<td>Decouple truck and shovel interface with loading buffer (surge loader)</td>
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<td><strong>5. Modular mining</strong></td>
<td>Develop modular equipment that can be containerized for easy transport and on-site assembly</td>
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<td><strong>6. Integrated operations with intelligent work environment</strong></td>
<td>Establish digital twins of all equipment as well as full mine and operations</td>
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<td><strong>7. Automation</strong></td>
<td>Automate back-office processes</td>
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<td><strong>8. Electrification &amp; renewable resources</strong></td>
<td>Electrification of all mining processes</td>
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<td><strong>9. Transact more efficiently</strong></td>
<td>Use blockchain (BC) to track ore mined throughout the value chain</td>
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<tr>
<td><strong>10. Improve Water Treatment &amp; Management</strong></td>
<td>Implement digital water monitoring and automated management</td>
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MINE MOBILE EQUIPMENT AT SYNCRUDE

- In the early 90’s Syncrude began to transition its fleet from Dragline, Bucket-Wheel operation...
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**MINE MOBILE EQUIPMENT AT SYNCRUDE**

- ...to the current truck and shovel operation

- ~130 Ultra Class Haul Trucks (400t)
- 20 large face shovels
- 300+ mobile support equipment
HAUL TRUCK MAINTENANCE STRATEGIES

- Maintenance costs have increased significantly over the past 10 years
  - Labour, consumables and components.

- Maintenance plans have been stagnant
  - Conservative calendar based scheduling.
  - 21 day cycle regardless of utilization, equipment duty and component condition.
  - Fleet scheduling challenging – size of fleet, production and resource constraints.

- Operating costs have increased.
  - Labour, fuel, environmental considerations.

- Capital costs have increased
  - Trucks cost more.
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TIME BASED PREVENTATIVE MAINTENANCE TO OPTIMIZED CONDITION BASED MAINTENANCE

- **Background**
  - Maintenance intervals calendar based including oil changes and oil sample and testing of component condition.

- **Objective** – optimize oil change frequencies
  - Understand lubricant degradation.
  - Validate component benchmarks.
  - Can we use this data to improve condition monitoring program.

- **Scope** – work with Queens University Centre for Advance Computing
  - Provide data – oil sample analysis, component condition on select Ultraclass Haul Truck drive train components.
  - Identify indicators, build model and determine optimal maintenance program.

Big Data -> Advanced Data Analytics -> Information -> Decisions
HAUL TRUCK MAINTENANCE STRATEGIES

- **Opportunity**
  - Reduce services by 10%
  - Increase availability ½ to 1%
  - Avoid major component failures
MOBILE EQUIPMENT DATA ANALYTICS PROJECT

Purpose

- Identify indicators in oil analysis data to assess the current maintenance program.
  - Provide used oil analysis from six ultra class haul trucks – upper powertrain (torque, transmission and engine).
  - Identify trends on engine oil change frequency.
  - Identify failure modes and leading indicators of failure.
  - Understand lubricant life degradation.
- Optimize the program to maximize the equipment productivity capacity.
- Change the current “fixed timing” maintenance schedule to automated scheduling and reduce maintenance costs.

Method

- Apply data analytics process.
- Predictive models w/ learning algorithm.
- Time series forecasting model.

Big Data -> Advanced Data Analytics -> Information -> Decisions
THE DATA ANALYTICS PROCESS

Cross Industry Standard Process for Data Mining (CRISP-DM)
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EXAMPLE: TIME SERIES FORECASTING MODELS

![Diagram showing a learning algorithm with inputs and outputs.](image)
MOBILE EQUIPMENT ANALYTICS

MULTI-VARIANT TEMPORAL DATA – WHEN AND WHAT

**Sampling Interval**
- Median: 350hrs (Min: 190hrs – Max: 558hrs)

**Oil Hours on Oil Change**
- Median: 1,715hrs (Min: 101hrs – Max: 3,976hrs)
## STATUS AND NEXT STEPS

- **Analysis – confidence model taking form**
  - Influence is calculated as the correlation between each attribute.
  - Most influential attributes defined.
  - Data problems highlighted.

- **Early results indicate:**
  - The majority of our powertrain components were being “under serviced” and the majority of the engines were being “over serviced”.
  - Engine Oil is changed every other sample, not enough data to find if oil would have remained operational for longer.

- **Next steps – enhance the predictive model accuracy:**
  - Data cleansing to fix anomalies.
  - Increase data set with more units to improve the statistical model predictability.
  - Generate new features with more influence on the decision to change oil.
  - Build time series forecasting for oil changes.
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PATH FORWARD

- Results to be shared with the CMIC Surface Mining Working Group.
- Expand to demonstration pilot
  - More equipment – more data.
- Plan for commercialization
  - Engage appropriate vendors.

- Syncrude Digitalization Strategy
  - World Class Maintenance and Reliability Management.
THANK YOU!