Application of 
Big Data solution to 
mining analytics
Big Data Analytics is now a big blip on the radar of the mining industry. In a recent survey that included 10 of the Top 20 global mining companies, the Mining Journal said that Big Data Analytics would spur the next wave of efficiency gains in ore extraction, analysis, transportation, and processing, by enabling faster and better-informed decisions at all levels.

In a competitive market, every effort to improve margins using operational intelligence is necessary. That is why analytics is expected to play a significant role in driving better asset utilization, boost productivity and address material flow delays.

Helping achieve this goal are sensors embedded across mining operations. These sensors are generating vast amounts of geoscientific, asset condition and operational data in real time. This data can be analyzed using parallel processing and faster distribution of intelligence to stakeholders.

It is possible to do this because modern Big Data platforms can assimilate vast amounts of heterogeneous, real-time inputs from multiple sources. These, in turn, extract real-time predictive and prescriptive analytics to drive operational excellence.

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### Figure 1: Big Data Analytics Solution Framework

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<thead>
<tr>
<th>Consumption Layer</th>
<th>Analysis Layer</th>
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<tbody>
<tr>
<td>Adhoc Discovery and Visualization</td>
<td>Complex Event Processing</td>
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<td>Business Process Management</td>
<td>Machine Learning/NLP</td>
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<td>Mining Remote Operations Control Room – Real-time Monitoring</td>
<td>Real-time Scored Results</td>
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<td>Business Alerts</td>
<td>Decision Management</td>
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<td>Real-time Data Navigation</td>
<td>Recommendation Engine</td>
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<td>Operational KPIs</td>
<td>Model Management</td>
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<td>Reporting Engine</td>
<td>Predictive Model / Statistical Model</td>
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<tr>
<th>Big Data Messaging &amp; Storage Layer</th>
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<td>Data Acquisition</td>
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<table>
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<tr>
<th>Big Data Source</th>
<th>Structured, Semi-structured and Unstructured</th>
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<td>Direct Data Store</td>
<td>Mining OT Systems (Ancillary Systems)</td>
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<td>GPS Data</td>
<td>Dispatch</td>
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<td>Geoscientific Data</td>
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<td>Drill &amp; Blasting</td>
<td>Rail Track System</td>
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<td>Asset Condition Monitoring</td>
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<td>Ore Geomodeling</td>
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2
Interventions across mining processes

Material process flow plays a significant role in the mining value chain. This includes analyzing the impact of unscheduled events owing to mechanical breakdowns of LHDs, trucks and critical transportation medium, queuing time, and such overheads. Numerous other causal variables can be analyzed for impact on production throughput on a daily/monthly basis using techniques such as Machine Learning, Continuous Pattern Matching and Statistical Predictive Model.

Big Data Analytics Platform, equipped with these models, can leverage the value, volume, velocity, and variability of data, delivering several benefits across extraction, intermediate transportation, and final transport to plants. Figure 3 shows the causal data used at each process step to improve operational effectiveness and enable higher ore yields.

The mobile drill rigs of the future resemble a mobile surveying and sampling laboratory, which can collect, analyze and access massive volumes of complex geochemical and geophysical data. The data can sync with the central server for validation. QA/QC routines built into data collection mechanism ensure that it can identify the data quality problems at the source. The adoption of Big Data platform enables processing and analysis of complex and near real-time geochemical/geophysical data. The interpreted results from the analysis are communicated near real-time to survey geologists.

Aside from providing insights for decision-making, the Big Data Analytics Platform can also provide prescriptive solutions around decisions (for an example see, Figure 2).
Causal processes

**Figure 3: Causal and Correlation Analysis using Big Data**

- **Value**: Improved Production
  - Causal Analysis to identify process bottlenecks
  - Control variability in the process

- **Variability**: Heterogeneity of data from Dispatch Control Systems, Fleet Management Systems and SCADA

- **Velocity**: Frequency of data change is real-time ETL batch process driven

- **Volume**: Historical data amounting to several terabytes for analysis

**Extraction**

- Causal Data
  - LHD Data
  - Productive Data
  - Extraction Points
  - Shift
  - Cycle Time
  - Operator

**Intermediate Transportation**

- Causal Data
  - Ore Pass
  - Operators
  - Piques Data
  - Cycle Time
  - LHD Data
  - Operator

**Final Transport at Plant**

- Causal Data
  - Ore Pass
  - Dumping Points
  - LHD Data
  - Equipment Condition

**Benefits**

- Optimized process flow
- On-time delivery of minerals to plant
- Higher throughput rate and cycle time
- Explicit view of performance alignment with Production KPI
Use cases for Big Data Analytics platform

LHD performing loading – hauling – dumping cycles from Extraction Point A to Dumping Point B for a given mine site in the transportation cycle time.
Mine Manager needs to identify and correlate typical causal variables impacting daily/monthly production variations:
(a) Effective operating hours of the LHD
(b) Available hours
(c) Scheduled hours
(d) Utilization %

Cost of unplanned and mechanical outages of trucks is a big expense on mining companies. Typical parameters that drive the maintenance cost are as follows to name a few of the variables:
(a) Engine oil pressure
(b) Engine oil temperature
(c) Hydraulics oil temperature
(d) Transmission oil pressure
(e) Transmission oil temperature
(f) Coolant temperature
(g) Break changing pressure

Using Big Data Analytics platform it is possible to identify machine patterns and predictive models to do proactive maintenance of trucks.
Find the value

The mining industry can derive several critical business benefits from Big Data Analytics. These include:

- Ensuring continuous flow of material from ore extraction point to the processing plant
- Maximizing ores hauled by optimizing bottlenecks in production
- Reducing non-productive time between unit operations, such as unscheduled maintenance, delays, wastage and waiting time
- Helping management make informed decisions on the “As-Is” production process, covering the value chain from extraction to delivery at plants and beyond
- Providing on-the-fly results and interpretation analysis to field geoscientists to take informed decisions

For organizations considering such a platform, ensuring a low total cost of ownership without vendor lock-in and the ability to scale horizontally are important considerations.

The critical success factors behind adoption of Big Data analytics platform is to simplify, scale and optimize cost of survey, analysis, interpretation and quick dissemination of data on lines of mobile drill rigs.

About the Author

Sandipan Chakraborti
Associate Partner – Energy, Natural Resources & Utilities, Wipro Limited

His work involves architecting presales solutions, realizing architectures through projects and engaging with customers for proof of concepts. Sandipan has over 18 years of experience in areas of consulting, presales and delivery. Prior to working with Wipro, he was a Principal Consultant in the strategy and architecture unit of a leading global consulting organization. He can be reached at sandipan.chakraborti@wipro.com
Wipro Limited
Doddakannelli, Sarjapur Road,
Bangalore-560 035,
India
Tel: +91 (80) 2844 0011
Fax: +91 (80) 2844 0256
wipro.com

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