"Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)"

Real-time optimization of extraction and the logistic process in highly complex geological and selective mining settings

in short

Real-Time Mining

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Dissemination Level: Public

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Real-Time Mining Process Flow Analysis

The aim of REAL-TIME-MINING (RTM) project is to develop a novel framework for real-time-process reconciliation and optimization of mineral resource extraction in highly complex geological settings, particularly for scenarios when selective mining is required. Such a framework requires a paradigm change from discontinuous intermittent process monitoring and control to a continuous closed-loop process management system enabled by high frequency sensor data acquisition and system state updating.

A generalised process flow map was developed for the key application scenario in selective underground mining operations. The map supports;

- Holistic system view of mine production in the RTM paradigm
- Common understanding of mining process components and interactions
- Clarity regarding data acquisition, data management requirements, modelling tasks and optimization options along the underground production chain
- Visibility of responsibilities and collaborative areas for the work packages (WPs)

The process map is appended to this document and consists of the standard underground production process chain, spanning from a block becoming available for mining to the mined product stockpiles. Crushing was incorporated as it is very common in todays underground mines. Sorting was added as it fits well into the RTM concept and has been applied successfully in a number of commodities and mines. Supporting processes such as scaling, cleaning, rock-bolting have been omitted.

Applying the RTM concept, the map incorporates a variety of data acquisition, modelling and control processes. The mining process is utilised to gather additional data regarding rock characterisation and the state mining process where and when possible. Data is modelled to deliver information for improved decision making as mining, haulage and basic processing proceed.

Note that most of the information related processes are part of todays mining operations in some form or other. However, typically the information is only available to operators within more or less ilo'ed parts within the mine; further information usage is usually generalised with local optimization opportunities being missed.

For the WPs referenced in the process map, please refer to the RTM project proposal.

Cyclic Underground Mining – Future State

Osterholt & Benndorf (Nov 2015): Real-Time Mining Process Flow Analysis.

Process nodes (top flow): Face available → Schedule → Drilling → Blasting → Muck pile → LHD → Transfer → LHD → Bin → Chrushing → Conveying → Sorting → Destination → Waste / Stock pile A / Stock pile B / Stock pile C

Decision nodes: Load Sequence, Load Sequence, Crusher ops control, Grain is Waste? (Yes / No), Processing control

Sub-processes: Face sampling, Face imaging, Ore Type Classification, Drillhole Logging, Drill Performance Monitoring, Update powder factor, Imaging, Imaging / Load Monitoring, Imaging / Load Monitoring, Machine Performance Monitoring, Material Scanning, Material Scanning

Data storage: Sensor data, Sensor data, Machine data, Image data, LHD data, LHD data, Crusher data, Sensor data, Sensor data

Data / Models: Resource Model, Grade data, Grade, geometry, geomet, hardness, GC Model, Grade, geometry, geomet, Hardness, Blastblock Model, Fragmentation, geomet, grade, Muckpile Model, Fragmentation, geomet, grade, SP Model, Fragmentation, geomet, grade, CR Feed Model, Hardness, Fragmentation, geomet, grade, Grain level data, Stockpile model

Modelling: GC Modelling, Blast design, Blastblock Modelling, Muckpile Modelling, Stockpile Modelling, Crusher feed modelling, Crusher out Modelling

Lab: x days delay

Legend

WP2 | WP3 | WP4 | WP5 | WP6 | WP7 | WP8

Production Control

- - -> Information Flow
— Mass Flow

Process | Decision | Data Storage | Data (Points) | Data (3/4D Models) | Inventory | Delay | Current Data and Info Flow

Diagram detail (bottom right): Drill Hole, Core Sample, FACE, Step 2 – Ore Removal, LHD (Load-Haul-Dump), Muckpile & Fragmentation, Ore Transfer, BIN, CRUSHER, A, B, C