Why do projects go wrong and what systemic risks exist in the current design process?

Processing

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Location: Webinar

Processing Systematic Risks and Reasons for Project Underperformance.

1. Failure to link sample selection with Project Phase Objectives
2. Design based upon simplistic LOM financial model fixed assumptions.
3. Project development lacks multiple sequential trade off studies (+/-35%) to permit flowsheet options to be eliminated at an early stage. To much reliance on technical perfection.
4. Not using multi-element geochemistry as a metallurgical proxy.
5. Lack of focus on pre-concentration of ores prior to extraction of metals.
6. Lack of focus on importance of comminution sample selection & testing
7. Too much focus on minimising capital cost.
8. Poor use or understanding of Key Performance Indicators “KPI’s” and Processing Dashboard, especially to analyse operational data for post mortem analysis and future production forecasting.

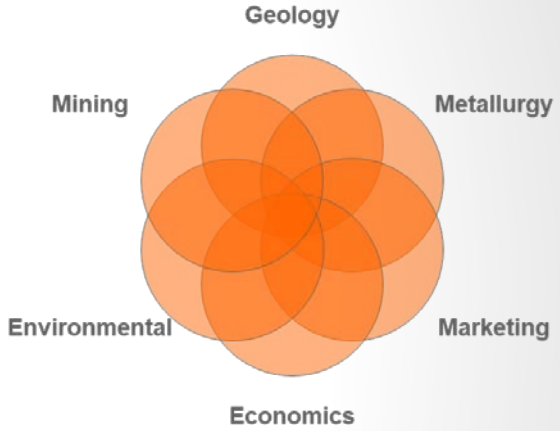
Sample Selection – Very Dependent upon Project Phase

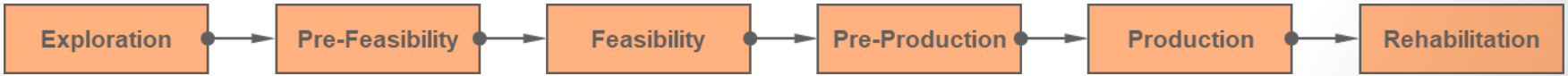
	Objectives	Test Sample Required	Trade off Studies	Economic Evaluation
Scoping	Select Optimum Conceptual Flowsheet(s)	Composites	Required to evaluate optimum flowsheet Grinding circuit and metal extraction circuit	Select Best Flowsheet(s)
Pre-Feasibility	Optimise the selected flowsheet process parameters.	Composites Individual Core Intervals	Optimum comminution configuration Optimise flowsheet unit processes	Optimum Flowsheet
Feasibility	Finalise all optimisation. Understand ore variability by mine, domain, lithology.	Bulk Sample (Case Specific) Normally Composites Individual Core Intervals	Ensuring the PFS design is completely optimised.	Final Detailed engineering economic evaluation

Greenfield
Typically 3-4yrs
Brownfield
Typically 2yrs

GeoMetallurgical Integrated Approach

- Most projects fail because of a lack of understanding of how the different lithologies, textures and other geological attributes link with metal extraction and operating costs and grinding circuit selection and design.
- Drilling is expensive and a common problem observed is that the core is frequently all consumed for large scale bulk (5-20 tonnes) test-work programs that in many cases are not required.
- The results of many individual recovery values from a set of samples is far more valuable and useful than the single recovery value from an “averaged” sample





Geometallurgical Integrated Approach

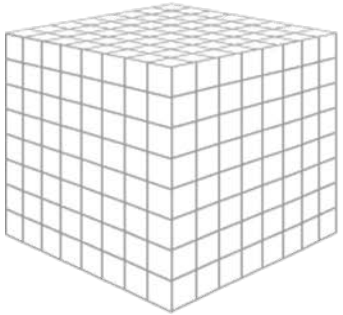
- Global best practice over the last 15-20yrs has employed increasingly smaller scale testing in conjunction with statistics and well proven software packages. Large bulk samples and pilot plants ONLY used where absolutely necessary to de-risk metallurgy.

- This trend has led to more sophisticated mine schedule optimisation programs being developed to deal with complex mining scenarios (e.g. Deswik, Minemax)

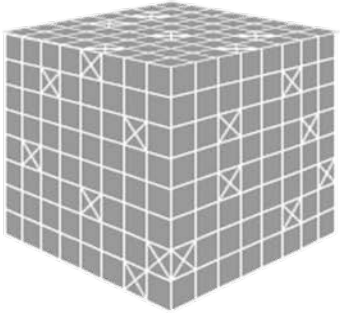
- Russian State Reglament documents tend to be focus the mine owners upon a fixed Life of Mine (“LOM”) grade of ore at fixed metal recovery, fixed operating cost and fixed grinding circuit throughput rates providing one fixed outcome. This never happens in practice.

- This mindset can create over simplistic adoption of fixed single inputs and outputs UNLESS the mine owner has adopted more sophisticated Geometallurgical techniques.

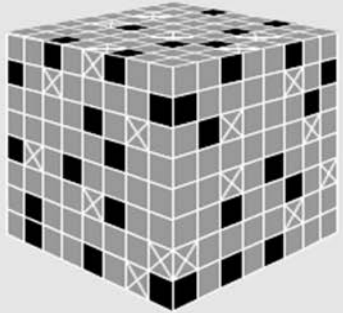
Inexpensive Methods of Populating Block Models



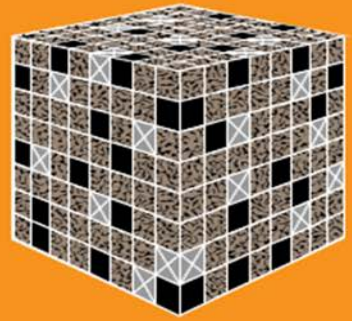
Test Data



Correlation and Regression Data



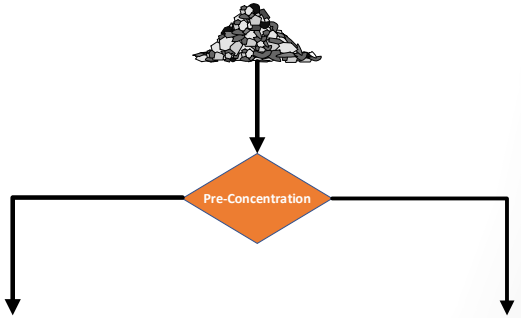
Data Distribution to block model



Pre-concentration of Ores – Ore Sorting is good technology for Russia.

- Russia is the biggest country in the world and still has vast areas that have no infrastructure.
- Processing costs in remote parts of Russia (Chukotka) tend to be extremely high
- Removing a large proportion of the waste rocks BEFORE the more expensive grinding and metal extraction processing plant significantly leverages project economics.
- The upstream mining benefits are as big if not bigger than the more obvious downstream operating cost benefits.
- Ore Sorting is a growth industry elsewhere in the world due to lower ROM feed grades.

Rock Differences	Sensor	Applications
Colour	Photometric	Base metals, gold, industrial minerals, gem stones
Atomic Density	X Ray Transmission	Base metals, gold associated with sulphides
Quartz Veins	Laser	Precious Metal hosted in Quartz Veins
Radiometric	Natural Gamma Radiation	Uranium, precious metals

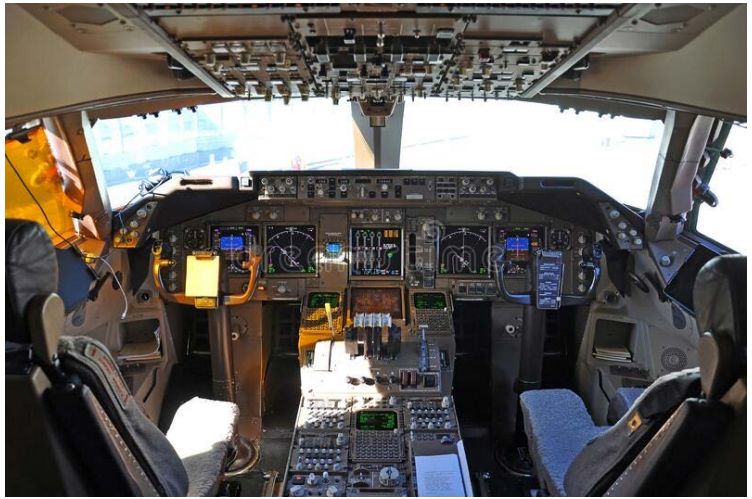


Comminution Circuit Selection & Design.

1. The comminution circuit will be the single biggest capital cost and operating cost that mine owners have to make
2. Comminution circuit selection is a key component of Scoping and/or PFS at very latest.
3. Testwork MUST be designed based upon the major lithologies and/or domains and utilise multiple samples from discretely selected diamond drill core.

Process Data Dashboards.

1. Operational and Metallurgical Data analysis is critical for ongoing performance tracking and using correlation analysis for understanding interdependencies.
2. To achieve this, it is vital that all data is in one dashboard that contains data from Crushing and Grinding, Metal Extraction and Metal Accounting……so that it is easy to review and audit.
3. This data base is vital for good operational report writing and for future budgeting when linked with test results on future ore types or blocks.



Processing Risks – Conclusions

1. Sample selection criteria is too focused upon technical metallurgical excellence on one or two big samples that consume tonnes of valuable drill core.
2. The flowsheet development phases can continue to look at different flowsheets in late stages and even in latter stage if the processing phase objectives are not followed correctly.
3. Process flowsheet development tend to lack sufficient trade off studies and ongoing commercial appraisal throughout the studies……reduce technical perfection…..increase economic and practical operational focus.
4. Projects tend to over simplify the financial model inputs, this is overcome if a geometallurgical approach is applied for very first drilling program. This approach does not stop on plant start up, it continues for LOM.
5. Full Multi element Geochemistry when linked with metallurgical data can provide excellent low cost, low core weight at Greenfield and as an ongoing brownfield production forecasting tool.
6. DO consider pre-concentration of ores as part of the scoping study in greenfield and/or for brownfield project expansions specifically deal with future lower grade ore grades and/or poor mine/grade control.
7. Grinding Circuit Selection and Design is vitally important
8. Dashboards that are arranged in a sensible and logical structured way are vital for measuring plant performances.

Discussion

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