Integrated technical and financial stochastic modelling in open pit mining projects

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ABSTRACT

The standard practice in the mining industry is to carry out the technical and financial modeling as deterministic, independent, and separated stages. The first involves mineral resources and mine-planning modeling, used as inputs for financial modeling in the discounted cash flow (DCF).

The mine planning process does not exploit the uncertainty of technical variables such as lithofacies, grades, and metallurgical variables, nor the uncertainty from financial variables such as commodity prices and costs. The mine planning optimization is risk-neutral or indifferent to the risk and focuses on maximizing expected net present value without considering the shareholders' risk preferences.

On the financial side, the risk assessment uses a deterministic mine-plan and Monte Carlo simulation on the discounted cash flow inputs using probability distributions derived from conventions and expert judgment. This procedure does not use the uncertainty of the inherent variability and information level of the technical variables.

This study presents an approach of stochastic, open-pit optimization and financial appraisal, including technical and financial uncertainty and risk preferences as part of the mine design optimization process. The key aspect of the approach is the interpretation of each block's economic value as a financial security (stock), with a distribution derived from the stochastic simulation of technical and financial variables. This interpretation allows reframing mine plan optimization under a portfolio theory perspective to create mine plans as a portfolio of securities under risk preferences. The method is suitable for the final pit problem and the mine-schedule subject to plant capacity and mining constraints.

The approach is applied in a case study in a feasibility copper project; the results illustrate the impact of the technical and financial variables on the net present value uncertainty and reveal that the risk-return trade-off also applies to mine planning optimization and the financial modeling of mining projects.