

# Robust mine schedule optimisation

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## Abstract

*The identification of high-value, practical mine plans is a complex and challenging process. Mineral prices are a crucial factor to the value of a project and, due to the inherent volatility of the commodities market, also the most uncertain. Despite this reality, conventional planning processes don't sufficiently account for the financial uncertainty associated with mining assets. As a consequence, life-of-mine schedules must often be extensively revisited as the fiscal climate changes. The inherent financial uncertainty of mining projects presents a substantial risk to stakeholders and without proper mitigation can easily reduce the perceived and real value of a mining asset.*

*The risks associated with uncertainty can be mitigated through the creation of robust mine schedules. In this paper, two distinct approaches to creating robust, optimised long-term underground mine schedules will be presented. The Genetic Optimizer for Stochastic Problems (GOSP) method incorporates price distributions, rather than fixed projections, into the optimisation process. The Horizon method incorporates the concept of 'management flexibility' into the process of schedule optimisation. As will be demonstrated by a case study, these methods, when integrated with the Schedule Optimization Tool (SOT), produce robust, high net present value schedules for underground mining operations.*

**Keywords:** *robust mine planning, schedule optimisation, financial uncertainty, genetic algorithm*

## 1 Introduction

Even with investors and economists having developed a variety of commodity price-forecasting methodologies, current long-term and mid-term price-predicting practices remain unreliable. The range of current commodity price-forecasting approaches includes qualitative methods (judgemental forecasting), cost-reserve based methods, trend extrapolation methods, time series methods, causal models and even the use of futures markets. The selection of the correct price-forecasting technique is determined according to the time period under consideration (short, medium or long-term) since prices and trends relating to each of these time periods are driven by very different factors (Labys 2006). Regardless of the vast body of work pertaining to these concepts, as expressed by Van Rensburg (1978) and maintained by the findings of others (Dooley & Lenihan 2005; Bowman & Husain 2004), forecasting remains an art, rather than a science.

Without reliable price predictions, strategic mine plans are subject to a large amount of financial risk resulting from uncertainty. Despite these challenges, modern computing power gives planners the ability to mitigate the risks of price uncertainty without sacrificing high-value schedules. In this paper, two methods of robustly optimising underground mine schedules will be presented: the Genetic Optimizer for Stochastic Problems (GOSP) method and the Horizon method. Their applications as scheduling tools will be presented as a case study, which will demonstrate how financial risk can be reduced through robust schedule optimisation.

### 1.1 Mine planning software

Most scheduling software approaches the strategic planning process by dividing and categorising all major tasks associated with the development and production of a mining project. Usually referred to as activities, these tasks represent the major distinct actions to be carried out as a part of a mining operation. Activities

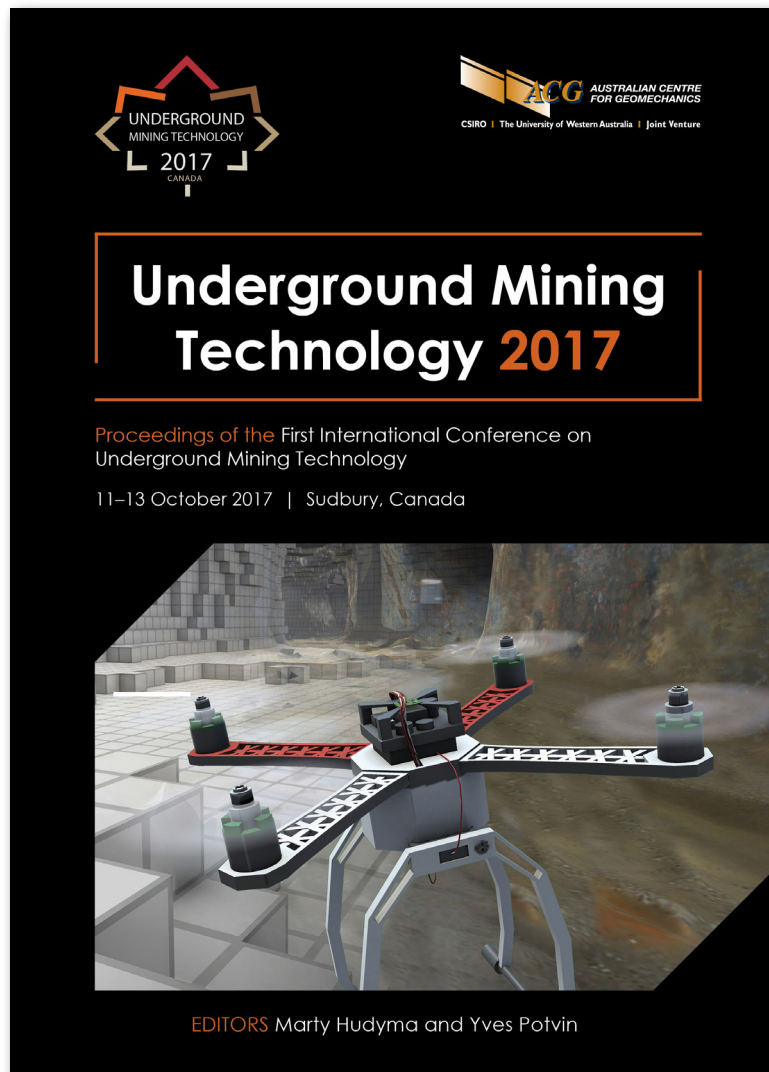
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From both these measures, it is apparent that Schedule B is the superior schedule when realistic and likely changes to initial schedules are considered. This conclusion contradicts those drawn using conventional valuation methods. This is significant as it demonstrates how consideration of real schedule options using the Horizon method during the valuation and risk assessment process can increase potential value that would have otherwise been lost.

### 3 Conclusion

Often an intended strategic plan cannot be implemented exactly as envisioned, and a major alteration to the schedule is made at some point during the life of the project. By applying the Horizon method to consider the various schedule options available to pursue for a candidate schedule, a better picture of the candidate's plan value and associated risk can be determined. As the results of the case study demonstrate, considering a schedule's real options can alter the choice of strategic plan by identifying a superior solution. Likewise, it was illustrated that without considering the real options of a schedule during the valuation and risk assessment process, potential project values may not be realised.

Similarly, by considering a variety of price scenarios within the schedule optimisation process, it was established that the risk resulting from commodity price uncertainty could be mitigated. Through the application of the GOSP method, schedules with a reduced below-target semivariance were generated. Moreover, the schedules produced in this manner exhibit superior NPV outcomes, when subject to various price scenarios, compared to those optimised from fixed price projections.

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