RPMGLOBAL

PERSPECTIVES

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INNOVATION IN MINING

SIMULATION AND PRODUCTION PLANNING

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Introduction

Mining companies are familiar with the ups and downs of the mining economy. However, in recent times, the large high and subsequent low fluctuations are hitting the industry hard. To compound the economic pressures, deposits are continually getting deeper and more complex to extract, and grades are lower.

The industry must meet consistent or rising production targets with a reduced cost of operation.

Whilst this is certainly a difficult situation, and it is no doubt challenging to find a means to meet this goal in each individual operation, innovation is key. Now, more than ever, it is time to think outside the square.

How can we meet our production targets, whilst maintaining consistent approach, mining methods and thinking, when the value for our mined resources is decreasing and the cost of extracting our resources is increasing?

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Problem Statement

There are many factors in play in mining that contribute to meeting production targets. Some examples include production planning and monitoring, equipment and its maintenance, labour and training, remote localities and logistics, mining techniques and continuous improvement. However, let's spend a moment considering just production planning and production statistics.

Most mining organisations create several mine plans or schedules, each covering a different range of time. These schedules will determine the intended production for the mine and are used for forecasting and also stakeholder considerations. It is critical they are accurate and achievable. The mines' stakeholders rely on the mine meeting those production targets for both current and future financial confidence. It is not anticipated that the mine will not achieve the production forecasts. However, due to the dynamic nature of mining, mining companies regularly do not actually meet the original production targets, and reforecasting and replanning is repeated multiple times during the production cycle. The more frequently replanning occurs, the less confidence stakeholders may have in the production originally forecasted. Ideally, production plans will be achievable and likely to be met when those plans are approved, released and implemented.

When the short term plan is created, many assumptions are included. These assumptions are based on the best known data at the time. Some assumptions are logical or relatively easy to estimate, such as fuel costs or payload. However, other assumptions are far more difficult to estimate, such as unplanned equipment breakdowns, or traffic congestion. All of these assumptions are included within the production planning process. However, given many of the assumptions have so much doubt, it starts to become more apparent that the plans will be less achievable. What would be ideal, is a method to determine the likelihood or probability of a plan to be achieved.

Common Processes

When a plan is released, it uses the best known assumptions, based on past data or 'tried and true' factors. The details that make up that plan are based on previous success or failures, and have been considered when creating the current plans. We expect that when we release our plans that they are achievable. However, in the back of every scheduler's mind, there is a niggling feeling that the plan they have released is not truly 100% accurate.

To compound this, whenever a problem occurs in production, short term fixes are required in order to maintain production. When this happens, the changes are usually decided quickly and it is assumed that the changes will rectify the problem, and that production rates will continue as or close to previously. An extreme example, but one that highlights the point perfectly, is a ground failure. If there is a rockfall in the mining operation, access to that mining location is temporarily blocked. In order to negotiate the rockfall and have production return to normal, decisions must be made quickly. Usually, an alternate mining location is selected, or an alternate access and haul route chosen. However, there is no guarantee that these changes will assist in meeting production goals.

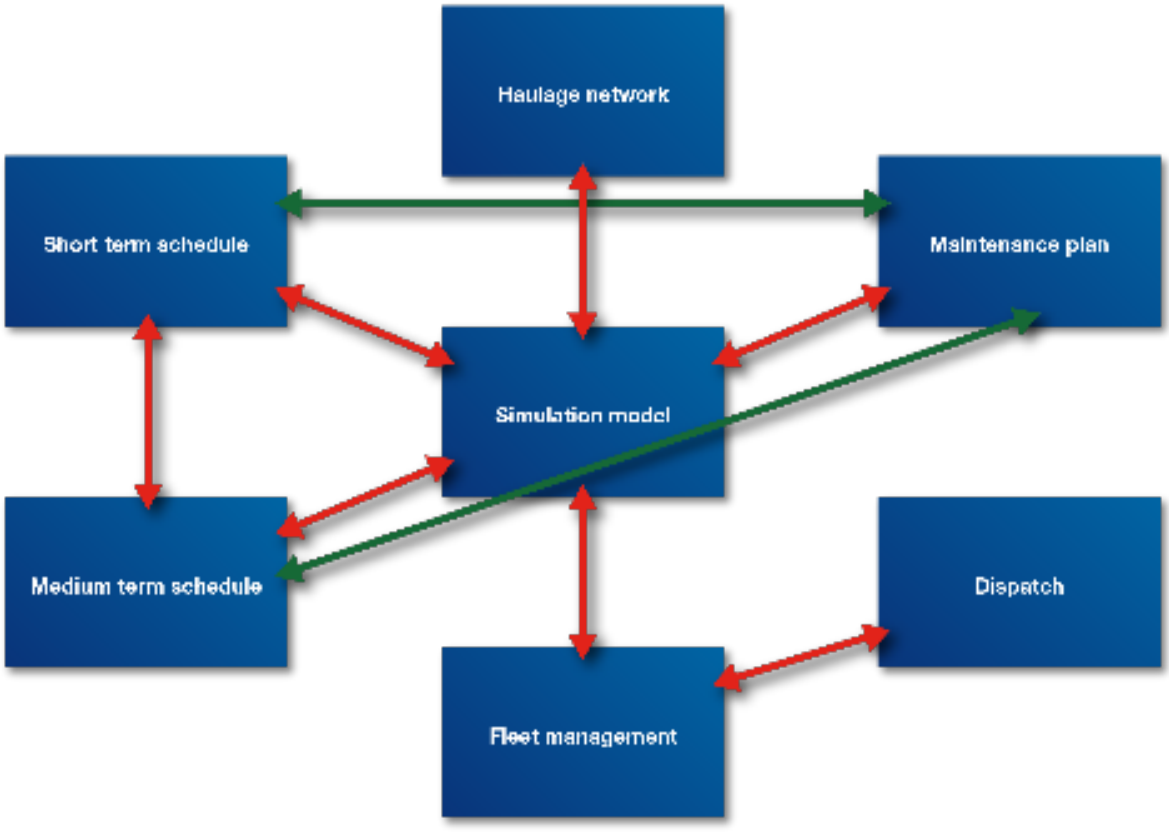

Figure 1: Shared Data Goals

In What Ways Can We Innovate Here?

We have highlighted a significant problem here and the issues presented are ongoing and certainly difficult to solve. Ultimately, mining stakeholders require the greatest confidence that the operations' forecasts are likely to be achieved. Our schedulers need a means to share the predicted outcome of their plans to the stakeholders with a likelihood or probability of those schedules achievability.

What is required is a means to test the outcome of a plan before production takes place. The most cost effective method to do this is by simulating the mining production. By utilising the benefits of simulation, the likelihood of a plans achievability is generated, and changes can be made, if required, before production actually takes place.

To date, simulation has not been a commonly used practice in mine planning. Mining organisations already collect abundant data. What we are suggesting here is to utilise this data in an additional new way. To utilise and connect data from various technologies (simulation, planning and fleet management or production) will bring far more benefit and value than initially meets the eye.

How Can it Work?

Abundant value lies between simulation and the short and medium term scheduling space. To date, simulations are not carried out frequently, perhaps annually or at best, biannually. However, these are out of date immediately after they are released, due to the dynamic and ever changing nature of mining. To get the most of a simulation model, it is best to update models daily or at most, weekly.

There are various forms of data stored and used in software and technology already in use in the mining operation. Sharing and utilising this existing data is key to a successful and reliable simulation. Data stored in mine design and fleet management systems (including vehicle information management systems) can both be used to greater effect when shared with simulation and mine planning.

Simulations should replicate the haulage network to a high degree of accuracy. Ideally the road network map will be sourced from the mine design package. These are updated regularly and, therefore, the updated road network should be incorporated as soon as it is released from mine design. To maintain confidence in the simulation outcomes, the road network should also include details of the road rules on all segments of that network. Examples of road rules include; one way or dual carriageway, along with speed limits and intersection behaviour. Similarly, details of the equipment such as payload, propulsion and retard rates, along with fuel consumption and cost of operation used in the simulation, should be included.

This level of detail of the road rules and equipment parameters allows accurate modelling of traffic behaviour and flow. When a change in production occurs the detail of congestion potential can be considered and managed appropriately in scheduling.

When a fast decision is required, then the potential changes can be tested quickly in the simulation model, and once an appropriate production outcome is generated in the simulation model, then it can be implemented in reality. The simulation tools should closely share the mine design data and incorporate haulage network and mining location changes once they are submitted by the designer.

Another detail to consider precisely in simulation is equipment behaviour. Accurate simulation of payload, load times, pass times and maintenance including unplanned maintenance will assist in generating the likelihood of production plans being achieved. The greater the accuracy of the details that are included in the simulation, the greater the reliability of that simulation.

As discussed earlier, assumptions used in planning can be the foundation for production targets not being met. Therefore, how is it possible to simulate payloads, maintenance and other equipment behaviours if these assumptions can be the underlying cause of production target issues? A means to address this issue lies in collecting and utilising current and historical production data. The more production data collected, the more accurate the assumptions are likely to be. Fleet management systems collect vast quantities of data from production itself, to maintenance and equipment behaviour. It is possible to analyse this data closely and gain a thorough understanding of individual equipment behaviour on various rock types, operators, weather conditions and mining locations. The assumptions used in simulations can therefore be relatively accurate, as they account for variability in individual equipment, material types and locations.

An additional complexity lies in equipment breakdowns. Traditionally, it is difficult to accurately assume details for unplanned maintenance in our mine plans. We understand that it happens, but the variability on the frequency and duration on these events makes assuming values tricky. Typically mine planners use factors based on general historical trends. However, again, in utilising the vast amount of data available from the fleet management systems and the vehicle information management systems on the equipment, it is possible to analyse this data and form detailed and accurate assumptions. The values may change daily, but the overlying trends can be analysed and utilised in plans and simulations. Again, the values should be separated for individual equipment, material types or locations in the interests of accuracy.

Once all of the relevant data share is ready (see Figure 1), it makes sense to begin simulating the likelihood of production plans being achieved. However, there is an important and necessary initial step. Calibration. Before any trustworthy simulations can take place, it is important to ensure the simulation results reflect normal production results.

We have discussed some benefits of sharing data between the mine planning tools and fleet management systems and simulation. These are based on sharing data from the past and using it to predict the future. Once this information is collected and utilised, it is possible to gain additional value from the simulation models. To date, we have discussed sharing this data in order to test the likelihood of the mine plan being achieved.

However, it is possible to take this a step further.

Take the scenario mentioned earlier, where production is in progress and there is an unexpected ground failure. This type of event can be difficult to predict and the mine planners must find a solution quickly, that is both safe and allows mining production to return to normal as soon as practical. Utilising all of the historical and current data from the fleet management system, haulage network, and mine design in the simulation model allows fast assessments of planned changes. Multiple scenarios can be tested quickly and a decision can be made quickly that is efficient and practical. Alternate haul routes, new haul routes or production from alternate mining sources including variations on equipment assigned can all be tested and analysed before the changes are incorporated in reality. Mine simulations are a highly valuable tool that can be used to evaluate multiple mining options in a safe and cost effective manner before production takes place.

Conclusion

It is difficult to meet our rising production targets when the value for our mined resource is decreasing while, at the same time, reducing our cost of operation. In order to do this, we need to innovate on improving efficiency of our existing methods and approach.

While there are numerous ways to do this, a cost effective means to improve the likelihood of meeting our production goals is to simulate equipment, haulage and production. Once the current production has been simulated, and therefore a calibration model has been created, it is possible to test various new options. This trial and error, or 'what if' analysis approach allows haulage and production to be optimised.

Not only is it possible to test the probability of meeting production targets, but production can be optimised and improved. An accurate simulation model will create more value from existing operational data that is collected, and changes in operational methods such as addition or reduced equipment, haulage route improvement, traffic rules or production location adjustments are well justified. The operation can run more efficiently, cost of operation can be reduced, and stakeholders will have confidence in the production forecasts of the operation.