Integrating Operational Design and Data Analytics to Maximize Shovel Performance in an Open-Cut Coal Mine

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# ABSTRACT

Real-time performance solutions are advanced systems that monitor and analyse the actual machine performance, providing instant feedback to operators and planners. Systems such as Argus and mRoc track metrics like bucket fill factors, cycle times, digging conditions, swing angles, and payload distribution. By delivering real-time insights, these solutions help operators to identify inefficiencies, adjust techniques, and maintain optimal performance during each cycle. Additionally, they support better compliance with the mine plan by continuously comparing shovel progress against predefined targets.

While these smart solutions excel at offering real-time feedback, their effectiveness is limited if they operate under a poorly designed plan. Shovel efficiency is closely tied to dig geometry, conditioned by factors such as bench height, width, and slope gradient directly influencing the excavation performance. Proper geometric configurations are essential to ensure optimal equipment performance and enhance efficiency across the mine plan.

In an open-cut coal mine, it may be required multiple shovel cuts to reach the coal seam. The profile of each cut is primarily determined by the thickness of the overburden, the characteristics of the coal seam itself and the shovel size. To expose a coal seam across an entire strip, various design scenarios are possible. However, only some specific configurations provide the most cost-effective solution by maximizing shovel performance while meeting operational constraints.

Despite its importance, geometric design is often focused on isolated shovel passes without considering their impact on overall strip performance. This disjointed approach can lead to inefficiencies and missed opportunities for optimization.

This study addresses this gap by converting historical data from real-time systems into actionable insights for mine planners in an open-cut coal mine in the Bowen Basin. Using historical data from the Mineware Database, the study develops a predictive model to estimate shovel productivity under specific digging conditions. By correlating geometric factors—such as bench height, slope gradient, and width—with performance metrics, the model serves as a decision tool for mine planners, enabling optimized operational designs that account for the entire strip rather than isolated passes. Additionally, the model provides feedback for short-term schedulers, refining productivity estimates to match actual dig conditions.

The study also compares this dynamic rate approach to the traditional method, which uses a flat productivity rate for the entire dig area, demonstrating the benefits of a more adaptable and data-driven methodology.