

ELECTRIC ROPE SHOVELS SPEAK

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GLOBAL
MINING
REVIEW

Romeu Kleinubing, Emerson, USA, explores how modern vibration monitoring technologies translate machine data into actionable insights, helping mining teams prevent breakdowns and keeping electric rope shovels working hard.

Figure 1. Easy to read – and understand – dashboards help local operators, and local or remote technicians, quickly diagnose shovel health issues.



Electric rope shovels are the backbone of material excavation in opencast mining, responsible for the efficient and reliable movement of massive loads of minerals. These machines, integral to the mining process, represent a combination of engineering ingenuity and operational necessity.

With ingenuity, however, comes complexity. Rope shovels are typically large, expensive, and driven by an array of complex rotating machinery. As a result, even the largest mines typically only have a small number of shovels on site, all in continuous operation with no redundant spares. When a shovel is out of commission, so is that area of the mine. Accordingly, for any organisation striving to maintain peak performance, ensuring the health of their shovels is a top priority.

Fortunately, modern reliability tools and strategies make it easier than ever to ensure electric rope shovels continually operate at their best. Today's most advanced vibration monitoring solutions help reliability teams continually and safely monitor the health of their rope shovels, leading to more effective operations and less unplanned downtime.

Rope shovels – the backbone of efficient mining

Electric rope shovels are highly specialised machines designed to withstand the rigours of mining operations. They use advanced systems – such as DC or AC motors, multi-stage reduction gearboxes, and rolling element bearings – to manage extremely heavy loads. With a lifespan of up to 15 years, electric rope shovels are built for durability.

Capable of handling over 120 t of material per scoop, the shovels require only three scoops to load the largest hauling trucks. However, due to their high operational costs and limited numbers in most mines, their availability is crucial. Downtimes – planned or unplanned – can result in production losses exceeding US\$300 000.

Many functions mean many potential points of failure

The efficiency of electric rope shovels hinges on the precise coordination of their primary components:

- **Crowd:** The crowd system is an electric motor and gearbox driving a rack and pinion gear system to pull the bucket toward, and away from, the shovel.
- **Hoist:** The hoist system's electric motors drive a gearbox to turn a drum that rolls up the cable to lift and lower the bucket.
- **Swing:** The swing system uses multiple electric motors to drive gearboxes that turn a bull gear, turning the cab and boom to the left or to the right.
- **Propel:** The electric rope shovel's tracks use traction converters to turn the sprockets that drive the tracks. The left and right-side tracks are independently driven.

Each movement is controlled by a motor and gearbox set. Depending on the size of the shovel, there can be two to three sets of gearboxes just to swing, plus additional gearboxes for hoist and other functions.

These components work together through robust systems engineered for variable speeds, cyclic movements, and many directional changes in movement, ensuring the shovel can handle its immense loads.

Vibration monitoring drives lifecycle performance

Vibration monitoring is the best and most accurate technology to detect a mechanical issue in its early stages. The most successful mining operations employ technology to detect the most common mechanical issues quickly and definitively in their shovels' rotating systems, including lubrication problems, bearing defects, gear misalignment or damage, and structural irregularities.

By identifying the most common rotating equipment issues as early as possible, mining operations can plan interventions that minimise disruptions, while reducing periodic maintenance outages and costly unplanned shutdowns. Moreover, the most accurate monitoring of vibration in rotating equipment can help teams pinpoint the cause of problems, allowing them to adjust operational strategies to better accommodate outage planning, or even to extend the lifespan of shovel components, further reducing the likelihood of unplanned shutdowns.

For example, if a gear on the swing function has a defect in one of the teeth when moving to the right but not the left, the most effective vibration monitoring technologies can differentiate that problem. In such a case, instead of shutting the shovel down immediately, the operator can change operating strategy – reducing loads or avoiding moving in one direction – to operate the shovel until a planned outage is convenient.

Traditional maintenance strategies limit insight

Proper maintenance has always been vital to the longevity and efficiency of electric rope shovels. Traditional monthly maintenance typically requires manual vibration data collection using portable sensors. Portable routes are

ideally scheduled every month and require a three to six hour planned outage. Typically, no other maintenance or production activity can be performed during the manual routes because while a technician is taking readings, the operator needs to simulate all the shovel movements for that person to gather necessary data. On average, a site using traditional maintenance methods will require 12 manual collections per month, with a minimum of six hours production loss each time. At an estimated cost of US\$50 000/hr, lost revenue can easily reach millions of dollars.

Furthermore, the coordination of maintenance and operations to accommodate maintenance rounds is difficult to accomplish. Both teams need to have the right people and equipment onsite to take accurate readings. In addition, those people must be onsite when it is as convenient as possible to shut that area of the mine down. Accomplishing this means having the right people, equipment, and planning all in place each time, every month.

Because coordination is typically complex, maintenance routes are frequently rescheduled, and quite often are simply not completed. Each reschedule or cancellation increases the potential for missing critical issues with the operation of the shovel. Over time, small flaws become critical issues, and critical issues become asset failures with the potential to stop the shovel entirely, and possibly even cause additional damage, increasing the time and cost of repair. Moreover, if a problem develops in the asset right after manual data collection has occurred, the team will have no insight into that problem until the next data collection cycle happens, increasing the likelihood of extensive damage and an unplanned outage.

Not only is the traditional maintenance process time-consuming, it also poses high safety risks. Workers must operate in proximity to moving machinery to gather accurate readings. The potential for accidents while a technician gathers swing, hoist, or other data is unacceptably high.

Traditional maintenance technologies also limit visibility into equipment health. Many traditional systems do not monitor propel – only crowd, hoist, and swing. In addition, these analog systems typically struggle to trigger data collection hardware fast enough to capture entire movements, particularly on swings.

Advancing maintenance with online monitoring

Today, many mining operations are improving upon their traditional maintenance strategies with the introduction of online vibration monitoring systems. Online, continuous monitoring provides several advantages that help further reduce the likelihood of unplanned outages, while simultaneously helping keep personnel out of harm's way.

Modern asset monitoring solutions can be installed by technicians right at the asset. The most advanced solutions not only detect vibration signatures, but also identify and analyse stress waves caused by metal-to-metal impacting – a critical metric for the health



Figure 2. Modern reliability tools make it easy and efficient to fully monitor electric rope shovels, helping avoid downtime.

of this low-RPM machinery. Continuous monitoring collects data in real-time, while digital impacting analysis helps teams filter out background noise from basic vibration readings.

Advanced technologies do not simply display spectrum and waveform data, but also apply AI-based edge analytics right at the source of data collection. Continuously scanning and processing the data at the edge, the AI system not only monitors shovel health and alerts users to issues, but also provides automated diagnostics, machine status, and recommendations to help operators and technicians of any skill level react quickly to emerging problems.

It is also important to note that modern, digital condition monitoring solutions react far faster than traditional analog systems. The most advanced digital collection systems can trigger immediately when a motor starts spinning, enabling the software to capture vibration data across the entire movement to provide a clearer picture of holistic asset health.

The system adjusts its monitoring based on load and speed conditions, capturing relevant data for more accurate diagnostics. Analysed data is visible locally, on the operator interface in the cabin, where colour-coded indications – red, yellow, and green – along with alerts for the most common problems, such as lubrication issues and bearing failures, make it easy to instantly identify the health of critical systems.

In addition, data can also be securely sent to remote locations for more extensive monitoring and analysis –

whether in the machine shop or by an external monitoring service. Armed with deep diagnostic data over more regular and extended time periods, technicians at these remote locations are empowered to track, trend, and predict asset performance, making it far easier to schedule the critical maintenance activities that are the foundation of operational excellence.

Modern maintenance captures a competitive edge

The adoption of advanced continuous monitoring and diagnostic technologies has empowered reliability teams to take full control of electric rope shovel maintenance. Real-time remote health monitoring allows teams to collect accurate data multiple times per shift without needing to send a technician to physically inspect the equipment each time, drastically reducing downtime. This evolution not only enhances productivity, it also supports safer and more sustainable mining operations.

As mining organisations struggle to compete in an increasingly complex global marketplace, the safety, efficiency, and sustainability gains unlocked by implementing modern reliability tools on their rope shovels will unlock the incremental performance improvements necessary to gain competitive advantage. There has never been a better time to modernise the reliability systems protecting some of an organisation's most valuable assets. **GMR**