Fleet Optimisation
Guide
2015

in association with

DINGO
RUN SMARTER®

HEXAGON
MINING
Advance your maintenance department today and build a successful strategy for tomorrow. DINGO provides the knowledge and tools to run a predictive maintenance program that will minimize variability, increase operating efficiency and put you in control of your budget.

Drive productivity, profitability and performance with DINGO. Visit DINGO.com to learn more.
SHAPING SMART CHANGE

Productive mines know technology drives their success. Companies must be smarter, safer, and quicker to respond to change. Their future depends on it.

Hexagon Mining is built for your future. Hexagon Mining recognizes that your competitive edge depends on integrating, automating, and optimizing critical workflows. Precision, accuracy, and safety are pivotal to those needs.

Hexagon Mining is the only company to solve surface and underground challenges by integrating design, planning, and operations technologies for safer, more productive mines. Uniting MineSight, Leica Jigsaw, SmartMine UG, and SAFEmine, Hexagon Mining is a global network of talented mining professionals, delivering technology, service, and support.

Hexagon Mining: Shaping Smart Change for the Life of Your Mine

hexagonmining.com
@HexagonMining
contactus@hexagonmining.com

Hexagon_MINING_MineSight_Devex_Leica_SAFEmine
Introduction
Ailbhe Goodbody introduces the guide and its contributors.

Operations: Hexagon Mining
Integration is pivotal
Fleet simulation, scheduling and optimisation and maintenance planning. Hexagon Mining offers three example to show how fleet management solutions are helping companies to address rising capital expenditure and operating costs.

Predictive analytics: Dingo
Reading the signs
Using predictive analytics to help build a strong asset health program. Dingo believes that the implementation of a strategic asset health system is a significant untapped lever for improving predictability, profitability, and performance in mining operations.

Contributor biographies
Short biographies about the companies and people who contributed to and wrote the articles within the guide.
Optimisation: core of innovation
An introduction by Mining Magazine

Fixed and mobile plant assets are clearly two major areas of capital investment for mining companies, and contractors, making them a constant focus of efforts to improve utilisation and investment returns.

A recent report from one of the big investment banks suggested cost inflation during the boom, and dealing with more complex and deeper deposits, had cost the major mining companies about US$35 billion over a decade from 2005. The report estimated the majors had cut operating expenditures by $8 billion between 2012 and the end of 2014 – a big number but, to be sure, only about 20% of the cost headwinds seen over the past decade.

The major focus, and that for the rest of the industry presumably, is now squarely on productivity gains. Some estimates suggesting improvements of 20-60% are achievable.

Mobile fleet management and optimisation is at the core of miners’ productivity and cost improvement strategies, along with improved maintenance practices and tactics. But navigating a fast-changing world of new technology, performance benchmarks, safety regulations and other changes, is not easy, and not all mining companies have the broad operational footprint of the majors.

Two organisations that have worked, and continue to work, with miners and contractors all over the world are Hexagon Mining, part of international software group Hexagon AB, and Dingo Mining. They offer crucial insights into the changes transforming – and potentially transformative for – mine fleet management and optimisation approaches across mining.

International experts from these companies have joined Mining Magazine to produce this guide to the latest, critical advances in fleet management and optimisation.

Here we examine the importance of an integrated approach to fleet and workforce management, including safety, and the possibilities offered by big data analytics engines. Also, the dividends that can flow from industry investment in vehicle health monitoring and supervisory systems, and fleet maintenance analytics. This guide provides a timely look at the present, and a key view of the future of fleet simulation, scheduling and optimisation, and maintenance planning.
Integration is pivotal
Fleet simulation, scheduling and optimisation, and maintenance planning

Hexagon Mining

Faced with fluctuating energy costs, volatile commodity prices, and tighter profit margins, mines must make the most of their equipment, data and people to succeed.

Hexagon Mining believes that by integrating design, planning and operations technologies, mines can be safer and more productive. Fleet management is central to this mission because it represents a huge opportunity for mines to become safer, minimise energy consumption, reduce carbon footprints and save money.

That’s why Leica Jigsaw technology is pivotal to Hexagon Mining’s vision of smart change and an integrated life-of-mine solution. Jigsaw is the world’s most comprehensive fleet management production optimisation and high-precision guidance solution. Now it is aligned and integrated with Hexagon Mining’s planning software, MineSight, and safety technology, SAFEmine. So people and processes traditionally separated into silos are becoming connected and more productive.

Hexagon Mining has wasted little time in incorporating Jigsaw into new products HxM Blast, for precision drill and blast, and HxM Athena. HxM Athena is the company’s business intelligence and business analytics tool for linking mine planners to operational information. It complements Leica’s existing Jview Business Analytics suite for Operation data. Jigsaw will also be central to the company’s LIVEmine ethos of harnessing real-time technology to connect mine operations with mine planning and mine safety.

In this chapter, we will look at the key technologies behind fleet management; its transition from best practice to standard practice; its applications in the mining industry today; and the exciting future ahead.

To properly assess fleet management’s direction, we first need to assess its origins and its importance.

Hexagon Mining VP Global Services, Matt Desmond, offers this perspective: “At
the core of what we do in mining, both in open pit and underground, we manage fleets and it’s critical to the business that we optimise those fleets and monitor what they’re doing. So, in Hexagon Mining’s vision of a life-of-mine solution, we see fleet management at the core of real-time production monitoring and optimisation. Fundamentally, that is going to improve safety, productivity and, therefore, lower the cost of mining.”

The 1970s saw the introduction of mainframe computers and true to Moore’s Law, computing power has been doubling every two years since. Communications technology, speed and bandwidth have increased significantly over the past 50 years. The late 1980s and early 90s saw the development of GPS for commercial applications. Meanwhile, equipment has simultaneously become smaller but more robust. All of this has had a profound effect on fleet management in the mining industry.

Today, fleet management systems (FMS) exploit advancements in computing, communications and positioning technologies to help optimise ore extraction and processing. In advanced FMS systems, optimisation is used to allocate trucks to shovels, accounting for many variables. Remote operating centres and autonomous control systems are becoming more common so more data is available than ever before. What was once best practice is now standard practice. Now Hexagon Mining is working on elevating a standard practice to a greater level of safety and productivity.

“In Hexagon Mining’s vision of a life-of-mine solution, we see fleet management at the core of real-time production monitoring and optimisation”

“Hexagon Mining is moving fleet management beyond standard practice to what we would call mission-critical practice,” says Desmond. “So we are integrating safety and connecting mine planning and scheduling systems to close the loop.

“Mining is not only capital-intensive but also relies on people, and people need information to make decisions. So it is critical that all of the information we are capturing from the various databases on board equipment, and in the mine planning systems, is centralised and put into a system such as HxM Athena.

The soon-to-be-released HxM Athena will pull information from a multitude of databases and allow mines to connect information from production with planning and scheduling.

The next step, says Desmond, is operational intelligence, “where we are actually getting information in real time from the equipment and people working in the field and we have the algorithms to act on it in real time.

“We are pushing the boundaries of business analytics into what we see is the real future of operational intelligence, acting on information in real time and creating smart change.”
Integral to that smart change will be HxM Live Terrain, a product due for release next year.

“When fleet management began in the 80s and 90s, we were really capturing information about production, about hours, about grade, about material and transactional data,” says Desmond. “What was missing from that was terrain information because everything we do in mining is about moving terrain safely and productively.

“Live Terrain will combine real-time terrain information, which we are capturing with sensors in the field, with HxM Athena, which will connect production information with planning information. Similarly, HxM Blast is connecting the drill and blast workflow between fleet management and the drilling department and mine planning. This will improve fragmentation, reduce the need for as much explosives, and improve the overall process down the road, which will lower the cost of processing.”

So, how are Hexagon Mining fleet management solutions helping companies to address rising capital expenditure and operating costs? Here are three examples.

1. Optimising gold production with African Barrick Gold

African Barrick Gold (ABG) contacted Hexagon Mining to address the issues of volatile energy costs and tightening profit margins at its North Mara mine in Tanzania. North Mara is a high-grade open-pit gold mine with a life-of-mine estimated at 10 years, and the potential to process 8,000t/d of ore.

In September 2010, North Mara implemented the Leica Jigsaw Mine Management Solution on 70% of its production fleet. The goal was clear: improve time management; increase production; reduce costs.

The results surpassed ABG’s expectations.

ABG installed the solution across North Mara’s entire production fleet and, by 2012, Leica Jigsaw was at work across all three of the mine’s open-pit deposits.

**Improved time management**

North Mara’s scale and size presented several challenges. Production spans several large pits 15km apart. Supervisors could not be present to constantly monitor all fleet-related activities in all of the pits.

Leica Jigsaw’s introduction reduced average collection time of the first load truck and shovel cycle times by a third. North Mara’s hourly output of 2,000t was boosted by an additional 450t/d. The tools used to complete this analysis satisfied one of the major goals set by North Mara dispatch supervisors: to produce up-to-the-minute, end-of-shift reports and loading details.
Figure 2, below, illustrates the improvements in time management, post-training.

![Operator Time Management Report](image1.png)

**Figure 1: Initial operator time management report for first shovel load**

![Operator Time Management Report](image2.png)

**Figure 2: Operator time management report post training**

**Increased production**
Within six months of adopting the Leica Jigsaw Mine Management Solution, North Mara mine reported a marked improvement in equipment usage and efficiency.

Isaac Yiadom, FMS manager at ABG North Mara Mine, said the expectation had been “that if we could increase our equipment usage, then production would also be increased by about four times that amount”.

“This has been accomplished just by improving time management alone.”

ABG uses a variety of Leica Jigsaw’s tools, including Joptimizer. Before North Mara mine could benefit from using Joptimizer, it was important for the mine to understand the variables affecting production. The system had to be configured to account for these variables. Vehicles had to be assigned to circuits, according to Joptimizer’s results.

Previously, supervisors would appoint assignments to truck operators regardless of their route after unloading at the dumping location. Trucks would go to their respective dumping locations and return to where they had originally loaded the truck.
Using Joptimizer, trucks now dump loads at the dumping location; then receive new assignments leading them to alternate loading units with shorter distances. Assignment routes are shorter and more efficient. With Joptimizer, only 13 trucks were needed to accomplish assignments, compared to 15 trucks that were previously necessary to complete the isolated circuits. Time is saved and productivity is increased.

Reduced costs
Originally, consultants created the North Mara mine design and recommended routes to and from each location. In one project, the consultants relocated a stockpile with an estimated 1Mt of sensitive material to a more adequate location. The original route assigned to move the material is labelled Old Route.

After implementing Leica Jigsaw, North Mara mining engineers ran a simulation using Leica Joptimizer tools. The findings presented the Proposed New Route, as the shortest path that yielded the best output.

Operators began using the Old Route and recorded an average 21-minute travel time between points A and B. Joptimizer’s Proposed New Route cut that time by a third. The optimised route meant increased truck productivity and significantly more output tons.

“In one project, the consultants relocated a stockpile with an estimated 1Mt of sensitive material to a more adequate location”
“We aimed for moving about 40,000t per shift, by improving on the road network and identifying the shortest routes, thus improving productivity,” said Yiadom. “We moved 925,000t in 18 days instead of the 25 days that were originally planned. This means equipment that was scheduled to work for 25 days can now do something else for seven days. These seven days are a big cost saving in terms of equipment.”

It costs US$236 per hour to operate a dump truck at North Mara mine; about $814 per hour to operate a Terex 170 shovel. Over 25 days using the Old Route, ABG would have spent $965,345. Using Leica Jigsaw, and specifically Joptimizer, ABG actually spent $663,068, saving more than $300,000.

Figure 4: Mine design to relocate 1 million tons from point A to point B
2. Mastering data at Cobre del Mayo

In 2013, Mexico’s Cobre del Mayo (CDM) was attempting to solve common, yet complex issues at its open-pit copper mine in southern Sonora, 21km from the town of Alamos. That’s when the company started using Hexagon Mining’s Leica Jigsaw fleet management solution.

The results are impressive.

First, the issues:

1. Geology

CDM produces grade-A copper cathode, supplied as refractory, and vein-type ore for processing into concentrate. The mine is a copper porphyry system, structurally controlled by shear faulting with mineralisation stockwork, disseminated and variable-depth ranging oxidation.

Oxidation is from the surface down to 430m, with chalcocite from 40m to 430m. The challenge lies in two types of minerals that cannot be processed the same way. The dominant alteration is quartz-sericite and sporadic areas with intense argillic alterations, meaning that close control is essential in the dilution and the selectivity of the ore.
2. Fleet management
CDM’s fleet comprises the following:
- Three hydraulic shovels, Komatsu and Terex, and two retro excavators, Komatsu and Caterpillar
- Three loaders and three high-precision first loaders
- 26 haul trucks, (twenty 789s and six 777s)
- Three drills, Sandvik, D75KS, and a high-precision dozer
- Auxiliary equipment, including dozers, graders and water trucks
- Retro excavators, which are roughly the size of the ore polygons (deposit areas).

The potential 2,000t in one polygon make a system for dilution control essential.

3. Tracking and reporting
CDM must deal with waste in various forms, from low grade to medium and high grade. Constant awareness of waste type is important because the loading equipment can be working with three or more polygons simultaneously, requiring frequent changes from truck to truck. So, like any mine, fleet management is important to CDM. The complicated ore distribution means CDM’s teams of operators must use the best tools to avoid dilution and improve selectivity.

However, even great systems and great tools can fall short if reliable and accurate reporting is not part of the process. Since CDM began commercial production in 2006, operators had compiled reports manually in the absence of an automated reporting process. Truck operators would include their cycles from origin to destination, and the dispatcher would capture all the information from the operators by hand and compile them.

CDM tracked usage times and equipment delays by hand and by radio.
Real-time alerts of delays were unavailable and receiving reliable data from the drill operator was difficult. Without a system to automate tracking and reporting, time management is a challenge.

In June 2013, Leica-Jigsaw was among six systems evaluated by CDM to help solve these issues. After a technical economical study of Leica-Jigsaw, Micromine, Modular, Wenco, Logimine, and Caterpillar, CDM made its decision.

“The best option was Leica Jigsaw,” said CDM’s Dispatch Manager, Victor Rodriguez. “The evaluation process was done in the form of a cost evaluation, as well as with a group of people who visited various mines. Most of them were in Chile and observed first-hand the Leica Jigsaw working.”

Less than two months later, initial hardware and software were deployed and on October 1, 2013, CDM went live with Leica-Jigsaw. On January 6, 2014, CDM began officially logging reports with Jview, Leica-Jigsaw’s business intelligence suite.


Jview converts operational machine data into usable, actionable information via a suite of reports and dashboards that deliver a real-time view into mine operations. Jview allows decisions to be made, based on accurate data, drastically improving site productivity practices on numerous levels.
For CDM, the core implementation time frame from first instalment to go-live was roughly three months. Like most mines, CDM’s overriding objective is to produce more while lowering costs. Armed with Hexagon Mining’s fleet management solution, CDM was quickly able to increase safe mining operations and production output, while managing cost, quality and control.
The chart right shows an average of 1,818 additional tonnes per first hour, representing a 21% increase in production for the month of March 2015, compared to December 2014.

“Leica Jigsaw presented the strongest technical offering, with its flexible and robust software all supported with remote problem solving,” said Rodriguez. A flexible user-permits policy also helped, said Rodriguez. The base licence permits access to all users on site.

“Although various people see the reports, and many departments contribute information, licences were not needed for everyone so this was a benefit,” he said. “So, as far as navigational systems, Leica Jigsaw products are the leader in the field. Therefore, the solutions for the satellite navigation in the high-precision products are the most advanced in the market. This was a decisive part for us,” said Rodriguez.

The system installation included a room for the dispatch in the highest part of the mine. This offered a full view of mine operations via visual controls. Three 52-inch screens were installed to display different dashboard views of the mine. Each dispatcher was supplied with three additional 32-inch screen displays. The smaller screens manage the roads on Jview and allow for real-time reports. The other dispatcher handles control of the operation and production equipment, including loaders and trucks.

Now CDM has designated maintenance dispatchers equipped with the proper notification systems, preventing maintenance issues from draining time and resources. Operators needing support or experiencing problems with equipment can speak directly with maintenance or text messages from the system, thus reducing radio-frequency demands.

CDM enjoys numerous benefits from Leica Jigsaw. The primary crusher is now monitored in real time. Any delay generates an immediate alert, avoiding the need for phone calls or radios, which can sometimes be unreliable. Individual dumps in the crusher, waste, leach pads, and stockpiles are monitored and reported on. With multiple destinations, every truck is unloading exactly where and when it needs to be.

“Prior to partnering with Hexagon Mining Operations, it had been extremely difficult for us to achieve precision in our extraction, given the size of our equipment,” said Rodriguez. “Since the implementation, significant improvements have
been achieved in our ore control, as can be seen in our current production increases.”

Daily plans can also be visualised via a quality tracker in each loader. Short-term planners load the plan in 12-hour increments so loading machines display their hauling requirements. This is a significant improvement on the old process, which involved marking surveyors with flags – flags that would sometimes be washed out in the rain.

“The solution provides reliable and flexible and automatic reporting, for production, productivity, availability, drilling information, and many other aspects of the mine operation,” said Rodriguez. The chart below shows an increase of 19,963t from July 2014 to August 2014, representing a 9% increase in overall production.

The road hazard alert equips each truck to recognise dangerous rocks on the road. A road hazard alert is sent, the co-ordinates are tracked via GPS, and a signal is sent to the graders who immediately know when and where they are needed.

“In contrast to the past, we now have real availability metrics on all equipment, and when equipment goes down, the operator pushes one button and reports it to the maintenance people, who may be out for maintenance somewhere but can react quickly and respond, effectively while minimising lost time,” said Rodriguez.

CDM has seen great benefits in time management. The chart left shows an average decrease of 35% on time-consuming, yet crucial activities, such as fuelling,
shift changes, and food services. Before the system, the average time required for truck haul was 2.6 hours, compared to 1.7 now.

CDM now monitors the authorisations of each worker and ensures only authorised personnel operate the machinery. Information on their ability and authorisation to operate equipment is stored and retrieved in real time, ensuring safety and efficiency.

CDM is implementing automatic shift changes to remove the paper reports generated by operators. Soon, employees will simply use a CS screen to know which truck they will be operating that day, and which mode of transport will get them to the pit.

“This will eliminate paper reporting and will greatly improve the process, as we eliminate some 12 or 15 reports that we did by hand,” said Rodriguez. “That’s great for us. We will use that time for doing other things.”

The chart below shows the July and August improvements in time saved on daily shift changes, after Leica Jigsaw implementation and staff training.

The new software helps CDM deal with its data. “Because with Hexagon Mining Operations, with the Leica Jigsaw tool, I simply make a simple filter from Day 1 to Day 30 and I have all the information from the dispatch I need,” said Rodriguez.
3. Jigsaw transforms data into knowledge at Pueblo Viejo

The Pueblo Viejo gold mine, in the Dominican Republic, is a joint venture between Barrick Gold and Gold Corp., which own 60% and 40%, respectively. The mine is operated by Barrick Gold and 2013 was the mine’s first full year of production. Efficient fleet management and production optimisation is a priority.

Pueblo Viejo purchased the entire suite of Leica Jigsaw software in January 2011, and is running Jmineops, Jview, and Jhealth. In the pit it has implemented Jtruck, and J²guidance for high precision on shovels/loading units, production blast drills, dozers and track dozers.

“One of the biggest benefits of the Jmineops system is the amount of data it captures,” said Shane Boak, former FMS administrator at Barrick Gold. “Everything that’s happening in the pit, in the mining environment, whether it be time-based information, where the material is being picked up, where it’s getting dumped, who’s operating the equipment, how fast it’s going, or what’s happening with the engine.”

In addition to Jmineops, Leica’s complementary software modules and hardware components provide more precise measurement, enhanced operations logic, and wider ranges of equipment usage in run-of-mine (ROM) processes. The Universal Hardware Platform (UHP) also allows numerous OEM independent interfacing options and integration potential for further equipment diagnostics, maintenance, and life-cycle management all within the same system.

“We’re using these tools to pull all this information together so we can make more informed decisions,” said Boak. “We’re keeping trucks running longer and
faster, optimising our production and better managing risks.”

Jview is then utilised to expand data collection and information management into knowledge. This improves processes, production efficiency and management decisions, all of which helps the mine stay on budget and achieve or exceed goals.

“It’s all recorded and this is where the BI tools come in really handy to come back and analyse all of this information and use it to make more informed decisions,” said Boak. “We can then improve our use of the FMS and our processes based on past performance and benchmarking results with goals.”

Jview scales data and focuses the content. Information delivery is tailored to many levels of user and data consumer, from mine fleet dispatchers up to managers and analysts. The standard report suite combines dashboards for near-realtime information, static reports for common daily and operational reports, dynamic reports for common longer-term analysis, and OLAP database cubes for ad-hoc reporting and in-depth analysis. Standard functionality is available out of the box. The platform is extensible and content is easily expanded and modified so you can own and interact with the data.

“Jview makes it easy to draft a report, show the manager, get feedback and then redesign the report to come up with the customised information requested,” said Boak. “We use these systems in a lot of areas. One recent project was looking at visualising the information. A table of data is one thing and we needed different perspectives. Putting it into a visual context and then manipulating the scenario, we can see how the data relates and gives a lot of benefit, a lot faster.”

Applying diagnostics information together with production events provides vital insight. This is where detailed historical information from the FMS on operators’ working hours, cycle times and travelling speeds is extremely valuable. With high-sample-rate GPS data, actual speeds and equipment orientation can be determined before and after an incident. When played back, the equipment path and activity can be reviewed.

Leica Jmineops allows mines to track vehicles in explicit detail, helping to reduce idle time, fuel burn, engine hours and tyre wear.

Photo: iStockphoto.com/Jason Bennee
“Accidents on the mine site are the last thing anyone wants, but when they do happen, it is important to analyse what was happening in the lead-up to the event,” said Boak. “Jmineops combined with Jhealth and use of conditional virtual alarms, operational sensor context and snapshots, make it possible to determine use of brakes, gear selection, and engine throttle position, giving you a ‘black box’-type analysis around many situations.”

Data from Jmineops’ general equipment time utilisation and availability can also be analysed to identify areas of improvement in planning. This allows for transparent decisions by management, shift supervisors, and maintenance crews concerning equipment use, rotation and requirements throughout operations. Tracking these details to reduce idle time, fuel burn, engine hours, tyre wear and other metrics increases efficiency and saves time and money.

The Hexagon advantage
The mining industry is on the cusp of a profound change, and Hexagon Mining is leading the transformation. Built on the wider foundation of Hexagon AB, a leading global provider of information technologies, Hexagon Mining is well positioned to turn tomorrow’s trends into today’s solutions: neural networks and artificial intelligence, operational intelligence and business analytics, remote operating centres, autonomous machines, nano-technology and virtual reality, advanced sensor fusion, open standards, plus the rise of point clouds, UAVs and laser scanners – these are all technological advances within Hexagon’s grasp. Their applications for Hexagon Mining clients excite Desmond.

“We have spent the last several years working closely with our customer base to educate them about Hexagon and the life-of-mine strategy,” said Desmond. “It has taken off with the formation of Hexagon Mining and the combination of these great technologies. This has really closed the loop with our customers.”
Reading the signs
Using predictive analytics to help build a strong asset health program

Dingo

Lower commodity prices are a catalyst for change
The success of a mining operation is largely dependent on the reliability and productivity of its assets, so most mines will spend a small fortune on maintenance in order to keep their equipment up and running. On average, maintenance accounts for 30-50% of total operating costs for a mine, so it’s no secret that a world-class maintenance program can lower a mine’s production costs and provide a significant competitive advantage. And in the current economic environment, a mine’s survival could very well depend on its ability to drive down production costs.

Dingo’s experience working with mining maintenance departments across the globe offers a window into the calibre of maintenance operations. Considering the criticality of the equipment and the sizeable budget allocated to maintenance, one would think that most mines are running state-of-the-art maintenance programs. The truth is that the majority of maintenance departments operate in a reactive state and are largely consumed with putting out constant fires. Moreover, the historical approach of throwing additional capacity at the problem through new equipment purchases and increased manpower is no longer viable as budgets are being cut across the board.

This climate of low commodity prices is driving a fundamental shift away from capital expenditure to operating expenditure in the mining industry (below).

Figure 1

2012-2015 Global Mining Capex (US $ million)
Source: Credit Suisse First Boston, DataStream, Deloitte Global Services Limited
As capital has dried up, the mandate is to **do more** with the equipment and labour that is currently available, or in some cases, being cut. With fewer resources, mining operations are scrambling to increase efficiency and reduce the operating costs of their fleets through better asset management. As general managers are being forced to rethink their approach, one of the biggest cost drivers – maintenance – has taken centre stage.

**More doesn’t equal better**

Dingo believes that the implementation of a strategic asset health system is a significant untapped lever for improving predictability, profitability, and performance in mining operations. While a considerable number of mining operations think that they have effective maintenance and asset health programs in place, Dingo figures indicate that very few mines actually do. Based on data compiled from more than 50 mining operations across Canada, Australia, the US and Indonesia, 33% of major components are regularly operating in a warning state – and more than 11% are running in critical condition. In other words, on a daily basis, almost half of a mine’s equipment is operating in an undesirable state.

One of the reasons behind this large percentage of unhealthy assets is that companies tend to focus too heavily on the ‘input’ side of asset management – the collection of piles and piles of information – rather than determining how to use the data as a means to an end. The attitude that ‘more is better’ is prevalent and this issue is being exacerbated by companies touting machine health products that were designed to generate reams of data.

A current equipment trend that is creating massive amounts of information is the use of real-time machine health monitoring technology. Most equipment manufacturers now offer both on-board diagnostic sensors and fleet management software to capture performance data and report machine health alerts. Numerous sensors integrated into heavy mobile equipment can stream data on temperature, pressure and other operating parameters, while the machine is running.
While this type of live sensor data has been available in other industries, such as aeronautics and oil & gas, for decades, it is a relatively recent advancement in the mining industry. Consequently, mining companies are experiencing numerous challenges associated with adopting this data-laden technology. One of the biggest difficulties that maintenance departments are contending with is that this new equipment is reporting from hundreds of sensors, multiple times per second, but the mines don’t have the back-end infrastructure to manage and interpret this volume of data. Without the appropriate support systems, reliability and maintenance teams end up drowning in information.

While the ‘internet of things’ and ‘big data’ are popular concepts and receiving a lot of industry attention, most mining companies simply aren’t prepared for the advanced data storage, handling, and subsequent processing and decision-making that is required to capitalise on this ‘big data’. We have seen very few mining organisations, including the biggest ones, with the systems or practices necessary to manage and extract the value from this real-time information.

**Predictive analytics are part of the solution... but are mines ready for it?**

Based on decades of experience working with maintenance departments, Dingo’s point of view is that there is only value in data when it is applied with the end in mind. All data should be put through the filter of ‘Will this information enhance our decision-making and ultimately improve the health of the asset?’ – if it doesn’t check these boxes, it’s simply creating noise in the system. This is where technology applications such as predictive analytics and data management come into the picture. Used wisely, with the desired outcome in mind, these tools can process and analyse enormous volumes of data to help companies make faster, better maintenance decisions and keep equipment healthy.

Predictive analytics, in its simplest form, is the analysis of historical and current data to make predictions about future. By using statistical techniques such as modelling, machine learning, data mining and the enormous processing power of today’s available technology stack, it is possible to quickly identify deviations from normal operating conditions and use predictive analytics to determine the most likely fault that will appear and how to correct it. Applied in a maintenance environment, this futuristic information can be used to proactively plan maintenance work that will keep assets healthy and operations running smoothly.

The linking of maintenance and operational outcomes to historical data and decisions in a machine is where we see the biggest business value of predictive data analytics for miners. By merging advanced diagnostics and machine learning with the practical knowledge of maintenance and operations personnel, problems can be quickly diagnosed and addressed before they become a real issue. By catching these events early, unplanned failures will be minimised, equipment will operate in a healthier state, and ultimately, machines will last significantly longer.

The current application of predictive analytics focuses heavily on health-
monitoring systems. However, the primary functions of the machine health-monitoring system are collecting and sharing the data. It is still up to the organisation to implement effective processes and procedures to extract the value from this information. So while predictive analytics has powerful potential applications, especially in the realm of on-board data, Dingo has found that most companies don’t have the systems in place to take full advantage of it. They are leveraging the data to avoid potential short-term equipment failures, but they aren’t focusing on improving the overall health of their assets. They simply don’t have the time, resources or knowledge to use predictive analytical tools to proactively tackle impending equipment problems.

Many equipment suppliers have identified this problem and are working on their own solutions to take some of this data analysis load off mine operators. However, most mines operate mixed fleets of equipment and they don’t want each original equipment manufacturer (OEM) providing a brand-specific solution. Not only does this create a multi-system management issue, the OEM is the primary beneficiary of the ‘learned’ knowledge from these tools, and not the mining customer. For a mine to truly capture the full benefit of machine learning and predictive analytics, they need to implement an OEM-independent Asset Health system that centres on improving the health, life and performance of the equipment.

**Building an asset health program**

A key takeaway from Dingo’s extensive experience working in this space is that data analysis is just one step in the overall workflow of taking raw data and turning into a corrective maintenance actions to rectify an identified equipment problem. Too often we see programs that are primarily focused on the data collection and processing of that data and not on the bigger picture of why it’s important in the first place. A sounder approach is to focus on what the overall goal is and then drill down to the elements that will make it successful.

For example, most mining companies are focused on one or two key metrics, such as cost per production unit. All decisions about the implementation of asset health and predictive analytics systems should be viewed with that goal in mind. To minimise cost per tonne, the focus must be on maximising productivity while reducing the cost to produce. To achieve this elusive combination, the asset health system needs to be structured to proactively manage the condition of the critical assets responsible for the production.

Based on over 20 years of implementing and managing Asset Health programs, Dingo has identified three key building blocks that will help mines lay a strong foundation for building a sustainable predictive maintenance program:

1. **People**: Organisation with clear goals, ownership and understanding
2. **Process**: Cross-functional, closed-loop process designed to solve the root cause
3. **Support system**: Comprehensive condition-management software platform to run the program
### People are the heart of the program

People are the glue that hold the entire program together. If there isn’t buy-in and support for the program from both the top down and ground up, it will never be successful. Also, it is critical that reliability, maintenance and operations teams are all working towards the same end. If these teams have competing KPIs, they will have competing agendas.

Here, some key insights on **what works and what doesn’t** in the area of People:

<table>
<thead>
<tr>
<th>What works</th>
<th>And what doesn’t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open to change: Organisations that promote a state of continuous improvement tend to continuously improve.</td>
<td>Content with the status quo: Technically strong teams often believe that they are already good enough, so why change.</td>
</tr>
<tr>
<td>Clear universal goals: The program needs to have clear, universal goals that all teams are working towards and measured against. SMART goals – Specific, Measurable, Achievable, Realistic and Time-bound – tend to work best.</td>
<td>Independent initiatives: When reliability, maintenance, and operations teams have independent initiatives that don’t roll up to the overarching goals, it can create a disjointed, inefficient operating environment.</td>
</tr>
<tr>
<td>Program ownership: Create an environment where the maintenance department owns the success of the Asset Health program. Celebrate victories and learn from failures as a team.</td>
<td>‘Top down’ mandates: If a program is mandated, people don’t embrace it and tend to focus on task completion versus goal attainment.</td>
</tr>
<tr>
<td>Program understanding: Each member of the team needs to understand that healthy assets lead to improved availability, extended component life, and reduced parts spend. Each person should know how they contribute to the success of the overall system.</td>
<td>Compartmentalised processes: If people and departments don’t understand how they fit into the bigger picture, they will purely focus on their own area and priorities, sometimes at the expense of the broader program.</td>
</tr>
<tr>
<td>Ongoing training and coaching: Hold regular training sessions with new and existing employees to continuously reinforce the behaviours that lead to a successful, sustainable Asset Health program.</td>
<td>One and done: Training once and assuming that everyone has it down is a flawed assumption. People are creatures of habit and tend to default to what they already know without reinforcement.</td>
</tr>
</tbody>
</table>
An integrated, close-looped process will create a cycle of continuous improvement

“All of the analytics in the world cannot replace the value of having a solid process in place”

All of the analytics in the world cannot replace the value of having a solid process in place.

Benefits of a closed-loop process

Once goals are defined and teams are on board, a mine needs a closed-loop process where work is visible across departments, iterative and tracked until issues are resolved.
Here some key insights on **what works and what doesn’t** in the area of **Process**:

<table>
<thead>
<tr>
<th>What works</th>
<th>And what doesn’t</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>An integrated cross-functional system:</strong> Implement an intuitive, holistic</td>
<td><strong>Working in silos:</strong> When teams operate as separate units, they focus on unrelated</td>
</tr>
<tr>
<td>process that spans departments and functions. Everyone from the ground up</td>
<td>outcomes.</td>
</tr>
<tr>
<td>should be trained on the process and have clarity on its goals and their</td>
<td><strong>Reliability:</strong> Our job is to create the work orders.</td>
</tr>
<tr>
<td>role in helping to achieve them.</td>
<td><strong>Maintenance:</strong> Our job is to complete the work orders.</td>
</tr>
<tr>
<td></td>
<td><strong>Operations:</strong> Our job is to operate the machines.</td>
</tr>
<tr>
<td><strong>Condition management:</strong> Condition data should be used as an input to</td>
<td><strong>Condition monitoring:</strong> Collecting volumes of data and storing it for later use</td>
</tr>
<tr>
<td>help manage the health and life of critical components.</td>
<td>adds complexity without value.</td>
</tr>
<tr>
<td></td>
<td><strong>Ordering without explanation:</strong> When work orders are lobbed over the fence</td>
</tr>
<tr>
<td></td>
<td>without providing any context or rationale, technicians focus on checking boxes</td>
</tr>
<tr>
<td></td>
<td>versus solving problems.</td>
</tr>
<tr>
<td><strong>Visibility:</strong> Ensure that everyone in the process can access the trends,</td>
<td><strong>Task completion:</strong> Simply doing the work defined on a work order and focusing on</td>
</tr>
<tr>
<td>data, and other important contextual information, so that each person</td>
<td>task completion often won’t resolve the root cause of the problem.</td>
</tr>
<tr>
<td>knows the what and the why.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Closing the loop:</strong> Continuously feed outcomes back to the teams that</td>
</tr>
<tr>
<td></td>
<td>originated the work to improve decision-making and foster a state of continuous</td>
</tr>
<tr>
<td></td>
<td>improvement.</td>
</tr>
<tr>
<td></td>
<td><strong>Pushing tasks through the funnel:</strong> When teams are disconnected, they tend</td>
</tr>
<tr>
<td></td>
<td>to focus on moving their own functional tasks through the system, without</td>
</tr>
<tr>
<td></td>
<td>regard for issue resolution. When equipment fails, this approach also tends to</td>
</tr>
<tr>
<td></td>
<td>create an environment of blame.</td>
</tr>
</tbody>
</table>
A centralised condition management software platform is the engine of the program

A centralised software system with the right capabilities will provide your people with the tools to succeed and facilitate a process that drives the desired results.

“A good system will use predictive analytics to improve decision-making and drive efficiency, while tracking issues through resolution via a well-designed workflow management system”

The software platform should work across OEMs, equipment types and condition monitoring data in order to provide your team with a 360° picture of asset health and achieve the optimal results.
Here some key insights on **what works and what doesn’t** in the area of Systems:

<table>
<thead>
<tr>
<th>What works</th>
<th>And what doesn’t</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centralised condition management software system:</strong></td>
<td><strong>Fragmented systems and data storage:</strong></td>
</tr>
<tr>
<td>A system that offers access and visibility across departments to</td>
<td>When condition data resides in different places, access can be limited and it</td>
</tr>
<tr>
<td>component health data, work order history, actions and outcomes.</td>
<td>generally doesn’t get used effectively.</td>
</tr>
<tr>
<td><strong>Holistic capability:</strong></td>
<td><strong>Piecemeal data:</strong></td>
</tr>
<tr>
<td>A good system will be able to bring in multivariate condition data from</td>
<td>When data gets reviewed in different systems by different people (or not</td>
</tr>
<tr>
<td>different labs, OEMs, and equipment types. Correlating the data will</td>
<td>reviewed at all), it’s easy to miss critical pieces of the puzzle.</td>
</tr>
<tr>
<td>improve analytics and help systems and people make better decisions</td>
<td></td>
</tr>
<tr>
<td>faster.</td>
<td></td>
</tr>
<tr>
<td><strong>Custom KPI reporting:</strong></td>
<td><strong>Evaluating checked boxes:</strong></td>
</tr>
<tr>
<td>Monthly Asset Health KPI suite reporting and reviews with site maintenance</td>
<td>If a system simply tracks activity without connecting it to big picture</td>
</tr>
<tr>
<td>teams and management helps ensure that the right work is being completed</td>
<td>goals, people can feel successful while equipment is breaking down.</td>
</tr>
<tr>
<td>and goals are being met.</td>
<td></td>
</tr>
<tr>
<td><strong>Action tracking to resolution:</strong></td>
<td><strong>Task completion:</strong></td>
</tr>
<tr>
<td>The software should track activities through resolution to ensure that</td>
<td>When work orders are closed after tasks are completed, equipment often doesn’t</td>
</tr>
<tr>
<td>problems are actually solved.</td>
<td>return to a normal operating state, which can lead to unplanned failures.</td>
</tr>
<tr>
<td><strong>Measure results:</strong></td>
<td><strong>No tangible metrics:</strong></td>
</tr>
<tr>
<td>In order to gauge the ongoing performance of an Asset Health program, the</td>
<td>If things don’t get measured, they frequently don’t get done. Also, it’s</td>
</tr>
<tr>
<td>software system should be able to quantify the financial benefits of</td>
<td>difficult to evaluate a program without concrete metrics.</td>
</tr>
<tr>
<td>managing the health and life of components.</td>
<td></td>
</tr>
</tbody>
</table>
Bringing it all together

Ultimately, companies should strive to build a holistic Asset Health system that is embedded in the people, processes, and systems of the mining operations.

While predictive analytics is an important part of the solution that will help streamline and improve decision-making, the whole system must be working well in order to materially affect asset health and gain a competitive edge.

“Dingo’s focus is on providing a complete picture of asset health. Instead of being data focused, Dingo is outcome focused. Dingo’s job is to cut through the noise”

Dingo is working towards this vision, by helping companies extract the maximum value from their condition data to improve operational performance. Unlike many companies that provide software or services in the condition monitoring and data management space, Dingo’s focus is on providing a complete picture of asset health. Instead of being data focused, Dingo is outcome focused. Dingo’s job is to cut through the noise and help customers focus on the ‘right’ information – the information that’s actually going to improve decision-making and drive business results.
Dingo

Dingo Mining is rapidly becoming the standard for Condition Management of mining equipment around the world. Dingo has built the world’s largest fleet health benchmarking database in its Trakka® Condition Management Software and is using the power of this information to improve equipment performance in mines around the globe.

Dingo has assembled a talented team of mining maintenance professionals with one goal: to improve the health and life of mining machinery through the effective use of condition-based asset management.

Dingo’s team of maintenance experts is supported by Trakka®, the industry-leading, cloud-based predictive analytical and workflow management tool that distills data down to precise maintenance actions that will keep assets in peak operating condition. This powerful system is also vendor, equipment, and data-type independent, allowing mining operations to roll-up entire fleets or subsets of fleets.

Dingo’s proven solution drives real results of increased availability, extended component life, and reduced operating costs, with typical payback of >3:1 within 12 months. Dingo’s software and experts are used in the mining, energy and rail sectors worldwide.

Website: www.dingo.com

Steve Bradbury

COO

Steve Bradbury has held the position of the Chief Operating Officer of Dingo since 2006. He leads Dingo’s international operations team of maintenance experts and is responsible for all aspects of program development and delivery to our global mining, energy and rail customers.

Under Steve’s operational leadership, Dingo’s condition-based asset management solutions have been adopted by the world’s leading mining companies across the globe.

Steve received his Bachelor of Science in Mining Engineering from Columbia University in New York and also obtained a Bachelor of Arts in Physics with a minor in Japanese language from Willamette University.
Hexagon Mining

Faced with rising energy costs and tighter profit margins, companies are turning to Hexagon Mining for solutions.

Hexagon Mining unites the innovative technologies of Devex Mining, Leica Geosystems Mining, MineSight and SAFEmine. It seamlessly links mine planning, design, fleet and production management, optimisation, fatigue monitoring, and collision avoidance software for a comprehensive flow of data across all operations. Hexagon Mining will focus on business intelligence and business analytics, (BI/BA) identifying non-productive time. By analysing such information and feeding it back into MineSight’s planning and operational programs, customers can plan and schedule around real-time information coming from their mine.

Essential to Hexagon Mining’s solutions is safety. SAFEmine is the global benchmark for solutions that prevent mining accidents. More than 20,000 mining vehicles in 45 mines worldwide are equipped with SAFEmine’s Collision Avoidance Systems (CAS). Now SAFEmine has launched FatigueMonitor, which is integrated with CAS.

Website: hexagonmining.com

Marcelo Romero
FMS Product Manager

Marcelo Romero oversees integration of the Leica Jigsaw fleet management solution with Hexagon Mining’s other technologies, MineSight, SmartMine UG, and SAFEmine.

Marcelo joined the Tucson, Arizona office of Leica Geosystems Mining in July 2014, bringing more than 15 years’ fleet management experience. Previously, he was an account manager for Mexico and the United States, a machine guidance specialist, a global technical expert engineer for health maintenance solutions in the US, and deployment and support engineer in Chile. His goal is to help create a life-of-mine fleet management solution, incorporating shovels, trucks, auxiliary equipment, and office applications. Marcelo has an electronics engineering degree with a major in automation from Federico Santa Maria Technical University in Chile.
The Leaders series published with Mining Journal

The Mining Journal “Leaders Series” was launched as a response to the industry’s ever increasing need for more analytical and educational information that is delivered in a concise and manageable format.

For information on how your company can get involved in future projects, or if you feel your company’s expertise and insight on a subject could benefit our readers, please contact:

Richard Dolan
E: richard.dolan@mining-journal.com    |    T: +44 (0)20 7216 6086

www.mining-journal.com/focus/leaders-series