



AUSTRALIAN MINING 2030: THE TRENDS THAT WILL SHAPE THE NEXT DECADE

WITH THE AUSTRALIAN MINING LANDSCAPE RAPIDLY EVOLVING, OPERATORS NEED TO EMBRACE NEW TECHNOLOGIES TO REMAIN PROFITABLE AND COMPETITIVE. BUT WHICH TECH WILL BE MOST IMPORTANT IN THE DECADE AHEAD? WESTRAC ASSEMBLED A PANEL OF EXPERTS TO HELP YOU UNDERSTAND THE BIGGEST TRENDS.

WesTrac



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OVERVIEW

We live in an age of unprecedented technological change. New technologies emerge daily, re-shaping the way human beings do business, communicate, and spend our leisure time. Breakthrough technologies have the power to disrupt entire sectors, challenging existing players and empowering companies with the courage and vision to embrace change. The mining sector is no exception. Technological advances are rapidly re-shaping the industry, changing everything from prospecting and exploration to development, extraction and finally closure and reclamation. The skills needed by workers are changing at an incredible rate as digitalisation, automation and data collection transform work practices.

The rewards are high for operators who can successfully harness new technologies. New solutions are becoming available to create a step change in:

- ✓ Safety
- ✓ Reduce costs
- ✓ Improve profitability
- ✓ Lower emissions
- ✓ Environmental impacts.

The challenge for Australian mine operators is to know which trends are relevant and where the future potential lies.

To help map out the way ahead, WesTrac has assembled a panel of industry experts, each highly familiar with trends

in mining technology. Carl Hendricks is Caterpillar's Mining Autonomy and Solutions Manager for Australia; Nakia Brewer is WesTrac's Technology and Solutions Manager and Alister MacPherson is General Manager for Technology at WesTrac.

The panel identified some of the trends to watch by 2030 as: automation; data collection and analysis; sustainability; mental health; virtual reality; and the changing workforce. These are explained in the coming pages, along with the current Caterpillar solutions in each category.

ABOUT THE MINING SECTOR

THE MINING AND RESOURCE SECTOR IS THE LIFEBLOOD OF THE AUSTRALIAN ECONOMY. GENERATING MORE THAN **\$250 BILLION DOLLARS** IN EXPORTS ANNUALLY, THE SECTOR CONTRIBUTES A HEFTY EIGHT PERCENT OF THE NATION'S GDP AND **PROVIDES JOBS FOR MORE THAN TWO PERCENT OF THE POPULATION.**

FOLLOWING A PAINFUL DOWNTURN IN 2012/13, MINING HAS BOUNCED BACK AND PREDICTIONS FOR THE COMING DECADE ARE POSITIVE. POPULATION AND ECONOMIC GROWTH ACROSS ASIA ARE EXPECTED TO DRIVE DEMAND THAT MIRROR TRADITIONAL GDP GROWTH, BUT IN ADDITION, THERE IS A NEW DEMAND FOR MINERALS USED TO PRODUCE BATTERIES FOR ELECTRIC VEHICLES.

AUTOMATION

Automation has been one of the hottest trends in mining over the past decade, with significant investments made by Western-Australian-based global miners, including Rio Tinto (Mine of the Future program), BHP and Fortescue Metals. Automation's overall aim is to make a step change in safety by leveraging technology and creating more consistent processes. Automation involves a fusion of technologies including GPS, LiDAR remote sensing, radar, and sophisticated software algorithms. In the case of full automation, machines operate completely independently, while semi-autonomous machines require a degree of operator supervision and periodic intervention, provided either on-site or via a remote operations centre.

Nakia Brewer says one of the key factors driving automation in Australia is the changing nature of deposits. "Gone are the days of having high-grade mineral deposits sitting just beneath the natural surface," he says. **"We now have significantly more waste to move before reaching the deposit, combined with pressure for mining operations to be more profitable. Autonomous mining systems allow for reduced operating costs, higher productivity and, most importantly, improved safety."**

To date, full automation has mainly been used in equipment such as haul trucks, drills and trains, while more complex machinery such as dozers and excavators have typically been run on a manual, operator-assist, or semi-autonomous basis.

The WesTrac panel is unanimous that will all change by 2030. Carl Hendricks says a major trend will be autonomy of all types filtering down from the pioneering big miners to medium-sized and smaller operators. Many tier two and three miners are likely to be on a path toward running autonomous haul trucks within a decade. "The tier one miners have cut their teeth on autonomy and demonstrated its ability to impact safety and productivity to the rest of the global mining community," Carl says. "Now the focus is very much on how tier two and three miners adapt and adopt what has proven to be an enabler of unprecedented safety and productivity improvements.

"Everybody understands that autonomy is a growing competitive advantage and that's driving spontaneous interest in the market."

Alister MacPherson says there is already huge interest in the autonomous hauling space in Australia, with Western Australia having the largest collection of Cat automated haulers in the world. "There are around 200 at the moment and that number is likely to more than double in the next three to five years," he says.

The panel believes full autonomy will become an option in a far wider range of mining applications within the decade.

Caterpillar semi-autonomous dozers are already in operation in Queensland and NSW in overburden slot dozing and will see expanded application to other dozing applications and integration with autonomous haulage within the next few years.

Carl Hendricks says, just like today, expect to see a mix of autonomy levels on mine sites by 2030. And the trickle-down benefits of autonomy will certainly impact safety. "Even for sites that aren't prepared to go fully autonomous, I think the next big thing is going to be active collision avoidance. This will leverage a lot of the building blocks that go into autonomy to make the mine site safer. In fact, Caterpillar is actively involved in the International Council on Mining and Metals (ICMM) initiative to provide technology by 2025 capable of eliminating fatalities from vehicle interactions

CATERPILLAR AUTONOMOUS SOLUTIONS

Caterpillar offers a broad range of autonomous solutions under the Command category of its Cat MineStar System, and these are available through WesTrac. Solution areas include haulage, drilling, and dozing, with the level of automation currently available varying according to application.

Caterpillar commercially deployed its first automated mining haul trucks in 2013, although it had prototype trucks running in the early 1990's, and as of September 2019 the fleet has now grown to more than 230, with over 1.6 billion tonnes hauled by the end of 2018. In the drilling space, the offering ranges from Auto Drill Assist to semi-autonomous to autonomous operation. In the dozing space, options currently include remote dozing and semi-autonomous operation.

Meanwhile, in an Australian first, WesTrac is working with leading contract miner PYBAR to roll out two fully autonomous Cat R1700 underground loaders for use at the Dargues mine in NSW. (See case study.)

1990

**AUTOMATED MINING HAUL
PROTOTYPE TRUCKS RUNNING**

2013

**THE FIRST AUTOMATED MINING HAUL
TRUCKS RUNNING**

2018

**OVER 1.6 BILLION TONNES HAULED BY
THE END OF 2018**

2019

**THE FLEET HAS GROWN TO MORE
THAN 230**

CASE STUDY: PYBAR TRIALS FULLY AUTONOMOUS CAT LOADERS

Orange-based contract miner PYBAR is embracing the opportunities offered by automation by putting two advanced Cat loaders to work at the Dargues gold mine in south-eastern NSW. PYBAR is in the process of developing the mine, located 60 kilometres south-east of Canberra, for owners Diversified Minerals, with production set to begin in March 2020. In the lead-up to operations commencing, the miner is putting two new Cat R1700 loaders through their paces in combination with Caterpillar's MineStar Command system and the new Command for Underground control platform. The goal is for the loaders to be operating on a fully autonomous basis once the mine is up and running, providing major productivity and safety benefits.

Chief Services Officer Andrew Rouse explains PYBAR currently uses tele-remote loaders at nearly all of its sites across Australia. "With tele-remote, you have an operator who is watching a couple of screens and remotely driving the loader and digging," he explains. "With full autonomy, the goal is for the loader to dig a bucket itself and then return to a given point and dump."

Andrew says PYBAR's adoption of autonomous technologies is driven by both safety and productivity concerns. "We're looking for opportunities to take people out of dangerous environments," he says. "But full automation also offers opportunities to gain utilisation time. With the tele-remote system, we currently have a certain amount of dead time between shift changes and that can add up to an hour or an hour and a half a day. If you can reduce that, even by 50 percent, and turn it into production time then over a year that adds up to a sizable increase in performance. So, it's really just a smarter way of doing things."

Andrew stresses automation is not about getting rid of people. "It's about redeploying them into jobs that are going to be required going forward. There are plenty of examples of senior operators coming off machines and coordinating younger people using tele-remote or putting their knowledge into making sure autonomous systems operate as close as possible to the human level of performance."

PYBAR is embracing technology in plenty of other ways. The company is saving 300,000 sheets of A4 paper and 26,000-man hours annually after equipping all its operators with tablets to record their daily tasks. PYBAR is also focusing on making maximum possible use of the data it harvests from its operations. "We are working with Caterpillar to extract machine data in a useful way for not only maintenance and health assessments but for production reporting and productivity assessments," says Andrew.

GOAL:

The goal is for the loaders to be operating on a fully autonomous basis once the mine is up and running, providing major productivity and safety benefits.

OTHER SAVINGS:

300K
SHEETS OF A4
PAPER

26K
MAN HOURS
ANNUALLY



DATA COLLECTION AND ANALYSIS

Data collection and analysis is another major area of focus by the mining industry. Advances in telemetry (remote data collection) technology over the past decade mean that OEMs are helping operators to accumulate significant amounts of machine health data. Miners are using their machine health, application and performance to gain valuable insights to improve machine availability and productivity.

The WesTrac panel expects increased miner focus on machine data analytics with a view to optimising equipment availability through maintenance practices. While at present harvested data is used predominantly to manage fuel economy and for service and maintenance on equipment fleets, the potential applications are enormous, and Australian operators are fast becoming smarter about using

this goldmine of information. “All this data can be used by operators to create a digital feedback loop about the whole operation,” explains Alister MacPherson. “So, the data that an operator receives from their drills about the ore body adds to their picture of the ore body in real time. They’re then able to compare that to their mine model and adjust. At the same time, fleet management technology allows for the control of material movement, tracking where ore has been transported and stockpiled.”

MacPherson expects data harvesting to also allow operators to tweak their operations to meet market conditions, increasing profitability. “In 10 years, we’re going to see some really sophisticated value chain models that will then tie back into equipment and processes,” he says. “Operators will be using data to control their product at different phases through the production cycle. For iron ore, for example, they will know if the market can tolerate a higher silica content or lower-grade iron content, or whatever the case may be, and tweak their production dynamically to meet demand.”

Carl Hendricks agrees there is enormous potential for increased miner profitability. “Data offers operators potentially very deep insights into the efficiency of their operations,” he says. “They will be able to identify variability in their ore bodies and identify in real time the impact on plant performance, mill throughput, grade and quality of the final product they ship. That in itself will be a very valuable product.”

Nakia Brewer is excited about the potential that data analytics presents for improving equipment availability. "At the moment we have a service that we offer in the equipment management space that benchmarks a particular machine against others in the same fleet and across all similar machine types across the globe from other sites who have elected to subscribe to the same service," he says.

"We're able to see slight trends kicking in over time that wouldn't have been picked up by traditional means of equipment management monitoring."

Nakia says technology now brings data together to create a real-time three-dimensional map of the mining operation, helping operators to understand current conditions – and dangers.

Emerging technology will be used to help identify the position of people and assets on a mine site without the use of GPS – a major benefit in an underground environment.

By fitting staff and equipment with cameras, mine operators will slowly be able to create a real-time digital picture of the mine.

Meanwhile, Alister MacPherson foresees increased use of 'digital twins' in mining. These are virtual simulations of either the whole operation or a particular asset created through the harvesting and analysis of data points. The simulation allows operators to work through potential operating scenarios in advance and to understand the potential repercussions, benefits and challenges.

CATERPILLAR DATA SOLUTIONS

Caterpillar today offers a broad range of data collection and management solutions under the Fleet, Detect, Health and Terrain categories the Cat MineStar System, and these are available through WesTrac. 'Fleet' provides operators with real-time machine tracking, assignment and productivity management, while 'Terrain' enables high-precision management of drilling, dragline, grading and loading operations. 'Detect' helps increase operator awareness and enhances safety, while 'Health' delivers critical event-based machine condition and operating data across the entire fleet.



SUSTAINABILITY

The mining sector is increasingly focusing on sustainability issues in response to both community pressure and the need to be more economical and profitable. Meanwhile, underground mining operations are continually looking for ways to increase safety by reducing emissions.

The entire panel agrees the electrification of vehicles is a key area to watch over the next decade, with automation also bringing in major sustainability benefits.

“As battery technology advances over the next decade, Caterpillar will continue to evaluate various technologies for their commercial and technical feasibility for all Cat products in the mining portfolio. Based upon the customer value generated, we see a wide range of electrification technologies, ranging from diesel/electric, hybrid, and full battery power to name a few, being applied judiciously by product and application over the near term,” says Nakia Brewer. “Advances in Cat electrification include the underground R1300 & R1700 which should lead to large battery powered equipment in the future.”

Alister MacPherson agrees electric vehicles have enormous potential and could potentially shake up the way

maintenance is carried out on mining vehicles. “The one area where technology hasn’t yet had a major impact on mining is in the area of maintenance,” he says.

“Carrying out maintenance on site, in plant or on the equipment is high risk and we have not fundamentally improved that. Electrification could be one of the building blocks to change that and to eliminate or greatly reduce the need for maintenance.”

Nakia Brewer believes as well as improving safety, increased automation of mining equipment will have massive flow on benefits in terms of fuel efficiency and sustainability.

“Human beings are by nature the most unpredictable of control systems,” he says. “Autonomous machines will operate consistently every time, and this consistency will eventually allow manufacturers to redesign equipment and components allowing for the industry to challenge the design principals of the past”.

CATERPILLAR SUSTAINABILITY SOLUTIONS

The range of Caterpillar fully electric equipment is growing all the time and new products are in development. While already offering draglines, electric hydraulic mining shovels, electric rope shovels, and locomotives, a fully electric 26-tonne excavator was recently produced for a company in Norway. **As announced earlier this year**, Caterpillar has also chosen to make the new R1700 its first battery electric load haul dump platform while using fast, onboard charging to facilitate high production levels. Caterpillar equipment is compliant with emission regulations in the market is released and Caterpillar’s vision is to provide work environments, products, services and solutions that make productive and efficient use of resources.

HEALTH & SAFETY

All members of the panel agree caring for the health and safety of the people working in mining operations will continue to be a big focus over the next decade. The emphasis will not only be on physical wellbeing, but also the emotional and psychological health of staff.

01

PHYSICAL WELLBEING

WesTrac's Alister MacPherson believes the ongoing roll-out of semi-autonomous machines has enormous potential to reduce the physical stress workers are exposed to – with positive health outcomes. Remote operating systems on drills and dozers using cameras and sensors will increasingly allow operators do their jobs at remote locations over the next decade.

"Being a dozer operator is currently one of the most arduous mining jobs and also one of the most complicated," Alister says. "If the operator is able to spend his entire shift in an office and manage the machine remotely, they can deliver their knowledge of how to doze optimally across a much longer career."

Alister warns one potential danger to watch with such technologies is social isolation if operators eventually end up working remotely by themselves, away from the mine site. One solution as the technology reaches higher degrees of penetration may be to have such operators working together in pods. This would provide them with human

02

EMOTIONAL HEALTH

contact and the ability to discuss work and other issues with colleagues.

Caterpillar's Cat Hendricks, meanwhile, predicts advances in another area – systems to monitor the alertness and fitness of drivers. With micro sleep being an issue, systems such as Caterpillar's Driver Safety System (DSS) are playing a large role in preventing injuries and incidents.

Nakia Brewer explains the Cat DSS platform works by monitoring eye-closure duration and head pose. If it detects a fatigue or distraction event the operator is immediately alerted through configurable in-vehicle seat vibration and / or audio alarm. "It also sends an alert off to the 24/7 monitoring centre at Caterpillar," Nakia says. "They have a team of fatigue scientists who will look at that information and following defined processes will ensure the correct on-site personnel are notified, ultimately allowing the avoidance of potential fatigue related incidents."

03

PSYCHOLOGICAL HEALTH

VIRTUAL REALITY (VR)

VIRTUAL REALITY (VR) VS AUGMENTED REALITY (AR)

Virtual reality involves creating three-dimensional computer-generated simulations of environments which people can interact with in real time. Current VR technology usually involves participants wearing goggles which are sensitive to head movement and give the impression of being immersed in an environment

Augmented reality (AR), meanwhile, involves computers being used in a real-world environment to provide humans with additional information and insights.

The panel agrees the technology has enormous potential in the mining sector, both in terms of training to staff and optimising mine operation.

Currently, VR is predominantly used to provide new staff with simulations of dangerous environments in which they will be working, thus gaining experience without risk to their lives. Carl Hendricks says there's enormous scope for the technology to be used more widely. "There's an opportunity for using VR and AR to instruct service technicians who will be maintaining the increasingly complex machines used on mine sites," he says. "We could also see a situation where the

technology is used to help technicians collaborate in real time with experts back at the OEM or a dealership's head office to get deeper expertise in the field while troubleshooting."

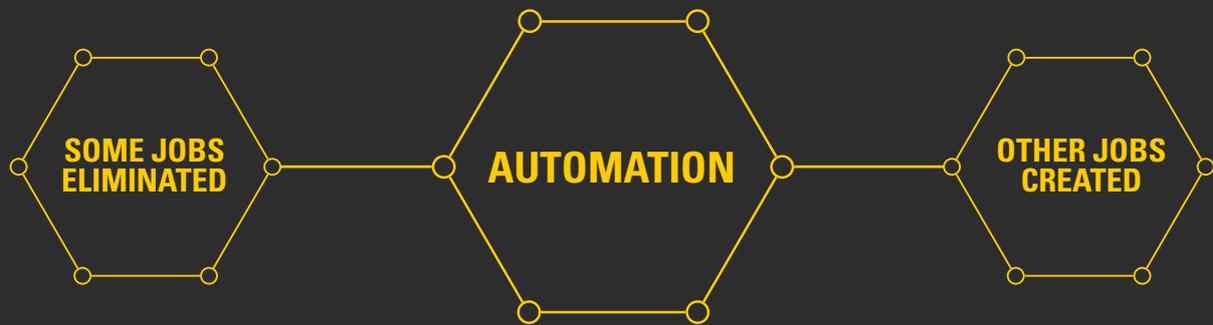
Carl also sees the potential for the technology to be used to provide real-time simulations of complex mine site operations, such coordinating the operation of autonomous loaders. "Virtual reality will allow you to simulate and look at different scenarios within a mine very quickly," he says. "You will be able to visualise how a change in one parameter will influence extractions sequences, for example, over the short, medium and long term."

CATERPILLAR SUSTAINABILITY SOLUTIONS

Caterpillar currently offers a range of VR products aimed at sharing knowledge and reducing risk. Cat Safety VR, for example, is a safety training module customised for paving applications. The module immerses trainees into a virtual four-lane rural highway construction site, where they learn how to interact with co-workers and identify hazards in a safe and controlled environment. The concept recognises that road construction job sites are full of hazards and distractions that create risks for employees, especially new workers and provides training in an extremely low risk environment.

The Cat Simulators Advanced Dozer Simulator System, meanwhile, teaches multiple applications, along with operational safety. The VR Edition with patented VR NOW™ technology allows for deeper engagement in the simulated environment. The VR headset allows the user to see more of the environment and machines and gain greater depth perception.

CHANGING WORKFORCE



The arrival of increasingly sophisticated technology on mine sites is likely to have a major impact on the nature of the mining workforce. While automation will see some jobs eliminated, the WesTrac panel agrees there will be new roles and jobs created, many with specialised skill requirements. This and other factors are likely to gradually change the demographic make-up of the industry.

Operator roles, where a human being sits in the cab of a piece of equipment and carries out a task, are likely to become less common. On the other hand, there will be an increasing need for individuals who can operate, service and interface with sophisticated digital equipment and increase mine productivity.

MacPherson says there's also potential for operators of tele-remote systems to be located hundreds of kilometres from the mine site in urban areas – a factor that could make mining far more appealing to a wider range of workers.

“The technology will potentially allow operators to spend less time on FIFO and spend more personal time with their family,”

he says. “They could just go downtown to an office and run their shift there and then go home at the end of the day without being physically exhausted.”

However, MacPherson identifies that evolving work practices will change mine employee roles and create new roles. Need to elaborate on the new roles created in WesTrac and some of the focus with mining companies on retraining people. “

CONCLUSION

The coming 10 years are likely to bring enormous technological advances. Mine owners and contract miners can expect to see an explosion in automation, analytics along with the use of Artificial Intelligence and sustainability-focused products, while major advances are likely on the areas of VR, safety and working roles.

There is a huge opportunity to use technology to improve capital intensity and reduce operating costs by leveraging technology. WesTrac and Caterpillar are well placed, motivated and able to assist operators on this journey.



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For more information on the latest technology in the industry visit the technology section on our website

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