

Lessons From Mining: 4 Autonomous Thing Benefit Zones for Manufacturers

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Mine operators are at the vanguard of profitable deployments of autonomous things at scale (robots, drones, vehicles and industrial equipment). This provides manufacturing CIOs with evidence for business cases that can improve collaboration, heighten efficiency, enhance safety and reduce costs.

Overview

Impacts

- As the intelligence of autonomous things improves, manufacturers can create a symbiotic environment where machines and humans work together collaboratively.
- The systematic way that machines perform repetitive tasks means that accuracy can be improved, which reduces the potential for error when human operators become bored or tired.
- The safety of working conditions can be improved when machines undertake work that is impractical or dangerous for human workers.
- When humans are designed out of the system, manufacturers can reduce costs by eliminating capital investments needed for human-centric supporting infrastructure, as well as ongoing operational costs.

Recommendations

Manufacturing CIOs who wish to utilize autonomous things as part of their digital transformation and innovation strategy must:

- Deploy systems that deliver measurable results by developing new workflows that enable autonomous things and the human workforce to work together collaboratively.

- Identify areas where quality could be improved by establishing which repetitive manual tasks could be performed by machines more consistently.
- Ensure the organization fulfills its duty of care to staff by identifying hazardous activities that could be done using autonomous things.
- Explain to the business how it can reduce costs through transitioning from its current operational state to a highly automated future by writing a strategic plan highlighting the deliverables that autonomous things can provide.

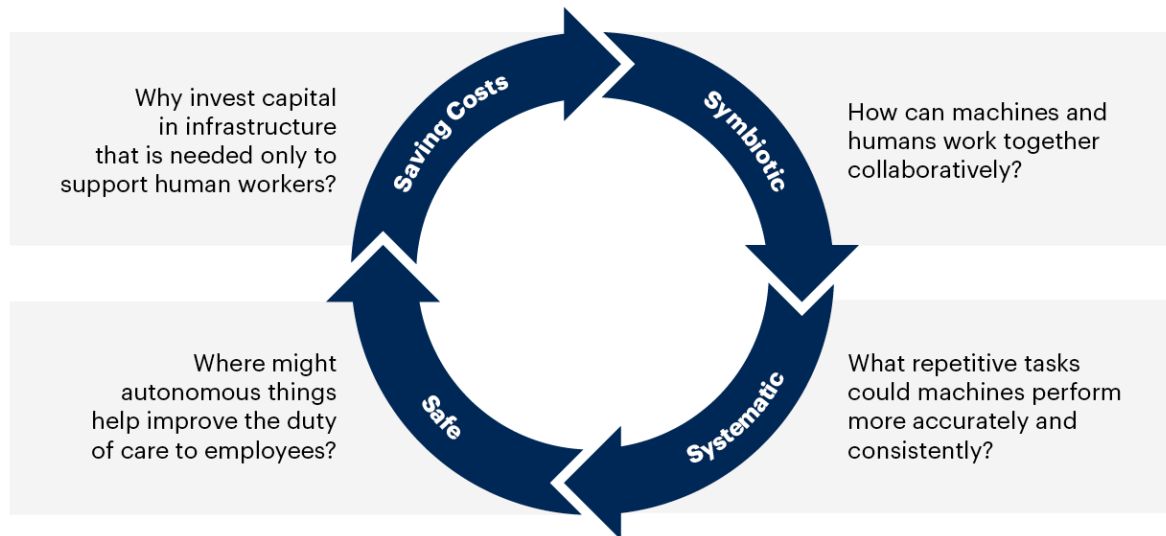
Analysis

Historically, mine operators have relied on human workers to perform repetitive tasks. However, as a business that operates in closed environments and takes a long view of investments, the industry has showcased how autonomous things, such as vehicles, robots, drones and industrial equipment, can be deployed profitably and at scale. Mine operators have shown how autonomous things can help reduce human exposure to dull, dirty or dangerous working environments, while delivering measurable productivity improvements. As a result of these early implementations, solutions offered by autonomous thing vendors have begun to mature, enabling lower price points.

Now that early use cases have been proven, manufacturers need to start planning for how they will implement autonomous things to improve their competitive position in the market. CIOs play an important role in this planning activity, as part of a cross-functional team that will include operational technology (OT), finance, procurement and HR functions (see [Autonomous Things Deployment: 5 Best-Practice Stages That Require Manufacturing CIO Leadership](#)).

As part of preparing for the factory of the future, manufacturing CIOs can use this research to understand each of the positive impacts that autonomous things deliver. Then they can use the recommendations to help assess how autonomous things can assist, replace or redeploy human workers to take advantage of the high — and occasionally transformational — business benefits. There are four key benefit categories that autonomous things have proven through mining implementations (see Figure 1).

Figure 1. Four Benefit Zones of Autonomous Things

Four Benefit Zones of Autonomous Things

Source: Gartner

Note: Symbiotic = Collaborative; Systematic = Efficient

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Impacts and Recommendations**Symbiotic Environment: Machines and Humans Work Together**

A new paradigm is emerging where manufacturers have a workforce that is made up of humans and intelligent autonomous things that collaborate to synergistically undertake activities more efficiently (see [Future of Work Scenarios 2035: How Will Leaders Manage in a Majority-Bot Workforce World?](#)). Machines and humans each have different skills. When those skills are fully leveraged, they deliver benefits where the whole is greater than the sum of the parts. For example, humans are needed to control and maintain autonomous things, but autonomous things can work without the need to sleep, eat or take a break.

Mining Case Studies That Manufacturing CIOs Can Learn From

The mining industry has been successful in creating a collaborative environment to automate routine human activities in a controlled environment where tasks are straightforward and repetitive and any potential damage caused by an accident would be minimal. Fortescue Metals Group, a mine operator in Western Australia, has a fleet of 112 driverless trucks that have delivered a 30% improvement in productivity. ¹

While it has eliminated the driving role, human workers and autonomous vehicles need to work together. Its autonomous vehicles need to communicate with the mine's command-and-control platform and fleet management system that are monitored by a human workforce. ² Trucks are loaded with ore by a human loader operator and assigned a destination. Then, when the truck arrives at its destination, operations center staff precisely direct it to an unloading location. In addition to operational support, a maintenance center is also required, which provides new roles for retained staff who must be trained on new technologies. ³

By operating vehicles on private road networks, mine operators can overcome the regulatory and safety concerns that have inhibited the rollout of autonomous vehicles on public roads. Specialist companies have developed self-driving systems targeted at closed-environment use cases (see Note 1). Vehicles are fitted with GPS transponders and sensors, such as cameras, radar and lidar, to classify objects and identify safe driving spaces to navigate around the mine.

Recommendations for manufacturing CIOs who want to create a symbiotic work environment:

- Model the most appropriate areas where improved symbiotic collaboration between machines and humans could be achieved by mapping the business processes where task handovers occur. Analyze the improvements that autonomous things could engender.
- Ensure the safety of human workers by creating autonomous and nonautonomous zones to protect staff and improve the efficiency of devices.
- Improve operational productivity by leveraging closed manufacturing environments. Although safety is paramount, regulatory and safety concerns that have hindered the use of these devices in public spaces can be bypassed.
- Support human-machine handover of tasks by investing in command-and-control fleet management systems.

Systematic Improvements: Machines Perform Repetitive Tasks More Accurately Than Humans

Autonomous things can undertake certain tasks better than humans, which leads to efficiency improvements. Therefore, the introduction of autonomous things into the manufacturing environment can support the systematic improvement of operational processes.

Mining Case Studies That Manufacturing CIOs Can Learn From

Rio Tinto in Australia uses fully automated hole pattern drilling to improve efficiency.⁴ The company's autonomous drill system enables a remote operator, using a single console, to control up to four autonomous drill rigs from various manufacturers simultaneously. Precision is also improved. These sorts of benefits have lowered production costs.

As a result, another company, Resolute, could mine new ore bodies that were previously unattainable or inaccessible, because the cost of production has dropped from \$881 per ounce to \$746 per ounce.⁵ This highlights how autonomous things can enable business production in a way that was previously thought impossible.

Recommendations for manufacturing CIOs who want to create systematic improvements to their operations:

- Identify areas where efficiency might be improved. For example, which repetitive manual tasks that humans are currently performing are those that machines could perform more accurately and consistently?
- Create a business case to support autonomous-things-based business process improvement. For example, use a proof of concept to assess the benefits that could be derived if equipment utilization was improved.
- Scale up the use of autonomous things by capturing detailed data (both qualitative and quantitative) to support further investments in autonomous things.

Safer Work Environment: Machines Undertake Work Impossible or Unsafe for Human Workers

Risks to human safety can be dramatically reduced or eliminated altogether by utilizing autonomous things to do work that is unsafe or otherwise impossible to accomplish. This is a really important point for manufacturers, because accidents can be very costly if people are injured, or assets are damaged. Plus, if the human workforce feels that their employers value them and provide a safe and comfortable work environment, they are more likely to perform better.⁶

The use of autonomous thing technologies can unlock the ability to perform tasks that were previously thought impractical because of the risks involved or the expense of the activities. This is either because of the need for specialized equipment or because of the opportunity costs of operations that must be ceased while the task is performed (for example, during maintenance of equipment).

Mining Case Studies That Manufacturing CIOs Can Learn From

Mine accidents claim about 1,000 lives every year in the U.S. Moreover, although accurate worldwide numbers are more difficult to find, some estimate that number to be as high as 12,000, most of them in coal mines.⁷ However, when there is no one in a mine, no one can be injured or killed, which is one of the drivers behind the use of autonomous things by mine operators. Robots and drones are recognized as bringing significant operational safety.

For example, autonomous mobile robots (AMRs) are used to undertake inspection tasks. Some of these inspections are to safely comply with legal regulations, whereas survey inspections of abandoned mines that are too hazardous for humans to enter are also being undertaken. These surveys help identify minerals that weren't in demand while the mine was active but could now be indispensable.⁸ The AMRs use lidar technology to autonomously navigate flooded passages and use cameras and other sensors to detect various minerals. Murky water and flooded tunnels are too dangerous for human divers and so are much more suited to AMRs.

Recommendations for manufacturing CIOs who want to support a safer work environment:

- Increase the ease with which inspection and surveying activities can be undertaken. For example, identify both the opportunity cost of current approaches (cessation of work and so on) and security and maintenance benefits that can be derived using regular monitoring of facilities.
- Manage investment costs by assessing whether the use of autonomous things for specific safety use cases should be operated in-house or brought in as a service when required.

Saving Costs: Target Investment on Value-Adding Infrastructure

Autonomous things have the potential to assist, replace or redeploy human workers, creating high – and occasionally transformational – business benefits. Operational staff costs can be significantly reduced, while the use of machines to operate vehicles can also improve both the utilization and the service life of vehicles, meaning fewer replacement parts and increased vehicle service intervals. By providing staff with safer and more stimulating and comfortable activities, manufacturers can expect that job satisfaction and, hence, retention will also rise, reducing both training and recruitment investments.

For new sites, one of the greatest hidden benefits of delivering an autonomous manufacturing environment is the reduction in capital costs. Today's manufacturing environments are optimally designed to perform the tasks for which they were intended, because they are required to support the human workforce. People currently operate in the environment. So there is a need for walkways, staircases, lighting, car parking, canteens, dressing rooms, restrooms, training facilities, personal protective equipment (PPE), human-machine interfaces (HMIs), ventilation, and heating and cooling.

But none of this is needed if the environment can be operated by autonomous things. It will not be cost-effective to retrofit this change, since the capital has already been spent. But future manufacturing designs can be simplified, with a much lower capital expenditure using autonomous things.

Mining Case Studies That Manufacturing CIOs Can Learn From

At the world's first fully autonomous mine in Mali, Resolute has been able to cut mining costs by 30%, despite its upfront investment in autonomous equipment. Each autonomous thing is now utilized 22 hours a day, rather than the 15 to 16 hours that equipment was utilized in the past. For example, mobile robots do not need to be protected from explosive gases, nor do operations need to be suspended to allow for ventilation. However, cost savings don't come from replacing the human workforce with machines – the company is adamant that automation will not reduce employment. Rather, new jobs will be created. ⁵

For Rio Tinto, which utilizes autonomous haulage trucks in the Pilbara region of Australia, automation enabled it to consolidate staff away from the mine itself. Staff program the information about vehicle routes while in an operations center that could be as far away as Perth (625 miles). ⁹ This improves the ability to hire staff by positioning the operations center near a large conurbation, removing the need for expensive on-site infrastructure and commuting costs. The experience of staff is also improved — they don't have to spend time away from home to perform their jobs and no longer have to endure harsh working conditions.

Likewise, Vale's introduction of autonomous haulage vehicles in Brazil is expected to reduce fuel consumption by more than 10%, maintenance costs by 10% and tire wear by 25%. Plus, the service life of equipment is expected to increase by 15%, which will reduce capital costs, too. ¹⁰

Recommendations for manufacturing CIOs who want to help their companies save costs:

- Break out of today's constrained thinking by working with cross-business (and in particular, operational) colleagues to list the operational tasks that autonomous things might enable. Think about what you want to achieve — rather than how you can achieve it.
- Create a strategic vision for business transformation by designing automated processes to complete all of the operational tasks. Don't factor in human requirements at the start — this will constrain your thinking.
- Prepare to redeploy staff to higher-value jobs by actively communicating with individuals and trade unions, while putting in place specific training and support packages.

Evidence

¹ [No One Behind the Wheel: The New Workforce Driving Australia's Mines](#), The Sydney Morning Herald.

² [The Normal, Everyday, Autonomous Mine](#), Smart Industry.

³ [Komatsu Becomes Automation FrontRunner at Vale's Carajas Iron Ore Mine](#), International Mining.

⁴ [Rio Tinto Orders Robot Trucks, Drills for Digital Mine](#), iTnews.

- ⁵ [Sizing Up Syama: The World's First Fully Automated Mine](#), Mining Technology.
- ⁶ [How a Safe Working Environment Improves Productivity](#), Smarter Time.
- ⁷ [Underground Robots: How Robotics Is Changing the Mining Industry](#), Eos.
- ⁸ [How Are Autonomous Mobile Robots Used to Inspect Mines?](#) Robotics Online.
- ⁹ [Rio Tinto to Expand Autonomous Truck Operations to Fifth Pilbara Mine Site](#), Rio Tinto.
- ¹⁰ [Current State and Development Prospects of Autonomous Haulage at Surface Mines](#), ResearchGate.
- ¹¹ [Australia Dominates Global Autonomous Haul Truck Use With Numbers Set to Triple](#), Mining Technology.
- ¹² [Our Story: Revolutionizing Transportation for the Better](#), Torc.
- ¹³ [Why the Pilbara Leads the Way in Haul Truck Automation](#), International Mining.
- ¹⁴ [Japan's Komatsu Selects NVIDIA as Partner for Deploying AI to Create Safer, More Efficient Construction Sites](#), NVIDIA.
- ¹⁵ [What Is a FrontRunner AHS Truck, and How Do They Operate?](#) Komatsu.
- ¹⁶ [SafeAI Raises \\$5M to Develop and Deploy Autonomy for Mining and Construction Vehicles](#), TechCrunch.
- ¹⁷ [John Deere Partners With Precision Makers on Autonomous Mowers](#), Golfdom.
- ¹⁸ [The Age of Unmanned Tractors Is Coming, But Not Without a Fight From Farmers](#), The Drive.

Note 1: Example of Closed-Environment Autonomous Software Vendors

According to GlobalData research, the two leading autonomous surface truck suppliers, Komatsu and Caterpillar, collectively account for 93% of vehicles in operation, with the 930E and 793F the most popular models for the two OEMs, respectively. ¹¹

The mining equipment OEMs are working with perception algorithm vendors to support their solutions:

- Caterpillar vehicles appear to be provided with Torc. ¹² Caterpillar utilizes a 64-channel Velodyne Lidar, which is combined with radar. It processes the data from these sensors at the edge by using significant vehicle onboard computing power. ¹³
- Komatsu uses NVIDIA's graphics processing units (GPUs) and Jetson AI platform to visualize and analyze the vehicle's environment. ¹⁴ Komatsu's system uses radar and lidar, ¹⁵ but places greater reliance on the wireless network, while performing most of the calculations on the server side. ¹³

The startup space contains a diverse range of companies:

- [Cognimine](#) has developed autonomous driving and AI technology for off-road vehicles. Its new autonomous haulage system component for mines has been integrated into intelligent trucks to replace human drivers, improving mines' productivity and safety.
- [Autonomous Solutions, Inc. \(ASI\)](#) has developed its Nav system of robotic components that installs easily into any vehicle platform, converting it from manual to robotic control. Depending on the unique characteristics of each vehicle, it uses any one or a combination of by-wire, mechanical and hydraulic modules to complete the automation.
- [SafeAI](#) has a solution to retrofit heavy equipment for autonomous applications in the mining and construction industries. Its autonomous technology enables equipment owners to transform existing machines into self-operating assets. SafeAI is working with Doosan Bobcat, the South Korean equipment company that makes Bobcat loaders and excavators, and it's already demonstrating and testing its software on a Bobcat skid loader. ¹⁶
- [Precision Makers](#) specializes in the automation of the agricultural and horticultural sectors. It is working with John Deere to develop autonomous mowing solutions for the golf and sports turf industry. ¹⁷
- [Hands Free Farm](#) is working on automated machines to grow crops autonomously, without operators in the driving seats or agronomists on the ground. It is working with Farmscan Ag to maintain an 86-acre area of land entirely by using automated farm equipment. ¹⁸

- [Universal Field Robots](#) wants to bring to market a fully autonomous robot with industrial-scale capabilities.
 - [Oxbotica](#)'s technology enables machines to navigate, understand and act in any environment, without dependence on external infrastructure, including GPS or third-party maps. This approach enables its technology to work on a range of vehicle platforms and domains — from airports and warehouses, to ports and mines.
 - [Ottopia](#), though primarily a teleoperation company, has developed its own self-driving system, which it offers to ports, mines and campuses.
 - [Outrider](#) provides autonomous yard management solutions.
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[Market Trends: Evaluate Drone Opportunities in Manufacturing and Natural Resources](#)

[Market Insight: Use Situationally Aware Platforms to Enable Safe Autonomous Vehicle Handovers](#)

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