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I4 MINING

How Industry 4.0 Technology will Transform **Plant, Machinery & Equipment.**

A report examining the need for, use cases and benefits of utilizing Industry 4.0 AI + IoT technology with plant in the mining sector.

Plant and the path to 2050.

Across many industries the utilization, efficiency and the lifespan of plant, machinery and equipment are critical measures which predicate productivity and profitability.

With vast fleets containing multiple asset classes, spread over large areas and across multiple, remote sites; the mining sector has a harder time than most when it comes to getting accurate measures and then improving upon them.

Not only this and beyond the bottom-line, the plant that miners use can be hazardous. Improper usage, catastrophic failures and a myriad of other potential causes make adverse interactions with it one of the leading contributors to injuries, fatalities and environmental harm.

Over recent decades, the plant that miners have been using have been getting better and through these enhancements, the sector has been able to reduce incidents and increase efficiencies - as long as they've been able to fund the large capital investments necessary to purchase and then implement them.

However, we are at something of a crossroads.

Zero harm, zero carbon and zero waste measures are now strategic as well as operational imperatives. The drive to be carbon neutral by 2050 (or sooner), the minimization of environmental harm and ability to prove stewardship...

Continued overleaf.

Contents.

Please note: Throughout this report we will refer to 'plant'. This is for ease of reading and refers to all plant, machinery and equipment unless otherwise stated.

...credentials, as well as the need to achieve zero workforce fatalities, are forcing miners to look at their entire operations in order to find the improvements that are going to enable them to achieve these goals, profitably.

Plant is no exception and the ascent to 2050 dictates that mining companies need to take affirmative, extensive action with their plant now rather than relying on OEMs and hardware manufacturers to innovate in order to get them there.

Pivotal in achieving these strategic and operational goals will be the application of novel plant solutions with the deployment of Industry 4.0 technologies that can deliver all-new data-led insights that uncover the hidden optimizations which already exist and that can leverage the power of AI and machine learning to seize all-new ones.

Whilst challenging, there are huge advantages to be seen on the other side, with predictive analyses that can do much more than achieve the zero goals outlined but deliver all-new ways of working and find efficiencies that increase profitability and much more.

...the ascent to 2050 dictates that mining companies need to take affirmative, extensive action with their plant now rather than relying on OEMs... to get them there.

The COVID lesson.

Many miners have already embraced automation and novel 'smart mining' technologies. Amongst them, Rio Tinto boasts driver-less fleets, Fortescue has put in place remote payload monitoring, and Vale now operates autonomous trucks*.

These are not isolated examples but what they all have in common was that they came about through longer-term projects that were steadily developed and implemented over time - COVID-19 forced many miners to move faster.

The inability to have FIFO personnel rotating on site nor have specialist expertise in the field meant that miners rapidly had to implement new work from home capabilities, set-up remote and secondary control rooms and operational centers, as well as further leverage the abilities of autonomous fleets to undertake new roles if their operations weren't to grind to a halt.

This did not happen and in 2020, when many industries were being hammered financially by the COVID-19 pandemic, net profits amongst miners rose by 15% and market capitalization increased by 64%, and 2021 is expected to be an even bigger boon - with revenue expected to increase by 29% and profits 68%†.

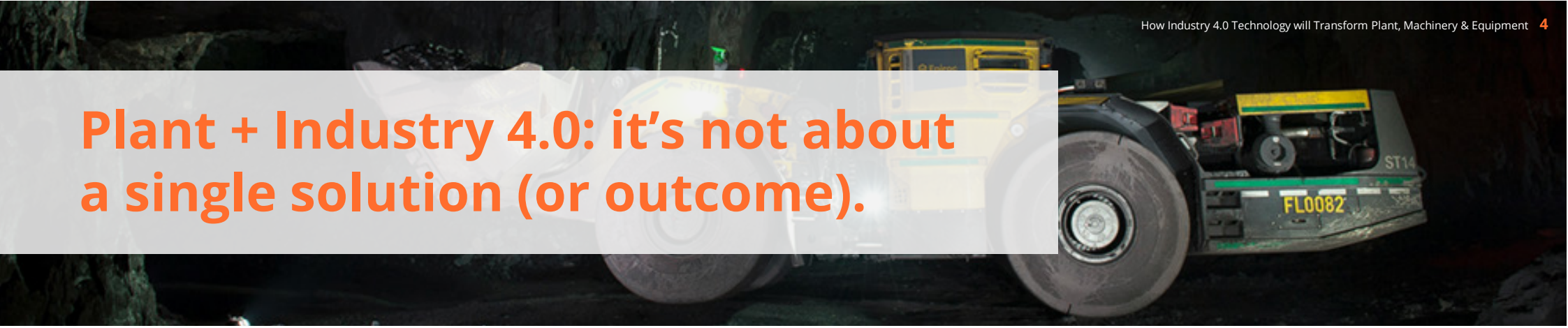
Whilst the long-term impact of the pandemic is far from certain, the process of change that it has begun feels unstoppable. Many of the lessons learned during the COVID pandemic, the technologies implemented via necessity, and knowledge and skills gained by workforces has enabled the sector to jump forward on its path to achieving Industry 4.0 status.

Immediate efficiency savings, utilization improvements and enhancements in both environmental and workforce safety can be simply and rapidly achieved through the further adoption of intelligent Industry 4.0 solutions that harness the power of machine learning to analyze large data sets (in real-time) and then direct manual optimizations or AI-led interventions.

When it comes to plant, miners are able to analyze individual asset performance based on all of the potential variables that go into its operation, drill-down and identify individual assets (or individuals) that might be causing operational problems today, predict those that will tomorrow, and provide decision-makers with a true single source of truth and the means to analyze and de-risk their operations like never before - all in real-time.

Not only this, but the technology also enables the sector to integrate all real-time and historical data sources (and leverage new ones); guarantee data completeness and accuracy via machine learning; and then apply adaptive and predictive analytics to give senior-management the insights they need to design a roadmap to 2050.

* Sources: Source: https://www.industryweek.com/technology-and-iiot/article/22026902/how-iiot-is-changing-mining and http://www.vale.com/brasil/EN/initiatives/innovation/industria-40/Pages/default.aspx
† Source: PwC: Mine 2021



Plant + Industry 4.0: it's not about a single solution (or outcome).

The fourth industrial revolution - where businesses build upon their use of computing power and automation with the adoption of intelligent, autonomous systems that can leverage complex data sets and machine learning to deliver AI-driven enhancements in real-time - is central to miners achieving more with their plant.

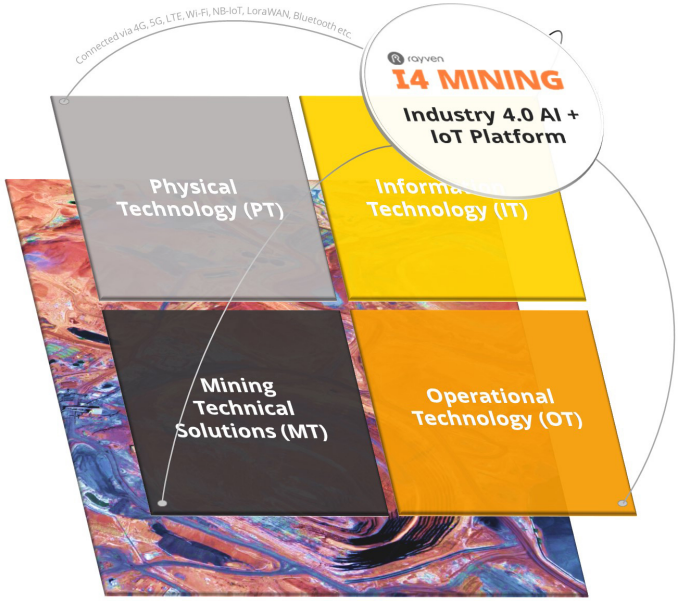
There is already a vast array of 'Industry 4.0 plant solutions' available. From new forms of IT and Mining Technical solutions (MT), to Physical Technology (PT) and Operational Technology (OT); all boast outcomes that deliver on efficiency, safety, productivity and other plant-orientated goals.

What these individual solutions and technologies cannot do, however, is deliver holistic change or fuel the attainment of strategic zero harm, zero carbon and zero waste goals alone - and relying on them to do so is akin to leaving change at the hands of OEMs.

What these individual solutions do deliver is the additional functionality that's needed to either deliver on Industry 4.0 transformation or which can deliver on changes that have been identified by it. For example, systems that measure whether a seatbelt is plugged in or that allows for a drill rig to be run remotely is great in improving safety, but is not going to analyze whether the person at the controls is doing a good job or whether that particular piece of plant is performing as well as others in its class.

In order to run plant optimally, it's necessary to analyze 'Big Data' sets that look at all the variables that go into how it operates: temperature, vibration, noise, driver operational score, energy usage, pressure etc.; compare it with other assets in the fleet and sites; analyze maintenance schedules; weather conditions; planned future usage; and much more to uncover commonalities, trends and optimizations.

To do this, miners need to adopt a new piece of technology that can sit in the middle of every Industry 4.0 business and/or operation to analyze and orchestrate: an integrated AI + IoT platform.



An integrated AI + IoT Industry 4.0 platform sits in the middle of your technology and operations. It integrates with all your other systems, platforms and data stores, offering extreme interoperability and creating a single source of truth through which you can analyze data, apply machine learning, seize optimizations either manually or via AI-led control, and much more.

An integrated AI + IoT platform is capable of a supremely high-level of interoperability, connecting to every possible system and data source, before then analyzing all of the data that's coming from them (plus other systems or data sources inside and outside your organization) to identify trends, relationships and insights hidden in the 'Big Data' that you're accumulating in real-time. The platform can also be programmed to take direct action based on pre-programmed business logic or via AI-led intervention to prevent harm or identify where and how a business (or individual employee) needs to improve, optimizing on an ongoing basis based on changing variables and performance.

The AI + IoT platform is critical because it's the one place in an organization where all of its data (both historical and real-time, from any system, sensor or data lake) can flow and be standardized for analysis, where machine learning algorithms can be leveraged, and where cross-functional decisions - made by human or AI - can be orchestrated and executed: it's an Industry 4.0 organization's brain.

This makes the path to achieving Industry 4.0 status one that involves a suite of use case-specific solutions that can be deployed and then integrated with one another piece-by-piece, function-by-function. It's not about a single technology in isolation, but the amalgamation of multiple solutions which are integrated together (along with legacy technology) via an integrated AI + IoT platform to share data, improve how it's analyzed (data science), and by improving how people interact with it and a mine's operations.

Why Industry 4.0 is about AI and IoT.

IoT and AI technology are distinct sets of interrelated technologies in the context of Industry 4.0 technology. To simply delineate the two:

IoT: Collecting the right data. ✚ **AI:** Using machine learning to do something with it.

IoT: IoT or IIoT (Industrial Internet of Things) technology enables miners to collect real-time data about their operations via infield sensors; through links from OT, MT, PT and IT; as well as via third party resources (such as weather forecasting). This data then enters a platform through which it is combined and can be examined via dashboards to assess performance in real-time and sometimes even execute simple automations based on 'if this then that' business logic.

On its own, IoT presents miners with opportunities for transformation and improvement, removing the need for people to enter hazardous environments to take measurements but cannot deliver true Industry 4.0 transformation on its own as it lacks the critical decision-making and predictive analysis required to meet the definition.

AI: The AI element of an Industry 4.0 solution is about the applications and subsequent actions taken as a result of the use of machine learning algorithms being applied to the data sets collated using IoT technology and the platform's other integrations.

To operate, you need to have in place a way to record and compare the interactions of all of the potential variables that go into an operation so that machine learning algorithms can be applied to the data sets to spot trends, relationships and uncover optimizations.

For Industry 4.0-status and strategic goals to be reached, this needs to be done in real-time, with interventions executed through automation before they're lost or before they occur, e.g. preventing accidents etc. Over time (and with growing data sets) machine learning algorithms find new and more effective ways to operate - they get better - and multiple ones can be applied to the same data to experiment with new use cases or test alternative approaches (via digital twins).

It is with the combination of AI + IoT that we get to the heart of what people mean by Industry 4.0 status: having operations that utilize machine learning-led automated interventions in real-time that self-optimize over time on an ongoing, incremental basis.

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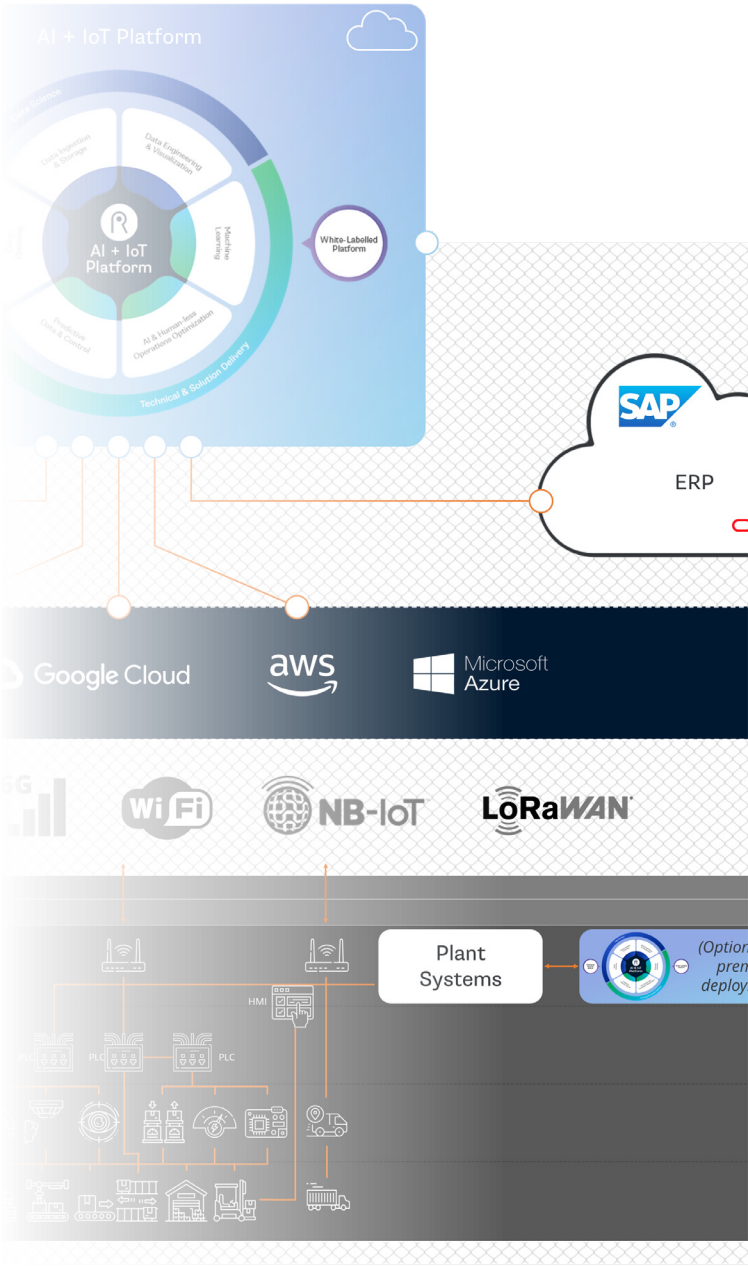


The drivers and path to change.

There are a huge array of technologies and solutions that can be applied to plant that can assist the mining sector in achieving their strategic goals.

Business are hugely reliant on their plant to dig, move, drill, spray, crush or build. With so many uses, fleets can be large, diverse and geographically spread; making them incredibly difficult to not only monitor and manage but get the most from them.

Reducing total cost of ownership, servicing and changing parts only when needed, increasing uptime, and learning what models and makes of plant provide the longest lifespan can have a huge impact on an organization's bottom-line. To achieve these goals (and a lot more), AI + IoT solutions can have a massive and immediate impact.

Rather than focusing on particular technologies (such as the electrification of assets and the increasing use of driverless technologies), we think it important to focus on the array of strategic impacts that the application of AI + IoT platform – with access to the right data – can have on the business rather than the functionality that it provides i.e. it's important not to put the cart before the horses.

AI + IoT + Plant = A lot.

Real-time plant monitoring + utilization metrics. Some plant is autonomous, but the vast array isn't. Simple real-time monitoring IoT technologies can enable its location to be tracked and individual functions measured second-by-seconds (such as vibration, noise, temperature, energy usage, flow, pressure, operator control application etc.) which, coupled with live production data, can provide a real-time view of how plant is performing and it's live utilization metric from anywhere, at anytime. In the field this could provide a productivity score or on the production floor, a real-time OEE measure. It also unlocks the potential for many other benefits, such as: geo fencing and theft detection, better plant allocation, reduced energy consumption, operator safety scoring, lowered insurance costs, proximity real-time alerts, compliance guidance, remote tracking, asset class comparisons, pinpoint underutilized machinery, improve maintenance regimes and much more. Verizon found that, on average, fleet tracking technology repays its ROI in less than one year.

Time to failure + predictive maintenance. There are many things that go into the failure of plant. Poor operation, difficult terrains, as well as the failure of individual parts. By using the data coming from real-time monitoring, historical and third-party data sources (such as weather, forthcoming usage and operator schedules), and the application of machine learning algorithms, it is possible to predict when plant is going to fail and why, as well as what the remedy is. This not only makes it possible to predict when machinery needs to be serviced (versus when it's scheduled to be, simply because it's been 6 months since its last check), but also identifies what the fix is (reducing maintenance crews time in the field) and prevents the development of problems that could cause hazardous failures that do harm to personnel and production. Benefits include: increased utilization, decreased scheduled downtime, reduced maintenance costs, prevent catastrophic failures and breakdowns, enhanced safety and compliance, increased asset lifespan, lower spare part inventory costs, quicker fixes, and more. McKinsey have demonstrated a 20% reduction in downtime and production increases† and PwC found it can reduce maintenance spend by 14%‡.

Performance analysis + real-time production optimization. An integrated AI + IoT platform makes it possible to analyze data sets across fleets, utilizing all the data from every system internal or external, to identify and predict plant performance. With the use of real-time data measurements, automation and staff alerts, it's possible for the platform to optimize performance and improve uptime and production immediately, meaning that plant can run optimally at all times, thereby improving yields and efficiencies. Additionally, through identifying patterns (such as how long it takes for an asset to start or whether it does better at a certain time of day), it is possible to use these insights to enhance safety and productivity by changing shift patterns and ensuring the correct personnel are on-site at the right time, e.g. have more maintenance staff rostered when failures tend to occur, change shift switchover times, or have attendants by machinery on the processing floor during higher-risk periods.

Autonomous vehicles + plant enhancement. Autonomous vehicles have been operating in mines for some years now and in that time they've demonstrated fuel efficiency savings and kept workforces out of harm's way, but there are numerous assets and plant that are yet to be transformed. Their growth is only going to grow as miners look to move people out of harm's way and find efficiencies. McKinsey estimates that by 2035 autonomous mining using data analysis and novel technologies like AI will save the mining sector between US$290bn-US$390bn annually Ω and further adoption of the technology (plus the growing data sets that come from) coupled with analysis via an integrated AI + IoT platform will offer new productivity, safety and efficiency benefits that enhance bottom-line results.

> By using the data coming from real-time monitoring, historical and third-party data sources... it is possible to predict when plant is going to fail and why.

* Source: Verizon Connect - 2021 Fleet Technology Trends Report
† Source: PwC - Mine 2021
‡ Source: https://insight.thinkiq.com/blog/how-industry-4.0-smart-manufacturing-improves-mine-to-metal-efficiency-for-mineral-manufacturers
Ω Source: McKinsey: Beyond the Super cycle: How technology is reshaping resources

Establish operator performance + safety scores. Through the analysis of real-time plant data monitoring, wearables, third party sources and by comparing it with environmental measures and operational understanding, it's possible to monitor employee performance based on the individual aspects of their role, as well as how safe they're being. This enables miners to identify when, for example, an employee is tired or beginning to make small mistakes and could be about to come to harm, whether they're consistently following required compliance standards, or if they're performing much better than their peers. In one trial, by providing operators with direct feedback based on how they were driving their trucks, they were able to limit peak speed, reduce short stops and restarts, and avoid abrupt braking and strong acceleration. In just eight weeks, fuel consumption dropped by 7%*.

Standard operating procedure adherence + safety margins. Putting in place all of the safeguards and procedures needed to achieve zero harm is always going to be ineffective if incidents aren't reported, standards aren't followed or if the safety margins that they are based upon are insufficient. Through real-time monitoring of plant and employees, it's possible to identify where deviations are occurring, where margins are insufficiently strict (or even where they're too constraining), as well as pick up on the small incidents that may never make it onto incident reports but which, occurring repeatedly over time, may be a key lead indicator of a problem that could have potentially more catastrophic consequences.

Catastrophic failure prevention. The real-time monitoring of plant, even with the use of predictive machine learning algorithms, needs time and large data sets to be able to learn from past failures and anomalies to predict future ones. What can be achieved sooner (and more accurately), however, is the prediction of catastrophic failures. Increased heat, vibration, bending and noise invariably proceed a total failure – even if it's just by seconds. Through the use of an integrated AI + IoT platform and real-time monitoring of data from the plant, it's possible to identify impending failures and implement fail-safe machinery shutdowns by understanding operational norms, the outcome of previous breaches of them across fleets, and by being able to identify from real-time measures where recovery won't be possible; utilizing automations to exert control and intervene. This not only prevents potentially hazardous situations where personnel or the environment come to harm, but catastrophic failures are generally bigger, more expensive and take much longer to repair.

Proximity alerts + real-time Permit to Work. Many injuries and plan failures occur because people are in the wrong place at the wrong time, doing something that they shouldn't be doing (e.g., using plant close to electric cabling), or through an unforeseen failure resulting in an action, such as inundation, gas explosion or rock fall. An AI + IoT platform enables miners to, via the use of wearables and the real-time monitoring of plant and environment, aggregate data in real-time and identify when someone is going to come to harm, sending alerts to clear areas and stopping machinery before an injury occurs.

Plant, mine, factory and cross organizational analysis + data silo busting. The aggregation of data from multiple sources across an entire organization makes it possible to uncover best practices, identify superior plant (e.g. by brand, age, model etc.) and operational methods used by different individuals, highlight top performing personnel and teams, as well as identify areas for improvement based on much larger data sets. This works at the short-term, site level, but will also improve longer-term results by guiding optimizations (e.g. better staff training or plant configurations) and takes away the barriers that sometimes exist between departments and business units.

Remote operations + superior skill set identification. The application of industry 4.0 technologies to leverage the ability to operate machinery remotely and leverage superior skill sets is an obvious one. Through the use of detailed data analysis, it is possible to examine individuals' performance who conduct similar functions in a business. By doing this, organizations can understand what it is that makes them better so that they can upskill a wider workforce, or even set-up remote control and operations rooms that enable top performers to conduct their highly-skilled roles across multiple sites without ever having to visit sites and be potentially put in harm's way on transport or other on-site activities (e.g. moving amongst unmanned vehicle operation). The centralization of expertise can be a business risk, but with the right technology and approach (e.g. the setting-up of a center of excellence to spread them), it can become a benefit.

Improved training opportunities. An integrated AI + IoT platform makes it possible to monitor the impact of workforce training initiatives, make simulations more realistic by utilizing more data sources, as well as spot individuals who need further support in particular areas of their role by comparing the performance of employees both before and after training via the use of productivity and safety score measures. With a strategic viewpoint, it's possible to then identify types of training that do and don't work, providing real data that makes it possible to improve regimes, schedules and optimize the time that workers spend away from production activities.

Process optimization (Digital Twinning). Current best practices in mining are reliant on doing the same thing, day after day; with every individual following the same steps, processes, and patterns. This makes the analysis of deviations in current practice in an attempt to find better ways of operating difficult because those are the very behaviors which are trying to be avoided. With digital twinning, it is possible to test new plant models or set algorithms with the task of analyzing all the current variables and finding better ways of functioning without risking harm, efficiency or productivity. As long as there is a way of measuring success, then any scenario can be tested and it is through digital twinning (plus the application of multiple machine learning algorithms to uncover which is the best in predicting and optimizing plant operations) where Industry 4.0 status can truly be achieved.

Aggregated risk profiling + improved productivity measures. The operation of certain types of plant at very high temperatures isn't a problem in itself, but it could be if the external temperature rises beyond norms or an external heat source, such as a welding torch, is applied in close proximity. Using an AI + IoT platform, it's possible to create algorithms that can explore the impact of certain activities and provides the ability to create accurate, aggregated risk scores that can't and mightn't be foreseeable; as well as model their impact on productivity and efficiency, thereby enabling production to be optimized.

Energy & Fuel Tracking + enhanced operational schedules. With large real-time data sets from plant, coupled with pertinent other data (such as outside temperature, operator action, maintenance regimes etc.) it is possible to utilize machine learning within an integrated AI + IoT platform to spot patterns and uncover the most efficient ways of operating it. Taking this a step further, the insights delivered can be directly inputted into automated plant to seize benefits, via instructions and alerts to operators (in real-time) to slow down etc., as well as other potential applications including rescheduling of usage to prevent restarts and short stops. One study found that, through providing direct feedback to operators, it was possible to drop fuel consumption by 7% in just 8 weeks*.

* Source: https://www.bcg.com/publications/2017/metals-mining-value-ai

Theft + loss protection. The theft and loss of plant is a significant cost to miners that directly affects the bottom-line through both OPEX and CAPEX - not to mention higher insurance premiums. The real-time monitoring of plant enables miners to set-up geo-fences, alarms and alerts that are triggered should a piece of plant be where it shouldn't or if being used in a manner inconsistent with its rostering that may foretell its loss.

Added advantage.

There are numerous other applications and potential benefits that can be derived from the use of Industry 4.0 technology, such as reducing the manual reporting burden, the retention of knowledge and freeing team members from repetitive work to focus on other aspects of their role. It also makes it easier for management to adopt competency-based risk management practices, ensuring that they have the full picture when it comes to plant performance and make better decisions that will enable them to achieve strategic goals.

The thing that all of these benefits have at their center, though, is the correct application of technology; namely an AI + IoT platform that has access to the right data in real-time from all potential sources via extreme interoperability, which is then coupled with in-field real-time sensors to, comms and networks, and other plant-related technologies.

A word on electrification...

The electrification of plant is going to have a huge impact on the mining sector. From reducing carbon, creating safer working environments and adding to efficiencies; its future role in Industry 4.0 transformation is all but ensured.

A boon for OEMs and supporting services, electrification will reduce operational costs plus CAPEX because it reduces other infrastructure needs, such as ventilation shafts in underground mines to extract harmful diesel particulates. However, it's important not to think of electrification as a panacea - it is a single technology that cannot alone drive transformation and achieve strategic 'zero' and profitability goals.

Where it will play a massive role is with data streams. By virtue of the way that electric plant is engineered (and increasingly) so, it will be able to provide real-time performance insight like never before. However the complete changeover of every piece of plant in an operation will not occur overnight.

AI technology advances, old fleets and the need to electrify assets means that many operations, processes, and approaches must be overhauled using a mix of new plant and retrofitting of others to ensure that plant's natural, scheduled lifespan is seen-out (protecting past investments and profitability). This is where in-field real-time sensors and the use of IoT solution providers will help, by bridging the data gap when it comes to current assets' use (or limited green electricity availability) up to the plant's natural end of life and its replacement with electric alternatives (electricity grid-willing).

> ...it's important not to think of electrification as a panacea.

Where to from here and implementation.

The first step is to Identify a particular objective or function that needs improving which can be used to test efficacy, as well as an individual (or small multi-disciplined team) who will be capable of championing and running the project.

For example, a common place within the mining sector to start with Industry 4.0 technologies on plant is with predictive maintenance and catastrophic failures prevention. Whilst improving asset performance is always likely to be of benefit by improving uptime (which directly relates to productivity), it's also likely to be closely tied to zero harm and efficiency measures.

From there, they must explore the use case. Our advice with Predictive Maintenance would be to pick a particular plant class at a single site and then identify all of the potential variables that would likely affect its maintenance needs; including plant, human, process, environmental, asset etc.

Once established, it is necessary to explore where the data gaps are. Is there certain data that cannot be collected at this stage? Is real-time data readily accessible? What's the internal skills gap when it comes to the necessary technology, implementation or data analysis and use of AI?

At this point, if it's not already occurred, it is prudent to look for the right suppliers. Critical to developing an Industry 4.0 footing is an AI + IoT platform, so this should be the starting point. Utilizing someone that has an understanding of mining operations and good cross-functional technology and data science expertise is going to be critical, as many providers are industry agnostic or lack the in-depth understanding of a sector to add value during solution development.

The next step would be to further explore the technology stack that is going to be needed. Central to this will be the in-field devices needed to collect real-time information, the...

Cited results from implementing a predictive maintenance regime within the mining sector:

- McKinsey 'Mining Productivity Index' has stated that they've identified operating efficiency improvements amounting to 70% of output due to breakdowns and stalled production.
- PwC stated in 'Balancing Uptime and Working Capital: Maintenance and Inventory Strategies in Mining' that effective condition monitoring of critical equipment can reduce maintenance spend by 14%.
- I4 Mining's solutions have lowered cost of maintenance on key plant by 9% and decreased unscheduled downtimes by 63%.

...integrations with systems (both internal and external), as well as the networks and comms which will be needed to transmit data to the AI + IoT platform and then action the instructions that are directed as a result of its real-time analysis. What's more, it's also important to begin developing (or buying) the machine learning algorithms that are going to be used to improve predictive maintenance of this plant at this stage, as there will be multiple options.

Once the full technology stack is identified, it's about the deployment, roll-out and internal communication/transition plan. Every site and piece of plant is unique, but there are commonalities across classes, mines and operations that can be applied to every situation and across projects.

The best approach is to start small and scale. Pick an easy-to-monitor use case without too many variables, where improvement can be clearly measured, and look to apply it to a single site. This enables the rapid deployment of technology (sometimes in weeks), reduces costs and risks, and provides a pilot program through which data is beginning to be collected (bigger data sets = faster optimizations and quicker success).

Once making a measurable impact, it's time to scale across multiple sites to capture bigger data sets from across operations or different types of plant. By scaling only at this point, it will be possible to utilize the learnings from the pilot to find efficiencies and enhance the optimization loop almost instantly. What's more, by working with a partner that can work over the longer-term and, critically, knows how to scale will reduce costs, speed-up the deployment process, and reduce further development cycles.

Work with someone who is a digital native, can explore your operations in relation to your business objectives, who understands the sector, knows the current technology, and has a global network of best-in-class partners who can provide you with the future-proofed technologies that you need to create complete Industry 4.0 solutions: talk to Rayven about I4 Mining.

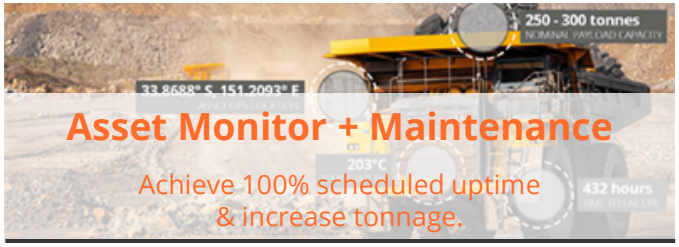
The best approach is to start small and scale.

Ready-to-go mining solutions

Discover I4 Mining's pre-built AI + IoT solutions or speak to us about your bespoke needs.

I4 Mining's Health + Safety digital mining solution enables you to connect all of your people, plant and systems to utilize historical and real-time data; preventing workforce harm across your operations and enabling you to achieve your zero harm objectives.

I4 Mining's Environment + Community digital mining solution is a complete environmental monitoring, management and compliance solution that enables you to monitor your operations in real-time and use AI to predict, prevent and remediate breaches, fast.

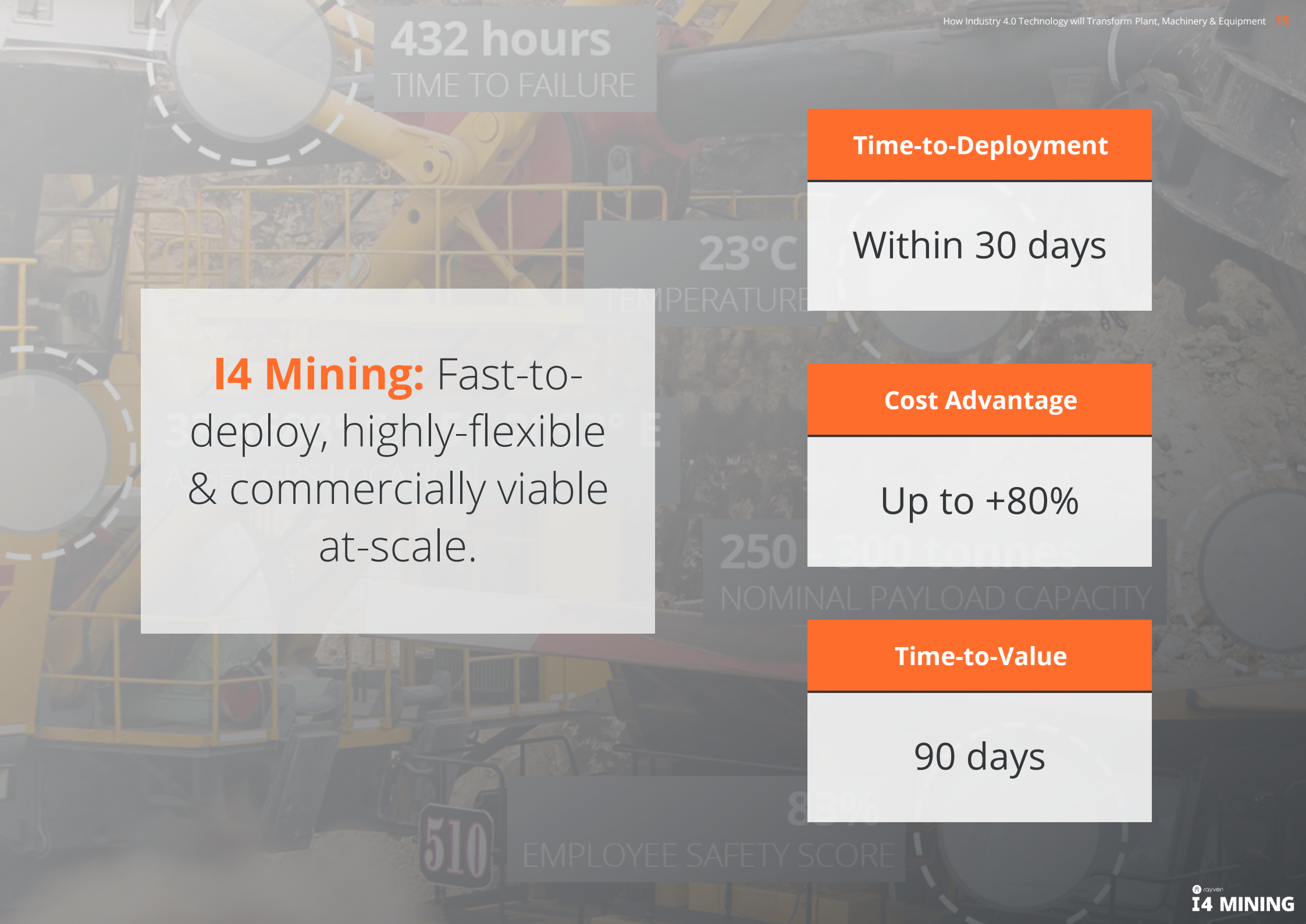


I4 Mining's Asset Monitor + Maintenance solution is a real-time asset monitoring, utilization optimization & predictive maintenance solution all-in-one. It enables you to improve plant performance across your operations, from drill rigs and motor graders, to pumps and HVAC equipment.

I4 Mining's Yield + Production digital mining solution enables you to monitor and analyze all of the variables that go into material extraction, screening and processing to uncover improvements and then seize upon them. It Increases yields, prevents breakdowns and finds efficiencies using the platform's IoT, AI and adaptive real-time data analysis.

I4 Mining's Energy + Resources digital mining solution enables you to optimize the usage of the costly inputs that go into your operations and reduce waste; delivering you immediate efficiencies and dramatically improving profitability, fast.

I4 Mining's Oversight digital mining solution improves real-time strategic decision-making, enhances risk assessment and reduces the reporting burden by providing you with up-to-date, accurate data in an easy-to-use predictive analytics engine. Beyond that, Oversight gives you the ability to execute those decisions, both manually or via AI-led automation.



I4 Mining: Fast-to-deploy, highly-flexible & commercially viable at-scale.

Time-to-Deployment
Within 30 days

Cost Advantage
Up to +80%

Time-to-Value
90 days

Want to see how an advanced AI + IoT platform is used in the real-world?

Watch the **Discover Rayven** video.

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Next generation Industry 4.0 digital mining solutions.