How Digitalization and Prescriptive Maintenance Optimize Sustainable Mining Operations

A Whitepaper by Mining Magazine

Minjng Magazine | aspentech

Introduction: Big gains await miners that accelerate into digitalization and prescriptive maintenance

The mining sector has long labored under a reputation for being a technology laggard. While other verticals such as financial services and banking, insurance, education, retail, hospitality, media and even utilities have tended to be progressive early adopters, the Metals and Mining sector has generally been more conservative. This is in spite of compelling evidence showing the benefits from breakthroughs in the digitalization of mining operations for modeling operational scenarios, making use of data analytics to gain actionable insights, employing autonomous equipment to accelerate and reduce risks in hazardous processes, and monitoring equipment health through Machine Learning (ML) and Artificial Intelligence (AI).

Today, however, mining is under the microscope to better perform in sustainability, safety and health, and operational efficiency. As mining companies chase new opportunities and markets, firms in the sector need to pursue innovation and make creative use of technology and digital transformation to better position themselves for the future.

In June 2022, Mining Magazine conducted a survey of global mining executives to better understand their attitudes towards technology. The survey explored what investments are being made, who is making them, what are seen as key opportunities and what are obstacles to progress. We also take a closer look at one of the more powerful approaches, prescriptive maintenance, which enables industrial organizations to significantly increase uptime, efficiency, performance and transform auditable, data-based insights into improved processes and infrastructure.

Miners recognize the opportunities data and technology provide for differentiation

What technology tools are the most valuable to mining operations? Which are the most beneficial for your organization?

● Most valuable ● Most beneficial

Technology	Most valuable	Most beneficial
Geological modeling tools	56%	22%
Asset performance management	56%	34%
Mineral process control solutions	54%	32%
Asset and equipment downtime prevention	52%	28%
IT/OT integration technologies	52%	30%
Autonomous vehicles and mining equipment	52%	34%
Health and safety related solutions	50%	30%
Sustainability monitoring and management tools	42%	40%
Mine planning and design tools	40%	40%
Digital twin	40%	32%
Data science, analytics and dashboarding	34%	46%
AI and ML	28%	40%

There is a growing realization among companies in the Metals and Mining sector that technology is a leading source of competitive differentiation. In fact, the Mining sector has entered a new era of smart mining where every effort is made to take out manual processes, deploy electrification where possible and generally think progressively.

Respondents ranked data science and analytics as being the most beneficial to their organization. This finding is especially relevant given the critical role of a data-driven strategy in creating new insights to help identify new mineral deposits, understand complex health and safety issues, re-engineer processes, map superior supply chain management and better plan maintenance logistics. The modern mining sector is alive to innovation, joining other sectors to understand that strong data foundations can enable bolder decision-making while demonstrating that their strategy is based on empirical facts rather than assumptions.

The high level of support for AI and ML suggests that more miners are thinking about cutting-edge technologies while the relatively high scores for sustainability and asset performance management point to an understanding of the wide applicability technology can deliver.

"The modern mining sector is alive to innovation, joining other sectors to understand that strong data foundations can enable bolder decision-making while demonstrating that their strategy is based on empirical facts rather than assumptions."
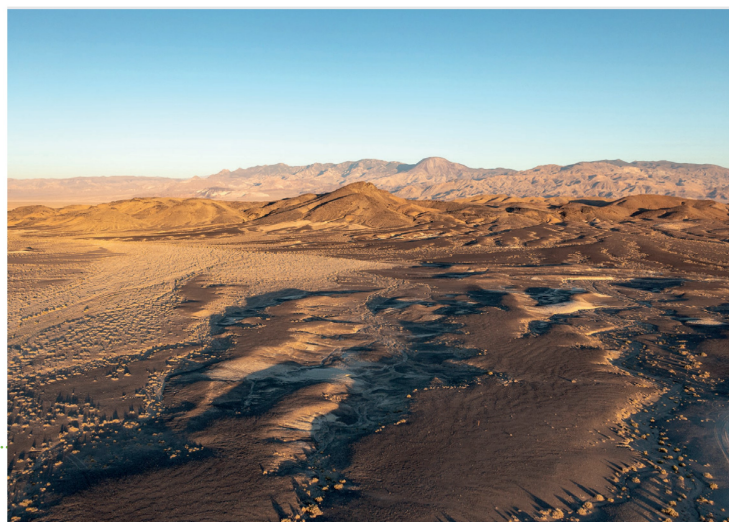
Unlocking the value of digitalization

Which of your organization's objectives can benefit from digitalization? Which of these is most important?

64% Data security, governance and regulatory compliance

62% Ability to switch processes and quickly make changes to activities
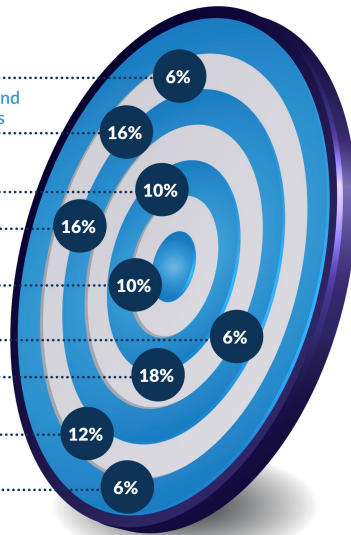
60% Asset management and optimization

58% Sustainability

56% Improved ability to extract resources

56% Integration of multivendor solution chains

56% Health and safety

56% Profitability and margin growth

54% Improved ability to define resources

6%
16%
10%
16%
10%
6%
18%
12%
6%

As we noted in the previous section, respondents see a variety of applications for technology. Health and safety remains a leading key performance indicator and technological advancements such as Digital Twin –where a simulacrum of real-world facilities can be visualized to simulate and evaluate process changes, for example–are leading the way forward. Technological advancements such as automated drilling and haulage fleets are reducing risks to people who would otherwise be exposed to potentially dangerous environments.

Sustainability is another area where technology is regarded as a boon. Certainly, use of software to visualize asset management and create auditable control over Scope 1, 2 and 3 emissions is beneficial. Improving sustainability records using recognized standards and frameworks will help miners communicate their efforts more clearly and efficiently to regulators and stakeholders.

More generally, there is widespread recognition of the role of technology in creating efficiencies that lead to margin growth, business flexibility and the ability to be more agile and make actionable decisions quickly.

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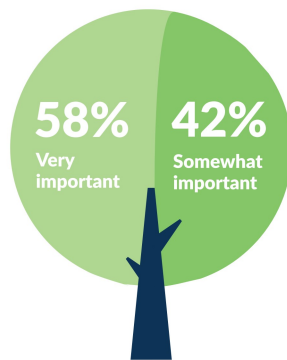
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Sustainability is being acted upon and measured... but should there be even more emphasis on it?

Professionally and personally, how do you value sustainability?

58% Very important

42% Somewhat important

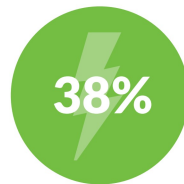## Are you measured on sustainability performance?

86% YES

14% NO

Looking specifically at sustainability, what actions is your organization prioritizing?

40%

Make More use of Alternative Fuel Sources Such as Wind, Solar or Hydrogen

38%

Mine Electrification

36%

Target Better Control Over Scope 3 Indirect Emissions

32%

Adopt Core Frameworks for Managing and Monitoring Progress

26%

Focus on Baseline Audits

We wanted to know about how our audience rated the importance of sustainability, given the scrutiny it is under in the mining sector. Every member of our panel rated it as important but a surprisingly low majority **(58%)** gave it the highest-value statement we made available: that of 'very important'.

This is all the more surprising given that **86%** said they are being measured in part on sustainability performance. Clearly, if we are to make our best efforts to reduce the environmental impacts of mining, it needs to be a very high priority in any decisions we make.
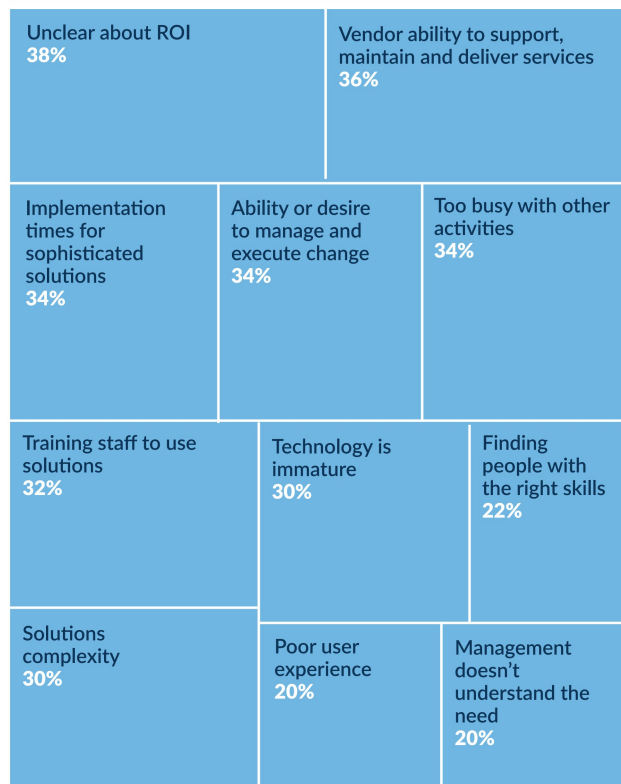
Miners are prioritizing actions such as making use of alternative fuel sources and closely monitoring emissions, including indirect emissions across value chains and trading relationships. The good news is that making best use of the technology tools at our fingertips can help us to reduce impacts on the environment. Using innovative tools such as Digital Twins and advanced data analytics allows operations to more effectively meet their production goals. This makes them more profitable while also increasing recovery rates leading to substantially less economic waste improving tailings management and water stewardship strategies, moving closer to the lowest possible ecological impact.

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Lack of ROI clarity leads deterrents for more technology adoption

What deters you from making more extensive use of technology within your organization?

Unclear about ROI 38%		Vendor ability to support, maintain and deliver services 36%	
Implementation times for sophisticated solutions 34%	Ability or desire to manage and execute change 34%	Too busy with other activities 34%	
Training staff to use solutions 32%	Technology is immature 30%	Finding people with the right skills 22%	
Solutions complexity 30%	Poor user experience 20%	Management doesn't understand the need 20%	

It turns out that in the industry there is a long list of supplied reason or caution with no single factor significantly the most prominent. Return on investment is a leading concern, showing the difficult task of proving out new technologies and showing their financial impacts both indirect and direct. Buyers should certainly ask vendors for clear evidence of return-on-investment in order for them to persuade CFOs to release budget. Or, vendors must do everything they can to shorten time to value for their customers. At the same time, vendors need to assuage fears that they can deliver and support solutions since miners, as well as any other vertical, clearly have concerns over their ability to do so. Years of vendors aiming to win quick deals then moving on rather than building deep relationships with customers have had an unpleasant effect and survey after survey shows that CIOs feel starved of binding, truly participative vendor relationships that develop mutual value.

On the purchase side of the relationship, there is a host of challenges from classic cultural phenomena such as fear of managing change to time/attention pressures and training needs. These are understandable concerns, but they should not become deterrents to acting on technology-enabled opportunity. The faster miners embrace change, the sooner they will arrive at successful competitive differentiation.

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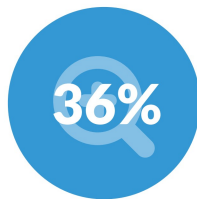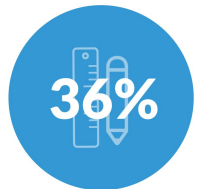
Safety leads key value areas

What are the top three considerations when measuring the value of digitalization in your organization?
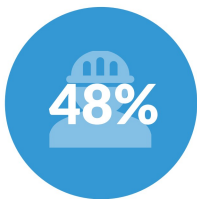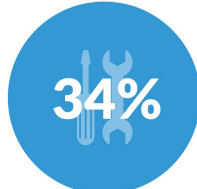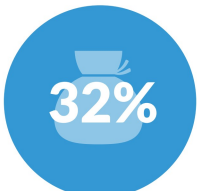
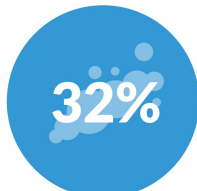**48%** Safety

36% Exploration and mine development

36% Mine design and planning

34% Equipment uptime

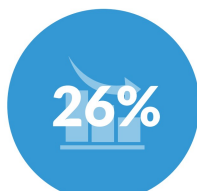**32%** Reduced labor costs

32% Emissions management
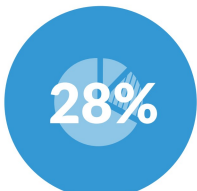
28% Operational efficiency
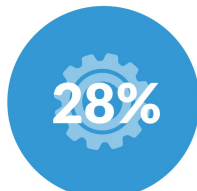
28% Automation

26% Reduced consumables expenses

As with our previous section, safety is seen as easily the single biggest source of technological benefits, again highlighting the importance and value companies are putting into this area. After this far and away leader there comes a tightly bunched range of areas where respondents sniff out technology-related advantages. These are led by mine design and planning, exploration and mine development: all areas where technologies such as Digital Twin, IoT and asset sensors, wireless networks and others can play a part.

These are followed by equipment uptime where technology is playing a greater role in anticipating and mitigating failure through Prescriptive Maintenance, sending alerts and even providing proactive actions to reduce failure downtimes. And if we can automate more of the ways we deploy, operate and manage equipment then we have the chance to take people out of harm's way, move them to remote tasks and switch their attention and skills to activities that add real value.

The ability to better manage emissions is also viewed as a major plus with software providing an audit trail that has a dual effect. That is, it can provide strong insights for emissions control in internal processes, but it can also show regulators what is being achieved through transparency and inarguable data.

Purchasing isn't just the domain of IT decision makers

Who gets involved in purchasing software solution tools?

Chief technology officer	Chief information officer	Chief digital officer	Chief financial officer	Mine manager	Chief operations officer	Department heads
36%	26%	24%	20%	12%	4%	2%

Technology-related purchasing has evolved over the years and decades across the mining industry. Once largely the domain of individual users and departments on-site, the surging importance has meant that these technologies and the need for better integrations across the value chain have increasingly gained the attention and involvement of company leaders. Our survey suggests that C-Suite and IT leaders are becoming influencers alongside roles that normally demand deep technical user knowledge and intimate understanding of the vendor landscape.
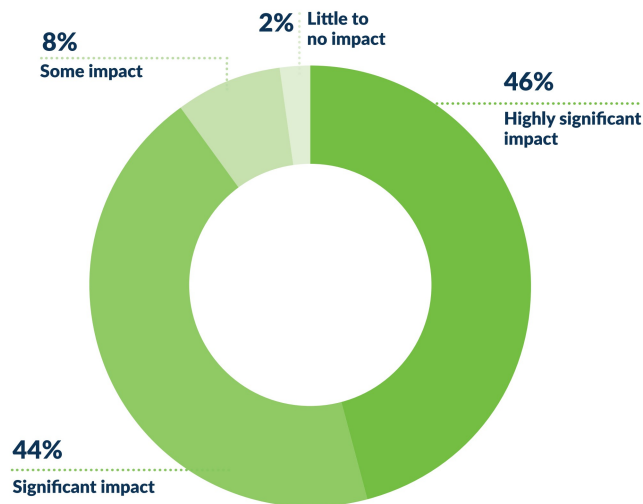
While CIOs, CTOs and CDOs understand the impacts of software procurement and deployment on support, integration with existing systems and future product roadmaps, other leaders can bring in a broader perspective. By involving CFOs and operations leaders, miners stand to benefit from insights into understanding value-for-money metrics and answering practical, on-the-ground (or under-the-ground) operational implications.

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Impacts of prescriptive maintenance

To what extent do you feel that prescriptive maintenance is having or could have an impact on asset performance in Metals and Mining?

2% Little to no impact

8% Some impact

46% Highly significant impact

44% Significant impact

How mature is prescriptive maintenance in your sector?

2% Don't know

10% It's a mainstream activity

52% It's very much for early adopters
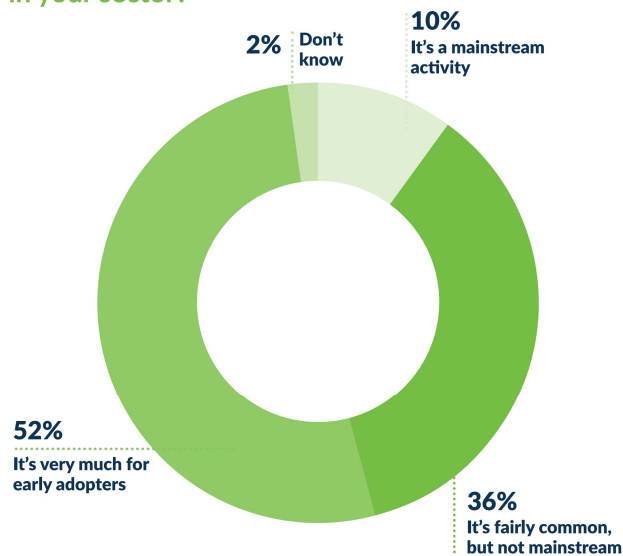
36% It's fairly common, but not mainstream

As we have outlined, prescriptive maintenance is a powerful means by which assets can be managed and serviced better but we wanted see how many respondents agreed. Our results indicate that almost all recognize at least a significant impact **(90%)** and almost half **(46%)** seeing a highly significant impact.

These findings suggest that prescriptive maintenance is becoming a fully-fledged phenomenon that merits the attention of mining. How mature is it really though? Well, **10%** see prescriptive maintenance as a truly mainstream activity, over a third **(36%)** see it as only fairly common while more than half **(52%)** see it as being for early adopters.

That's a concerning finding: But the technologies discussed in this report are all proven and mature and need to be treated as such. And other advanced technologies for increasing equipment performance, improving safety, expanding overall awareness of operations and making actionable decisions quickly. Those that don't will inevitably lag behind faster-moving peers or competitors.

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Can prescriptive maintenance impact downtime?

How confident are you in the ability of prescriptive maintenance to minimize downtime?

50%
Very confident

38%
Somewhat confident

8%
Only a little confident

4%
Not confident
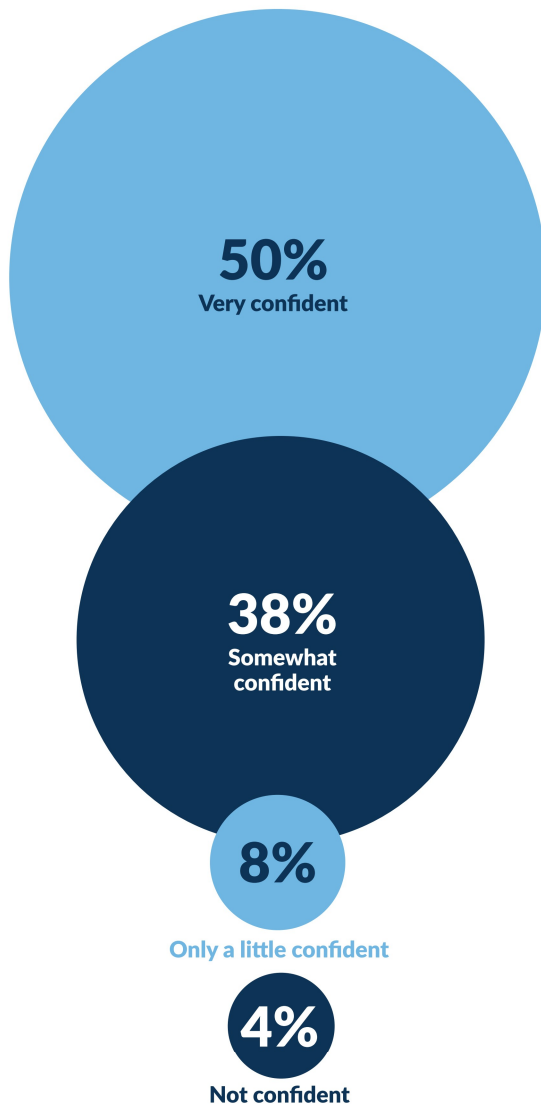
When we asked about confidence in prescriptive maintenance, almost everybody **(96%)** said they had some confidence, the vast majority **(88%)** were at least somewhat confident and half **(50%)** were very confident of positive effects.

This suggests once again that those those companies would benefit from accelerating their activities in this space.

Conclusion

For decades now, organizations across fast-moving sectors have sought to tap the power of technology more broadly to gain an advantage on peers. They have automated, accelerated, invested in data and scrutinized cutting-edge tools in order to gain efficiencies, revamp processes, see into the future and appease regulators. Metals and Mining companies have not always been so willing to innovate but today, a perfect storm of sustainability, regulatory, competitive and other pressures are forcing their hands. It is time to adapt or place themselves at existential risk competing against companies that have embraced new technologies to empower their organizations.

Our survey suggests that there is at least some recognition of this threat. Respondents have at least reasonable recognition of the importance of data, improving safety records, investing in new waves of technology and preemptively servicing the assets they depend on.

To learn more about the critical role digitalization and prescriptive maintenance can play in mining operations, **visit aspentech.com/mining.**