



FUTURE OF WORK(ERS) IN THE MINING INDUSTRY

October 2021





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EXECUTIVE SUMMARY |

INTRODUCTION

The mining industry is under pressure to change at a more rapid rate than ever before. This need to change is driven by external trends and from within, by the increasing need for mining companies to compete with new sectors to attract top talent, the adaptation of the new technologies, and as a result, the need to invest more in training and upskilling the current workforce, and ever-existing operational pressures to reduce costs and increase productivity while at the same time maintain a safe and healthy working environment.

To explore how these external and internal drivers will combine and shape the future of work and the workers in the mining industry, [Wikistrat](#) and [idoba](#) partnered to run an online simulation with the aim of exploring scenarios for the future of work in the mining industry in order to understand what the future holds for both the industry and its workers.

THE SIMULATION

The simulation was conducted online from August 18 to August 25, 2021. During this period, a crowd of 28 professionals from across the mining industry and experts from other industries and disciplines collaborated to generate a wide range of scenarios for the future of work in the mining industry and described the most dominant drivers and trends that will impact the industry and its workers in the upcoming decade.

FINDINGS

What the crowd sees

If all the scenarios, stories, and recommendations were to be condensed into a single insight, it would be this: **technology advancement and ESG issues are profoundly connected, and industry leaders must act now in order to be well-prepared for inevitable changes within the mining industry.**

According to the crowd, the biggest impact on workers and the industry will come from technological trends like automation, AI, AR, and robots. However, the growing attention on ESG issues will create an increased focus and public pressure on environmental issues and workers' rights, whilst the connection with different communities and governments to achieve sustainability goals is already posing an acute need for action from industry leaders, decision-makers, and companies.

What the crowd fears

There was a broad consensus among the experts that **the industry is not well-prepared** for the different developments that include the growing focus on maintenance and operation of mines (becoming automated), loss of jobs and its impact on mining communities, and the deep lack of technical upskills already required for the industry to progress. All of these, the crowd assumes, will increase the industry's inability to draw in new talent because many will not see the mining industry as an attractive career choice.

Many in the crowd, therefore, argued the critical need for the industry to better prepare for impending transformations to the skills needed for existing and future employees, and their retention and recruitment, which will become more challenging with time. This task, according to many experts, might be especially challenging as the current industry is risk averse, and not creative enough.

What the crowd recommends

Reading through the scenarios and the discussions and looking at the drivers mentioned above, a clear insight has emerged: the crowd is seeking a more creative, open-minded approach from decision-makers in the industry when it comes to HR and business strategy decisions like the exploration of new organizational structures, internal digital transformations within companies, talent recruitment and training, and heavy investment in developing technologies.



CHAPTER 1
STRATEGIC INSIGHTS



STRATEGIC INSIGHTS |

Technological changes will have to be accompanied with meaningful adjustments.

During the simulation, the significance of technology (AI, AR, and robots) to the future of work and workers in the industry played a major theme. It will make mining safer for workers, less environmentally damaging, and more efficient. However, these technological changes will have to be accompanied by a rethink of firms' approaches to training, ensuring that personnel are upskilled and able to work effectively alongside advanced new technologies.

Industry leaders must increase their companies' preparedness for the future.

In terms of skills, investment, and HR decisions, the industry will have to radically upscale its game to better prepare for the impact of tech and ESG issues, such as the reduced need for human labor in light of an anticipated increase in automation and growing environmental requirements. Industry leaders and firms will have to plan to retrain employees and further invest in innovation and technology to offset their impact on the environment.

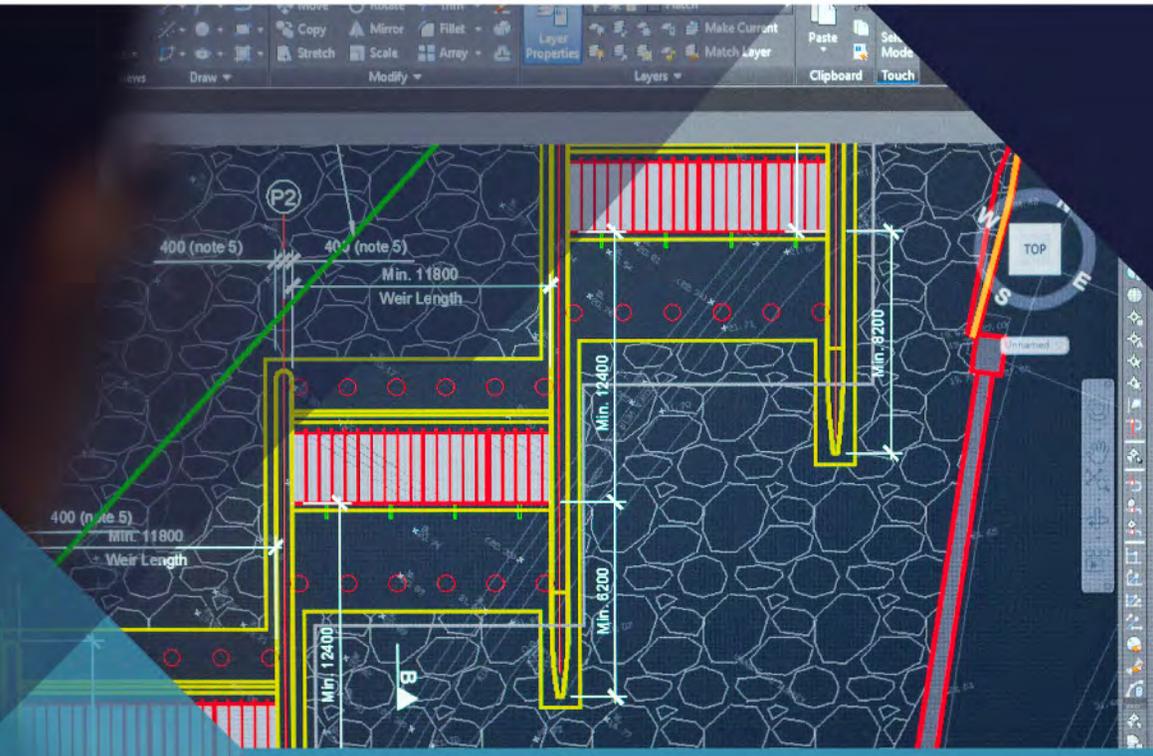
Talent won't be easy to retain or recruit; creativity will be needed. A highly discussed trend was the need for a more creative approach from industry leaders to keep and recruit top talent and move from the fairly conservative approach of management. Potential solutions that were discussed were a decentralized autonomous organization (DOA) model, a more open talent-hiring approach, the creation of multidisciplinary teams of people from different backgrounds, and the completion of digital transformations in companies.

ESG issues will change the future. The rapid advance of digitization and fast transformation of information and knowledge between people around the globe will increase public pressure for change in issues like commodity pricing, climate

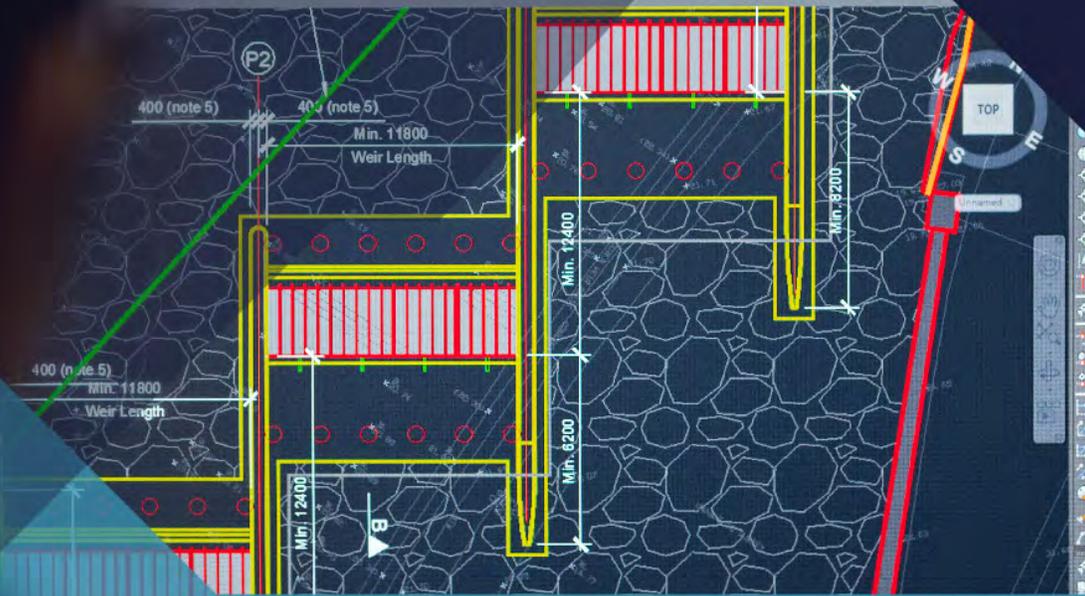
change, decarbonization, and sustainability. Governments, who will address the public sentiment, will gradually become a significant factor, and the mining industry will have to improve its readiness to answer the requirements. In order to do so, the mining industry will have to enhance its communications with local communities and governments, as well as diversify and engage with the circular economy and end-users that will help collaborate solutions to ESG problems.

Does COVID-19 play a marginal role in the future of the industry and its workers?

Surprisingly, the pandemic did not play a major role in the different themes and discussions during the simulation. In the voting phase of the simulation, 43% of the participants assessed that COVID will have a very low significance or none at all for the future of work in the industry. This might suggest that while COVID impacted the future of work in other industries in terms of remote-working and firms/managers-employees relations, the crowd did not identify relevant focal points of impact on the mining industry or was not sure in what exact ways it will impact the industry.



CHAPTER 2 INTRODUCTION



INTRODUCTION

In the next decade, the post-COVID-19 world will have changed in ways that will have profound effects on the workforce environment. A shifting economic landscape, technological innovations, and new work models are all drivers of change both today and in the future. However, the synergy between these drivers will combine in new ways that will drive the global dynamics into a different paradigm than that of today. These changes will undoubtedly impact the future of work and workers in the mining industry.

In order to explore how these changes and trends will combine and shape the future of work and the workers in the mining industry, Wikistrat and idoba partnered to run an online simulation with the goal of exploring the identity of the changes, their impact, and ways to prepare for them in the upcoming decade.

In this simulation, we aimed to map the main changes and trends that will impact the future of work in the mining industry by the year 2030 by answering the following research questions:

1. What major changes and trends will shape the future of work of the mining industry by the year 2030?
2. How will these changes impact the workers in the mining industry?
3. What is the level of preparedness of the mining industry for these changes and how will it impact the workers and the productivity of their work?

The following report presents the key insights, analyses, and recommendations that were synthesized from the work of 28 participants who, over a period of seven days,

generated 30 scenarios for the future of workers in the mining industry in the upcoming decade, focusing on the impact of three main drivers: Technology (eg robotics, data science, digital transformation), People (talent, skills, labor supply), and Society (ESG, regulation, legal and social changes).



CHAPTER 3

ABOUT THE SIMULATION



CHAPTER 3

ABOUT THE SIMULATION

OVERVIEW

“The Future of Work(ers) in the Mining Industry” simulation ran for a period of seven days, from August 18 to August 25. During this period, a crowd of 28 professionals from within the mining industry and experts from other industries and disciplines collaborated to generate more than 30 scenarios.

The simulation ran online via Wikistrat’s collaborative platform, which enabled the participating crowd to review one another’s work, to collaborate in developing scenarios, and to engage in interactive discussions.

The simulation consisted of two phases. In the first phase, which ran for five days, the participants were asked to generate scenarios describing the main drivers that will impact the future of work and workers in the mining industry in the next decade. For this purpose, the crowd was provided with three different categories: Technology (robotics, data science, digital transformation), People (talent, skills, labor supply), and Society (ESG, regulation, legal and social changes).

In each category, the participants were asked to analyze what drivers are likely to shape the future of work in the mining industry and how will they shape it, and then to provide her/his analysis of how prepared the industry is for these changes, what impact the driver will have on the future of the mining industry’s workers, and finally, provide a recommendation to current industry leaders for how to best prepare for these changes and trends in the next decade.

The division into these three categories and structure of requested analysis in each allowed us to learn what drivers will be most impactful, in what way they will change

the landscape of the workers' future, and what the industry leaders and decision-makers can do about it.

In the second phase of the simulation, we asked the crowd to rank the most dominant drivers and trends that will impact the industry and its workers in the upcoming decade, within the framework of the three categories and beyond. In total, 27 participants voted and provided valuable insights. These are further discussed later in this report.



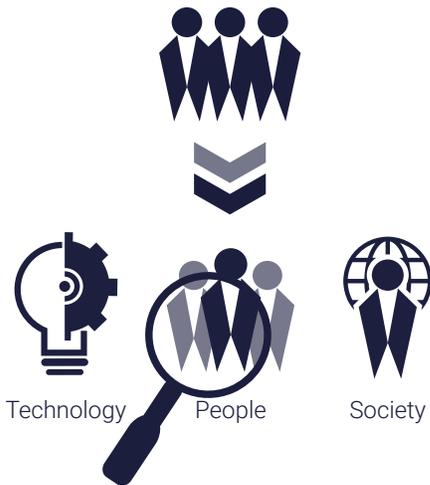
THE FUTURE OF WORK(ERS) IN THE MINING INDUSTRY

SIMULATION OVERVIEW



PHASE I: DRIVERS OF CHANGE

AUGUST 18-22



In this phase of the simulation, the crowd explored the main drivers that will impact the future of work and workers in the mining industry in the next decade.

The drivers were grouped into three categories, according to the following framework:

- Technology
- People
- Society.

Each driver provided a description of how it will shape the future of work in the mining industry. Then, it explored how prepared the industry is for this change and the impact it will have on the industry's workforce. Lastly, it asked for recommendations on how to best prepare for it in the next decade.



PHASE II: VOTING

AUGUST 23-25



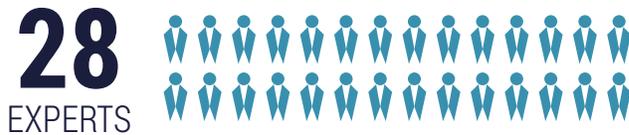
The crowd ranked the scenarios according to their likelihood and impact.

ABOUT THE CROWD

In total, 28 participants from more than 13 countries took part in the simulation, with more than 15 of them linked to the mining industry. As the crowd also included professionals from academies, consulting, HR, and industries like tech and innovation, energy, and more, there was a multidisciplinary discussion throughout the entire simulation and across all categories.

The overwhelming majority (80%) of the crowd was Western, with 12 participants from Australia and another 10 from the US, Canada, UK, Germany, Spain, and Israel. As a result, most scenarios were written from a Western perspective, with a focus on Western values and norms.

The crowd was generally fairly experienced, with the average years of experience of participants being over 15. This is quite common in simulations related to mining.



DIVISION OF EXPERTS BY: GEOGRAPHICAL LOCATION

 AUSTRALIA 12	 LATVIA 1
 US 4	 MALAYSIA 1
 CANADA 2	 NIGERIA 1
 CHILE 1	 SOUTH AFRICA 1
 CHINA 1	 SPAIN 1
 GERMANY 1	 UK 1
 ISRAEL 1	

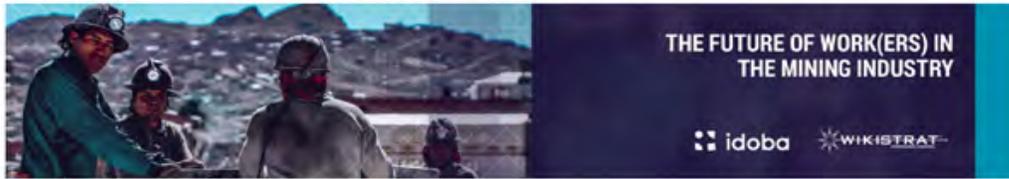
DIVISION OF EXPERTS BY: INDUSTRY

 MINING 16
 HR 4
 ACADEMY 4
 TECHNOLOGY 2
 OTHER 2

SCREENSHOTS FROM THE SIMULATION

The Future of Work(ers) in the Mining Industry Home

Created by Lironne Alice Koret [Staff], last modified by Tali Stambulchik [Staff] just a moment ago



Background

Background and instructions for the simulation.



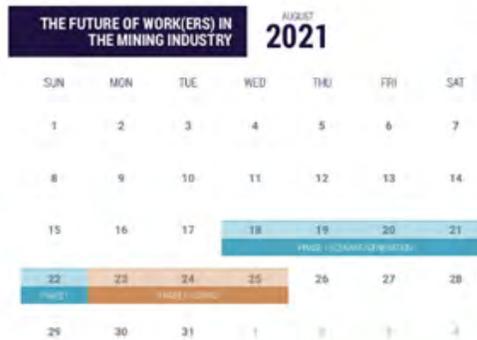
Participants

See who else is participating in this simulation.



FAQ

How to use the platform & answers to frequently asked questions.



Module	Description
	<p>Phase I – Drivers of Change</p> <p><i>Live</i></p> <p>August 18-22</p> <p>In this phase of the simulation, the crowd will generate scenarios describing the main changes that will impact the future of work and workers in the mining industry in the next decade.</p>
	<p>Phase II – Voting</p> <p><i>Live</i></p> <p>August 23-25</p> <p>In this phase, participants will vote on the likelihood of each scenario and answer additional questions related to the topic.</p>

SCREENSHOTS FROM THE SIMULATION

Phase I – Drivers of Change

Created by Lironne Alice Koreit [Staff], last modified by Tali Stambulchik [Staff] on Aug 16, 2021



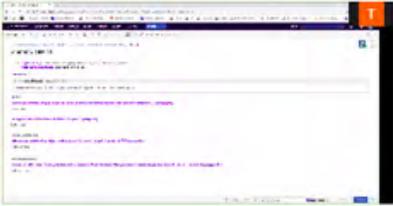
Instructions

In the first phase of the simulation, which will run for five days, you are asked to map and explore the top drivers that will impact the future of work and workers in the mining industry in the next decade.

The drivers will be grouped into three categories, according to the following framework:

- Technology (such as robotics, data science, digital transformation)
- People (such as talent, skills, labor supply)
- Society (such as ESG, regulation, legal and social changes)

Each driver will first provide a description of how it will shape the future of work in the mining industry. Then, it will explore how prepared the industry is for this change and the impact it will have on the industry's workforce. Lastly, it will ask for a recommendation for how to best prepare for it in the next decade.



Tutorial: adding a new entry, modifying, commenting and endorsing

How to Start

- Select one of the tabs below.
- See if you can contribute to an existing entry by clicking on it and then commenting or editing it.
- If you wish to write a new entry, click on the blue button and create an entry by clicking "Generate a Scenario".

Technology People Society

Please generate scenarios pertaining to **Society** (ESG, regulation, legal and social changes).

Generate a Scenario

Page	Summary	Author	Replies	Likes
Collective ownership models for deposits and operations	Who owns natural resources and the profits from extraction? Implications for traditional landowners, employee engagement, taxation and wealth inequality.	 Aug 23, 2021 @LaurenAmos	1	3
Deep Sea Mining - Human and Environmental Impact	Technology advances and/or scarcity of resources will expand the frontiers of deep sea mining. The positive impacts on humanity could include new jobs, more income and access to scarce resources. The negatives could include damage to sensitive marine environments and human rights violations from additional staff working in international waters.	 Aug 20, 2021 @Grant Pretorius	12	2
ESG disrupting the Future of Work	Society is exponentially evolving and driving disruptive change to services, manufacturing, and mining industries alike. The changes		5	5



CHAPTER 4: **INSIGHTS**

INSIGHTS

TECHNOLOGY CATEGORY

INTRODUCTION

In this category, the simulation participants were asked to explore the technological drivers that will impact the future of work and workers in the mining industry over the next decade, including robotics, data science, and digital transformation. “Technology” attracted 15 entries from 15 different participants (50% of all participants) and, in response to those entries, 51 comments from 16 different participants.

A noticeable focus among the experts participating in the simulation was the discussion of the potential for increasing automation. Another interesting trend was the potential role of robotics and other advanced technologies, including augmented reality and artificial intelligence, in the future of mining. A third issue considered by the participants was ESG issues, particularly on environmental elements of natural resources and mining.

AI, AR, AND ROBOTS CAN HELP MINING COMPANIES TO INCREASE PRODUCTIVITY AND SAFETY

AI Primarily Used for Workplace Safety

Participants engaged in several interesting discussions on the potential for advanced technologies, including robotics, augmented reality, and artificial intelligence, to play an important role in the future of mining. **The experts noted that AI is considered to be at the forefront of workplace safety presently with the increased use of robotics.** An [interesting case study](#) of robotics was provided by a participant who commented on the potential that Tesla’s 5’8” bot and similar devices may have for the mining sector in the future.



“Field workers will be connected using internet of things, augmented reality displays showing cutting-edge deep learning-based analytics and options analysis for the actions to take and related trade-offs involved. Many high-risk activities will be replaced by autonomous bots or devices.”

Sachin Sharma
Founder, IndustriaNX



It was acknowledged that the implementation of AI is not a new idea, but that there is still a lot of work to be done before proper strategies are devised and pursued. According to several experts, we have still not seen real investment pertaining to technology regarding data and safeguarding in mining. Further investments in such technology could accelerate automation, considered in the section below.

Safety in the mining industry has improved over time, and AI is now being used to further improve safety in a variety of ways. An example of how AI is already being widely used in improving safety includes the use of sensors, real-time data, and analytics to better understand when changes in factors such as temperature or vibrations can lead to danger. Machine operators and drivers can then be warned in advance, preventing accidents and injuries.

Another way AI is already impacting the mining industry and helping to create a safer work environment is through the use of wearables. Many mining companies are now monitoring their workers in real time and are able to identify when a worker is at risk of dehydration, experiencing blood pressure or heart issues, or is working in a fatigued state. Alerts are given or machines are shut down to prevent an incident from occurring. These type of devices are becoming more and more accessible and are being designed to suit the conditions of mining.

The Use of Gamification

The crowd considered the potential of the use of augmented reality/virtual reality and digital wearables to increase productivity. This may result in gamification in the industry that, while presenting important benefits, may lead to internal competition and thus increase stress and tension in the workplace; several experts noted the potential risks posed by gamification if it is not focused on the right outcomes.

Another use of gamification is for recruitment and increasing awareness purposes. It [was recently reported](#) that “more than 57 Australian primary and secondary schools will pilot two new games for school students from this month to build awareness of opportunities in the modern technology-driven Australian minerals industry,” using games to “increase awareness about Australia’s world-leading resources sector, the application of Earth Sciences to resources and beyond to support carbon sequestration and other future environmental technologies and career opportunities in the industry amongst Australia’s primary and secondary students.”

Gamification is already being used in mining to help with making breakthroughs in a learning environment, just like it is being used in schools. For some mining companies, it is being used to simulate situations that require a new way of working or a new way of approaching a legacy issue. Mining has long cycle times and learning through failure can be expensive, dangerous, or not an option at all. Therefore, by simulating

the work situation, they are able to test different ways of working and try new ideas in an environment where safety and failing is not an issue.

THE FUTURE OF WORK IN THE MINING INDUSTRY MAY BE NONHUMAN

Is the Industry Ready for the 'Man-Less' Mine?

Several participants agreed that the recently witnessed trend toward automation in the mining industry is likely to continue, with the requisite technology being developed rapidly. The next phase of this will focus on maintenance of mines – as well as operation – becoming automated, posing the possibility of what the crowd referred to as the “man-less” mine. If adopted successfully, mining companies would be able to cut costs and improve productivity significantly. Mines would also potentially be made safer, according to the experts, and inflict less severe damage on the natural environment.

There was a broad consensus among the experts that the industry is not particularly well-prepared for this development. According to the participants, the fully automated mine will only become a reality if we “rethink the whole process.” The cost of such technologies, particularly for small and medium mines, is one important element hindering the adoption of automation-enabling technologies. Further, the reduced need for labor is likely to prompt disputes, an issue discussed in the final section. For those that are able, mining companies must invest heavily in developing technologies and seek to mitigate the potential backlash from the reduced need for human labor.

It was [reported in August](#) that autonomous drill rigs controlled from 50km away had come online at a copper-molybdenum mine in Chile after an automation process at the mine began in 2016. In Australia, two mines run by Rio Tinto [began moving all of their iron ore](#) using fully remote-controlled trucks in 2015. These developments reflect the advances predicted by the experts, but also demonstrate that there is a significant way to go in reaching the stage of fully man-less mines

Automation will continue to evolve, and it will become more accessible for small and medium mines. However, to reach the vision of a fully automated mine, it will take more than just a focus on technology. There will also need to be a significant shift in how work is carried out at mine sites. The entire system will need to rethink management and their approach to work.

We talk a lot about how mining companies will need to invest in technology to realise the full potential of automation, but we also need to invest heavily in the social aspect of mining to drive this shift.

TECHNOLOGY IS A DOUBLE-EDGED SWORD WHEN IT COMES TO ESG ISSUES

Technology Used to Reduce Mining's Impact on The Environment

The significant connections between ESG issues – especially environmental and social issues – and technological developments were an important element of the participants' discussions. **There was a focus on environmental issues and the potential for technological developments to help mining companies offset their impact on the environment**, including comminution and separation and techniques to decrease water usage.

Further investment in innovation and technology adoption is required on this front, too. Issues surrounding the reduced need for human labor in light of an anticipated increase in automation were another particular focus.

Mining companies are already focusing on how technology can significantly impact ESG. Many companies have strategies to reduce waste and limit their environmental footprint through technology choices. There are also many companies that have a large social impact in the areas that they mine, from providing water and electricity through to employment and safety.

The focus on ESG will continue to evolve and become more important for all mining. Technology will help to create transparency in the true environmental cost of production as well as provide innovative ways to improve the current impacts of mining on the environment.

Loss of Jobs Will Lead to a Backlash

According to several experts, there is a high likelihood that operator-type jobs will disappear as equipment becomes (semi-)autonomous. As good jobs are lost, there is likely to be backlash for mining companies, particularly in those communities heavily reliant on the industry. Here, too, the participants perceived industry leaders to be unprepared. **Companies must preempt these issues and devise strategies to mitigate such backlashes, including potentially retraining employees to ensure skills are congruent with future trends and more related to equipment diagnostics.**

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“I am thinking of many parts of Latin America or the near north in Canada or the USA West, where there are populations close to many of the mining projects. Mines provide good jobs in remote places, out-of-the-way places, and can really lift an entire area out of poverty. If most of the workers are robots, then local rejection of the mine becomes more likely.”

Ernest Mast

President of EDM Mining and Metals Advisory



EXECUTIVE INTERVIEW PART 1

**Grant Pretorius**

Associate Director, Sandpit Innovation

Khushti Shah

Consultant, Sandpit Innovation

What major changes will inform the strategic direction of the mining industry by 2030?

Grant Pretorius:

I suppose from a social lens, the first thing that strikes me is that we're now at a stage where there's increased acceptance of the impacts of climate change. There's also increased recognition of the urgency for change. We've seen that said in the recent IPCC report that was released. As a result, we've seen that society and shareholders are applying even more pressure on businesses to demonstrate clear plans and actions particular to decarbonize. The race for zero carbon is on.

So from a social standpoint and the impact to workers of the future, I think what that'll mean particularly for mining and industry is that we're going to have more need for fresh thinkers and people that can help demonstrate a pathway to zero to help people develop executable roadmaps. I think we're going to need some super-smart people to start developing and working on the technologies, particularly where we don't have any clear solutions. And from an operational perspective, I think we're going to need people to help execute and support these changes, not only from a technical level but also guiding the humans through some of the changes that we need.

And I think on the negative side of things, businesses that are lagging will find it very hard to attract staff, particularly investment. And we're even seeing services like insurance becoming hard to find and quite demanding.

Khushti Shah:

I think the next generation is more socially aware of where products are coming from and wanting to know how products are being developed and manufactured. There's a big push toward ethically sourced raw materials for products, and that's going to fundamentally change how mining as an industry needs to look at this challenge. Furthermore, I see a lot of the next generation, at least in Australia being quite reluctant to work for industries such as coal or such resources, due to the mis-match in values, driving a further drift in type of workforce such industries may be able to attract into the future.

I think we're going to have to fundamentally shift the way we do mining and the principles around people and process that that have brought the industry this far. I do believe technology can be a huge enabler to helping create such a shift that ultimately drives novel ways of mining, whether it's achieving net zero carbon operations, driving social value in local communities or whether it's relating to wellbeing of human talent and the value that can be driven through working in tandem with technology.



INSIGHTS

PEOPLE CATEGORY

INTRODUCTION

The “People” category specifically focused on talent, skills, and labor supply. It resulted in eight scenarios, and 14 experts actively engaged in the discussions on how people would be impacted by the future of mining. Of the eight scenarios, the top three themes in terms of discussions, upvotes, and responses were about the need to upskill the workforce, explore new and organizational structures, and further digitize the industry.

UPSKILLING THE WORKFORCE

An Increasing Need for Talent

The driver with the most expert participation was about how the drive for transformation in mining and related sectors will require **access to high-skill employees** and how the industry will need to partner with government and educational institutions to ensure a pipeline of talent is being developed to support future workforce needs.

According to the crowd, **the industry will need to “radically upskill,” or require access to high-skill employees such as those with digital capabilities, technology skills, and communication and critical thinking skills.** The crowd identified this as a major challenge for the mining industry as a vast majority of the current workers lack the technical upskilling needed to be useful going forward.

Workers at the underground [Syama](#) gold mine in Mali, having been trained in utilising advanced technologies, now operate the mine 24/7 from above ground. The employees being trained in such methods has meant that no layoffs were required as the mine moved toward automation.

Competition for Labor is Across Industries, Not Within It

Therefore, **many of the experts believe that organizations will have to make the decision to fund upskilling of the current workforce, hire new employees, or borrow**

them (contract, contingent, or consultant labor) **to continue competing with the industries that succeed such as tech, finance, and media.** Additionally, one expert raised a concern about the industry's inability to draw in new talent because many do not see the mining industry as a good career choice.

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“We are missing a real opportunity by assuming that our workforce of the future is ‘out there somewhere’ rather than the workers that are and have been familiar with our domain but lack the technical upskilling needed to be useful going forward. As organizations wrestle with this, the bottom line is that orders of magnitude increases in funding are needed for upskilling.”

Steve Rader
CEO, Crowd Resources Consulting



DECENTRALIZED AUTONOMOUS ORGANIZATIONS

Seeking New Agile Work Models

During the simulation, the crowd explored **how mining could move to new agile organizational structures leveraging open talent (freelance).** The expert that proposed this idea went on to discuss how the mining industry is built largely on traditional, top-down, full-time employment organizations. However, due to the rate of technological changes, these traditional companies are severely limited. New agile companies that follow the decentralized autonomous organization (DOA) model can launch into the global market in a matter of weeks or months and pull from an open talent (freelance) pool.

According to the experts, while the current mining industry is **not ready** for such drastic changes, it will need to scrap the old model (top-down, full-time employment) and work to develop the new DOA model. This can be accomplished by **beginning to explore and use open talent in the industry, completing digital transformations of the companies,** and exploring how **new organizational constructs such as DOAs can match certain companies.**

DIGITALIZATION

Unleash and Diversify

The third most talked about theme revolved around the **digitalization of the mining industry.** According to some of the crowd, to accomplish this digitalization within the mining industry, companies need to first **unleash their imagination** and **change the common practices both in project work and mine maintenance.** The mining industry of today is fairly conservative, and these changes will depend on many factors, including the human element. Two recommendations came up – leaders of the organizations need to unleash their imaginations and think about how the industry from a broader scope, and they need to create multidisciplinary teams of people from different backgrounds who can work together.

Other experts identified these recommendations to be challenging **as the current industry is too reluctant to take such a move**. According to these experts, while this is possible, it would require a shift in mindset toward thinking and psychology first.

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“Their [many mining companies] field of view is too narrow – leading to incrementalism and novelty as the digital application, rather than transformation.”

Priscilla Nelson
Professor, Colorado School of Mines



AI AND HUMANS AND GREEN MINING

The Knowledge the Tech Needs is Found With the Employees

A fourth theme that was discussed in this category focused on how artificial intelligence and human partnerships can enable tacit knowledge innovation explosion. A blending of AI and the knowledge found within the minds of human workers will take the industry’s organizations to a whole new level. Right now, many employees fear automation of their industry because they worry about being replaced.

By gradually adopting AI techniques within the workforce, **workers can begin to see the value of having their time freed up and they can focus on using their experience for innovative problem solving within their field**. Unfortunately, the mining industry will not be prepared for the partnership of human intelligence and artificial intelligence until AI and automation are no longer seen as a replacement of labor but as a replacement for non-value-added transactional work.

Finally, another theme was the one of green mining. This entry discussed how green mining will become increasingly important over the next several decades. However, the expert stated that it was hard to say where the current mining industry stands on the future of green mining. The impact that green mining could have on the future of those who work within the mines could be positive because there will be an increased focus on sustainability, health, and safety. For those who work in the office, this trend could also be positive, but there is less of an impact on these individuals. The two experts that commented on this entry were confused about what green mining is and asked for clarifying points about what the expert meant by green mining.

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“For people in the mine, the impact will be very positive, as an increased focus on sustainability, health, and safety, will clearly make their jobs better... For people in office jobs, a trend toward green(er) mining will also be very positive... Green mining is a chance to give the industry a new, better reputation and being able to attract more talent and skilled labor. Particularly in times of war for talent and shortage of skilled labor, this will be a great chance.”

Benjamin Bader
Deputy Head of Leadership, Work and Organisation, Newcastle University Business School



EXECUTIVE INTERVIEW PART 2



Therese Muirhead

Senior Consultant, idoba

Ben Sayer

Associate Director, Sandpit Innovation

How will these changes impact the composition of the workforce and the way the work is done?

Ben Sayer:

Building on the concept of “a thriving workforce”, which in a technology-enabled world means that we need a workforce that is adaptable and curious towards change and open to new ways of using technology; because in two, three and four years, the way technology supports our ability to thrive at work will be different.

To enable our people through technology augmentation in the work of roles, we need a workforce that embraces change as a positive feeling, rather than a threat to their wellbeing. A simple example, today we take for granted that web searching is effective, quick and that we can find what we’re looking for. Well that is true in-part because there’s an algorithm helping us, while also distracting us towards advertising. So we need to evolve and be smarter in how and when we use technology, and at the same time adapt with new skills to gain value from the use of technology, while being aware of its limitations.

With endless opportunities and new problems to solve we need diverse teams of creatives, engineers, scientists, with industry and education collaborators to find solutions together. By bringing new combinations of different skill sets together, for example more creative or visual-based expertise into mining and resources, we can co-create the future use of technology in unique ways to help our thriving workforce. So for me, that’s what really excites me about the opportunities for how work is done in the future.

Therese Muirhead:

To demonstrate this, I would like to quote Minouche Shafiq, who is a director at the London School of Economics. “In the past jobs were about muscles, now they’re about brains, but in the future they’ll be about heart.” A practical application of this is in managing safety, psychosocial and environmental risks. We are now seeing a move away from a “tick a box” methodology that is the responsibility of a few key people within the organization, to managing risk being about caring for people, the environment and the workplace as a system. When all people in the system are given shared knowledge and shared accountability for their wellbeing and the wellbeing of the system in which they operate, an organization will flourish.

INSIGHTS

SOCIETY CATEGORY

INTRODUCTION

The “Society” category specifically focused on ESG, regulation, legal, and social changes and consisted of five scenarios. 13 experts actively engaged to discuss how society would be impacted by the future of mining. Of the five main scenarios mentioned in the society category, the top three in terms of discussions, upvotes, and responses were: deep-sea mining and the human/environmental impact, potential mines outside planet Earth, and ESG disrupting the future of work.

IN THE DEEP BLUE SEA

Plausible but Challenging

The driver that resulted in the most expert participation revolved around the topic of **deep-sea mining** and the positives and negatives of this advancement. According to the experts, due to increasing costs, depleting grades of land-based resources, and technology advancements, the likelihood of deep-sea mining will become increasingly plausible.

It will lead to an increase in jobs, ocean-based resources, and training for reputable operators. The cons, however, include the potential damage to marine life that could be irreparable. Another participant raised the concern of ownership; international law is just as undefined about the deep ocean as it is with outer space. This could lead to conflict between state powers as they try to establish a legal basis on the surface to restrict any action in the deep ocean.

Many of the experts currently agree that the mining industry **is not prepared** for such advancements but see it as a plausible scenario for the future of the industry. One expert raised the concern of environmental NGOs and how many have already pushed back and opposed deep-sea mining.

As of 2017, the International Seabed Authority, an intergovernmental body that regulates mineral-related activities in the international seabed area, had granted [contracts](#) to more than 25 countries for mineral exploration. The difficulty of the endeavour, though, continues to deter firms from mining resources deep below the surface. In 2019, Nautilus Minerals sent [robots](#) to excavate deposits in the territory of Papua New Guinea, demonstrating that deep-sea mining is increasingly becoming a reality as technology develops further.

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“There has already been significant pushback and opposition from environmental NGOs (Greenpeace, etc.) over mining of Mn/Zn/Ni nodules based on, among other things, sediment plumes which are alleged to disrupt the deep ocean ecosystem, and even potentially impact climate change.”

Andrew Brodkey
Principal, Energy Metals Discovery Group



TO THE MOON AND BEYOND

The Road Towards Space Mining Will Impact Mining on Earth

The second most active driver that was discussed is the potential **for mines outside of planet Earth**. The purpose of this driver comes from concerns about irreparable damage already done to planet Earth.

According to the experts, some research has been done into exploring other planets, such as Mars. However, the current mining industry would not be the one exploring these alternate routes. **If anything, this approach would create a new mining employee, different from those in the current mining industry in terms of skills, knowledge, and experience.** This new approach would focus on robotics, mechanics, engineering, physics, and mathematics.

Currently, according to the experts, the plausibility of this driver is decades from fruition due to the logistical costs. However, many of the experts agree that exploring the moon or Mars for rare earth minerals is entirely possible. According to them, the biggest challenge facing the exploration of the moon and Mars is the capacity to ship these materials to and from space. The cost to carry out these operations is substantial currently, but one expert believes that while the initial cost will be great upfront, it will decrease over time as the appeal spreads. Another expert, who has worked in the space industry for the past 30 years, states that the only affordable option for a while is robotic operations. These operations will need to be more autonomous and technologically developed to sustain themselves.

Private [investment](#) in commercial space ventures has increased rapidly in recent years; increasingly, commercial ventures are being facilitated by governments and government agencies. In 2017, Luxembourg passed a law providing a [legal framework](#) for private companies to exploit resources in space in a significant step toward space mining becoming a reality. In 2020, NASA awarded [contracts](#) to four companies to extract small amounts of lunar regolith by 2024, which is likely to be the beginning of commercial space mining in earnest.

ESG IS CHANGING THE FUTURE

A Circular Mindset

The third most talked about theme was how ESG will disrupt the future of work within the mining industry. Society has entered a phase of rapid digitization that connects people across the globe like never before. Media information sharing is becoming more viral, sparking responses from the general public for change and governments responding to public sentiments. While the mining industry has evolved over the past decade, the progress has been slower than the required pace.

The crowd mentioned certain drivers that are currently dictating the mining industry changes, such as commodity pricing, climate change, decarbonization, and sustainability. As the mining industry shifts to remote sensing and operational controls, the future of the mining industry may see **a shift in skillset** resulting in those that are not automated and managing and maintaining the digital infrastructure and automated equipment. Several of the experts pointed out major problems that are ongoing within the mining industry, such as thinking in a small field of view, image problems, and poor communication. To challenge these current problems, the experts recommended **diversifying and engaging with the circular economy and end-users** because they are the ones that will help develop solutions to ESG problems.

REGIMES & OWNERSHIP

Dealing with Totalitarian Regimes

Another driver that was mentioned in one of the discussions was how to mine under totalitarian regimes and collective ownership models for deposits and operations. According to the few experts who raised these issues, in order to access resources, the mining industry may be forced to cooperate with these regimes.

However, there comes a clashing of values and the need to develop a plan of action on how to work with these regimes while maximizing the support of locals and achieving sustainability goals. As a result, according to one expert, this shift could go one of two ways. It could result in customers looking for substitutes or omissions of minerals that are too scarce, or the mining industry could be forced to work with totalitarian regimes.

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“If certain minerals become scarce or too expensive to mine in non-totalitarian countries, either the customers might look for substitutes or omissions, which will affect the mining industry as it will dry out revenue streams, or the mining industry will be forced to work together with totalitarian regimes in a way that’s not damaging their reputation and sustainability goals.”

Roger Gorges
Head of Innovation and Product Testing, MAHLE



EXECUTIVE INTERVIEW PART 3



Grant Praetorius

Associate Director, Sandpit Innovation

George McCullough

Director, Customer Success, Optika Solutions

How prepared is the industry for these changes?

George McCullough:

I might be a little controversial here, but I actually think the mining industry is actually not in such a bad state to deal with these coming changes. The one thing that's interesting about the mining industry is, if I think about it from a buying behavior point of view, it's very crisis-driven. It unfairly gets accused of being risk-averse. And I don't really think that's necessarily true. I think as long as the status quo is maintained, yes, you generally don't see a lot of technology adoption and a lot of change, but when there's a crisis, change can happen in the mining industry really, really quickly.

Now for a while, we've been talking about the great crew exchange and generational change and the brain drain, all of these workforce issues. And there hasn't really been an impetus to cope with that change, but at the same time, you know, steadily but surely there's been an improvement in the adoption of technology. And now with a very, very sharp ramp-up in focus around ESG performance, these three things are coming together to essentially precipitate a crisis for mining companies, getting access to capital, attracting the right talent, making sure that talent can work anyway. I actually think that the infrastructure is there, and I think that we will find a way.

Grant Pretorius:

What we've noticed is that the world is becoming a smaller place and a lot of these problems are becoming global problems. So I think particularly if you look at things like ESG, climate change, et cetera, those are all becoming global challenges, and I think what we've seen particularly across regions is that there's a range of readiness. If you've got certain players in the market that are majors, they've got loads of resources at their disposal and they have a belief and a commitment to make the changes, they'll be much more ready.

What we're also seeing is that there are certain challenges that are really tough, certain technical challenges. So, for example, finding an alternative for hydrocarbon-based fuels for heavy material movement, shipping, et cetera. And what we've seen emanating from certain pockets in the mining industry is a willingness to collaborate, a willingness to open source some of those solutions. And I think we're going to start seeing more and more of that in the future and we're

going to need more and more of that where we solve these problems together for the greater good. Sort of summarizing my view on where I think that readiness is, I think there are some challenges technically, economically, and sort of socially or from a human side. I've covered some of the economic challenges, particularly within the regions.

Technically, I think we've got some solutions out there that are technically viable if you look, for example, at some of the renewable energy technologies, so they might not be new, but they're new to certain regions. So I think some areas will need support to start implementing some of those, and in other areas, the barriers will be less significant. I think throughout all of these, the thread is the humans that are the decision-makers and the people that are potentially impacted through this.

So as the world becomes more automated, the scope of the work changes. The locations that we work in change. The skills that we require change substantially, and mostly for the better. But I think we do need to be mindful of these impacts on people and their families and have very strong, robust transition plans to help people through that and particularly as they navigate a change in skill balance. And the other one that we need to also be reasonably aware of as a human race is that as we explore frontiers that haven't been looked at before, like space mining, deep-sea mining, et cetera. These areas will be very, very difficult to regulate. They'll be very difficult to enforce. And left unchecked, the toll on humanity could be quite interesting, and potentially disastrous as well. But I think, in general, there's a significant willingness, particularly from the mining industry, to change and rise to these challenges. So I'm optimistic about the future.



CHAPTER 5 **VOTING**



VOTING RESULTS |

Phase 2 of the simulation was the voting phase. We asked the participants two types of questions: quantitative questions they could rank between 1-5, and qualitative questions they could answer freely. The questions referred to a broad array of topics concerning the future of the mining industry and its workers: the future required skills, prominent stakeholders that will be part of shaping the future of work and workers, the impact of technology on the industry, and more. 28 participants answered the questions, and the results presented here are calculated accordingly.

Some of the most surprising results in this chapter concern the crowd's opinion of the **significance of COVID** for the future of work in the mining industry: almost 50% voted that it won't be significant at all/very low. Another interesting result is the unanimity around the question of the needed **adjustments in the mining industry to keep top talent** in the coming decade: 86% assessed that significant changes will be needed, and none thought that no changes will be needed.

Additionally, many experts pointed out that **communities and governments will become increasingly important** stakeholders due to growing environmental requirements and regulations. Finally, the experts pointed out the benefits and risks of **the great impact of technology** in the upcoming decade – on the one hand, it will make mining safer for workers, less environmentally damaging, and more efficient; on the other hand, the technological changes will have to be accompanied by a rethink of firms' approaches to training, ensuring that personnel is upskilled and able to work effectively alongside advanced new technologies.

OPEN QUESTIONS RESULTS:

What new skills will be required from mining workers in the coming decade?



AI



Automation & Controls



Robotics



Virtual/Remote Collaboration



Data Science/Big Data



Sustainability



Machine Learning

Several experts believed that mining workers will be required to become more adept technologically, rendering them able to incorporate AI and other advanced technologies in the mining process. There was also a focus on human-machine integration and interaction and robotics as automation in the mining industry progresses. Workers will also require the ability to service and maintain such advanced technologies.

A second trend identified by the experts was the need for workers to consider ESG issues and ensure that these are integrated into decision-making and the operation of mines. The crowd noted that workers will be required to **effectively communicate with the local communities** in which they operate. There was a particular focus on the interaction between mining workers and indigenous peoples on whose lands they often operate. This is linked to the experts' belief that workers will be required to maintain a local as well as a larger picture of their operations.

Which stakeholders will be part of shaping the future of work and workers in the mining industry?



Local Communities



Investors



Governments



University Research Centers



Environmental Groups



Expert Consultants



Consumers

Existing stakeholders will continue to play important roles, but many experts believe that **communities and governments will become increasingly important**. Consumers are increasingly demanding sustainable produce, putting buying pressure on mining firms. Similarly, environmental groups will continue to play an important role, as will investors, who are increasingly concerned about firms' ESG credentials.

Local communities and governments in mineral-rich countries will play increasingly important roles. Tensions with local communities may be reduced, however, by increased automation and technologically driven changes that mitigate some of the environmental impacts of mining.

University research centers and expert consultants will play an important role in the development and implementation of new advanced technologies. Related to this, individual workers will play an increasingly important role as automation and technological developments potentially threaten jobs. Additionally, mines will increasingly be run as cohesive wholes rather than silos. Experts believe that change in the industry will be bottom-up.

What will management in the mining industry look like in the new world we are adapting to?



Multi- and Inter-Cultural



Female Representation



Diversified Hiring



Flexible and Innovative



Board Representation of
Developing Countries

According to the experts, management will be increasingly multi- and inter-cultural. Diversity will also be increased through the hiring of those with different academic backgrounds who bring skills and knowledge from other industries, including technology and AI, to mining. Developing countries with mineral deposits may request higher levels of board representation in exchange for mining rights. A higher level of female representation in management is also expected.

Management will also be required to be more flexible and innovative, but this is likely to be a long-term process. Management must continue to promote and pursue digitalization and corporate social responsibility. In order to improve productivity and efficiency, many experts believe that management within the mining industry will pursue flatter organizational structures.

In the next decade, what impact will technology have on the mining industry?



Greater Automation



Small and Medium Mining
Companies will Compete with
Larger Firms



Safer Mining



Enable firms to move toward a
Net-Zero Carbon Sector



Change in Companies Training
Process



Improve Productivity

The majority of experts concurred that **technology would have a significant impact on the mining industry over the coming decade, including predictions that it will redefine the way work in the mining industry is done.**

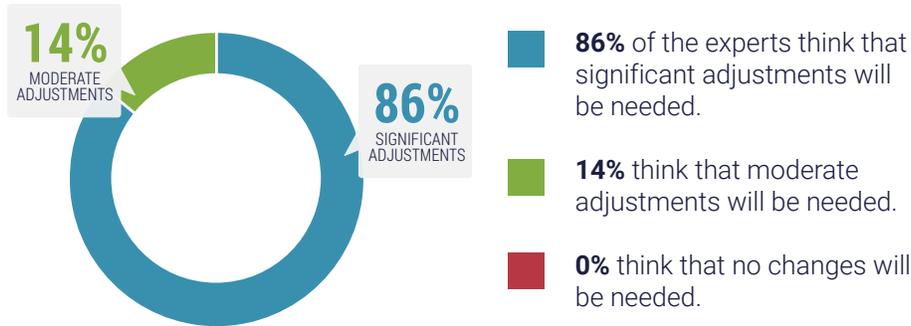
The crowd focused particularly on the likelihood of technological development enabling **greater automation**, which will reduce the need for human resources. Automation may make mining safer for workers, less environmentally damaging, and more efficient. The experts noted, however, that technology must be accompanied by a rethink of firms' approaches to training, ensuring that personnel are upskilled and able to work effectively alongside advanced new technologies. There will be a greater need for interaction and integration between human resources and technological resources. Automation will also enable small and medium mining companies to improve efficiencies and thus compete with larger firms.

Technological developments will also have important impacts on firms' ESG credentials. Data will allow firms to measure their sustainability indicators and improve where needs be. Social media will allow consumers and other stakeholders to scrutinize firms further. Technological innovation should better enable firms to move toward a net-zero carbon sector.

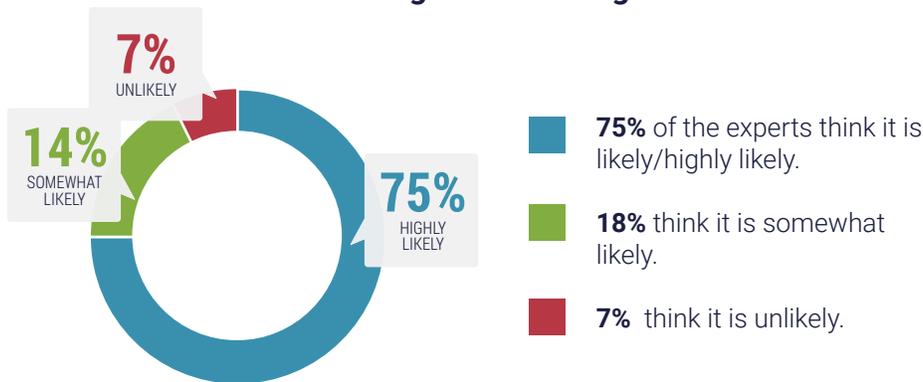
Data analytics will allow firms to improve their productivity and thus profitability, as well as further reduce the need for human intervention. Real-time data flows will allow for responsive mine operation, management, and communication with stakeholders.

CLOSED QUESTION RESULTS (RANKING)

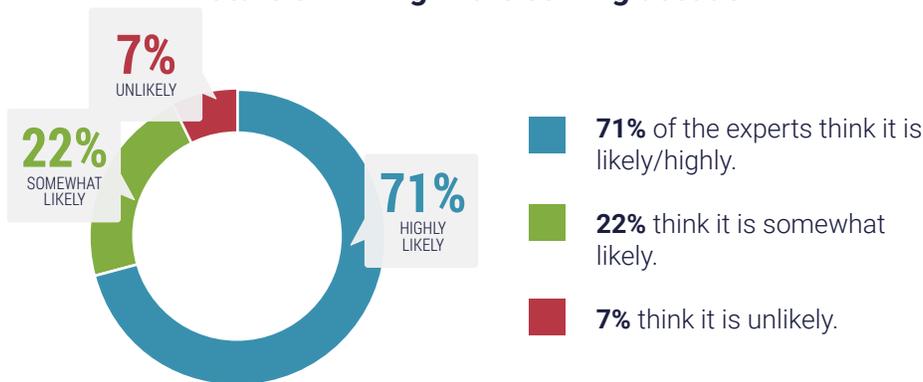
To what extent will adjustments need to be made to keep top talent in the coming decade in the mining industry?



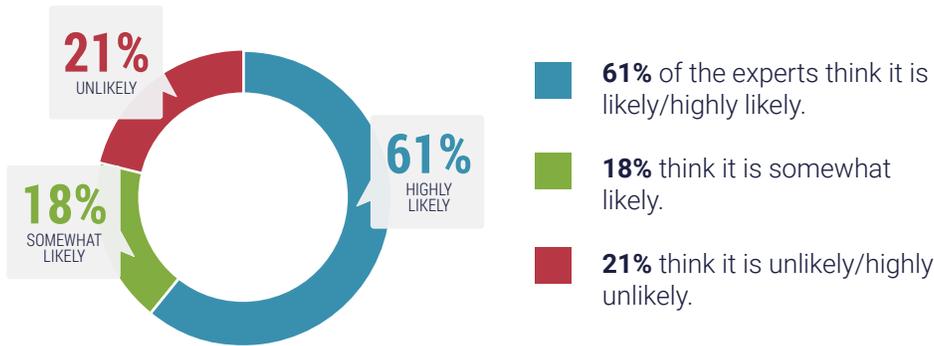
How likely is it that the public will play a role in shaping the future of mining in the coming decade?



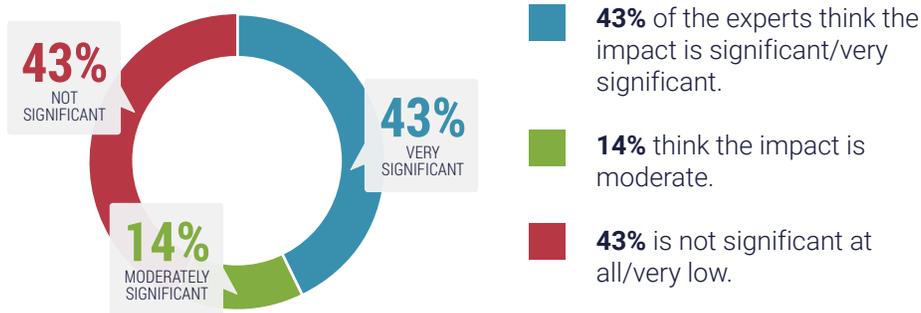
How likely is it that governments will play a role in shaping the future of mining in the coming decade?



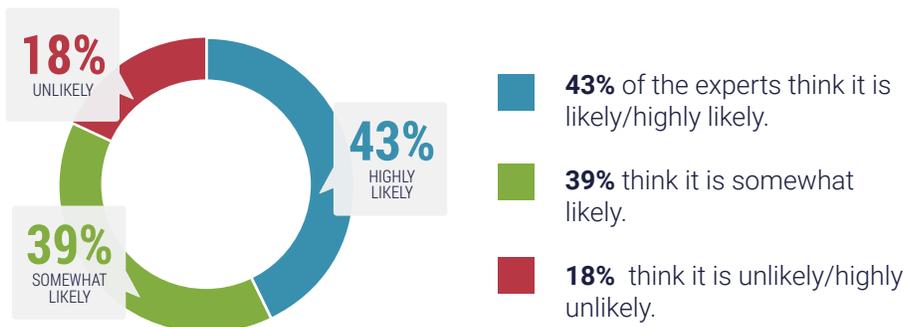
How likely is it that organizations will collaborate to solve industry-wide problems in the next five years?



How significant is the impact of the COVID-19 pandemic for the future of work in the mining industry?



How likely is the industry to adopt the needed changes resulting from the impact of the pandemic by the year 2030?





THE FUTURE OF WORK(ERS) IN THE MINING INDUSTRY

OCTOBER 2021



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