We need to talk
About the future of mining

PwC's future in sight series

pwc

pwc.com/futureofmining

The trick to seeing the future…
is knowing where to look for it.

PwC's future in sight series brings together our insights and perspectives on the disruptive forces we believe will have a transformative impact on the future.

Contents

Is mining really ready for the future?

Mining is often considered a relatively straightforward business, with integrated value chains and strong control over many of the variables of production.

Or is it? Many mining companies have a deeply ingrained, conventional view of their sector and the environment in which they operate. But while it's served them in the past, it's less likely to work in the future. Miners can no longer afford to ignore the role they play in a much larger economic, social and technological ecosystem – an ecosystem that is growing and becoming more complex every day.

Consider some of the key disruptive forces emerging today and the impact they might have on mining in the future. For instance, how will robotics change the way we mine? How will digital enablement or blockchain technology reduce costs, influence mining processes, and enhance product specialization and end-customer service? How will social media impact the sourcing and consumption of minerals?

While mining executives typically make large-scale investment decisions with long timeframes, the fast-paced, disruptive influences we are seeing today already impacting these choices. What needs to change to ensure mining can benefit from technological advances and other disruptive influences, rather than fall victim to them?

Have mining companies really thought broadly enough about what the future might hold for their businesses, and what they could be doing now to make sure they profit from it?

Competing in the era of new entrants

Take the rise of non-mining companies entering the sector. Often cashed-up, technologically advanced, and brand savvy, these businesses are appearing at a time when conventional players are struggling for the capital, skills and capacity to innovate, and barriers to entry – a result of depressed asset values–are low.

For example, back in 2015, automotive and energy storage company, Tesla signed early stage agreements[1] with junior mining companies to supply their new 'gigafactory' in Nevada with lithium, a key ingredient in batteries. The fact that none of these companies had any existing production did not dent Tesla's plans. The deal signaled to the world's incumbent lithium miners that new customers like Tesla are not frightened to explore high-risk, high return alternatives when they find that current market conditions do not suit their needs.

On the other side of the world, Australian telecommunications giant Telstra recently launched a new mining services company[2], saying "the timing of the commodity price downturn means there's a different outlook among mining customers as to how they are going to drive process change in their operations."

While new entrants bring much-needed capital and ideas to mining, what impact might it have on competition? What if Toyota seeks to market a 'really green' Prius with all its metals directly sourced from and traceable to the highest ecologically-rated mines on the planet – mines the company also happens to own?

[1] *Tesla in stand-off over lithium supply,* Sanderson Henry in Financial Times,15 DEC 2015
[2] https://exchange.telstra.com.au/2016/06/23/telstra-invests-mining-technology-solutions-services/

Keeping up with the pace of technological change

Technology is not just a factor in the future of mining operations, it's also impacting the market for mining's outputs, often faster than companies can respond. For example, the growing use of smartphones, tablets, and batteries has seen shares in rare earth and lithium miners skyrocket, while the price for thermal coal was recently bumping along at historic lows. The once reliable foundations for competitive advantage in the mining sector are shifting under companies' feet.

Technology is also leading to competition from unexpected quarters. Consider the dramatic rise of the 'sharing economy', where consumers use their smartphones to share goods and services such as accommodation, car rides, and finance, as well as music, TV, and staffing. What will be the impact of the sharing economy on mining? Will demand for commodities drop as asset utilization increases? Will mining companies 'share' assets amongst themselves or with other industries?

Engaging a divided and skeptical public

Disruptive change is not limited to technology; there are major shifts taking place in the social landscape as well. A major one is the fracturing of public attitudes towards established institutions. 'Brexit' and the election of once-derided US presidential candidate Donald Trump are evidence of a growing willingness to buck conventional wisdom and pursue untested options. The impact of this mindset on the mining sector cannot be underestimated. Companies are already struggling to build trust and secure their privilege to operate. What if the public becomes even more immune to reasoned argument or 'expert advice'? What if they just tune out to miners all together?

And how will miners respond to people on the other side of the divide: socially conscious and tech-enabled consumers demanding greater transparency about what they buy? Whether it's diamonds from Sierra Leone, power generated by thermal coal or the source and sustainability of the metals in the bike or car, bus, train, ship or plane they use to go about their day or take vacations? These stakeholders are highly engaged and motivated to share their opinions with others on peer-to-peer social networks, often mobilizing others to their cause. What if their demands and advocacy continue to grow? And how will the stance of governments and regulators towards mining change in response?

Thinking through the future, today

So what can mining executives do today to prepare for such an uncertain tomorrow? What strategic decisions need to be thought through and made now, to ensure your company will be thriving 5, 10 or 20 years down the track?

To help you answer these questions, we took a trip into the future. We brought together specialists from across the PwC global network and industry to explore how the sector will be affected by the powerful dynamics reshaping not only mining but also the global economy and broader ecosystem that miners operate in.

We came up with four scenarios that give an insight into the types of challenges and opportunities miners (and indeed today's non-miners) might need to deal with, and what they can do to win. We explore not only the kinds of strategies required but the shift in mindset needed to make those strategies work.

You can use these scenarios to think about where you want to be in the future, compare it to where you are today and consider what that means for your medium to long range strategy.

Exploring four possible futures for mining

These future scenarios are based on what we see as key uncertainties shaping the future of mining, depending on how they play out. One is the extent to which new entrants– non-traditional mining companies such as finance, tech players or consumer brands – change the sector. The other is public trust of mining companies and the extent to which external stakeholders gain greater control of miners' privilege to operate.

We can't predict the future, of course, but we believe the conversation about what the future might look like is an important one.

Low trust – others control privilege to operate

1. *Constrained success*

Miners in constant conflict with stakeholder interests. Very little trust in the sector to do the right thing. Success becomes increasingly difficult; no one can truly win.

2. *Non-miners in ascendency*

Well-funded, hi-tech and socially savvy companies out-compete many existing players in a highly regulated and scrutinized world.

Incumbents shape sector

New entrants change the game

Left to self-regulate, miners operate collaboratively, with short, predictable projects. Transparency is high, smaller but sustainable profits favor the mining superpowers.

3. *Mining superpowers*

Mining attracts highly innovative entrants from new industries. Free to set their own course and flush with new ideas and capital, miners transform.

4. *Mining transformed*

High trust – miners in charge

1. Constrained success

In this scenario, trust in the mining sector has all but evaporated. A miner's privilege to operate is no longer an enduring right, but a tenuous permission slip that can be withdrawn at any time by a range of regulatory 'guardians'. Those with this right consider it their most valued asset, more valuable than ore reserves. While the high cost of compliance discourages outside competition, turning a profit is extremely challenging. Only policy savvy operators will prosper, those who recognise the need for sustainable development and who understand the need for mutual outcomes.

It's all about compliance

The public no longer trusts miners to do the right thing. They've stopped listening to companies or their industry associations and instead put their trust in regulators to keep the sector accountable. NGOs dominate the social media landscape and forcefully push their agendas. Regulatory scrutiny continues to rise and becomes standardized globally.

Technology allows real-time monitoring of compliance on an unprecedented scale. Drones and remote sensors, operated by regulatory agencies, monitor a wide range of indicators inside the mine gates: air quality, working conditions, temperature, equipment loads, tailings, operator alertness, training, medical condition, pit wall stability and so on. There's nowhere to hide.

When breaches are detected, automatic 'fail safe switches' are activated by regulators, and operations come to an undignified halt until regulators are satisfied appropriate standards have been reinstated. This high level of external scrutiny keeps the sector on tenterhooks, and 'bad' mining is no longer tolerated, anywhere in the world. The cost of regulatory compliance could become the single largest expense item in some miner's results. Executive time is consumed by responding to stakeholder concerns, dealing with compliance and securing funding. The role of Chief Regulatory Officer emerges with direct accountability to the Board.

Capital is constrained, profits under pressure

The impact of lower trust also extends to capital, and funding becomes fragmented, more expensive and harder to find. Pension funds, sovereign wealth funds, insurance and lending banks, as well as other institutional investors, are not prepared to back certain parts of the sector. Some will not lend to coal projects, or to mines with particular environmental sensitivities (for example, mining in rainforest areas), or to energy intensive projects or those with a low proportion of indigenous workers.

It's a long, long checklist. CFOs seeking capital a place where it's hard to please anyone. It's pretty much impossible to attract significant tranches of new capital in thermal coal or uranium. Which commodities will be next?

Making a profit in this high cost, low-return future is extremely challenging. Project progression is slow, and it takes longer to move into the production phase. Regulatory stage gates make it impossible to accelerate development cycles when economic conditions are ripe. Mining companies struggle to bring new mines online to replace depleted operations or to take advantage of increased demand. As a result, company valuations, share prices, and the ability to attract new capital suffer. Indeed, some miners might forsake public markets and rely on patient private capital to advance projects. State-owned enterprises, backed by sovereign capital, thrive under these conditions.

Unexpected delays to regulatory sign off on business-as-usual permitting result in supply disruption and price shocks; production is often disrupted, and assets are stranded. The ability of companies to mitigate risk via insourcing and alliances is severely curtailed, as regulators won't allow the transfer of compliance risks via contract. Share prices are volatile.

How can you get ready?

- Innovation is a team sport: build collaboration across your ecosystem.
- Maintain a portfolio of mines to ensure business continuity in a world where operations can be closed at a moment's notice.
- Invest in becoming a partner of choice. Understand what your mining company brings to the table and where there are gaps. Be willing to share the rewards.
- Build productive relationships with mining regulators and policy influencers to shape the agenda.
- Look for sources of 'patient' capital – shift focus away from short-term goals to long-term sustainable returns.

In many countries, a rise of resource nationalism – in response to social populism – leads to increasing 'caps' on mining returns. A greater portion of profit is taken in the form of taxes, rents and duties, with little left for shareholders. Mining companies are forced into wholesale hedging as their only means of protecting downside price risk.

In this future, only the largest miners can afford to survive as operators of assets. Smaller players don't have the means to support all the necessary overheads required to ensure compliance. Mid-tier miners are forced to either sell assets pre-production to global companies or SOEs, or go into non-operatorship settings as minority partners. Single asset players are rare. Producing assets rarely change hands due to onerous regulatory approvals, suppressing value.

Technology changes the way we mine

On the positive side, increased scrutiny leads to significant improvements in safety, community, and environmental outcomes. But in the absence of new entrants and new sources of funding, innovation is incremental.

One of the keys to maximizing returns lies in the speed of adopting new mining techniques and technologies. In this future, equipment has a shorter useful life as OEMs continue their relentless drive for greater operating efficiency. Leading mines have onsite recycling facilities as machinery is decommissioned and rebuilt in situ using 3D printing technology. Drones are used throughout most mines, even those underground.

Miners with more agile mine plans and cultures supporting change are rewarded. Mining decisions are highly sophisticated and driven by big data, with far greater certainty around ore body characteristics. With technology delivering measurements down to the cubic meter, geological 'surprises' become a thing of the past, and mine managers can effectively mine to order. Large-scale open pit mining has been abandoned as a result of both environmental restrictions and improved mining techniques. Most mining decisions are made remotely: there are few middle or senior managers onsite anymore.

2. Non-miners in ascendancy

In this scenario, miners have lost trust and no longer control their privilege to operate. Time, attention and capital are spent responding to increased levels of scrutiny, rather than on growth and shareholder returns. This creates the ideal conditions for new entrants to thrive, especially those with a record of success in highly regulated environments.

Outsiders call the shots, customers think 'brand risk'

Reputation and trust can be fleeting commodities. As the adage goes, a reputation takes a lifetime to build and a minute to destroy. In this future, miners have failed to maintain trust and ceded control of the sector to regulators and stakeholders. Growth and profitability are increasingly difficult, with miners forced onto the back foot in the face of rising oversight.

NGOs and special interest groups are well resourced and politically savvy, having maximized social media avenues to build influence. As the trusted advisors to governments, they drive the agenda for the sector. Poorly operated mines are subject to regular closure as a result of social activism, funded through crowd-sourced campaigns.

Countries with already high environmental standards drive those standards even higher: open pit mining is effectively outlawed and the use of water severely curtailed. Sovereign risk goes through the roof. Mining company customers, reflecting public concerns about the origin of materials for consumer products, are increasingly worried about 'brand risk'. Legislation around transparency and source of origin issues becomes commonplace. The voice of mining is fragmented and diminished.

Fertile ground for new entrants

While incumbent miners struggle, others seize the opportunity. New entrants, knowing they can do a better job, and knowing that they are free of legacy issues around trust, take advantage of low valuations and asset fire sales from the major miners. Others bring a new level of innovation to a traditional sector; Google's recent partnership with a global consulting firm to boost productivity in mining in Kazakhstan is a case in point.[3]

Some new entrants are major users of mining products that want to take full control of their supply chains.

In this future, big brand technology businesses acquire diversified mining portfolios to deliver on a brand promise that the minerals that go into their products are produced in the most responsible way.

Capital flows easily to these new players, many of which have access to cutting edge technologies and a track record of success in highly regulated environments such as healthcare, finance or defense. Sovereign wealth funds, which could comfortably buy even the largest miner, favor the new entrants.

Innovation looking backward?

Given the reckless spending of capital investment funds during the recent boom, investors are reluctant to fund R&D. For the incumbent miners, innovation is largely reactive, geared towards keeping up with ever tightening rules and surveillance, such as regulators using remote technology to monitor operations on mine sites and track illegal activities.

There's a focus on retrofitting innovation for compliance, as opposed to increasing productivity and profitability in mining. Miners are at a disadvantage compared to new entrants, which have been less constrained in their R&D investment and can bring fresh thinking to old problems. Many entrants enjoy a 'second mover' advantage, having learned the lessons from the first wave of non-traditional players in the mining sector.

In this future, players from the health sector develop biological microorganisms that release carbon-based minerals from ore without the need to dig up the entire ore body. Fintech companies use blockchain technology to create marketable parcels in mineral reserves and mining outputs that are measured in kilograms rather than tons and contracted years in advance of actual production. Mining assets change hands faster than ever imagined. Some precious metal ore bodies are kept in the ground, never mined but still traded, effectively securitizing reserves.

High-tech manufacturers develop new 'dry mining techniques', unlocking the potential of ore bodies previously thought to be constrained by lack of water supply or located too close to sensitive catchment areas.

Only the best or specialized thrive

Many of the mid-tier operators are forced out of the sector, unable to afford the high cost of compliance and starved of capital for expansion or innovation. Those that remain specialize in niche products, hard to mine reserves, and end-to-end customer services. Some morph into contract mining companies. The role of discovery and exploration remains largely with start-up and junior miners, as it is today.

For the incumbents, advantage comes through frontline mine experience. Those that can show best in class for productivity, efficiency, and mining techniques, and have a brand built on delivering to a mine plan, do well. But the twin pressures of regulation and competition have created margins that are razor thin. The difference between the very best performers and the rest is measured in cents, not dollars, per ton.

How can you get ready?

- Evaluate your capacity and hunger for rapid adaptation. Think like a venture capitalist – look for the next big idea that will make a difference.
- Develop new ways to grow or acquire the talent necessary to execute your strategy, taking into account realities like the distinctive needs of millennials.
- Manage brand risk and improve transparency along your supply chain.
- A B2C (Business to Consumer) lens can help to identify new product enhancements.
- If you're a new entrant, identify the specialist capabilities that could change the face of mining.

[3] *Google and McKinsey to mine Kazakh data*, Farchy, Jack in Financial Times 21 APR 2016

3. Mining superpowers

In this scenario, trust is high but new entrants are few. And although the sector is strong, there are plenty of casualties. The high cost of earning trust, combined with limited access to outside capital or new ideas, favors the very rich or the very innovative. Mid-tier players leverage their agility and low cost of doing business to specialize in smaller, niche product operations to survive.

Trusted and collaborative, but how profitable?

Miners have assured stakeholders and the public that they can be trusted to get on with the job. They have built trust all along the supply chain, from mining service companies to third party suppliers to markets and traders. And because accountability is in their hands, miners collaborate continuously to maintain this hard-earned trust.

Companies outside mining, however, show little interest in the sector. Some see better growth elsewhere, while others are discouraged by the failure of an early wave of new entrants. The result is that any new ideas must come from miners themselves. Technology and innovation continue to play a critical role, but it's incremental rather than transformative. As a result, the

mining sector struggles to attract new, non-traditional sources of capital or talent. Profits are not as high as they could be. Investors are restless.

Mining services on the rise and a new mid-tier

This future favors large and/or diverse miners with big balance sheets, diverse asset portfolios and money to spend on compliance, innovation, and R&D. Consolidation has left only super miners standing. Competition is usually confined to things such as identification and appraisal of ore bodies, speed of executing new projects, advances in production technology and ownership of different elements in the supply chain.

Many mid-tier miners have had to reinvent themselves in order survive. They are focused on in-demand niche markets and commodities and lead the way on 'origin sourcing' for mineral products. Smaller miners struggle to compete on their own terms. The ones that do are reliant on third party mining services companies, which can operate with a high degree of efficiency and maintain trust. In fact, it's an ideal environment for services companies, which become drivers of the innovation agenda for miners big and small.

Attack of the drones

Big spending on mining-specific R&D results in a future dominated by robotics and drones. More cost effective and versatile than helicopters and emitting less pollution than mining vehicles, drones have replaced humans for many dangerous or monotonous jobs across all aspects of exploration, planning, operations and reporting.

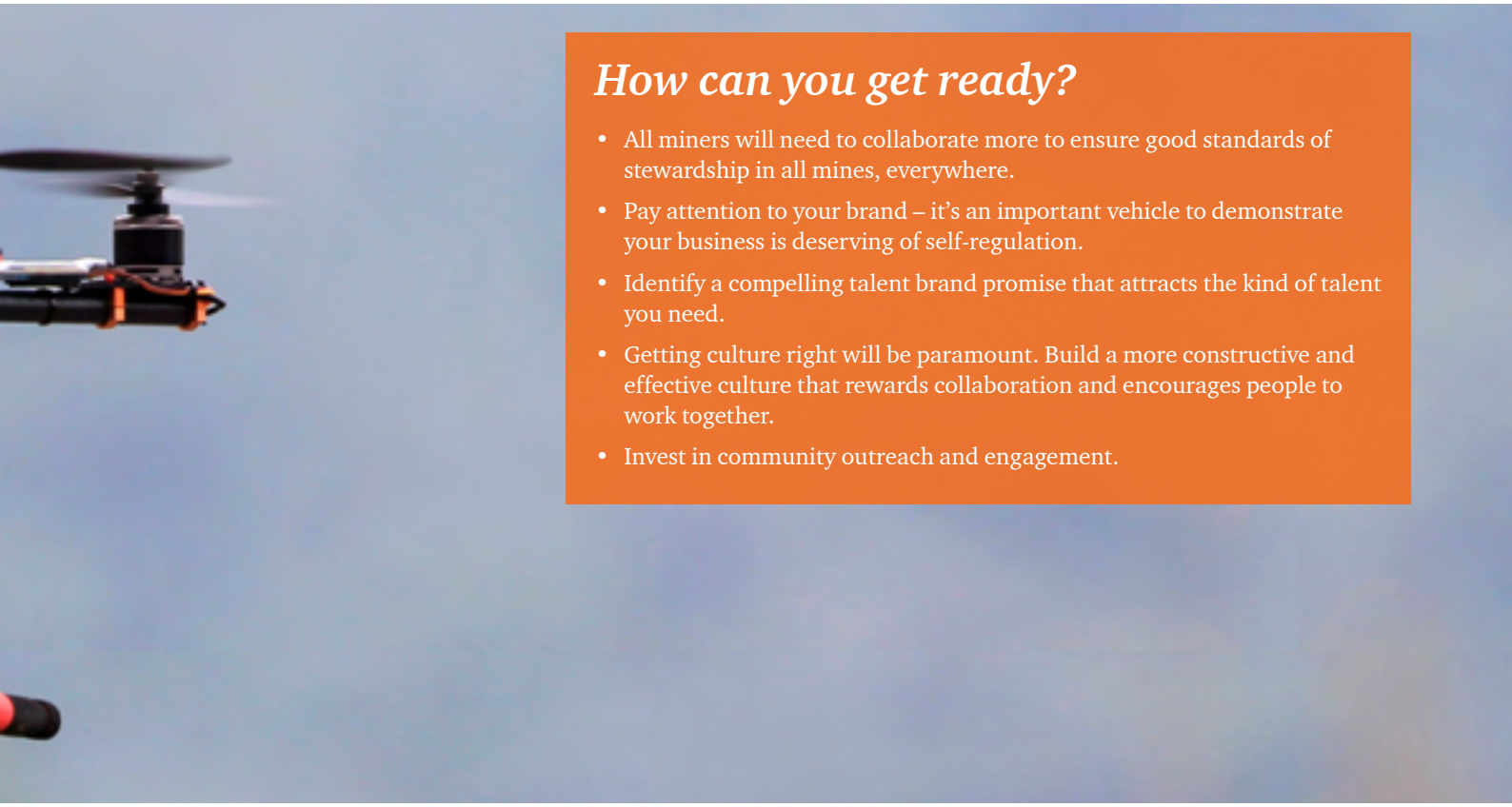
Drones are used to quickly map new mine areas, analyze mineral samples in real time, and optimize haul routes. They detect erosion, track changes in vegetation, and search for defects in mining infrastructure that may endanger the environment. They're used for many of the high-risk jobs, such as transporting hazardous waste to dedicated storage facilities or checking for chemical contamination.

Drones are deployed in emergencies, transporting medicines and rescue equipment and monitoring the health of injured workers until help arrives. They even ferry spare parts to machines operating at the far reaches of a mine.

Mutual self-interest emerges, but to what end?

In this scenario, miners are largely left to themselves. While this fosters a high degree of collaboration, there are unintended consequences. With only a handful of global players in the sector, an inevitable sense of mutual self-interest comes to dominate. There's a tendency for production to become over-controlled and prices to be managed. Anti-trust/anti-competition challenges are a regular event, contrasting with the social license trust that has been established.

Paradoxically, the sector's stability and strength attracts greater scrutiny from outside, causing miners to work even harder to maintain the trust they've invested so much to earn.



How can you get ready?

- All miners will need to collaborate more to ensure good standards of stewardship in all mines, everywhere.
- Pay attention to your brand – it's an important vehicle to demonstrate your business is deserving of self-regulation.
- Identify a compelling talent brand promise that attracts the kind of talent you need.
- Getting culture right will be paramount. Build a more constructive and effective culture that rewards collaboration and encourages people to work together.
- Invest in community outreach and engagement.

What can blockchain do for mining?

Imagine being able to securely and irrevocably verify the provenance of the raw materials in a new car or jewelry. Or digitally trade geo-tagged cubic meters of gold ore – while it's still in the ground?

A big challenge for miners in the future will be shifting from a business-to-business mindset to one that gives greater consideration to the needs of the consumer and other stakeholders.

We already see demand for electric cars due to their perceived environmental benefits – what if that extends to knowing if the materials for those cars came from environmentally verified mines around the world?

Discerning consumers are increasingly interested in the provenance of their products – whether from a quality, social or environmental perspective – and are prepared to pay for it.

But how can miners capitalize on this growth opportunity? How do they change their business processes and outputs as well as increase revenue?

One answer may lie in blockchain technology.

Blockchain is a potentially revolutionary new technology that allows for the creation and maintenance of a continuously-growing list of records, called blocks, secured from tampering and revision.

Originally designed to underpin the crypto-currency bitcoin, blockchain is fast being used for myriad other applications, such as providing assurances around manufactured products.

For example, blockchain is already used with mining products such as diamonds, which are imprinted with a tiny QR code that links to a digital token verifying their quality, ethical extraction, and authenticity. This is helping minimize fraud, theft, and related insurance costs, as well as creating a much more robust, transparent end-to-end view of the custody of goods.

But blockchain could also be used in more complex supply chains. Materials could be tracked and traced from the moment of extraction to the point of sale, satisfying increasing consumer demand for both increased supply chain transparency and more environmentally sound products.

From the miner's perspective, blockchain could also be used to provide peace of mind on products sourced in less regulated environments as well as easily identify any supply chain weak spots or substitution risks.

More radically, blockchain could be employed to transform the identification, trading, and management of ore bodies.

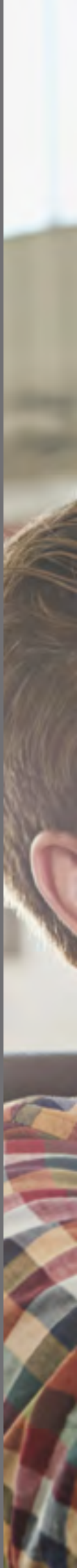
For example, a gold mining company could identify its ore body and subdivide it into smaller parts, say one cubic meter segments. This information, verified by a trusted on-ground third party, would be recorded in a blockchain as a cryptographic token.

The blockchain record would enable anyone to trace ownership as well as the specific geographic location of the ore beneath the earth's surface. It could also link to a physical tag that detects if the ore body is physically moved or otherwise disturbed and communicates that information to a third party on the blockchain that can notify the ore's owners or even law enforcement.

Once tokenized, the geo-tagged cubic meter could then be sold and further traded on a marketplace enabled by the very same blockchain that houses that token. In effect, this blockchain will have enabled the creation of not only a data-secure, monitorable record of unmined ore, but liquidity and a market for that ore. Actual mine product could be traded without actually being mined, taking advantage of movements in commodity prices and future improvements in extraction techniques.

Securing the provenance of raw materials and creating a liquid marketplace for unmined ore are merely two examples of how blockchain technology could conceivably impact the mining industry. And when combined with other innovations in the Internet of Things, logistics, and trade finance, the possibilities only multiply.

The mining industry should not only be paying attention to how the blockchain space is developing but actively considering how it might begin to take advantage and where to invest.



4. Mining reinvented

In this scenario, miners have radically reinvented themselves. They've opened their doors, smartened up their act and renewed trust with the public and regulators. At the same time, a wave of new entrants has led to an explosion of fresh ideas, technologies, techniques, and capital. In this transparent, diverse and highly competitive future, there's no place for the also-rans. Only the best of breed are thriving.

Trusted, transparent and brand-savvy

Imagine a global miner superseding Apple for brand value. Imagine miners are trusted in the same way as leading consumer goods companies.

In this future, miners have done what it takes to build trust by being transparent, listening to stakeholder concerns and acting on them. And they maintain that trust through open and continuous disclosure, supported by advanced technology that minimizes environmental footprints and accelerates rehabilitation. For example, sensors monitor production processes and keep an eye on environmental impact, rehabilitation activities, and

safety practices. Outputs are streamed to the web so any stakeholder or investor can see what's happening live. There are no secrets anymore.

As a result of increased transparency and consumer awareness, miners are far more brand-savvy. Close attention is paid to the 'look' of mining operations, as well as the aesthetic impact. Just as agricultural companies now think about 'paddock to plate', miners consider branding across their entire operation, from exploration to the point of sale. Origin sourcing becomes a critical part of this branding. And along with better branding comes premium pricing.

Capital, competition, and ideas abound

With brand risk under control, mining has become an attractive place to invest, and capital is readily accessible. To attract the right sort of operators, resource-rich countries are under pressure to mitigate sovereign risk and keep fiscal settings stable. Listed miners are on an equal footing with national mining companies.

But the influx of capital also brings new entrants – and new competition. In this scenario, a significant number of the large players are from outside the mining sector. These businesses are adept at applying technology in new ways and extending their dominance across supply chains. Big brand consumer technology companies are taking control of product sourcing to the point of buying and running mines.

Traditional mining companies must compete both among themselves and with new entrants for access to capital, talent, and communities. Only those with the best environmental record, best safety record, best employee record – not to mention appropriate capital return – can prosper.

Technology and innovation play a major role as new entrants force a rapid uptake of new ideas and new ways of working. But it's not just about mining more efficiently: companies are using new and different technology and methods to evaluate ore bodies with superior accuracy before beginning their production plans. Innovation also extends across supply chains and entire business models.

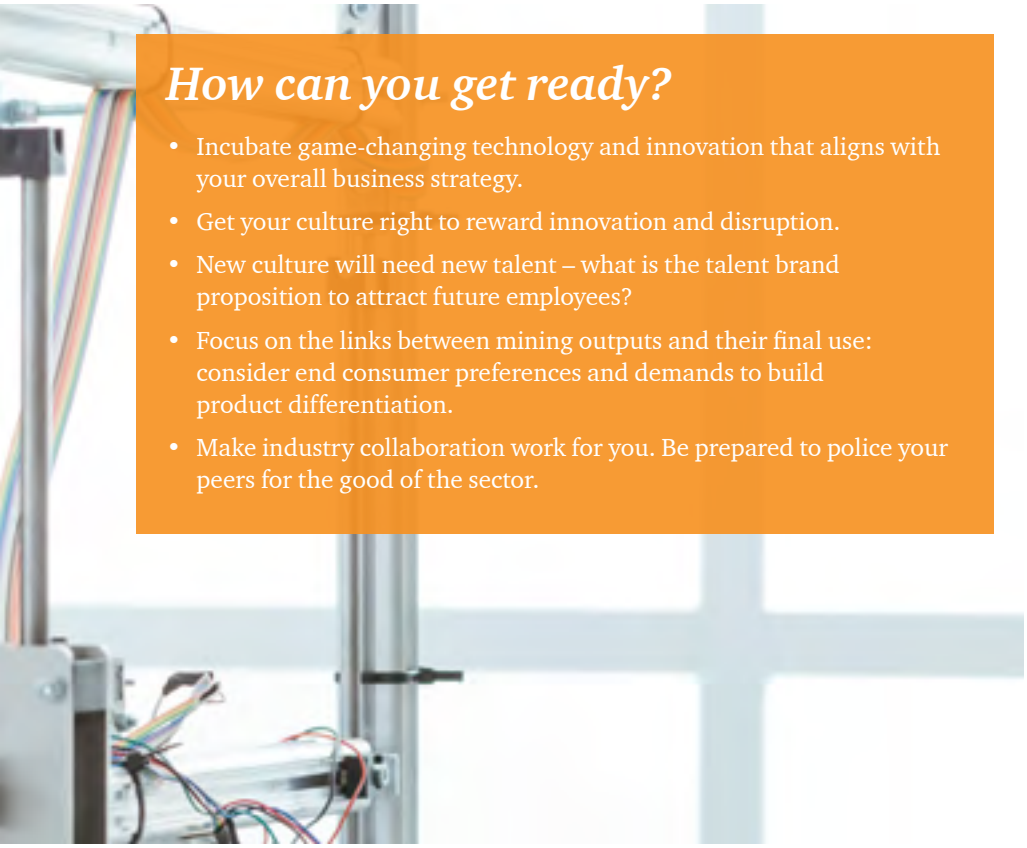
Diversity rules

Increased trust in the sector and the influence of new entrants mean mining is better able to attract and retain a highly diverse workforce. Gender and cultural backgrounds have equal representation at all levels of mining companies, from graduate to CEO.

The greater diversity of thinking has helped improve practices, methods, and techniques to solve long-entrenched problems like water use, land access, environmental impact, safety, and carbon. In this scenario, miners have developed water purification technology at sufficient scale such that water from tailing dams can be used for irrigated agriculture: mining helps to increase global food production and well as serve the globe's need for raw materials.

Peer-to-peer policing

In a future where success depends on trust, the sector has moved beyond self-regulation to peer-to-peer regulation. This means that mining companies look to what their competitors are doing just as actively as they address external expectations. Companies are not afraid to call out bad behavior, as they know this strengthens, rather than diminishes, the reputation of the sector as a whole. Miners that refuse to meet expected standards are expelled from industry associations. With trust established and maintained, stakeholders no longer feel the need to look to special interest groups or NGOs to represent their concerns.



How can you get ready?

- Incubate game-changing technology and innovation that aligns with your overall business strategy.
- Get your culture right to reward innovation and disruption.
- New culture will need new talent – what is the talent brand proposition to attract future employees?
- Focus on the links between mining outputs and their final use: consider end consumer preferences and demands to build product differentiation.
- Make industry collaboration work for you. Be prepared to police your peers for the good of the sector.

Navigating uncertainty

Miners that want to win in the future need to adopt a different mindset to the one dominating the sector today.

Currently, many see their businesses as integrated value chains with strong control over most variables. But what's increasingly apparent – and what the future scenarios show – is that mining exists in a large global ecosystem that goes beyond its own supply chain and beyond the stakeholders and customers that miners deal with on a daily basis.

So what are the key mindset shifts that need to occur?

Becoming a partner of choice

Miners can no longer afford to go it alone. To maximize innovation and growth, they need to be willing to form partnerships with elements of the broader ecosystem. For example, a miner might enter a co-branding alliance with a car manufacturer to supply the raw materials for a vehicle with strong branding on environmental credentials. They might also partner with a digital company to identify and market the car to consumers globally based on the online habits of buyers.

But being a partner of choice is a title earned, not decided. Miners will have to think about what companies might want to work with them and why. And given innovation can lead to a significant competitive advantage, miners will need to face the dilemma of ceding control to partners that may have more power than they do.

Collaborating to protect the mining 'brand'

The entire mining sector has a stake in the reputation of mining. As brand awareness continues to spread along the entire supply chain – accelerated by growing use of social platforms – miners will need to collaborate more to protect the brand. To do so they will need to to emerge from efficient converters of dirt to prominent builders societal capital.

Such collaboration must go further than just a coordinated public relations effort and public policy endeavors. It needs to result in real improvements in technical, commercial, and social outcomes – across the sector and all around the world. This means better safety records, better environmental performance, better community engagement and better labor relations. Companies must be prepared to police their peers, not just themselves, and to call out bad behavior.

Getting more agile

Even though miners have been working hard to become more agile and responsive to change, there's still a long way to go. Technology can become a fundamental success factor. This is a world where "leading practice" not "best practice" is the goal.

Rapid advancements in technology – such as robotics, remote operations, drones, machine learning, and blockchain – mean the innovations

that are cutting edge today might not even exist in five or ten years' time. So how do you build that flexibility into your mine plan and capital plan (as well as your workforce) if you're developing a mine that will run for 20 or more years?

There is a fundamental mismatch between the lifecycle of mining assets and the lifecycle of technologies and digital enablement that is disrupting the sector. This raises important questions about reconciling capital commitments, which may become redundant because of changes in mining techniques, processing, marketing or customer demands.

Modular designs with 'plug and play' components will feature strongly in the mine of the future. A modular approach lends itself to smaller miners who may want to target a particular market, such as premium 'clean' iron ore.

Smaller, shorter-life assets with lower capital costs become more viable. There's also the prospect of reusable plant and equipment that's moved from one ore body to another as the first comes to the end of its life. Think of a mining version of a Floating LNG vessel.

Building a culture for a new world

Intrinsic to the DNA of most mining companies is the tendency to control and manage, where a focus on the task at the expense of people is commonplace, resulting in silos and repetition.

But this deep-seated disposition has to change. To create an organization that is match fit for the future, miners need to build a more constructive and effective culture – one that rewards collaboration and encourages people to work together towards Key Performance Indicators and safety standards.

No-one would suggest it's easy. Forces must be activated simultaneously from multiple directions: top down, bottom up and across the organization to create the kind of momentum that leads to sustainable change.

Authentic, informal leaders can drive the transformation by harnessing positive energy and focusing on a few critical traits and behaviors. Aligning the organization's formal Key Performance Indicators with the new direction will be critical.

Rethinking talent and diversity

One of the biggest mindset shifts that must occur in mining is the one around talent and diversity. Mining has traditionally drawn skills from a narrow pool of engineering and business graduates, and while this has served the sector well to date, it will not deliver what mining needs for the years ahead.

Talent from non-traditional sources can provide the range of skills and thinking that will enable miners to deal with future challenges. In particular, an entrepreneurial mindset and a startup mentality should be nurtured to encourage innovation and growth.

Mining companies must recognize the need to change their talent strategy, open up their culture to welcome it, and then go looking for diverse talent and bring it into the organization.

Let's continue the conversation

For a deeper discussion please contact one of our regional leaders or your local PwC partner:

Global Mining Leadership Team

Global Mining Leader

Jock O'Callaghan, PwC Australia
+61 3 8603 6137 jock.ocallaghan@pwc.com

Argentina

Leo Viglione, PwC Argentina
+54 11 4850 4690 leonardo.viglione@ar.pwc.com

Australia

Chris Dodd, PwC Australia
+61 3 8603 3130 chris.dodd@pwc.com

Brazil

Ronaldo Valino, PwC Brazil
+55 21 3232 6139 ronaldo.valino@br.pwc.com

Canada

Liam Fitzgerald, PwC Canada
+1 416 869 2601 liam.m.fitzgerald@pwc.com

Chile

Colin Becker, PwC Chile
+56 229400689 colin.becker@cl.pwc.com

China

Chong Heng Hon, PwC China
+86 10 6533 2244 chong.heng.hon@cn.pwc.com

India

Kameswara (Kami) Rao, PwC India
+91 (40) 44246688 kameswara.rao@in.pwc.com

Indonesia

Sacha Winzenried, PwC Indonesia
+62 21 5212901 sacha.winzenried@id.pwc.com

Peru

Alfredo Remy, PwC Peru
+51 (1) 211 6500 alfredo.remy@pe.pwc.com

Russia and CIS

Denis Gorin, PwC Russia
+7 (495) 967 6439 denis.gorin@ru.pwc.com

South Africa

Michal Kotze, PwC South Africa
+27 (11) 797 4603 michal.kotze@pwc.com

United Kingdom

Jason Burkitt, PwC United Kingdom
+44 (0) 20 7213 2515 jason.e.burkitt@pwc.com

United States

Jim Moraga, PwC United States
+1 720 931 7457 jim.moraga@pwc.com

Marketing

Jacqui Thurlow, PwC Australia
+61 7 3257 5311 jacqui.thurlow@pwc.com

pwc.com/futureofmining

127047509