



## Transforming mining through technology

**Tom Isobe**, Director, Energy and Natural Resources

**Mark Davies**, Chief Technical Officer, Rio Tinto

**Andrea Culligan**, Climate Agenda Lead Partner, Deloitte, Australia

**Sonia Scarselli**, former VP of BHP Exploration and BHP Xplor

**Nathan Flaman**, CEO, I-ROX

**Fred White**, CCO, DEScycle

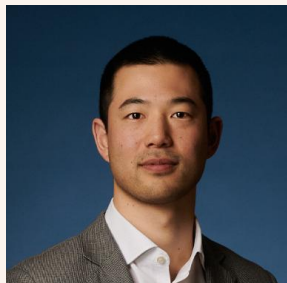
**Luis Canepari**, CIO and Senior Vice President, Newmont Corporation

**Hassan el Bouhali**, CIO, Vale Base Metals

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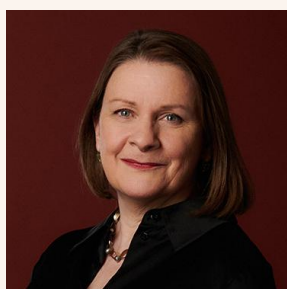


## Authors – Cripps Leadership Advisors



### **Tom Isobe, Director, Energy and Natural Resources,**

Tom sits on our leadership team and heads our energy practice. His global network and access is second to none. He joined us in 2010 after taking a degree in Economics and has come through the firm. He is now well known for his executive work globally in the oil and gas industry. Tom enjoys helping shape the trajectory of a business and making a positive impact. He takes a particular interest in macroeconomics and studies their effect on clients and markets. He has also pioneered our drive into new sectors, geographies and competencies, particularly around decarbonisation and technology.



### **Sarah Sweetman, Head of Advisory Services**

Sarah leads on the wider advisory services that complement and enhance executive search. The team's work helps businesses strengthen their ambitions, capability and impact, and enables people and teams to thrive in new roles and paradigms. She began her career in financial services and retail, before returning to university to study for her Masters in Organisational Psychology. Prior to joining us, she was a director of Europe's first business psychology consultancy and runs her own consultancy business. Sarah has experience across energy, automotive, construction, technology, financial services, local government, pharmaceuticals and advertising.



### **Jana Botha, Advisory Consultant**

Jana is an Organisational Psychologist with a Master's in Business Psychology. Her expertise lies in consulting leaders on strategic decision making to improve organisational performance and enjoys partnering with clients in solidifying and realising their strategic vision, with a strong focus on the scientific integration of psychological assessments.



## Contributors



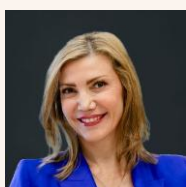
### **Mark Davies, Chief Technology Officer, Rio Tinto**

Mark was appointed to Rio Tinto's Executive Committee in 2020 and became Chief Technical Officer in October 2021. Mark's remit also includes technical centres of excellence as well as the Office of the Chief Scientist, which drives their global research and development activities.



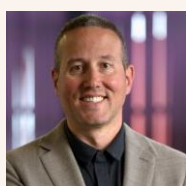
### **Andrea Culligan, Climate Agenda Lead Partner, Deloitte, Australia**

As the Innovation, Ventures and Ecosystems Lead for Climate & Sustainability, and the Global GreenSpace Tech by Deloitte Lead, Andrea manages a team of innovation and venture strategists to create solutions for clients and connecting them with the necessary technology they need to meet their climate ambitions.



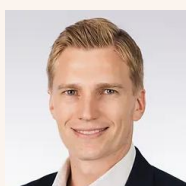
### **Sonia Scarselli, former VP of BHP Exploration and BHP Xplor**

Sonia was appointed VP of BHP's Exploration program in September 2023, in addition to her role as VP of BHP's Xplor program which she was appointed to in June 2022. Sonia started her career at ExxonMobil UK and will be joining Endeavour Mining as EVP Exploration in 2025.



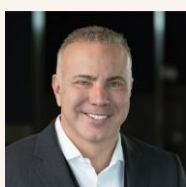
### **Nathan Flaman, CEO, I-ROX**

Nathan joined I-ROX in September 2023 and has 20 years of leadership in mining and energy across four continents. Prior to I-ROX, Nathan was Head of Innovation at BHP having started his career in the nuclear sector and has experience across business strategy, transformation, marketing, investor relations, and corporate development.



### **Fred White, CCO, DEScycle**

Fred is Chief Commercial Officer at DEScycle, a clean technology company that aims to change the way the world produces and recycles metals. Prior to DEScycle, Fred was a Director and Portfolio Manager at Medea, a natural resources focused investment group specialising in investment management and corporate advisory.



### **Luis Canepari, CIO and Senior Vice President, Newmont Corporation**

Luis is Chief Information Officer and Senior Vice President for Newmont Corp. Previously, he occupied the position of Director-Engineering & Construction at The AES Corp. and Principal at Exxon Mobil Corp. He holds an MBA from Georgetown University and an undergraduate degree from Universidad Metropolitana.



### **Hassan el Bouhali, CIO, Vale Base Metals**

Hassan is currently Chief Information Officer at Vale Base Metals and holds 25 years' experience in leadership positions in various industries. Previously, he was Head of Technology & Digital at Mastercard Foundation and has held global CIO/CTO roles at Rio Tinto, Bombardier Recreational Products and Woodbridge Automotive.



## Industry transformation

Emerging technologies are no longer important to the future of mining, they're essential. Tom Isobe, Director of Energy and Natural Resources at Cripps Leadership Advisors, explores companies' shifting attitudes towards transformative technologies and mechanisms to better foster and integrate them into mines of the future.

The future of the mining industry, its workforce and the productivity and sustainability of its operations are intricately linked to its transformation through emerging technologies. For many mining companies, their journey with innovation has been one of ebb and flow over the years. Historically, high commodity prices fuelled innovation and the adoption of new technologies, while in lower parts of the commodity cycle, investments and activities were often reduced.



The way that companies view technology is changing; it's no longer about technology for technology's sake but about using it to pinpoint and troubleshoot specific problems or move the organisation closer towards its strategic objectives."

**Tom Isobe** | Director, Energy and Natural Resources, Cripps Leadership Advisors

Increasingly, technology is seen as a tool that companies can use to position themselves for future critical growth. To investigate this change and its nuances, Cripps Leadership Advisors invited a panel of experts from companies both large and small to share their thoughts.

Mark Davies, Chief Technology Officer at Rio Tinto, kicked off the discussions: "In the past, mining companies developed and experimented with technologies, some of which they then had to find use cases for. But now, they're driving the equation in the opposite direction."



At Rio Tinto, we identify our biggest challenges and how technologies could potentially help to solve them, then make targeted investments and decisions based on the value they could deliver."

**Mark Davies** | Chief Technology Officer, Rio Tinto

Demand for minerals and metals is currently strong and, to meet society's future needs, including those of the energy transition, is likely to continue to increase sharply. For example, the [International Energy Agency](#) states that a net zero scenario would require a 50 percent increase in copper production by 2040, a doubling in the production of nickel, cobalt and rare earth elements (REEs), and a four-fold increase in graphite production.





# Industry transformation

This means that more mines need to be developed and built, and fast. Given reserve scarcity in the context of projected demand, and considerable labor challenges, technology could play a vital role in unlocking complex ores, shifting the cost curve and increasing labor productivity.

Currently, the biggest constraints in project development revolve around societal acceptance. Therefore, technologies that enable mining companies to lower their environmental footprint and social impacts could prove fundamental to their future.

Technology also has an important role to play in operational productivity and profitability. In 2023, as a consequence of falling commodity prices and rising costs, the revenue of the [world's top 40 mining companies dropped by seven percent](#) despite increases in production, and profits shrank too. Artificial intelligence (AI) could help to better manage the inherent cyclicity of commodity prices through data-driven decision-making, enhanced efficiencies and reduced operational downtime.

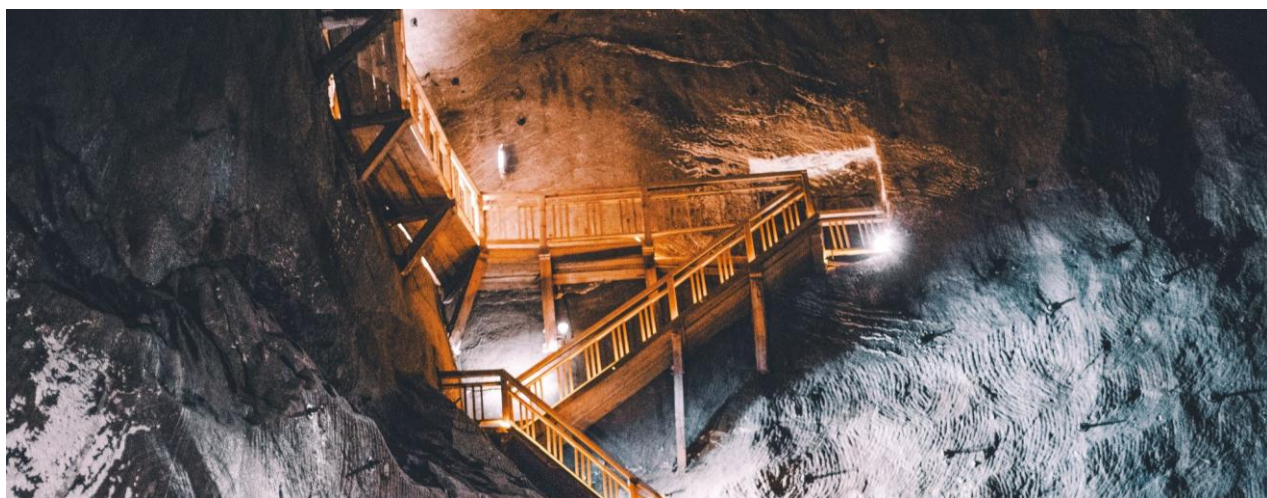
Luis Canepari, Chief Information Officer at Newmont Corporation, said: “Mining, like many industries, has traditionally relied on standard processes and incremental improvements to unlock value. But by leveraging AI and re-examining our data, we can achieve significant advancements and potentially redefine our future operations.”

Safety is another important factor. As miners delve deeper to reach scarce resources and companies search for new mineral deposits, doing so safely is the highest priority. Automation and robotics support both safety and productivity improvements through remote operations, removing people from hazardous environments and increasing precision.



**Technology is critical to the mining industry's future, but to realize its full value – not just financial, but environmental and social too – we need to make implementations more structured and purposeful.”**

**Mark Davies** | Chief Technology Officer, Rio Tinto





# Technologies driving change

The rapid advancement and implementation of new technologies is reshaping every aspect of mining operations today, from exploration and extraction to processing and logistics. Put into some broad categories, these hinge around the following challenges:

- **Electrification and decarbonization:** including new battery chemistries, electric or power-agnostic vehicle platforms, vehicle charging solutions, renewable energy technologies combined with advanced energy storage solutions and more. These technologies have an important part to play in miners' decarbonization strategies, specifically in reducing their scope one emissions.
- **Mineral processing:** these innovations aim to process ores that are more geochemically complex or harder to separate than those of the past, and/or to improve the efficiency of traditional processes. [Rio Tinto's Nuton bioleaching technology](#) which enables the processing of primary copper sulphides, the most abundant copper resources in the world, with a lower carbon footprint than a traditional technology is a good example. [I-ROX's pulsed power comminution technology](#) is another. This uses pulsed power to burst rocks from the inside rather than crushing them from the outside. I-ROX aims to eliminate entire parts of the traditional milling process, cutting both energy and maintenance costs. The solution also increases the amount of metal recovered from ore, thereby delivering increased production volumes at lower cost – a dramatic improvement in productivity.
- **Reprocessing and waste valorization:** including technologies and processes that help to characterize waste streams (both current and historic) and turn them into saleable products. For example, [UK-based DEScycle](#) is creating innovative metal recovery and recycling methods using eco-friendly deep eutectic solvents. These non-toxic, non-water based salts allow for low-temperature, low-energy operations, producing low-carbon, low-impact metals and unlocking the potential for greater e-waste recycling, as well as new pathways for primary metals recovery.
- **Big data, AI and machine learning (ML):** these hold enormous potential to transform every step of the mining value chain. For example, AI and ML are revolutionizing predictive maintenance, resource estimation and operational optimization. Canepari said: "AI and ML enable industries like mining to become more agile and efficient without the need for new technology infrastructure. We have the data; now we can understand and action it faster and more effectively." These technologies also enable more accurate forecasting and data-driven decision-making, significantly improving efficiency and reducing downtime. For instance, generative AI is being deployed to summarize vast amounts of data from technical and government reports, enhancing mineral exploration efforts and identifying new mineral deposits with greater precision.
- **Internet of Things (IoT) and 5G connectivity:** these facilitate real-time data collection and communication across mine sites. Enhanced connectivity supports smarter mines with improved monitoring, control, and decision-making capabilities. The ability to gather and analyze data in real time is crucial for optimizing operations and ensuring safety.
- **Automation and robotics:** including teleremote operated equipment, fleet management software, autonomous haulage systems and advanced process control solutions. These technologies alleviate pressure on operations that are talent and/or resource starved, allowing the workforce to undertake higher level supervisory or problem-solving roles from a safe, comfortable location. They can also drive greater process efficiency and equipment utilization.



## The challenges of innovating in an ecosystem

While some innovations are developed internally by miners, the majority originate from collaborative research and development (R&D) projects within an ecosystem of mining equipment, technology and service (METS) providers, academic institutions and startups.

For these companies, particularly startups and small-medium enterprises (SMEs), the challenge lies not just in developing a new technology, strategy or concept, but progressing it through various technology readiness levels and finding a mining partner to pilot and later prove the technology at scale. Often, innovations stall, not because they're unviable, but because the structures, finance and growth mechanisms needed to sustain the company during the initial stages of this process are not in place.

Fred White, Chief Commercial Officer at DEScycle, explained: "Seed funding from the mining industry is still relatively scarce. For startups, funding themselves to the point where they can showcase a technology to major miners and secure a pilot is hard."

Another challenge is the integration of innovative technologies into production settings without disrupting current processes and workflows. Nathan Flaman, Chief Executive Officer at I-ROX, said: "Fundamentally this boils down to risk appetite. The mining industry is notoriously risk averse, and with good reason. However, this attitude is beginning to shift, particularly in how actively miners are engaging with innovators for things like on-site pilots."

Both White and Flaman noted the importance of relationships and communication in aligning mining companies' innovation objectives and processes with the development of new technologies. Most miners use rigorous stage gating to ensure time and resources are not wasted on projects which have less chance of delivering returns. However, it's very difficult for entrepreneurs and startups with limited staff and resources to 'stage gate' their company growth and technology development in three to six-month increments.

Flaman said: "The appetite of any particular mining company for innovation tends to increase and decrease over relatively short cycles, whereas the timeframes needed to develop and prove transformative technologies are much longer. There's a mismatch there. Also, opportunities to showcase or pilot technologies are often based on individual relationships and can quickly disappear if a key contact leaves the business."



**Finding ways to engage innovators in a more sustainable fashion is something the whole industry could improve upon."**

**Nathan Flaman** | Chief Executive Officer, I-ROX



## Supporting and scaling innovation



To address these challenges, many major and mid-tier mining companies are introducing a range of models, including corporate venture capital (CVC) arms, innovation incubators and acceleration programs, and using open innovation or crowdsourcing platforms to better engage startups and SMEs.

These vehicles are designed to amplify the voices of mining companies surrounding problems to be solved and extend their search capabilities outside of the mining and metals space. Some also provide innovators with a leg-up in technology commercialization through access to funding, coaching, subject matter expertise and networking. This two-way value proposition has proven to be a standout feature of the most successful ventures today.

[BHP's Xplor](#) global accelerator program is one of the best-known examples. This leverages a partnership model to help early-stage mineral explorers fast-track and de-risk their geological concepts and prepare for investment.

Sonia Scarselli, former Vice President of BHP Exploration and BHP Xplor, and incoming Executive VP of Exploration at Endeavour Mining, explained: "Xplor is a true acceleration program because it provides cohort companies with funding, network connections and technical and operating capabilities to develop their concepts that they might not otherwise have the budget or scale to access.

"For instance, we had one cohort member company that developed a new AI tool for mineral exploration but lacked the data to train it and verify their results. We were able to provide that, and the team saw remarkable results – the error on their predictions was less than 2 percent. In return, the BHP team gained exposure and understanding of a potentially very important technology."

Rio Tinto also uses a range of options to engage startups. In 2021, [it established a dedicated venture capital fund](#) which is currently invested in 10-20 companies. One of its first investments was in a startup called [Aymium](#) whose Metallurgical Carbon product can immediately replace coal and coke in steelmaking with no capital modifications. The companies have since formed a joint venture and are establishing a facility at a former paper and pulp mill in Québec, Canada, to feed Rio Tinto's titanium business with biocarbon rather than anthracite.

Davies added: "There are lots of things that tier one miners can do internally in terms of processes and systems to help speed the commercialization of innovative technologies. But startups have a culture of innovation and are built to move quickly, so outsourcing innovation to them through investments and partnerships can help us to move faster too."





## Moving from company to industry problems

Scarselli pointed out that elevating the mining innovation agenda and its acceleration provisions from 'company-level' to 'industry-level' problems is another growing priority.



Tackling industry problems effectively requires consortiums of majors rather than the efforts of individual companies," she said. "This has been done very successfully in other natural resource sectors but is still relatively new to mining."

**Sonia Scarselli** | former VP of BHP Exploration and BHP Xplor

Decarbonization is a prime example of where this approach is beginning to add value. The mining and metals industry contributes [approximately eight percent of the global carbon footprint](#). Ninety percent of these emissions originate from the manufacturing of iron and steel, and the decarbonization of these processes transcends the capabilities of individual companies. In February 2024, [BHP, Rio Tinto and BlueScope Steel](#) announced a collaboration to pilot Australia's first electric-smelting furnace which would significantly cut emissions from steel production.

Innovation accelerators are also emerging in this space. For instance, in January 2023, Deloitte Global launched [GreenSpace Tech](#), a platform that addresses the inefficiencies in identifying, selecting, and implementing emerging decarbonization technologies for all industries.

Andrea Culligan, Climate Agenda Lead Partner for Deloitte Australia, and one of the Founders of GreenSpace Tech by Deloitte, explained: "For mining companies, this process was taking too long, delaying their transition to more sustainable practices. Companies were evaluating each of their operational systems, seeking to understand what technologies were available, where they were located, their technology readiness levels, who was investing in them and how they could or should collaborate."

GreenSpace Tech uses an AI-driven platform to scan the global landscape for emerging technologies and trends relevant to each industry. These insights are then combined with those from GreenSpace Tech's global research and intelligence team and its global ecosystem team to connect mining companies with the partners they need to achieve their sustainability goals at pace.



## New technology requires new roles and skills

Given their critical role in the mining industry's future, the integration of emerging technologies into production settings is at the forefront of strategic planning for leaders today. This challenge includes identifying suitable assets for pilots and creating strategies that allow the scaling of successful technologies into flagship assets, thus avoiding their rejection in favor of 'business as usual'.

Hassan el Bouhali, Chief Information Officer at Vale Base Metals, commented: "To realize the full value of digital technologies, mining companies need to move away from 'performative digitalization' which often delivers sub-optimal solutions. To overcome this, organizations must step back, unbundle their existing processes end-to-end and re-bundle their workflows with automation and AI at the forefront. This approach will provide orders of magnitude more efficiency and value from investments in digital technologies."

He added that digital technologies should be treated as a thread that runs through the company value chain, streamlining it and increasing efficiency through automation and robotics.

"The perception that IT is a back-end function rather than a core asset is an odd perspective that is, unfortunately and surprisingly, still a common belief in the mining industry," he said. "I'm confident that the industry will soon catch up with other sectors in this regard."

Another important piece of the puzzle is the way in which technological implementations are optimized for integration with the workforce. To harness the full potential of transformative technologies, new functions, skills, and roles are required and not all of these are taught through mainstream mining educational pathways. For instance, some of the most prominent new roles include data scientists and analysts, automation and robotics engineers, cybersecurity experts, sustainability and environmental specialists and remote operations center (ROC) managers.

With the support of IoT enabled technologies, many of these roles can now be carried out remotely, increasing the geographical, as well as cultural and skills diversity of potential candidates.



**Looking ahead, these technology themes will continue to evolve, and the workforce will need to continuously adapt and upskill to keep pace with technological advancements. The future of mining will require a blend of both mining-specific skills and more lateral, cross-functional skills."**

**Andrea Culligan** | Climate Agenda Lead Partner, Deloitte Australia

She added that while technical expertise such as geology, geotechnical, engineering and metallurgy will remain critical, skills such as digital and data literacy, technical integration, sustainability management, change management, collaboration and critical thinking will soon be just as important. This combination will enable the industry to navigate the complexities of modern operations, sustainability goals and technological advancements.

El Bouhali agreed: "There's no such thing as a non-tech job anymore," he said. "Traditional mining roles, such as mining and process engineers and metallurgy researchers, all need to embed data and analytics into their everyday work. These roles will need to lead with data and algorithms and complement their tasks with the unique human creativity and experience they bring to the table. Universities are adjusting their program's content and curriculum to this reality, but companies are lagging when it comes to updating their organizational structures and job descriptions to reflect this new reality."



# The importance of change management

Change management is another critical consideration, as implementing new technologies can disrupt existing workflows and require significant cultural shifts within organizations. Effective change management strategies ensure a smooth transition and minimize resistance from employees. Additionally, automation and robotics may lead to job displacement for certain roles, posing a challenge for workers whose tasks become automated. However, this also creates opportunities for upskilling workers to take on new, higher-value roles that require advanced technical skills.

"Context is important when considering how and where to deploy autonomy," explained Davies. "For example, we use autonomous mining fleets in areas such as Western Australia where there's a labor shortage. In contrast, in places like West Africa and Mongolia where lots of people are looking for jobs, our fleets will likely be manually operated. It's more responsible for us to create jobs and provide skilling opportunities in those regions and our ability to do so could influence our social license to operate."

White added: "Often with innovative technologies, there's great buy in from senior level executives who can see the bigger picture and the benefits they will bring to the organization, but when it comes to implementation at the operational level, the focus is usually on whether a technology can solve one specific problem and how much it costs."

He stressed that getting operators involved in technological assessments and pilots as early as possible and helping them to see how the change could benefit them personally and professionally could help to overcome this acceptance hurdle.

For example, emerging technologies significantly enhance worker safety by automating hazardous tasks, reducing the risk of accidents and improving worker safety. They also drive efficiency and productivity, leading to cost savings and increased profitability. Furthermore, technologies such as digital twins and renewable energy solutions support sustainable practices, helping companies meet their environmental goals and regulatory requirements – a factor that's increasingly important to younger generations when selecting employers. Ultimately, by embracing these technologies and offering opportunities to upskill workers, the industry can create a more skilled, efficient, and sustainable workforce.

Davies agreed: "It doesn't matter how good a technology is, if mining companies don't show the teams who are impacted by its implementation the wider benefits and include them in the journey, then they will continue to do things the way they've always done."



Storytelling surrounding the value that emerging technologies can bring to mining, not just externally to investors and stakeholders, but internally too with the workforce, is central to realizing their full value."

**Mark Davies** | Chief Technology Officer, Rio Tinto



## Science to support transformation

People are naturally resistant to change, particularly changes that they don't fully understand or haven't encountered before, so taking the time to educate the workforce, familiarize them with the technology and how it could affect their roles over time is an aspect that should not be rushed. The importance of leadership being aligned on the transformation process and having a clear communication strategy so that unified messages are proliferated throughout the business cannot be understated.

Sarah Sweetman, Head of Advisory Services at Cripps Leadership Advisors, joined the conversation: “For mining leaders, changes to long-standing business models, structures and processes to accommodate transformative technologies will likely push them outside of their own comfort zones.



The fact that many leaders come from technical backgrounds themselves, means they have a unique understanding of traditional roles and skillsets and can help provide clarity, direction and a feeling of safety for the people below them during the transformation period.”

**Sarah Sweetman** | Head of Advisory Services, Cripps Leadership Advisors

Focus groups which bring together leaders with staff from every level of the organization to share their experiences with new technologies and ideas to improve the implementation and integration process can be valuable in this respect. Having leaders spend time onsite with workers in production environments can also enrich their perspectives and help them to design better upskilling or reskilling strategies.

Jana Botha, Advisory Consultant at Cripps Leadership Advisory, explained that an understanding of behavioral science, whether developed internally or accessed via third-party consultants, can be useful in creating implementation and skilling strategies that ‘meet people where they’re at’ and in redesigning mining roles to better harness emerging technologies.

“In addition to developing the people that mining companies currently have to realize the full potential of emerging technologies, there’s also an opportunity to become more strategic in recruiting new talent,” she said. “Prioritizing people who have the requisite skillsets, even if they come from different industries or backgrounds, could be hugely beneficial to organizations. Many mining companies shy away from this currently and select people who have mining-specific experience, but in being brave, there’s a chance to expand the scope and depth of talent to which companies have access.”





# Creating safer, smarter more sustainable mines

It's clear that emerging technologies will redefine the landscape of the mining and metals industry over the next decade. For executives, staying ahead of technological trends and creating effective models to bring forth new innovations and ensure their integration into operations is not just about maintaining competitiveness; it's about ensuring the long-term viability and resilience of their businesses.

When undertaken strategically and with systematic consideration for people, processes and technology, a virtuous circle can be created whereby the adoption of emerging technologies and the sustainability, productivity and safety advantages they generate help change perceptions of the mining industry. This could, in turn, increase people's desire to work within the sector, driving an influx of skilled, more diverse talent who could accelerate the development and adoption of further technologies. In this way, companies can create the smart, safe, sustainable mines of the future.



To thrive in a world demanding improvements in productivity as well as environmental and social performance, mining companies must embrace emerging technologies like AI and ML as core technologies. These tools will soon be as essential to our infrastructure as the drills and trucks that extract ore.”

**Luis Canepari** | CIO and Senior Vice President, Newmont Corporation

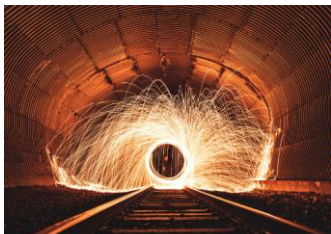
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