

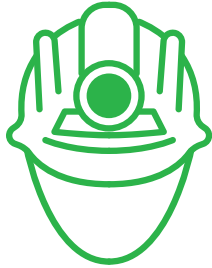
Future of mining with wearables:
Harnessing the hype to improve safety



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Introduction



As declining ore reserves push mines to greater depths and increasingly remote locations, new technologies are being developed to cut costs, decrease risk, and drive productivity; throwing automated machines and people increasingly into the mix. Wearables—clothing, gear and other accessories incorporating computer and advanced electronic equipment—are one set of emerging solutions driving productivity, but are also critical in ensuring mining executives are equipped to address Health, Safety and Environmental (HS&E) challenges.

For successful implementation, leaders need to understand the benefits to the business, the impact on stakeholders, along with potential challenges to implementation and plan to adjust accordingly. As leaders continue to shift from being reactive in their HS&E strategy to adopting more proactive and predictive approaches, wearables are becoming key enablers for the mining industry in addressing major HS&E challenges, including:

- **Environmental monitoring**—where remote sensing technologies help frontline workers anticipate and companies respond to risks of overheating
- **Focus on workers' health**—where biometric devices provide real-time alerts of overworked (i.e., highly stressed) operators who are at risk of injury or causing accidents
- **Training with new technology adoption**—where real-time virtual and augmented reality training applications are accelerating skills and knowledge development, especially in the context of increased use of mobile equipments and higher risk of collisions
- **Incident rates at new or exploratory mine sites**—where data tracking and communication technologies are driving overall response capability

This latest instalment of NORCAT and Deloitte series on innovation in mining¹ extends the idea of (re)designing mining operations with the workforce user in mind; by focusing on how wearable technologies are advancing worker safety, productivity and well-being, as well as understanding where the industry is trending. Successfully shaping an integrated health and safety strategy while driving behaviour change requires addressing some key questions, including:

- **What are the impacts of wearable technologies to the frontline workers?**
- **Are the proposed health and safety benefits practical and attainable during day-to-day operations?**

- **How should mining companies engage with stakeholders (i.e., unions, frontline workers, executives) through the implementation process to mitigate possible risks related to worker privacy and security?**
- **What challenges are mining companies facing when implementing wearable technologies and what steps should mining companies undertake to scale new products?**

The wearable revolution

Deloitte
Wearables

Wearables are clothing and accessories that incorporate computer and advanced electronic technologies. Both of the following technology classifications are already helping mining companies to benefit workers and operations:



Passive tracking

Where data for the worker and/or the environment is collected and stored periodically or at certain points within the asset



Active tracking

Worker and/or environment data is collected continuously to generate insights and readily access the insights remotely

Some examples of the different categories of wearables include:



Personnel tracking

Use of proximity sensors (e.g., RFID tags) to locate frontline workers on site



Augmented reality and virtual reality

Displays on eyewear to show essential safety and maintenance data (e.g., equipment data, alerts, procedure checklists) or other relevant insights to support site operations



Environment monitoring

Sensors and detectors to track key metrics (e.g., oxygen, heat and hazardous gas levels) and high-definition cameras to record procedures and provide instructions in real time when necessary (e.g., conducting maintenance deep underground)



Biometric monitoring

Devices containing sensors worn by the workforce to capture information about the employees' health condition (e.g., heart rate, concentration and fatigue levels, repetitive biometric movements, load weights)

Wearing it well



Wearables are driving productivity, and pilots in mining are showing an improvement in operational safety and overall employee well-being.

But issues remain, and companies face many of the challenges common to approaching the implementation of any new technology, including:

- **Being on-point regarding privacy**
Lack of data privacy for both workers on site and the mining industry
- **Driving leadership buy-in**
Leadership stalling the implementation of wearables within existing operations
- **Developing workplace culture and adoption**
Workplace culture and lack of engagement with frontline workers and external stakeholders (e.g., unions)

- **Designing for the human interface**

Wearables designed to gather data, but not with the user or worker in mind

- **Connecting to the technical infrastructure**

Availability of reliable technical infrastructure, including strong connectivity

The good news is that the mining industry is attempting to solve some of these challenges through iterative and collaborative approaches that simultaneously break down barriers to adoption and focus on understanding the end-users' needs. In an effort to better understand the main drivers behind the adoption of wearables,

and ultimately build on that trend to optimize their implementation, Deloitte recently teamed up with NORCAT to conduct a series of interviews with wearable technology companies affiliated with NORCAT, leaders from key mining industry companies and unions. The result is an emerging picture to provide mining executives with a better understanding of how to engage mining leaders, frontline workers and external stakeholders to successfully drive the implementation and adoption of wearable technologies.

Being on-point regarding privacy

One key area of focus in driving the successful adoption of wearables involves recognizing frontline workers' concerns about the technology. Here, mining technology companies have been working hard to solve a number of issues surrounding the capture and use of biometric data, including ensuring confidential data gathered by wearables is secure, understanding whom the data is shared with, and recognizing the need for a common policy to govern data collection.

Unions, often take the perspective that, contrary to monitoring the environment, wearables do monitor the worker—including management monitoring confidential health data that a frontline worker may not be comfortable sharing.

– United Steelworkers

Jannatec Technologies, for example, is one company helping to improve worker safety and productivity by developing wearable technologies, including using proximity detection. To address possible concerns about data sharing, **Jannatec Technologies** introduced a dedicated processor on the wearable to not only analyze the raw data collected and issue alerts to supervisors if the worker is in danger, but protect confidential employee information so that only occasional and/or sporadic key insights from that piece of technology is shared. This helped mitigate the identification of the user which otherwise would have resulted had continuous raw signals been used. This also reduced

strain on the network infrastructure by limiting the volume of data shared. For their part, **M3SH Technology**, a health and safety electronic equipment manufacturer in Fredericton, New Brunswick developed a configurable helmet that monitors ambient conditions within a mine, as well as workers' vitals. To prevent the user from being identified, **M3SH Technology** assigns a number to each wearable, meaning the wearable can be used by multiple workers across the mine site without identifying the individuals. As a result, insights generated identify the helmet only, and privacy is further protected by configuring the units to turn off when workers enter certain areas of the mine (e.g., washrooms).

With wearables it is of great importance to put safeguards in place so that the data collected is not misused by mining companies or workers.

– M3SH Technology

Driving leadership buy-in

A common challenge in technology implementations is leadership slowing down the process by seeking full-blown solutions, while also following conservative protocols for IT/ERP implementation. Depending on the type of implementation (i.e., pilot, scale), however, technology companies are finding that leadership buy-in is often enhanced when an agile approach to technology implementation is adopted. **K4 Integration**, a wearables technology company in Sudbury, Ontario recently deployed a basic system very quickly by taking advantage of the passive nature of their wearable technology to implement product in compartmentalized areas—from

the vehicle to the frontline operator. By adopting an agile methodology, **K4 Integration** was able to show successful results to leadership iteratively, which better aligned with operational needs while also keeping development costs low.

During their pilot project, **M3SH Technology** engaged different levels of leadership in order to gain an understanding of the key concerns across the organization (e.g., managers concerned about production levels; HS&E leaders concerned about exposure to toxic gases). This allowed them to improve their smart helmet and to include the correct environmental and vital sensors. The result was a full-service product tailored to the needs of workers, managers and mining leadership.

Occupational health and safety is everyone's responsibility, it is an integral part of all aspects of production and operations. The improvement of health and safety performance is a long-term goal that requires sustained effort, resources and commitment across the organization.

– M3SH Technology

Developing workplace culture and adoption

A common view held by frontline workers is that wearables are intrusive, lack clear benefits at best and at worst, undermine workers' rights, while shifting the relationship between employee and employer².

Often engaged after the decision to implement a wearable has been made, unions and the workers they represent can come away feeling their concerns are irrelevant. Some union representatives would feel more at ease if mining corporations consulted with the local Occupational Health and Safety groups about the implementation of wearables.

- United Steelworkers

Depending on the type of users and their demography (e.g., age, type of job), though, mining companies are adopting different methods to encourage adoption. In one case, **K4 Integration** developed an education and marketing campaign to drive wearable technologies adoption, using social media channels, brochures and printed documents to show frontline workers the benefits they would personally feel during their day-to-day activities.

Management often wants all the technology at the same time (i.e., voice, video and location), rather than doing it one step at a time.

- K4 Integration

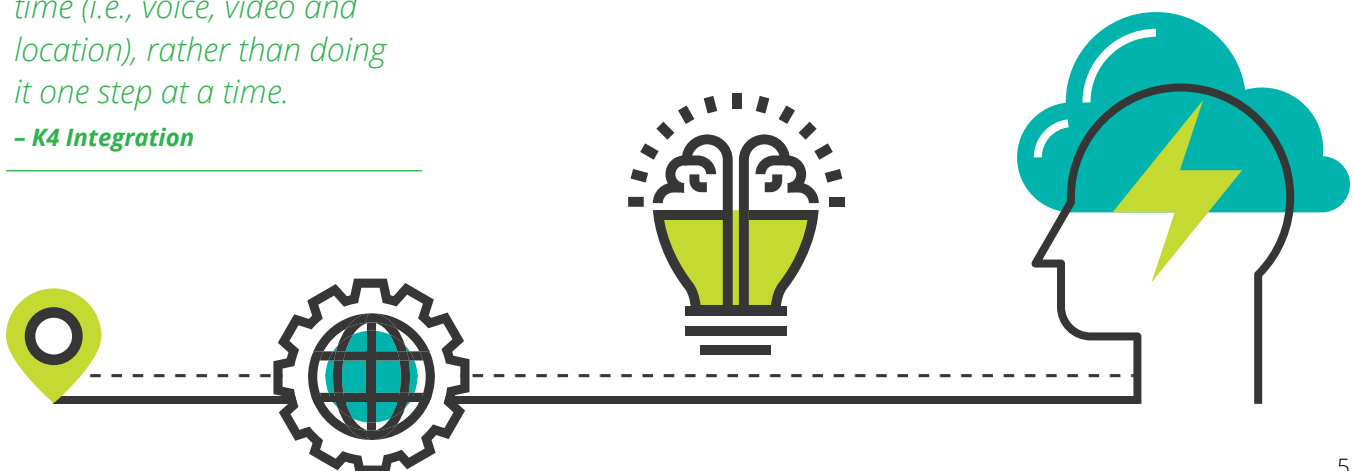
Targeting different age groups, **Jannatec Technologies** plans a dual approach involving beta trials—where the wearable will be provided free of charge to early adopters and users who are uncertain of its benefits—and then marketing efforts aimed at driving consistent messaging about the products' benefits while also encouraging workers to try it out. Feedback from the trials will be incorporated into further product development to remove negative perceptions of the technology, while social media campaigns successful amongst younger workers will be augmented with traditional printed documents and flyers.

The most valuable and precious resource we have in a mine is the time and attention of the people running the operations. Each new technology, such as wearables, needs to integrate into and improve their everyday roles, and ideally should free up more of their time rather than consume this limited resource.

- Steve Walsh, Consulting Energy and Resources Lead

Designing for the human interface

Aimed primarily at gathering data as opposed to meeting end-user needs, wearables are often seen by frontline workers as bulky and an unnecessary add-on to existing encumbrances of everyday gear. New approaches by companies, however, are helping frontline workers adopt wearables. During prototype testing of **M3SH Technology's** mining wearable, feedback received from deep mine frontline workers resulted in ergonomic and functional improvements. **M3SH Technology** was able to reduce the overall device weight significantly and added specific functionality to support workers in hazardous environments. Another approach has been **K4 Integration's** integrating RFID tags into hard hats specific to each worker. This means the small strip of RFID tag attached to each hard hat is automatically tagged to a specific worker without the need for additional data infrastructure—an innovation that streamlines data processing costs and maintenance by focusing on passive tracking only, and where data is processed within those locations, thereby affording leaders and managers real-time information about a mine's operations and worker states.



Digitally enabled wearables are aimed at pro-active health and safety combined with keeping workers connected—these are not mutually exclusive. Companies will gather a significant amount of data for analysis and application. Acceptance of the wearable by the frontline users—employees are paramount and it is consequently an imperative that the design and change management process builds a clear understanding in the mind of end users that the wearable technology benefits the user in first instance.

**- Ben-Schoeman Geldenhuys,
Toronto Mining Leader**

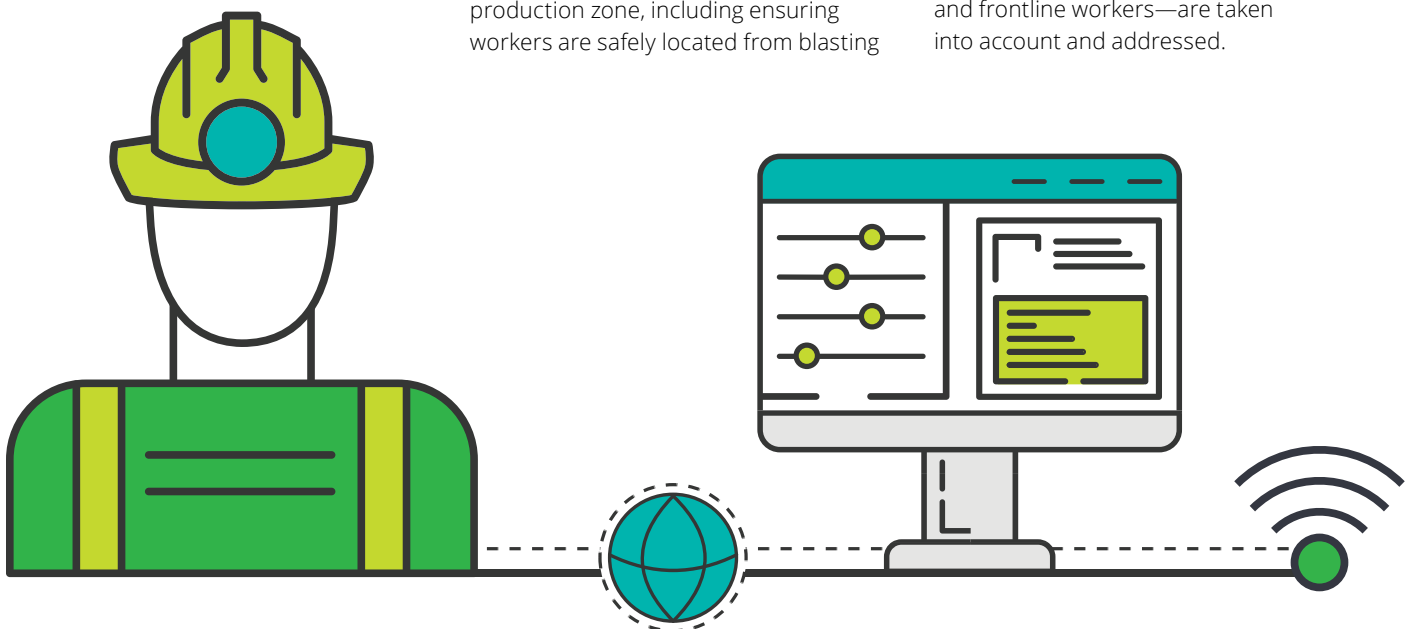
Connecting to the technical infrastructure

It is also abundantly clear that successful implementation of wearables in mining requires reliable technical infrastructure, including strong network connectivity to ensure that—where appropriate and secure—data can generate actionable insights in real time. Indeed, as mining corporations start focusing on a full-scale implementation, many are working to adapt the infrastructure back end to accommodate and enhance both passive and active wearables. This was the case of **Jannatec Technologies** in implementing its technology across multiple mine sites, and where the company is continuing to interface with mine infrastructure to support the collection of data for process improvements—affording mass generation and transfer of insights that will enable companies to develop a holistic view of their workers' health in real-time. At the same time, **K4 Integration** has found that while their RFID tags can trigger local alerts about basic worker safety, generation of insights is ideally conducted in a central location as opposed to on the product—affording better insights into where workers are located within the production zone, including ensuring workers are safely located from blasting

zones. However, it does require a large amount of physical infrastructure for this data processing to occur.

The mining industry is learning quickly that, as with any technology, applications and devices with the potential to make operations safer, more productive and sustainable also bring fundamental issues to the forefront—such as worker privacy and data integrity, to integration with existing systems and organizational culture in ways that solve problems and align with stakeholder expectations.

The potential of wearable technologies is clear, and the mining industry is making significant positive strides in their adoption. But mining companies also need a clear methodology to overcome the complexities of wearable technology implementation. This requires approaches that are both systematic in nature and ultimately flexible in how they respond to the rapid evolution in the technology environment. What mining companies need is a robust framework for thinking through their wearable implementations such that the needs of multiple stakeholders—including mining executives, unions and frontline workers—are taken into account and addressed.



A structured approach



Structuring one's thinking around the pilot, implementation and scaling stages is critical to an organization's success in deploying any technology, including wearables.

Simply put, a thorough implementation and scaling strategy drives focus and alignment across the organization, enabling leaders to better engage relevant stakeholders, ensuring both commitment and increased transparency.

Leveraging Deloitte's methodology for designing and scaling new products, and based on interviews conducted as part of our recent research with NORCAT, the Design2Scale framework helps leaders as they think through their initiatives, whether an initial pilot project, a full-on implementation or scaling phase.

Answering the core questions of the framework will ensure that stakeholders' concerns and expectation are addressed by adopting a collaborative approach.

1. Thinking about strategy

Preparing for pilot and/or implementation when dealing with evolving technology requires a step-by-step approach that considers not only how wearables address existing HS&E concerns, but where they align with mining industry's objectives in general, how they integrate seamlessly into operations, and what key factors will enable mining companies to embrace the impacts of the technology going forward.

As mining operations become more complex, the implementation of wearables could become more prevalent due to increasingly strenuous working conditions and difficulty in excavating the ore.

2. Collaborating with stakeholders

Building trust with employees and overcoming lack of transparency in data collection demands approaches that leverage communication that is timely and focused on issues, while engaging workers in ways that respect diversity; this approach also creates the conditions for union and worker feedback to reflect stakeholder interests and promote better working environments.

There needs to be one dedicated resource, trusted by both workers and unions, who can ensure their feedback and concerns are heard early on and used to sustain the wearables' deployment.

3. Focusing on the product

Driving adoption means paying singular attention to how the technology best complements workers' needs, functionalities and overall well-being. Understanding the trajectory of a technology in terms of its maturity and stability—especially its potential for scaling and adoption across the organization iteratively—are key to bringing maximum benefits to workers and the business.

To increase adoption rates, the wearables need to be iterated to make sure they are non intrusive, fits with the body and becomes part of everyday gear (e.g., miners have a lot of wrist movements, so a watch will not work).

4. Building technical capabilities

Deploying a technology implementation capable of supporting field applications and devices, while also driving insight and data security capabilities requires deep IT and data infrastructure expertise that few companies retain in-house. Yet, integrating IT systems from different parts of the mine into one platform is critical for analyzing wearables data and improving operational safety and productivity.

Mining companies need to integrate IT systems from different parts of the mine into one platform to derive insights from data collected by wearables and improve the safety and productivity of the entire asset.

Design2Scale: Driving implementation and adoption of wearables within organizations

 <p>Strategy Develop a vision for wearables that aligns with the overall HS&E strategy</p>	 <p>Stakeholders Develop a plan to involve and manage internal as well as external stakeholders</p>	 <p>Product Decide on the type(s) of wearable features which will bring maximum benefits to the worker and the organization</p>	 <p>Capabilities Develop the infrastructure and physical support required for this wearables</p>
<p>Goals and aspirations How can wearables help in achieving current HS&E goals and fit into the future vision in the most impactful manner?</p>	<p>Communication When and how do we pre-emptively engage with internal (e.g., most impacted roles and jobs) and external stakeholders (i.e., unions and operators) to ensure their concerns are met?</p>	<p>Data privacy and product adoption Which features most impact adoption and how do we mitigate the negative perception of personal data collection?</p>	<p>Internal capabilities What internal capabilities do we need to support wearables and derive relevant insights from aggregated data (e.g., dashboard, real-time analytics, talent, IT and information security infrastructure)?</p>
<p>Key operations How can we implement wearables while minimizing disruptions to mine operations and measuring their performance?</p>	<p>User needs What are the skills necessary for a successful workforce in the future and what features and characteristics should we look for in wearable technologies that will complement or augment those skills?</p>	<p>Encouraging adoption How are we communicating the benefits wearables bring to the operators' lives everyday while incorporating feedback to improve features users find to be intrusive?</p>	<p>IT and data infrastructure Which technologies (e.g., Wi-Fi, radio, Bluetooth) and databases are required for successful implementation across different types of mines (i.e., open pit, underground)?</p>
<p>Deployment and scaling approach How do we iterate the deployment approach to easily adopt new technology innovation and to account for constant changes in operations when scaling wearables across the organization?</p>	<p>Leader and feedback Who is managing the transparency of the wearable to sustain the product's adoption? How are we continuously capturing and integrating stakeholder feedback to improve the product?</p>	<p>Innovation How mature is the wearable technology and does it have potential for incremental innovation to increase the adoption rate across the organization (e.g., ability to include cheaper technology)?</p>	<p>IT support and cybersecurity What data infrastructure and cybersecurity capabilities are required to implement wearables company-wide and to protect the information captured by wearables?</p>

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A technology for the times



With deeper mines and strenuous working conditions increasingly becoming the norm; productivity, employee well-being and safety are critical priorities for the future of mining. Wearable technologies are one part of the equation, but, as with any new technology there will be a transition period where the product will be slow to show tangible results. As we have heard from the mining industry, complicating factors will also be brought to the forefront, including issues around data privacy, human interface, and overall trust in leadership when deploying wearables.

Embracing the full potential of wearables requires mining leaders to think through questions that will arise during pilot, implementation and scaling phases. Deloitte's research, interviews, and global insights have shaped some of these key questions in a framework that will generate value for leaders as they start to think about deploying wearables. This multifaceted framework—across strategy, stakeholders, product and capabilities—will guide mining executives when investing in wearable technologies to benefit mining operations and reduce safety incidents in a sustained manner.

Contact Information

To discover some of the best of these approaches to wearables implementation, or to discuss which steps you should undertake as part of your wearables journey, contact us today:

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About Deloitte/NORCAT partnership

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NORCAT is the only non profit regional innovation centre in the world that has an operating mine designed to enable start ups, small and medium enterprises, and international companies to develop, test, and showcase new and innovative technologies in an operating mine environment. This unique facility anchors one of the world's leading advanced manufacturing and mining technology clusters and represents a "one stop shop" to see future technologies and innovations that are poised to transform the global mining industry.

NORCAT's Underground Centre has been working with mining companies to understand the urgent need for training—for both new and existing workers—on the efficient, productive, and safe use of new technologies.

To accomplish this, over the past 20 years NORCAT has worked with clients, government, academic institutions, and partners to develop an array of integrated training and development programs to serve multiple sectors both in Canada and around the world.

As part of their strategic partnership, Deloitte and NORCAT are taking steps to help the global mining industry better understand emerging mining technology and innovation trends. Their goal is to combine on the ground insight gained from companies that have installed emerging technologies at the NORCAT Underground Centre with the market knowledge of the Deloitte global mining team.

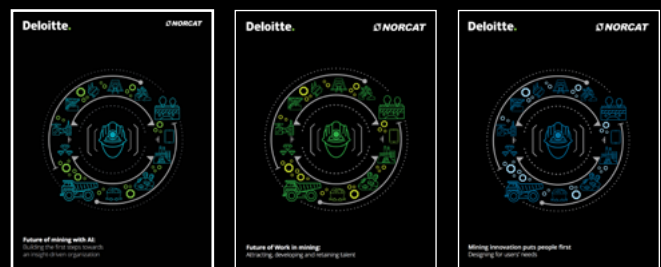
Special thanks

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Publication series

Other articles Deloitte has developed in collaboration with NORCAT, focus on how the mining industry is:

- How the mining industry is adopting a "Human Centred Design" approach to mining innovation
- How the "Future of Work" in mining will affect both front-line employees and leadership, and
- How organizations can take the first steps towards a "Future of Mining with AI"



All publications can be found on the webpage "Deloitte and NORCAT—Collaborating to explore the future of mining" at www.deloitte.ca.

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