The digital revolution
Mining starts to reinvent the future
February 2017
Success for mining companies is not about adopting the latest applications or technology solutions, these will continue to develop and evolve. They must instead embed digital thinking into the heart of their business strategy and practices in order to completely transform the way corporate decisions are made across the enterprise.

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The disruption of business models through the advancement of digital technology has been a reality for other industries for many years. Digital is now impacting the mining industry. Technology has advanced such that the barriers of high cost of entry, and a very physical value chain are no longer protection against large scale disruption.

By bringing together our understanding of shareholder value, mining operations, technology and analytics, we have developed an approach to the "digital mine" which helps mining organisations make the most of the digital opportunity and avoid the many potential pitfalls that come with the adoption of new technologies.

Our recent "Innovation in mining" studies examined current perspectives on mining innovation around the world. Among the 31 mining companies involved in the Australian study, most agreed that successfully navigating the industry’s mounting challenges and ensuring the long term sustainability of the sector requires moving beyond the status quo – doing things differently by embracing innovation.1

Building upon this innovation theme to focus on digital, we explore:
- Why digital is now a reality for mining
- What the future might look like and what is possible
- How mining organisations can take steps to protect themselves from disruption and falling behind the industry or new entrants, while also protecting against poor investments or failure, through:
  - Developing a digital strategy and proactively managing digital transformation
  - Automating operations and digitising assets
  - Building a "digital mine nerve centre" for data-driven planning, control and decision-making
  - Implementing supporting platforms and enablers
  - Leading a diverse, distributed and connected workforce.

Digital is now impacting the mining industry. Technology has advanced such that the barriers of high cost of entry, and a very physical value chain are no longer protection against large scale disruption.
Digital disruption has been changing businesses and operating models, reshaping competitive differentiators and in some cases, completely altering the entire fabric of an industry.

For example, 10 years have passed since the launch of the first full touchscreen smartphone. This single innovation is now regarded as a pivotal game changer – having fundamentally changed the way people communicate, consume information, and enabling the creation of entirely new billion-dollar businesses such as Uber.

While the biggest impact has been in consumer-facing industries, there are growing examples of digital transformation in asset-intensive industries such as advanced manufacturing and natural resources. As industries become more data intensive, disruptive technologies are increasingly taking a digital form.

The potential for digital capabilities to create value by reducing waste is massive:

- Eradicating execution waste by reducing process variability
- Eliminating process waste by enhancing decision making
- Reducing structural waste by automating processes and improving systems
- Removing design waste by using digital technologies in the design of new assets

Beyond these cost and productivity benefits (typically targeted at 10-20% improvement), the digital revolution represents a terrific opportunity to forge much closer relationships with stakeholders, facilitate knowledge sharing and training, drive new revenue streams, provide access to new markets and most importantly, make day-to-day operations safer for employees.

Why should the mining sector pay attention?

For miners, the commodity cycle, cost and productivity pressure means that in many cases the easily attainable savings have gone. As such, innovation is needed to deliver the next wave of improvements.

An opportunity for mining organisations to reduce waste and create value

Digital disruption is changing the face of the mining industry, offering a chance to transform operations and create value. Here’s how:

- **Reduce Execution Waste**: By improving process variability
- **Eliminate Process Waste**: By enhancing decision-making processes
- **Reduce Structural Waste**: By automating processes and improving systems
- **Remove Design Waste**: By integrating digital technologies into asset design

Beyond cost and productivity benefits, the digital revolution presents opportunities for closer stakeholder relationships, knowledge sharing, new revenue streams, market access, and most importantly, enhancing employee safety in day-to-day operations.
What will the future digital mine look like?

The question for business leaders is how to turn potential benefits into reality. Success for mining companies is not about adopting the latest applications or technology solutions, these will continue to develop and evolve. They must instead embed digital thinking into the heart of their business strategy and practices in order to completely transform the way corporate decisions are made across the enterprise.

To “begin with the end in mind”, we have envisaged the future state digital mining organisation and how this might transform the core mining processes, the flow of information, and supporting back-office processes. This vision of the future state is not based on theoretical concepts or unproven technologies – it is based on capabilities which exist now and are already being applied within energy and resources businesses, but no organisation is yet doing it all in an integrated way.

To effectively lead in a digital mining environment, leaders needs to be adept at understanding and driving this change, using data insights to support effective and rapid decision making, and leading a more distributed workforce with fewer people based ‘on site’.

As the location of work becomes more flexible, this enables a more diverse workforce to become involved in what traditionally would have been considered core mining, which also requires new skills and new practices for effective leadership and management.

“I think the industry has not really embraced what digitisation and technology can do. And I think that is the next piece we have to get our mind around and where you should expect to see a quantum change in how we do things.”

Graham Kerr, South32

“Harnessing the potential of digital technology will unlock value across our business, helping us grow our free cash flow per share. In so doing, we will make ourselves into a leading twenty-first century company—enhancing productivity and efficiency at our mines, and improving decision-making and performance across every area of our business.”

John L. Thornton,
Barrick Gold Corporation

Businessweek, 13 September 2016
Core mining processes – automating physical operations and digitising assets

The core operational processes in the future mining value chain will be highly automated, a wide range of digital capabilities will be deployed.

Autonomous vehicles will improve safety, productivity, and reduce cost (through fuel and maintenance savings). Drones will be used for data collection, inspection, stock control, condition and safety monitoring. 3D printing of critical spare parts will reduce lead times and inventory holding cost. Wearable technologies will be used for field maintenance and real-time machine inspection instructions, improving operator-based care and safety.

A connected network of low cost, highly capable sensors using Internet of Things (IoT) technology will capture data in real time, to enable integrated planning, control and decision support.

A “digital twin” is a digital model of the physical environment constructed using geological, engineering and asset information such as ore body models, engineering drawings, parts catalogues and service manuals. Data from sensors and location-aware mobile devices can then continuously improve the ‘digital twin’, as an accurate reflection of the physical environment. This begins by implementing standardisation of data formats to allow ongoing interaction between systems across the mining value chain.

Digital in action

Rio Tinto’s Mine of the Future® program centres upon driving production while improving health, safety and environment performance through greater automation. Rio Tinto has the largest fleet of autonomous trucks in the Pilbara, and is widely recognised as a leading innovator and as one of the lowest cost producers of iron ore in the world. Earlier this month, Rio’s driverless train program made its first complete journey without driver assistance, although there was a driver on board to take over if things went awry. Quoted recently, Rio’s CEO Jean-Sébastien Jacques said he took a ride on one of the driverless trains in the Pilbara in September. “It is working very well; we just have to ramp up the very fast and structured way.”

Globally, 69% of mining companies are looking at remote operation and monitoring centres, 29% at robotics and 27% at unmanned drones.

Remote operations, combined with all of the above, will result in fewer people in hands-on operational roles, which will improve productivity, safety, and reduce overall cost.

Digital in action

A Canadian synthetic oil producer’s existing solutions for management of asset information were not delivering value to the business. The data managed within the existing systems was often difficult to find, incomplete or viewed as untrustworthy. Clean-up efforts were met with limited long-term success due to lack of data integrity controls, validation and enforcement within the systems.

To address these issues, the company developed asset and enterprise information management strategies, and selected and implemented a new engineering information platform. The next generation template solution for management of asset information has been developed and proven at scale through pilot implementation at a major facility, built on principles of supportability, maintainability and minimal customisation.

Consistency of information management at the pilot facility has improved through enhanced business processes supporting creation, update and usage of asset information. Data quality has also been enhanced, and leading edge information management tools which enforce information quality at source have been deployed.

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The digital mine nerve centre – data-driven planning, control, and decision making

The direct benefits of automation and digitisation in execution will be significant, and even greater value realised when the data is used to plan, optimise and integrate the activity across the value chain.

To fully leverage the automation of core operations, companies will need to rethink the way in which they generate and process information, and utilise data-driven analytics techniques to optimise their complex systems all the way from pit to customer.

The information layer or “nerve centre” of a digital mine will bring together data across the mining value chain in multiple time-horizons, to improve planning, control and decision-making, in order to optimise time-horizons, to improve planning, control and integrated technology in one of its underground mines. Through an initiative called “Taking the Lid Off”, £ it exhibited the way in which a myriad of communication and location technologies, as well as software systems, can combine to create an intelligent mine management system, including features such as real-time production management, tracking and monitoring.

Central to enabling this will be an integrated and well governed data platform to support analysis across all time horizons, and a centre of excellence in data management, reporting and analytics, which employs specialist data scientists and analysts.

Real time data derived from processing equipment and machinery sensors during operation will enable short interval control to identify key drivers of process variability, and drive rapid and focused operational improvements.

More timely data from across the value chain will also enable one-body models, mine plans, and financial models to be updated more frequently, and shorten the planning cycles.

Reporting and analysis of historical data will enable insight from trends, patterns and opportunities for improvement learned from experience. Future insight will be derived from historical analysis to improve planning, simulate the integrated supply chain, and predict future outcomes. Increasing use of analytics and artificial intelligence (AI) tools will support knowledge workers.

**Digital in action**

Dundee Precious Metals - a Canadian-based international mining company has combined innovative thinking and integrated technology in one of its underground mines. Through an initiative called “Taking the Lid Off”, £ it exhibited the way in which a myriad of communication and location technologies, as well as software systems, can combine to create an intelligent mine management system, including features such as real-time production management, tracking and monitoring.

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**Digital in action**

A major global miner was seeking opportunities to identify latent system potential across their pit, rail and port network.

Data-driven analysis generated over two million scenarios to identify significant unrealised value in the system and tested each of them against operational reporting data to measure the feasibility of the proposed changes (i.e. based on historical performance, the analysis determined if it was possible to process, move, or operate in each scenario). This determined the most achievable scenario with the greatest potential increase in value.

The analysis highlighted that higher production and greater shareholder return could be achieved by adjusting traditional assumptions in the mine and system planning. All of this within a system which was previously considered as “at maximum capacity”.

This rapid scenario based analysis is now being used to augment planning decisions on an ongoing basis.
A diverse, distributed and connected workforce will expect an enhanced user experience consistent with the home consumer experience.
The convergence of IT and OT has been an increasing conversation point within the mining industry in recent years, and we are now seeing many of the large global miners evolving towards organisational alignment – to remove the historical separation between IT and OT environments – in search of lower operating costs and more efficient teams. Effectively delivering IT/OT convergence is as much a people, culture and change management challenge as it is a technology project.

**Digital in action**

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**Digital in action**

BHP launches online freight platform to sink shipping costs

*Reuters, 26 January 2017*

“BHP Billiton has launched an online system under which shippers compete to offer the best price to haul cargoes of commodities such as iron ore and copper to the mining giant’s customers. BHP this week allocated its first cargo using the auction-style platform, which it hopes will save money as it bypasses brokers who traditionally help negotiate vessel hire rates between cargo owners and shippers. Such platforms could potentially overhaul the way miners contract freight services, reducing their costs at a time when commodity markets appear to be picking up following years of low prices.”
How can mining companies achieve true digital transformation?

A measured and agile approach

Although it can seem daunting to execute on an effective digital strategy, embracing the digital future should not be a make-or-break proposition. Agility will be key, and will likely be a buzzword, but it must be combined with ruthless discipline in driving and demanding value from digital initiatives. This means that strategies that fail are quickly shelved, while strategies that deliver can be rolled out in phases.

A holistic organisational perspective will also be necessary: To leverage the power of digital transformation, miners cannot afford to get caught up in the widgets and toys. Instead, they need to embed digital thinking, processes and structures into their entire organisation in an effort to take corporate decision-making to the next level.

To thrive in the digital future, mining organisations should approach digital transformation by considering the following five areas of focus:

1. Developing a digital strategy and managing digital transformation
2. Automating operations and digitising assets
3. Delivering the “digital mine nerve centre” for data-driven planning, control, and decision making
4. Implementing supporting platforms and enablers
5. Leading a diverse, distributed and connected workforce.
The digital revolution | How can mining companies achieve true digital transformation?

We consider the typical challenges faced by mining organisations, and suggested approaches:

### #1 Developing a digital strategy and managing digital transformation

Rather than spawning disconnected initiatives, digital strategy has to be motivated from the enterprise level and clearly define the value of digital initiatives to the organisation as a whole.

Digital initiatives are often focused on the technical solution and are not always driven by a well-articulated vision and strategy, nor a direct link to business value. Digital transformation should begin with an understanding of the desired future state, and the value to be created.

A key challenge in this new digital era is the ability to deliver change at the pace that achieves short-term results (within existing constraints) while maintaining flexibility to enable longer term transformation. New approaches can be tested in a pilot or sandbox environment, rolled out in phases, or easily shelved.

Another key challenge is the large number of vendors offering products and platforms to provide solutions for many digital opportunities, but no single vendor has a complete solution for the entire future digital mine - organisations will need to be able to manage an ecosystem of providers, which will evolve over time.

### #2 Automating operations and digitising assets

From our experience with major mining organisations in programs such as autonomous haulage and remote operations, we understand the benefits and key considerations for successful implementation. In this context, collaboration is critical as companies will need to operate in an ecosystem of providers and partners, and will also need strong program management and integration capabilities.

A key question is how many mining organisations have really delivered in the promise of remote operations centres to challenge and change their operations, including taking advantage of a global skillset (most operations centres are still single product/single country focused).

Most asset-intensive organisations face challenges with management of engineering and asset information throughout the asset lifecycle, including data integrity issues and time wasted looking for documents. An initial step towards the creation of a “digital twin” should be an assessment of engineering data management (EDM) capabilities and maturity, to highlight the gaps and focus digitisation efforts on the areas of greatest value and impact.

### #3 Delivering the digital mine nerve centre

To deliver on the digital mine nerve centre, companies must establish a capability to use data to resolve a wide range of business problems. In essence, intelligent business decisions will ultimately hinge on access to timely and relevant information, in all time horizons.

Most organisations only use a fraction of the data they are already collecting, let alone the potential real-time volume that could be captured via IoT, and many are still struggling with limited business intelligence capability from historical ERP environments and non-integrated operational systems.

Skills and experience in data science and analytics are in demand and scarce. Establishing the capability for an insight-driven organisation requires developing and embedding data science and analytic skills across the organisation, as well as the foundational data platforms and analytic tools.

### #4 Implementing supporting platforms and enablers

Today, many roads to digital transformation are blocked by core systems such as ERP, which are often expensive to run and maintain, and inflexible for future changes. Upgrading core systems to cloud-based applications and platforms can deliver total cost of ownership (TCO) benefits (typically in the range of 20-40%) and improved user experience, as the capability of these solutions, and the associated “as a service” business models, have matured.

Around the edges of core systems there are typically many manual processes and spreadsheets. Complementary to core system changes, RPA can replace some tasks currently performed by humans, presenting an opportunity for cost reduction in support processes and shared services. Mining companies should embark on proof of concept and pilot implementations to test the potential benefits and gain experience in a rapidly growing domain.

### #5 Leading a diverse, distributed and connected workforce

As the digital mine becomes a reality, our interpretation of what work is and how it gets done is constantly changing. The future of work needs to consider the impact of human machine interaction on future work, workforce, and workplace. The future workforce will demand and expect an improved user experience, based on their experience as consumers.

74% of global business executives surveyed by Forrester state that they have a digital strategy, but only 15% believe they have the necessary capabilities and skills to execute that strategy.

The digital mine is an organisation transformation, it requires a new approach to leadership, a culture which embraces data-led decision making and diversity, a new way of operating and diverse and different skills and capabilities. This is no easy task for mining companies, which will increasingly find themselves competing for scarce digital talent. To succeed, companies must bring in these new skills whilst also supporting their current high talent pipeline to successfully make the transition.

### Digital in action | Deloitte Enterprise Value Map for Mining

#### INNOVATION STRATEGY AND BUSINESS DESIGN

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### Executives serious about reaping the benefits of the digital future must consequently ask some hard questions:

- Can current incumbents make this transition?
- How can they train for new skills and capabilities?
- How can they foster a supporting and inclusive culture?

74% of global business executives surveyed by Forrester state that they have a digital strategy, but only 15% believe they have the necessary capabilities and skills to execute that strategy.
The time to act is now

Digital disruption is absolutely a reality for the mining sector. What we’re seeing is that “the mining industry is going through one of the most intense periods of change we have ever seen, and the ability to innovate – to evolve, adapt, and improve – is indispensable.”

With the technological landscape rapidly evolving, there’s no time to waste. It’s clear that “organisations, big or small, that are not able to adapt to this new era of automation are likely to struggle. Although their workforces may have scale, brawn or deep technical skills, they are unlikely to be able to compete against the might of the machines or organisations with a workforce with more adaptable skills.”

References


Authors

Steven Walsh
Partner | National Consulting Lead, Energy & Resources
D: +61 8 9365 7097
M: +61 418 613 302
swalsh@deloitte.com.au

Paul Klein
Partner | Technology, Strategy and Architecture
D: +61 8 9365 7060
M: +61 419 013 405
paulklein@deloitte.com.au

George Simpson
Director | Technology, Strategy and Architecture
D: +61 8 9365 7048
M: +61 416 025 717
georgesimpson@deloitte.com.au

Andrew Swart
Partner | Global Mining Consulting Lead
D: +1 416 813 2335
aswart@deloitte.ca

Nicki Ivory
Partner | National Mining Leader
D: +61 8 9365 7132
M: +61 422 024 597
nivory@deloitte.com.au

Julie Harrison
Partner | Human Capital
D: +61 8 9365 7061
M: +61 404 820 005
juharrison@deloitte.com.au

For more information please contact a Deloitte mining professional:
Global contacts

Global Leader, Mining
Phil Hopwood
+1 416 601 6063
pjhopwood@deloitte.ca

Africa
Andrew Lane
+27 11 517-4221
alan@deloitte.co.za

Africa
Tony Zoghby
+27 11 806 5130
tzoghby@deloitte.co.za

Cathy Gibson
+27 11 806 5386
cgbison@deloitte.co.za

Americas
Glenn Ives
+1 416 874 3506
gives@deloitte.ca

Argentina
Edith Alvarez
+54 11 4320 2791
edalvarez@deloitte.com

Argentina
Alejandro Jaceniuk
+54 11 4320 2700 ext. 4923
qaceniu@deloitte.com

Australia
Juliet Bourke
+61 2 9322 7379
jbourke@deloitte.com.au

Brazil
Eduardo Tavares Raffaini
+55 21 9881 0538
eraffaini@deloitte.com

Canada
Philip Hopwood
+1 416 601 6063
pjhopwood@deloitte.ca

Canada
Andrew Swart
+1 416 813 2335
aswart@deloitte.ca

Canada
Ben-Schoeman Geldenhuys
+1 416 775 7573
bgeldenhuys@deloitte.ca

Chile
Christian Duran
+56 22 729 8286
chrduran@deloitte.com

China
Michael Liu
+86 10 8520 7813
jlliu@deloitte.com.cn

Colombia
Julio Berrocal
+57 5 360 8306
jberrocal@deloitte.com

France
Damien Jacquart
+33 1 55 61 64 89
djacquart@deloitte.fr

India
Kalpana Jain
+91 11 4602 1406
kjain@deloitte.com

Mexico
Cesar Garza
+52 871 7474401 x4401
cgarza@deloittemx.com

Peru
Karla Velasquez
+51 1 211 8559
kvelasquez@deloitte.com

Poland
Tomasz Konik
+48 32 603 03 35
tkonik@deloitteCE.com

Russia
Igor Tokarev
+7 95 787 0600 x 8241
tokarev@deloitte.ru

Southeast Asia
Rick Carr
+65 623 27138
RickCarr@deloitte.com

Turkey
Uygar Yörük
+90 312 295 4700
uyoruk@deloitte.com

United Arab Emirates
Salam Awawdeh
+971 4 376 8888
SAAwawdeh@deloitte.com

United Kingdom
Tim Biggs
+44 20 7303 2366
tbiggs@deloitte.co.uk

United Kingdom
James Ferguson
+44 20 7007 0642
jferguson@deloitte.co.uk

United Kingdom
John Woods
+44 20 7007 5992
jwoods@deloitte.co.uk

United States
Sandeep Verma
+1 214 840 7182
sxverma@deloitte.com

United States
Amy Winsor
+1 303 312 4156
awinsor@deloitte.com

United States
Kara Bresnahan
+1 212 436 7448
kBresnahan@deloitte.com

Switzerland
David Quinlin
+41 58 279 6158
dquinlin@deloitte.ch