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# Improving productivity from market to mine

**Paul Mitchell**  
Global Mining &  
Metals Advisory  
Leader

The finding of our last productivity paper was that mining companies need to reduce the integration gap in their organizations to achieve the next level of productivity gains. This requires an integrated end-to-end approach across the value chain. We couldn't understand why miners were not focusing more on this area and so we undertook interviews with global executives and senior mine managers to get a better view on this. Our conclusion based on these interviews and our understanding of the broader issue is that there are two key steps that can significantly reduce the integration gap:

1. Adopting an end-to-end process model approach to the business
2. Adopting digital strategies to reduce variability in the organization, enhance an end-to-end approach and improve decision-making

To be successful, both steps need to be supported with strong leadership and cultural change.


## The issue

During the super cycle, productivity fell to its lowest rate in more than 30 years, with the sector focusing on production at any cost because of an unprecedented boom in commodity prices. As a result, productivity has been the No. 1 operational risk for mining companies for the past three years, as referenced in both our business risks papers and our productivity insights series.<sup>1</sup> Many of the executives we interviewed observed a decline in productivity levels as their operations expanded, primarily due to the challenge of managing complexity, compounded by the talent challenge, and lack of appropriate skills development.

“We always want to get bigger and grow to the point where we've got maximum economies of scale. I think it's fair to say that a number of operations have gone beyond the point of economies of scale to what I call 'diseconomies of scale.'”

**Note:** All quotes are from survey participants.

1. Refer to EY's website [ey.com/mining](http://ey.com/mining) to access these reports.



While mines were scaled up to maximize production, mine managers were not provided with the tools or training to manage this increased complexity. The scale of these larger mines and the related complexity resulted in an increased pressure on the functional departments to manage these burgeoning workforces. The executives who were interviewed had many anecdotes about the lack of communication between the functional departments and how a silo mentality has crept into the management of mining companies. We called this gap “the integration gap.”

### **The integration gap fascinated us – what was the size of the impact on productivity?**

Research studies suggest that the integration gap in the mining sector can create a productivity loss of about 10%-20%.<sup>2</sup> Our view is that it could be even higher.

There has been significant progress in short-term cost reduction and a greater focus on cash in the sector to combat falling prices, for example, working capital improvements. Attention has also been turned to improving labor productivity, and this too has been successful. However, data indicates that asset productivity has barely changed over this time, and this appears to be the hardest area for the mining sector to increase productivity. We, therefore, looked at how the leading industries, such as manufacturing, have gone about solving this issue.

“I think we’re at the end of a period in which incremental improvements were the answer. What we’re finding now is diminishing returns, or even deteriorating return, in trying to incrementally improve mining from an operational cost-cutting perspective.”

To help us better understand the unique sector challenges in reducing the integration gap, we had conversations with senior mine managers and industry executives in association with the researchers at the Sustainable Minerals Institute, the Australian Institute of Business and Economics at the University of Queensland, and the Norman B. Keevil Institute of Mining Engineering at the University of British Columbia. Our participants recognized that a great deal of value was being destroyed as a result of the silos that had crept into the sector during the commodity boom, and that something needs to be done to close the integration gap.

In this paper, we look at the findings from these conversations and focus on process model integration.

I would like to thank all of the participants for their open and candid insights.

<sup>2</sup>. “Understanding mine to mill,” *CRC ORE*, 17 July 2013.



## How do you close the gap?

We believe that closing the integration gap requires miners to adopt more of a manufacturing mindset. Often the reaction to this is that mining is “not a factory” because there is far more variability than a factory environment. Our participants agree.

“Factories, where you can build a shed around something and you can control the inside of that shed, are almost deterministic. By deterministic, I mean you can write the equations, you can design the engineering, and you can run them that way. Mines are not like that. There’s too much randomness in there.”

Factors such as weather, ore body knowledge, work conditions and quality of people all impact variability. Clearly as you go further upstream, there is more and more variability, more and more uncertainty, and less and less information, and hence decision-making becomes more complex. We don’t have a silver bullet to remove variability. But we believe that it is possible to reduce it to a more manageable level and improve long-term productivity.

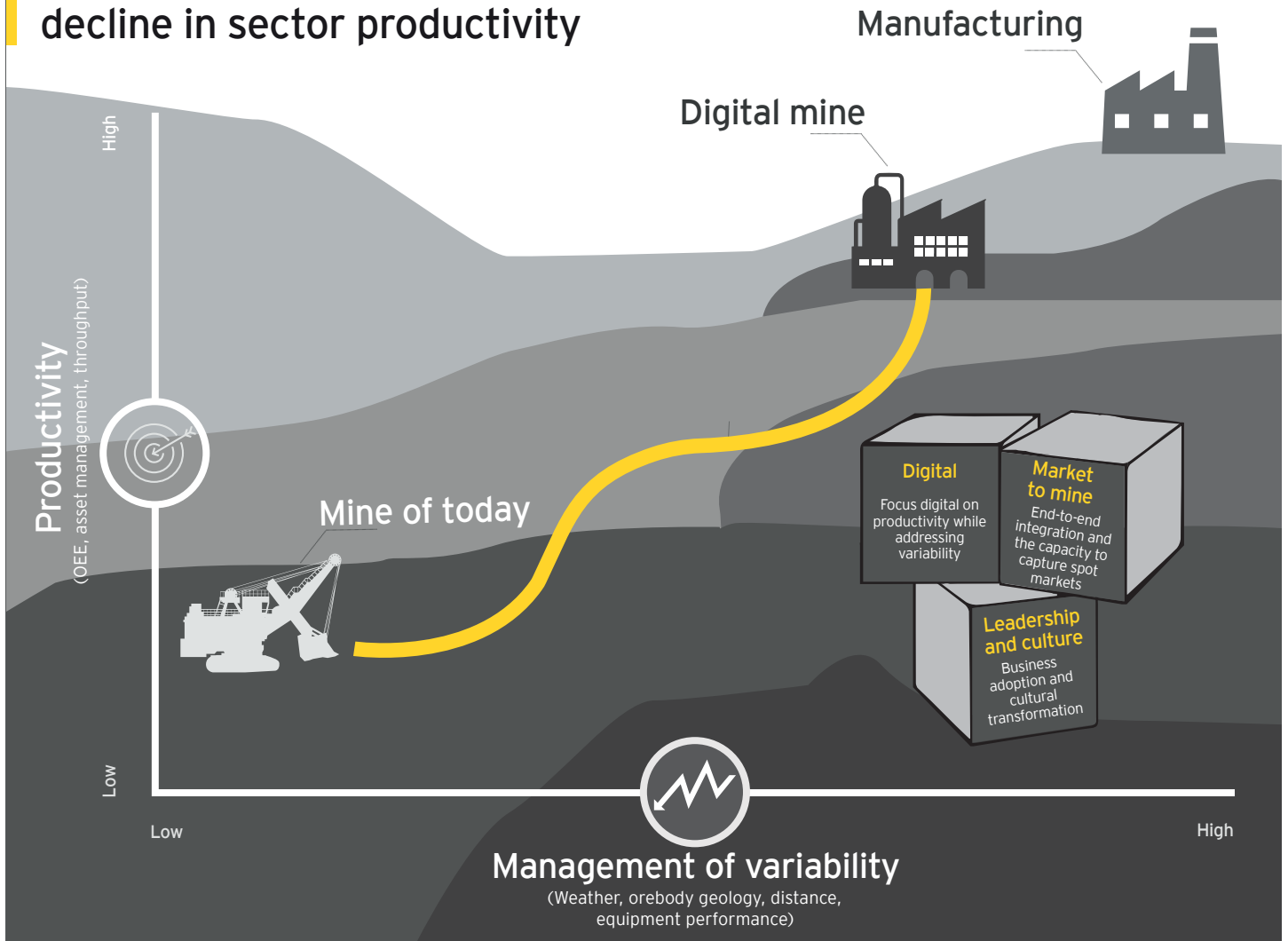
Our view is that two approaches are needed to help reduce variability and close the integration gap:

- ▶ Adopting an integrated process model approach to the business
- ▶ Embracing and implementing a digital transformation

To achieve success in either of these and to make sure that any implemented approaches are sustainable, a focused leadership and cultural change are required.

We believe that a focus on these two areas will enable miners to adopt a manufacturing mindset and focus on elimination of loss to enhance productivity and create value. In this way, mining companies can move along the path toward what we have termed “digital mine” as depicted in the following diagram.

# Transformational approaches to address the decline in sector productivity



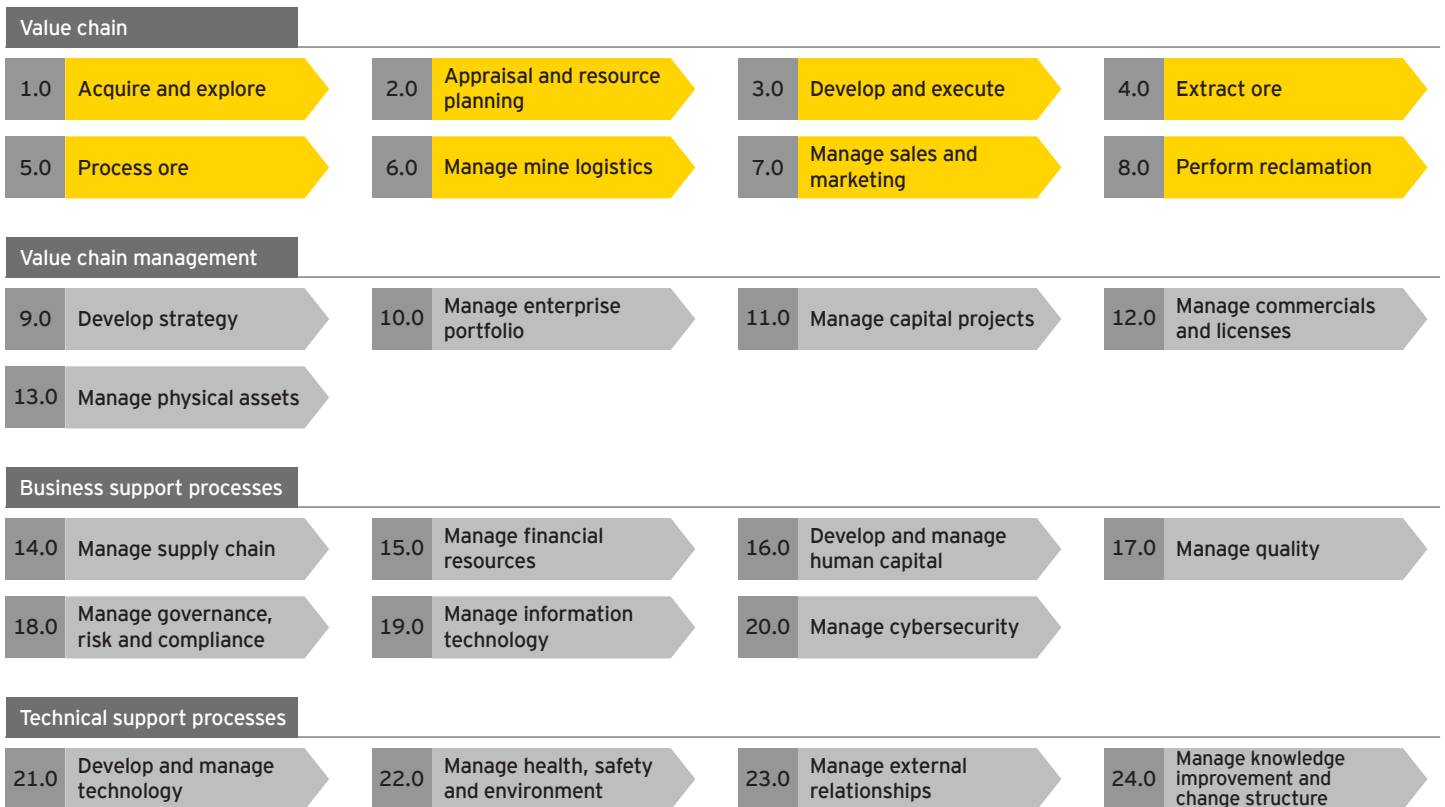
Process models enable you to be more agile, and with this, the management of variability becomes simpler. A process model is an enabler, which can be implemented either independently or with technology.

“Miners make excuses, and the fact is that it’s a hole in the ground. Let’s not make it any more difficult. It’s a simple process. If you think it’s difficult and complex, it’s probably going to be difficult and complex, but the whole intent is to make this process simple. It’s to take complexity out. It’s to minimize and simplify things and clarify things for people. Now, the best way you can do that is to plan the work or work the plan. It’s coming back to task assignments, coming back to detail.”

# What is a process model approach?

A process model is an element of an operating model informing the business on who is performing the processes, how to measure the performance of each process, what the potential risks are and how they can be mitigated and controlled. It is also adopting a focus on end-to-end excellence (simplicity, standardization, sharing, etc.).

Process models are end-to-end, independent of organizational boundaries and cut across different organizational functions to deliver the desired outcome. For example, the procurement and finance functions have core processes to deliver efficiently and effectively, with handover or interfacing points with other processes. In a truly end-to-end process view – where scenarios are built for completeness – procurement, inventory, logistics, financial management, materials planning, maintenance planning and other related activities are all embedded in a supply chain functional process as shown below.

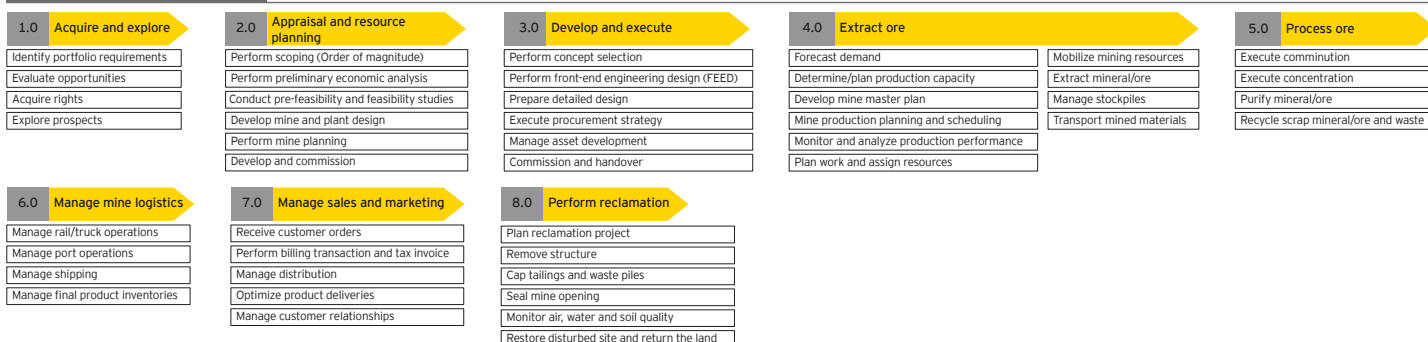


Within a process-led organization, the process model links the business processes, performance metrics, practices and people skills to a unified, clear and unambiguous process-led structure. There is clear ownership so that someone is focused on maintaining and improving processes. These processes are well-documented and standardized across the business, along with roles and responsibilities, process measures and benchmarks, etc.

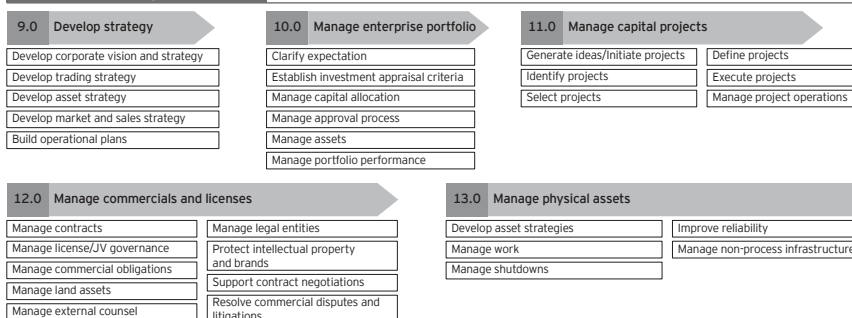
From a mining sector perspective, it is important to note that the process model is based on the end-to-end processes, from resource to sold product at the first or second level, and not on commodity or geography. In this way, each element of the business, from the resource in the ground to the product being delivered to the client, is optimized as a business system. The diagram below shows an example of the EY PRIME model with level 1 and level 2 processes visible (for base metals).

## PRIME model (Levels 1 - 2)

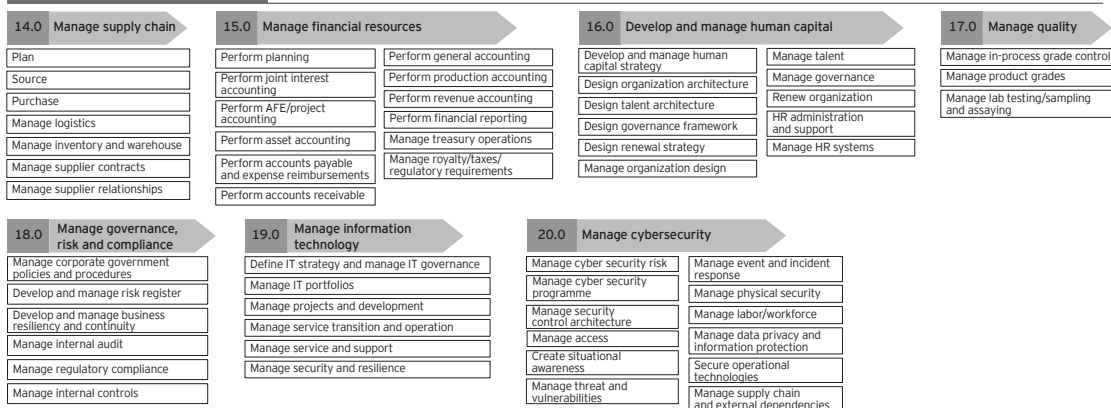
### Value chain



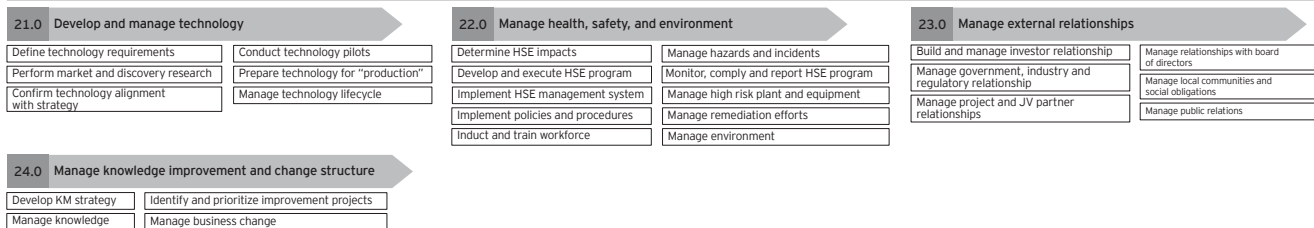
### Value chain management



### Business support processes



### Technical support processes



# What are the benefits of a process-led structure?

Process models are very effective in improving current business operations and establishing a common language across the business, and they are often used as a foundation for improvement initiatives. Benefits are as follows:

- ▶ Facilitates easier implementation of manufacturing style performance improvement efforts such as Lean Manufacturing, Toyota Production System or P&G's IWS as a result of having robust process models in place
- ▶ Provides a clear guideline on how processes can be improved over time, and thus achieve an ongoing performance improvement through documenting a process
- ▶ Includes process-based management that measures the full set of activities in one business from quality of product and security through to financial data such as costs and profitability
- ▶ Helps create an understanding of the interdependencies between business processes which prevents poor decision-making, thus reducing wastage (and the associated costs)
- ▶ Analyzes the processes, helping to identify risks, thus serving as a factor in reducing risk and improving safety
- ▶ Focuses on continuous improvement of product and enables productivity improvement
- ▶ Provides clear visibility and understanding of the company's goal or vision
- ▶ Reduces complexity and silo mentality
- ▶ Reduces duplication by identifying where the same process is undertaken in different parts of the business
- ▶ Improves response time to issues and demands of customer or other external demands (e.g., shipping schedules and commodity prices)

- ▶ Creates a more cohesive integrated workforce
- ▶ Provides greater long-term job satisfaction through clear process-based KPIs and performance measures (often across teams)

By integrating our processes, we immediately have greater communication and visibility across the line, which leads to improved and more timely decision-making, and ultimately to improved productivity. Many of the executives we spoke to, echoed this view:

“It's really about getting rid of variation and improving predictability process to process. It forces a level of behavior, a level of delivery, consistency, stability of plan. It forces your discipline on delivery and it forces a level of quality. It forces you to stop doing stuff that is wasteful.”

The ramifications of not integrating your value chain are clear:

“If you vary the design or if you've done something wrong or you've decided to eliminate something or do something different without going through a proper chain management process, it can take two or three months before the ramifications of that decision are even felt, let alone realized. So it's not just that the issue occurs, it's then understanding and backtracking and working out why.”



# Why hasn't a process model approach been implemented before?

A process model approach has been implemented before, though in a limited way, and not in an integrated fashion. Our observation is that mining companies have had some success at a back-office level (in procure-to-pay, hire-to-retire and finance) and also in shipping, source-to-customer, etc. Since there is less variability across these areas (which are not unique to the mining sector), it would explain the ease of implementation of a process model approach. There has been little progress, however, in service functions such as asset management and marketing, and in core functions such as mine production or mineral processing, and this is what the sector needs to focus on next.

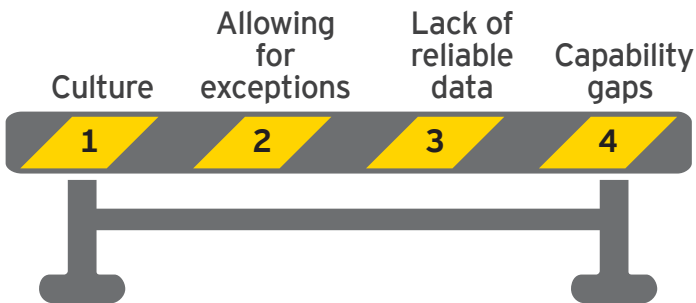
## 1 Culture

It appears that there is very little systems-thinking in the mining sector and hence a silo mentality is adopted as soon as a mining operation starts up.

“In the early stages, the operation is usually run by an MD who’s a geologist because he knows how to talk about the resource. If you’re focusing only on your discipline area, it can be to the detriment of that bigger prize, which is ultimately to get into production. To run the operation effectively and make the most value out of the operation, it’s actually important that the geologists and the metallurgists talk before you design.”

# What are the barriers?

From discussions with the mining participants, it is clear that there are a number of factors preventing the sector from achieving real end-to-end integration. They are:



Once operational, the silo mentality continues to disrupt one department to another.

“You can have a cost-saving initiative in one part of the operation. What you can’t calculate is the downstream flow-on effects that are much harder to identify. Over time, it’ll probably become very obvious that that decision was probably the wrong decision, but in the short term, it looks like it’s the right decision because it saves money.”



As per the old adage “what gets measured gets done,” it’s clear that KPIs are still based on volume-based metrics, which are incompatible and inadequate in the current environment where driving end-to-end efficiency is key.

“The reality is that we reward people for certain behavior. So if you’ve got a concentrator, you’re rewarding someone for throughput in recovery. You’re not necessarily rewarding them properly for concentrate-grade contaminants, which are really important for optimizing value chain to the smelter. If you want to change something in the pit, then that has a flow-on effect all the way through the plant. It is just communication and transparency; it’s the only way of managing and those guys working together rather than saying, ‘It’s not in my patch. I don’t care about it.’ That’s management structure and also the culture on the site about how those guys are rewarded and whether that’s financial, KPIs or even the pat on the back from respective people. It’s the way that management runs the job.”

Change needs to be driven from the top. With the level of autonomy and empowerment currently given to site managers, this could be difficult, and there may be the need for some recentralization in order to enable strategic decision-making to take place. This comes down to driving in the organization a culture that’s open-minded and broad enough to actually understand, acknowledge and embrace the fact that there’s a whole-of-firm benefit, as opposed to the mindset that my piece is the only piece that matters.

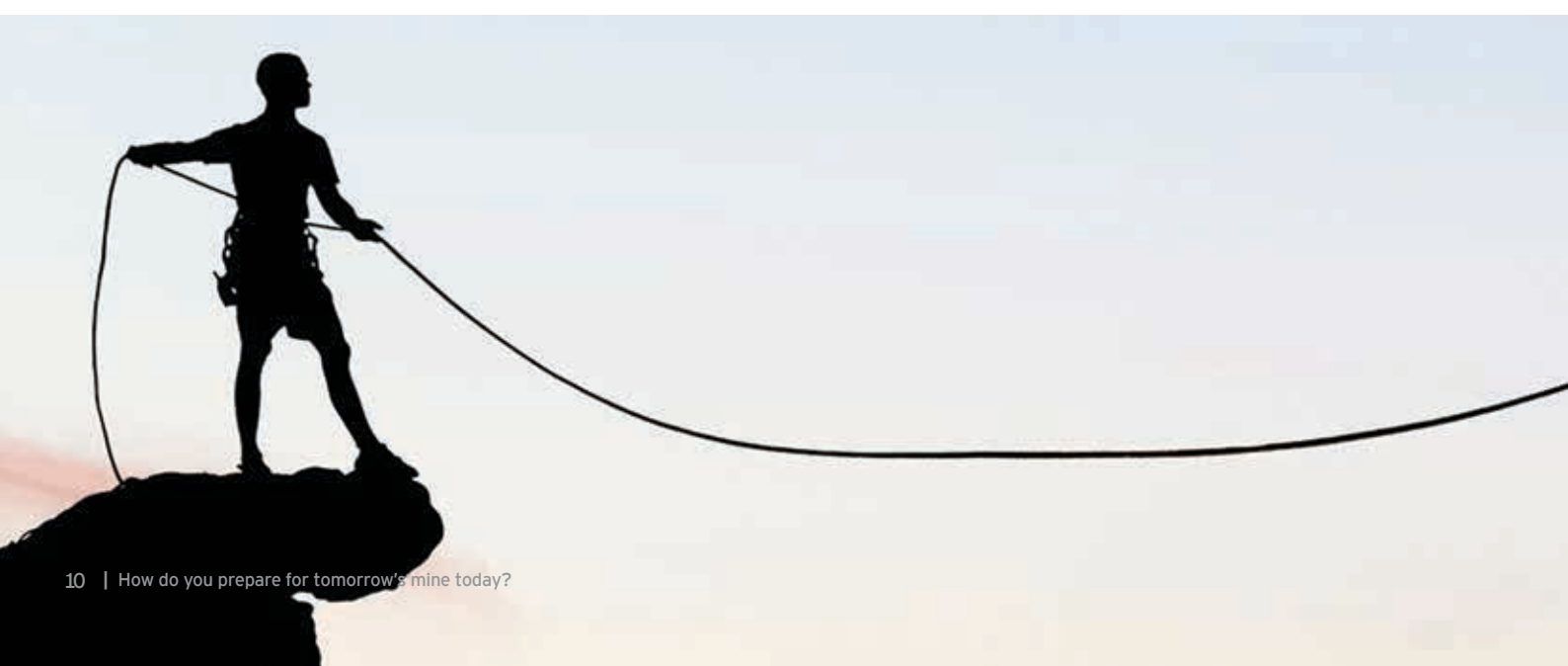
“So try to change the culture, so people aren’t thinking ‘If I get that wrong, I’m going to be in trouble,’ to ‘Wow, there’s an opportunity there. I’ll give it a go, and if we fail, I’ll learn from that and we’ll do it better next time.’”

2

#### Allowing for exceptions

Allowing for exceptions doesn’t remove silos; it enables poor behavior and inefficiency to continue. The CEO of a global mining company who has been down this pathway said,

“When you’re putting this model through the organization, you get push-back. It’s a different way of working, it’s a different culture but you’ve got to hold the course. You can’t start introducing exceptions.”



Clearly if you do, you start to lose the benefits, and you don't get to scale economy.

Another CEO concurred:

“You hold the line, otherwise you dilute the process ... You have to finish what you started and if you start to create opportunities to move, then people will move. So unfortunately, if you're going to disrupt an organization, there has to be a level of discomfort and the temperature has to rise and, therefore, you've got to finish what you started. There are competitors of ours that have gone through these grueling painful implementations of an enterprise-wide system change, and yet they've allowed properties to make changes to those systems because they're different. And it's like: 'You've got to be kidding me. The reason you're doing this is to be the same. You must be joking.'”

3

Lack of reliable data

The Cooperative Research Centre for Optimising Resource Extraction (CRC ORE) has sought to understand why the mine-to-mill approach failed to deliver and be broadly adopted. Their conclusion is that it was due to the crucial gaps in technology and systems that meant solutions were not robust enough to survive the operating environment.<sup>3</sup> Mining companies were challenged with a lack of reliable data (not coded properly) and/or the people not utilizing or analyzing the

available data. Current technology makes it a lot easier to access and analyze reliable data, and this should help reduce variability and enable better decision-making and flexibility.

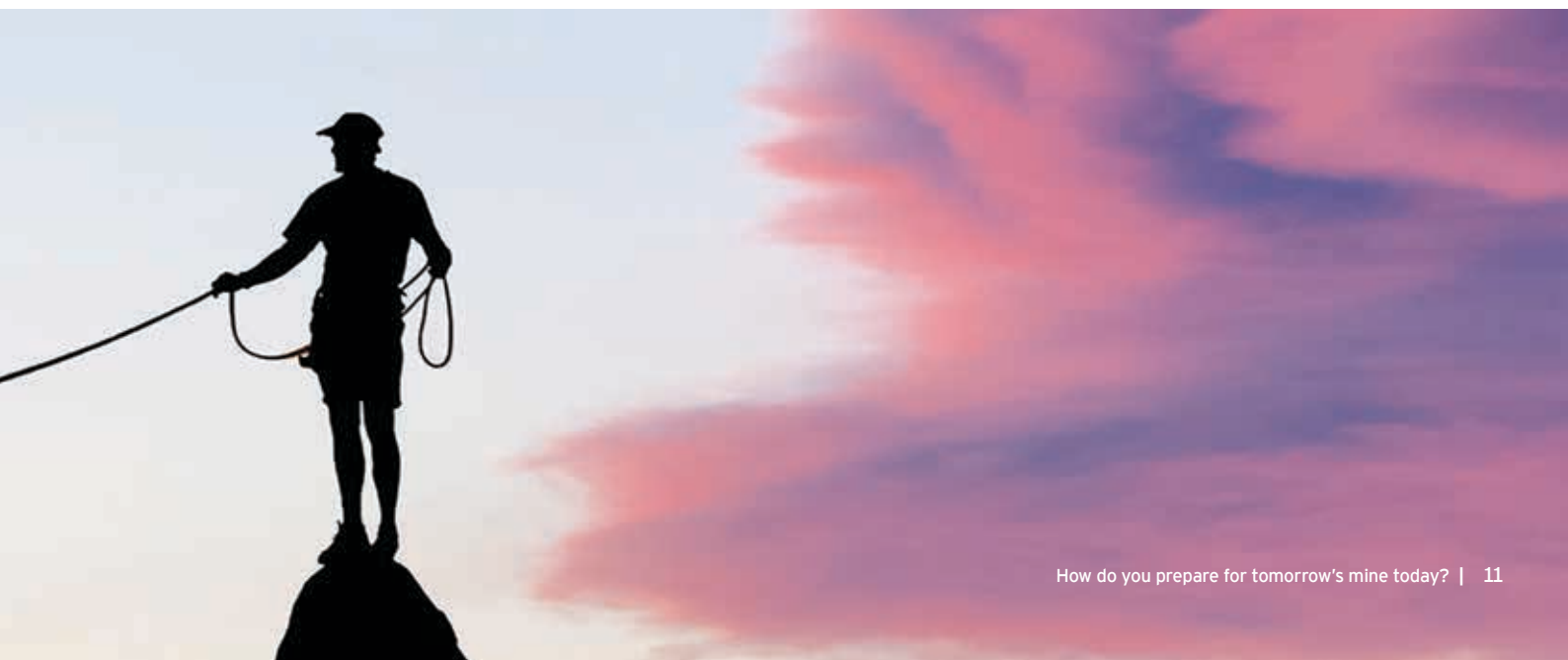
Digital has been confusing for miners but our view is that it will be a key enabler of process models and productivity.

“Everybody's saying, 'We'll have a factory or a manufacturing paradigm for mining.' We need a mining paradigm. We need a digital advanced understanding of the way mining can be that's mining.”

We will look at this in more detail in our next paper, but in the words of a CEO:

“The technology is there to have an almost real-time feed of what's coming up from underground: you know what we've unearthed in a blast, what is going to be coming up from underground, what's going to be hitting your concentrators and smelters. In theory, you can decide what to do with it, you can decide how to blend it or how to treat it; you optimize the ability reagents required to maximize recovery. You can optimize in theory, because you've got all these models; you can optimize the recovery and grade formula so that you're getting the best out of it.”

3. “A step change in mining productivity,” CRC ORE, April 2015.



While emerging talent and new ways of thinking will continue to be critical to a sector which is adapting to the productivity imperative, this will not be a substitute for the deep experience of those who have traversed

the sector over many years. Many of the mine operators today have never experienced working in a volatile environment. There is an urgent need to buy or build the following skills to help teams operate under a leaner, more efficient operational model, culture and mindset – project management, change management and process improvement.

## The solution is to put the market to mine approach at the heart of the mining business

As in any game-changing initiative, building good, dynamic and useful process models requires a disciplined approach and methodology:

- ▶ **People:** The internal knowledge capital of the mining company needs to be complemented by existing documentation of processes (including flow sheets), but also the expertise of third parties that have successfully executed similar projects.
- ▶ **Process:** Existing standard processes can be leveraged to capture the current state, and also lay out the future state for optimization and integration purposes. Generally, it is essential to pilot within a group or function, deploy within a site, and expand across multiple sites. Change management and leadership are fundamental in encouraging adoption and sustainability.
- ▶ **Systems and technology:** A suitable IT platform is another foundational decision to simplify, integrate and deliver user-friendly and user-accessible functionality. The platform needs to also allow updates and upgrades as the organization's maturity rises.

We believe that to truly achieve a sustainable productivity improvement, an integrated end-to-end business transformation, which can only be achieved through a market to mine approach, is required. This was echoed by our discussion participants:

“Mine-to-mill seems to come and go. It gets learned and unlearned, and I think it's because of the unpredictability and the reward. For some reason, it's hard to sustain a mine-to-mill or a mine to market sort of process. There's no obvious reason for that because it is such an obvious requirement.”

“It's quite obvious that you want to optimize the processes between identifying the stuff in the ground and selling it to whoever you sell it to. There's still massive gaps in the process between finding an ore body underground and selling the product. Mining is a basic set of activities. But putting them together and trying to optimize it, it becomes a very complex model. To have a fully integrated model, from the geology through to the finished product, is something that generally you don't find.”

“This whole integration piece is around the idea that if you understand what it is you have to process and what it is that's in the ground, you can work out how to mine it best. You can work out how to process it best. You can then work out how to design your process to cater for that as well, and how to maintain and optimize the operation of the process. So all of that is, for me, the integration piece.”

A photograph of two people climbing a large, dark rock formation. One person is on top of the rock, leaning over and holding the hand of another person who is climbing up the side. The background shows a vast, mountainous landscape under a cloudy sky. The word 'Conclusion' is written vertically in large, bold, black letters over the image.

# Conclusion

Whether the objective is a rapid uplift in productivity, or long-term sustainable change, the principles remain the same. Companies need to embed sustainable loss elimination practices through employee engagement and an integrated end-to-end approach for long-term sustainable improvement in productivity. Effective implementation of technology is slow in the sector and the industry is poorly rated for digital intensity. However, digital can be a key enabler of productivity by enabling more effective loss elimination and management of variability. We will look at how the sector can achieve this in our next paper in this series.

# Contributors to the report

Interviews were undertaken with senior mine managers and industry executives in association with the researchers at the Sustainable Minerals Institute and the Australian Institute of Business and Economics at the University of Queensland, and the Norman B. Keevil Institute of Mining Engineering and the Liu Institute for Global Issues at the University of British Columbia.

We have anonymously quoted these participants throughout the report. We would like to thank all of our interviewees for their participation and their candid insights.

We would like to recognize the contributors to this report:

**Paul Mitchell**  
Global Mining & Metals  
Advisory Leader, EY

---

**Louise Higgins**  
Global Mining & Metals  
Strategic Operations  
Leader, EY

---

**John Steen**  
Associate Professor in  
Strategy, Sustainable  
Minerals Institute at the  
University of Queensland

---

**Nadja Kunz**  
Assistant Professor  
NBK Institute of Mining  
Engineering and Liu  
Institute for Global Issues  
University of British Columbia

---

**Afonso Sartorio**  
South America Mining  
Advisory Leader, EY

---

**Theo Yameogo**  
Canada Mining  
Advisory Leader, EY

---

**Wayne Bolton**  
Oceania Mining  
Advisory Leader, EY

---

**Wim Hoogedeure**  
Africa Mining  
Advisory Leader, EY

---

**Dr. Samuel C. MacAulay**  
Thiess Research Fellow  
UQ Business School  
University of Queensland

**John Jackson**  
Principal Consultant –  
Geometallurgy Lead  
JKTech Pty Ltd  
University of Queensland



## EY's productivity series



In the first paper in our productivity series, *Productivity in mining, a case for broad transformation*, we discussed the size of the productivity issue. Economists typically measure productivity across a range of factors, with the most common being labor, capital and materials. Since the mining boom, all of these have been in decline:

- ▶ **Labor:** Our research showed us that this was a contributor due to the “hire at any cost” approach to the boom which resulted in an inadequate skills mix – teams became ill-equipped to deal with the post-boom efficiency drive (which is covered in more detail in our labor productivity paper, *It is only a ceasefire – the war for talent will continue*).
- ▶ **Capital:** Achieving predictable return on investment outcomes when delivering complex multibillion dollar asset developments is a challenge. We analyzed a global megaproject sample group, which showed an average budget overrun of a staggering 62% (which is subsequently discussed in more detail in our capital productivity paper *Opportunities to enhance capital productivity, mining and metals megaprojects*).
- ▶ **Materials:** Clearly depleting reserves, deeper ore bodies and falling grades are factors, with productivity falling per ton of mined ore.



We undertook a survey to better understand why the decline was so significant and how different organizations were tackling the issue. The results of this survey were published in our paper, *Productivity in mining: now comes the hard part*. The executives we interviewed told us that the expected declines in labor, capital and material productivity occurred, but an additional factor of economies of scale played a significant role in the decline.

## How EY's Global Mining & Metals Network can help your business

With a volatile outlook for the sector, the global mining and metals industry is focused on how to maintain a strong and flexible balance sheet while preparing for future growth. The sector is also faced with the increased challenges of improving productivity, access to capital, dealing with increased transparency, maintaining license to operate and cybersecurity.

EY's Global Mining & Metals Network is where people and ideas come together to help mining and metals companies meet the issues of today and anticipate those of tomorrow by developing solutions to meet these challenges. It brings together a worldwide team of professionals to help you succeed – a team with deep technical experience in providing assurance, tax, transactions and advisory services to the mining and metals sector. Ultimately it enables us to help you meet your goals and compete more effectively.

### EY area contacts

#### EY Global Mining & Metals Leader

Miguel Zweig  
Tel: +55 11 2573 3363  
miguel.zweig@br.ey.com

#### Oceania

Scott Grimley  
Tel: +61 3 9655 2509  
scott.grimley@au.ey.com

#### China and Mongolia

Peter Markey  
Tel: +86 21 2228 2616  
peter.markey@cn.ey.com

#### Japan

Andrew Cowell  
Tel: +81 3 3503 3435  
cowell-ndrw@shinnihon.or.jp

#### Africa

Wickus Botha  
Tel: +27 11 772 3386  
wickus.botha@za.ey.com

#### Commonwealth of Independent States

Boris Yatsenko  
Tel: +7 495 755 98 60  
boris.yatsenko@ru.ey.com

#### France, Luxemburg, Maghreb, MENA

Christian Mion  
Tel: +33 1 46 93 65 47  
christian.mion@fr.ey.com

#### India

Anjani Agrawal  
Tel: +91 22 6192 0150  
anjani.agrawal@in.ey.com

#### United Kingdom & Ireland

Lee Downham  
Tel: +44 20 7951 2178  
ldownham@uk.ey.com

#### Canada

Jim MacLean  
Tel: +1 416 943 3674  
jim.d.maclean@ca.ey.com

#### Brazil

Afonso Sartorio  
Tel: +55 11 2573 3074  
afonso.sartorio@br.ey.com

#### Chile

María Javiera Contreras  
Tel: +56 2 676 1492  
maria.javiera.contreras@cl.ey.com

### Service line contacts

#### EY Global Advisory Leader

Paul Mitchell  
Tel: +61 2 9248 5110  
paul.mitchell@au.ey.com

#### EY Global Assurance Leader

Alexei Ivanov  
Tel: +7 495 228 36 61  
alexei.ivanov@ru.ey.com

#### EY Global IFRS Leader

Tracey Waring  
Tel: +61 3 9288 8638  
tracey.waring@au.ey.com

#### EY Global Tax Leader

Andrew van Dinter  
Tel: +61 3 8650 7589  
andrew.van.dinter@au.ey.com

#### EY Global Transactions Leader

Lee Downham  
Tel: +44 20 7951 2178  
ldownham@uk.ey.com

EY | Assurance | Tax | Transactions | Advisory

#### About EY

EY is a global leader in assurance, tax, transaction and advisory services. The insights and quality services we deliver help build trust and confidence in the capital markets and in economies the world over. We develop outstanding leaders who team to deliver on our promises to all of our stakeholders. In so doing, we play a critical role in building a better working world for our people, for our clients and for our communities.

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