

# Productivity in mining: now comes the hard part

A global survey

**SMI** Sustainable Minerals Institute

**EY**  
Building a better working world



# Contents

Executive summary	2
What has caused the decline in productivity?	3
Cost cutting vs. productivity	7
The integration gap	8
Innovation and value chain transformation	13
The way forward	17

# About this survey

This survey was conducted in association with the Sustainable Minerals Institute at the University of Queensland and Imperial College London. EY's preliminary research outlined in *Productivity in mining, a case for broad transformation* found the decline in productivity had been more significant than that for other sectors. So we have tailored our subsequent research to better understand why the decline was so significant and how different organizations have addressed this issue.

Our research team undertook more than 60 interviews with senior mining executives from around the world to understand:

- ▶ The key productivity challenges the sector is facing

- ▶ The key initiatives being developed to overcome these challenges
- ▶ Better practices to manage these initiatives in the post supercycle environment

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.

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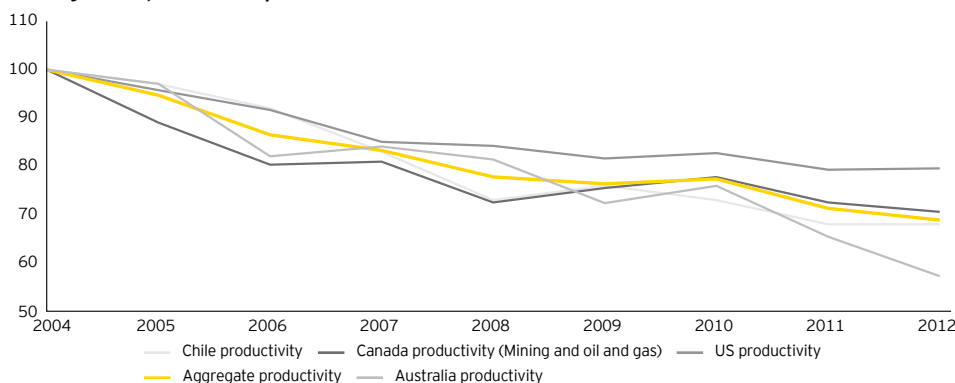
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# Executive summary

## Productivity in the mining sector has been on a steady decline over the past decade as miners focused on output at any cost in an unprecedentedly high commodity price environment.

Over the broad spectrum of different mining operations (geographic location, commodity focus and age), it is difficult to define the exact size of the productivity problem. Economists refer to productivity as “multifactor” in that a range of factors are measured, including labor, capital and material (resource). These factors are often reported individually, e.g., labor productivity has declined 35% since 2007 in the South African gold sector,<sup>1</sup> and capital productivity in Australia has declined 45% since 2000.<sup>2</sup> Each of these factors has declined across most of the mining sector, significantly more than for other sectors,

### Mining labor productivity 2004-2012 (2004=100)



Source: Country statistical data, EY

1. SA Statistics.

2. Australian Bureau of Statistics.

resulting in a significant decline in total productivity.

The executives we interviewed told us that productivity is the number one challenge in the mining sector and is firmly on the CEO's agenda. The expected declines in labor, capital and material productivity all occurred, but an additional factor of economies of scale has played a big role in the decline. Many have found that productivity decreased as operations got larger, and that it was difficult to manage the complexity of these large operations, particularly given the additional challenge of high turnover and lack of staff experienced in focusing on driving efficiency. The growth in mining operations has resulted in complex structures and inadequate functional collaboration.

### The integration gap – the reality of the productivity issue

Many “productivity” initiatives to date have been focused on cost cutting, which have led to some modest, short-term results, but our survey participants acknowledged that what needs to be done now is more complex. Our view is that mining companies should move beyond point solutions, and adopt an end-to-end solution to transform the business. We believe there is a need to ensure that each part of the business is optimized, not on its own but as part of a business system. We have titled the lack of this as “the integration gap.” A number of the executives interviewed highlighted this gap and their desire to close it. Addressing

integration is a key challenge for improving productivity, and requires an approach that breaks down the silos and adopts an end-to-end perspective. We believe this is achievable by changing the culture to empower the workforce and finding new solutions to existing problems, and using data and technology to support this.

### ► Using technology and data to enhance integration

Technology can break down silos and enable new working practices to evolve. Only with good data can companies understand what good performance looks like, and companies that successfully use data outperform their peers by 20%.<sup>3</sup>

### ► Sustaining end-to-end transformation through culture

The critical role people will play in transformation was highlighted around three key themes:

1. Engagement – empowerment, flexibility and self-direction
2. Measurement and reward – aligned to productivity measures not headline outcomes
3. Ongoing talent management – requiring systems thinkers to manage complexity

### What else needs to be done? The role of innovation

In recent years, the passion for innovation in the mining sector has not been lost. New innovation can be a productivity game-changer, especially with ore grades declining around the world, and we are beginning to see some innovations underway.

### The way forward

Productivity is a CEO issue and therefore needs the CEO to lead and drive end-to-end transformation to solve the issue. As a first step towards transformation, we recommend a refresh or review of operational strategy to help to change the focus of the business and start to change culture.

3. “For Big Data Analytics There's No Such Thing as Too Big: The Compelling Economics and Technology of Big Data Computing,” 4syth.com, March 2012, [http://www.cisco.com/c/dam/en/us/solutions/data-center-virtualization/big\\_data\\_wp.pdf](http://www.cisco.com/c/dam/en/us/solutions/data-center-virtualization/big_data_wp.pdf), accessed 23 September 2014.

# What has caused the decline in productivity?

In their own words

# 01



## Key factors

The survey participants were asked to describe the key factors that caused the decline in productivity in their organization. The responses covered each of the factors regularly referred to by economists, namely – labor, capital and material (resource). An additional theme that emerged from our interviews is the challenge of operating at scale.

### 1. Labor

During the boom, a focus on growth at any cost forced many mining companies to accelerate recruitment. Higher salaries enticed workers from other sectors to work in remote locations, but the subsequent war for talent escalated labor costs, and consequently labor productivity fell. The survey participants attributed the fall in labor productivity to the following:

#### ► Inexperienced teams

From our interviews, it became apparent that during the boom time many mining companies undertook less rigorous induction programs in order to get new joiners operational faster.

“Obviously we got caught up when the mining boom was happening and people were losing productivity because we were losing good operators. Good operators make a big difference. New people weren’t getting enough experience in using a digger or driving a truck.”

Also, the focus on building talent from within the organization had been lost, which accentuated the acute shortage of experienced mining managers, superintendents, etc.

“Labor productivity may have declined just because we’ve made team sizes too big, and we haven’t given the supervisors or superintendents the right leadership to deal with this.”

#### ► High turnover and an aging workforce

During the commodity boom, the sector experienced high labor turnover due to increased bargaining power and availability of opportunities with higher wages and better conditions in other sectors; in addition, the remoteness of operations and the challenges of fly-in-fly-out (FIFO) caused many to leave the sector.

“We’ve averaged close to 30% employee turnover.”

The mining sector also suffers from an aging workforce, and retirement rates are anticipated to increase over the next decade. A recent Mining Industry Human Resources Council (MiHR) report shows retirement to be the most significant contributor to the Canadian mining sector’s future hiring needs. Canadian mining employers indicated that roughly 20% of their workforce was eligible to retire in the next three to five years and 6% of workers were currently eligible to retire. These retirements impact operational continuity and lead to a great loss of organizational know-how and operational experience for mining companies. Many of the survey participants said that they have regretted loss of good talent, which has caused inefficiencies to creep into their operations.

“The sector had lost too many good operators – costly in a finely-tuned, margin business where seconds and minutes make a big difference.”

► **A focus on volume rather than efficiency**

A further concern cited by executives was the lack of understanding of the business model throughout their organization, and as a result definitions of “good” performance were not uniform across the organization.

“If I asked the truck driver or the float operator or the shovel operator: How do you know if you have had a good day? What’s a good day look like to you? They couldn’t tell me.”

## 2. Capital

Capital productivity has been impacted by long lead times between investment and production, over-investment in capital, as well as the following factors:

► **The definition of “good” has changed**

High employee turnover levels and an inexperienced workforce have had an adverse impact on equipment utilization levels. Competitive advantage has been lost due to lack of knowledge of how to best optimize resources.

“When you start to talk about fleet utilization in the developed world, if we’re getting about 85%, we’re doing well. If you go back 10 or 15 years ago, people were pushing the 90s, the low 90s. We’ve lost 5% or 6% on fleet utilization.”

► **Lack of innovation**

The mining sector used to pride itself on innovation, with new exploration, mining and mineral processing techniques being a common feature of the sector. This innovation has slowed. The first automated truck trials were 20 years ago, yet we still do not have a fully automated pit.

“We use the same equipment today we did 20 years ago, it just got bigger – but is it the best?”

Fifty years ago, the oil and gas sector was limited to operating in shallow water and the thought of operating on a platform in the middle of the ocean was unimaginable. Ten years ago, the idea of operating on a floating LNG platform would have seemed far-fetched. The comparatively easier access to economic resources in development portfolios has led the mining sector to fall behind the oil and gas sector in their innovative thinking.

“Our industry is damned by the fact that our spending on innovation is one-tenth of the petroleum industry. ... If we don't start to bring innovation back ... the major diversified will be subsidiaries of General Electric or some other conglomerate that has still got innovation in their vocabulary.”

- Mark Cutifani, CEO, Anglo American<sup>4</sup>

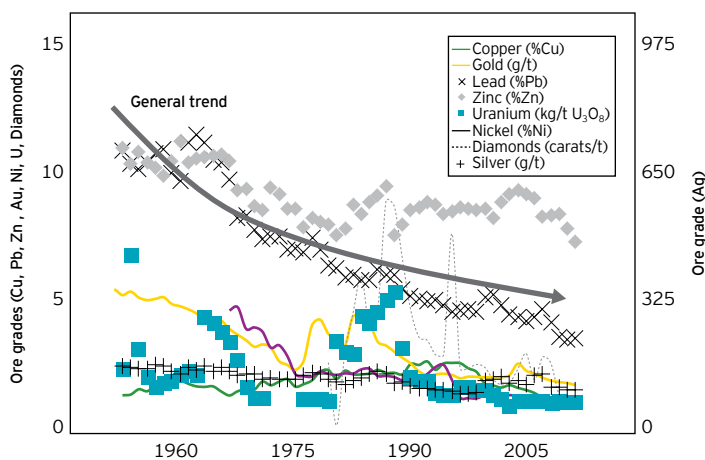
Our survey respondents recognize there is a pressing need to innovate.

“You do get to a point where, without innovation, there are diminishing returns.”

### 3. Material (resource)

Depleting reserves and falling grades are also a contributing factor as shown below, with productivity falling per tonne of ore mined.

#### Declining ore grades



Source: “The Sustainability of Mining in Australia,” Department of Civil Engineering, Monash University and the Mineral Policy Institute, April 2009, <http://users.monash.edu.au/~gmudd/sustymining.html> accessed 23 September 2014.

4. “Is increasing mining R&D the only hope for saving a stalling industry?” *Mining-technology.com*, 26 May 2014, <http://www.mining-technology.com/features/featureis-increasing-mining-rd-the-only-hope-for-saving-a-stalling-industry-4274633/>, accessed 22 September 2014.

### 4. Economies of scale

During the boom time, mines expanded as quickly as possible with little consideration around how to manage the additional complexity that this created. Many of the executives 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.

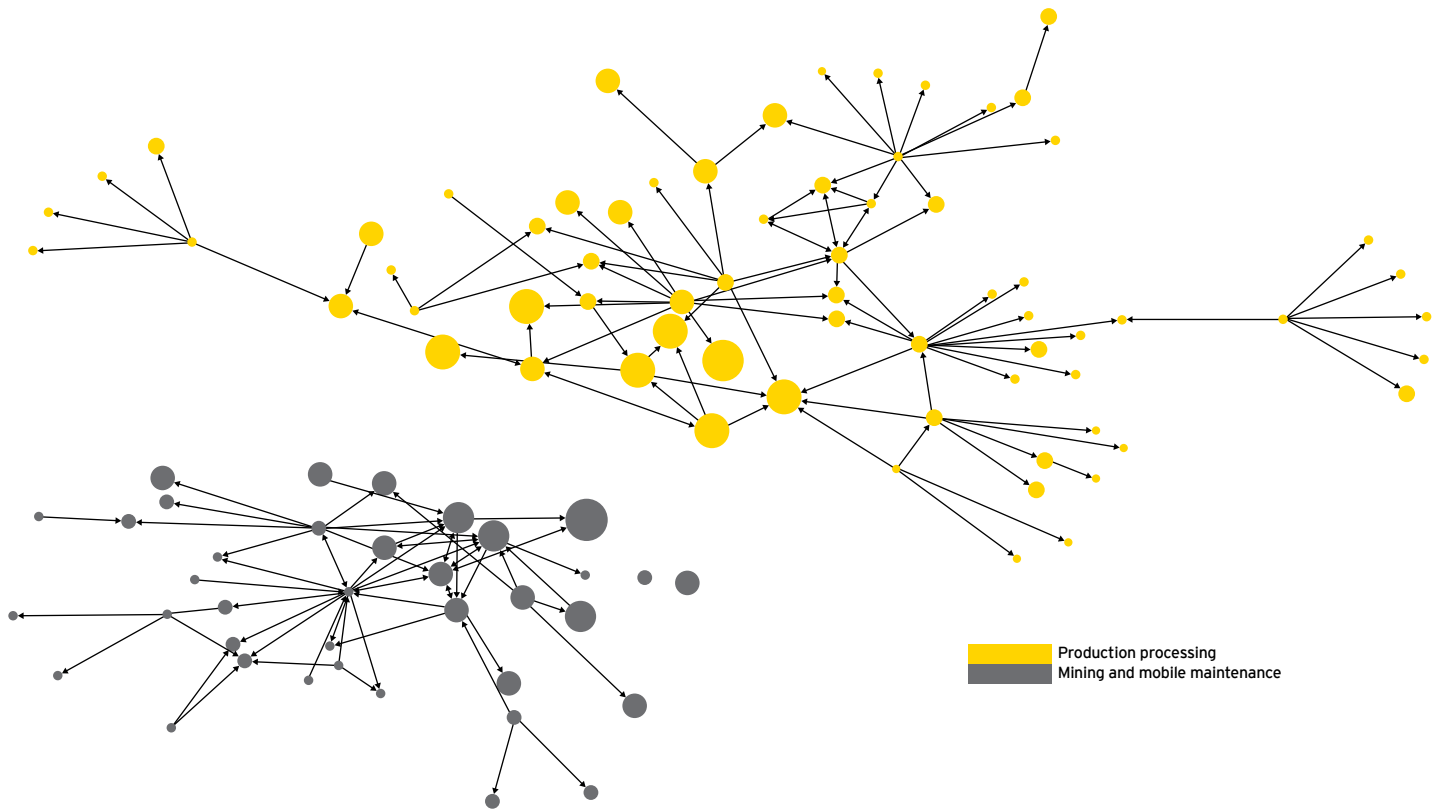
“We always want to get bigger and grow to the point where we've got maximum economies of scale. I think it's fair to say that a number of operations have gone over the point of economies of scale to what I call 'diseconomies of scale.'”

So, although mines were scaled up to meet greater demand, inexperienced mine managers were not provided with the tools to manage this increased complexity. The scale of the mega mine and the related complexity resulted in an increased pressure on 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 management of a mining company. The analysis and mapping of communication networks by researchers at the University of Queensland show how severe these problems have become at some mines.

In one study at a large mine, maintenance and processing employees were asked to nominate people who they regularly involved in problem solving. When these connections were turned into network maps, it showed that very little communication existed between these functions. On some whole-of-mine technical problems such as water management, no direct connection between the functions was found, which revealed a hidden operational risk for the business.

## Mine X – problem-solving network map



Source: University of Queensland

To overcome this mentality of working in silos and bridge the communication gaps, the company has since held a number of online collaboration events known as “innovation jams,” which allow large groups of employees to participate in the innovation process by submitting their ideas and opinions in response to specific challenges. This approach was used with groups of up to 500 participants to generate potential solutions across a range of topics, including technical issues related to rock breaking and throughput/recovery trade-offs, and more general engagements on themes such as safety and productivity. Using the web as a platform

for collaborative, time-limited engagements has proved effective in crossing site and business unit boundaries and has also increased knowledge-sharing among the globally dispersed workforce. It has also provided a seamless mechanism for external subject-matter experts to contribute to the company’s innovation efforts, as a practical form of “open innovation.”

Collaboration in smaller mines is far higher as familiarity among functions supports greater natural collaborations. However, larger mines require different approaches to promote collaboration.

# Cost cutting vs. productivity

# 02



EY has been tracking the strategic risks to the sector over the past seven years and publishes these in our annual *Business Risks facing mining and metals 2014-2015* paper. A decade of higher prices concealed the impact of falling productivity in the sector, and it was only in 2013 when commodity prices softened, that productivity improvement (along with margin protection) moved up to the number two spot of our risk ranking. The supercycle altered the DNA of mining companies to adapt the processes, performance measures and culture solely toward growth. Boards and CEOs are now realizing that regaining lost productivity and gaining new ground is critical for long-term return on capital employed, and requires a whole-of-business response. This is why in our *Business risks in mining and metals 2014-2015* report, productivity improvement is the top risk facing the sector.

In our report – *Productivity in mining, a case for broad transformation* – we observed that the sector was still largely focused on point solutions and traditional cost-cutting exercises. Many mining companies have achieved excellent results in cost reduction as evidenced by commentary at the time of half yearly results:

- ▶ Rio Tinto: “We have beaten our cost reduction targets, with US\$3.2 billion of sustainable operating cash cost improvements.”<sup>5</sup>
- ▶ BHP Billiton: “We embedded productivity-led volume and cost efficiencies of US\$2.9 billion, exceeding our target by 61% or US\$1.1 billion.”<sup>6</sup>
- ▶ Anglo American: “Higher volumes across most of the portfolio, with cash costs down 2% in real terms.”<sup>7</sup>

We believe more still needs to be done. Many of the executives we interviewed believe that they are soon to reach a ceiling on cost reduction. From our conversations with clients, we feel there is a real desire to address the productivity issue, but there is a lack of knowledge of where to begin and a reluctance to spend on fixing this situation, when the promise of price increases may once again shift miners’ focus to production growth.

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“We have reached the limit of cost reduction, now the business is asking: ‘What’s next?’”

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5. “Rio Tinto slide presentation,” 7 August 2014.

6. “BHP Billiton Results - Year Ended 30 June 2014,” ft.com, 19 August, <http://announce.ft.com/Detail/?DocKey=1323-12056052-56JK3KJMOM3JV30P71M1AT1RBT>, accessed 23 September 2014.

7. Anglo American, 25 July 2014.

# The integration gap

03

Many of our survey participants recognized that more has to be done. Despite the excellent work that some members of the mining sector have undertaken in the past 6 to 12 months, the productivity gap has not yet closed. Most participants acknowledged that the easy work has been done and that what needs to be done now is more complex. There is an overriding need to ensure that each element of the business, from the resource in the ground, to the product being delivered to the customer, is optimized – not just on its own but as part of a business system.

A number of our participants highlighted the creation of these silos during the supercycle and their desire to eliminate these silos.

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“How wonderful would it be if the drilling operator knew that by drilling the right hole size and the blaster knew that by blasting it right so it’s not oversized, that there will be no downstream impacts. That by not doing it right it can impact the shovel operator and the truck driver. The challenge is trying to get them to understand how they all fit in.”

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We have titled the creation of silos and the desire to eliminate these as “the integration gap.”

Our participants concurred that there was a need to have more effective systems or end-to-end thinking in their organization, without which only limited productivity gains could be achieved.

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“It’s taking a holistic view of all the different parts and how they fit together – getting managers to work at a systems level and removed from the general operation.”

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People who can understand how to manage at the systems level can make a real difference in an organization.

“Systematic thinkers at a mine site do very well because they’re doing something that a lot of us don’t do. There are a lot of people who jump to conclusions without any analysis. They say, “This is what the problem is.” and they spend six months, quite often working and helping on tasks irrelevant to the issue.”

Unfortunately, a number of participants highlighted that system thinkers are now at such a senior level that they are sidelined from the day-to-day operations of the mine and/or they have retired or are close to retirement.

“I would say that at an asset level and one step above that, we do have granular controls with great visibility to help those people manage the business, but beneath that we could be doing much better.”

One of the most common things we heard from executives is about the need to “go back” or “relearn” the higher-productivity behaviors of the past. While we agree looking back is part of the solution, we do believe that it is time for some new and innovative thinking.

## Addressing the integration gap

The integration gap aligns with our early thinking published in *Productivity in mining – a case for broad transformation*, that mining companies need to move beyond point solutions and adopt an end-to-end solution that transforms the business.

“When you ask what productivity means, it really revolves around the best utilization of our resources. However, you want to define resource – is it people, equipment, or plant? All those things have to come together to increase our productivity.”

While the issues around labor and capital productivity did not come as a surprise, we were surprised at how many participants mentioned the issues that have arisen when operating at scale. One theory we have is that operating at scale is difficult because we are operating larger mines without a strategy for managing complexity. Clearly, operating a larger mine the same way as a smaller mine is not the answer. Mining companies need to look for new and innovative ways to increase the connectivity of the larger mines that will pave the way for mines of the future.

Operating at scale requires different capabilities, and in particular, needs systems that are not reliant on key personnel. One executive remarked that the reliance on key personnel in large and complex operations was a significant business risk. Not everyone is able to handle this level of complexity.

“Some people can deal with more complex environments than others and if you put someone that does not have that capability and you give them a very wide span of control, you’re setting them up for failure.”

Another executive suggested that the role of senior mine managers and the way they are supported with information technology needs to fundamentally change in order to make these roles less susceptible to information overload.

“The way to manage complex environments is to make individuals’ roles uncomplicated. It sounds simple but that’s what must happen in large-scale operations. If you’re trying to get lots of people across all of it, then you’ve got a disaster.”

There is a need to match management support systems to operational complexity. If operational systems are focused on individuals or functions, they will fail at the level of large-scale mine operations because of overwhelming complexity. Similarly, it is possible to over-engineer management systems for simple functions. What is needed is matching the span of the management system to the scale of the operation.

It is important that management takes a longer term view of what needs to be done to resolve the productivity issue, and that this is firmly embedded into the organizational strategy.

A number of our survey participants talked about transformation and the need to be bolder. It was particularly pleasing to see the recognition of the need to align transformation with a clear strategy.

“It’s about having some sort of a plan or a strategy, whether it’s a global corporate strategy or it’s a business site.”

They also saw the need to communicate that strategy to the whole business.

“One of the things that we’re trying to work through at the moment is how [to] move from that very high-level perspective of, ‘We think we’re more productive than our competitors’ to something our people understand. So they can see the results: understand the key drivers and know what to focus on.”

## 1. Sustaining end-to-end transformation through culture

The critical role that people will play in transformation was highlighted by a large number of our survey participants.

While tough decisions to reduce staff and contractors have been made over the last 18-24 months in order to improve the bottom line, this will not address the challenges of improving integration across the organization. Conversely, these efforts to improve short-

term profitability have increased the tendency of employees and managers to play a waiting game, focusing only on improving their own areas and avoiding being seen as underperformers relative to their peers. Our survey respondents highlighted three key areas requiring an increased focus from the business:

### 1. Engagement

The integration challenge can be met head-on by increasing connectivity, emphasizing the importance of communication and fostering a more holistic view across the organization. A change in mine leadership is required from the “command and control” methods, with an emphasis on strong supervision and compliance to rules, to increased flexibility, autonomy and self-direction. This will enable people to quickly solve problems and adapt to changing conditions, and will build a wider sense of accountability across mining teams. Mine leaders can further increase engagement by underscoring the importance of improved productivity and the role each person plays in achieving this.

“Engagement is really powerful. Telling people what’s really important is empowering.”

### 2. Measurement and reward

There is little value in talking about a change in how things are done without measuring and rewarding new ways of working. Many mining companies have “gain share/bonus” plans that incentivize individuals based on shift length / attendance or on measures that are not true measures of productivity. Mining companies could instead measure and reward outcomes such as heightened output, improved safety or process improvements. In addition, line managers, for example, are typically assessed

on measures that are on a headline outcome and not how they go about it. Mining companies have the opportunity to measure and reward the actions to improve productivity (the “what”) and the way people go about delivering this (the “how”). It is equally important to recognize and reward teams and leaders who collaborate well across business units, keep other groups informed and involved and break down the silos.

### 3. Ongoing talent management

Managing talent post the supercycle is a major consideration for mining companies. The “war for talent” has not ended just because labor market conditions have eased in favor of employers; it has rather entered a ceasefire. There is a greater need than ever before for “systems thinkers” who can manage complexity and see improvements across the whole value chain. Retaining and attracting these resources during the downturn could prepare mining companies for the next phase of growth and innovation.

“We have limited resources we can put for improvement work. As a business we’ve got to try and have the discipline to say we’ve got limited resources. We need to utilize them where we’re going to deliver the highest value rather than trying to spread those resources evenly across the whole field.”

## 2. Using technology and data to enhance integration

Technology can play a major role in breaking down traditional silos and enabling new work practices to take shape. Embracing new ways

of working and defining productivity beyond production may move the sector into a more technology and digital business-driven world.

“It’s about the systems and processes, it’s taking a holistic view of the different parts and how they fit together.”

This is not as easy as it sounds. Typically, the information and data needed to bring about this understanding is spread across the organization and differs greatly in terms of:

- ▶ Volume – how much data
- ▶ Variety – the type of data
- ▶ Veracity – how authentic
- ▶ Velocity – how quickly it is generated

These four Vs are the routine descriptors used to codify a big data opportunity, which in turn demands a different approach to analyzing and obtaining insights from this data. Good data is needed to understand what good performance and good productivity looks like. Many organizations are struggling with each of these measures. They lack the means to cope with the sheer scale of data flowing into the business via enterprise business systems (IT) and operation systems (OTs) and with the diverse nature of structured and unstructured data. While they understand the advantage of turning data into an insight quickly, they are intimidated by ideas such as real-time analytics. Nor do they always know which data sources are to be valued and trusted, when to question the insights generated, or which technological tools can help them with these concerns.

Ready access to process condition, equipment state and financial performance can enable managers and workers to make better decisions about how to enhance and protect production value. For this type of insight and analysis to be available, a more strategic view of data is required. The unification of internal data, original equipment manufacturer (OEM) data and vendor data requires new protocols that go beyond tactical monitoring and retrospective reporting. Adoption of cloud-based services will reduce time for information and communications technology development and bring benefits to the sector sooner – an area that mining has traditionally been slow at achieving.<sup>8</sup>

It is critical to link business imperatives to reliable processes and clean data, so miners can understand where they are, as it relates to productivity and which levers will drive the maximum gain.

But that is not enough. They also have to look at their people strategy and capability/capacity measures to ensure they have the right mix to be able to realize the value – in other words, the “who” in “who owns and pulls the lever.”

## Learning from others

Significant productivity gains can be made possible by rethinking how work is being done, and by being prepared to look outside the sector for ideas. Looking at disruptive innovation and open-source approaches (e.g., collaboration with academia, suppliers and others) will also be required. Here are some ideas from other sectors that we think could be considered for the mining sector:

- **Consumer and industrial:** Manufacturing excellence from the consumer and industrial sectors is a great starting point, but could be extended into logistics and supply chain best practice from OEM or tier1/2/3 practices by automotive and integrated logistics providers.
- **Engineering:** Using systems engineering concepts (modularization; specification; reduction in process interfaces and their complexity; simulation-based analysis; performance analysis and use of optimal control theory in process optimization; and other concepts) for plant design and also in some aspects of project development (e.g., contracting strategy).
- **Medical:** Adopting a CAT scan-type approach by using in-line analysis of core sample data.

<sup>8</sup>. “Productivity in the mining industry: Measurement and interpretation,” *Productivity Commission Staff Working Paper*, December 2008.

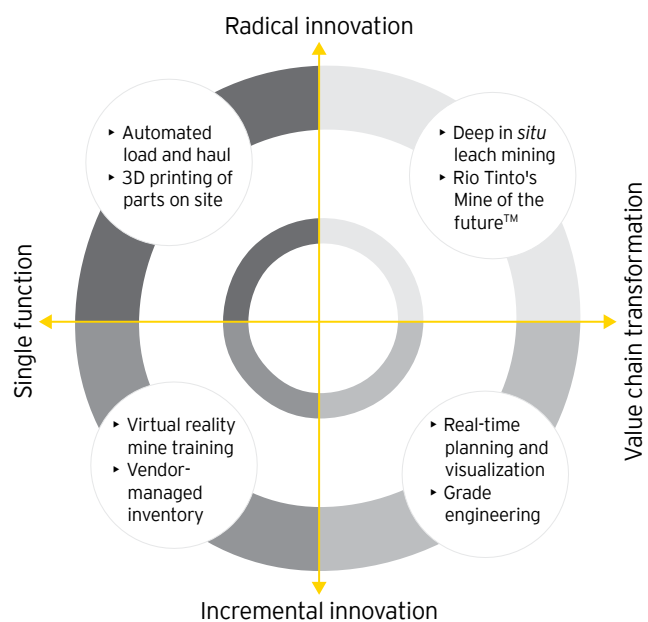
# Innovation and value chain transformation

# 04



Innovation in the sector has the opportunity to change the paradigm of productivity from historical comparison to what may be possible only in the future. Some innovations focus on single-point solutions, while others have the potential to change productivity levels at multiple points in the value chain.

## Mining innovation matrix



While all forms of innovation are important, those on the right-hand side of the mining innovation matrix are more likely to have step-change effects on multifactor productivity, because they have the capacity for end-to-end transformation of the mine business model.

Compared with the oil and gas sector, there is an accumulated deficit of transformational innovation in the mining sector. In the 1970s, with the decline of large oil fields on land, most people were forecasting the end of the oil and gas sector. After the introduction of LNG (1960s), deepwater drilling (1960s), shale and coal seam gas (2000s) and now, floating LNG platforms (2010s), global reserves of oil and gas will last much longer than the predictions of "peak oil." With ore grades declining in mines around the world,

the mining sector will have no choice but to embark on similar step-change innovation programs. EY and the University of Queensland Business School have shown a clear link between innovation and productivity improvement in the oil and gas sector in the oil and gas productivity report – *Adapt to win*.

Innovations focused on single-point solutions need to be developed with caution. If these are not developed and implemented to successfully integrate with other elements of the end-to-end mining operation, then the productivity results may be disappointing.

**“The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency.”**  
**Bill Gates**

Despite the challenges, innovations in mining are underway and show some promise for increasing productivity. As is the case with all improvements, innovations localized to a specific area of the mining process will have a lower long-term value compared to disruptive and transformational innovation.

Challenges	Potential innovations
Controlling rise in costs at greater depth and declining grades	1. Deep in situ mining 2. Grade engineering® 3. Ultra-high intensity blasting
Reducing complexity and improving decision-making	4. Real-time planning and visualization 5. Data analytics
Creating consistent outcomes from manual and automated processes	6. Automation of load and haul 7. Virtual reality mine training
Improving supply chain and logistics	8. 3D printing 9. Vendor-managed inventory

**1. Deep in situ mining:** For some ore types, deep in situ leaching may be a radical way to transform mineral extraction and processing. This is a frontier technology under development at the University of Queensland Sustainable Minerals Institute that is a response to declining ore grades. It has the potential to change the sector in a way similar to the invention of shale gas technology in the oil sector.

**2. Grade Engineering®:** CRC Ore has developed an integrated approach for dealing with declining grade quality. As the process is adapted to ore grade in real time, instead of mine, haul and mill low-grade ore, this approach uses mine planning, blasting and sorting to remove low-grade ore sources prior to the costly haul and mill operations. This reconfiguration of the mining value chain is an example of the integrated approach that will be required in the future to find new ways to improve mine productivity.

**3. Ultra-high intensity blasting:** Orica’s Dr. Geoff Brent and his research team have been recognized for ground-breaking research using a novel method of ultra-high intensity blasting to improve mine productivity and decrease processing costs. Orica Managing Director, Ian Smith, said, “The quest to use chemical energy in explosives to improve ore fragmentation and deliver a step change in mine processing efficiency has been a priority. ... Independent modeling has indicated that increasing the explosive energy by several fold can lead to increases in mill circuit throughput of up to 40% and savings of tens of millions of dollars annually.”<sup>9</sup>

**4. Real-time planning and visualization:** 4D analysis of space and time, combining gaming visualization with engineering and geographic data, are extending the accessibility of planning and operations information to new business functions. As less technically-skilled users are able to access and interrogate the information held within the data, there are new opportunities for innovation. These technologies will have applications in training, skill assessments, safety, operations planning, risk assessment, cost control, project planning and supply chains.

9. “Improving mine productivity through ultra-high intensity blasting,” Orica company website, 12 August 2014, <http://www.orica.com/news---media/improving-mine-productivity-through-ultra-high-intensity-blasting>, accessed on 23 September 2014.

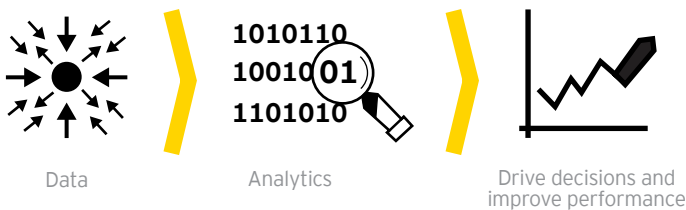
**5. Data analytics:** A major contributor to mine productivity improvement will be the ability to deal with big data around operations – to analyze, process and react quickly to make a difference.

“You’re now getting terabytes of data and trying to work your way through that to ensure you have better integrity of data and can convert the data to actionable information.”

Enhanced data is now available as a result of the investment in both enterprise systems and control systems.

“We’re looking at technical data plus economic data to actually drive ‘where is value here.’”

Data technologies represent a disruptive innovation that market-leading businesses will use to drive competitive advantage. Analytics is the means for extracting value from business data – through which actionable insights are generated. Without analytics, businesses have no way of using their big data to establish competitive advantage.



Companies that successfully use data outperform their peers by 20%<sup>10</sup> and continue to generate additional value through analytic insights that enable informed data-driven decision-making at an executive level.

**6. Automation of load and haul:** Use of robotics may improve the performance of load and haul, but may not improve the total mine productivity if it creates discontinuities with other parts of the value chain, such as drill and blast, and processing. Automation strategies will need to be applied carefully. Rio Tinto’s Mine of the Future program shows how automation can be introduced in tandem with whole-of-mine activities.

**7. Virtual reality mine training:** Skill levels of operators have a major effect on capital productivity. While training simulation has existed in the aircraft and shipping sector, it is still rare in the mining sector. Powerful virtual reality technology has the capacity to take simulation beyond the operation of equipment, such as trucks and draglines.

**8. 3D printing – augmenting the mining supply chain:** EY believes 3D printing is an innovative idea that can help change the way the mining sector thinks about their supply chain. We believe substantial productivity benefits and working capital reduction may be realized by developing the capability to print parts at remote mine sites and by enabling an agile and proactive response to maintenance. “By enabling a machine to produce objects of any shape, on the spot and as needed, 3D printing is ushering in a new era.”<sup>11</sup>

**9. Vendor-managed inventory:** This has existed in the electronics manufacturing industry for years but is almost unknown in the mining industry. Rather than miners owning warehouses of inventory, suppliers own the inventory. This will keep this inventory off the books and free up working capital. In this way a third party can coordinate production/storage from suppliers and deliver to where parts and materials are needed.

11. “3D printing will change the world,” *Harvard Business Review*, March 2013.

10. “For Big Data Analytics There’s No Such Thing as Too Big: The Compelling Economics and Technology of Big Data Computing,” *4syth.com*, March 2012, [http://www.cisco.com/c/dam/en/us/solutions/data-center-virtualization/big\\_data\\_wp.pdf](http://www.cisco.com/c/dam/en/us/solutions/data-center-virtualization/big_data_wp.pdf), accessed 23 September 2014.

## What's next for innovation?

Increasing scale and complexity (interlinked) are exposing management limitations and work practices that have not evolved, to take full advantage of the increased scale (with reduced grade). Below are some of the solutions that miners may choose to adopt.

### Operational development driven by market signals/customer demand

- ▶ The mining sector has increased investment in data collection and storage, and new analytical processes and techniques could offer insights to mine managers to retain value typically captured by commodity traders. Digitization of ore body knowledge could unlock potential reserves from what were previously deemed as uneconomical deposits. As grades continue to decline, capturing more value from known resources will increase the life of assets and improve return on capital deployed.
- ▶ Aligning operating asset investment through innovative analysis of mine-planning models could better align production volume with market conditions. Asset owners are now holding data that could better inform resource allocation and achieve improved returns.
- ▶ Driving the commercialization of research initiatives that improve the recovery of mined product once it is out of the ground. New beneficiation and mineral processing techniques could add more value to commodities and allow for differential marketing.
- ▶ Developments in renewable energy sources could allow cost-effective mining and processing of previously "stranded" or uneconomical resources. See EY's *Renewables in mining: futuristic or realistic?* for more detail.

- ▶ Dynamic production and sales planning could allow mining companies to take advantage of short-term market shortages to improve pricing without impacting production volumes. There is not only a requirement for full transparency of the supply chain from pit to port, but also for the rapid translation of market signals into decisions, to exploit this advantage.

## Innovative supplier agreements

- ▶ Asset owners are now driven to improve flexibility to react to changes in the market, e.g., by evolving relationships with key suppliers to cover activities such as maintenance.

"Over time we have attempted to get more and more of our supply contracts with performance-related factors in them, but we're certainly not to the level that we want to be."

- ▶ Build long-term commercial relationships that can be sustained through the mining boom and bust cycle to develop new technologies that will give the mining company first-mover advantage and encourage broader sector productivity.

# The way forward

# 05



Productivity is an issue on the CEO's agenda, and needs a CEO solution to be resolved. CEOs are in the unique position of being able to drive and lead end-to-end solutions and transform a business, in a way that functional general managers cannot address. But to truly integrate, the entire leadership team will need to be engaged.

While the business's objectives may not have changed, a refresh or review of the operational strategy can be an excellent tool in not just changing the focus of the business, but also in initiating a change in the culture. A new operational strategy is a great way to drive a common sense of purpose and unity within a leadership team and focus it on resolving the critical issue of integration as a way of transforming a business.

A strategy does not have to last forever; a strategy that is focused on driving change and delivering value, even if it only lasts a couple of years, is a valuable exercise. In our view, the operational strategy should address the following key factors:

- ▶ **Management of complexity:** Identify the complexity within the business and come up with alternative strategies to reduce and manage this complexity.
- ▶ **End-to-end focus:** Break down silos that may have been created and involve each element of the value chain in driving and creating value.
- ▶ **A supportive culture:** Engage the whole workforce in addressing the issue of productivity, and embed a sense of discipline and focus around key business issues.
- ▶ **Data enablement:** Look for opportunities to integrate data from both currently available sources and big data, into decision-making.
- ▶ **Innovation:** Challenge the status quo or the way things were done before, and look for new ways to operate a 21st century operation.

Ultimately, companies that can successfully improve productivity will be well-positioned to take advantage of growth opportunities when, true to the sector's cyclical nature, new capital investment returns.

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

With increasingly positive sentiment in the sector, miners are focused on restoring balance sheet strength and liquidity in preparation for growth. The sector's key opportunity is still productivity. Although many have made productivity improvements, the critical next wave of gains needs a strong focus on loss elimination, with digital being a key enabler.

EY has significant experience in assisting companies to evaluate and implement strategic initiatives, with deep sector knowledge to support you on finance initiatives, such as portfolio optimization and capital planning, and through to operational improvement programs, such as productivity and digital enablement.

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