

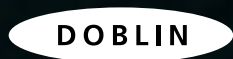
Monitor
Deloitte.

**Innovation in mining
Australia 2016**
Create. Change. Illuminate.



Contributors

Monitor
Deloitte.



Foreword

The Australian 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 industry's focus on maximising volume during the boom phase of the cycle, inefficiencies became embedded in operations, organisational structures and in back office functions. When the cycle turned, the industry shifted its focus to unrelenting and often brutal cost-cutting efforts, followed by successes in operational excellence and continuous improvement. With so many gains now realised, the industry has to ask itself, where to from here?

We've found a local industry well-placed to lead the world in mining innovation, and with a consensus that it is true innovation that will drive the next wave of productivity gains and financial growth. Yet our study revealed that despite this recognition and our industry capabilities, many barriers still exist to the wholesale adoption of innovation within companies.

Firstly, while many companies ask innovation actions of individuals, they fail to recognise that innovation is a team sport that requires all players to participate. Secondly, people tend to conflate innovation with creativity – however innovation should be recognised as a discipline, not an innate skill. Like any other business function, innovation has tradecraft that can be learned, practiced and honed.

For any business imperative to be taken seriously, it must have a clear set of measurable results. Innovation is no different. When we start to measure our innovation efforts, we will start to see truly transformative changes to our industry take place.

Lastly, innovation should no longer be an ask, but a demand. As executives, employees, shareholders and policy makers, we should set a mandate for the Australian mining industry to innovate. We must set ourselves the task of creating an environment where innovation thrives and where the Australian mining industry is recognised by global leaders as setting the new world standards for innovation.

About the study

The Innovation in mining: Australia 2016 study (or the 'study') was conducted by Deloitte in association with Diggers and Dealers and the Association of Mining and Exploration Companies (AMEC).

This is the third study examining current perspectives on mining innovation around the world. By conducting executive interviews and using the Innovation Scorecard survey methodology developed by the Deloitte innovation unit, Dublin, the aim of this study – as well as the others in the series – was to:

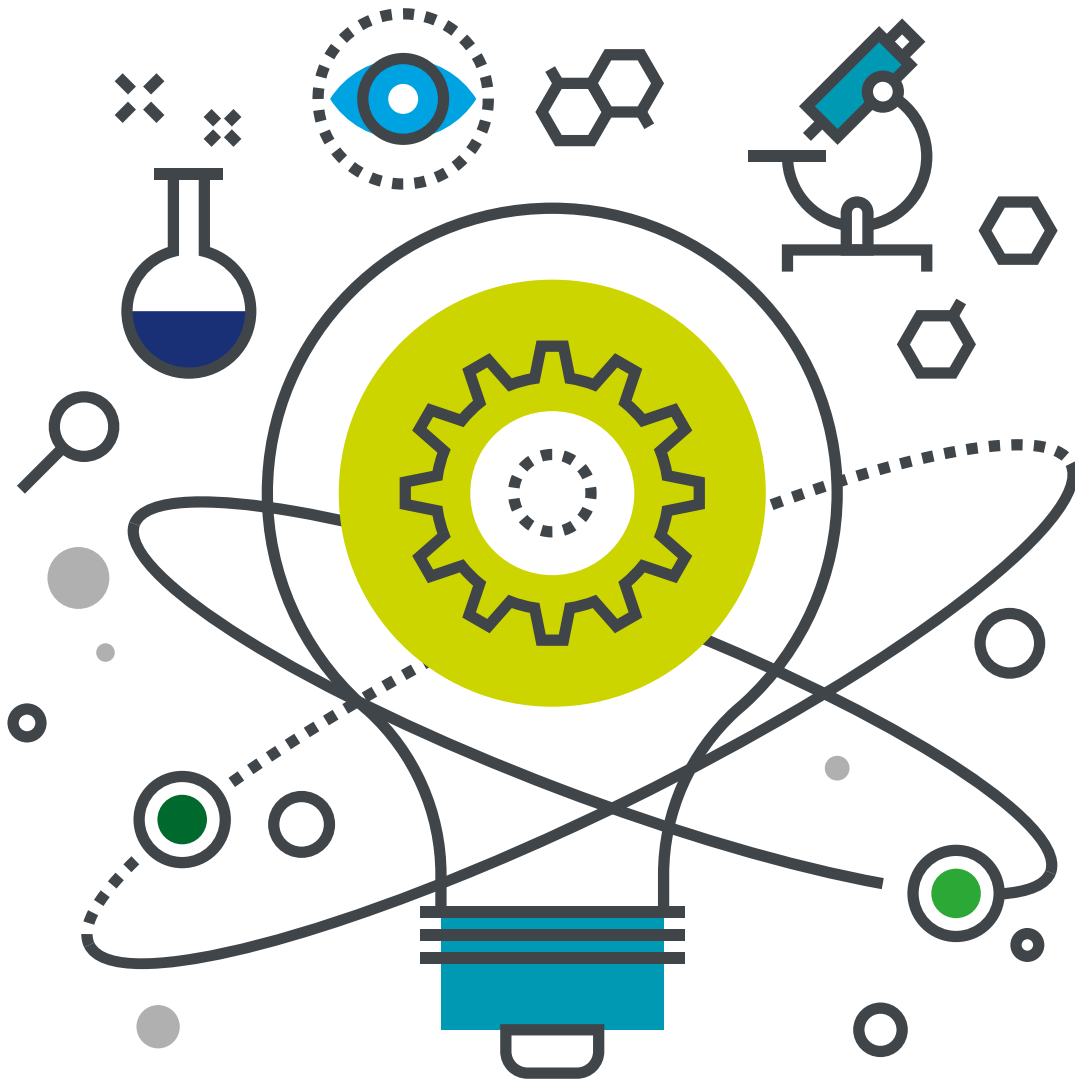
- Assess participants' current innovation efforts
- Build a deeper understanding of key pain points and gaps in companies' innovation capabilities
- Explore the broader issues the sector faces and hopes to resolve by becoming more effective at innovating
- Assess the role of innovation in mining
- Pinpoint where innovating in different areas (or types) can unearth greater business value.

This report builds on the findings of the prior two studies: the first of which was conducted in Canada in 2015 by Monitor Deloitte and The Prospectors and Developers Association of Canada (PDAC), and the second of which was undertaken in Africa by Monitor Deloitte and Mining Indaba in 2016.

Like the two previous surveys in the series, this study sought to obtain a greater understanding of how mining companies are innovating in order to identify ways to strengthen and enhance their efforts. However, unlike the previous two surveys, this study had the benefit of comparing the innovation activities among mining companies in Australia today with the activities undertaken by mining companies in Canada and Africa over the past 12 months. The findings reveal that much progress has been made since then and that Australian companies today are further along the maturation

continuum concerning certain aspects of their innovation practices. Indeed, the mining industry as a whole has moved on considerably, and a broad consensus has been reached that innovation will play a central role in lifting productivity and driving growth. Despite this general awakening to the innovation imperative, a tremendous amount of work has yet to be done in order to move innovation out of the realm of discussion and into the realm of systematic action.

The remainder of this report presents the findings of the study, explores what they may mean for the sector, and suggests some possible answers to the question of: 'Where to from here?'



“The suggestion is not to pursue innovation for its own sake, but to look for ways that innovation can unleash the next wave of productivity and cost cutting. Right now, the mining industry is at a tipping point as it tries to identify strategies to make innovation deliver bottom-line value.”

Andrew Swart, Global Mining Innovation Lead, Deloitte Canada

The current state

It's time to decide.

As mining companies continue to endure the downturn, operational excellence remains the main focal point of the industry.

While companies have generally succeeded in creating more efficient operations, the law of diminishing returns is now setting in. This has focused companies' attention on innovation as the means for driving the next wave of productivity gains, along with a realisation they have to work smarter, not harder.

Our own research has shown that high performing companies approach innovation in a holistic way, going beyond the continuous improvement of existing products and processes. Even more importantly, this research shows that the more types of innovation companies pursue, the greater the return to shareholders.

The study findings indicate that the industry is on track to becoming more proficient at innovating, and ultimately at generating more bottom-line value from it. Mining companies understand that innovation is the path to greater productivity as well as to long-term sustainability, but most of their attention is still centred upon innovating to drive short-term performance. This short-term emphasis on boosting earnings appears to have blurred the line between continuous improvement and pure innovation.

The Australian mining industry is at a critical juncture where companies must decide if they are willing to go beyond the basics of operational improvements to embrace innovation in a broader sense. This would require a significant commitment to developing their innovation capabilities over the long-term.

Among the 31 mining companies involved in the study (majors, juniors and service companies alike), 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. Despite this, most respondents indicated that they presently do not have the resources, metrics or incentives needed to broaden their innovation programs and to produce longer-term transformational outcomes. They also recognised collaboration is a key enabler that needs more emphasis.

This report has been designed to help the Australian mining industry adopt a systematic approach to innovation, moving the field from a mysterious art to a disciplined science. It seeks to illuminate the way forward by highlighting some of the progress that has already been made and provide a framework for achieving full innovation maturity.

What does innovation really mean?

Through overuse, misuse, hype and enthusiasm, the word innovation has essentially lost its meaning. To provide greater clarity, Doblin, the innovation unit of Deloitte, offers the following definition: Innovation is the creation of a new, viable business offering. Simple enough, but more to the point:

Innovation [as separate from invention] is the creation of a new [to our market or the world], viable [creating value for both our customers, stakeholders and ourselves] business offering [ideally going beyond products to platforms, business models and customer/ stakeholder experiences].

While the desire or imperative to innovate is as old as business itself, innovation is too often asked to solve both the problem *du jour* (reducing capital intensity, for instance) and every other problem at hand.

However asking so much of innovation can dilute an enterprise’s capacity to use innovation to its greatest advantage. That’s why Doblin not only provides a useful definition of what ‘innovation’ signifies in a business context, but it also offers a multi-faceted approach for embracing innovation, i.e., helping companies to generate ‘new viable business offerings’ that earn disproportionate returns and are more difficult for competitors to copy. This approach begins with a simple framework, whereby innovation occupies one of three ‘ambition levels’ (see Figure 1), which define its purpose or result:

- **Core** innovations optimise existing assets, products and services .
- **Adjacent** innovations incrementally expand existing business into ‘new to the company’ business.
- **Transformational** innovations are breakthroughs and inventions that are new to the industry or the world.

Ambition levels serve not only as a useful way to align activities with the goals and objectives that innovation aspires to achieve, but also as a framework to manage innovation investments.

Our research suggests that the most successful innovators manage their innovation efforts and investments as a portfolio of activities that is balanced across the three ambition levels (see Figure 1). While every company’s circumstances are unique, the world’s leading industrial innovators have on average 70% of their innovation investments and activity occurring at the Core level, 20% at the Adjacent level and 10% at the Transformational level. However, even the leaders may not be realising optimal benefits from their innovation efforts since returns on innovation investment tend to work in the reverse order: 70% from Transformational innovation, 20% from Adjacent and only 10% from Core.

Figure 1. Innovation ambition levels

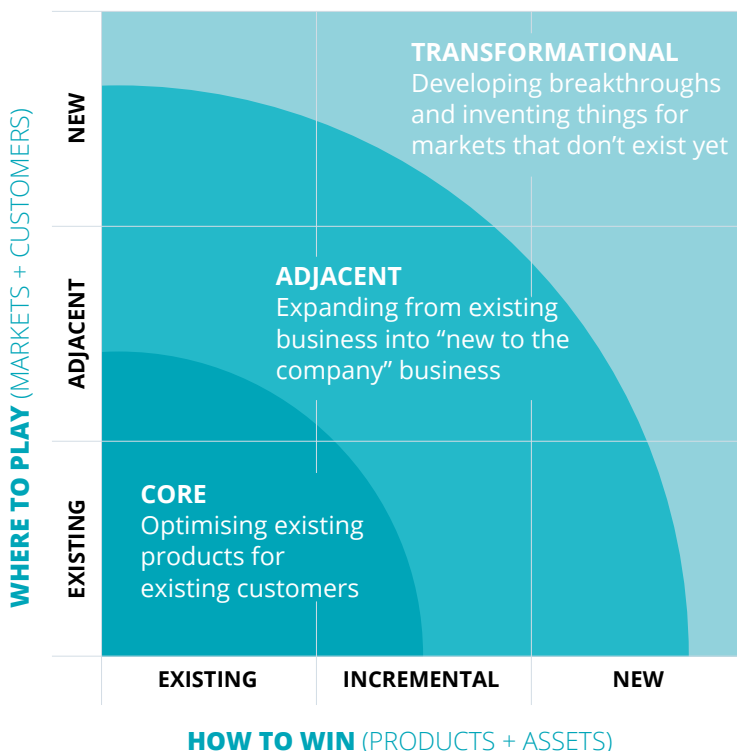
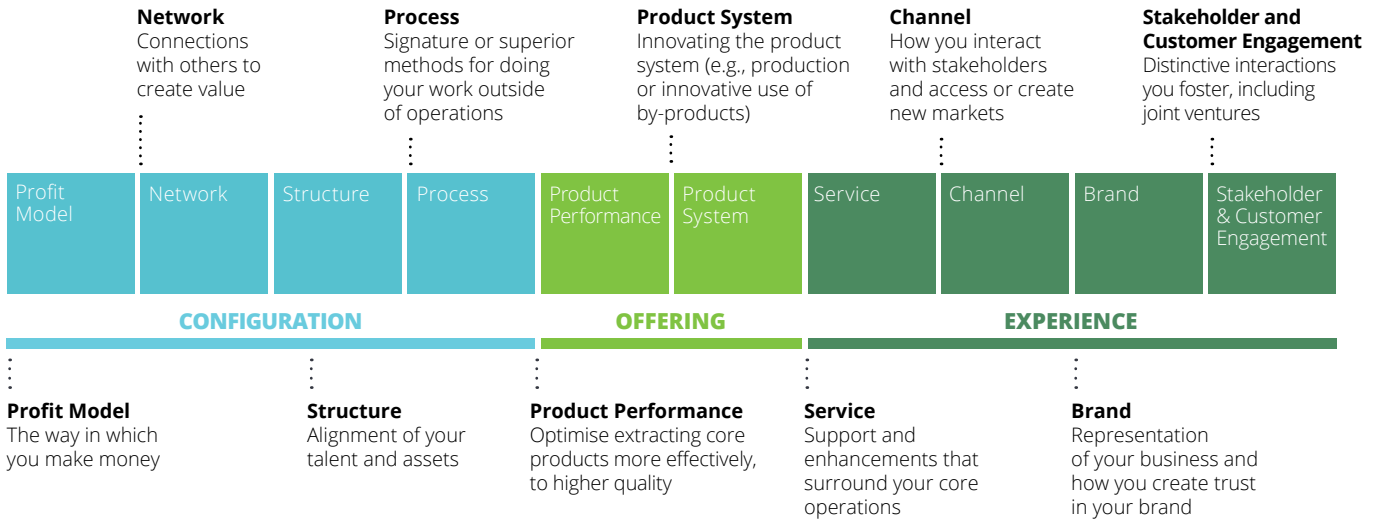


Figure 2. Ten types of innovation



In your own words

“We tend to have taken a technology-focused view to innovation; however, we need to be more innovative in our entire approach as a company.”

Major

To successfully develop more Adjacent and Transformational innovations, mining companies will need to push beyond the current focus on product innovation and expand their view of where and how they can innovate. The second part of our multi-faceted approach helps companies to think about innovation more broadly by identifying ten distinct types of innovation across three categories (see Figure 2):

- **Configuration** innovations apply to profit models, networks, structures and processes. This comprises the 'back of the house' activities needed to develop the offering.
- **Offering** innovations apply to product performance and product systems. This is what companies produce.
- **Experience** innovations apply to services, channels, brands, and stakeholders. This is how an offering is delivered to customers and how stakeholders are engaged as a company performs its business activities.

Outperformance by the numbers

Why does a broader approach to innovation matter? Deloitte research shows top innovators outperform the S&P 500 in relation to how many different types of innovation they pursue (see Figure 3). This is important for mining companies questioning where the next wave of productivity will come from. Broadening one's approach to innovation could open up a host of new possibilities for expanding margins and growing revenue. And, in refining that approach, the research also shows the most shareholder value accrues not from Offering innovations (i.e. Product Performance or Product System), but rather from Configuration innovations or Experience innovations, since Offering innovations are often easier to duplicate.

That's why leading mining companies are beginning to pursue innovation more broadly. Examples include Rio Tinto using driverless trucks (i.e. Offering) and BHP Billiton hosting a hackathon to foster open-source collaboration (i.e. Configuration), along with launching its 'World-class Supplier' program in Chile.^{1,2} Through this program, BHP Billiton challenges suppliers to resolve specific business problems, while helping them to develop their capabilities to do so (i.e. Experience and Configuration).

1. <http://unearthed.solutions/events/unearthed-minehack-perth-2016/>
 2. <http://www.bhpbilliton.com/society/ourcontribution/world-class-supplier-program>

Figure 3. Five-year indexed stock price returns of the top innovators vs. S&P 500



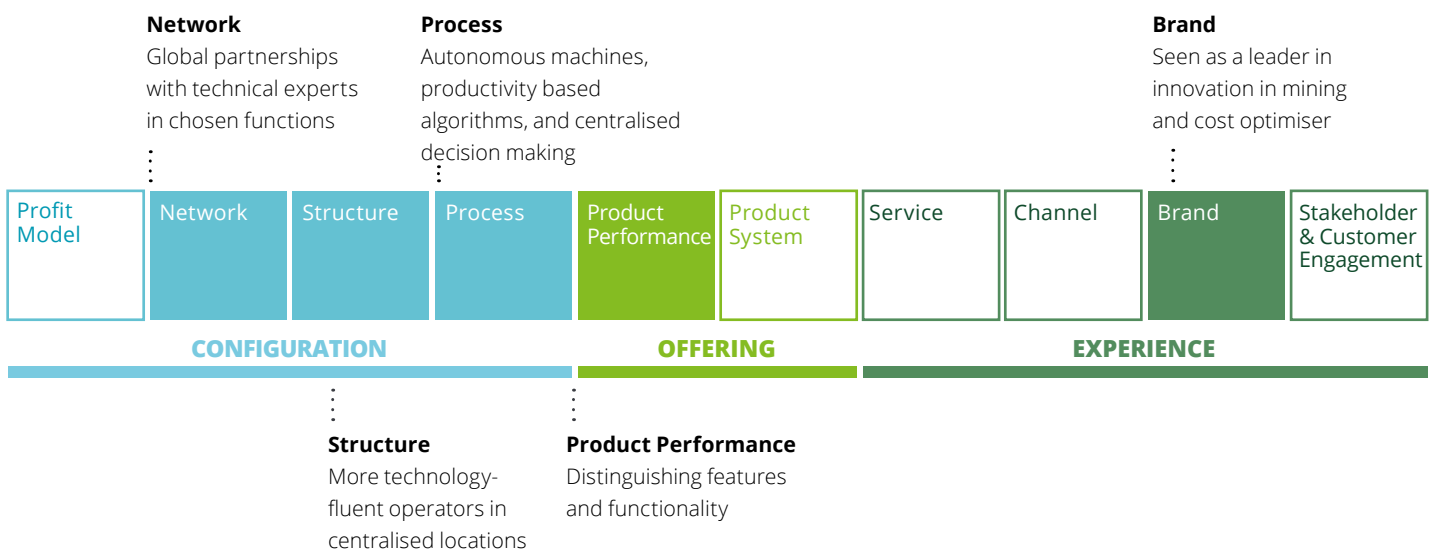
Innovation in action

In 2008, the price of iron ore, at approximately US \$60/tonne, was triple what it was only five years earlier. With Chinese GDP growth just below double digits, it appeared that the iron ore market would remain strong for some time to come. Nonetheless, around this time, Rio Tinto launched its Mine of the Future™ initiative, not only to capitalise on the boom but to invest in sustainable performance.

The program centres upon driving production while improving health, safety & environmental performance through greater automation, and it produced five types of innovation in pursuit of this goal (refer Figure 3.1). When the cyclical downturn came, the company was able to safely navigate the drop in iron ore prices. Today, Rio Tinto is widely recognised as a leading innovator and as one of the lowest cost producers of iron ore in the world.

Source: <http://intheblack.com/articles/2015/11/01/why-iron-ore-prices-dont-worry-rio-tinto>; and, www.riotinto.com/

Figure 3.1. Mine of the Future™ achieved five types of innovation through a single initiative



In your own words

“We use a similar approach throughout the business to promote new ideas and innovation via a standard management system and software package to advance projects from ideas to implementation.”

Major

“Innovation is an embedded key element of our culture, with formalised processes around idea generation, review committees, in-house engineering capability, project implementation teams and feedback loops. Leveraging innovation is fundamentally important for us to remain ahead of the competition by reducing unit costs of operation, while adding capability and improving safety.”

Service provider

Building capability in innovation

In order to outperform the competition and drive higher levels of productivity and growth, mining companies must mobilise their innovation efforts beyond the technical R&D groups and into the wider organisation. Doblin notes that leading companies typically exhibit capabilities across four key building blocks (see Figure 4). Furthermore, each of these four building blocks is associated with specific capability levers (12 in total) that organisations need to focus on to embed innovation into their structures and move towards being a serial innovator.

A closer examination of how successful serial innovators use their building blocks and capability levers suggests:





1. They employ a tailored Approach built around clear definitions and methodologies for the work to be done in generating innovations – phases, activities, deliverables, and decision rights. Furthermore, they manage their innovation efforts as a portfolio across Core, Adjacent, and Transformational innovations.
2. They structure the Organisation to house the innovation competency (i.e., teams, divisions, and leadership) and established interfaces for connecting it to the broader enterprise and the world. Driving Adjacent and Transformational innovation, which is where the greatest value typically lies, often requires new organisational structures and interfaces.

These can include 'greenhouses' that both retain knowledge and stimulate innovation; service centres that use distinct expertise to support the innovation efforts of different business units; and highly distributed systems where most employees have some innovation responsibility. The two constants are: 1) the preferred structure(s) must foster collaboration across functions and divisional silos without being impeded by internal bureaucracy or politics; and 2) they must interact well with the existing business units.

3. They acquire and nurture the appropriate Resources and Competencies, i.e. the people who perform the work of innovation; the skills, tools, and training they need to do it capably; and, the funding and time to fuel it. An insular approach that relies mainly on personnel from technology or R&D groups is limiting and misses the broader opportunity of driving innovation into the rest of the business.
4. They develop the right Metrics and Incentives with targets to guide performance, i.e. measures to evaluate progress, and incentives (monetary and non-monetary) to drive the supporting behaviours.

Leaders need to be collaboratively-oriented, not just functionally-focused, if they are to drive innovation most effectively. This orientation rarely happens on its own: innovation leaders need to be developed alongside innovation capabilities.

Figure 4. Innovation building blocks

 APPROACH	 ORGANISATION	 RESOURCES AND COMPETENCIES	 METRICS AND INCENTIVES
<ol style="list-style-type: none"> 1. Innovation strategy Goals for innovation and thematic opportunities to pursue 2. Pipeline and portfolio management How the collection of innovation initiatives are managed in a pipeline and portfolio 3. Process How innovations move from abstract hypotheses and ideas to launched businesses 	<ol style="list-style-type: none"> 4. Senior leadership How senior leaders engage with innovation 5. Governance How and by whom innovation decisions are made 6. External connection Mechanisms for identifying and leveraging external capabilities, partnerships, and solutions to deliver innovations 	<ol style="list-style-type: none"> 7. Funding The amount of financial resources devoted and the mechanisms for accessing the funding 8. Talent management Attracting and deploying those with the right skills at the right time to do the work of innovation 9. Innovation tools Specialised protocols, software, techniques, etc. for different aspects of innovation 	<ol style="list-style-type: none"> 10. Financial and non-financial rewards Monetary incentives, formal and informal recognition of contributions to innovation 11. Innovation metrics Targets and indicators to guide innovation decisions and measure progress 12. External attraction How you foster and incentivise other organisations or groups to participate in innovating on your platforms

Innovation in the Australian mining industry

While the industry has done well in creating more efficient operations, the law of diminishing returns is becoming increasingly evident regarding additional streamlining efforts.

This has focused the industry's attention on innovation to drive the next wave of productivity gains by allowing companies to work smarter not harder. Accordingly, the view towards innovation in the mining industry is overwhelmingly positive and companies are unanimous in their belief that innovation is the key to future success and growth. However, most companies still favour pursuing operational excellence, continuous improvement, and cost-reduction over investing in Transformational innovation. Study participants cited several reasons for the disconnection between acknowledging the need to innovate and acting on this imperative in a systematic way.

One of these reasons is the conservative nature of the industry and the culture of being a 'fast follower.' Mining is inherently a risky business in terms of orebody uncertainty, commodity price volatility, and physical hazards, both to people and the environment. Therefore, some companies are reluctant to take on additional risk associated with innovation, especially if it could impact cash flow or their licence to operate. In today's economic environment, a minor operational delay caused by piloting a new process or technology innovation could prove crippling. This has led to the view that it is good to be second when it comes to doing things differently.

Another factor that inhibits innovation is the sector's propensity to focus on short-term bottom-line improvements to the detriment of longer-term growth. For many mining companies, the intense focus on maximising production volume during the boom years has resulted in inefficiencies becoming deeply embedded in their businesses. When the downturn came, they naturally focused on eliminating these inefficiencies by slashing costs and headcount. In many respects, this relentless focus on belt tightening, which diverted attention and investment away from innovation, created a short-term operationally-focused mindset that continues today.

In your own words

"We want to be first to be second."

Major

"For all intents and purposes, we see little true innovation. While being innovative is something we will seek out, our primary focus is on continuous improvement and a better bottom line, without compromise to safety, quality, production and the service we provide."

Major

"Innovation is limited at this stage due to cost constraints."

Major

In your own words

“When our clients don’t communicate well and involve us in their operations and planning, we can’t be effective in our innovation capabilities to assist them.”

Service provider

Furthermore, many of the brutal cost-cutting measures implemented during the downturn hit service providers and other ecosystem participants hard. Participants noted lingering resentment over pricing demands and that swiftness with which relationships were curtailed was inhibiting collaboration. This is particularly problematic considering that the inexorable striving toward ever-leaner operations has pushed innovation outward. As explorers and miners operate in increasingly challenging environments, they are looking to collaborate with outside partners to help them develop low-risk, cost-effective solutions. However, for many mining companies, collaboration, both internally and externally, appears to be sporadic at best.

In addition to lingering resentment, there are other barriers to collaboration. The interoperability of original equipment manufacturer (OEM) systems and fears of jeopardising the security of intellectual property remain a challenge to the fluid exchange of ideas across internal silos as well as among external ecosystem participants. Nonetheless, there is a clear need to repair relationships and embrace strategic alliances with suppliers, universities, industry bodies, collaborative research centres (CRC's) and the likes of the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

The situation is such that mining companies can no longer afford to go it alone. Diversity of thinking will be essential to creating the steady stream of innovations needed not only to deliver the next wave of growth and productivity, but also to build sustainable business models over the long run.

Some believe this will require a significant investment, involving capital that mining companies presently do not have. Juniors, however, have demonstrated that this is not necessarily the case. They lack the funding and expertise for continual innovation in an isolated setting. However, while their resources are limited, they do not lack for problems to solve. Notably, a culture of open innovation has emerged within this group, and out of necessity, they have become adept at leveraging external partnerships to find solutions to complex problems. They also tend to benefit the most from government incentives, having learned how to stay abreast of policy changes and to take advantage of what is being offered.

Service providers are also demonstrating that advancements can still be made amid difficult economic conditions. R&D activity has shifted to the service industry over the past decade as mining companies cut back on their R&D departments. This has revamped the role of service companies. Today, they act as a catalyst for innovation by developing mostly pre-competitive technology that is made available to the entire industry.

In your own words

“Innovation is currently the buzzword in the mining industry, and the focus is on new collaborative ways of working together to solve some of today’s biggest mining challenges. Things like open innovation, hackathons, new operating models and technology partnerships between small and large mining equipment, technology and services (METS) companies are being used to change the paradigm of how the mining industry operates.

Innovative METS are characterised by visionary leadership, world-leading products and services, international focus and a high level of connectivity. This includes having a strong network both in Australia and abroad, as well as learning from, networking with and leveraging those connections for commercial opportunities”.

Christine Gibbs Stewart,
CEO of Austmine

Innovation in action

The iron ore price crash in April 2015 provided the catalyst for step change. Atlas Iron, which was under duress, needed a solution – and fast. The company's key contractors came to the table to assist. The group created a new profit model (i.e., Configuration innovation) that linked the company's outsourced providers to productivity, cash flow and net operating profit. As a result, the company's contractors now have skin in the game across the whole supply chain and own equity in Atlas. This not only put the company on a better financial footing but also gave it a new platform for driving further innovation.

Indeed, throughout the entire Australian sector, there are positive signs that mining companies grasp the need to take a structured approach to innovation and to work with others in developing and deploying new ideas. For instance, collaboration ecosystems have recently proliferated in the form of:

- **Open industry forums** where a mining company presents an issue and suppliers and other members of the mining ecosystem brainstorm about how to resolve it. These gatherings represent an interesting, collaborative way to attack an issue and determine what to do next.
- **Hackathons** where a large number of people meet to engage in intense, collaborative software development aimed at rapidly resolving a specific problem. When these first started, mining companies were reluctant to engage in them due to data privacy issues, but now are getting more comfortable with the concept and hackathons are growing in popularity.
- **Mining innovation hubs** through which multiple stakeholders connect and collaborate. They often engage technology start-ups, businesses and industry leaders with finding creative solutions to resource challenges in mining.

In addition to these collaborative mechanisms, mining companies have been showing greater interest in leading-edge technologies, and while they aren't rapidly adopting them, they are considering new ways of doing things. Some of these technology enablers could prove to be genuine game-changers, according to Tracking the Trends 2016, Deloitte's eighth annual examination of international mining sector trends.

Innovation in action

Alcoa is expanding its 3D metal printing capability, also known as additive manufacturing. This innovation could transform the mining sector by condensing, or even eliminating, complex supply chains and the associated costs of managing them. Through 3D metal printing, parts can be produced in their entirety with minimal materials, thus eliminating the need for complex component assembly. In addition, 3D-printed parts, which can be made to exact specifications, can be lighter and more geometrically complex than those manufactured in traditional ways. This facilitates even greater innovation, as it allows parts to be produced in the precise shapes needed to improve the performance of other system components.

Source: <http://www.wsj.com/video/3-d-metal-printing-and-the-future-of-manufacturing/774F8B33-BD61-4864-B31E-4E41CF054F6D.html>

The report, which also presents possible solutions to shared problems, identified a few technologies that could potentially alter the trajectory not only for miners, but also for industry in general:

- **Networks** – Servers, personal computers, mobile devices and sensors of all kinds can increasingly connect to the Internet – and to each other. With the cost of sensors dropping, it is becoming more feasible to collect data on a wide variety of mining equipment. This is empowering OEMs to offer uptime guarantees designed to virtually eliminate all unplanned maintenance. This can only happen, however, if mining companies are equipped to share operational data with their suppliers. Given the unquestionable advantages of ensuring continuous equipment uptime, some companies are exploring the feasibility of adopting cloud-based, integrated IT platforms to facilitate collaboration with suppliers.
- **Machine learning** – The move towards autonomous vehicles and robotic process automation has already revolutionised mine operations. As the “intelligence” of these machines grows, they will be able to perform increasingly complex tasks, including hazardous processing activities. This will likely result in reduced labour costs and enhanced safety and productivity. As an end game, companies could ultimately operate fully autonomous mines, concentrating labour in centralised functional hubs rather than in remote regions.
- **Genomics** – In a meeting of the sectors, medical gene research has spawned unanticipated genomic mining solutions, such as the use of bacteria capable of extracting minerals in situ, and bio-remediation processes that use natural enzymes to clean sites contaminated by metal leaching and drainage. While still relatively new, genomics solutions have already been used to bio-remediate polluted soils, improve mine drainage and mitigate threats to biological diversity through bio-monitoring.
- **Wearables** – By incorporating computer and advanced electronic technologies into clothing and accessories (i.e., hats, glasses, gloves, watches, etc.), miners stand to realise a range of unprecedented advantages from wearable technologies. For example, wearable devices can track truck-driver fatigue to cut down on accidents. By pinpointing the exact location of underground workers, they can also allow mine operators to ventilate, heat or cool only occupied areas of the mine, thus reducing energy costs. Wearable devices can even signal if their wearers are in physical distress, enabling rapid response in the event of accidents or injuries.
- **Hybrid airships** – Lockheed Martin has recently developed and commercialised giant hybrid airships that would enable mining companies to haul equipment and fuel to remote regions that lack accessible roads. Costs for the airships are comparable to truck transport over hazardous roads, and considerably cheaper than helicopter transport.

Innovation in action

Autonomous haulage essentially eliminates the need for drivers. One worker at a computer screen can monitor multiple driverless trucks, allowing greater amounts of material to be moved safely and efficiently. While Rio Tinto has the largest fleet of autonomous trucks in the Pilbara, with about 70 presently in operation, BHP Billiton and Fortescue Metals Group use autonomous trucks as well. With several successful implementations underway, and many more miners and equipment manufacturers running pilot programs, the movement toward autonomous haulage appears to be picking up speed.

Source: <http://www.smh.com.au/business/mining-and-resources/rio-tinto-pushes-ahead-with-driverless-trains-in-pilbara-20150309-13z28v.html>; and, <http://www.bloomberg.com/news/articles/2015-09-10/surviving-iron-ore-blood-bath-requires-a-lot-more-mining-robots>

Key findings

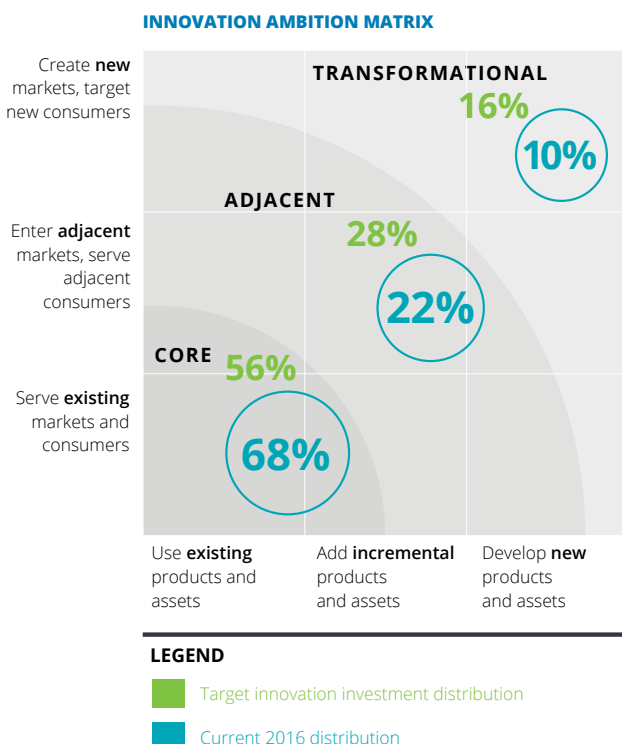
Across the industry, innovation ambition appears to be mostly focused on the Core level, with a strong emphasis on technological solutions to optimise old techniques as needed.

Innovation according to study participants is all about using technology to:

1. Reduce costs
2. Find better ways to increase production
3. Improve mineral recovery
4. Remove gangue (waste material) early in the process.

Based on the responses from study participants, the current breakdown in the region's mining innovation was 68% Core, 22% Adjacent, and 10% Transformational. While most companies are currently focused on continuous improvements and operational excellence (i.e., Core innovation), the industry does acknowledge the need to focus on Adjacent and Transformational innovation to a greater extent. As a whole, study participants are targeting a portfolio of 56% Core, 28% Adjacent and 16% Transformational, as shown in Figure 5.

Figure 5. Innovation ambition matrix



This trend line within the innovation matrix generally parallels those revealed in the Deloitte Canadian and African surveys. Around the world, mining companies acknowledge that they must look beyond Core-level product innovations, and re-balance their investment portfolios to aim much higher, ultimately aspiring to more Adjacent expansions and Transformational breakthroughs.

Both majors and service providers believe they should be doing more in the Adjacent and Transformational arena. Notably, service providers believe they should be pursuing opportunities in adjacent markets by incrementally expanding their portfolios of products and assets, possibly because they need to change the dynamics in their current markets. Meanwhile, majors are more intent on increasing their Transformational innovation. This may indicate the sector now realises it needs to shift its innovation focus toward more sophisticated efforts with greater impact (i.e., to work smarter and not harder) as the law of diminishing returns for cost-out initiatives takes effect.

In your own words

“Focus is not really on innovation but on reducing costs. Cost reductions have brought minor innovations but no big revelations.”

Major

“Innovation is developing the means to continuously improve efficiency and reduce costs in existing operations, assets and working processes.”

Major

Note on innovation ambition
 Less integrated companies often have difficulty spreading their risks and are less likely to adopt Adjacent and Transformational innovations in-house, or put another way, a low risk appetite gets in the way. Developing better external collaboration networks for innovation can be a way to overcome that barrier.

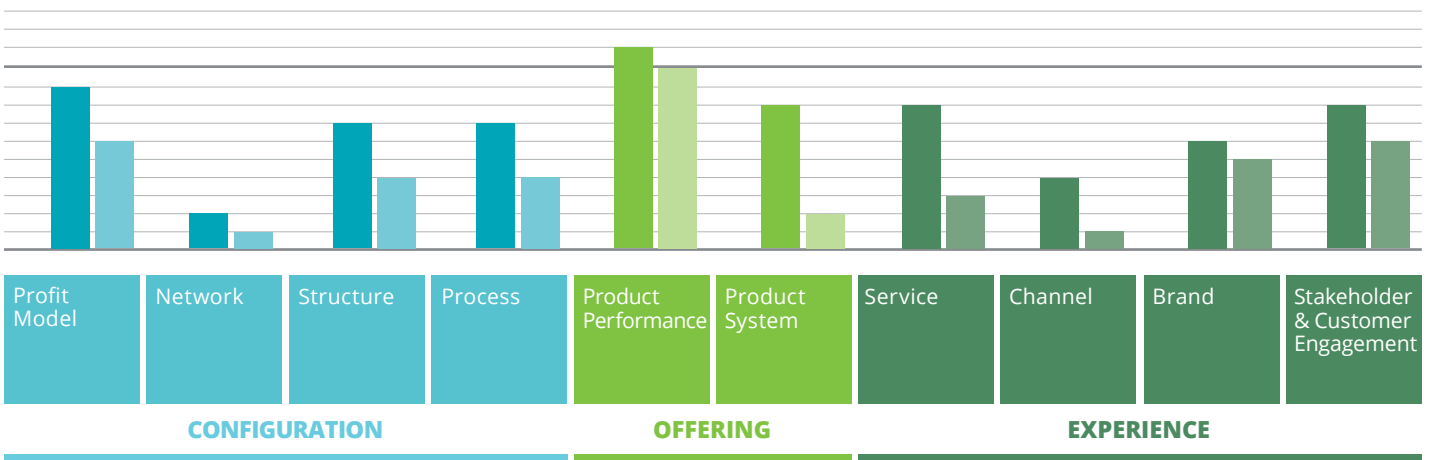
Innovation importance by type

As mentioned previously, Doblin identifies Ten Types of Innovation. Survey participants were asked to rate the importance of each type to the competitiveness of their companies. They were also asked to consider how effective their companies were at producing innovations within each type. By a wide margin, respondents identified Product Performance (i.e., optimising the extraction of core products more effectively, and to a higher quality) as the type of innovation most critical to maintaining their competitiveness, which was also true of the Canadian study.

In comparison, respondents in the African study rated Profit Model (i.e., the way in which companies make money) as the most important. The emphasis on Product Performance was not surprising, considering that Australia’s miners are still grappling with slowing demand and intense pricing pressures. Interestingly, the other type of product-focused innovation, Product System (i.e., the use of by-products) had the largest gap between perceived importance and companies’ effectiveness at it. This points to an opportunity: with companies generally rating this type of innovation as critical to their competitiveness, it seems they could benefit greatly from identifying why their efforts in this area are not coming to fruition.

Notably, there were some differences in how companies rated each type of innovation according to their roles within the mining ecosystem. Service providers, for instance, rated Stakeholder & Customer Engagement higher than other groups. Across almost all types of innovation, majors and service providers are generally more focused than juniors are. However, juniors did outscore majors in Structure (i.e., the alignment of their talent and assets), Process (i.e., signature or superior methods for work outside operations), and Product System.

Figure 6. Innovation focus across the Ten Types of Innovation



TYPE OF INNOVATION	IMPORTANCE	EFFECTIVENESS
Profit Model	3.9	3.6
Network	3.2	3.1
Structure	3.7	3.4
Process	3.7	3.4
Product Performance	4.1	4.0
Product System	3.8	3.2
Service	3.8	3.3
Channel	3.4	3.1
Brand	3.6	3.5
Stakeholder and Customer Engagement	3.8	3.7

LEGEND

Perceived importance by innovation type
 Perceived company effectiveness

In your own words

“Each operation has different needs and drivers. Where each one is [i.e., its situation] determines whether innovation is well-entrenched or not occurring.”

Major

Innovation drivers

Respondents were asked to identify what drives innovation within their companies, and to rank the importance of each factor. The findings, which mirrored the results of the previous two surveys in this series, indicated the Top 5 innovation drivers in the mining industry are:

1. Reducing cost to operate
2. Improved asset productivity
3. Reducing risk
4. Safety
5. Reducing cost to develop assets.

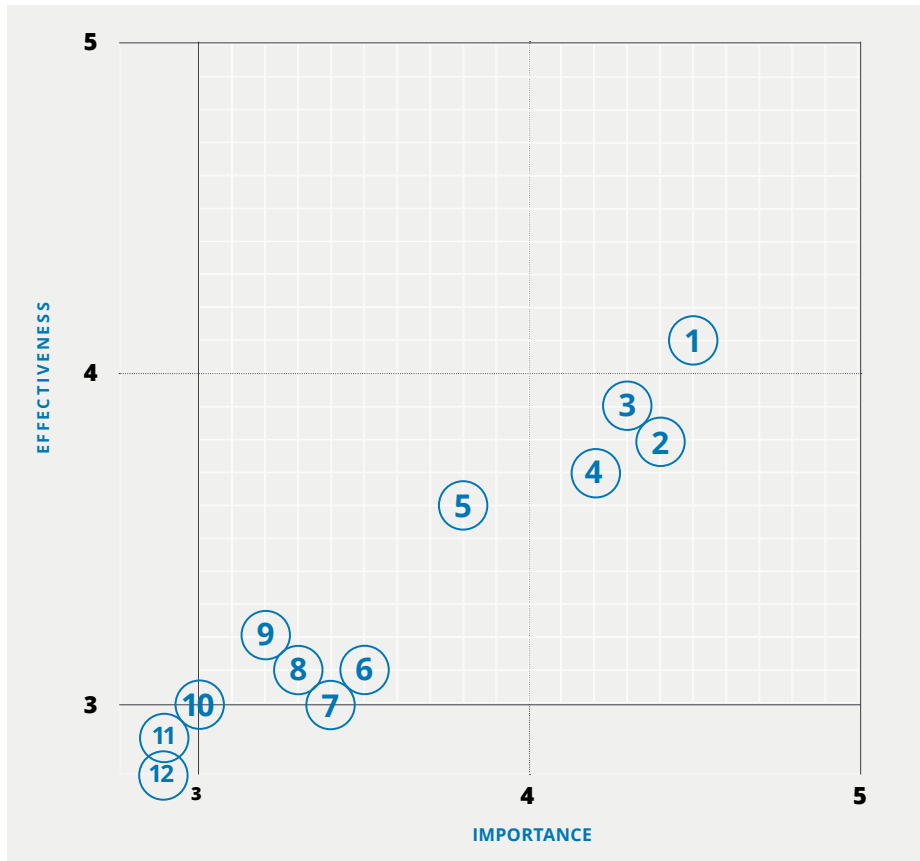
Innovation in action

A lithium explorer is looking to leverage disruptive technology to provide a low-cost, more efficient alternative to the expensive roasting process traditionally required to recover lithium and other metals from conventional minerals. The innovative process gives the explorer the ability to bypass third-party converters and to supply end users, mainly the battery industry, directly from the mine site. On a grander scale, the process could create a paradigm shift within the mining sector by allowing global lithium deposits to be re-evaluated, potentially turning geological curiosities into reserves.

When the differences between majors, juniors and service providers were analysed, majors indicated they are more driven to innovate by the need to improve vendor/contractor management, reduce cost to operate, reduce cost to develop assets, and improve back-office function effectiveness.

All three types of companies were also asked to identify how effective they believe they are at innovating in relation to each of the drivers (see Figure 7). Of note, perceived effectiveness generally lags behind importance across most of the drivers, although there were a few exceptions among the different types of companies. These exceptions included license to operate (majors and service providers), adding more high-value assets (juniors) and back-office function effectiveness (service providers).

Figure 7. Importance of innovation areas and perceived effectiveness with them



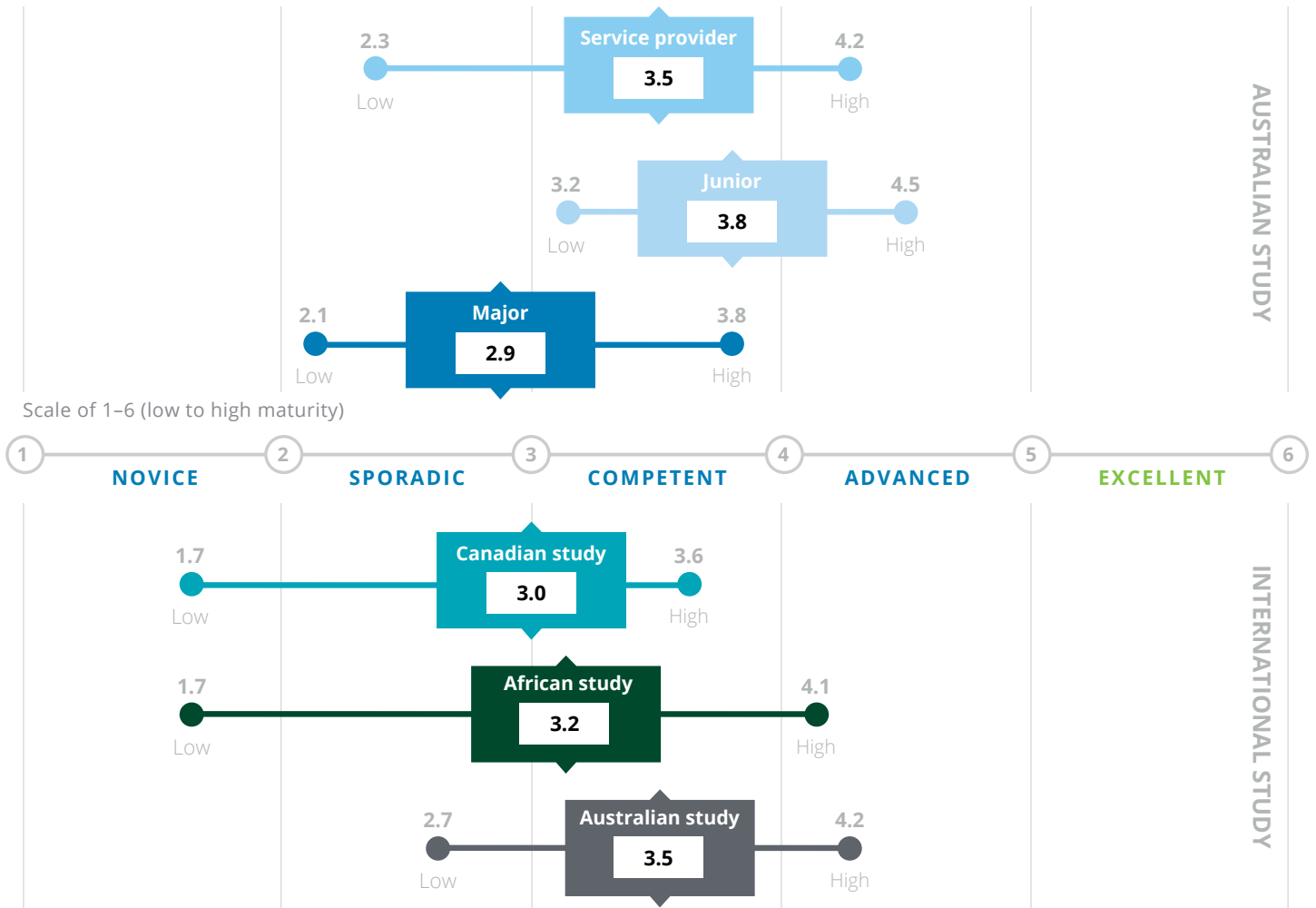
Innovation in action

Rio Tinto and Anglo American have deployed 'SmartCap' technology in numerous Australian coal mines, while BHP Billiton has deployed the technology in Chile. Resembling a standard baseball cap, the SmartCap contains sensors that monitor the wearer's alertness, allowing workers to judge their ability to perform and consequently manage their fatigue. Since fatigue is one of the main causes of accidents involving heavy mobile equipment, this 'wearables' innovation is a natural fit for improving safety performance within the mining industry.

Source: <http://exms.co.za/pdf%20files/SmartCap%20Overview%20RSA%202013.pdf>; and, <http://smartcapchile.cl/EN/>

INNOVATION DRIVER	IMPORTANCE	EFFECTIVENESS
1. Reduce costs to operate	4.5	4.1
2. Improved asset productivity	4.4	3.8
3. Reducing risk	4.3	3.9
4. Safety	4.2	3.7
5. Reduced cost to develop assets	3.8	3.6
6. Adding more high-value assets	3.5	3.1
7. Improved vendors/contractors management	3.4	3.0
8. Improved employee relations and retentions	3.3	3.1
9. Improving time to develop assets	3.2	3.2
10. Improved license to operate – regulatory relations and compliance	3.0	3.0
11. Back office function effectiveness	2.9	2.9
12. Improved license to operate – landowners, indigenous Australian affairs, environmental groups	2.9	2.7

Figure 8. Junior miners see themselves as more mature innovators than majors



Novice
Highly random efforts

- Innovation capability is not considered a key strategic imperative.
- No disciplined approach to innovation; haphazard processes, governance, and resourcing are the norm.

Sporadic
Fragmented efforts

- Need for systemic innovation capability often recognised.
- Pieces of an innovation system begin to emerge.

Competent
Increasingly repeatable

- Systemic innovation capability is nascent. Leadership is taking action to develop maturity.
- Pockets of reliable and repeatable processes, governance and resourcing are surfacing.

Advanced
Systematised efforts

- Critical capabilities for innovation functioning as a cohesive system are being developed.
- Clear innovation strategies are emerging and an innovation system is well defined.

Excellent
Adaptive capability

- Innovation becomes an organisational core capability.
- Innovation systems are refined and specialised capabilities are created to adapt to new opportunities and accelerate outcomes.

Industry maturity

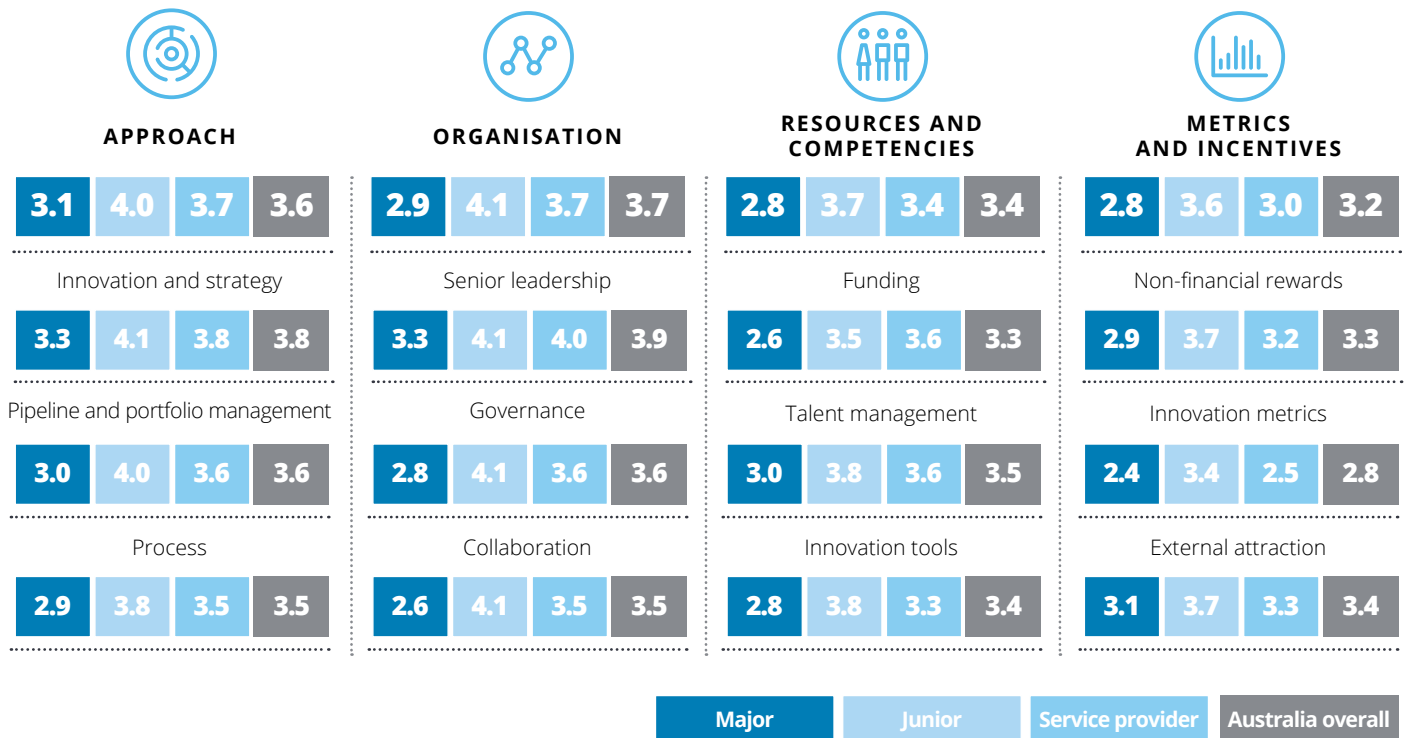
Figure 8 shows the scale used to measure the extent to which companies have integrated innovation into their organisations—their relative innovation maturity. Scoring low on the scale (1-2) suggests innovation efforts are more random, haphazard and lacking discipline—characteristics of a novice. Scoring at the other end of the scale (5-6), are those who regard themselves to be truly excellent innovators, demonstrating adaptive capabilities that are ingrained within their organisational cores and supported by refined innovation systems.

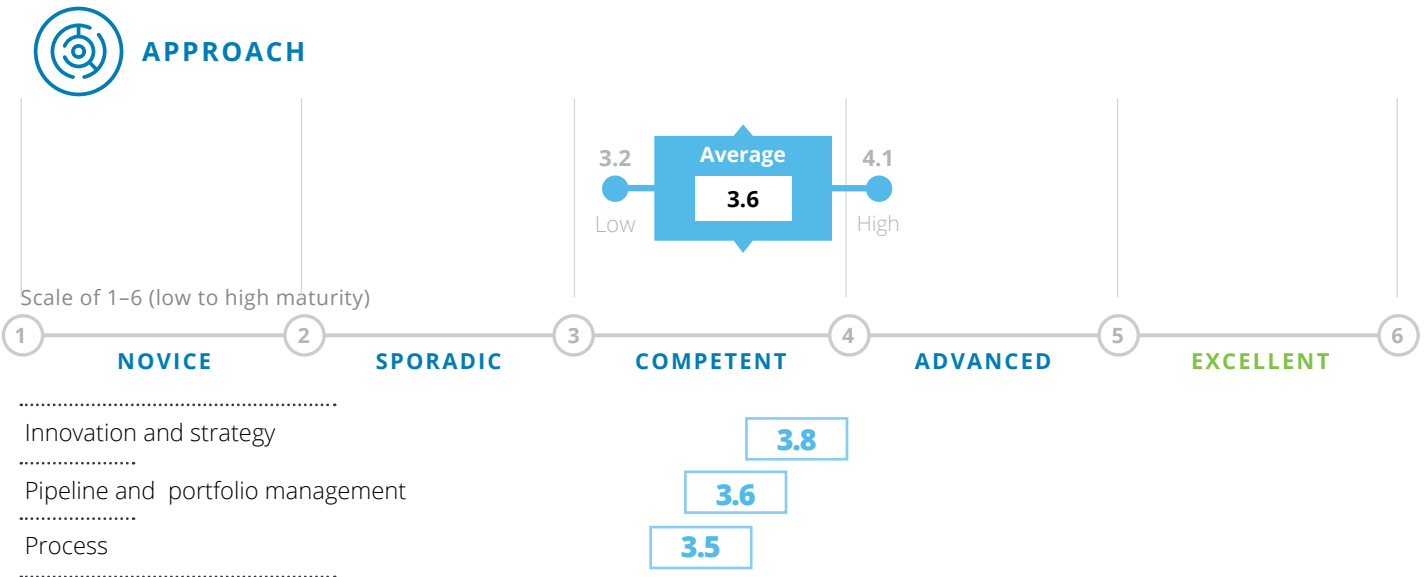
The results reveal the Australian industry sees itself as competent in its innovation capability, and is relatively more mature than the Canadian and African mining industries. The relatively tight spread in the results indicates that the different types of companies are moving forward strongly together. This highlights a key benefit of collaboration: cross-pollination. One of the greatest benefits of this collective evolution may come as majors adopt some of the more agile traits of juniors and service providers.

The study confirms junior miners see themselves as more competent innovators when compared with the more fragmented nature of innovation amongst majors. However, the study also found— not surprisingly—that all types of companies still have some way to go before their innovation capabilities would be considered fully mature (excellent). Rather than being seen as a negative, this finding points to the 'good news' part of the story.

The global mining industry is on course to becoming more proficient at innovating, and the Australian sector is relatively mature. Companies in Australia appear to have learned not only from their own experiences but also from those of other miners and other industries around the world. As a result, they are well-placed to seize the next level of innovation opportunities and to compete on the global stage.

Figure 9. Maturity of innovation building blocks and capability levels





Participants were generally confident in their approach to innovation, demonstrating a good understanding of the strategic capabilities and assets that are key to ongoing advancement. Companies are increasingly integrating processes to manage innovations across their lifecycles, although most noted a need to better prioritise and make decisions about where to focus. This may be because the appropriate metrics and iterative processes at different stages of innovation development do not exist. Another likely inhibitor is that innovation objectives are not always aligned and integrated with the company's overall strategic growth goals—a reality further noted by many participants.

The crux of the matter is that there is significant room for improvement in framing an innovation strategy around the opportunities and industry shifts that matter most. Companies need to be agile in managing their innovation portfolios, which requires trying new things, adjusting quickly, and not being afraid to fail. At present, this type of rapid trial and error is not happening to a great extent.

“Always thinking ‘how could this be done differently’ and being quick to implement new thoughts and changes in order to see if they will have a positive effect – being willing to fail in order to succeed.”

Major

Note on senior leadership

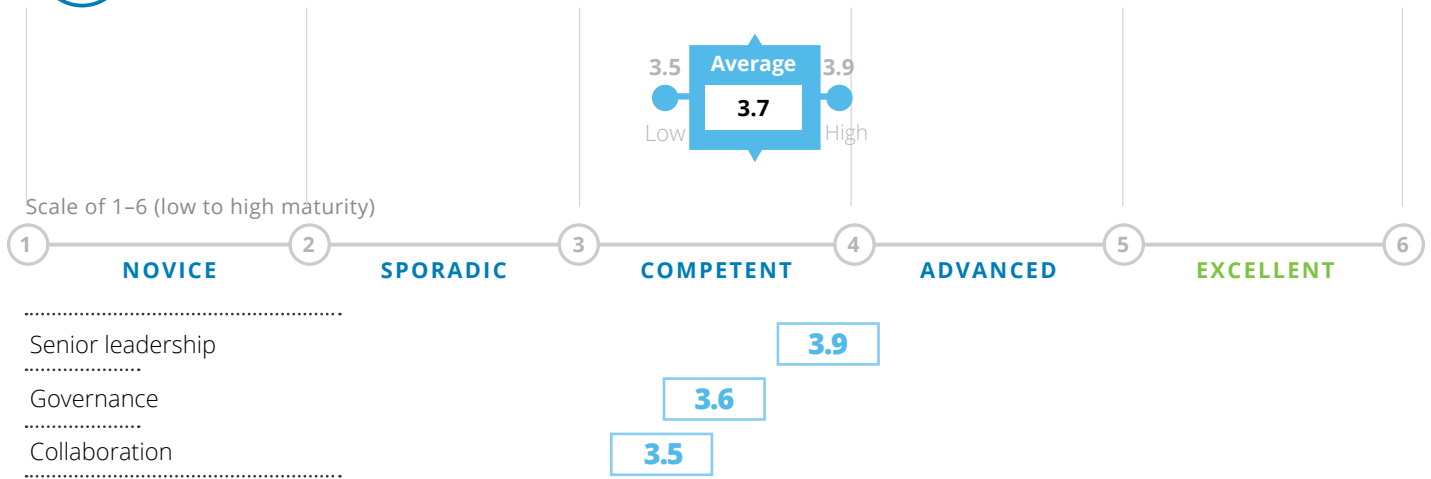
It takes more than one passionate leader to champion innovation within a company – it takes an entire team of them. It's about bringing the right minds together (not necessarily the subject matter experts) to look at things from a different perspective and enabling them with the right processes, supporting technologies, and know-how to create an innovative organisation. And, contrary to popular belief, great leaders are developed, not born, which requires time and investment.

Successful innovation leaders:

- Stand in the future and help others see it
- Trust their talent and hold them accountable
- Have a strong vision of what they are trying to achieve
- Put in a lot of effort to stay in their leadership positions
- Are well connected: they want to meet people, learn, and find other examples, get their brand out there, have the opportunity to interact with their peers and learn from others
- Are willing to stretch themselves and expand their products, services and/or expertise into new areas.



ORGANISATION



Senior leaders appear to grasp the innovation imperative and are discussing it within their organisations. In fact, most participants believe that senior leaders are highly engaged in the innovation process at a personal level. Still, too many senior leaders believe that innovation is all about reducing costs through operational excellence, thus giving most of their attention to near-term, product-focused, Core-level ambitions.

Although participants largely perceive senior leaders to be engaged, they also believe that their organisational structures are inadequate to support innovation, due to sluggish decision-making processes and poor collaboration among business units and functions. Among the functions within their organisations, participants perceive the corporate strategy group as being the most vital to collaborate with internally for achieving their innovation objectives, followed by operations, technical services/ engineering and then finance. The stated importance of the corporate strategy function is not surprising, considering that half of the participants indicated that alignment between the corporate vision and long-term innovation goals was lacking throughout the organisation, most notably within the shared service functions.

As a result, employees in many instances believe they must drive innovation on their own. Interestingly, participants also rated the innovation group as relatively less vital to collaborate with than many other functions. Rather than lacking importance, this result is likely explained by the current absence of this function within many organisations, although it is becoming more common.

Juniors and service providers are significantly stronger in the organisational capability levers compared to majors. This may be explained by their nimbleness and willingness to change in the face of the innovation imperative. At least among juniors, there are fewer layers between leaders and employees and less 'red tape' to work through. The majors, in comparison, tend to follow a more rigid protocol. This finding aligns with the perception of junior miners in Australia as being more 'gung-ho,' whereas majors are considered to be more conservative, often out of necessity in protecting their social license to operate.

"The strategic context for driving innovation has only recently been developed at a board level."

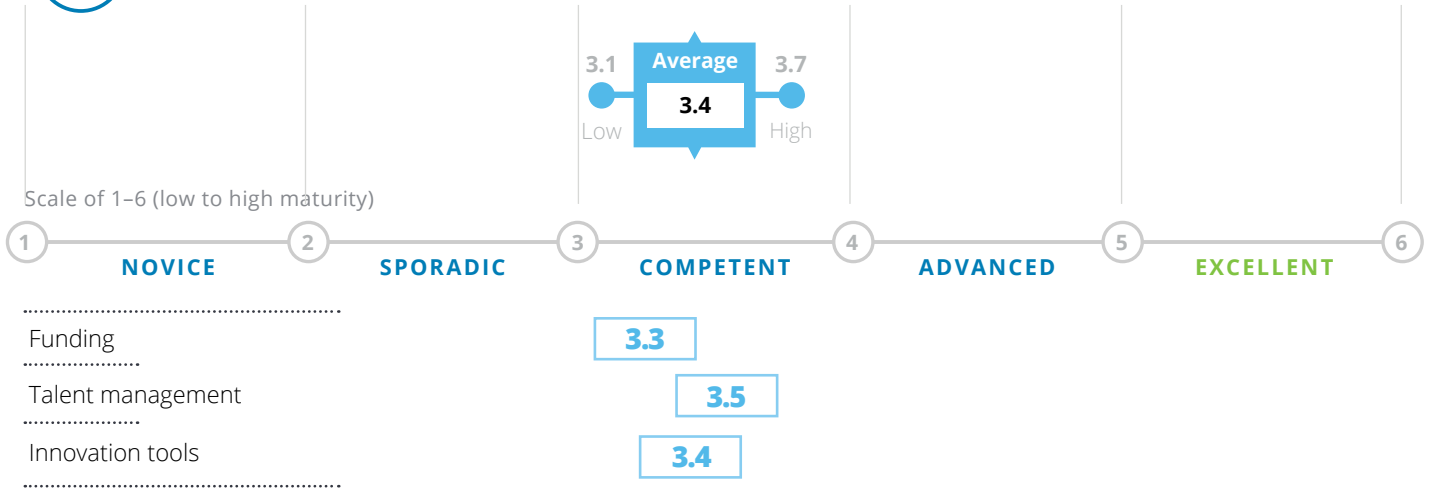
Service Provider

"Innovation is a culture not practised in every corner of the organisation. There are areas where the thought process is to develop methods for efficient management of processes for improvement, productivity and safety. In other areas, it is slow or non-existent. It is analogous to running a high end software in a 'dated' computer. Upgrading is required in both ends simultaneously to achieve better results."

Major



RESOURCES AND COMPETENCIES



Most respondents perceive timely access to funding as a significant hurdle to innovation. A big part of the problem is that innovation funding competes with operational budgets within many organisations. Another aspect of the financing conundrum is government's role, or lack thereof, in making R&D funding available. Similar capital constraints with regard to innovation are being faced in the Canadian and African industries. Collectively, this represents a key area of improvement for the global industry.

Participants also noted prevalent funding constraints often morph into talent constraints. Most believe that their organisations do not have reputations for being innovative, which makes it difficult to attract and retain talent possessing the agility and creativity they're looking for. That said, Australian miners appear to be doing many things right with regard to assembling talent and enabling them to innovate. Respondents said they are increasingly mobilising talent cross-functionally across the organisation as needed to deliver innovation, and more than 60% believe that their companies have widely identified and leveraged the relevant technologies to support innovation.

The findings also suggest that enabling innovation within an organisation doesn't necessarily require incentivising employees with substantial financial rewards. For example, one of the majors surveyed found that listening to and recognising innovative ideas is enough to motivate their employees. And, while there is much talk about obtaining the right people with the right skills to innovate, creativity is rarely the scarce resource in innovation. What most organisations need is discipline, not just creative ideas.

"There are some great and talented people at all levels in the organisation. Within their sphere of influence, there is really unlimited capability. It is a question of capacity in their roles to be able to exercise that capability to innovate. It is strongest where there is capacity in the role."

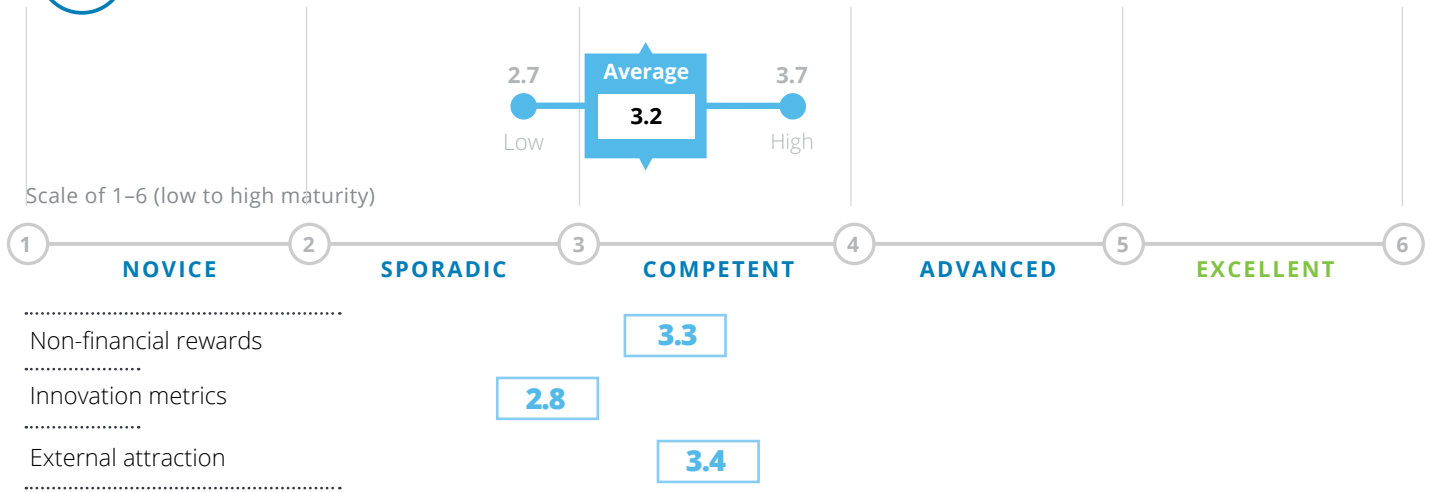
Major

"People are encouraged to come up with ideas, and are recognised for it. People are our strongest capability."

Major



METRICS AND INCENTIVES



Most companies cited misaligned incentive systems in addition to inadequate innovation metrics as major roadblocks. In most organisations, innovation metrics were under-developed and sporadic, and poorly integrated with overall management metrics. As the old adage emphasises, 'What gets measured gets done.' If innovation is to be delivered as a discipline, then effectiveness at innovating needs to be measured in order to ensure that the innovation portfolio is delivering for the enterprise and the business is held accountable for achieving the intended results.

With much more work around internal alignment to be done, many companies are turning to external sources for help in sparking new ideas, and respondents acknowledge that working within an innovation ecosystem is becoming increasingly important. The findings suggest that significant opportunities exist with regard to enhancing external collaboration with third parties to foster innovation. While respondents were highly motivated to collaborate, they reported that a collaboration strategy for pooling resources and collectively developing innovative solutions is often lacking.

"We are a drilling contractor (underground diamond core) and our current strategic objective is to 'double our metres per man-hour.' This is driving innovation at all levels—engineering, training, safety and operations."

Service Provider

The role of government

Whether one favours the concept or resists it, governments play a major role in influencing innovation. Policymakers affect the number and type of people who live in Australia and what skills they have. They also establish tax regimes, incentive frameworks, public research priorities, regulations, etc. – all of which impact the urgency around innovation and how effectively businesses can respond. In fact, governments can be a great ally and enabler of innovation by:

- Establishing steady policies to fuel a sense of stability and confidence, which enables companies to grow
- Assisting companies in maintaining their competitive advantages
- Helping companies to identify trends and plan for what is coming next.

Despite these advantages, only 10% of respondents believe government programs are sufficient for promoting and incentivising the innovation process in the mining industry. And, only 17% believe that their companies have maximised all potential government incentives related to innovation. Most surprisingly, some companies were not aware of these well-intended programs, let alone how to claim the benefits.

Of those taking advantage of government incentives, a vast majority of companies feel that the payouts are not being re-invested in the appropriate departments to continue to foster innovation. Respondents also generally noted a need for better coordination of state and federal programs, although this is unlikely to occur since states typically have their own agendas.

Innovation in action

Federal government initiatives

- Administered by AusIndustry, a division within the Department of Industry, the Cooperative Research Centres (CRC) Programme supports industry-led collaborations between industry, researchers and the community. CRC Mining has become the preeminent, industry-driven centre for global mining research and innovation, having produced industry-transforming innovations for more than two decades
- The Department of Industry, Innovation and Science has established the Mining Equipment, Technology and Services (METS) Growth Centre as part of the federal government's \$225 million Industry Growth Centres initiative. The Growth Centres are designed to boost the Australian industry's competitiveness, productivity, and capacity to innovate. They aim to set long-term strategies and priorities to boost the capability of their sectors, increase productivity and skills, create jobs, reduce red tape and engage internationally.

State government initiatives

- There are now government employees with 'METS' in their titles. While seemingly insignificant, this highlights the importance of the METS sector to some state governments. For instance, New South Wales is uniting METS and government organisations together under one brand so there is streamlined information regarding what is happening in the service sector. Meanwhile, Victoria is hosting the International Mining and Resources Conference, the only truly international mining event in Australia, and Queensland is developing a long-term roadmap for METS.
- The Exploration Incentive Scheme (EIS) is a \$130 million initiative sponsored by the Government of Western Australia. Initially supported by Royalties for Regions, it is being funded from April 2009 to June 2017. EIS is managed by the Department of Mines and Petroleum and it supports five high-level programs, including:
 - Exploration facilitation
 - Innovative drilling promotion
 - Geophysical and geochemical surveys
 - 3D mapping
 - Strategic research with industry.

Of note, other Australian states and territories have similar pre-competitive geoscience and co-funded drilling programs.

Where to from here

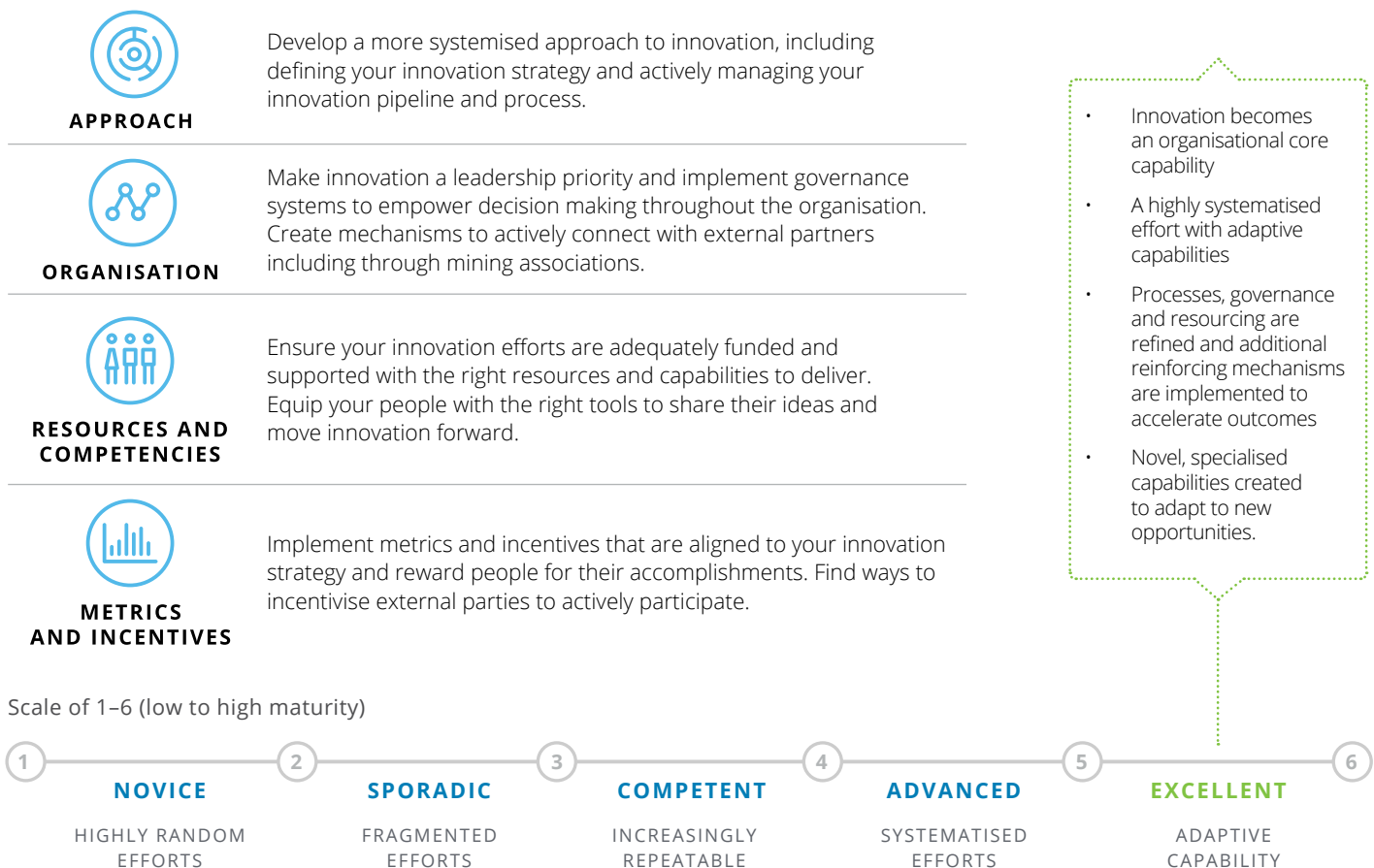
It can be tempting to think of innovation solely in terms of products and technologies.

Indeed, it's now widely accepted that exponential technologies – big data, the Internet of Things, 3D printing, wearables, etc. – will disrupt the way most sectors operate. Nonetheless, dealing with this disruption, along with increasing environmental and community concerns, will require a broader, more structured approach to innovation. Whether they're seeking to develop a new technology, process or business model, or to find new applications for existing ones, companies are encouraged to embrace three key principles:

1. Be explicit about your ambition and vision for innovation. Only then can you effectively organise and execute this
2. Look beyond product innovation to develop, launch and de-risk new offerings
3. Build the capabilities of an innovation discipline – because innovation almost never fails due to lack of creativity.

More specifically, the mining sector is encouraged to consider the advice in Figure 10 for enhancing the overall effectiveness of its innovation culture.

Figure 10. Moving toward 'excellent' innovation capabilities



The following recommendations are offered to help companies set targeted priorities for maturing their distinct innovation capabilities.

MAJORS

Approach	Organisation
<ul style="list-style-type: none"> Clearly articulate an innovation strategy and rally your people around it Think beyond technology innovation: look to innovate across multiple areas and types while being explicit about what you want to achieve Manage innovation as a portfolio, implementing governance structures and aligning metrics and incentives to drive outcomes. 	<ul style="list-style-type: none"> Set the tone – innovation needs to be driven from the top and shouldn't be an unstructured effort from middle-management. To this end, leadership development needs to focus on the managerial capabilities required to deliver innovation Think beyond just R&D – assess how you collaborate on common issues with a wider set of partners, including service companies and even competitors.

JUNIORS & SERVICE PROVIDERS

Resources and competencies	Organisation	Metrics and incentives
<ul style="list-style-type: none"> Preserve your nimbleness as you grow. Stay flexible and adaptive to change. 	<ul style="list-style-type: none"> Make the most of your limited resources and tap into incentives available at state and national levels. 	<ul style="list-style-type: none"> Collaborate with (other) juniors and work with (other) service companies who are struggling with many of the same issues If you're a junior, work with service companies. If you're a service company, work with other service companies.

The general idea is reciprocity. If juniors work on improving exploration performance with a focus on high quality deposits, they will increase their value to majors. If majors work on improved recovery with a focus on lower-grade deposits, they will reduce the pressure on juniors. That's a win-win, where everyone has increased cash for investment: juniors to adopt/commercialise innovations and develop assets, and majors to buy juniors.

Although Australian miners are progressing in developing their innovation competency, they have yet to pursue many of the 12 capability levers. This means that many stones are waiting to be turned, and there is great opportunity to drive a growth and productivity agenda forward. As such, the value of a disciplined innovation program has never been stronger.

Mining leaders understand that innovation is an imperative for driving productivity and growth; now it's time to act. If they do so collaboratively and systematically, what they discover could be many times more valuable than they've ever envisioned.

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Monitor Deloitte

To grow with confidence, organisations need to make clear choices about where to play and how to win. And in a world where the pace of change is rapid and sometimes unexpected, leaders need to act nimbly, and decisively. Monitor Deloitte strategy consultants employ cutting-edge approaches embedded with deep industry expertise, working with leaders to resolve critical choices, and drive enterprise value.

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Doblin, the Deloitte innovation unit, is a global practice deeply committed to helping clients innovate with confidence while advancing the frontiers of strategy and innovation leadership. Doblin possesses an ever-evolving set of multi-disciplinary capabilities and diverse perspectives, which are effectively integrated in highly collaborative teams and client programs. Taking a user-centric approach, Doblin practitioners combine design, research, and strategy expertise to help organisations innovate more boldly and effectively.

Diggers and Dealers

Diggers and Dealers is Australia's leading resource-focused conference held in Kalgoorlie, Western Australia, each August. The event attracts close to 2,000 people each year and showcases the dynamic activities in the Australian resources sector through 45 presentations and 135 exhibitor booths over 3 days.

Association of Mining and Exploration Companies (AMEC)

AMEC is the peak industry representative body for mineral exploration and mining throughout Australia with offices in Perth, Brisbane and Sydney.

Founded in 1981, AMEC's purpose is to facilitate a positive political and economic environment to grow the exploration and mining industry on behalf of members. AMEC members benefit by having an active and effective advocate, driving policies to reduce the cost of doing business and increase exploration and mining opportunities in Australia.





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