Innovation state of play

Mining edition 2015

Monitor Deloitte.

DOBLIN

PDAC

FOREWORD

How do we, as a country, do better? Deloitte has been asking variations on that question for a few years in our Future of Canada series of studies on productivity, the latest edition of which—*Age of disruption: Are Canadian firms prepared?*—takes up the matter of disruptive change, as characterized by exponential technologies.

Exponential change always disappoints in the early days; however, once past a certain tipping point, there's no going back. Unfortunately, our latest research shows that, as a business nation, Canada is not prepared. That also includes the mining sector. In fact, only about 12% of all Canadian companies understand what's coming.

We have to change the way we're doing things. And that starts, we fervently believe, with innovation. Companies that get this and act on it are going to be the successful ones in the long run.

I would like to express our sincerest appreciation to the PDAC for working with us on this study, as well as to the many individuals who shared their time and their perspectives. Our interests are your interests, and so we begin and end with you. We hope you find value in the effort, and welcome your feedback.

Glenn Ives
North and South America Mining Leader, Deloitte

Making discoveries and operating mines have become more complex than ever. Junior and senior mining companies are now confronted with a myriad of financial, technical and operational challenges, along with enhanced societal expectations.

Given these mounting challenges, it's time to acknowledge that innovation is no longer a luxury. In fact, innovation is now critical to the survival and sustainability of our industry, integral to value creation and adequate returns on investment, and essential to sustaining mining's contributions to the Canadian economy.

Taking stock of where we are is a key step toward understanding each of our roles within the innovation ecosystem and identifying the actions required to overcome the challenges we are facing.

The PDAC is pleased to have had the opportunity to partner with Deloitte to undertake this important study, and very appreciative of those who gave graciously of their time to participate. We've learned a great deal and look forward to working with member companies, governments, academia and innovation institutes to create an environment that fosters mining innovation in Canada.

Rod Thomas
President, PDAC

Innovation state of play

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Welcome to the tipping point

A joint study recently conducted by the Prospectors and Developers Association of Canada (PDAC) and Monitor Deloitte (Deloitte) examined current perspectives on innovation in an age of rising costs, multiplying risks, increasing environmental concerns, escalating activism and shrinking margins. The landscape is truly shifting and the environment within which the industry operates is more complex and challenging than it has ever been.

The general consensus? Innovation is key to the mining sector's survival.

Among the 19 mining companies involved in the study (majors, juniors and service companies alike), everyone agreed that successfully navigating the current cyclical downturn and ensuring the long-term sustainability of the sector requires moving beyond the status quo—doing things differently through innovation.

And not a moment too soon.

"While cautiously optimistic growth prospects for countries like China and India remain uncertain, Japan is struggling with a mountain of sovereign debt and a rapidly aging population, and instability in the Russian border areas and the Middle East is raising concerns. Stakeholders around the globe are becoming increasingly vocal in their demands from the industry. **Prospects for many commodities remain weak, particularly iron ore and coal.**"

That's from the opening paragraph of *Tracking the trends 2015*, the seventh annual publication of Deloitte's global mining practice, which closely examines international mining sector trends and proposes a range of potential solutions to shared problems. And while the publication's overall outlook does include reason for optimism, finding innovation as "the new key to survival" among not only study participants but the industry as a whole did not come as a surprise to Deloitte or the PDAC.

IN YOUR OWN WORDS

"We are at a historic place in our industry. We need to innovate to create step changes, otherwise we will face serious challenges in the future." —Major

"Innovation is core to the way we have to think every day." —Service company

"Historically, the mining industry hasn't been visionary enough about the future." —Major

01

Vocabulary lesson: the innovation imperative

The word *innovation* is used to describe everything from the invention of the wheel or first moon landing to new hairstyles or colours of adhesive notes. It's a fuzzy word that most everyone can rally around. And, in their own ways, they are right.

However, to make innovation more meaningful for business, Doblin 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 and ourselves]* ***business offering*** *[ideally going beyond products to platforms, business models and customer experiences].*

Innovation is complex, to be sure, but it's not always complicated. Moreover, it can also occupy one of three "ambition levels," which define its purpose or result:

Core innovations optimize existing products for existing customers.

Adjacent or **incremental** innovations expand existing business into "new to the company" business.

Transformational or **new** innovations are breakthroughs and inventions for markets that don't yet exist.

Study guide

While the desire or imperative to innovate are 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. But asking so much of innovation can dilute an enterprise's capacity to use innovation to its greatest advantage. That's why Doblin, Deloitte's innovation unit, promotes a multi-faceted approach to innovation that can increase innovation "hit rates" and help companies generate innovations that earn disproportionate returns and that are more difficult for competitors to copy.

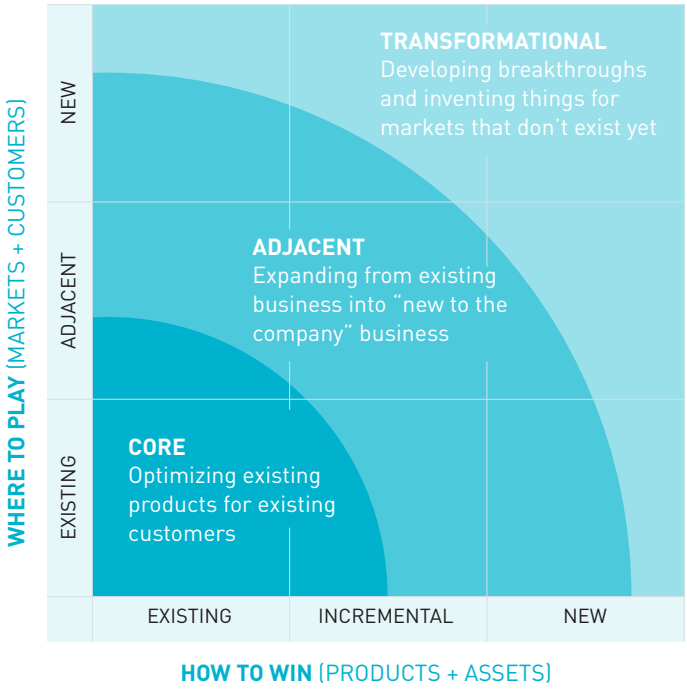
It's also a lot easier to say innovation than it is to do it, no matter the context or milieu. Through a series of executive interviews and using the Innovation Scorecard survey methodology developed by Doblin, the aim of this study was to assess participants' current innovation efforts, build a deeper understanding of key pain points and gaps in companies' innovation capabilities, and explore the broader issues the sector faces and hopes to resolve by becoming more effective at innovating. The idea was to engage mining companies and understand how they are innovating in order to identify ways to strengthen and enhance their efforts.

The results reveal a mining sector that wants to innovate, that knows it has to innovate, and that already is innovating to some extent—but that just hasn't been entirely consistent, strategic, or systematic about it.

More specifically, the study found that majors are largely sporadic when it comes to innovation, while juniors and service/supply companies are more practiced and competent. Everyone, however, places the majority of their innovation focus on technological optimization of old techniques, in particular on ways to reduce costs or discover deposits more efficiently. Everyone therefore has some way to go before they are seen as innovation leaders outside of the industry.

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. Doblin research suggests that the most successful innovators manage their innovation efforts and investments as a portfolio of activities that is balanced *across* the levels (see Figure 1). And while every company's circumstances are unique, the world's leading 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.

Figure 1. Innovation ambition levels



To successfully develop and launch Adjacent and Transformational innovations, companies need to push beyond exclusively product innovation. And the mining sector is no exception.

INNOVATION IN ACTION

*Service provider **GroundTruth Exploration** plays equally well at the Core and Adjacent innovation ambition levels simultaneously. They use innovation to make certain classical aspects of exploration more efficient and cheaper (e.g., a track-mounted drill costing one quarter the conventional drilling cost) while also using new technologies and applying them for exploration purposes (e.g., using drones to map areas at better resolutions less expensively).*

Revel in the details

Innovation's complexity, however, doesn't end with ambition levels. Indeed, Doblin identifies 10 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, brand, and customer engagement. This is how an offering is delivered to customers.

Some examples of how this is already being achieved in mining include Dundee's creation of real-time information assets using radio-frequency identification tags (configuration), Rio Tinto's use of driverless haul trucks (offering) and Freeport-McMoran's public and independent external audits (experience).

As it happens, top innovators also outperform the S&P 500 in relation to how many different types of innovation they pursue (see Figure 3). This is because returns on innovation investment tend to work in the reverse order: 70% from Transformational innovation, 20% from Adjacent and only 10% from Core.

Figure 2. Ten types of innovation

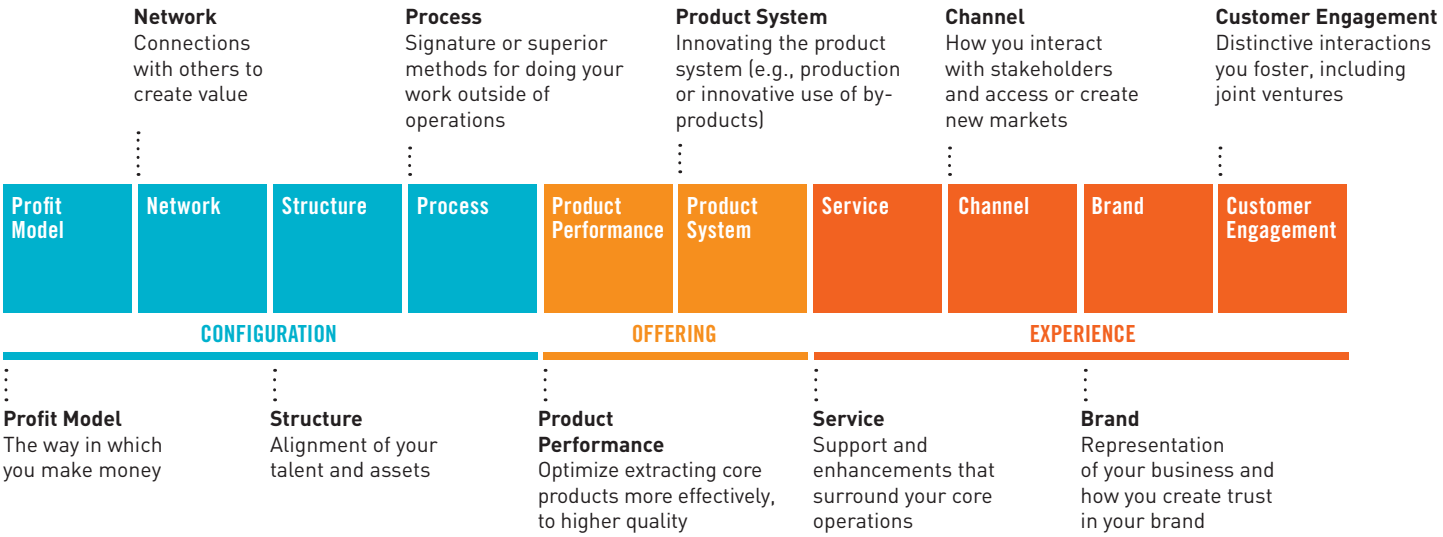
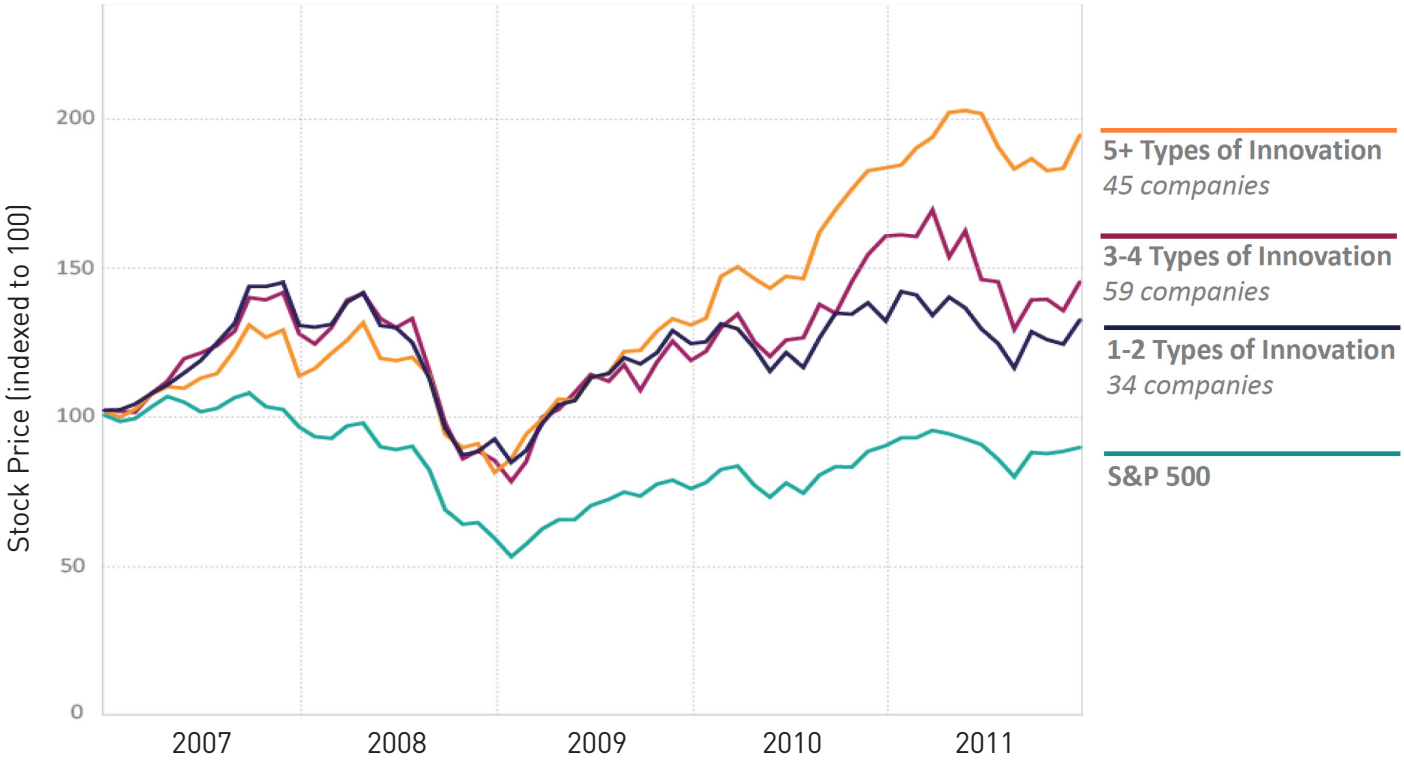


Figure 3. Five-year indexed stock price returns of the top innovators vs. S&P 500



IN YOUR OWN WORDS

"Terminology around innovation is not always clear. Once people truly understand what innovation is, they become much more passionate about it."—Major

INNOVATION IN ACTION

*Explorer/producer **Eurasian Minerals** demonstrates that mining and exploration companies can innovate in more than just the Offering category of innovation types. Eurasian's profit model (a combination of royalties, investments in key properties and exploration discovery) using geographical experts is carried out through many of the Configuration and Offering categories.*

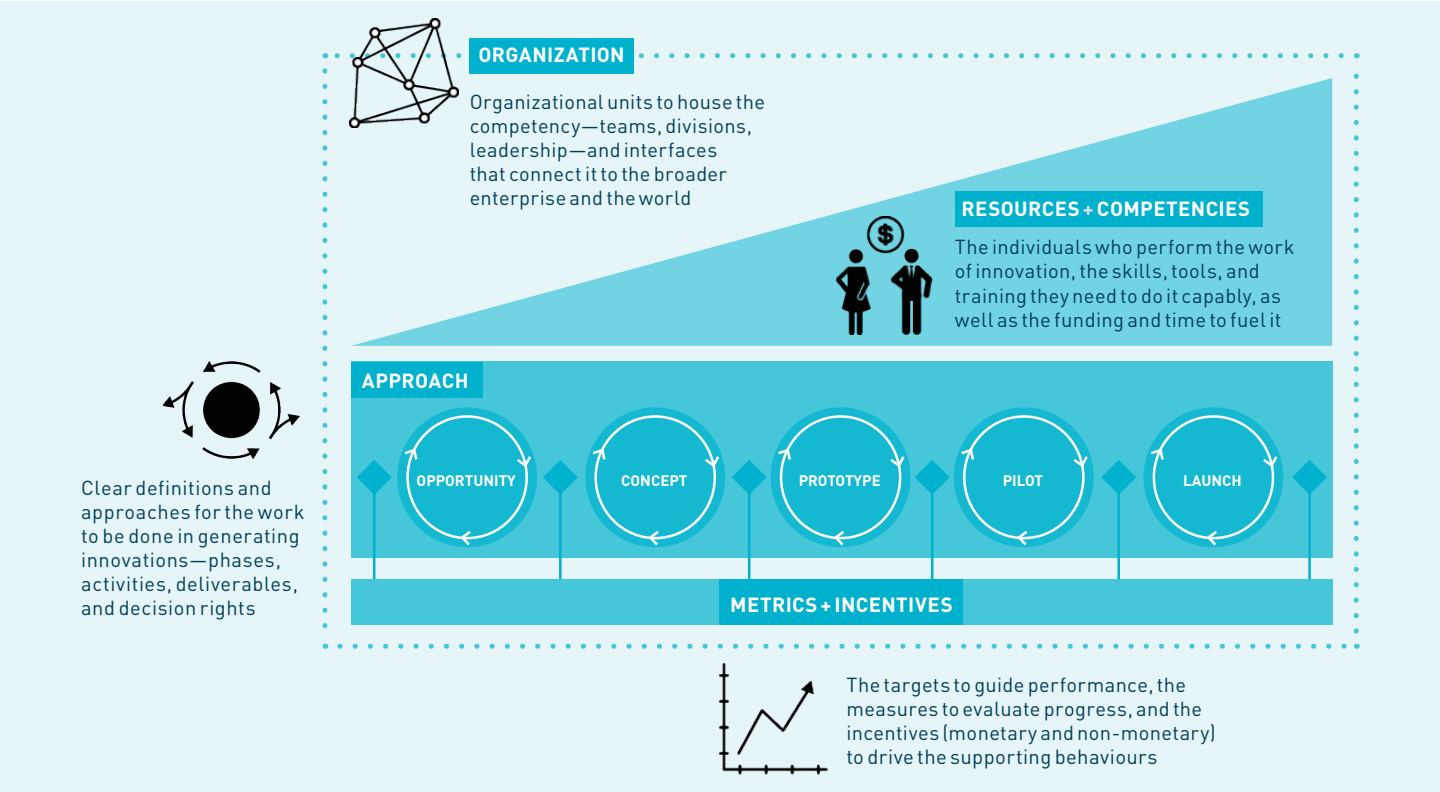
In order to reliably deliver the kinds of innovations required to outperform the competition, then, leading companies exhibit capabilities across four key building blocks (see Figure 4):

1. They employ a tailored **Approach** built around clear definitions and approaches for the work to be done in generating innovations – phases, activities, deliverables, and decision rights.
2. They have structured the **Organization** to house the innovation competency—teams, divisions, leadership—and interfaces that connect it to the broader enterprise and the world.
3. They acquire and nurture the appropriate **Resources and Competencies**, the people who perform the work of innovation, the skills, tools, and training they need to do it capably, as well as the funding and time to fuel it.
4. They have developed the right **Metrics and Incentives** with targets to guide performance, measures to evaluate progress, and incentives (monetary and non-monetary) to drive the supporting behaviors.

Each of these four building blocks is associated with specific capability levers any organization can emphasize or adjust to ensure they can consistently and continuously identify, develop, and deliver new value to their customers. They are 12 in total and include innovation strategy, pipeline/portfolio management and process (approach); non-/financial rewards, innovation metrics and external attraction (metrics and incentives); funding, talent management and innovation tools (resources and competencies); and senior leadership, governance and collaboration (organization).

Put simply: with the right use of these levers, organizations can innovate at will.

Figure 4. Innovation building blocks



02

Mining state of play

In defining innovation for themselves, study participants typically conceptualized it within the context of specific business functions, including:

Operational excellence (Core), or continuous improvement through the adoption of methodologies and processes that increase exploration or production efficiency.

Application of new technology (Adjacent) for early and cost-effective detection of superior ore bodies in increasingly challenging environments—including at depth, under cover, and in northern and remote regions.

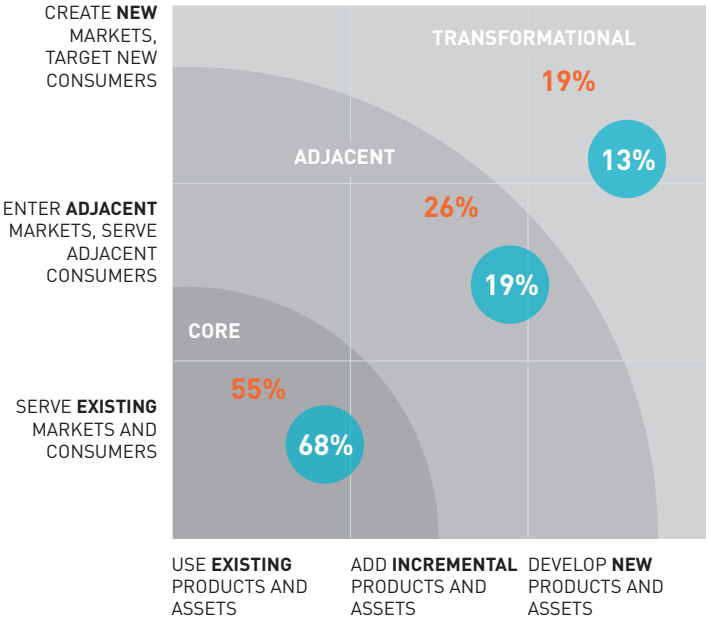
Breakthrough ideas (Transformational), especially ones that foster a collaborative environment—within and between companies, and across disciplines—and enable the generation of novel approaches to reducing risks and costs.

That last one is particularly encouraging for juniors, who often have difficulty spreading their risks—they are less likely to adopt Adjacent and Transformational innovations in-house, but may be successful through an external ecosystem.

Survey says

The current breakdown in mining innovation, based on the responses from study participants, works out to a theoretically balanced 68% Core, 19% Adjacent and 13% Transformational, as shown in Figure 5.

Figure 5. Innovation ambition matrix



Across the board, innovation ambition is focused squarely on the Core level, with a strong emphasis on technological solutions to optimize old techniques "as-needed." Innovation for study participants, in other words, is mostly a means to an end, either (1) finding better ways to discover high-quality deposits or (2) reducing exploration or production risks and costs.

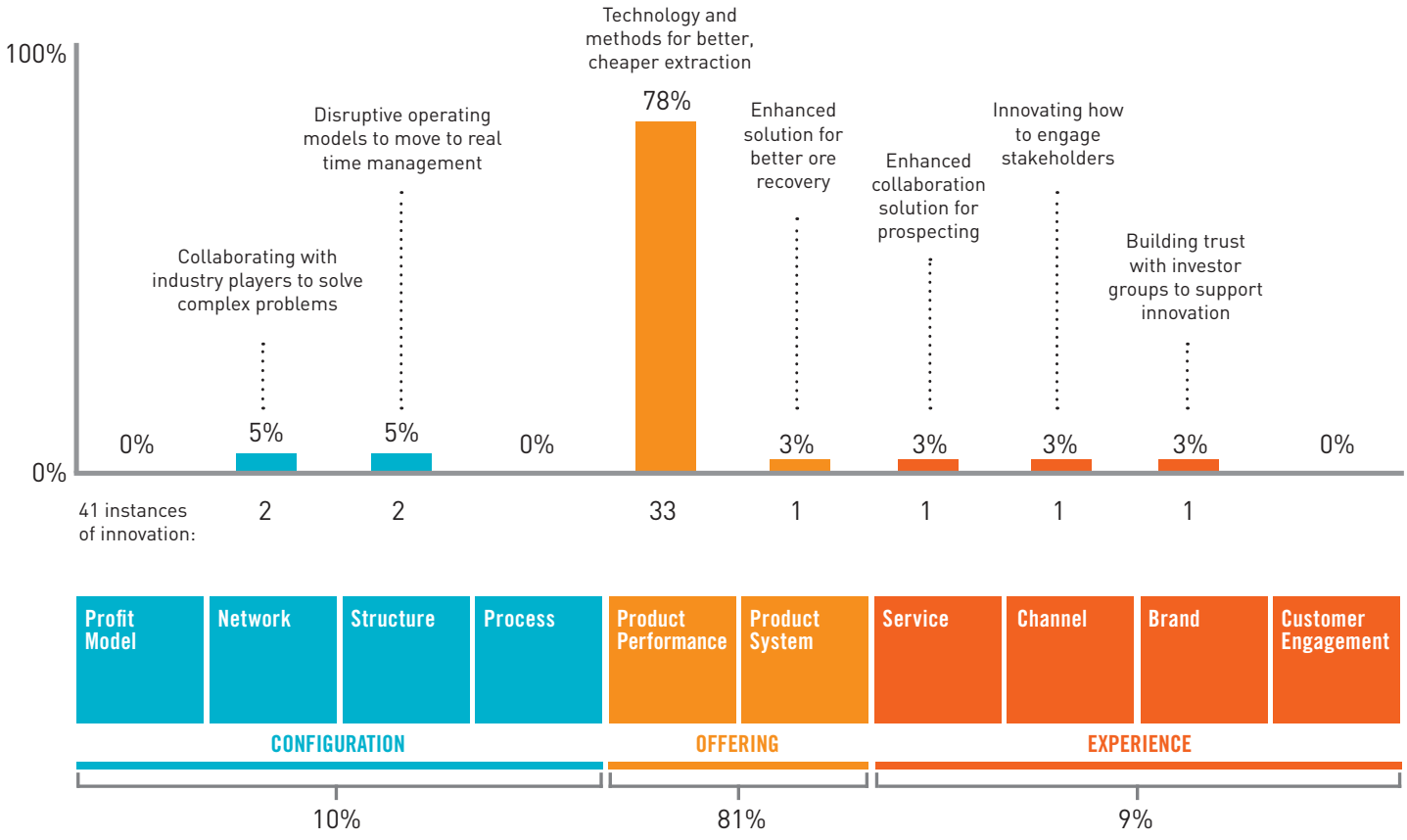
Juniors in particular often have difficulty spreading their risks and are less likely to adopt adjacent and transformational innovations in-house; these may, however, be achieved through an external ecosystem.

Broken out into the various *types* of innovation, on the other hand, 81% (34) of the combined 41 innovation initiatives reported between all respondents were in the Offering category, 33 of those specifically in product performance: technology and methods for better, cheaper extraction (see Figure 6 for a detailed breakdown). This is very much Core innovation activity for the industry. To achieve more Adjacent and Transformational innovation, it will be necessary to look beyond product innovation.

Further examination revealed several urgencies—the top five of which, in order of reported importance, as follows:

1. Reducing costs to operate
2. Improving asset productivity
3. Safety
4. Reducing risk
5. Reducing costs to develop assets

Figure 6. Mining innovation is especially focused on better, cheaper extraction technology and methods

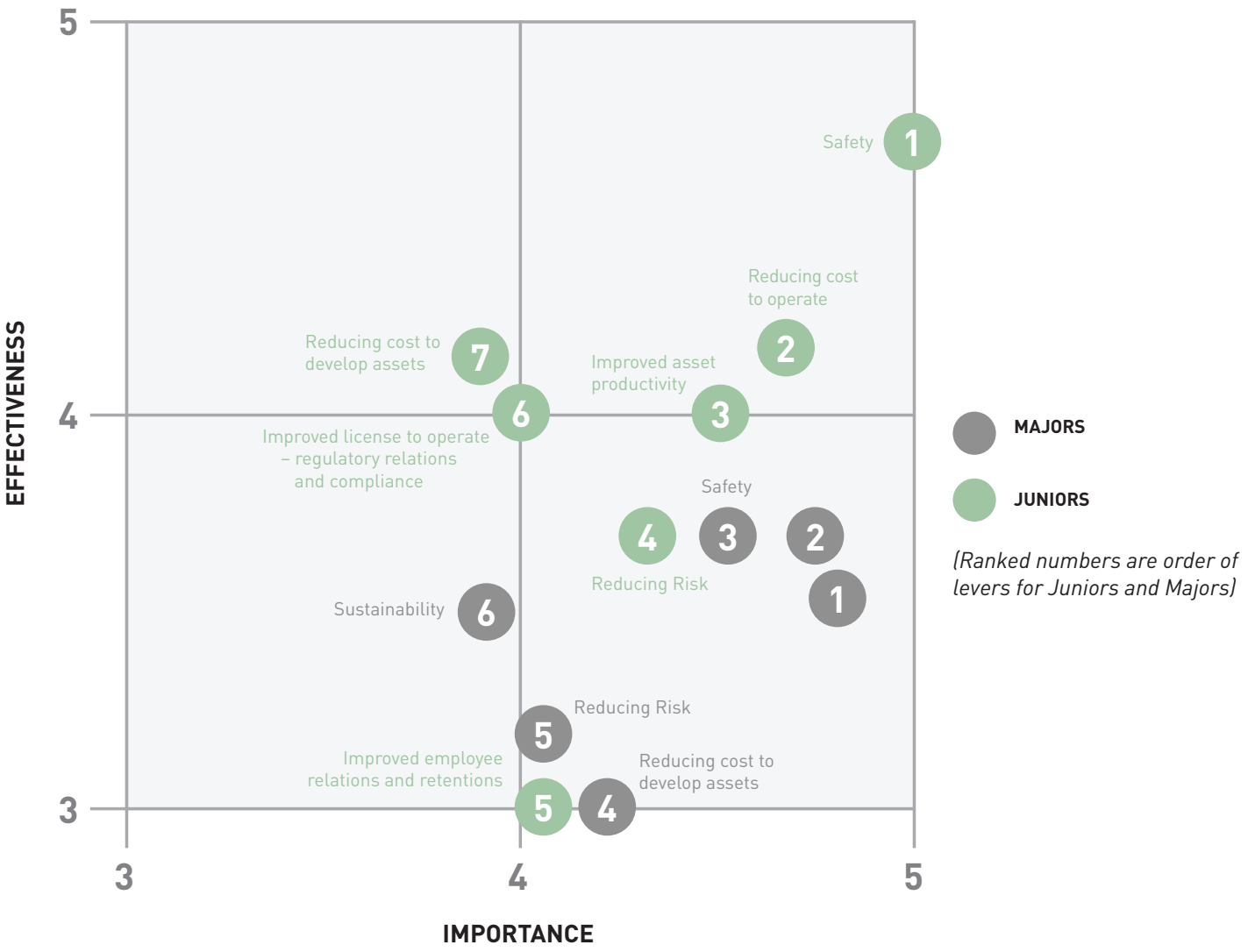


Majors and juniors are aligned on four of these five. The exception is cost to develop assets, which is less important to juniors than improved employee relations and retention.

Companies were also asked to identify how effectively they believe they are gaining in each of these areas (see Figure 7). On average, juniors scored a higher level of effectiveness than majors, especially for innovation areas also ranked as highly important—likely due to juniors' more agile and nimble structures.

There's room for growth in each area, however. No company in any industry can drop everything and focus on innovation for the future, so some way of prioritizing efforts is vital.

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



03

State of mining players

Mining companies are unanimous in their belief that they need to become more innovative if they are to succeed and grow. Perhaps Tony O'Neill, Group Director for Technical & Sustainability at Anglo American, said it best: "With industry margins being squeezed on all fronts, we simply have to embrace innovation if we want to find more productive, efficient and sustainable ways of extracting value from the minerals we mine. In fact, mining needs to leap forward 20 years in the next five." Something, however, is stopping them. And while the barriers vary significantly, they are all considerable.

For some, reluctance to take on additional risk associated with innovation has become entrenched. For others, the perception that innovation requires large capital investments that companies on their own don't want to make is compounded by a perceived funding gap. Long-established leaders, meanwhile, see innovation as fundamental neither to their business nor to their future competitiveness, resulting in the non-existence of a formalized innovation strategy in most organizations.

Similarly, most companies lack systemic processes, formal structures and internal incentives to foster and encourage innovation, making it incredibly difficult for majors in particular to change. To top it off, the complexity of the mining business coupled with the intensity of competition has led to an internal, functional focus, such that collaboration not only internally but also with other industry players remains sporadic at best.

This all affects different kinds of companies—majors, juniors and service/supply companies—in different ways:

Juniors: The smaller players lack the funding and expertise for continual innovation in an isolated setting. Their resources are scarce but they do not lack for problems to solve. A culture of open innovation has emerged within this group—using external resources (through partnerships) to find solutions to complex problems.

Majors: Striving toward being ever-leaner has resulted in innovation that primarily occurs outside the companies themselves. As the search for high-value deposits requires explorers to operate in increasingly challenging environments, the need for low-risk, cost-effective solutions has put increasing emphasis on outside partnerships.

Service/supply: Over the past 10-15 years, research and development departments in producer companies have seen significant cutbacks, driving increased R&D activity in the service industry—which in turns takes a leadership role by acting as catalysts for innovation, developing mostly pre-competitive technology that is made available to the entire industry.

IN YOUR OWN WORDS

"It is equally as important to communicate breakthroughs in innovation as it is to innovate."—Service company

"A lot of people view mining negatively. We need to find an innovative way to communicate the value that mining brings to society in terms of natural resources, careers and opportunities." —Junior

What's needed is a more systematic environment in which all innovation can thrive. To minimize or remove the perceived barriers to innovation, mining companies and the broader ecosystem of industry participants would significantly benefit from coming together in a structured manner to discuss, promote and foster innovation. Some collaboration is taking place organically but on a very small scale. More structure, organization and support is required to help develop major mining innovation hubs—the likes of which would include companies, educational institutions, incubators and the various levels of government.

In Canada, the federal government could play an important role in promoting innovation in mining through various incentive structures. At present, however, the streamlined funding available to other key sectors of the Canadian economy is not available to the mining sector. Instead, federal financing resources are spread out over thousands of programs, most of which are unknown to both juniors and majors.

Furthermore, Canada does not have an innovation policy that explicitly sets out national goals and priorities. This makes it difficult to design funding mechanisms that incentivize necessary innovations and provide the right supports to industries as they move the innovation cycle from idea to R&D and, eventually, commercialization.

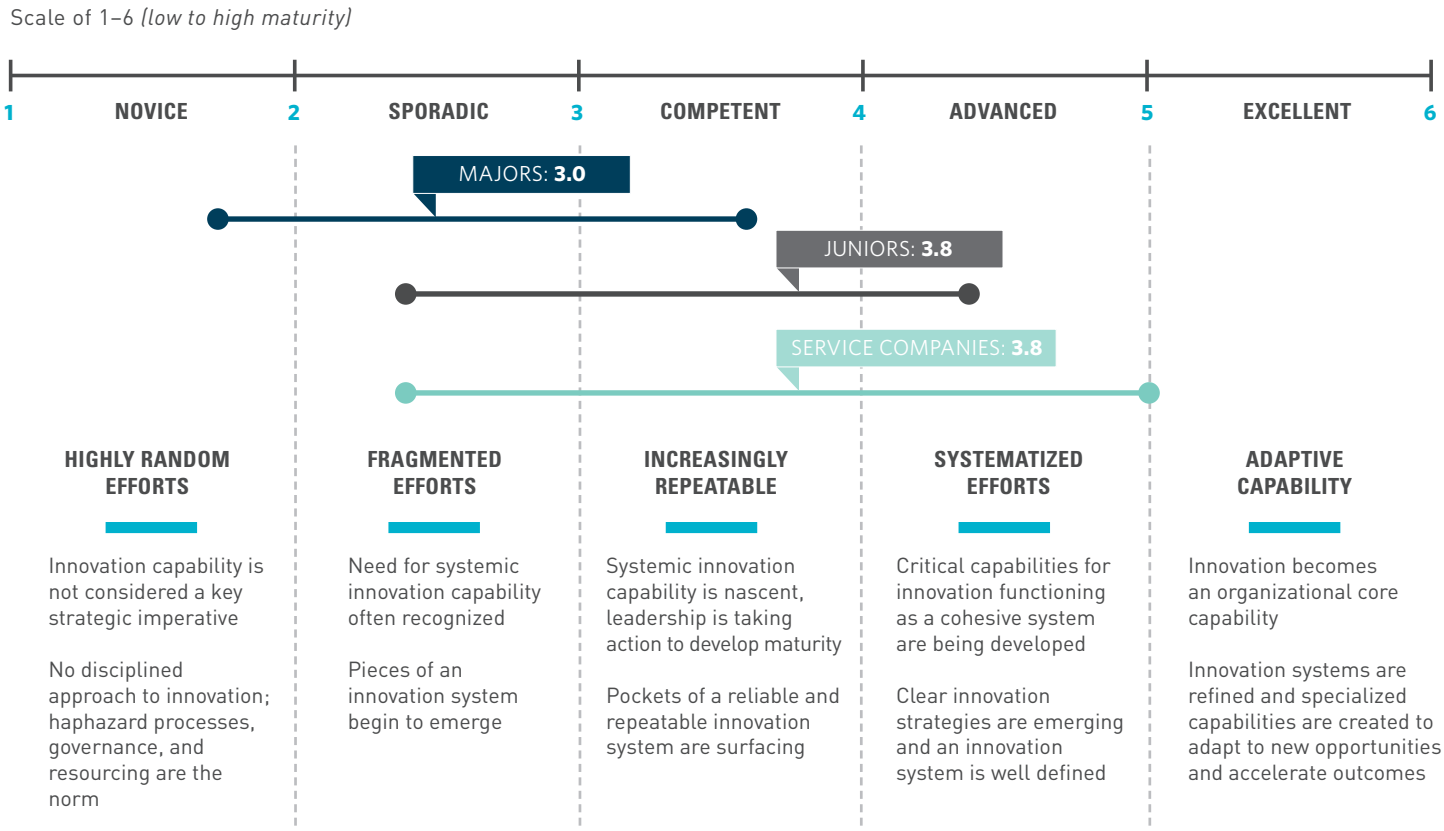
04

Self-organization

Figure 8 shows the scale Doblin uses to measure the extent to which companies have integrated innovation into their organization—their relative *innovation maturity*. Scoring low on the scale (1-2) suggests innovation efforts that are highly random, haphazard and lacking discipline—characteristics of a novice. At the other end of the scale (5-6), companies have become truly excellent innovators, demonstrating adaptive capabilities that are ingrained at their organizational cores and supported by refined innovation systems.

The joint PDAC-Deloitte study confirms junior miners as more competent innovators when compared with the more sporadic nature of innovation amongst majors. Service companies, meanwhile, scored identically with the juniors. However, the study also found—not surprisingly—that all groups of companies still have some distance to go before their innovation capabilities can be considered excellent or leading edge.

Figure 8. Junior miners are more mature innovators than majors

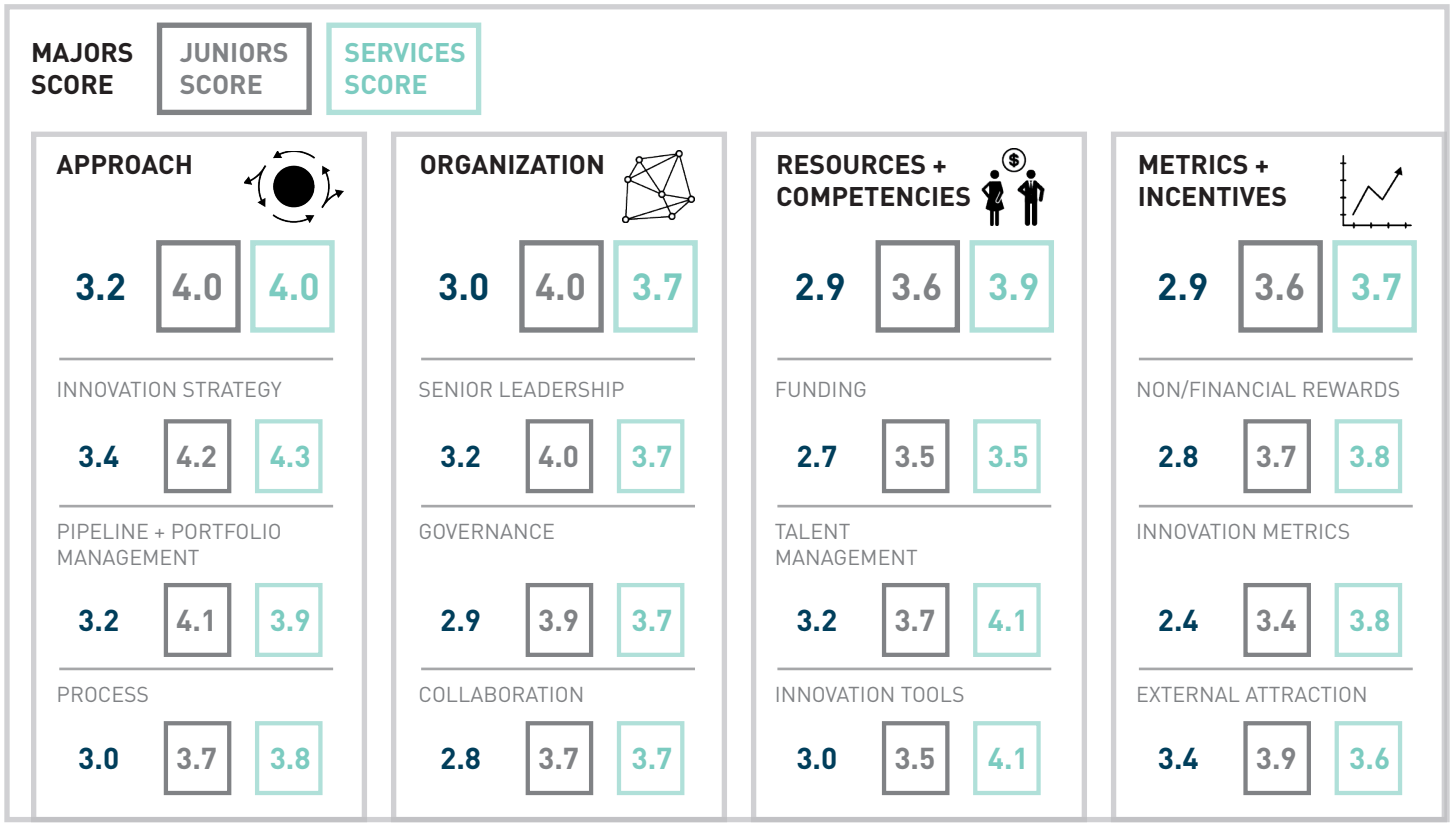


The 12 innovation capability levers are also scored on the maturity scale (see Figure 9). On those terms, the sector shows particular strength in innovation strategy, senior leadership and pipeline/portfolio management and has the furthest to go with collaboration, funding and metrics.

In addition to the differences between the average aggregate innovation maturity of majors, juniors and service/supply companies, we also discovered some interesting weaknesses and strengths across the organizational building blocks:

APPROACH *(Current maturity scores: Majors 3.3, Juniors 4.0, Service/Supply 4.0)*
The innovation imperative remains unclear throughout the sector and is not collectively understood. Innovation is more often than not uncoordinated, fragmented, and performed in siloes, with no integrated portfolio view. A disciplined approach to collecting ideas or defining processes for developing, launching, and tracking innovation investments is lacking, particularly amongst seniors.

Figure 9. Maturity of innovation building blocks and capability levers



That said, this is the one area where both majors and juniors are strongest. Some companies are being selective about where they innovate, placing deliberate focus specifically on reducing energy usage. Many are moving toward real-time data analytics, process monitoring and decision-making. And in the areas of stakeholder management and risk perception, they're communicating proactively with the investment community to manage risk and rally support for innovation, as well as engaging stakeholders early on to address issues and build relationships.

ORGANIZATION *(Current maturity scores: Majors 3.1, Juniors 4.1, Service/Supply 3.7)*
Formal governance structures to enable innovation are too often missing and decision-making is therefore frequently slow and fragmented. Innovation is largely dependent on the views and beliefs of senior leaders and would benefit from increased collaboration across both internal functions and the sector at large, whether between mining companies themselves or inclusive of a wider set of multidisciplinary partners. Still too many believe that longstanding approaches to "taking stuff out of the ground" aren't broken, and thus don't need fixing.

However, in a few cases, considerable support for the innovation imperative was demonstrated, and some companies are applying organizational effectiveness tools to create role clarity.

RESOURCES AND COMPETENCIES *(Current maturity scores: Majors 3.1, Juniors 3.5, Service/Supply 3.9)*
Access to funding is a significant hurdle for miners, as is allocating funds efficiently and to the right initiatives. Unfortunately, innovation in mining is often funded through operational budgets, with few dedicated resources in place. Accordingly, organizations are usually unable to adequately enable or develop the resources and competencies required to innovate, nor are they hiring for innovation.

Some companies, however, are scanning the external environment for new ideas and deliberately choosing to explore those that tie to the existing strategy. Others, meanwhile, are collaborating with universities and peers to research and test new ideas, and collaborating with governments to manage the economics and share risk.

METRICS AND INCENTIVES *(Current maturity scores: Majors 2.9, Juniors 3.6, Service/Supply 3.7)*
Most companies, however, do not differentiate innovation from everyday operating activities, yet the two run at odds. This is where the majors are weakest. With no recognition or measurement system for innovation, employees don't feel incented or empowered to explore new ways of doing things. Most new ideas come from external sources, including other industries, yet there are no formal mechanisms in place to monitor them.

Of critical importance going forward will be the implementation of systems to help differentiate between day-to-day management and innovation. That's the best way to cultivate the behaviours and culture that will allow innovation to flourish.

IN YOUR OWN WORDS

"If we don't work together to evolve, we will not exist as a mining industry." —Major

"We are encouraging innovation and trying to create some structure around it. Our employees know that they have the ability to innovate and won't be shut down for it." — Major

"Partnering with competitors to research and test new ideas has proven to be very cost-effective."— Junior

05

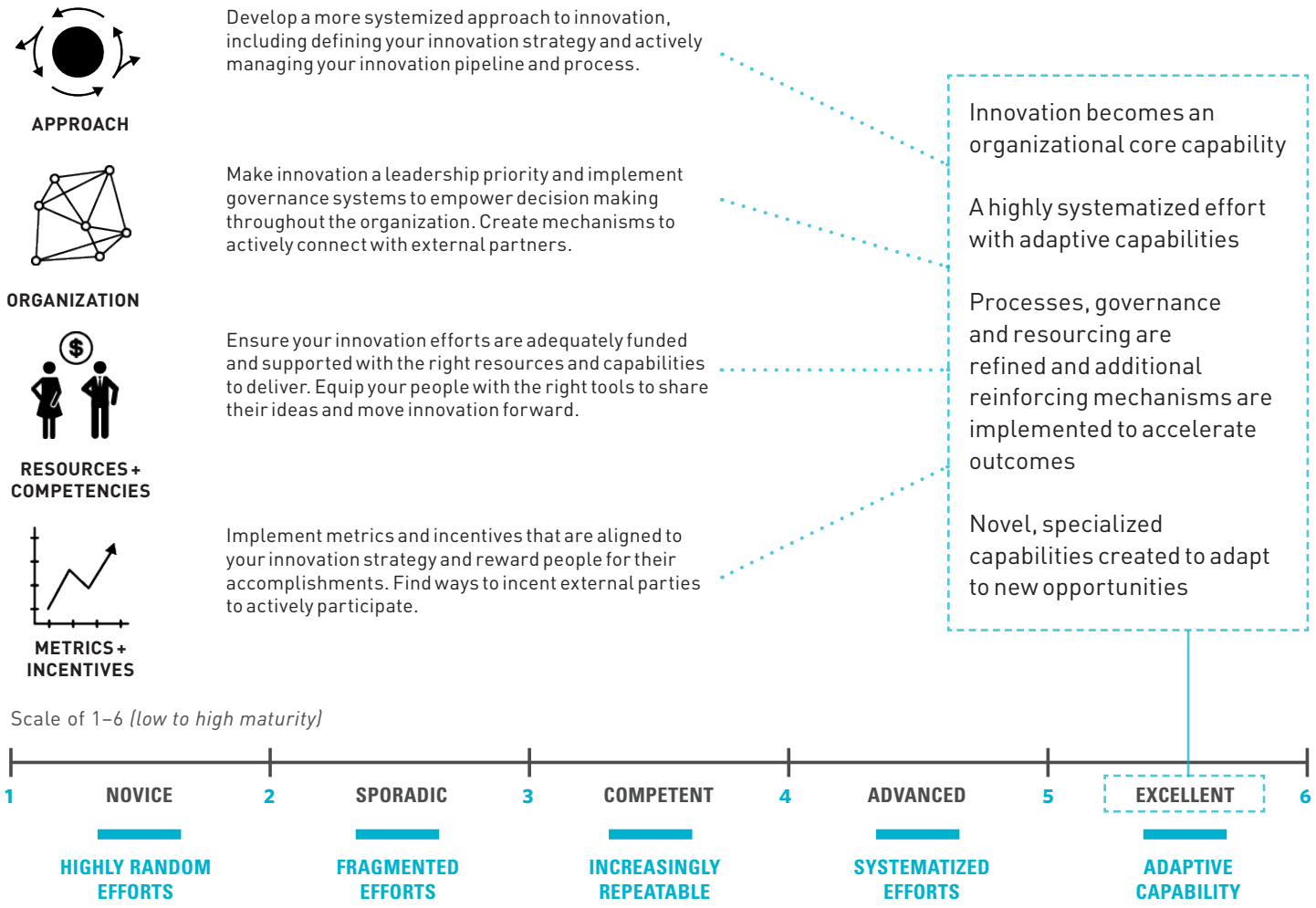
Coming of age in an age of disruption

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 how *most* sectors operate. And mining companies can also add rising environmental concern and associated activism to their list of pressures. But whether it's the emergence of a new technology or an updated way of using an old one, companies are encouraged to embrace three key principles:

1. Be explicit about your ambition and vision for innovation. Only then can you effectively organize and execute.
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 general advice offered in Figure 10 for enhancing the overall effectiveness of their innovation culture.

Figure 10. Moving toward "excellent" innovation capabilities



To address the *pace* of market change and disruption, meanwhile, an integrated external innovation ecosystem is essential. In that spirit, the following recommendations are offered to help companies set targeted priorities for maturing their distinct innovation capabilities.

MAJORS

APPROACH	ORGANIZATION
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.	Set the tone—innovation needs to be driven from the top and shouldn't be a middle-management skunk works. 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

RESOURCES + COMPETENCIES	ORGANIZATION	METRICS + INCENTIVES
Preserve your nimbleness as you grow. Stay flexible and adaptive to change.	Make the most of your limited resources and tap into incentives available at provincial and national levels.	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.

More generally, 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/commercialize innovations and develop assets and majors to buy juniors.

Success, after all, is about thriving, not merely surviving. In a down cycle specifically, that means adapting to an increasingly complex and challenging operating environment. As such, the value of innovation has never been stronger. But success in these terms for the mining sector in particular also means more collaborating, working together to solve mutual problems for mutual gain.

It's simple strength in numbers: together, we're much more powerful.

IN YOUR OWN WORDS

"Any one company on its own can only achieve so much. The key to being successful in the innovation space is to develop strong relationships. You have to balance the competitive edge of trying to fund innovation yourself versus the opportunity for big changes." —Junior

FOR FURTHER READING

Ten Types of Innovation
Ten Types of Innovation: The Discipline of Building Breakthroughs is the culmination of thirty years of analysis and research. The innovation framework was built around a seminal Doblin discovery, that there are ten distinct types of innovation that need to be orchestrated with care to make game-changing innovations. Learn more.

Managing Your Innovation Portfolio
People throughout your organization are energetically pursuing the new. But does all that activity add up to a strategy? Firms that excel at total innovation management simultaneously invest at three levels of ambition, carefully managing the balance among them. Read more here.

Tracking the trends 2015
The 2015 edition of *Tracking the trends* takes a look at the issues miners will face in the coming year and outlines a wealth of potential responses proposed from mining professionals at Deloitte member firms around the world. Download the report here.

ABOUT

MONITOR DELOITTE
To grow with confidence, organizations 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.

DOBLIN
Doblin is a global innovation 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 organizations innovate more boldly and effectively.

PDAC
The Prospectors and Developers Association of Canada (PDAC) is the national voice of the Canadian mineral exploration and development community. With a membership of over 7,000 individuals and 925 corporations, the PDAC's mission is to promote a responsible, vibrant and sustainable Canadian mineral industry, both at home and abroad. The PDAC is known worldwide for its annual convention, regarded as the premier event for mineral industry professionals.

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