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DIGITAL LEADERSHIP SERIES

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BRIDGING THE GAP

Five Shifts to Unlock Mining Innovation in Canada

Insights from the DIGITAL Mining Innovation Roundtable

Executive Summary

Canada's mining sector is on the cusp of leading global mineral production. The sector extracts over 60 minerals, employs 700,000 people and has secured a $117B project pipeline over the next decade. Amplifying this, Canada has one of the fastest-maturing technology ecosystems in the G7.

Despite these strengths, significant gaps remain and the stakes are also rising. In recent years, mineral sovereignty has grown from a competitive advantage to a matter of national security.

In January 2026, DIGITAL convened more than 20 ecosystem leaders at a roundtable during AME Roundup to confront this disconnect. Operators described a culture where caution has calcified into inaction. Builders described a "pilot roundabout" where trials never graduate to deployment. Both sides agreed the status quo is breaking.

During the robust and bold discussion, five shifts emerged to bridge critical innovation gaps. These shifts require moving from:

- Incremental improvement to first-principles redesign
- Funding builders to incentivizing buyers
- Mismatched capital to industrial-scale investment
- Pilot culture to safe-to-fail deployment
- Siloed innovation to ecosystem alignment

None of these shifts can be executed alone. With over $750 million invested across 200+ projects and a network of 1,600+ members, DIGITAL's role is to orchestrate connections between buyers, builders, capital, government, and academia to turn these shifts into rapidly deployed technology.

The builders are ready. The technology is ready. The next step is adoption.

The Disconnect

Canada is a mining powerhouse, producing over 60 minerals and metals, employing more than 700,000 people, and contributing 5% of national GDP[1]. With 140 planned or proposed mining projects valued at $117 billion over the next decade,[2] the investment pipeline is massive and growing.

Canada also has a rapidly maturing technology ecosystem. AI adoption among Canadian businesses doubled in 2024 and reached 12.2% by mid-2025,[3] while new research suggests that AI-driven economic growth could contribute $298 billion and 41,500 new jobs annually to the Canadian economy over the next decade.[4] Digital tools are already reshaping industries from agriculture to logistics to financial services.

Yet in mining, these two strengths are not connecting. The industry that underpins much of the economy remains one of the slowest to adopt the technologies that could transform it, and the gap between what is possible and what is deployed continues to widen.

Mining companies spend less than 3% of EBITDA on R&D, as opposed to 8% for materials producers, 30% for industrials, and 40% for automakers.[5]

The disparity in research investment tells the story in a single number: mining companies devote a fraction of what comparable heavy industries spend on innovation, even as their operational challenges intensify.

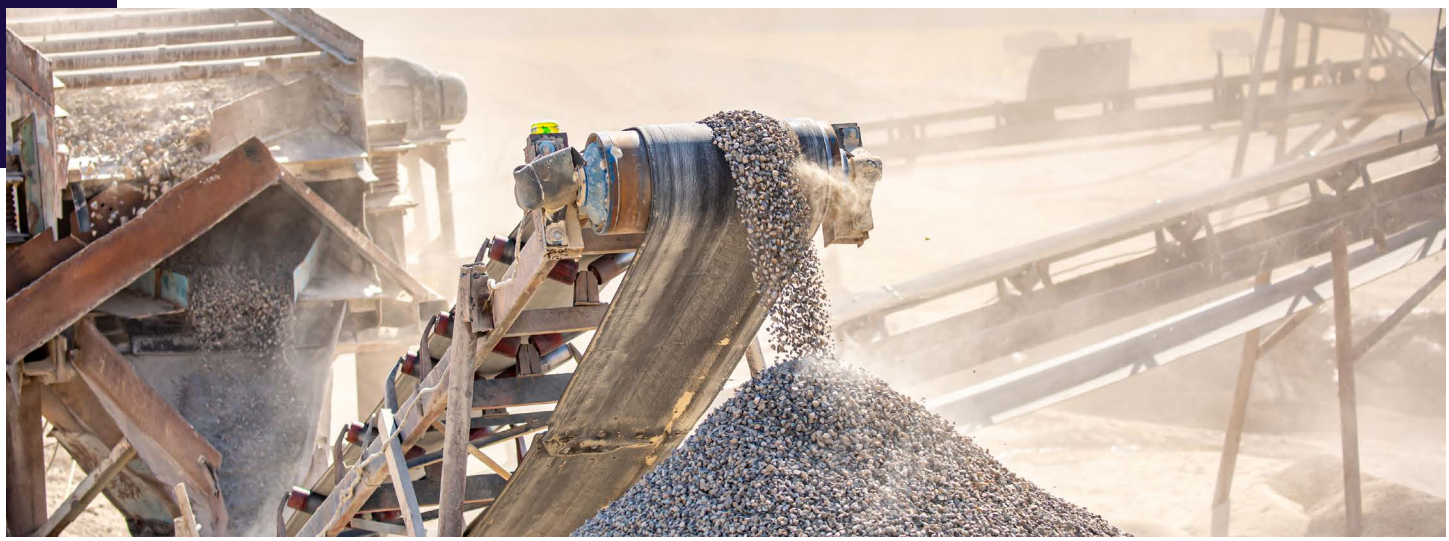
This urgency is sharpened by a volatile global landscape where shifting trade dynamics have transformed mineral sovereignty into a matter of national security. In this environment, the rapid adoption of domestic technology is no longer just a commercial advantage, it is a strategic necessity to ensure Canadian IP and critical data remain secure domestic assets.

In January 2026, DIGITAL convened more than 20 ecosystem leaders at the AME Roundup event in Vancouver to confront this disconnect directly. These leaders encompassed technology builders, mining operators, researchers, investors, and government voices.

The room was not short on ambition. Asked for a single word to define their goals, participants offered: **boldness, urgency, sovereignty, deployment and integration.** The tone was clear that incrementalism is no longer an option.

One speaker captured the imagination deficit with a striking observation. Even James Cameron's *Avatar*, set 150 years in the future on an alien moon, depicts mining with the same yellow haul trucks and manual drivers we see today. The industry does not have an innovation problem. It is a failure of vision about what mining could become.

[1]Mining Data, Statistics and Analysis, NRCan, February 2026
[2]Canada's Critical Minerals Strategy Progress Update, NRCan, 2024.
[3]Statistics Canada, "Use of artificial intelligence by Canadian businesses," Q2 2025.
[4]The Economic Impact of Public investment and Growing Adoption of AI, Deloitte, 2025.
[5]White & Case, "Technology – The Hottest Commodity in Mining & Metals," 2024.



What the Buyers Need

It would be easy to cast mining operators as an obstacle. They are not. Their caution is a rational response to an environment where geological uncertainty is enormous and the cost of getting it wrong can be catastrophic. Understanding this reality is essential if technology is going to scale.

The roundtable unearthed what participants identified as the "safety paradox", i.e. the industry's success in reducing physical risk over the past three decades has been extraordinary, but that very success has bred a culture deeply uncomfortable with any kind of failure, including the controlled, iterative kind that innovation requires.

There is also a deeper structural issue at play. Operators view their competitive moat as their assets (e.g. the ground they own) not the technology they use to extract value from it. This makes technology investment feel discretionary rather than strategic, and it explains why Canadian mining companies are often described as being "in a race to be fifth," waiting for competitors to absorb the risk of adoption before they consider following.

Meanwhile, the physical reality of mining is getting harder. Global copper ore grades have fallen dramatically over the past three decades,[6] and the world's largest copper mine saw its head grades plummet from roughly 2.5% to 0.5%, forcing billions of dollars in expansion investment simply to maintain output.[7] In Chilean copper operations, total energy consumption rose 46% in a single decade as mines pushed deeper into lower-quality rock.[8]

Copper ore grades are down ~40% since 1991. Mines are going deeper, energy costs are rising, and margins are compressing.

The declining quality of the resource base means that technology adoption is shifting from a competitive advantage to an operational necessity, yet the incentive structures around operators still do not reflect that urgency.

Several trial projects discussed at the roundtable were reported "dead" in the last year. These examples were not because the technology failed, but because personnel turnover, mine expansions, or corporate restructuring reset the entire sales cycle to zero.

> *"Even within companies with multi-million dollar innovation budgets, internal teams struggle to get technology adopted at the site level."*

[6] IEA copper supply analysis, cited in Crux Investor, 2025.
[7] Earth Resource Investments, "Grade Decline at the World's Largest Copper Mine," 2025.
[8] Calvo et al., "Decreasing Ore Grades in Global Metallic Mining," MDPI Resources journal, 2016.

What the Builders See

On the other side of the table, technology builders are exhausted – not from building, but from endlessly proving what has already been proven.

The dominant theme of the roundtable was the never-ending pilot cycle. Builders described running proof-of-concepts like a competitive endurance sport: same product, different site, new champion, same outcome. One participant coined it as the "pilot roundabout", capturing a cycle where trials never graduate into deployment and every new site resets the clock.

> *"Great work... now let's do another pilot!"*

This pattern is not unique to mining, though its constraints make it especially acute. Research into enterprise AI adoption has found that the vast majority of pilots across all industries fail to deliver measurable returns[9] not because of weak technology, but because organizations cannot absorb the change. In mining, where safety requirements, remote operations, and geological variability add layers of complexity, the odds of scaling from pilot to production are even steeper.

Founders also described a quieter but equally challenging drain: the "soft no", where prospective customers do not reject a proposal outright but drag the evaluation process cycles until the startup's capital runs out.

> *"A 'soft no' takes twice as long as a straightforward 'yes' and consumes resources just the same."*

Compounding this, a typical procurement process involves more than 60 stakeholders who can say "no" but only one or two economic champions who can say "yes."

The roundtable also surfaced a persistent language barrier between the two sides. Startups speak of "disruption", which sounds like a threat to a mine manager responsible for keeping operations running safely. The industry, meanwhile, uses "trial", "POC", and "demonstration" interchangeably, creating genuine confusion about what stage a technology has reached.

Perhaps the most telling observation was self-awareness: builders acknowledged they are often talking to each other rather than to actual decision-makers, and the roundtable itself reflected this pattern with the buyer side of the table noticeably thin and symptomatic of the broader conversation the roundtable sought to address.

[9] MIT Media Lab / Project NANDA, "The GenAI Divide: State of AI in Business 2025," July 2025.

Five Shifts to Bridge the Gap

The second half of the program catalyzed discussion around a set of forward-looking, concrete proposals for the ecosystem. We've distilled the discussion into the following five shifts with alignment across builders, buyers, researchers, and policymakers.

Shift 1: From Incremental Improvement to First-Principles Redesign

The mining sector has a habit of optimizing old processes rather than questioning whether those processes should exist in their current form.

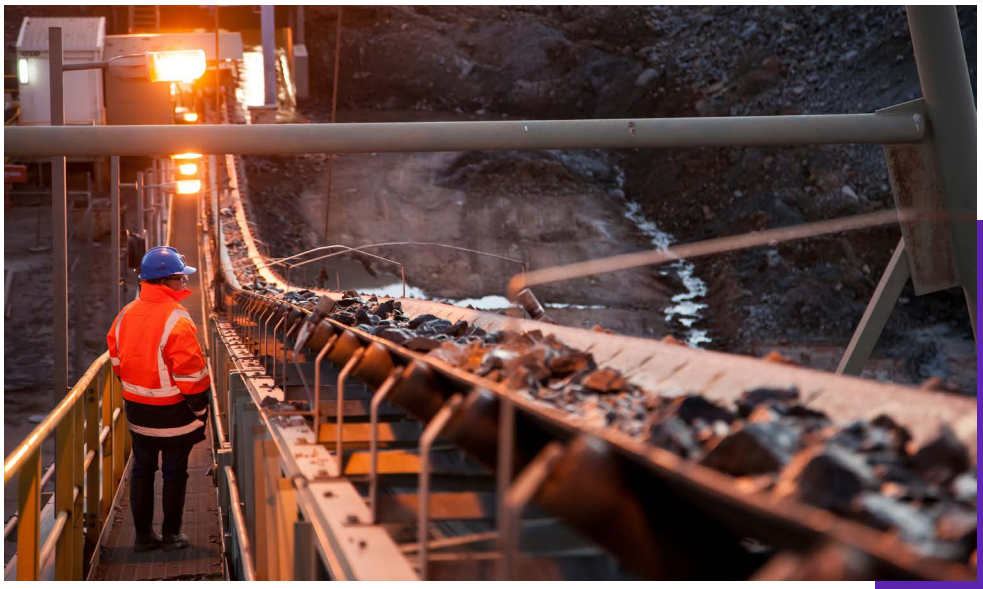
> *"The industry needs a 'SpaceX-style' approach… rethinking problems from the ground up rather than just improving existing, inefficient processes."*

This means designing future mines for autonomy and zero-entry from Day 0, rather than retrofitting technology onto mine plans conceived for a previous era. The distinction matters: a mine designed around autonomous systems from the outset will look fundamentally different – in layout, ventilation, infrastructure, and workforce model – from one where autonomy is added as an afterthought. The first-principles question is not "how do we make this truck autonomous?" but "do we need trucks at all?"

Another radical first-principles opportunity lies in what the industry has already discarded. The environmental liability of closed and abandoned mine sites globally runs into hundreds of billions of dollars. In the U.S. alone, cleanup costs are estimated at more than $70 billion[10], yet these legacy sites also contain significant concentrations of critical minerals that were either not targeted in original operations or could not be economically recovered using older technologies. Re-mining tailings (extracting value from what was once classified as waste) represents the ultimate first-principles rethink: turning a perpetual cost centre into a profit centre, reducing environmental liabilities rather than managing them, and producing critical minerals without new land disturbance. It is precisely the kind of reimagination this shift calls for.

The scale of the opportunity reinforces the urgency. The global AI in mining market was valued at $30 billion in 2024 and is projected to reach $686 billion by 2033, representing a compound annual growth rate of 42%.[11] Companies that continue to optimize yesterday's methods risk missing a market that is growing 20 times in under a decade.

Yet in most mining organizations, innovation budgets remain the first casualty of downturns. **The sector does not lack access to technology.** It lacks the organizational imagination and institutional will to deploy it at the scale this moment demands.



[10] James S. Lyon, et al., Burden of Gilt, 1993
[11] Grand View Research / Barchart, "AI in Mining Market Report," 2024.

Shift 2: From Funding Builders to Incentivizing Buyers

> *"...what if we incentivized buyers? Then market need would determine which solutions thrive."*

The roundtable reached a striking consensus: the fastest way to unlock innovation is not funding more builders. It's in empowering more buyers to take calculated risks on new solutions.

Current incentive structures focus almost exclusively on the supply side. Builders receive grants and tax credits to develop technology while operators receive no corresponding financial motivation to adopt unproven solutions. The result is a market flooded with pilot-ready technology and almost no demand-side pull to move it into production.

Suggestions shared included redirecting supply-side programs toward technology buyers and creating new mechanisms that directly reward operators for adoption. Participants were candid that some current programs inadvertently prop up companies without genuine market demand, crowding the field and masking the technologies that are actually ready to scale.

Shift 3: From Mismatched Capital to Industrial-Scale Investment

Even when technology is market-ready, the capital available to scale it is often structured for the wrong kind of business with an overall inherent "lack of industrial-scale capital". Funding for mining technology frequently mimics models designed for enterprise software: fast development cycles, low capital expenditure, and quick returns. However, mine sites demand precisely the opposite: high CapEx, long timelines, and physically demanding deployment environments where costs at scale can dwarf the cost of development.

The discussion surfaced several mechanisms worth exploring, such as applying a "flow-through share" model (currently used in mineral exploration) to mining technology investments, leveraging Industrial Technological Benefits (ITBs) from defence contracts, and learning from Australia's MinEx CRC cooperative research model. Until the capital structure matches the physical and financial reality of the sector, promising technology will continue to die in the gap between pilot and deployment.

> *"Government is not a long-term answer to the innovation gap with respect to subsidies that mask an underlying need for private equity investment and genuine hustle on the part of builders."*

Shift 4: From Pilot Culture to Safe-to-Fail Deployment

> *"Builders must find test beds that do not impact active operations to gain the 'hardness' required for prime-time deployment."*

While the safety paradox described earlier is real, participants also offered a powerful reframe: the risk of *not* adopting technology now exceeds the risk of adopting it. Declining ore grades, rising energy costs, and intensifying global competition are compressing the window for action, and the question facing Canadian mining is not whether to move but how to create environments where the industry can move safely.

Many participants identified the lack of physical testing infrastructure as a critical gap: Canada needs a nationally supported, physical "industrial-scale sandbox" where TRL 5-7 technologies can be trialed at meaningful scale without disrupting active production.

Canada is not starting from zero. Promising provincial initiatives are emerging. In Ontario, NORCAT operates the only regional innovation centre in the world built around an active underground mine. Startups and established companies alike can develop, test, and demonstrate technologies in a real mining environment, supported by the province's $63M "Next Generation Network" program and technology partners. In British Columbia, a new province-wide mining and critical minerals testbed was launched in February 2026 under the "Look West" strategy, linking technology providers with industrial buyers and offering companies a lower-risk pathway to validate and deploy solutions across mineral processing, waste streams, and value-added processing.

These are meaningful steps. But they remain provincial and relatively modest in scale compared to what a coordinated national approach could achieve.

Shift 5: From Siloed Innovation to Ecosystem Alignment

> *"Without 'vision match' across technical, economic, and strategic champions, technology stays stranded in the lab."*

Technology does not stall because it lacks a champion. It stalls because it lacks the right combination of champions. Success requires alignment between the technical champion who validates a solution, the economic champion who funds it, and the strategic champion who commits the organization to scaling it. In practice, these three people rarely sit in the same room at the same time.

The alignment problem extends well beyond individual organizations. Canada's innovation economy is deeply siloed. Robotics researchers, defence technologists, AI specialists, and mining operators often work in parallel without meaningful intersection. Canada's top digital talent often has no idea that mining's challenges exist, and mining companies rarely look outside their sector for solutions. Dual-use technologies, such as robotics, autonomous systems, and remote sensing, could serve both defence and mining, but without deliberate cross-sector connection, these synergies remain untapped.

> *"Align the innovation in product or service development to a known industry or societal problem. This is the core strength of DIGITAL's approach."*

The alignment Canada needs is not only between champions within organizations, but across an entire ecosystem that has yet to recognize itself as one.

Closing the Adoption Gap Together

The five shifts outlined above are systemic. No single company, program, or policy can achieve them alone. But each shift has identifiable actors who can move it forward, and the roundtable made clear that waiting for someone else to go first is precisely the habit that created the gap.

What buyers can do. Mining operators hold the key to Shifts 1, 2 and 4. They can embrace first-principles thinking in how future mines are designed. They can signal demand by engaging earlier with technology providers – not at the procurement stage, but at the design stage. They can advocate within their own organizations for dedicated adoption budgets that are protected from commodity-cycle cuts. And they can co-invest in sandbox and testbed environments where new technologies can be validated at industrial scale without putting active operations at risk. The most important contribution a buyer can make is simply showing up: being in the room with builders, sharing operational realities openly, and committing to evaluate solutions on their merits rather than defaulting to the safety of inaction.

What builders can do. Technology companies hold the key to Shift 1. They can adopt first-principles thinking in their own product development, designing for mine-site realities from the outset rather than adapting enterprise software for underground conditions. They can invest in building commercial and operational evidence that de-risks adoption for buyers, including credible ROI data from pilot deployments. And they can be honest about what is genuinely market-ready versus what still requires development support, helping to clear the field of pilot-stage noise that makes it harder for deployment-ready solutions to be seen.

What government, financial industry, and academia can do. Policymakers, capital providers, and research institutions hold the key to Shifts 2, 3, 4 and 5. Provincial and federal governments can redesign incentive structures so that technology adoption, not just technology development, is financially rewarded. They can invest in shared physical infrastructure like testbeds and sandboxes. The financial industry, including venture capital, private equity, and institutional investors, can develop capital structures that match the realities of mine-site deployment. This includes longer timelines, higher CapEx, and patient returns, rather than forcing mining technology into enterprise software funding models. Academic institutions can direct applied research toward industry-defined problems and build training pipelines that equip the next generation of mining professionals with digital fluency.

What DIGITAL does. DIGITAL's contribution is not to own all five shifts but to orchestrate connections between people who can. As Canada's Global Innovation Cluster for Digital Technologies, DIGITAL is one of the few organizations that consistently brings industry, academia, and federal and provincial government voices into the same room – a capability the roundtable participants themselves identified as valuable. With over $750M invested across 200+ projects and a network of over 1,600 member organizations across the country, DIGITAL's role is to design programs that embed these five shifts into how projects are scoped, funded, and measured. DIGITAL ensures buyers are at the table from Day 0, funded technologies are designed for deployment rather than demonstration, and cross-sector pollination between mining, defence, genomics, AI, quantum, and clean technology is a feature of every program, not an afterthought.

DIGITAL plans to expand future roundtables to include more buyers and mining operators and will utilize insights from this brief to shape future programs in mining and digital technologies.

The roundtable was a starting point, not a conclusion. The builders are ready. The technology is ready. The missing ingredient is not innovation – it is alignment, momentum, and readiness to act quickly. These five shifts are the roadmap. **The next step is yours.**

About This Brief

This brief synthesizes insights from a closed-door roundtable convened by DIGITAL at AME Roundup 2026 in Vancouver, BC. The session was held under the Chatham House Rule: participants' identities are not disclosed. Findings are supplemented by a post-event participant survey and publicly available industry data. All quotes reflect roundtable discussions or survey responses and are presented without attribution.

Acknowledgments

DIGITAL thanks the 20+ participants who contributed their time, candour, and expertise to this roundtable. Their willingness to speak openly – across organizational boundaries and competitive lines – made this brief possible.

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To learn more about DIGITAL's technology mining programs, explore collaboration opportunities, or participate in future roundtables:

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