



## IDEATE 2026

May 14, 2026

8:30 am – 4:00 pm

Boffins (106 – 111 Research Drive, Atrium Building)

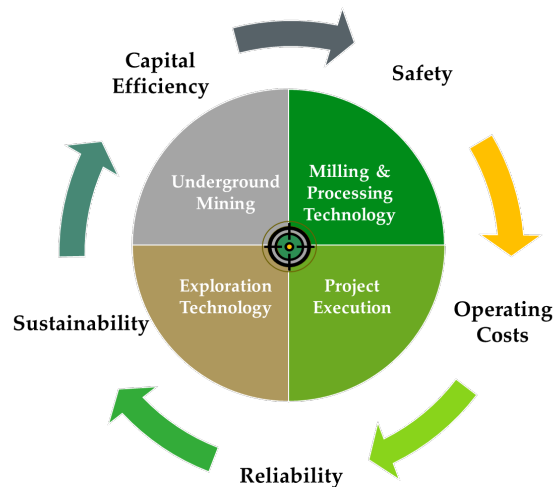
Innovation Saskatchewan's Innovation and Technology Research Park  
(formerly Innovation Place)

### Agenda:

8:30 – 9:00 am	Registration
9:00 – 9:15 am	Opening Remarks
9:15 – 9:30 am	Refreshment Break
9:30 – 10:30 am – Workshop #1	
Advanced Materials & Advanced Manufacturing Part 1	Water Use & Tailings
10:30 – 10:45 am	Refreshment Break
10:45 – 11:45 am – Workshop #2	
Advanced Materials & Advanced Manufacturing Part 2	Ground Control
11:45 am – 1:00 pm	Lunch, Guest Speaker & Networking
1:00 – 2:15 pm – Workshop #3	
MSI, Repetitive Strain & Human Factors	Process Sensors & Data
2:15 – 2:30 pm	Refreshment Break
2:30 – 3:30 pm – Workshop #4	Next Generation Mining and Mineral Processing
3:45 – 4:00 pm	Expression of Interest (EOI) Process Overview & Closing Remarks
4:00 PM	Networking

## IDEATE 2026 Research Needs

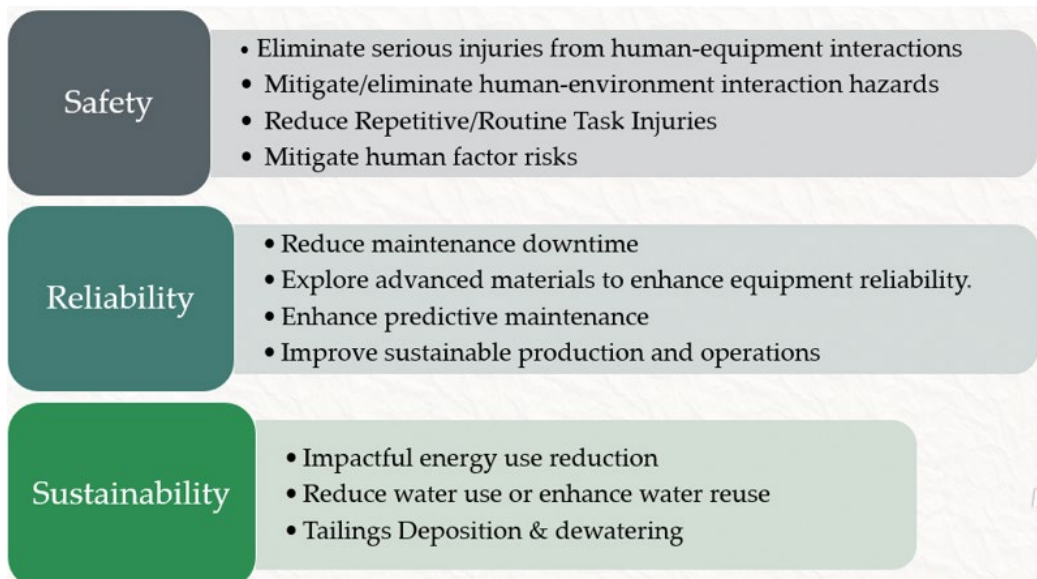
IMII's industry member research needs are driven by the organization's overarching strategy. For the 2025-28 Strategic Plan, IMII is focused on 4 core areas and 5 innovation drivers, as illustrated in the graphic below. The 4 quadrant focus areas define the areas of interest industry is prioritizing in this strategic cycle – essentially, the what. The five innovation drivers of safety, operating costs, reliability, sustainability and capital efficiency are the why – they are the things that drive why industry is seeking innovation and what will help justify funding support for innovation projects. By addressing these focus areas and drivers, from ideas toward development and demonstration, IMII facilitates projects in the innovation ecosystem that drive growth for the Saskatchewan minerals sector.



Academic research serves the innovation ecosystem by digging deeper into knowledge development needed to better inform innovation or develop a concept that will lead to a commercial innovation. This document outlines some areas that have been identified by industry as requiring this type of effort near the front-end of the innovation curve.

In addition to advancing innovation, IDEATE projects also serve to develop talent by fostering the core skills that industry needs to solve innovation challenges. Therefore, research efforts should demonstrate a tie to IMII's research strategy and articulate which focus areas and which strategic drivers relate to each project. Submissions should also consider the core fundamental skills these projects will help foster in the faculty, graduate or undergraduate students engaged in the projects.

At a high level, IMII's innovation needs across three of IMII's primary drivers are summarized on the graphic below.



The following more detailed research needs have been selected as focus areas for the 2026 IDEATE event.

## Safety Topics

### Human Factors, Fatigue, and Cognitive Safety Technologies for the Mining Sector

Mining environments place significant cognitive, physical, and psychological demands on workers. Long shifts, repetitive or “mind numbing” tasks, and high risk operational contexts all challenge human performance and decision making. As the industry advances mechanization and automation, new opportunities exist to improve fitness for duty, situational awareness, and cognitive safety.

Recent developments in wearable technologies, biometric monitoring, attention tracking, and human machine interaction tools offer potential paths to reduce fatigue related incidents, improve worker wellbeing, and enhance operational reliability.

Projects for these topics should explore human factor and fatigue related injuries in mining, and technologies currently used in mining and other industrial sectors. Areas of interest include detecting, predicting, and mitigating safety incidents arising from human factors, fatigue, cognitive overload, or reduced situational awareness.

### Eliminating or Redesigning Repetitive, Routine & High Strain Tasks in Mining

Mining operations involve numerous repetitive, high strain, and vibration intensive tasks that increase the risk of musculoskeletal injuries, chronic vibration exposure, and performance errors driven by routine complacency. Despite existing mitigation measures, many activities—such as operating impact wrenches or performing repetitive manual processes—continue to contribute significantly to lost time injuries, cumulative strain, and reduced operational productivity.

Advances in mechanization, automation, robotics, and ergonomic engineering present new opportunities to redesign or eliminate these high-risk tasks. Understanding which tasks present the greatest injury and vibration risks and identifying technologies or design changes that can address them is a critical priority. This area may benefit from a comprehensive review of the current state of research in this area.

Potential projects in this area might include exploring task risk analysis to identify mining tasks with the highest rates of repetitive strain and vibration related injuries. If tasks have already been identified projects could explore potential solutions—including mechanization, automation, ergonomic redesign, and engineering controls—to reduce or eliminate repetitive strain injuries and improve long term worker health and safety.

**Potential disciplines** - Robotics, kinesiology, data science

## Advancing Ground Control Through Forward Visibility in Potash Mining

Ground control remains one of the most critical safety challenges in underground potash mining. A key limitation in current operations is the lack of forward visibility beyond the active cutting face, which creates uncertainty in detecting:

- Geological anomalies
- Voids or discontinuities
- Stress conditions that may lead to instability

This uncertainty increases the risk of sudden roof failures, unplanned ground falls, and associated safety hazards, posing significant risks to mine workers and operations.

Present ground control practices in potash mining are largely reactive, relying on methods such as sounding, scaling, and established procedures. These are supplemented by ground penetrating radar (GPR), which provides limited subsurface imaging but does not enable continuous or reliable insight into conditions ahead of the mining face. As a result, there is currently no direct or proactive method to “see” or assess ground conditions before they are exposed.

There is a clear need for proactive solutions that enable real-time, reliable imaging or predictive modeling of ground conditions ahead of mining activities. Such capabilities would significantly improve hazard anticipation, enhance worker safety, and support more informed and optimized mine planning

### Research objectives

- Enable detection of geological anomalies, voids, or adverse stress conditions ahead of the mining face
- Reduce the risk of unexpected roof failures and ground falls
- Move ground control practices from reactive to predictive and proactive
- Support real-time or near real-time decision-making underground

**Potential research topics include:**

- Novel sensing or imaging technologies capable of operating beyond the cutting face
- Hybrid solutions combining sensing technologies with predictive analytics
- Advanced geophysical or geomechanical monitoring approaches

## Reliability Topics

### Wear-Resistant & Corrosion-Resistant Materials for Harsh Mining Environments

Mining operations—particularly in potash, uranium, and other mineral sectors—expose equipment and infrastructure to high abrasion, corrosive brines, scaling, erosion, and cyclic fatigue. These conditions contribute to premature equipment wear, unplanned downtime, costly maintenance, and elevated safety risks. As mines become deeper, more remote, and more production intensive, the industry requires next generation materials that can deliver longer service life and improved performance under extreme conditions.

Advances in materials science and advanced manufacturing technologies are creating new possibilities for highly durable alloys, ceramic reinforced composites, engineered coatings, and surface treatments that could dramatically improve equipment longevity and reliability across the mining value chain.

Research opportunities include:

- Novel high hardness, high toughness alloys engineered for abrasion and erosion resistance.
- Metal matrix composites (MMCs) incorporating ceramic or carbide phases.
- Superalloys tailored for high temperature, corrosive, or radiological environments.
- Materials optimized for compatibility with potash, chloride brines, acidic effluents, and uranium bearing fluids
- Corrosion kinetics in potash brines, saturated salt solutions, or chloride rich media.
- Material behavior under simultaneous corrosion + abrasion + fatigue.

### Advanced Functional Coatings and Surface-Engineered Systems for Predictive Reliability in Mining Equipment

Mining equipment in potash, uranium, and related sectors operates under combined mechanical, chemical, and thermal stressors that drive degradation at material surfaces long before bulk material failure occurs. While advances in alloys and composites address intrinsic material performance, surface engineered coatings offer an underleveraged opportunity to both extend component life and enable condition-based maintenance.

Next generation coatings—such as multilayer ceramics, nanostructured metallic coatings, amorphous alloys, and functionally graded surfaces—can be tailored to simultaneously resist abrasion, corrosion, erosion, thermal cycling, and fouling. When combined with embedded sensing or self reporting

capabilities, these coatings could also provide early indicators of degradation, enabling predictive maintenance and improved asset reliability.

**Research opportunities include:**

- Design and evaluation of multifunctional coatings providing simultaneous abrasion, corrosion, and erosion resistance in chloride rich and brine saturated environments
- Nanostructured, amorphous, or functionally graded coatings optimized for cyclic loading and impact conditions
- Investigation of coating–substrate interactions, adhesion durability, and failure modes under combined wear–corrosion–fatigue loading
- Self-healing or damage tolerant coatings that mitigate crack initiation and propagation
- Development of sensor enabled or “smart” coatings that change electrical, thermal, or optical properties as degradation progresses
- Coatings compatible with additive manufacturing and advanced repair techniques for in-situ refurbishment of critical components
- Performance benchmarking of advanced coatings versus traditional hard facing and thermal spray solutions in mining specific conditions

**Research objectives:**

- Extend service life of high wear and high corrosion components
- Reduce unplanned downtime and maintenance frequency
- Enable transition from reactive to predictive, condition-based maintenance
- Improve capital efficiency and lifecycle cost performance of mining assets
- Keep life cycle costs in mind when considering these opportunities (new technologies will have to compete with frequent replacement of conventional steel components).

Additional related interest areas:

- Advanced welding and joining technologies
- Improved or semi-automated non-destructive testing technologies

**Potential disciplines** - Chemical, mechanical engineering, material science

## Sustainability Topics

### Water use and reuse technologies

Potash operations in Saskatchewan operate under a zero-liquid-discharge (ZLD) policy. As part of this approach, all excess water originating from precipitation or freshwater sources is deep-well injected to maintain brine containment and operational stability. As a result, large volumes of fully co-saturated brine—primarily containing sodium chloride (NaCl) and potassium chloride (KCl), with variable concentrations of magnesium chloride (MgCl<sub>2</sub>) and calcium chloride (CaCl<sub>2</sub>)—are disposed of annually.

Technologies capable of economically processing these brines, particularly those that enable desalination and recovery of KCl or other valuable salts, would represent a significant environmental and resource-efficiency advancement for the potash sector.

**Research objectives:**

- Evaluate processes capable of treating brines with high concentrations of NaCl and KCl
- Accommodate variable brine chemistries, including  $MgCl_2$  and  $CaCl_2$
- Enable economic recovery of KCl and/or other valuable products

Potential areas to explore

Research approaches may include, but are not limited to:

- Innovative separation and crystallization technologies
  - e.g., membrane distillation–crystallization (MDC)
  - hybrid thermal–membrane processes
- Novel selective membranes
- Advanced evaporation, precipitation, or fractional crystallization methods

**Potential disciplines** - Environmental, chemical engineers, process engineers, materials

## Understanding and Mitigating Potash Fines/Slimes Migration in Tailings Facilities

Potash tailings facilities are integral to safe and sustainable production in Saskatchewan. A recurring challenge in several operations is the unexpected migration of potash fines and slimes from the top layers of deposited tailings toward the base of the pile. Operators have observed instances where fines refloat, migrate, or become suspended, ultimately settling toward the base.

This behaviour reduces available brine storage capacity, affects consolidation and stability, and may contribute to operational inefficiencies and elevated maintenance requirements.

A deeper scientific understanding of this phenomenon is needed to support improved tailings management strategies and long-term facility performance

Key questions include:

- What mechanisms cause potash fines/slimes to refloat or migrate?  
(e.g., salinity gradients, density differentials, fluidization, chemical effects, gas entrainment)
- How do hydrodynamic, mineralogical, or depositional conditions influence fines movement?
- What mitigation strategies could reduce fines migration or enhance fines capture?
- How can tailings deposition practices be modified to preserve brine storage volume?

**Potential disciplines** - Environmental, chemical engineers, process engineers

## Efficiency Topics

### Processing Sensors and Advanced Data Analytics for Mining Applications

Modern mineral processing operations generate vast amounts of operational data; however, many process decisions remain constrained by delayed analysis and challenging operating environments. Harsh conditions—such as dust, vibration, elevated temperatures, radiation, corrosive reagents, and slurry-based systems—often limit sensor reliability, accuracy, or measurement resolution. These challenges are particularly pronounced for critical variables such as mineral grade and composition, particle size distribution, product density, product moisture and mass flow or weight measurements. Even where sensors are already deployed, frequent cleaning, recalibration, and maintenance may be required before the data can be trusted for operational decision-making.

At the same time, other industries—including healthcare, agriculture, defence, energy, and advanced manufacturing—have made significant advances in the use of novel sensors, soft-sensing techniques, real-time analytics, and high-performance computing. These technologies enable faster diagnostics, tighter process control, and improved outcomes. There is considerable opportunity to translate and adapt these advances to address sensing and analytics challenges in mining and mineral processing.

Potential focus areas could include:

- New sensors or near real-time analysis for key variables such as mineral grade and composition, particle size distribution, product moisture, density and mass flow or weight measurements
- Development of soft sensors, which infer critical process variables from analysis of directly measured parameters.
  - Ex. estimating mineral grade based on other indicative measurements
- Exploration of advanced process control integration for grinding circuits, leaching, and conversion processes
- The primary value of these advancements lies in faster troubleshooting and decision-making, improved data integrity for reporting, and direct profitability impacts through increased throughput, reduced energy and reagent consumption, and enhanced production system reliability. When evaluating these opportunities, it is critical to consider full lifecycle costs, as new technologies must remain competitive with conventional methods in terms of reliability, maintainability, and long-term value.

**Potential disciplines:** Mining, Chemical and process engineering, electrical and instrumentation, data science, control systems

### Next Generation Mining and Mineral Processing Technologies for Step Change Efficiency Gains

Both surface and underground mining operations face increasing pressure to improve productivity, reduce energy and water intensity, and minimize operating costs while maintaining safety and reliability. Many

core mining and mineral processing steps—cutting, crushing, material handling, separation, and dewatering—remain energy intensive, mechanically complex, and constrained by legacy equipment designs.

This research area focuses on fundamentally new or substantially reimagined processing technologies that enable step change improvements in efficiency, rather than incremental optimization of existing systems. The intent is to explore novel physical, chemical, and hybrid processing approaches that reduce energy consumption, simplify processing flowsheets, increase recovery, and improve overall system robustness in both surface and underground contexts.

Rather than targeting specific pieces of equipment, this topic emphasizes process level innovation, integration, and rethinking how material is extracted, conditioned, and transported through the mining value chain.

Research opportunities include:

- Non-traditional rock breakage and comminution technologies (e.g., electrical pulse fragmentation, high-pressure fluid jets, microwave assisted breakage) that reduce energy intensity and downstream processing requirements
- Insitu or near face processing concepts that reduce material handling, hoisting, and surface processing loads in underground operations
- Selective mining or separation technologies that enable early waste rejection or grade control closer to the mining face
- Continuous or low maintenance processing systems designed to replace batch based or mechanically complex unit operations
- Hybrid physical–chemical processing approaches that improve liberation, separation efficiency, or reagent utilization
- Process integration and simplification, reducing the number of unit operations required to achieve target product specifications
- Technologies designed to operate reliably in constrained underground environments, including space, ventilation, and power limitations

**Research objectives:**

- Achieve step change reductions in energy intensity per tonne mined or processed
- Increase material throughput and recovery efficiency with fewer processing steps
- Reduce maintenance burden, downtime, and process variability
- Improve overall system reliability through simpler, more robust process designs

Enable productivity improvements without proportional increases in capital or operating costs

**Potential disciplines:** Mining, Chemical and process engineering, electrical and instrumentation, data science, control systems