INTERNATIONAL
MINERALS INNOVATION
INSTITUTE

2022 IMII ANNUAL REPORT

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Introductory Comments to the 2022 Annual Report

EXECUTIVE DIRECTOR

Dear Friends of the IMII:

IMII was established in 2012 to support and sustain the Saskatchewan minerals industry for the long-term benefit of Saskatchewan. This means that 2022 saw IMII celebrate its 10th anniversary, and we did so by marking 10 years of innovation.

In its first ten years, IMII has sponsored more than 50 industry driven projects, valued at more than $24 million, and in doing so has leveraged more than $11 million in project funding from outside of its mineral industry and provincial government funding members.

IMII's purpose is to serve as an ***Innovation Steward*** to strengthen the Saskatchewan minerals industry's competitiveness and growth through ***Research, Development & Demonstration*** and ***Education & Training*** to drive the future's ***Qualified & Representative Workforce.*** In this report's pages, you'll see how we brought this purpose to life in 2022 – from our largest ever DEMOday, to our first AI collaboration, our latest technology development project, our first Innovation Challenge winner, and more women and Indigenous scholarship recipients. You'll also see how our efforts to support the minerals industry's digital transformation have reached new heights with a featured story during Saskatchewan's Mining Week, Mosaic's $1 million commitment to continue the Digital Transformation in Potash Training Program for five years, and Saskatchewan Polytechnic's Diggin' Digital Teacher Resource Hub going live.

Outside of IMII, 2022 was also notable for the continued impact of the COVID pandemic on all our lives and those of the organizations with which we work, volunteer, and engage, and the further disruption caused by Russia's invasion of Ukraine. We should keep all those whose lives were lost in 2022 in our hearts and minds.

Al Shpyth, Executive Director

Introductory Comments to the 2022 Annual Report

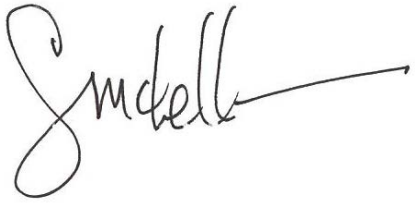
BOARD CHAIR

Dear Members of the IMII:

While I am new to the IMII, I came to the organization knowing of its efforts on behalf of its minerals industry, provincial government, academic and other members. As you read this annual report, I believe you'll see much evidence of how IMII has built its activities and projects around the four pillars of the strategic plan:

- **Innovation Steward:** Drive the Innovation Value Chain and Transform Innovative Ideas into Practice
- **Research, Development & Demonstration and Education & Training:** Enable Sustainable Innovation
- **Qualified & Representative Workforce:** Operationalize Equity, Diversity & Inclusion
- **Operate & Govern IMII Consistently:** Maintain Robust and Transparent Processes to Deliver Good Performance

Looking forward not only to 2023 but beyond, you may be assured that IMII will continue to seek outputs and outcomes that positively impact Saskatchewan's minerals industry and contribute to economic growth in the province.



Steve McLellan, Board Chair

Innovation Steward

Drive the Innovation Value Chain and Transform Innovative Ideas into Practice.

AES CHALLENGE WINNER

The Alternative Energy Systems Challenge was launched in 2020, seeking innovative solutions that can be piloted at a Saskatchewan mine site to reduce greenhouse gas emissions and improve energy efficiency.

Grengine (formerly Growing Greener Innovations) was chosen as the inaugural winner of the AES Challenge in September 2022. Grengine is a Canadian energy technology company focused on developing and manufacturing batteries, battery energy storage solutions, and battery management systems for commercial, residential, and industrial customers.

Grengine's winning innovation is a battery storage solution with the potential to minimize the need for diesel-fired electricity generation and operational downtime when backup power is required at a mining operation.

The challenge is supported by our minerals industry members: BHP, Nutrien, Cameco, Mosaic, and the Challenge Dialogue System Network.

DEMODAY 2022

DEMOday was introduced in 2018 in cooperation with the Saskatchewan Industrial and Mining Suppliers Association to invite inventors, start-ups, and supply chain companies to pitch their innovative solutions in equipment, technologies, processes or products to solve an industry problem.

IMII's DEMOday 2022 received a record number of applicants (32) and innovative pitches (11)! This was due to our minerals industry partners (Nutrien, Cameco, Mosaic and BHP) outlining 18 technology needs they'd like to see provided.

The innovators that pitched in May 2022 for DEMOday include Teal Electrification Systems, Solar Steam, 2S Water, MMKLGroup, InnoTech Alberta, GFL Environmental, Dyna Industrial, Continental Mine and Industry Supply Ltd., iRing Inc., and Muon Vision.

All who pitched in May 2022 are considered for IMII's Innovation Award, with the potential to receive up to $250,000 in funding to further develop, demonstrate, or deploy their innovations.

INNOVATION AWARD WINNER

We were pleased to announce 2S Water's Aquavalid Sensor as the winner of the 2022 Innovation Award. The winner was chosen by our minerals industry members—BHP, Cameco, Nutrien, and Mosaic at the 14th Annual Saskatchewan Mining Supply Chain Forum.

"2S Water has a mission of protecting water with real time data….The automated sensor has the potential to assist the minerals industry with process optimization, incident prevention and effluent monitoring and making a meaningful contribution to our members' ESG efforts," said IMII's Executive Director, Al Spyth.

Contenders for the 2022 Innovation Award were so well-matched that for the first time we had to recognize two other finalists: Copperstone Technologies and SolarStream both received honourable mentions.

LET'S TALK MINERALS

The 8th Annual Let's Talk Minerals saw industry and education professionals gather to discuss innovating education for mining-focused post-secondary.

The day started with Innovation Row, addressing mineral literacy, building STEM career capacity, and youth boot camps. Following Innovation Row we heard from Jeremy Breker, VP of Technical Operations for Cameco, on how the minerals industry is changing and how post-secondary must adapt in response. After Jeremy, Gina Grandy, Dean of Business Administration at the University of Regina, spoke about advancing EDI in mining through post-secondary education. In the afternoon, we heard from Tavia Laliberte, Vice President Academics of Saskatchewan Indian Institute of Technologies on Indigenous innovation.

Thank you to everyone who joined us in robust conversation and networking.

INDUSTRIAL CONCIERGE

Partnering with SIMSA to support digital innovation, carbon reduction, and ESG initiatives in the supply chain through the creation of the Industrial Concierge

DICE CONTRIBUTION

Supporting the Digital Integration Centre of Excellence (DICE) on infrastructure to enable new paths of research that can build upon and enhance DICE's existing research with industry partners.

Research, Development & Demonstration

ENABLING SUSTAINABLE INNOVATION

IMII's mandate is to enable sustainable innovations that matter to the minerals industry in Saskatchewan. By stewarding collaboration and providing opportunities for moving ideas to solutions, IMII helps to ensure the innovation ecosystem is aligned with the needs of and is providing solutions for the minerals industry. IMII's two programs – Research, Development & Demonstration and Education & Training – offers their members the opportunity to pool resources with others to foster and accelerate the development of innovative new technologies and human resources.

SUPPORTING A SAFE ENVIRONMENT

Creating a safe and sustainable industry is on the top of IMII's industry members priorities. Working with researchers to explore and develop concepts, methodology, and technologies can lead to innovative solutions for the industry.

USING DATA FOR FAULT LOCATION IDENTIFICATION IN MINES' ELECTRICAL SYSTEM – UNIVERSITY OF SASKATCHEWAN

The research team at the University of Saskatchewan aims to create a bridge between available measurement data and the fault locating issue which regularly occurs in mines electrical system.

The team has developed a machine learning-based data up-sampling method. By using the proposed up-sampling method, the data can be reconstructed in higher resolution, improving localization accuracy. On the other hand, the same localization accuracy can be realized by a lower sampling rate which saves the cost on the data acquisition unit.

The proposed method has been validated by comparing the conventional up-sampling method, and the main features are as follows:

- The model up-samples data, which improves the accuracy of finding traveling wave arrival times.
- The model eliminates the necessity of costly data acquisition units.
- The model performs better than conventional interpolation techniques in terms of increased accuracy in finding traveling wave arrival times.

DATA COLLECTION AND INTERPRETATION FOR STRESS CHANGE MONITORING – UNIVERSITY OF SASKATCHEWAN

This research set out to assess the validity of the proposed 2-cell convergence method for measurement of stress change in time-dependent materials such as potash, where the effects of large creep strains need to be included in the analysis.

After defining and simplifying to the term Effective Modulus (E') the 2-cell convergence method was applied to three stress measurement sites at the Nutrien Rocanville Potash Mine. To ensure the instruments were applicable in potash and assess the 2-cell Method at a small scale, two laboratory programs were completed with a simple yet practical numerical model used to assess the reasonable accuracy of the results.

STATISTICAL HAZARD ASSESSMENT AND MODELLING OF MINING SEISMICITY – UNIVERSITY OF WESTERN ONTARIO

Gaining a better understanding of what "normal" and "abnormal" microseismic patterns are in potash mines, and whether they have any predictive value with respect to mining activity, can help to derive a quantification of mining induced microseismicity in Saskatchewan potash mines.

There are two avenues to this project – statistical modelling of mining microseismicity and constraining the magnitudes of the largest expected mining earthquakes.

Applying AI to the Industry

Credit: Boston Dynamics

Digital transformation has been an area of exploration on many avenues from technologies to training the workforce for the future of mining.

AI TO GENERATE MINING ALGORITHMS – CAMECO AND SASKATCHEWAN POLYTECHNIC

Cameco has developed unique mining methods and systems around a proprietary "Jet Boring System" program at Cigar Lake and has generated a large amount of data. This project utilized machine learning algorithms and tools to understand and analyze historical geological and geophysical data, digitizing and mapping it, and utilizing rules-based machine learning techniques to improve the mining method.

By using random forest and decision tree machine learning techniques, Saskatchewan Polytechnic has demonstrated that optimization of Cameco's jet boring technology is possible. New modelling geometry and data has produced a revised model that is better able to predict cavity excavation.

The machine learning (ML) algorithms and tools developed under the project could be applied to other optimization and automation projects for the industry.

BOSTON DYNAMICS ROBOTICS DEMONSTRATION – CAMECO, MOSAIC AND SASKATCHEWAN POLYTECHNIC

The objective of the proof of concept (POC) was to demonstrate the utility of an autonomous robot (Boston Dynamics SPOT robot) in conjunction with conventional hazards as well as people present in the mine. It is also integral to understand the issues that would need to be overcome to operationalize the robot with minimum human intervention.

The proof of concept for this project showed that the combination of Boston Dynamic's SPOT (NPX) and a Leica RTC360 Laser scanner (Cameco) in combination with VEERUMs Digital Twin software would generate actionable insights during projects that reduce capital costs associated with execution, oversight, and asset quality.

The key to success in the case of this POC was the collaboration between multiple groups bringing in multiple experts in different fields all relevant to the project's needs. NPX provided the robot and an SME for operation and planning, Cameco provided the Laser scanner and an SME for operation and planning, SaskPoly (DICE) provided an individual who was able to quickly adapt to the coding needs of the team, while other project members were part of the consulting team during the planning and execution of the POC. This project was also a first between IMII and the Nuclear Innovation Institute.

Credit: Boston Dynamics

Demonstrating Technologies in Industry

The supply chain is an integral part of the innovation ecosystem. Partnering with them to demonstrate their innovative solutions can bring improvements for operations or solve an advanced issue with practical application for the minerals industry.

Both projects currently under the IMII Demonstrating Innovations program came out of DEMOday and were selected as recipients of the IMII Innovation Award.

UNDERGROUND DUST COLLECTION SYSTEM – CONTINENTAL MINE & INDUSTRIAL SUPPLY

CMI, winner of the 2019 Innovation Award, has developed a skid mounted dust collection system suitable for underground potash mining. This project will see a demonstration unit constructed and deployed at an IMII member operation to see how well the system collects dust at an ore transfer point.

SAFEBOX LOCKOUT SYSTEM IN PILOT COMPACTION FACILITY – IONIC MECHATRONICS

The SafeBox System is lockout/tagout technology that reduces time for energy isolations, while enhancing the safety of those working on equipment. This project was developed by Ionic Mechatronics and won the IMII Innovation Award in 2020.

The SafeBox is a two-part lockout/tagout system consisting of a Master Control Device and a Field Isolation Device (FID). It will be deployed on a trial basis in a pilot plant at an IMII member operation which is used for technology and product development. The process, equipment, and lockout requirements closely match the requirements of a full-scale SafeBox implementation on a compaction production circuit.

This pilot project will be for the validation of the SafeBox system user experience in a minerals environment in Saskatchewan. If successful, it will provide confidence to the industry to apply the system for increasingly mission critical and productivity enhancing applications. This project is currently being supported by IMII member companies Mosaic, Nutrien, and Cameco.

Education & Training / Qualified & Representative Workforce

The Saskatchewan minerals industry is experiencing changes in innovation, technology, and diversity at all levels. When education and training organizations work with the industry to develop and prepare the next generations of the mineral workforce, the industry will consistently be infused with diverse and informed ideas, backgrounds, thought processes, experiences, educational backgrounds, and more. This will develop a Saskatchewan minerals industry that we can be proud of.

Scholarships

IMPOWERED SCHOLARSHIP

The iMpowered scholarship supports women, Indigenous students, mature students, and new immigrants in their educational journey to a career in the minerals industry.

The winter winners of the iMpowered scholarship in 2022 were:

- Tia Tootoosis, Power Engineering
- Tashrwin Tarique, Power Engineering
- Joshua Cossette, Power Engineering Technology
- Royce Bigsky, Power Engineering Technology Program
- Jodi Delorme, Environmental Engineering Technology Program

The fall winners of the iMpowered scholarship in 2022 were:

- Vera Sayese, Minerals Exploration Techniques Program
- Nicole Launders, Mine Engineering Technology Program
- Case Langevin, Mine Engineering Technology Program
- Brandon Roberts, Resources and Environmental Law Program
- Lauren Pederson, Civil Engineering — Masters of Science — Thesis

This scholarship upholds everything the IMII believes about encouraging diversity in the Saskatchewan minerals industry. Congratulations to our 2022 winners!

MINING FUTURES AWARD

The Mining Futures Award recognizes undergraduate students enrolled in one of three mining options—chemical, geological, or mechanical engineering in the University of Saskatchewan College of Engineering.

The winner of the Mining Futures Award in 2022 was Kiera Heinbigner. She is currently finishing the last year of her geological engineering degree at the University of Saskatchewan. Kiera is president of the Geological Engineering Students' Society and secretary of the Canadian Institute of Mining Saskatoon Student Chapter. She says this award will allow her to dedicate more focus to her studies and memberships in this last year of her schooling.

STEM+ – UNIVERSITY OF SASKATCHEWAN

The University of Saskatchewan's "STEM+ Building STEM career capacity among prospective and current undergraduate Indigenous students" project aims to support the success of Indigenous students in STEM degree pathways with innovative, academically-integrated programming.

STEM+ delivery will be supported by the creation of a new ISAP STEM+ Coach staff position, who will work within and between existing academic and cultural programs; leveraging campus, community, and industry partnerships to enhance students' academic confidence, digital literacy, and career readiness with culturally-responsive learning opportunities and mentored participation in career-oriented internship experiences. The goal is to build a strong applicant pool for both professional STEM degree programs and career opportunities in the Natural Resources and Mining sectors—areas of vital importance to the economic and social resilience of communities across Saskatchewan.

ACTIVATING ALLIES

The Activating Allies study is a multiphase interdisciplinary research project focusing on the recruitment and retention of women in the Saskatchewan engineering and mining industries. This project will span from January 2021 to August 2024, gathering information on how to advance equity in the Saskatchewan minerals industry.

The goal of this study is to recommend actions and tools to aid with sustainable, equitable and inclusive culture shifts in Saskatchewan engineering and minerals industries. We look forward to seeing the results next summer and implementing real change.

DEVELOPING A DIVERSE WORKFORCE THROUGH EDUCATION AND TRAINING

Supporting its members' efforts to build a more diverse and inclusive minerals sector workforce in Saskatchewan, IMII seeks innovative project ideas to increase the numbers of Indigenous peoples and women in areas such as information, communications, and technology (ICT) programs and occupations in Saskatchewan's minerals industry.

As technology needs change, it's become key to not only create programming that can teach the basic skills that one will need, but to also support the diverse learning culture that exists.

INNOVATIVE DIGITAL TRAINING: TAILORED FOR INDIGENOUS, FOCUSED ON POTASH, PHASE 2 – MORRIS INTERACTIVE

The Digital Training in Potash program is a course that helps First Nations, Métis, and Inuit students develop competencies to gain meaningful careers in the mining industry. Phase 2 involves the delivery of the program on Cowessess First Nation and a work practicum at Mosaic's K3 mine.

Students spend eight weeks in the classroom and two weeks on-site at a Mosaic mine, exposing them to invaluable teaching from mining professionals and hands-on experience.
The 10-week pilot project resulted in nine Indigenous graduates, four of whom have acquired mine-specific jobs at the time of reporting. The students built confidence in themselves and their abilities relative to the potash mine workforce, establishing competencies that will lead to fulfilling careers. A second group of ten students accomplished 100% attendance with nine of the ten students graduating on March 18th. Of this group, six went on to work in mining-specific careers.

In August 2022, Mosaic announced a long-term investment of $1 million dollars to further expand the Digital Transformation in Potash Mining training program to more Indigenous students for the next five years. Gabriel Dumont Institute has partnered with Morris Interactive to host the Saskatoon edition of the program, graduating ten students in December of 2022—five of whom have already joined the mining industry in different capacities. The program has received applications from individuals residing in Treaties 4, 5, and 6.

DIGGIN' DIGITAL PROFESSIONAL DEVELOPMENT: AN EDUCATOR'S ONLINE ICT & STEM RESOURCE HUB – SASKATCHEWAN POLYTECHNIC

Saskatchewan Polytechnic designed this program to improve basic information, resources, materials, and professional development opportunities to allow them to incorporate Information, Communication, and Technology (ICT) and Science, Technology, Engineering, and Math (STEM) into lesson plans for Indigenous youth in culturally relevant and appropriate ways.

This free resource hub includes links to resources and videos in ICT and STEM learning. It is specially designed to support lifelong learning through information management, collaboration, effective use of technology, and cultural awareness, and career and life skills.

THE TEACHER RESOURCE HUB IS HOUSED HERE

DIGGIN' DIGITAL BOOTCAMPS – SASKATCHEWAN POLYTECHNIC

Saskatchewan Polytechnic in collaboration with the School of Continuing Education created a new program that is designed to provide responsive training opportunities to support the minerals industry requirements. This program was designed to improve basic information, communications and technology skills and STEM subject awareness among the residents of Saskatchewan's Indigenous communities located in regional and remote parts of the province.

Access to the Sask Polytech Teacher Resource Hub highlighted above It provides age-appropriate content to engage students in science, technology, engineering, and math (STEM) activities and inspires students to think about careers in STEM.

Workshops can include content on Business Information Systems, Civil Engineering Technology, Computer Automated Systems Technology, Engineering Design and Drafting Technology, Mining Engineering Technology, and Natural Resources Technology.

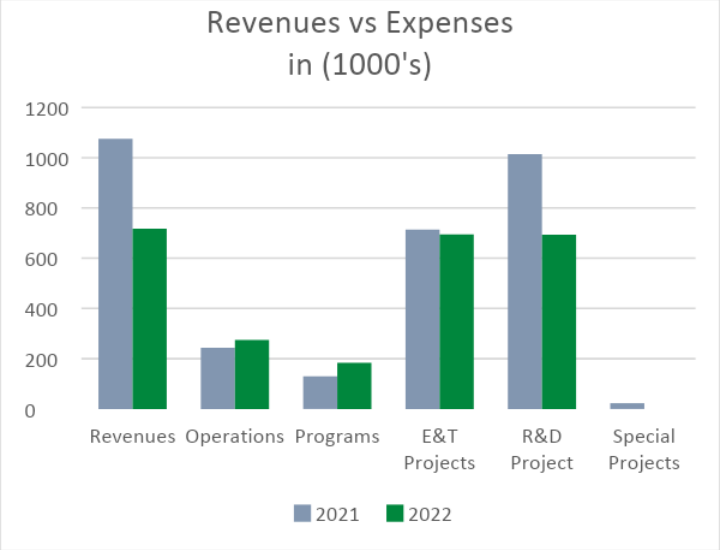
Saskatchewan Polytech wrapped up the project in 2022, reaching a total of 255 Indigenous students in 9 communities. A great remote program has been developed for future use enabling students in remote areas of Saskatchewan to take part in digital boot camps.

BUILDING MINERAL LITERACY WITH STEM: TEACHER TRAINING PROJECT – MINING MATTERS

The Mining Matters "Building Mineral Literacy with STEM: Teacher Training Project" will provide in-service teacher training, resources, and programs for on and off-reserve teachers and students in Saskatchewan. Teacher training during the year of the project will involve the delivery of a series of professional development workshops and the implementation of curriculum-linked educational kits in classrooms.

2022 Financial Summary

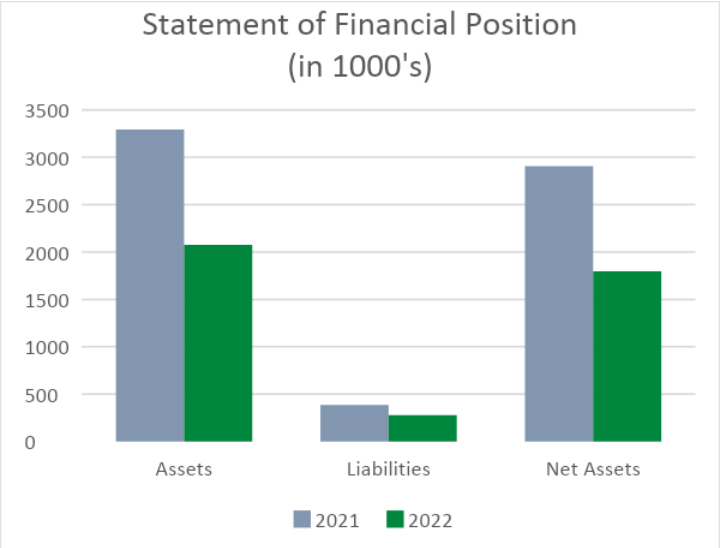
REVENUES AND EXPENSES



IMII's mainstream of revenues comes from industry memberships, industry R&D participation, and the Government of Saskatchewan through Innovation Saskatchewan

- IMII awarded $212,000 in scholarships.
- IMII funded seven education & training and diversity & inclusion projects
- IMII funded nine research, development and demonstration projects.

FINANCIAL POSITION



As of December 31, 2022, $1.586 million was commited to fund approved projects and initiatives for 2023 to 2025.

- $284,314 for education and training/diversity and inclusion commitments.
- $463,834 for research, development, and demonstration commitments.
- $628,100 for future initiatives
- $210,000 held as a windup reserve

In 2022, IMII drew down its cash and net assets by approximately $1.2 million.

IMII Membership

Membership in IMII is open to organizations (e.g., companies, institutions, government bodies) that share a commitment to innovation and are interested in advancing the minerals industry. Collaborating with industry, supply chain, academia, and government brings together unique perspectives to drive innovation bring value add to your innovation resources.

- BHP
- Cameco
- Mosaic
- Nutrien
- Innovation Saskatchewan
- Ministry of Advanced Education
- Hatley Engineering and Applied Technologies Inc.
- Canadian Light Source
- Carlton Trail College
- Cumberland College
- Genome Prairie
- Northlands College
- North West Regional College
- Parkland College
- Prairie Agricultural Machinery Institute
- Saskatchewan Indian Institute of Technologies
- Saskatchewan Literacy Network
- Saskatchewan Mining Association
- Saskatchewan Polytechnic
- Saskatchewan Research Council
- University of Regina
- University of Saskatchewan
- Saskatchewan Regional Economic Development Authority
- Saskatchewan Industrial & Mining Suppliers Association
- Women in Mining/Women in Nuclear-SK Inc.

2022 BOARD OF DIRECTORS

As of December 31, 2022, the following serve on IMII's Board of Directors:

- Tanya Smith, BHP
- Jeremy Breker, Cameco Corporation
- Murray Schultz, The Mosaic Company
- Craig Funk, Nutrien Inc.
- Kevin Chung, Innovation Saskatchewan
- David Boehm, SK Advanced Education
- Rashid Bashir, Hatley Engineering
- Larry Rosia, Saskatchewan Polytechnic
- Christopher Yost, University of Regina
- Baljit Singh, University of Saskatchewan
- Chandra McDougald, Northlands College
- Larry Long, Saskatchewan Mining Association

A special thank you to Arnfinn Prugger for his three years of service as our Board Chair.

AN INNOVATIVE SOLUTION IS OFTEN A COMBINATION OF IDEAS, FROM CONCEPTION TO DELIVERY. WITHOUT THE SUPPORT AND PARTICIPATION OF INDUSTRY, GOVERNMENT, AND ACADEMIC AND RESEARCH MEMBERS, IMII COULD NOT ADVANCE INNOVATIONS THAT MATTER TO MINING OR HELP DEVELOP THE INNOVATIVE PEOPLE REQUIRED BY THE MINERALS INDUSTRY.