

Annual Report

2010—2011



Established in 1998, MIRARCO has been developing innovative solutions to mining industry challenges. We are a not-for-profit corporation that operates with support from the private and public sectors. The driving force behind MIRARCO is a dedicated workforce made up of experienced professionals and students at all levels of post-secondary education. This hybrid of academic and professional dynamics has helped advance the innovative research for which MIRARCO is well known. MIRARCO is engaged in five core research domains:

G R C

Geohazard Assessment and Risk Mitigation
(Geomechanics Research Centre)

V P O

Ventilation and Production Optimization

E M R

Environmental Monitoring and Rehabilitation

E R C M

Energy, Renewables and Carbon Management

C A S C (O C C I A R)

Climate Adaptation and Sustainable Communities
(Ontario Centre for Climate Impacts and Adaptation Resources)

MIRARCO is an Eligible Research Institute. Research conducted with MIRARCO may provide your entity with valuable tax credits.

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Message From the President/CEO

The rejuvenation of MIRARCO, begun in 2010, has continued through 2011. Despite the persistent uncertainty in the global economy, the outlook for the Corporation remains positive and staff morale high. Adversity has indeed made the Corporation stronger and more resilient. This is good as the coming year will test our mettle with the successful conclusion of the PERM project and its significant revenue stream.

We began the year with Doug Morrison assuming the role of Interim CEO until such time as the position could be filled on a permanent basis; no one foresaw that that would be such a long time coming. Due to the lengthy process, it was necessary to relieve Doug of his MIRARCO obligations so that he could assume a leadership role with the Centre for Excellence in Mining Innovation. The Board then asked me to assume the President's role on a similar, interim basis. I trust that my tenure will be shorter as, pending immigration approvals, a new President & CEO will be announced shortly.

This past year, a tangible return on our investment in research capacity at Laurentian University was realized. Dr. Ming Cai, the MIRARCO Chair in Geomechanics, has secured multiple sponsorship for the development of a rockburst support design tool and Dr. Dean Millar, MIRARCO Chair in Mine Energy, has been successful in delivering capital cost savings on ventilation for one mining operation and setting the stage for a comprehensive research program on energy savings in the broader minerals industry; i.e., the 40% Mine. We have since increased our University investment with the support of Dr. Dave Pearson and the Science Communication program. Dr. Pearson is a valued collaborator in our CASC Group.

All groups, excepting Environmental Monitoring & Rehabilitation (EMR), have maintained or grown their research capacity. Like MIRARCO itself, EMR is in a rejuvenation period, albeit at a much less advanced stage. With Dr. Graeme Spiers, the former Director, now heavily engaged as Director of the Elliot Lake Research Field Station, the Group lacks the research leadership needed to thrive. Our challenge is to now provide that new leadership and supporting personnel to rebuild this group.

The coming year will likely be not unlike the past as the world's economies continue to adjust, however, the issues facing the resource sector have not diminished; indeed if anything, they have increased. This represents a great opportunity to capitalize on our expanded research capacity; first steps have already been taken with a new application to the Ontario Research Fund in preparation. With our great people and sound financial footing, I believe that MIRARCO is well poised to meet any challenge thrown its way.



A handwritten signature in black ink, appearing to read 'Sean Maloney', written in a cursive style.

Sean Maloney
Vice President, MIRARCO
Interim President, MIRARCO

Message From the Chair

The foremost challenge for the Board during 2010-2011, was the selection of a new President and CEO. I am happy to report that this process has been successfully completed and a formal announcement will follow soon.

With the successful completion of the PERM project, it is without doubt that MIRARCO must diversify its business in many aspects and continue building the necessary relationships with industry, academia, SMEs, various funding agencies and First Nations. The Far North has recently been recognized as an area of immense opportunity and successful relationships for work in this area will prove invaluable.

The Board of Directors is working diligently to help guide the corporation through this evolutionary phase. I would like to thank all board members for their guidance throughout the year and also want to make special mention to both Sean Maloney (Interim President and CEO) and Sherry Greasley (Interim Secretary/Treasurer) who have increased their respective roles and responsibilities as we await the arrival of MIRARCO's new President and CEO.

MIRARCO is poised for continued success in 2012 as a result of the efforts and ingenuity of all its employees. Recognizing that project management expertise, in tandem with research initiatives is necessary for success, MIRARCO is committed to developing and building these capabilities within its team. MIRARCO's involvement in the highly valued CEMI funded SUMIT project is but one example of the many initiatives underway within MIRARCO's five key research areas.

Moving forward, the new organization focuses on five distinct areas of research and commercialization namely; GRC, EMR, VPO, ERCM and CASC that all independently create significant value to the global mining community.



Marc Boudreau,
President and CEO, BESTECH
Chairman of the Board, MIRARCO















Productivity Enhancement and Risk Management (PERM)

PERM, which came to a conclusion in 2011, was a 5 year, \$24 million program, delivered by MIRARCO. The program was funded by the Ontario Research Fund as well as industry and institutional contributions. The goal of PERM was to keep Ontario competitive in the global mining industry through research, development and knowledge transfer under three themes:

THEME 1: Design and Construction of Underground Excavations

THEME 2: Integrated Planning, Design and Optimization

THEME 3: Environmental Risk Management

	Total Project Value	—————>	\$24.4 million
	Partner Contributions	—————>	\$16.4 million
	ORF Contribution	—————>	\$8.0 million
	# of Private Sector Partners	—————>	55
	# of Institutional Partners	—————>	35
	>100 publications		
	>70 citations		
	HQP Development:	—————>	 >50 Researchers
		—————>	 3 Post-Doctoral Fellows
		—————>	 9 PhD
		—————>	 >25 masters students
		—————>	 >30 undergraduate students
	Establishment of 2 Research Chairs at Laurentian University	—————>	

MIRARCO Research Chairs



Dr. Ming Cai

B.A.Sc., M.A.Sc., Ph.D.
Civil/Mining Engineering

Associate Professor

Geomechanics, Tunnelling, Seismicity and rock-burst in mines,
Rock support, Computational geomechanics

MIRARCO Research Chair in Geomechanics

Dr. Cai is an Associate Professor in Laurentian University's School of Engineering and holds a position as MIRARCO Research Chair in Geomechanics. Dr. Cai holds Bachelor and Master degrees from Tsinghua University in China and a Ph.D degree from the University of Tokyo in Japan. Prior to joining Laurentian, he worked for Mansour Group Inc., MIRARCO, Tokyo Electric Power Services Ltd., and Tsinghua University and had over 20 years' research, education, and industry experience. Dr. Cai is the author/co-author of more than 120 scientific publications.



Dr. Dean Millar

B. Eng. (Hons), ARSM, PhD, DIC, FIMMM

Full Professor

Synthesis mining and renewable

MIRARCO Research Chair of Energy in Mining

Dr. Millar is a Full Professor in Laurentian University's School of Engineering and also holds the position of MIRARCO Research Chair of Energy in Mining as well as the Director of MIRARCO's Energy, Renewable and Carbon Management Group. Dr. Millar holds a Bachelor degree in Mining Engineering and a PhD in Rock Mechanics, both from Imperial College, in London, UK. Prior to joining Laurentian, he worked for Camborne School of Mines at the University of Exeter, Imperial College, G. Maunsell & Partners, Redland Aggregates and Anglo American. He was also the head of the Peninsula Research Institute for Marine Renewable Energy (PRIMaRE) and founding director of ZigPlug Ltd, and has over 12 years research and consulting experience in renewable energy.

Dr. Millar is the author/co-author of more than 52 publications, including 2 patents.



The PERM initiative saw the creation, development and success of a number of research projects, with many of these initiatives continuing in projects being developed between MIRARCO and various partners as the success of PERM continues to be built upon.

MIRARCO's Impact

As MIRARCO continues to successfully deliver on our mission and vision, the five core research domains have been established. These centres deliver innovative solutions that impact across our partner organizations as well as the global mining industry. MIRARCO has highlighted four key impact areas. **Financial, Sustainable Communities, Leading Edge / Innovation, and Health and Safety.**

The **Geomechanics Research Centre** conducts engineering and scientific research and development in the field of geotechnical engineering and applies its findings to promote safer, more economical excavations at depth. In concert with its research activities, GRC continues to offer unique services on an occasional basis. These services often provide a catalyst for research activity.

The **Ventilation and Production Optimization** team is developing the next generation of mine planning tools with an emphasis on underground mine ventilation and schedule optimization. These two areas of research are key in maximizing the profitability of a mining operation.

The **Environmental Monitoring and Rehabilitation** centre employs detailed environmental sampling and remote monitoring technologies to provide research and technical services to support the needs of mining and other resource industries. Innovative mine closure and remediation strategies are used to mitigate environmental and anthropogenic hazards of tailings and long-term monitoring is performed to ensure the remediation tools utilized are safe and sustainable.

Housing the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR), the **Climate Adaptation and Sustainable Communities** group is dedicated to assisting communities and sectors adapt to climate change through the provision of climate science and adaptation tools. The Centre is also a resource hub for researchers and stakeholders searching for information on climate change impacts and adaptation.

In partnership with Laurentian university, MIRARCO has invested in a new Chair of Energy in Mining to lead research in **Energy, Renewables and Carbon Management**. The ERCM team focuses their research on the integration of renewable energy technologies in the mining sector.

“MIRARCO is a crucial part of our mining research cluster in northeastern Ontario.”

“The findings and the practical applications of the work being conducted through Mirarco are changing the mining industry for the better, both here and around the world. Our collaborative relationship engages the best and brightest of Laurentian’s faculty and graduate students in the important research led by Mirarco. It is a relationship that enriches us all.”

Dominic Giroux

Laurentian University President and Vice Chancellor

- ◆ In situ stress determination using stress relief methods in conjunction with field observations
- ◆ Determination of strength and deformation properties of rock
- ◆ Determination of properties of rock support elements and systems
- ◆ Geophysical borehole logging and interpretation of geotechnical characterization (optical and acoustic televiewer and full waveform sonic)

- ◆ Ventilation Optimization
- ◆ Production Optimization
- ◆ Development of Decision Support Software

- ◆ Remediation of Mine Sites
- ◆ Environmental Systems Monitoring
- ◆ Environmental Data Management and Interpretation
- ◆ Mine Operation Effects Monitoring

- ◆ The Climate Change Adaptation Community of Practice
- ◆ Ontario’s Regional Adaptation Collaborative
- ◆ The International Upper Great Lakes Study
- ◆ Community Adaptation Initiative

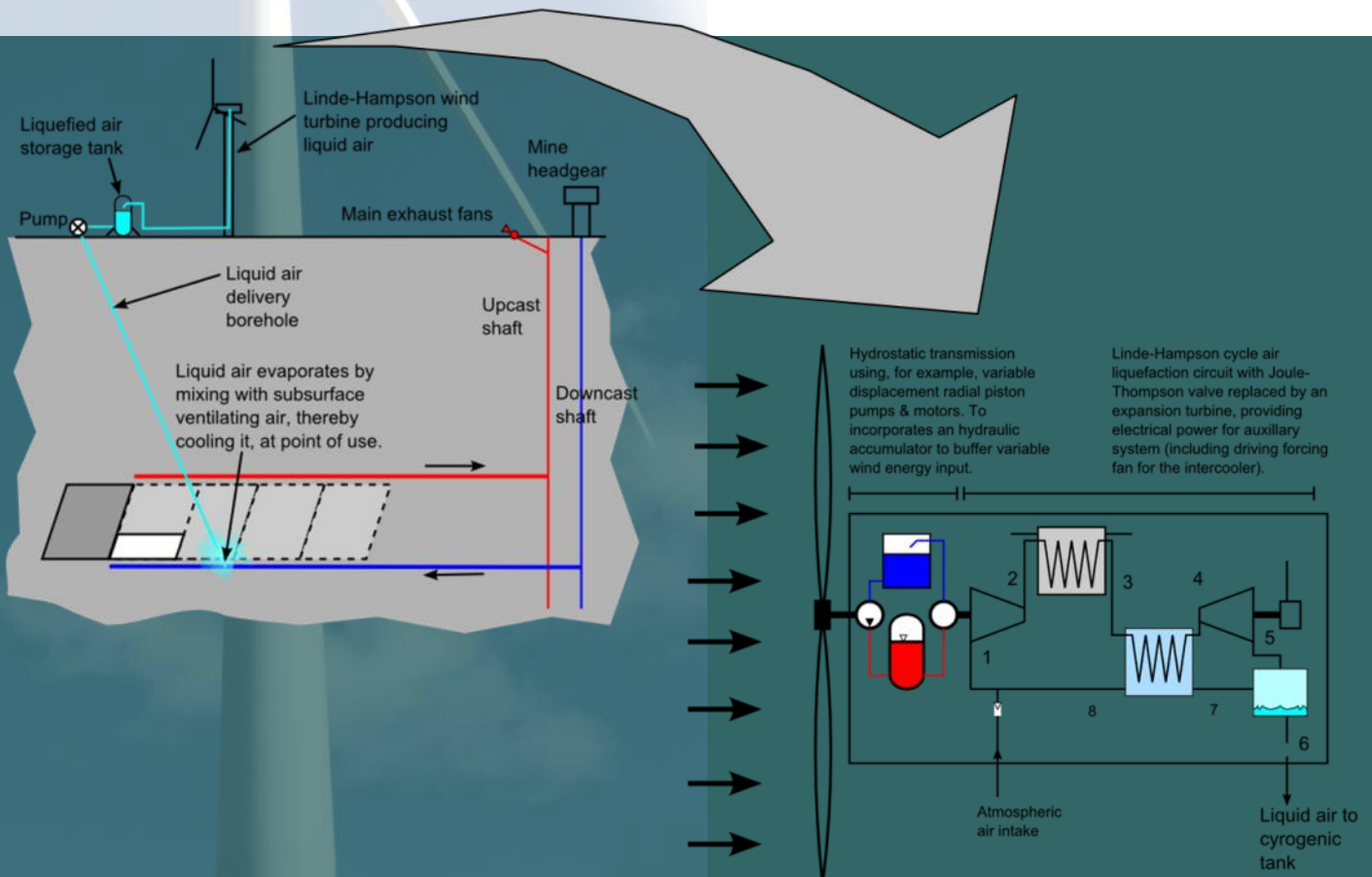
- ◆ Whole and life cycle, power, heat and fuel audits and demand profiling.
- ◆ Appraisal and concept development of energy consumption reduction technologies for the mineral sector.
- ◆ Renewable heat technology application development including heat recovery and geothermal energy use.
- ◆ Greenhouse gas mitigation and avoidance, development of innovation in carbon capture technology.

Financial Impact

Our partners invest in MIRARCO research because the results may have a positive financial impact for their organizations. The cost of the research has very often been outweighed by the potential cost savings to be realized upon application of the results.

Cryovent

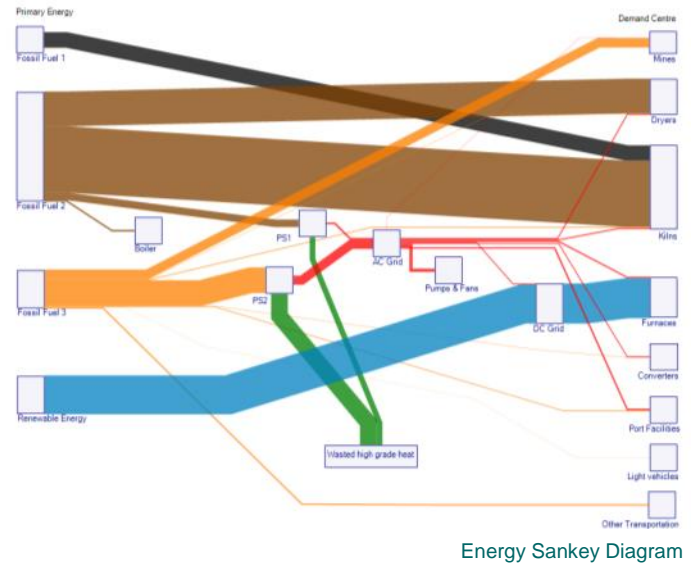
The project involves the design of a system that uses the shaft work from a wind turbine to drive the compressor in an air liquefaction plant. The concept involves supply of air in liquid form via a completed borehole, precisely to the location of need of greatest cooling in deep mines. While evaporating in the subsurface, relatively small flow rates of liquid air can deliver MW scale cooling. As air liquefaction cycles and wind turbine design represent fully established technology, the central research issue is whether the air liquefaction cycle would still be able to produce liquid air in the face of the variability of shaft work input from the wind turbine. In a collaboration with the Camborne School of Mines at the University of Exeter, UK, the research plan involves use of their SCADA data from two Vestas V52s wind turbines to define variability in torque / rotational speed curves. A proof-of-concept laboratory rig which will be assembled in Laurentian University laboratories will use these signals to drive a DC motor that physically simulates these while driving a multi-stage radial piston compressor that forms the heart of a Linde-Hampson air liquefaction cryogenic cycle. Funding has been secured from CEMI to fund a junior researcher for this project for 4 years and also from the Canadian Foundation for Innovation to fund the building of the experimental rig.



Low carbon cryogenic cooling for deep mines, [Dean Millar, ERCM, MIRARCO]

Energy Sankey Diagrams

Since January 2011 ERCM researchers have been investigating the use of Sankey Diagrams to illustrate energy usage and conversion within minerals production operations. In these diagrams, the magnitude of energy usage is indicated by the thickness of the 'ribbon' joining one node to another. The various colours used can indicate different types of energy. A key advantage of presenting data on energy consumption during mineral production in this manner is that energy resources that could be more effectively utilized than they are currently being can be readily identified. Sankey diagrams are thus a key component of energy management practice as they assist in the communication and explanation of energy auditing processes.



NHEA2

The Natural Heat Exchange Area (NHEA) is the primary intake for the ventilation system of Creighton mine, and has provided a natural source of air conditioning, avoiding the need for mechanical refrigeration. The NHEA is a pit containing a mass of broken rock connected to underground mine workings, including a set of tramways and slusher trenches. Doors located in the trenches are operated manually to regulate the airflow that comes from surface, passes through the rock mass and enters the fresh air system of the mine.

With the completion of Phase 2 of an ongoing collaborative research project, MIRARCO has delivered software for two applications providing decision support for improved operation of the NHEA. The first application, the heat exchange model generator (HEMG), uses a genetic algorithm to generate a model of the heat exchange within the NHEA by fitting historical sensor data. The door state selector (DSS) application then makes use of the resulting heat exchange model to make recommendations on the operation of the trench doors. The algorithms of the DSS must take into account constraints on the operability of the trench doors, in part due to the risk of ice formation at certain times of the year. Two alternative DSS algorithms were developed, one employing a genetic algorithm, and the other based on a deterministic protocol.



NHEA control door, [Sidney Schafrik, ERCM, MIRARCO]

The work that MIRARCO has completed on the Natural Heat Exchange Area has provided Creighton Mine opportunities to plan improved strategies for management of the system which will potentially allow mining to greater depth without mechanical refrigeration.

Sustainable Communities

Mining organizations are increasingly aware of their social responsibility in creating and maintaining sustainable communities. MIRARCO research in all five core domains areas is contributing and finding solutions in innovative ways.

Simulated Uranium Surface Heap Leaching and Closure

The Simulated Uranium Surface Heap Leaching and Closure project is moving into new experiments. Having completed leaching experiments defining economically viable leaching parameters optimizing uranium and rare earth metals recovery from ore from Elliot Lake. An additional finding of great interest was near complete dissolution of sulphur and iron which would eliminate risk of acid mine drainage, a serious reclamation issue. New experiments using microcosm study and large column experiments will be focusing on closure strategies for the bioleaching methodology developed and pyrite removal. Detailed mineralogy will also be conducted to help define the kinetics of uranium release.



Large columns, [EMR, MIRARCO]

Green Mines Green Energy

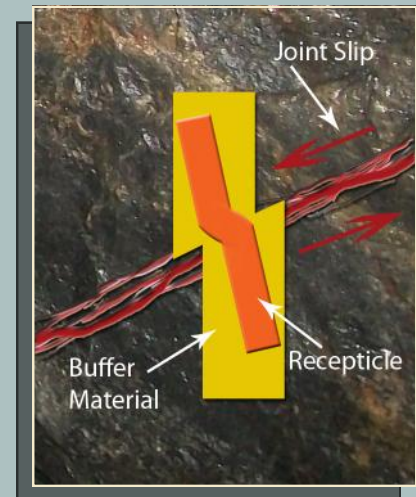
The Green Mines Green Energy (GMGE) initiative was developed by Natural Resources Canada in partnership with MIRARCO, with MIRARCO overseeing the field trials in northern Ontario. The project began as a feasibility study examining the potential of utilizing residual organic materials as covers to mining tailings and a growth medium for bioenergy crops. Phase I demonstrated the technical feasibility of the reclamation model, producing high and potentially profitable yields of bio-energy crops including corn, canola and switchgrass. In 2011, the Green Mines Green Energy project entered Phase II and is now exploring perennial crops, specifically, willows and switchgrass along with a new annual, sunflower as well as continuing with the annual canola which was demonstrated to be a potentially lucrative crop in Phase I of the project. This year, nearly 10,000 native and non-native willows were planted at the GMGE sites. The willows are expected to grow 5 – 6 metres over the next three years, and on an operational basis would be harvested on a three year cycle as would switchgrass. The GMGE reclamation model offers a healthier and safer community to residents nearby brownfields through prevention of re-suspension of fugitive dust. Green Mines Green Energy has supported environmental training of numerous students from the high school to post-graduate level including two M.Sc. students, two fourth year undergraduate thesis students, eight Laurentian University summer students, and one post-doctorate fellow.



Sunflowers on Xstrata tailings, [Jennifer Hargreaves, EMR, MIRARCO]

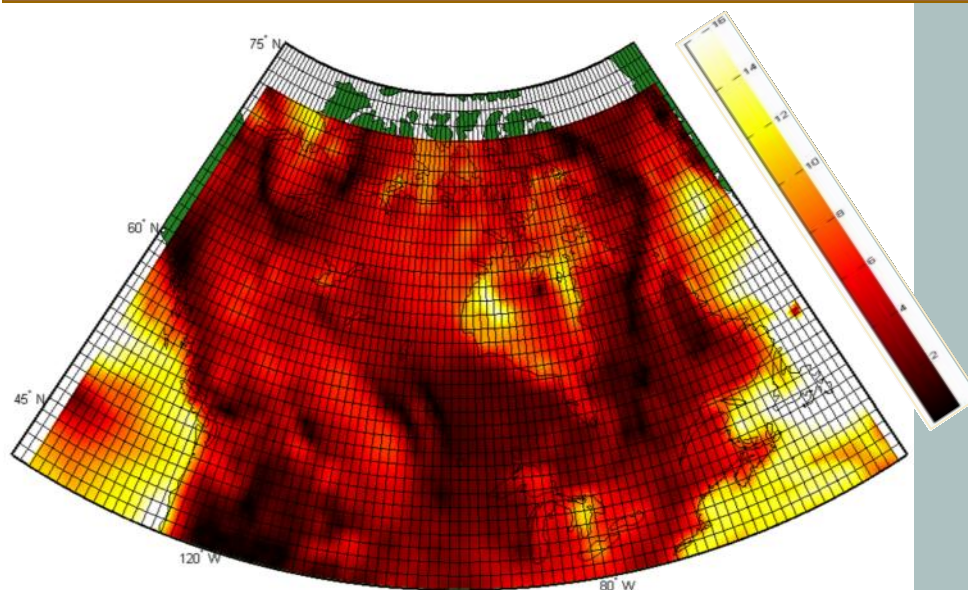
Safe Hazardous Waste Containment

As part of the Nuclear Waste Management Organization's (NWMO) research program into the safe disposal of hazardous wastes, the Geomechanics Research Centre was engaged to undertake an extensive review of the current state-of-practice in the area of fault-slip seismic events and their potential impacts to underground repositories located in the crystalline rock of the Canadian Shield. Of particular interest was the likelihood of an event posing a hazard to the integrity of the waste containment receptacle either through shear along fractures or dynamic compression. Factors considered of relevance were: event magnitude, distance, displacement (slip) and ambient stresses. A secondary objective was to identify any knowledge gaps so that further research could be directed to address them.



Waste containment, GRC, MIRARCO

Canadian Offshore Wind Resource Assessment



Standard Lambert projection of surface (10m AGL) wind speed across Canada at midnight on February 14th 2006.

In June 2011, ERCM leader Dean Millar reported on his work in conducting wind resource assessment analyses for the offshore environment within and around Canada, highlighting the potential benefits for mining operations located close to large bodies of open water where these wind resources are best. The analyses adopt the CCMP wind vectors data which are derived from radiometry sensors on satellite platforms. The result is quality controlled wind vector coverage for any location on the planet at a resolution of $0.25^\circ \times 0.25^\circ$, going back over 25 years, most accurate in the offshore areas where it is much more technically challenging and costly to obtain surface mounted anemometry observations. This work triggered an article and an editorial in the Sudbury Mining Solutions magazine, as well as radio coverage on CBC.

Leading edge / Innovation

Floating Photovoltaics

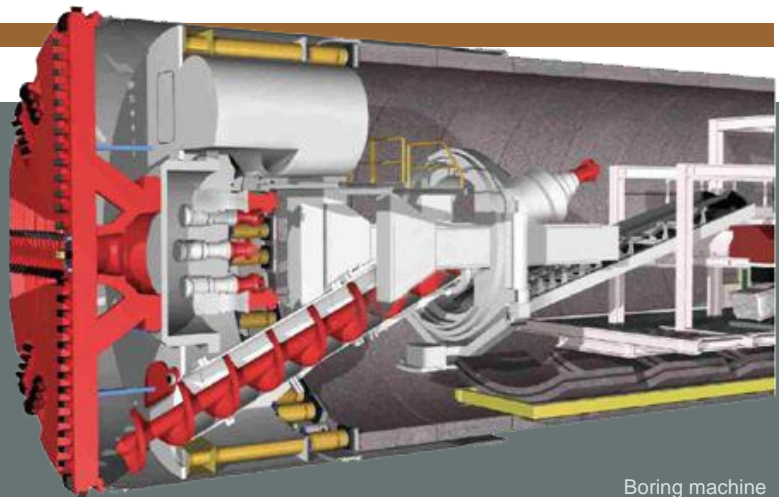
A new application area for solar photovoltaic (PV) technology is deployment in the offshore environment. PV panels convert sunlight directly into electricity and are thus potential power generation solutions for mining operations located far from electricity transmission and distribution infrastructure. Using McFauld's Lake as a case study, it was demonstrated that potential cost reductions of up to 10% when PV panels are operated alongside conventional diesel generating plant are possible. In 2011-2012, it is hoped that this project will progress to the point where an experimental deployment within a freshwater lake will be made, adopting flexible PV material that floats on the waterline and thus experiences cooling which enhances the panels' conversion efficiencies. For this project, MIRARCO's ERCM researchers are collaborating with academics at Loughborough and Exeter Universities in the UK, and are in negotiation with the Maltese government about funding a second prototype deployment in the marine environment of the Mediterranean Sea.



Image courtesy SPG Solar Inc.

Facilitating New Technology

The global metal mining industry is undergoing a massive transformation, from opencast to underground operations. With demand for resources ever increasing, this brings new challenges as well as opportunities in mine development and material handling. Rio Tinto, a global mining giant, through its Mine of the Future™ program, has recognized that innovative solutions must be found to revolutionize mining in the 21st century. The Geomechanics Research Centre is assisting Rio Tinto in this mining revolution, through its newly established Centre for Underground Mine Construction at the Centre for Excellence in Mining Innovation (CEMI). GRC is addressing geotechnical issues related to the deployment of new mine development technologies, specifically their Shaft Boring and Tunnel Boring Systems currently under development .



Boring machine

Community of Practice

In order to advance policy in the field of climate change adaptation, the Ontario Centre for Climate Impacts and Adaptation Resources at MIRARCO has developed a National Climate Change Adaptation Community of Practice. This online community has been designed to create a link between adaptation scientists and experts and provincial and territorial policy staff. This web portal is well populated with climate change adaptation reports, articles, case studies and other resources to advance adaptation planning and policy. The OCCIAR community facilitator actively engages community members by inviting content contributions, responding to resource needs and directing people to experts across the country. The project is supported by the Council of the Federation and has membership from all jurisdictions and all levels of government in Canada.



The team at MIRARCO has done an excellent job in developing and operating the Climate Change Adaptation Community of Practice (CoP), an online space where researchers and practitioners generate ideas and share knowledge on climate change adaptation. The purpose of the CoP is to formalize the knowledge transfer necessary to assist provincial and territorial governments on climate change adaptation. MIRARCO has very capably provided the project management, technological and related services for the development and operation of the CoP which has over 350 members and continues to grow and evolve to meet member needs.

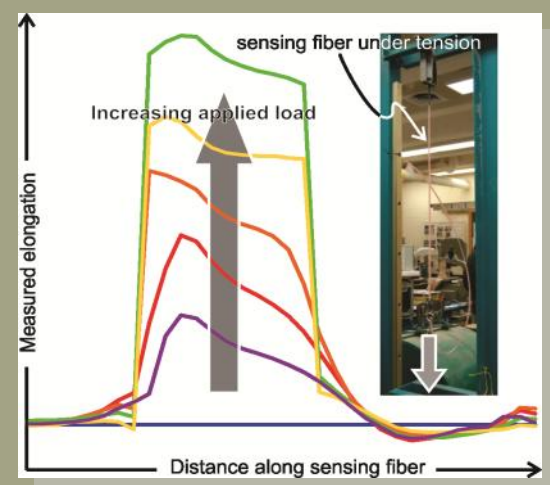
Loretta O'Connor, MBA

Executive Director, Council of the Federation Secretariat

Technology Adaptation

Fiberoptic strain sensors have seen wide application in the civil/structural field, often in the realm of 'smart infrastructure', however their use in mining geomechanics represents a novel approach. These sensors offer strain sensitivity and accuracy over measurement lengths not achievable with conventional instrumentation but are yet unproven in the mining environment. GRC intends to change this. GRC has initiated both laboratory and field scale investigations into the performance of these sensors with a current focus on the BOTDR (Brouillan Optical Time Domain Reflectometry) type.

The issues being addressed revolve around means of installation in deep boreholes (anchoring, grouting and monitoring) and interpretation of response characteristics when embedded within a grout column. Several sensors have been installed at Vale's Coleman Mine alongside conventional multi-point extensometers for direct comparison of field scale performance. Ongoing laboratory studies have focussed on the modification of the response characteristics imposed by the grout annulus.

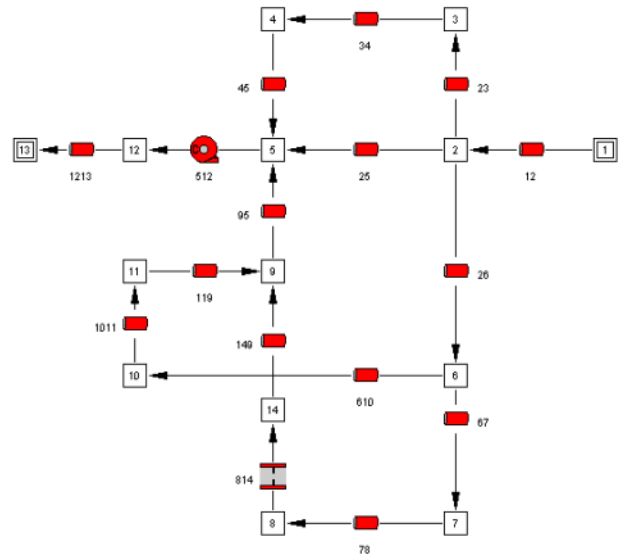


Leading edge / Innovation

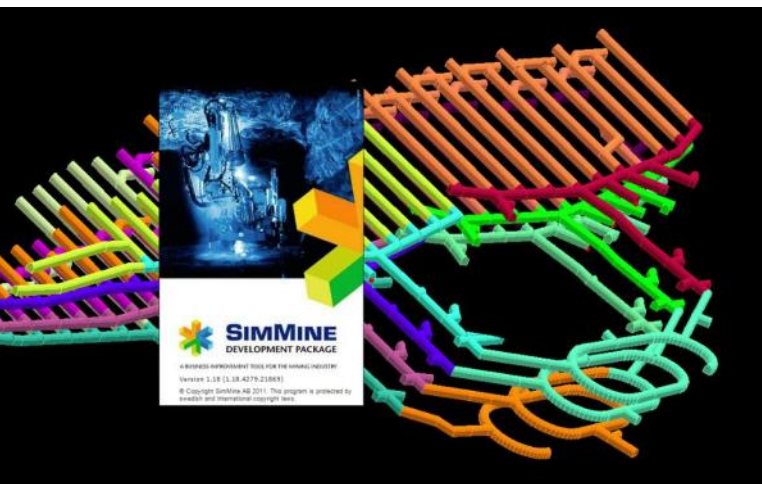
The challenges facing the resource sector are ever increasing. Research undertaken at MIRARCO continues to provides innovative solutions to existing and upcoming challenges facing the mining industry.

GFSSP Evaluation

This investigation was undertaken in an effort to determine the efficacy of adopting GFSSP to solve underground mine ventilation network problems. The project comprised a collaborative research investigation with Dr Alok Madiumar of the Thermal and Combustion Analysis Branch of NASA's Engineering Directorate at the Marshall Space Flight Centre. It aimed to establish whether data requirements, solution procedures, etc. associated with this novel application area for this code presented significant obstacles to accessing its advanced functionality for mine ventilation purposes. The simulations conducted confirmed that the GFSSP code can be used effectively to model underground ventilation networks. The code is capable of predicting expected air flowrates for parallel and series networks, of responding to transient conditions (e.g. closing or opening a ventilation door or airflow regulator) and of modeling the behaviour of clearing contaminants from within a control volume. Simplified scaling studies indicated that GFSSP can handle the scale of problems practically encountered but the investigations did not extend to analysis of a real mine ventilation network; this is recommended for a phase of future work. The final report of this work was identified by the NASA technology transfer office as a potential exemplar spin-off application of NASA intellectual property into non-aerospace applications.



SOT-SimMine Interaction project



Working with Labrecque Technologies, a project was completed that established a preliminary integration between MIRARCO's Schedule Optimization Tool and the SimMine mining simulation software. Functionality was added to SimMine to facilitate the integration, including a reader to import SOT schedules. One outcome of the completed work was a process for validating or adjusting the development and production rates provided as input to SOT. Since the simulator typically operates at a higher level of detail, it was used to assess whether the rates supplied were achievable. Several avenues of potential future investigation were identified through this collaboration.

Health and Safety

Health and Safety is a critical factor for mining and related operations. Research and other activities undertaken by MIRARCO are helping companies proactively implement health and safety initiatives.

Contaminant Clearance Optimization

A software module for optimizing contaminant clearance in an underground mine was developed in a project sponsored by Bestech as a client-server application for integration with their NRG1-ECO product. The software determines how the ventilation system should be operated in order to quickly clear the air of contaminants and allow personnel to return to the area safely.

Global Minerals & Industry Risk Management Course (G-MIRM)

Recognizing that safety is one area where companies can and should collaborate Anglo American is making their highly-acclaimed and award-winning education program available to the whole industry to contribute to a systemic change in safety and risk management. MIRARCO has successfully implemented the delivery of the G-MIRM course in North America in partnership with JKTech Pty Limited, University of Queensland, Australia.

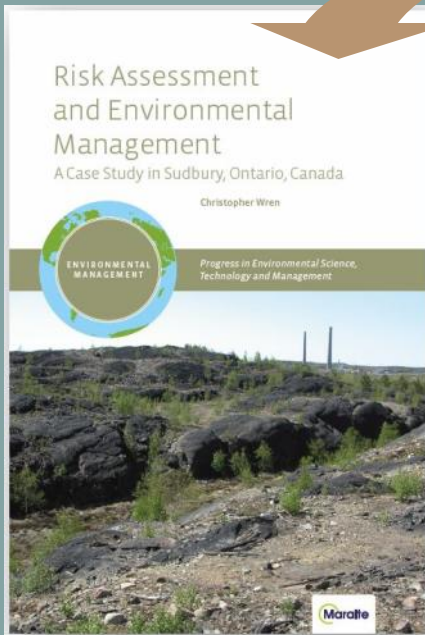
Since May 2011 MIRARCO has successfully delivered 2 sessions of the GMIRM course. The delivery of 3 additional closed sessions has been secured for later this year and early 2012.

"The GMIRM G3 course from MIRARCO is very comprehensive, practical and applicable. There is enough theory to ensure understanding, and terminology and tools are supplied to manage risk. The trainers are knowledgeable and presented the material so as to keep the participants well engaged. The group exercises are very effective and help apply the concepts. It was also interesting to see others use the information provided to evaluate other business risks. I would highly recommend this course for anyone who manages safety risk in any industry."

*Christina Redhead, CRSP
Safety, Health and Environment Coordinator
De Beers Canada Inc.*



Knowledge Transfer



Case Study Text Book (January 2012)

MIRARCO is pleased to announce that the text book will be released in January, 2012. The book was edited by Dr. Chris Wren and is based on the ground-breaking Sudbury Soils Study. The book covers all aspects of the study including human health risk assessment, ecological risk assessment, risk management and risk communication and consultation. The book contains many photographs, figures and tables of data to make it a very readable and useful case study that will be of interest to students and practitioners of risk assessment. The book will be available in both hard copy and electronically through MIRARCO and Maralthe Publishing, Netherlands.

Role of Risk Assessment for Mine Closure

Dr. Chris Wren delivered a one day short course at the 5th International Conference in Mine Closure in Vina del Mar, Chile. The course was attended by over 30 participants from 9 different countries.

Dr. Wren also presented at a primary session of the conference, which was attended by over 300 delegates. Co-authors from Vale and Xstrata Nickel supplied information on examples of risk management strategies for mine closure.



RA course in Chile, [Chris Wren, EMR, MIRARCO]

Mine Ventilation Symposium

The 13th U.S./N. American Mine Ventilation Symposium was held in June 2010 on the campus of Laurentian University. The symposium was internationally attended with 400 delegates/short-course attendees from 16 different countries spanning 6 continents; the associated trade show was the also the largest to-date.

An underlying theme of the biennial symposium was “Green Mining” with numerous papers, courses and exhibits focusing on ventilation efficiency, such as through ventilation on demand, energy management, reduced environmental impact from diesel equipment and methane abatement.

Major sponsors of the event included Vale and Xstrata, Natural Resources Canada as well as the US National Institute for Occupational Safety and Health (NIOSH). Other sponsors included both local and US mining suppliers plus other research and governmental agencies.

“Mirarco/Laurentian University continued to show that Canada can host some of the most successful mine ventilation symposiums. The globally recognized symposium provided a forum for the exchange of mine ventilation knowledge and R&D experience amongst experts from industry, government, academia and the supply sector.”

*Dr Stephen Hardcastle
Chief Ventilation Research,
CANMET-MMSL,
NRCAN-RNCAN
Adjunct Professor,
School of Engineering*

Ontario's Community Adaptation Initiative

OCCIAR (at MIRARCO) in partnership with the Clean Air Partnership continues to successfully deliver Ontario's Community Adaptation Initiative project.

The objectives of the Community Adaptation Initiative project are to:

1. Develop, promote and deliver resources focused on assessing climate change impacts, vulnerability and risks, facilitating adaptation in the target audience and increasing adaptation knowledge and expertise; and
2. Conduct outreach, capacity building and training sessions focused on assessing climate change impacts, vulnerability and risks, facilitating adaptation in the target audience and increasing adaptation knowledge and expertise.

The objectives of the project are met by a variety of methods including;

Continuous updating of the OCCIAR website to offer relevant and up-to-date information and resources on climate change impacts and adaptation;

Hosting of community workshops in Northern Ontario;

Hosting of citizen forums

Providing case studies and videos

Hosting technical workshops



CLRA Discussion Groups

MIRARCO, in partnership with the Canadian Land Reclamation Association (CLRA) hosted reclamation seminars and discussion groups to bring together industry, academia and other interested associations and individuals. The seminars encouraged sharing of ideas and collaboration, and offered a venue for networking with people working in the area of reclamation. The seminars focused not only on local reclamation efforts, but have also invited speakers from across Canada.

Some of the selected seminars were:

Brad Walker, Golder Golder Associates Ltd.: "Biodiversity and its Practical Application to Mine Operations".

Dr. Graeme Spiers and Dr. Peter Beckett: "Reflection on Smelting Impacts in Russia"

Dr. Daniel Campbell, "Developing Restoration Protocols after Mining in the Hudson Bay Lowland"

Dr. David Pearson, "Land Reclamation in a Changing Climate"

Dick Cowan, Bill Mackasey, and John Robertson, "The Policy Framework in Canada for Mine Closure and Management of Long-Term Liabilities"



Knowledge Transfer

Student Achievements

ERCM researcher Kim Trapani was recognized as providing the best student presentation at the 5th annual Mining and Environment International Conference held at Laurentian University in June. Kim's PhD concerns a new application area for solar photovoltaic (PV) technology: deployment in the offshore environment.

Michelle Levesque, ERCM researcher and Laurentian University MASc candidate has been successful in attracting interest from industry for her work investigating the use Sankey Diagrams and also received recognition for it by the panel judges of the 5th International Conference on Mining and Environment by winning a \$200 prize.

Aimee Williamson is a second year Ph.D. candidate with Laurentian University was awarded NSERC funds through their Post-Graduate Industrial scholarship and support from MIRARCO. Aimee is also the recipient of the Chakrabarti Award for best overall presentation in the spectroscopy section of the EnvironAnalysis 2010 conference in Toronto, May 2010.



Samantha Smith, EMR, MIRARCO



Jamie Waine, ERCM, MIRARCO

Bryan Maybee successfully obtained his PhD in Natural Resources Engineering. Bryan is currently an academic at Curtin University in Australia.

Juma Joseph Mgumbwa a Masters student from Tanzania successfully defended his Masters thesis in Natural Resources Engineering. Juma has gone on to work in industry.

Samantha Smith's M.Sc. project was highlighted in the Laurentian University magazine article "Field of Dreams"

Researcher Jamie Waine, of the ERCM group was awarded second prize for his student poster by judges of the 5th International Conference on Mining and Environment. Jamie's research focused on CryoVent - Low or zero carbon cryogenic ventilation for deep mines.

"MIRARCO has offered a unique experience working directly with industry helping create solutions with application to real life problems. I am able to interact with a variety of people from students to professional engineers and scientists. Through support from MIRARCO, I was successful in obtaining NSERC funding, a prestigious award, enabling me to pursue an advanced academic degree. MIRARCO support has extended to providing me with a safe work environment."

Aimee Williamson

PhD Candidate, Laurentian University

HQP Development

Researchers	14
Post-Doctoral Fellows	3
Doctoral Students	9
Masters Students	13
Undergraduate Students	14
Visiting Scholars	1

Publications & Presentations

Published Works	15
Posters & Conference Papers	25

Selected works

Vasak, P. and Suorineni, F.T, 2010. Extracting more value from mine data using virtual reality and scientific visualization techniques. UMaT 1st Mining & Mineral Conference, University of Mines and Technology, Tarkwa, Ghana, 4 to 7 August, 2010, 15 p.

Smith, H.C.M., Pearce, C. and Millar, D.L. 2011. Further analysis of change in nearshore wave climate due to offshore wave farms. Renewable Energy, Accepted

Millar, D.L., Brown, T.J., Kruyswijk, J.B., Smith, N., Coggan, J.S., Foster, P.J., Steadman, E.J., Evans, D.J., Hewitt, J. 2011. Assessing the feasibility of underground mining of aggregates in southern and eastern England. Proc. Conf. Extractive Industry Geology, Portsmouth, UK, September 2010. In press.

Millar, D.L., Fava, L., and McKinnon, D.L., (2011), Procedures for conceptual design of orebody extraction, in preparation for submittal to: AusIMM Section A.

Zhao, X.G. and Cai, M., (2010), Influence of plastic strain and confinement dependent rock mass dilation on the failure and displacement near excavation boundary. International Journal of Rock Mechanics and Mining Sciences, 47(5), pp. 723-738.

Hargreaves, J.H., Lock, A.S., Beckett, P.J., Tisch, B., Spiers, G.A., Lanteigne, L., and Posadowski, T., (2011), Suitability of an organic residual cover on tailings for the production of oil seed crops. Submitted to: Canadian Journal of Soil Science (by invitation).

Valley, B., Evans, K. F., (2010), Stress heterogeneity in the granite of the soultz EGS reservoir inferred from analysis of wellbore failure. In: Proceedings, World Geothermal Congress 2010.
URL <http://www.wgc2010.org/>



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