WORKFORCE OF THE FUTURE

Critical Skills in Saskatchewan's Minerals Industry

International Minerals Innovation Institute

TABLE OF CONTENTS

MESSAGE FROM EXECUTIVE DIRECTOR 3

INTRODUCTION 4

CONTEXT 7

CASE STUDIES 16

DIGITAL SKILLS JOURNEY 36

REFERENCES 39

Courtesy of Cameco

MESSAGE FROM EXECUTIVE DIRECTOR

In the fall of 2018, the International Minerals Innovation Institute (IMII) embarked on a special project – the Digital Mining Transformation Initiative with its minerals company, post-secondary education, and government members.

The Initiative found that as digital technologies transform how mines and mills operate, the composition and level of specialization within the workforce will change and we must train employees to thrive in this digital future, attract experts and educate the emerging workforce as well as support a more diverse and inclusive workplace culture to access highly qualified people. If this industry need is not addressed, Saskatchewan mines and mills will become less competitive globally.

As a result, defining 21st century competencies and skills for Saskatchewan's digital minerals workforce has become a priority for IMII and its members. This new report, developed in partnership with EY, is the first of several follow up actions IMII is stewarding on behalf of its members to answer the challenges of ensuring Saskatchewan's principal minerals producers have access to the talent required to not only digitally transform their operations but to also undertake innovations in other areas key to their ability to compete globally.

The successful adoption and deployment of digital technologies and other innovations depend on an educated workforce. This report confirms that as the future of work changes, so must the future of education. The response will require new approaches and new partnerships – between the minerals industry, post-secondary institutions, and governments, as well as others if the future of work is to be more diverse and inclusive. It will also require a broader focus beyond engineering as mining's digital transformation will impact every occupation in the industry's workforce.

The minerals industry in Saskatchewan will not only be competing for digital skills and digital talent within its own sector but will be competing across all sectors of the economy. As a result, reskilling of workers is growing in importance and new approaches, such as micro-credentialing, are becoming more significant. In line with other research, this new report confirms that digital transformation is primarily a people play and that to reap the rewards we'll need people who can think differently, behave differently and support work being done differently.

The future of work in Saskatchewan's minerals industry will be a different one – digital, dynamic, and diverse, with new opportunities for indigenous peoples, women, and younger workers. Please join us on mining's digital journey.

-Al Shpyth

Executive Director, IMII

SECTION 1 INTRODUCTION

INTRODUCTION EXECUTIVE SUMMARY

More and more, the labour market, both nationally and in Saskatchewan, is characterized by a changing skills landscape that has placed upward pressure on the demand for digital skills. Meanwhile, the talent ecosystem is facing the challenge of identifying mechanisms to adapt to labour market needs in an inclusive and efficient way. What are the critical skills that the mining and minerals industry requires now? What are the skills of the future? How is the overarching skills landscape impacting the industry? This report seeks to answer these questions by assessing six traditional industry roles across value chain and identifying the current state of their critical skills, and the predominant shifts in skills as it relates to future industry needs, cross-referenced with research and literature on the changing operating environment of the working world.

While the impacts of the changing skills landscape indicate anticipated outcomes and speaks to the down-the-line impacts of digital disruption on the economy, industry, and the workforce; an important takeaway is the insight that the mining and minerals industry requires more robust and proactive strategies to lay a strong foundation for closing current and future skills gaps. There are four key themes discussed in this report that anchor the role assessment in the context that underpins the need for an industry response to the impacts of digital trends. These themes discuss the dichotomies of digital adoption among industry players, the changing nature of 'target' critical roles as a reflection of the overall world of work, the subsequent challenge of finding digitally skilled talent, and, ultimately the disproportionate impact on Indigenous constituents in Saskatchewan's labour market.

As an outcome, this report seeks to outline a journey forward by identifying two key channels for strengthening the talent pool and aligning the industry with emergent trends. Opportunities for partnership are a central insight, coupled with the opportunity to develop modern and alternative ways of delivering digital knowledge to strengthen key skills within the talent pool.

Courtesy of Mosaic

SECTION 1 INTRODUCTION

INTRODUCTION OBJECTIVES

This report is intended to:

- Provide an overview of the current digital trends and skills landscape in Saskatchewan's mining industry
- Highlight some of the anticipated shifts in skills as the industry increases its' adoption of digital trends
- Share recommendations to support the digitization of the industry and help equip the workforce of the future

INTRODUCTION KEY DATA SOURCES

Industry Stakeholder Consultations & Primary Research

A key component of data collection for this report was the primary research gathered from industry stakeholders. This research was coupled with the use of EY's proprietary tool, SpotMentor, that is used to collect real-time quantitative data from online scraping of thousands of job descriptions.

Industry Stakeholder Consultations

The activities undertaken to collect stakeholder data included two surveys and eleven consultation sessions. To collect data from mining organizations, surveys focused on anticipated skills in addition to consultations with representation from human resources and digital transformation offices, where applicable, were conducted. In order to gather findings from educational institutions, a survey on anticipated skills was used. The main purpose of the industry stakeholders surveys and consultations was to validate the quantitative data and secondary research findings. Validating the findings allowed the insights to be grounded in a Saskatchewan-specific context. Examples of the types of questions used to collect data are noted below.

Survey Questions: Mining Organizations

1. Which skills are the most challenging to recruit for?
2. Which skills are the easiest to recruit for?
3. Which skills are most amenable to reskilling and upskilling?

Survey Questions: Educational Institutions

1. Does your institution have any formal partnerships with industry-related organizations?
2. Does your institution work with or involve industry partners in the development program curriculums?
3. Does your institution have any formal partnerships as it relates to mining programs or courses?

Courtesy of Cameco

SECTION 1 INTRODUCTION

INTRODUCTION KEY DATA SOURCES

Consultation Questions: Digital Transformation Office

1. How do digital trends impact talent in your organization?
2. How is your organization monitoring the anticipated impact of digital skills requirements on talent?
3. What are the critical digital roles needed in your organization? How are roles evolving to reflect digital trends?
4. How do you believe these digital trends will impact the organization's short and long-term plans?
5. In your opinion, how will your talent strategies need to change to keep up with the evolving industry?

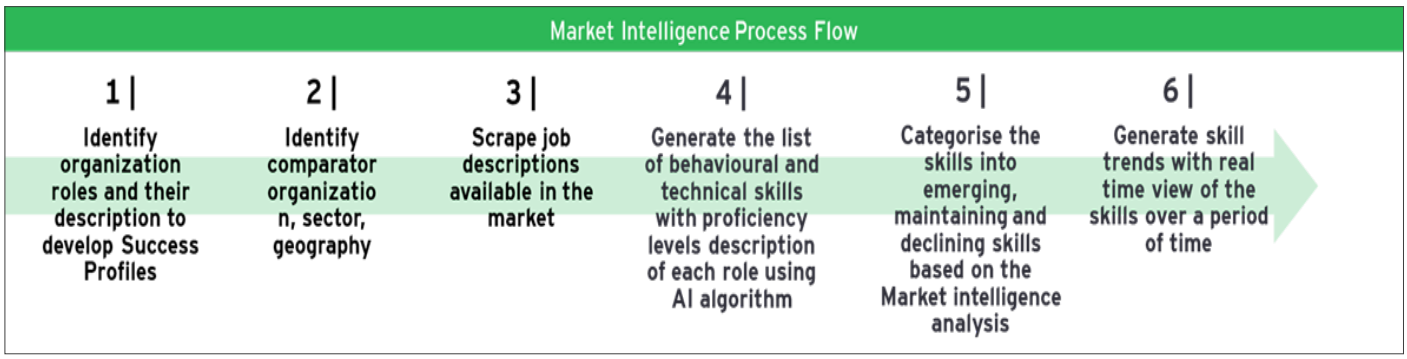
Consultation Questions: Human Resources

1. Which roles and/or skill sets are most challenging to hire for?
2. Why do you believe these roles are difficult to hire for?
3. Currently, where are you finding your greatest skill gaps in your organization?
4. To what extent are these skill gaps influenced by digital trends?
5. To what extent are these skills gaps influenced by other industry trends and/or challenges?

A significant limitation was incurred due to the availability of formalized strategies focused on digital enablement in the industry, from both an operational and workforce perspective. That said, the limitation also served as a key outcome of primary research. The absence of formalized a digital transformation function (or equivalent) noted among the majority of consulted organizations acted as an indicator in demonstrating the industry's degree of preparedness for adapting the workforce to the evolving skills landscape.

SpotMentor

SpotMentor is EY's tool that uses an artificial intelligence (AI) based skill inference engine based on a proprietary skill ontology. Skill ontology is a knowledge graph of skills, knowledge, and competencies; their relationships with each other, and statistical information like co-occurrence between various indicators. The market intelligence methods used in complement to the AI skill inference engine is as follows:



SECTION 2 CONTEXT

CONTEXT INTRODUCTION

The world of work is changing. This means changes in labour markets, talent supply, industry needs, and technologies. While the working world can expect to witness some significant disruption among certain demographics; due to the rapid evolution of technology, jobs are overwhelmingly projected to fundamentally change. Industries ranging from energy, to manufacturing, and even retail are increasingly assessing whether (and which) skills and roles are required to effectively adapt to the changing world of work, and its subsequent impact on talent strategies and skills landscapes.

Courtesy of Cameco

There are several key trends that are driving a need to act proactively in the face of changing skills, economies, and technologies. Key characteristics of our evolving working world consist of socio-demographic, and technology-based factors. The former encompasses shifting workforce expectations leaning increasingly towards flexible work arrangements, and corporate culture that includes life-long learning, and diversity and inclusion commitments. The latter complements this shifting context with an increasing emphasis on technologies such as robotic process automation, artificial intelligence, and data & analytics. These shifts, together, foster a context that drives the mining and minerals industry to re-evaluate and redefine the core components of work. Questions that become the forefront of organizational planning, then, include: Which core and essential skills are required, and which are nice-to-have? What are some of the complementary behavioural skills that can help enable an agile and digital workforce? Which mechanisms are needed to ensure that both the workforce, and industry are prepared to adjust and align to these changing contexts?

The mining and minerals industry is facing a unique challenge of dual trends in the world of workforce planning, and talent and organizational modernization. While companies successfully maintain low unemployment rates due to low turnover in the sector; they are simultaneously, and consequently, faced with the challenge of adapting to a rapidly changing skills and labour landscape. As technology continues to evolve at a rate outpacing labour market and skills development, the availability of digitally ready talent, coupled with high employee retention rates has emerged as a significant challenge for the industry as it pertains to talent readiness planning, and modernization and digital enablement. Because of this, our industry is facing especially unique circumstances.

SECTION 2 CONTEXT

CONTEXT INTRODUCTION

Not unlike other sectors then, the mining industry requires proactive management and action on these circumstances to support a smooth transition into the changing skills landscape. In planning ahead, our industry can begin maximizing the benefits of a digitally-enabled workforce, while also cultivating inclusive, equitable, and nimble talent pools that can continuously respond to changing work environments.

Key challenges emerging from the changing skills landscape facing the industry:

- Inconsistency among key actors in the industry as it pertains to the objective of modernizing, versus staying traditional – this results in mixed messaging for emerging talent (i.e. students), and hinders their ability to drive strong value propositions, and cultivate a relevant and modern workforce – no 'one-size-fits-all' approach to supporting digital adoption in the mining world, which also makes cultivating a digital workforce more challenging
- Roles of the future are increasingly hybrid in nature. To adapt to changing technologies, and in seeking to ensure that onboarded teams are resilient to digital disruption, roles are increasingly characterized as having strong emphasis on non-automatable behavioural skills, alongside strengthened competencies in key technologies
- Indigenous workers are expected to be uniquely impacted by digital disruption because of the roles that they predominantly occupy in the current state – heavily manual – this means that special attention is required to ensure adoption maintains an inclusive lens, and does not forego existing talent with the potential for learning and skills acquisition

Courtesy of Nutrien

SECTION 2 CONTEXT

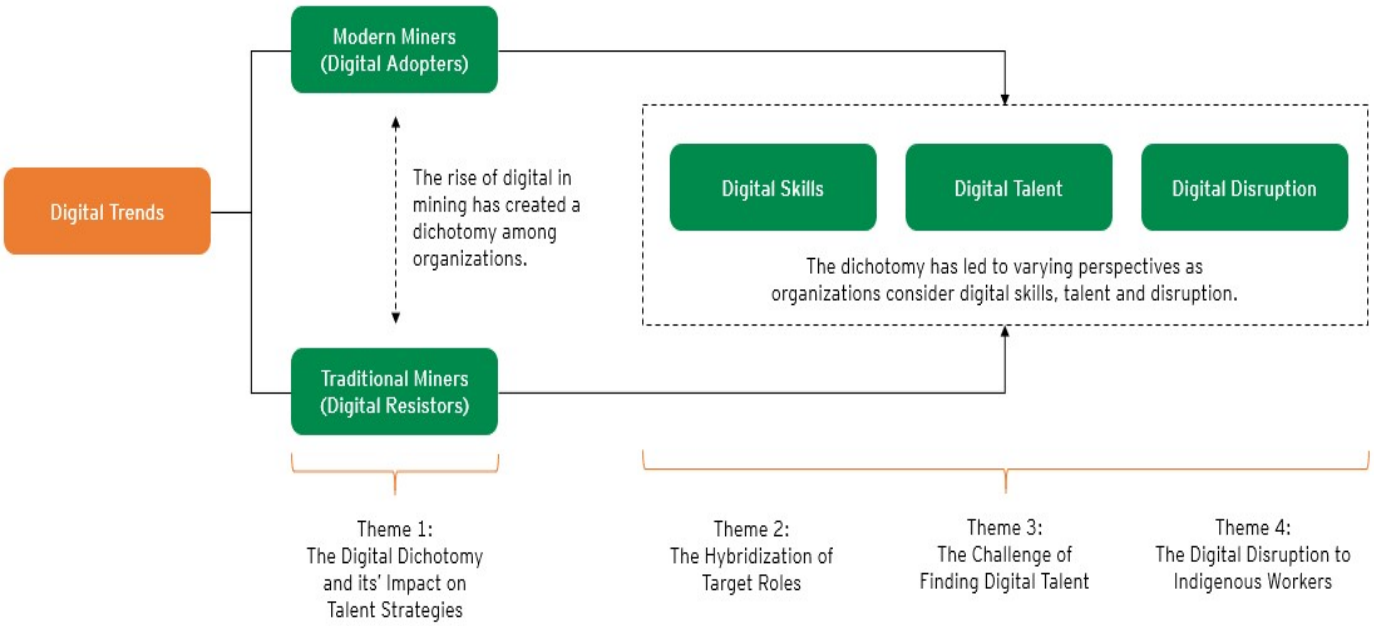
CONTEXT THE DIGITIZATION OF THE INDUSTRY

Top Trends in Canada's Mining Industry

The mining and minerals industry is, by character, cyclical and unstable. The changing skills landscape has result in emerging skill gaps, and overall labour shortages that have resulted in significant impacts for Canadian Mining and Minerals sector as they think about workforce planning. According to a Mining Industry Human Resources Council (MiHR) Report (2018), over the next decade, between ~97k and ~135K workers will need to be hired to account for fluctuations in labour availability, and to account for a retirement boom expected within the next ten years. Further, on a national level, there are key gaps in technology-related, managerial, and trades and production-based roles. Exacerbating these conditions are a) the gaps in representation of women in the mining labour market, b) the persisting and impact of continued technological evolutions, and c) the corresponding demand for workers in the mining sector that have core skills strengths in technology engineering, and science (including data science) skills. For example, women comprise 48% of the Canadian workforce (Statistics Canada, 2016 Census of Population), but only 14% in the mining industry. Although according to NRCAN, this has increased by 10% from 2001, the proportion of women in the sector is an ongoing concern. This low representation of women in the mining workforce is both an occupational and industry-level issue. The former means that the low percentage of women in this workforce will have considerable impacts on labour availability, while the latter refers to the impacts expected from a diversity of skillsets perspective constituting the workforce. The combination of these prominent economic and labour force shifts means that higher education, or, increased access to high-quality, but flexible training strategies may be required inclusively and accessibly.

Impact of Digitization on Mining Talent in Saskatchewan

An analysis on the impact of digitization on talent and talent strategies in Saskatchewan's mining industry resulted in the identification of four themes:



SECTION 2 CONTEXT

CONTEXT THE DIGITIZATION OF THE INDUSTRY

Theme 1: The Digital Dichotomy and its Impact on Talent Strategies

The digital dichotomy describes the divergence, and variability in digital adoption in the mining industry. The analysis found that there are companies that have successfully developed plans for digital adoption by aligning their workplans, skills and leadership programs with the labour market of the future. On the other hand, others have remained traditionally oriented, paying minimal attention to digital skills trends. This contrast among players in the industry has resulted in a digital dichotomy where there is no one-size-fits-all model/strategy to support digital adoption in the mining industry. However, while the dichotomy exists within the industry, mining companies are aware of trends and the associated key benefits (productivity, efficiency, safety).

The digital dichotomy identifies variability in digital adoption and focus across mining companies in Saskatchewan. On one side of the digital dichotomy, there are the traditional organizations. The organizations typically:

- Have no digital strategies in place and no collective approach to monitoring digital trends
- Lack the internal capability to pursue transformation (e.g. alignment, change management, project management)
- Do not identify digital skill gaps in the organization
- Have talent strategies reflective of traditional operations

Oppositely, there are modern organizations. These organization tend to:

- Have established digital leadership and programs
- Have the internal capabilities to support transformation (e.g. deployment models, change management)
- Have identified digital skill gaps and have begun implementing talent programs to support a digital workforce (e.g. reskilling programs, including digital adoption as part of performance evaluations, shift to looking for transferable skills/adaptiveness)
- While human resources are seen as reactive to digital transformation rather than proactive, talent strategies are being implemented as a response to the business

The existence of a digital dichotomy within the industry has several impacts, such as:

- Impacts on talent strategies: by influencing attitudes towards digital within an organization, there emerges significant impacts on talent strategies and on an organization's active willingness to change
- The dichotomy impacts digital adoption because:
    - Traditional miners are seen as more apprehensive towards innovation and seeking new skillsets
    - There is a resistance to developing a digital strategy or vision, and they rely heavily on on-site management roles to support day-to-day operations
    - Modern miners are willing to explore emerging technologies and seek employees with broader skillsets who can work cross-functionally

SECTION 2 CONTEXT

CONTEXT THE DIGITIZATION OF THE INDUSTRY

The findings on the digital dichotomy notes that there appears to be a disconnect between human resources and its' role in digital transformation. Human resources lacks strategic direction and appears solely responsive to business needs.

Theme 2: The Hybridization of Target Roles

The findings suggest that the success of the mining industry, and others similar to it, is premised on the level of adaptability to both digital trends and the overall operating environment that defines the future of work – that is, the requirement for soft, leadership-oriented skills. Most organizations consulted have noted that the hybridization of roles within their specific context is informed by HR, and their leaning towards 'future of work' trends, while not addressing the other end of the hybrid: technical. Digital skills are being called the "secret of career success in the digital world ahead". The roles identified in stakeholder consultations have emphasized aptitude and critical thinking – future oriented skills – while citing a disconnect with digital transformation functions, and lack of insights into business needs.

In the case of the modern organizations:

- Roles are shifting in the maintenance areas, troubleshooting for problems, etc.
- Organizational structure perspectives mean that the roles needed are geared towards a blended model, as a means for covering the skills requirements. For example:
    - Some talent is to have both technical, and manual expertise and;
    - Other talent is to be more specialized
- Believe education institutions are not doing enough to develop the soft skills in technical skills programs. (e.g., engineers need to become agile thinkers)

Courtesy of Nutrien

SECTION 2 CONTEXT

CONTEXT THE DIGITIZATION OF THE INDUSTRY

On the contrasting side of the dichotomy, traditional organizations:

- Have identified that roles are centered on 'basic skills' such as computer skills, which are identified as easy to fill, or more broadly, aptitude
- There is evidence of a disconnect between organizations and education providers and a lack of mechanisms for effective collaboration between parties
- While organizations noted that formal education does not keep up with talent demand, research, on the other hand, states that educational institutions find it difficult to convince industry to provide work experience to students

Theme 3: The Challenge of Finding Digital Talent

While there is an interest in increasing the labour supply, the lack of tri-partisan collaboration between companies, education and government has contributed to the talent gap. Greater awareness of career paths and employee value propositions is needed to better position the industry for attracting talent, While further enhancement of employee value propositions (e.g. reskilling, career advancement opportunities) would help companies capitalize available talent. According to MiHR (2020), mining employment has grown every year for the last 5 years and is expected to add 80k new workers in the next 10 years. That said, there are indications of an anticipated digital talent shortage, due in part to:

- Industry conditions: Volatile markets, the retirement of baby boomers, and remote operations are some of the factors that have created labour supply challenges for the industry
- Digital competition: As digital skills become more in demand across industries, mining's talent pool shortage will only increase
- Lack of awareness: There is not enough awareness of mining career paths across all levels of education and employee value propositions are also not being leveraged enough to attract new talent into the industry

Courtesy of Mosaic

- Lack of tripartite collaboration: Companies, educational institutions and government have not been effective at working together to increase the talent pool

Views on talent gaps and the need for stronger tripartite collaboration differ based on the degree of digital adoption. For traditional organizations:

- Current skill gaps are not digital, therefore, some are tapping into local communities to develop semi-skilled talent
- Struggling to compete for talent when oil & gas companies are booming because they cannot meet total rewards offerings

SECTION 2 CONTEXT

CONTEXT THE DIGITIZATION OF THE INDUSTRY

On the other hand, modern organizations:

- Find that the education does not keep up with talent demand, with bureaucratic systems slowing down approvals for new programs and courses
- Believe education institutions are not doing enough to develop the soft skills in technical skills programs. For example, engineers need to become agile thinkers and move away from the "one size fits all" solutions.
- There is evidence of a disconnect between organizations and education providers and a lack of mechanisms for effective collaboration between parties
- While organizations noted that formal education does not keep up with talent demand, research, on the other hand, states that educational institutions find it difficult to convince industry to provide work experience to students

Theme 4: The Digital Disruption to Indigenous Workers

The findings show that that all mining organizations need to examine the impact of digital transformation on their indigenous workforce and surrounding communities. It is critical to consider developing indigenous training programs that target future digital skill gaps and identify opportunities for better consultation initiatives with communities to ensure the sustainability of the remote workforce and provide better community support.

The indigenous workforce is one of the most important labour pools in Saskatchewan's mining industry, representing a higher percentage of Canada's mining workforce in comparison to other industries (MiHR, 2020). Key considerations when assessing the digital disruption to indigenous workers include:

- Mine remoteness: Indigenous workers will become increasingly important as mining operations become more remote.
- Impact and benefit agreements: These agreements with local communities hold organizations accountable to various requirements including employment quotas.
- Digital disruption: Indigenous employees are at a higher risk of being disrupted by digital transformations since they hold a higher percentage of manual/semi-skilled occupations (e.g. underground miners, heavy equipment operators, labourers)
- Skills training mismatch: Currently, indigenous employment development programs focus on skills for production occupations and do not focus on the essential and transferable skills needed to adapt to future roles and technologies, such as critical thinking and collaboration

SECTION 2 CONTEXT

CONTEXT THE DIGITIZATION OF THE INDUSTRY

Some organizations have implemented indigenous training programs for manual/semi-skilled roles. These organizations noted the importance of engaging with the community, however, no plans regarding digital skills training was mentioned. One organization was cited as being excited about digital and desired broader and newer skillsets, however, noted digital skillsets tend to require post-secondary education and are more challenging to find in rural communities.

Based on the findings, there is little indication that organizations are considering the potential negative impact that digital transformation (especially automation) could impose on the indigenous workforce and local communities.

The Increasing Need for Tripartite Relationships

The overarching mining education context in Canada has historically been characterized by its excellence in research, technology development, and program qualities. Higher education has served the purpose, as is the case with most industries, of developing the talent required by industry, while in this case also fostering and maintaining a global reputation for quality, and employment prospect.

Historically, the mining industry has clearly offered two key sustained value propositions:

- Higher than average salaries
- Opportunities to travel

Courtesy of K+S

SECTION 2 CONTEXT

CONTEXT THE DIGITIZATION OF THE INDUSTRY

In more recent years, attracting talent to mining related programs, and therefore to the mining industry, has faced a number of significant challenges such as (Gallagher, 2013):

- Industry and environmental impact, and public perception
- Perceived safety concerns
- A lack of understanding about the industry by the general public

From 2015 to 2016, for example, mining engineer programs witnessed one of the most significant declines in undergraduate enrolment across Canada. Program enrolment dropped by 12% (MiHR, 2018). Trends in recent years have reflected similar declines in interest by the student body. Labour shortages that the mining industry is facing today requires strengthened partnership between industry and educational institutions in order to mitigate the continuation of skill gaps, shortages, and increased overall workforce instability.

Courtesy of Mosaic

The challenges facing the mining industry necessitate a strategy that nurtures the sustainability of Canada's education for the mining industry, and ultimately, the mining industry itself. While the cyclical nature of the mining industry has typically led companies to make decisions with short-term timelines in mind, investing in education and partnerships can be considered strategic and proactive, as an investment in learning and skills development supports the overall sustainability of the workforce, and therefore the industry.

In the next section, a series of case studies will explore how the skills of traditional mining roles may be impacted by the digitization of the industry. Each case study also highlights the anticipated challenges in the industry may face in ensuring talent have the critical skills to operate in the future.

SECTION 3 CASE STUDIES

CASE STUDIES PURPOSE

The purpose of this section is to provide hypothetical case studies that highlight the anticipated impact digital technologies will have on traditional mining roles. While it is impossible to precisely pin point the impact of digital on the mining workforce, the case studies provide a view on the skills gaps the industry will likely face.

Each case study looks at the role's current state persona and critical skills to provide a picture of how the role operates today. A persona is used to describe generalized key aspects of a particular role. Personas are used in the case studies to provide additional context, however, it is important to keep in mind that the generalized aspects may vary person to person. Additionally, the current state of critical skills notes the five most critical skills for a given role and the level of competency typically seen in that role.

In terms of the future state, the case studies describe a potential digital scenario, using different scenarios for each role. These scenarios are used to add context, however, are not intended to define the future state of a given role. Based on the future state scenario, primary and secondary research, the case studies look at how digital impacts not only the role's critical skills profile, but also the persona. Each case study concludes by noting the anticipated challenges of transitioning from the current state to the future state. A consolidated view of recommendations, such as talent strategies to support the transition from current state to future state, will be included in the following section of the report.

The case studies in this section include:

- The Exploration Geologist & Artificial Intelligence
- The Underground Miner & Remote Operations
- The Maintenance Supervisor & Next Generation ERP
- The Mining Engineer & Automation
- The Business Analyst & Advanced Analytics
- The Information Technology Manager & Edge Computing

Courtesy of BHP

SECTION 3 CASE STUDIES

CASE STUDIES SUMMARY

The case studies are intended to show the anticipated shift in skills due to the implementation of digital technologies in mining organizations. Again, while the case studies cannot precisely pin point the future state for the given roles, the case studies do note a trend in emerging skills.

With regards to emerging skills, there is a series of technical and soft skills that are currently on the rise and are anticipated to continue moving forward. These skills include:

- **Digital Literacy:** Refers to an individual's ability to find, evaluate, and compose clear information through writing and other media on various digital platforms
- **Data Visualization:** The ability to graphically represent information and data. By using visual elements like charts, graphs, and maps, data visualization tools provide an accessible way to see and understand trends, outliers, and patterns in data
- **Artificial Intelligence:** The knowledge and ability to work with intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals
- **Stakeholder Management:** The ability to manage stakeholders, whether an individual, group or organization that can affect, be affected by, or perceive itself to be affected by a program
- **Agile Project Management:** The ability to apply iterative approach to planning and guiding project processes
- **Change Management:** The ability to prepare, support and help individuals, teams, and organizations in making organizational change

It is important to note that these trends are currently being seen across industries, including power & utilities and in oil & gas. These industry agnostic trends are also being witness across Canada, North America and the globe.

Courtesy of Nutrien

CASE STUDY EXPLORATION

The Exploration Geologist

CURRENT STATE PERSONA

I work in one of the following roles:

- Exploration Geologist
- Project Geologist
- Field Geologist

My job typically consists of:

- Identifying and assessing mineral deposits
- Planning exploration programs focused on collecting and recording samples
- Using traditional and digitally-enabled approaches to investigate deposits

My demographics are typically:

- Female, aged 30-35
- An undergraduate degree in geosciences, earth sciences, geophysics or geochemistry
- May have Master's degree or working towards P.Geo
- 2 to 3 years of experience in mineral exploration

A day in my life means:

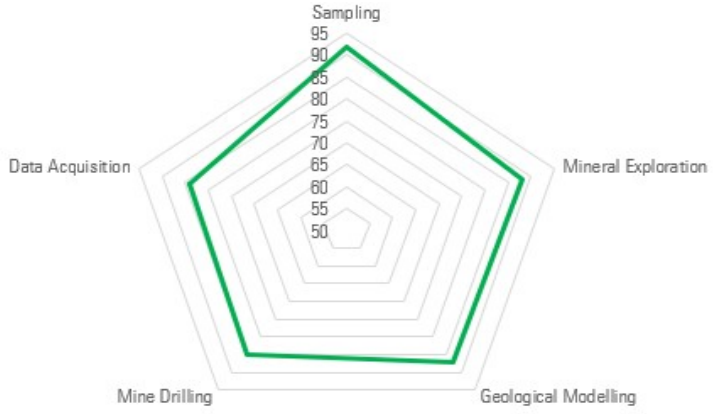
- Working 40 hours a week in a range of working environments, including remote field work and office work
- Interacting with local communities
- Face-to-face communication during field work
- Using geological software

I work in the mining industry because:

- Travelling to and working in remote locations
- Career growth opportunities
- Applying skills and knowledge learned from formal education

CURRENT STATE CRITICAL SKILLS

A current state assessment, including the quantitative analysis of 160 job descriptions, results in the following skills profile:



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

The competency level for each of the critical skills is outlined below:

Beginner | Intermediate | Knowledgeable | Expert

Sampling

- Knowledge of master variables, geochemical conditions and mobility of elements
- Supervises the correct sample management procedures
- Recommends improvements to sample management systems

Mineral Exploration

- Knowledge of inspections laboratories to ensure the quality of sample preparation and analysis processes
- Strong understanding of structural geology, quality control protocols design techniques, and ground geophysical survey design
- Responds to inquiries related to mineral leasing and development

Geological Modelling

- Knowledge of rig management, geological logging & validation
- Proficiency in using appropriate geological software
- Supervises the creation of plans, sections, and designs, using software and other design methods

Mine Drilling

- Knowledge of all types of exploration drilling, with an understanding of directional drilling techniques and its equipment
- Plans all drilling and blasting efforts and ensures all are in total compliance with all organizational policies and procedures

Data Acquisition

- Familiarity with cloud and data management trends, and leading vendors that relate to data acquisition and management
- Manages the generation and delivery of high-quality, defensible, timely, and cost-effective data

CASE STUDY EXPLORATION

The Exploration Geologist

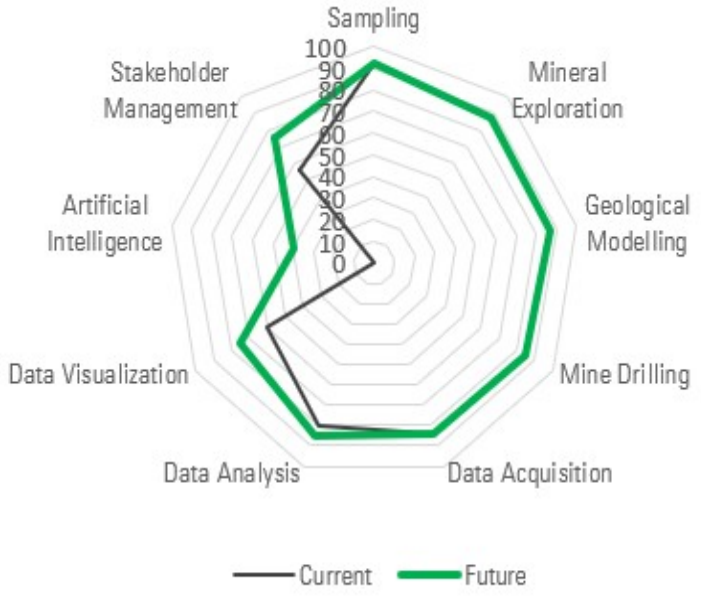
FUTURE STATE SCENARIO

Smarter exploration using artificial intelligence is leading to greater certainty in decision making

According to Robin Fell (2018), "geologists spend roughly 80% of their time looking for and manipulating data, versus analyzing and interpreting data based on knowledge and experience. As data sets continue to grow in size and complexity, not only does big data provide new challenges, but the complexity within the data tools, and the lack of harmonization between them, adds to the difficulty." [1] The use of artificial intelligence is allowing geologists to gain deeper insights from historical data, by identifying undetected patterns and creating greater certainty in geological models.

FUTURE STATE ANTICIPATED CRITICAL SKILLS

A future state assessment, including an analysis of emerging skills and considerations of the future state scenario, indicates the addition of new critical skills to the current skill profile. New critical skills are primarily focused around working with data and knowledge of emerging technologies. Additionally, this role is also expected to see an increase in the importance for stakeholder management.



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

FUTURE STATE SOFT SKILL SPOTLIGHT

An emerging skill, one that the analysis shows will continue to become more critical to the Exploration Geologist, is: Stakeholder Management

As exploration activities continue to reach into more isolated areas, this role should:

- Understand principles of conflict resolution, strategic stakeholder engagement and change management
- Support stakeholder relations strategies by regularly engaging with stakeholders connected to an exploration project

The future state shift in competency levels worth noting, include:

Data Visualization

Current State: Beginner – Intermediate – Knowledgeable – Expert

- Knowledge of data visualisation tools and techniques
- Incorporates interactive graphics, visuals and technical features into the data presentation

Future State: Beginner – Intermediate – Knowledgeable – Expert

- Develops dashboards incorporating advanced visualisation techniques and embedding analytics capabilities
- Establishes effective data presentation architecture to address critical business questions

Artificial Intelligence

- Knowledge mathematics functions, statistics, data structures and data bases
- Knowledge of programming language in order to develop code for data analysis

- Knowledge of virtual machines and cloud environment
- Analyses the suitability of an algorithm if it caters the needs of the current task

CASE STUDY EXPLORATION

The Exploration Geologist

FUTURE STATE PERSONA

Key changes to the Exploration Geologist persona include:

- The ability to learn and work with artificial intelligence. This may become a key factor in attracting and retaining top talent
- Experiencing a reduction in guesswork, minimized risk when modelling deposits and decision making based on greater certainty

FUTURE STATE DISRUPTION

The level of anticipated disruption for the Exploration Geologist is low:

- Data-centric skills are already seen as critical skills for this role, and will act as a strong baseline to allow for a smooth transition to adopting new technologies
- There are no significant changes in working conditions

FUTURE STATE ANTICIPATED CHALLENGES

The main challenges facing the future of the Exploration Geologist stems from career awareness and job market perceptions.

- According to the 2020 MiHR publication "Canadian Mineral Exploration HR Outlook", there are indications that the next generation of Geologists have a negative outlook on careers in mineral exploration, 80% of geology students in 2017 graduated without established career prospects. Without proper mitigation, these findings could continue or worsen for future generations.
- There is a disconnect between the level of experience employers are looking for from new graduates and the experiences students are able to access during their studies.
- The misalignment between the mining industry's talent needs and what educational institutions are offering is anticipated to worsen as a shifting skills landscape may widen the gap further.
- In addition to the downstream effects the lack of collaboration between industry and educational institutions is having on job outlook, there are also indications that careers in mineral exploration are not being marketed to younger generations. According to the MiHR publication, 54% of respondents indicated they did not learn about careers in exploration until reaching college or university.
- All together, the combination of job outlook perceptions and lack of career awareness may results in limited numbers of new labour market entrants - a segment of the workforce that will be critical to the mining industry over the next 5 to 10 years.

FUTURE STATE CURRICULA

Examples of upskilling opportunities for the Exploration Geologist include:

- Introduction to Artificial Intelligence: Understanding basic concepts, including data structures and algorithms
- Big Data Visualization: Developing dashboards using advanced visualisation techniques
- Artificial Intelligence & Geology: Exploring use cases of the application of artificial intelligence in geology

CASE STUDY EXTRACTION

The Underground Miner

CURRENT STATE PERSONA

I work in one of the following roles:

- Mining Machine Operator
- Mine Labourer

My job typically consists of:

- Extracting ore in underground mines
- Constructing tunnels, passageways and shafts to facilitate mining operations

My demographics are typically:

- Male, aged 45 to 55
- Indigenous male, aged 25-35
- May hold high school diploma or equivalent
- Has previous experience operating heavy duty equipment

A day in my life means:

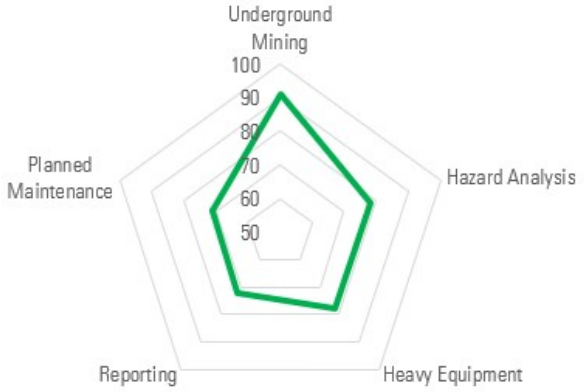
- Working 12-hour shifts at Uranium or Potash mine sites
- Working primarily with heavy duty equipment
- Wearing personal protective equipment
- Working with loud and uncomfortable noise levels
- Most communication is done face-to-face
- Working alone or in a small team
- Minimal use of information and communication technology

I work in the mining industry because:

- Competitive pay
- Working close to home and community
- Does not require high school diploma
- Access to on-the-job training

CURRENT STATE CRITICAL SKILLS

A current state assessment, including the quantitative analysis of 274 job descriptions, results in the following skills profile:



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

The competency level for each of the critical skills is outlined below:

Beginner — Intermediate — Knowledgeable — Expert

Underground Mining

- Knowledge of types and functions of the equipment used
- Able to explain and set up positions between the tool loading, unloading and transportation
- Able to perform basic calculations relating to equipment use

Hazard Analysis

- Knowledge of safety protocols, types of hazards, organizational quality systems, procedures and policies
- Identifies undesirable events that lead to hazards
- Can collect information for root cause analysis

Heavy Equipment

- Able to successfully use equipment as required with minimal guidance
- Understands the application and implications of changes to various pieces of equipment

Reporting

- Knows the stages in the preparation of a report
- Knows how to report underlying problems
- Prepares reports based on the pre-determined requirements
- Prepares and submit incident reports to the appropriate persons

Planned Maintenance

- Knowledge of types of planned maintenance (scheduled and unscheduled maintenance)
- Understands equipment functions and operating principles
- Can conduct some fault diagnostic procedures

CASE STUDY EXTRACTION

The Underground Miner

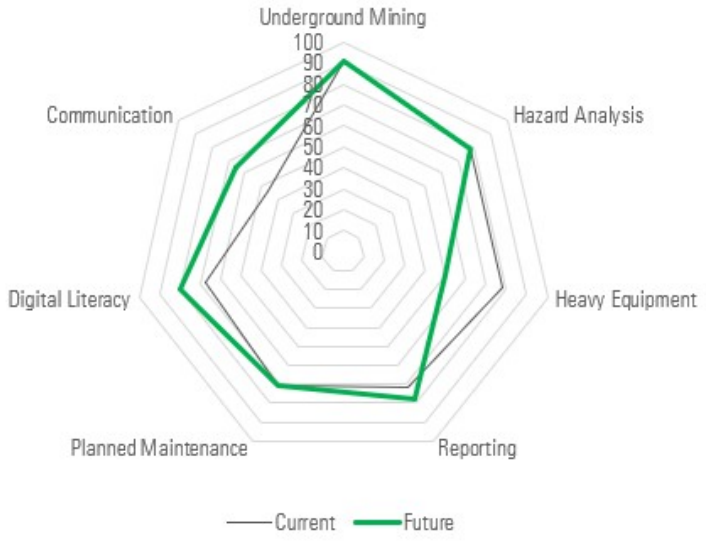
FUTURE STATE SCENARIO

Removing miners from the mines

Remote operations use underground communication, positioning, process engineering, monitoring and control systems, to operate mining equipment remotely. These types of operations allow workers to safety extract minerals from underground while remaining in a safer, above-ground location. Typically, the technology requires skilled workers as it emulates the cab controls of traditional equipment, while being operated through a centralized fleet management system.

FUTURE STATE ANTICIPATED CRITICAL SKILLS

A future state assessment, including an analysis of declining & emerging skills and considerations of the future state scenario, indicates the decline in importance of heavy equipment and new critical skills to the current skill profile. New critical skills are geared towards operating in a digitally-enabled work environment, with skills such as digital literacy and communication.



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

FUTURE STATE PERSONA

Key changes to the Underground Miner include:

- Work location is safe, removed from mine, indoors and above-ground
- Physical labour is limited to only the emulated cab controls (e.g., using a joystick)
- Most tasks and communications are done through information and communication technology
- Role will require high school diploma or equivalent in order to ensure foundation of digital literacy
- Shifts could be reduced to 8-9 hours per day due to shortened shift handovers
- Role title may change to Remote Equipment Operator

The future state shift in competency levels worth noting, include:

Digital Literacy

Current State	Future State
Beginner – Intermediate – Knowledgeable – Expert	Beginner – Intermediate – Knowledgeable – Expert
• Performs basic functions using software pertaining to computer operating systems and file management, and search online information	• Uses available software features to enhance documents, analyse and manipulate data • Uses information communication technologies to organise, share and communicate information clearly and coherently

Communication

Current State	Future State
• Understands sources of information within the organization • Performs activities using appropriate communications techniques to clarify and respond to information received	• Understands and uses effective communication techniques • Interprets and responds to information received • Evaluates gaps and barriers in communication

CASE STUDY EXTRACTION

The Underground Miner

FUTURE STATE ANTICIPATED CHALLENGES

The main challenge facing the Underground Miner will be transitioning the current workforce segments to the future state.

- Educational levels, socio-economic status and maturity of digital infrastructure are major predictors of becoming digitally literate.
- Workforce segments may not currently hold the level of education or previous exposure to technology needed to effectively demonstrate digital literacy and system evaluation without interventions.
- Older adults are frequently marginalized when it comes to digital inclusion. Additionally, the challenges go beyond systemic issues, with research noting older adults need more time and different learning approaches in order to acquire digital skills.
- From an Indigenous perspective, barriers relating to digital infrastructure and literacy are based not only on their often remote locations but also by existing literacy challenges and unique cultural context.

FUTURE STATE DISRUPTION

The level of anticipated disruption for the Underground Miner is medium.

- Major shift in digital skills, with an increase in both importance and ability
- Digital skills lay the foundation for the future state role, enabling the execution of other critical skills
- Major change to working conditions, including physical environment, and communication

FUTURE STATE CURRICULA

Examples of upskilling opportunities for the Underground Miner include:

- Introduction to Windows 10 - How to work effectively using Microsoft's operating system
- Introduction to Fleet Management System - Understanding basic principles and concepts
- Interpersonal Communication - Concepts in verbal and nonverbal communication
- Effective Workplace Communication - How to leverage techniques and tools to effectively communicate

CASE STUDY PROCESSING

The Maintenance Supervisor

CURRENT STATE PERSONA

I work in one of the following roles:

- Maintenance Supervisor
- Maintenance Superintendent

My job typically consists of:

- Advising mining and processing teams of correct operation for mining equipment
- Ensuring equipment compliance with legislation and regulations
- Ensuring planned and ad hoc repairs are executed to keep all equipment running smoothly and safely, etc.

My demographics are typically:

- Male, aged 40-45
- A high school diploma or equivalent
- A recognized professional designation or trades certificate (e.g., Millwright, Mechanical Technologist)
- 7 to 10 years of experience in maintenance management, ideally in mining industry
- 3 to 5 years of supervisory experience

A day in my life means:

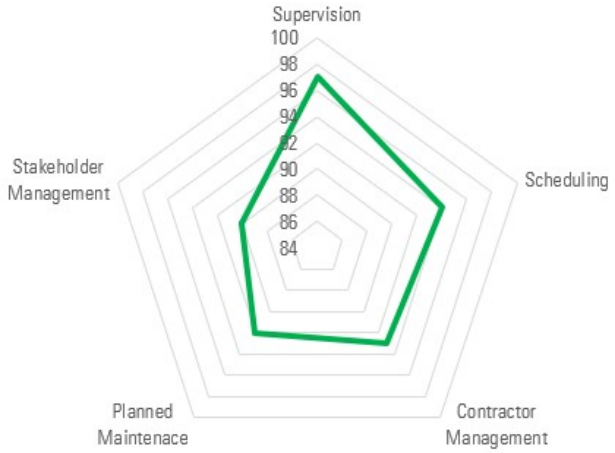
- Working 40 to 60 hours a week at a mine site
- Manages a team of people (e.g., planners, mechanics)
- Responsible for maintenance schedules and planned shutdowns
- May act as advisor on equipment

I work in the mining industry because:

- Enjoys working with major equipment and machinery
- Opportunities to work with new technologies
- Competitive pay

CURRENT STATE CRITICAL SKILLS

A current state assessment, including the quantitative analysis of 2135 job descriptions, results in the following skills profile:



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

The competency level for each of the critical skills is outlined below:

Beginner | Intermediate | Knowledgeable | Expert

Supervision

- Tracks and evaluates employee performance and job assignments
- Aware of performance evaluation methods and importance of rewards and recognition in a workplace
- Maintains a safe and healthy work environment for employees

Scheduling

- Understands business priorities and impact on production output
- Oversees and manages schedule processes, and conducts audits
- Identifies planning and scheduling problems and produces contingency plans

Contractor Mngt.

- Understands the implications of contractual issues
- Assesses the need for changes and/or modifications to contracts
- Sustains smooth interactions and relationships with vendors and/or service providers based on shared objectives

Planned Maintenance

- Knows methods of resource planning and scheduling
- Understands labour estimation and wrench time principles
- Applies methods of decision making for repair or replace strategies

Stakeholder Mngt.

- Engages relevant stakeholders to understand project expectations and requirements
- Facilitates alignment of expectations between relevant stakeholders and project teams

CASE STUDY PROCESSING

The Maintenance Supervisor

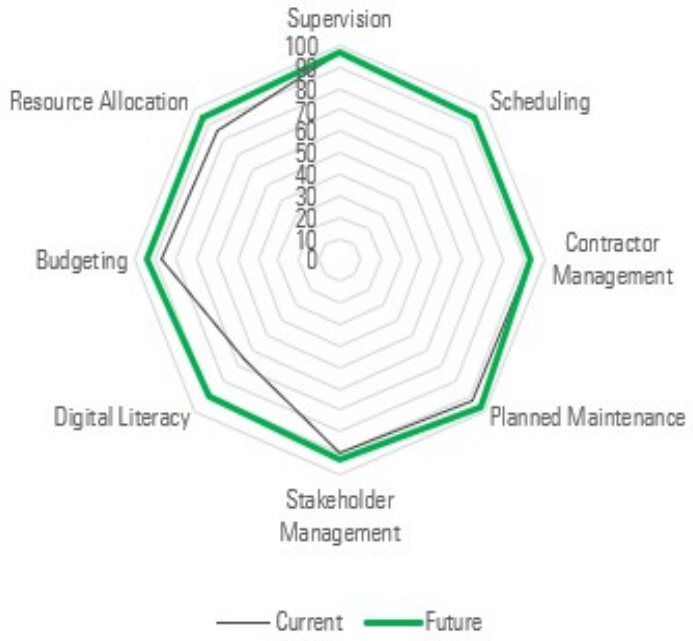
FUTURE STATE SCENARIO

Shifting from a stand-alone solution towards the all-in-one package

Next Generation Enterprise Resource Planning (NexGen ERP) provides mining companies with an all-in-one solution that integrates all business planning activities, while incorporating leading technologies such as cloud computing and artificial intelligence. ERP systems with artificial intelligence capabilities will allow the Maintenance Supervisor to access tools that provide a deep understanding of technical structure, performance and maintenance history of equipment. Additionally, there will be a shift towards predictive maintenance, rather than today's focus on preventative maintenance.

FUTURE STATE ANTICIPATED CRITICAL SKILLS

A future state assessment, including an analysis of emerging skills and considerations of the future state scenario, indicates greater importance of some current critical skills and the addition of new skills to the current profile. Changes to the skills profile are geared towards operating in a digitally-enabled work environment, including digital literacy and stakeholder management.



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

FUTURE STATE SOFT SKILL SPOTLIGHT

An emerging skill, one that the analysis shows will continue to become more critical to the Maintenance Supervisor, is: Stakeholder Management

As mines become increasingly more connected, this role will have greater interactions with various stakeholders and involves:

- Understanding principles of conflict resolution, strategic stakeholder engagement and change management
- Supporting stakeholder relations strategies by regularly engaging with stakeholders
- Developing communication strategies to build and maintain successful relationships with key stakeholders

The future state shift in competency levels worth noting, include:

Planned Maintenance

Current State	Future State
Beginner – Intermediate – Knowledgeable – Expert	Beginner – Intermediate – Knowledgeable – Expert
• Performs basic functions using software pertaining to computer operating systems and file management, and search online information	• Understand statistical data analysis, methods and techniques • Manages the implementation and integration of technology-driven predictive maintenance systems and maintenance plans and schedules

Digital Literacy

• Uses available software features to create and edit documents, customise templates and reports and evaluate online information	• Uses available software features to enhance documents, analyse and manipulate data, and uses ICT to organize, share and communicate information clearly and coherently

CASE STUDY PROCESSING

The Maintenance Supervisor

FUTURE STATE ANTICIPATED CHALLENGES

The main challenges facing the Maintenance Supervisor include:

- Given the nature of the future scenario, the challenges anticipated for this role are related to change management. This is due to smarter technologies requiring additional training to address potentials gaps in the baseline knowledge among employees.
- There are additional change management considerations regarding emerging interdependencies between business functions and maintenance; training may be rendered more complicated due to the emerging interplay between technology-based, and change management- based knowledge and buy-in that is required for the successful adoption of NextGen ERP and its correlated business process changes.

FUTURE STATE DISRUPTION

The level of anticipated disruption for the Maintenance Supervisor is low to medium:

- While digital technologies and skills are already embedded in this role, new technologies may present a learning curve
- The management of employees will have a greater focus on employee development, rather than coordination of activities

FUTURE STATE PERSONA

Key changes to the Maintenance Supervisor include:

- Ability to learn and understand new dependencies between maintenance and business activities
- Opportunities for career growth in other business areas
- Skill development opportunities in the areas of training and stakeholder management to support employee upskilling

FUTURE STATE CURRICULA

Examples of upskilling opportunities for the Maintenance Supervisor include:

- Introduction to Managing Changing - Best practices for employees transition into new technologies
- Introduction to NextGen ERP - Creating a greater understanding of business interdependencies
- Introduction to Predictive Maintenance - Understanding the approaches and methodologies

CASE STUDY ENGINEERING

The Mining Engineer

CURRENT STATE PERSONA

I work in one of the following roles:

- Mine Engineer
- Project Manager
- Mining Safety Engineers

My job typically consists of:

- Undertaking feasibility studies and assessing site viability
- Reporting, planning, designing methods and structures for the operations
- Overseeing the production process
- Monitoring projects

My demographics are typically:

- Male aged 30-45
- An undergraduate and graduate degree in mining engineering
- Holds P.Eng designation
- Minimum of 5 years experience working in the mining industry

A day in my life means:

- Working 40 hours a week, mostly at the mine site
- Using planning software and computer modeling to develop mine, waste disposal, and mineral transportation plans
- Assessing characteristics of mining sites and determining necessary extraction and processing structures via modeling software

I work in the mining industry because:

- Competitive pay
- Career growth opportunities
- Opportunity to work at the intersection of mining and environmental care
- Ability to apply formal education to everyday work
- Opportunities to work with new technologies

CURRENT STATE CRITICAL SKILLS

A current state assessment, including the quantitative analysis of 106 job descriptions, results in the following skills profile:

Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

The competency level for each of the critical skills is outlined below:

Beginner — Intermediate — Knowledgeable — Expert

Mine Planning

- Knows how to prepare a site infrastructure plan to support all mining, tailings and return water infrastructure requirements
- Knowledge of underground mine safety standards
- Manages the development and execution of mine plans

Technical Drawing

- Understands advanced principles of engineering design and discipline engineering expertise
- Understands methods of evaluating feasibility and constructability of engineering designs

Stakeholder Mngt.

- Understands key principles of strategic stakeholder engagement
- Initiate early engagement to allow time for buy-ins and consultations with stakeholders
- Collaborate with stakeholders to ensure implementation of feedback

Agile Project Mngt,

- Demonstrates proficiency in applying agile methodologies for project management
- Can resolve issues pertaining to the implement of project plans

Occupational H&S

- Understands methods of monitoring the implementation of control measures
- Formulates plans in accordance to the Risk Management policies
- Can liaise with external governing bodies on standards and legal compliance issues

CASE STUDY ENGINEERING

The Mining Engineer

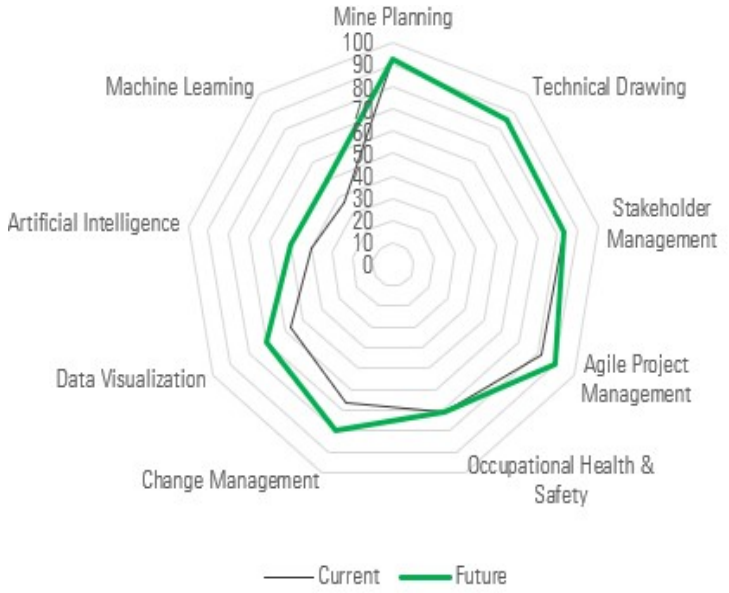
FUTURE STATE SCENARIO

Better technology for optimized planning, and improved operational and environmental outcomes

The digital scenario anticipated in the future state will centre new technologies such as 3D modelling, robotics & automation, and predictive analytics. The availability and adoption of these technologies will create opportunities to digitize mining by automating reporting and systems monitoring, automated analysis and reporting of optimal mine development based on geological characteristics; meanwhile access to, and knowledge of predictive analytics software improves insights on quality assurance and probability analysis of waste disposal impacts, and optimizes broad-based plan development (e.g. transportation, waste disposal, and geological characteristics assessments).

FUTURE STATE ANTICIPATED CRITICAL SKILLS

A future state assessment, including an analysis of emerging skills and considerations of the future state scenario, indicates greater importance of some current critical skills and some "nice to have" skills becoming "must have" skills. Changes to the skills profile are geared towards managing increasingly complex projects.



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

FUTURE STATE SOFT SKILL SPOTLIGHT

As projects increase in complexity, the Mining Engineer will have an important role in helping organizations transition and adapt to change. This will require the role to:

- Determine readiness level of business users for upcoming changes and identify readiness gaps
- Plan a series of engagement activities to secure stakeholder commitment to the success of change implementation before introducing the change
- Maintain oversight of change performance against set goals

The future state shift in competency levels worth noting, include:

Artificial Intelligence

Current State	Future State
Beginner – Intermediate – Knowledgeable – Expert	Beginner – Intermediate – Knowledgeable – Expert
• Knowledge of data structures, databases, and programming language • Develops code for data analysis and manipulation	• Knowledge of virtual machines and cloud environment • Analyses the suitability of an algorithm • Deploys AI models through programming

Machine Learning

• Knowledge of reasoning and knowledge representation, and machine learning algorithms • Can extract substantial business insights from data	• Knows how to visualize and manipulate big datasets • Analyzes algorithms that could be used to solve a given problem and can rank them by their success probability

CASE STUDY ENGINEERING

The Mining Engineer

FUTURE STATE ANTICIPATED CHALLENGES

The main challenges facing the Mining Engineer include:

- With the adoption of advanced technologies such as AI, predictive analytics, and 3D modelling, the mining engineer is faced with a divergence in employer expectations.
- According to a recent MiHR report (2020), there is a divide between employers seeking technologically-savvy mining engineers who are data-driven; and other employers placing a stronger emphasis on soft skills such as leadership, communication, and collaboration.
- Emerging from this is a key challenge:
    - In order to effectively and efficiently digitally adapt, industry is required to adopt new technologies, while seeking mining engineers that can complement the technology (through soft skills), while also possess significant digital literacy as it pertains to new tools
    - While mining engineers have a technical background and an existing degree of digital literacy that showcases a potential for transferable skills and knowledge, the talent pool will still require a degree of reskilling.
- While mining and minerals engineering jobs are expected to grow by 7% over a ten year period from 2016-2026, student interest mining engineer roles is not aligned. For example, undergraduate mining engineering program enrollment dropped by 12% between 2015-16, with outlooks into 2020 and beyond reflecting similar trends.

FUTURE STATE DISRUPTION

The level of anticipated disruption for the Mining Engineer is low.

- Digital technologies are already present in this role in the current state, so adoption of new technologies should be characterized by a smooth transition as the baseline is higher than average
- Working conditions may become more flexible, offering opportunities for remote work, however no significant changes are expected

FUTURE STATE PERSONA

Key changes to the Mining Engineer include:

- More of the Mining Engineer's work will become computer-based, therefore the working environment will include more time in an office setting
- The role will entail more project management responsibilities or working closely with a project manager depending on the organization

FUTURE STATE CURRICULA

Examples of upskilling opportunities for the Mining Engineer include:

- Introduction to Predictive Analytics - Understanding basic terms and concepts
- RPA and Digital Mining – Exploring the benefits of RPA in optimizing mine planning & design

CASE STUDY CORPORATE

The Business Analyst

CURRENT STATE PERSONA

I work in one of the following roles:

- Business Development Analyst
- Business Intelligence Analyst
- Business Systems Analyst

My job typically consists of:

- Evaluating business cases for investment proposals, M&A opportunities and other business development and/or strategic initiatives
- Conducts industry, competitor, and commercial analysis to execute business development efforts and identifies new growth opportunities

My demographics are typically:

- Male, aged 30-35
- A digital native
- An undergraduate degree in business, finance or mining engineering
- Minimum 5 years of experience in business analysis in mining industry

A day in my life means:

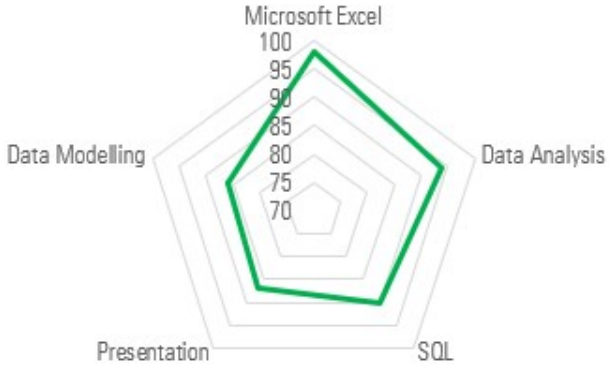
- Working 40 hours a week in an office setting
- Using and communicating via a computer for the majority of the time
- Having a mix of tasks that are routine or unstructured

I work in the mining industry because:

- Competitive pay
- Able to work in a corporate office, located in an urban center
- Career growth opportunities

CURRENT STATE CRITICAL SKILLS

A current state assessment, including the quantitative analysis of 3639 job descriptions, results in the following skills profile:



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

The competency level for each of the critical skills is outlined below:

Beginner — Intermediate — Knowledgeable — Expert

Microsoft Excel

- Proper understanding of the basic concept of pivot table and charts
- Knowledge of the advanced functionalities and integrations
- Automates workbook Functionality
- Creates mapping data

Data Analysis

- Understands phases of logical data modelling, frameworks for and quantitative analysis and data mining techniques
- Defines hypotheses to measure and test
- Implements data analysis processes for organizations

SQL

- Knowledge of operations performed by SQL to optimize databases
- Designs, creates, and implements database systems
- Aware of the importance of formatting source code for its readability and to facilitate maintenance

Presentation

- Prepares content for presentations
- Conducts presentations based on prepared content
- Seeks clarifications and address questions raised by audience

Data Modelling

- Demonstrates mastery of data modeling in practical applications
- Has experience in using a data modeling case tools
- Demonstrates logical data modeling principles for normalizing logical/ semantic data objects
- Demonstrates the ability to view and develop an advanced model

CASE STUDY CORPORATE

The Business Analyst

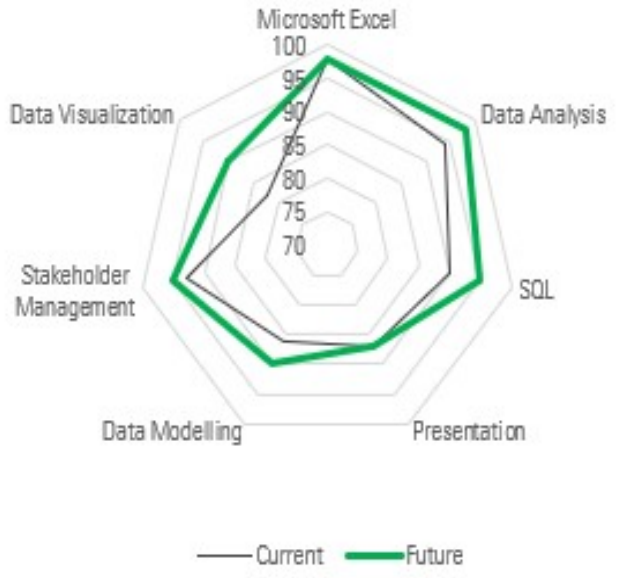
FUTURE STATE SCENARIO

Shifting away from traditional business intelligence methods towards advanced analytics

Current business intelligence practices focus on analyzing past performance in order to guide business planning. Advanced analytics uses past performance data to answer forward-looking questions. Using methods such as predictive and multimedia analytics, advanced analytics can discover undetected patterns . The discovery of and communication of patterns, without defined work by humans, truly expands the horizon of traditional business intelligence.

FUTURE STATE ANTICIPATED CRITICAL SKILLS

A future state assessment, including an analysis of emerging skills and considerations of the future state scenario, indicates greater importance of new and some current critical skills. Changes to the skills profile are geared towards being able to work with increasing amounts of data and the capability to apply advanced analytics.



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

FUTURE STATE SOFT SKILL SPOTLIGHT

The analysis of job descriptions notes stakeholder management as an emerging skill for the Business Analyst.

Due to the number of stakeholders this role would need to engage with for a given initiative, it is important for this role to:

- Understanding principles of conflict resolution, strategic stakeholder engagement and change management
- Supporting stakeholder relations strategies by regularly engaging with stakeholders
- Developing communication strategies to build and maintain successful relationships with key stakeholders

The future state shift in competency levels worth noting, include:

	Current State	Future State
	Beginner — Intermediate — Knowledgeable — Expert	Beginner — Intermediate — Knowledgeable — Expert
Data Visualization	• Knows a range of methods to portray data patterns, trends and correlations • Develops dashboards and scorecards incorporating advanced visualization techniques	• Knowledge of emerging trends and developments in data visualisation • Knowledge of intelligent data dashboard design methodologies and techniques
Data Modelling	• Knowledge of generic data modeling and semantic data modeling • Able to design models that reduce data redundancy and streamline data movements	• Can design logical and/or physical data models for one or more applications • Demonstrates the ability to view and develop advanced models

CASE STUDY CORPORATE

The Business Analyst

FUTURE STATE ANTICIPATED CHALLENGES

The main challenges facing the Business Analyst include:

- The interest in skills and responsibilities associated with business analyst, and business administration related roles is on the rise in the labour market, however, attracting young talent to mining specific business analyst positions remains a challenge
- Women are underrepresented in this role, meanwhile they make up a more significant proportion of graduates in related disciplines year over year. This leaves the mining industry needing to develop talent strategies that attract women to the role, and the industry altogether.
- Young people are also underrepresented in this role, which results in additional challenges related to talent attraction. When young people see themselves represented, they are more likely to apply for positions.

FUTURE STATE CURRICULA

Examples of upskilling opportunities for the Business Analyst include:

- Introduction to Advanced Analytics - Understand basic terms and concepts
- Advanced Analytics & Mining - Exploring use cases of the application of advanced analytics in mining
- Dynamic Dashboards - How to tell a story with big data

FUTURE STATE DISRUPTION

The level of anticipated disruption for the Business Analyst is low to medium.

- Digital technologies and skills are already heavily embedded in this role
- Being a digital native will support upskilling efforts, however, programming skills may take time to develop
- There are no significant changes in working conditions

FUTURE STATE PERSONA

Key changes to the Business Analyst include:

- Role may transform into or may work very closely with a Data Scientist
- Training or formal education in computer programming will be seen as desirable
- Ability to learn and work with advanced analytics will become a factor in attracting and retaining top talent

CASE STUDY BACK OFFICE

The Information Technology Manager

CURRENT STATE PERSONA

I work in one of the following roles:

- Information Technology Manager
- Technology Manager
- Network Manager

My job typically consists of:

- Managing the IT department operational and strategic planning, including business requirements, project planning, organizing and coordinating the allocation of resources
- Leading all software implementations and deployments as required, including enhancements to existing systems

My demographics are typically:

- Male, aged 35-40
- An undergraduate degree in computer sciences, IT, or engineering
- Minimum 2 years experience in a managerial position
- Minimum 5-7 years experience in IT management, ideally in the mining industry

A day in my life means:

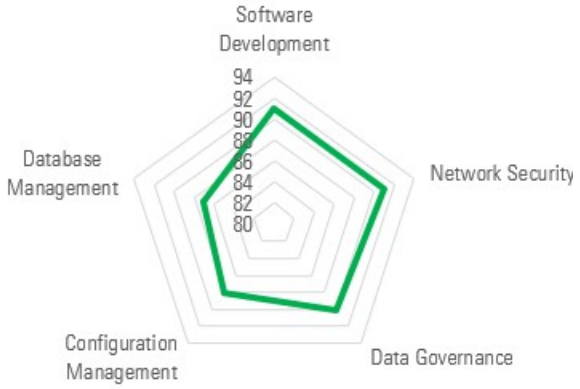
- Working 40 hours a week, primarily in an office setting
- Responsible for planned IT shutdowns and system maintenance, and monitoring, managing, and determining systems functionality, and information system requirements

I work in the mining industry because:

- Opportunities to apply IT approaches to unique remote locations
- Opportunities to help shape, and work with new technologies
- Competitive pay
- Career growth opportunities

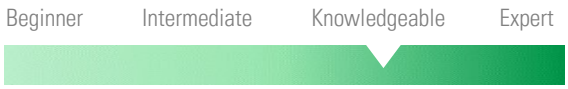
CURRENT STATE CRITICAL SKILLS

A current state assessment, including the quantitative analysis of 621 job descriptions, results in the following skills profile:



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

The competency level for each of the critical skills is outlined below:



Software Dev.

- Knowledge of software development life cycle models for applications and concepts like data structures and algorithms
- Adds new application components or features
- Creates project plans to guide the application development process

Network Security

- Knowledge of network security best practices and emerging trends
- Understands key compliance and threat intelligence topics
- Knowledge of cybersecurity tools including data protection, end-point protection and systems and network fundamentals

Data Governance

- Understands impact of poor data quality and strategies to mitigate poor data practices
- Investigates data breaches and identifies corrective actions for data breach or potential data misuse scenarios

Configuration Mngt.

- Knowledge of components and process of configuration management audits and change control policies & processes
- Oversees program configuration change controls

Database Mngt.

- Understands best practices and emerging trends for data management, and relevant technologies
- Leads the implementation of data management technologies for the organisation
- Reviews data management technologies against business needs

CASE STUDY BACK OFFICE

The Information Technology Manager

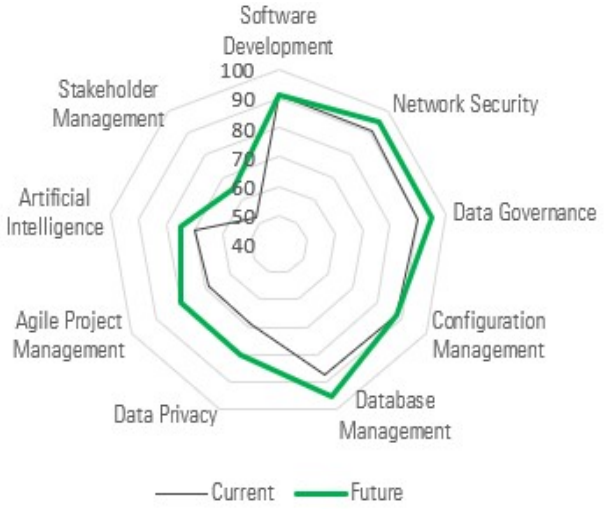
FUTURE STATE SCENARIO

Closing the transmission gap to improve remote (system) interoperability

The increasing emphasis on underground safety in mining has spurred innovation and the search for a strengthened role of digital mines. The design of new systems that both adopt new technologies and address safety concerns is vital, and will evolve to include technologies such as edge computing, or mobile edge computing, and operations design around the internet of things. The emerging responsibilities for the IT manager around edge computing is premised on the importance of ensuring remote operations are functioning correctly and efficiently. This new technology helps to transform remote operations and mine maintenance by circumventing the need to access cloud-stored state to make key decisions. It provides real-time data, and sits closer in proximity to the equipment it is operating on which addresses transmission latency experienced in conventional data computing methods. In this way, the digital scenario affiliated to the IT manager is complementary to other digital evolutions occurring across the Mining and Minerals value chain.

FUTURE STATE ANTICIPATED CRITICAL SKILLS

A future state assessment, including an analysis of emerging skills and considerations of the future state scenario, indicates greater importance of new and some current critical skills. Changes to the skills profile are geared towards being able to work with increasing amounts of digital projects, networking opportunities, data and cybersecurity threats.



Criticality Score: 30 to 50 = Good to Have, 51 to 100 = Must Have

FUTURE STATE SOFT SKILL SPOTLIGHT

As the rise of digital trends continues, the IT Manager will have an important role in helping organizations plan and implement new technologies using Agile Project Management. This will require the role to:

- Demonstrates proficiency in applying agile methodologies for project management without support from others for moderate to difficult tasks

The future state shift in competency levels worth noting, include:

Database Management

Current State: Beginner – Intermediate

- Understands best practices and emerging trends for data management
- Leads the implementation of data management technologies for the business

Future State: Beginner

- Defines physical database design specifications
- Devises risk mitigation plans for the adoption of new data management frameworks

Network Security

- Knowledge of network security best practices and emerging trends
- Understands key compliance and threat intelligence topics

- Responsible for network security requirements as per business needs
- Able to facilitate installation and maintenance of network security systems

CASE STUDY BACK OFFICE

The Information Technology Manager

FUTURE STATE ANTICIPATED CHALLENGES

The main challenge facing the Information Technology Manager is:

- Given the presumed transferability of skills and knowledge among the IT manager role in its the anticipated challenges emerging with the emerging importance of edge computing and IoT will pertain primarily to the attraction of diverse talent, and ensuring that training is accessible and amenable to both workers' digital literacy levels (i.e. differentiated), and the organization's desired learning schedules.

FUTURE STATE CURRICULA

Examples of upskilling opportunities for the Information Technology Manager include:

- Edge Computing and Remote Mining – How Mobile Data can Improve our Safety
- Introduction to the Internet of Things – Connecting Systems & Digitizing Mines

FUTURE STATE DISRUPTION

The level of anticipated disruption for the Information Technology Manager is low.

- This is due to the presumed level of digital literacy that exists in the current state
- There are no significant changes to working conditions

FUTURE STATE PERSONA

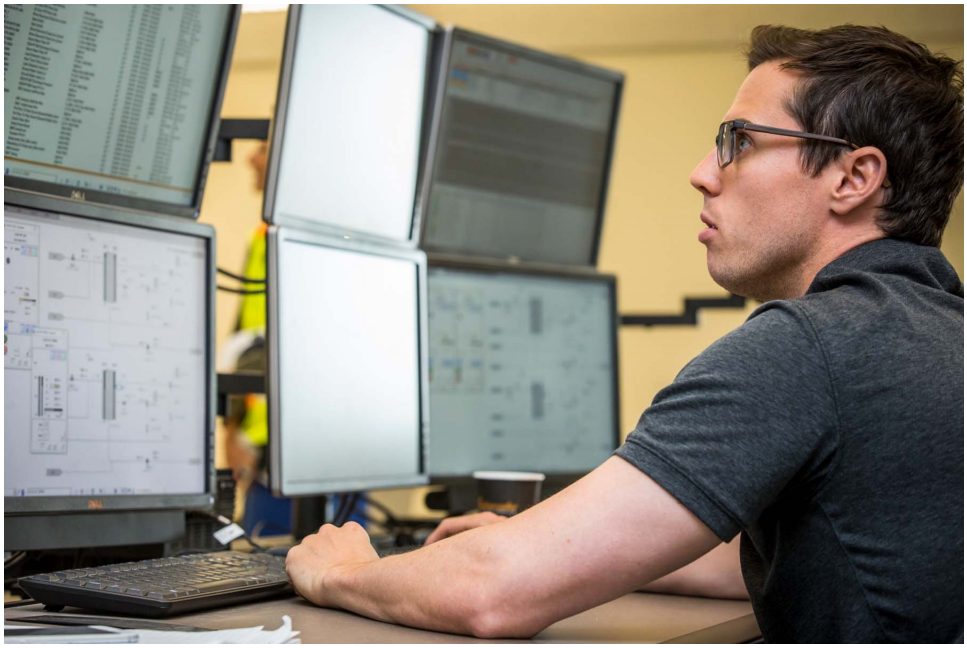
Key changes to the IT Manager include:

- The role will entail more project management responsibilities or working closely with a project manager depending on the organization
- The role will include working with leading mining technologies

SECTION 4 DIGITAL SKILL JOURNEY

DIGITAL SKILL JOURNEY INTRODUCTION

The digital skill journey seeks to outline opportunities and principles that can serve as a reference point for readers and they think through, and develop strategies to adapt to the changing skills landscape both in Canada, and in Saskatchewan. Emerging from our research, both primary and secondary, we were able to identify three key 'principles for success' that act as the foundational elements needing address in order to successfully plan for the future. This is based on the gap assessment, and the identified emerging skills, as they relate to the overarching operating context of the changing world of work.



Courtesy of K+S

Foundational Principles for Success:

1. Digital inclusion policies and programs to provide vulnerable workforce (older groups, indigenous peoples, etc.) segments with opportunities to learn digital skills and reduce the digital divide in the workforce (for example, in ICT)
2. Partnerships in planning for the future. The future is characterized by constant flux. While we may anticipate the skills of the future based on our knowledge and data today, contexts will continue to change, and will require flexible but robust partnership models to support shits in labour market preparation and planning
3. Alternative and innovative learning. Given the various inputs driving the changing nature of our working world, we need to think innovatively about the way knowledge is disseminated in society

DIGITAL SKILL JOURNEY TRIPARTITE RELATIONSHIPS

The case studies sections above demonstrates the impact of digitization on the Saskatchewan mining and minerals talent and labour ecosystem. There are several emergent skills across the six roles analyzed that will require upskilling and reskilling strategies to support digital enablement across industry actors.

The anticipated gap in digital-related skills is, expectedly, exacerbated by the current state of tri-partisan relationships (and the lack thereof) primarily between universities or polytechnics, and industry. The role of the education system in cultivating the labour force of the future is invaluable. The role of industry partners such as schools and universities goes beyond just skill development, they also serve to increase career awareness, mining and mineral industry value proposition awareness, and therefore increase inflow of talent to the industry where needed.

SECTION 4 DIGITAL SKILL JOURNEY

DIGITAL SKILL JOURNEY TRIPARTITE RELATIONSHIPS

The shortage of talent witnessed at this point in time, and that has served to add layers to the challenge of digital skills gap is the reflection of a lack of pro-active planning over the course of the last decade. This is due to the cycle of education, and the rate at which talent and skills are produced. What this means is that in order to prepare for the next five years of skills needed, the industry needs to act promptly in order to ensure that students entering the higher education system are geared towards the industry, proactively.

Given bureaucratic considerations around curriculum development and changes, it is important to take these actions sooner, rather than later.

Key Benefits of a Robust and Responsive Partnership Structure with Universities and Polytechnics:

1. Strengthened curriculum alignment with overarching labour market needs, with focus on industry-specific needs based on programs in question
2. Universities play a key role in cultivating interest in industries. Partnership creates overarching career awareness and interest by the respective student body
3. Partnerships between universities and/or polytechnics and industry create pathways for employment for the student body, driving interest and confidence in the choice of selecting a mining-related educational program

DIGITAL SKILL JOURNEY TRAINING

The unprecedented social turbulence caused by COVID-19, the worst recession in a century, and a global reckoning over [systemic injustice] has added a sense of urgency to the development of alternative pathways to career and life success

Paul Fain, Inside Higher Ed, 2020

Labour shortages facing the mining and minerals industry are significant in the current day. On average, based on average graduation rates, an educational institution can attract and develop talent every 5-6 years, which leaves the industry in a position requiring unique and alternative solutions to workforce planning.

Current contexts because of COVID-19 have resulted in a heightened interest in short-term, flexible learning programs that allow workers to access materials online and improve skills based on their individual interest, their company's interest, and more importantly, on their independent timelines.

SECTION 4 DIGITAL SKILL JOURNEY

DIGITAL SKILL JOURNEY TRAINING

Online and hybrid education is rapidly increasing, with the pandemic accelerating this interest due to the majority of the population required to stay indoors, universities who have been historically reluctant to partner, or to develop digital capabilities for delivering lessons and programs are witnessing an uptake in exactly these things. This means that non-traditional programs can expect to see growth in interest from an institutional and student body perspective. New educational business models are creating additional opportunities for partnership, allowing the mining industry to take advantage of an innovative opportunity to solution for workforce needs. For example, a recent report highlighted how corporate partnerships with higher education on curriculum design for short-term credentials are projected to expand, as educational bodies begin focusing more on their value propositions and fostering graduates that are attractive to potential employers.

The information technology industry, with leading companies such as Google, Facebook, IBM, Salesforce, and Microsoft are all beginning to implement alternative credential acceptance models based on certificate programs hosted and developed internally. Some companies are even going as far as foregoing degree requirements as a prerequisite to employment, resulting in a wider labour and talent pool and increased access to employment for members of society unable to access university or college degrees.

The opportunity that current labour market, public health, and socio-economic contexts offer point to the potential of micro-credentialing as an alternative approach to learning that aligns with the increasing relevance of hybridized education, while helping the mining industry better meet its workforce needs.

Micro-Credentialing

The structure for micro-credentialing programs is emergent, and therefore variable and open to innovation and development. At the moment, it can look like any of (but is not limited by) the following examples:

1. MicroHe: A think tank in the EU who has acted as a steward championing the importance and relevant of micro-credentialing. They have successfully partnered with government and provided policy guidelines to EU states and organizations as they develop micro-credentialing programs.
2. Queensland, Australia: a government launched program geared at fostering tri-partite relationships to develop relevant, responsive, and flexible curriculums. Partnered with the TAFE, Queensland's largest training provider, several Universities, and the Foundation for Young Australians to develop micro-credentials for businesses, employees, job-seekers, etc. through a series of short-courses
3. The New Zealand Qualifications Authority (NZQA): Initiated several pilot projects with several organizations to test and develop a micro-credentialing system

SECTION 4 DIGITAL SKILL JOURNEY

DIGITAL SKILL JOURNEY TRAINING

The opportunity presented for micro-credentialing is based on series of factors that have successfully impacted both the current talent pool, and the future one. In order to adapt and effectively respond to changing labour market needs, worker expectations, and socio-economic responsibilities, industry, education, and government must respond appropriately.

By providing alternative ways to access career and life success, micro-credentialing can allow the mining and minerals industry to align itself with cutting edge organizations such as Google and Facebook, increasing its value proposition, while also addressing the gaps that it currently faces.

Some Key Benefits of Micro-Credentialing

- Increased alignment between industry and labour market on skills
- Flexible (and accessible) learning structures
- Responsive curriculum
- Supports disruption mitigation objectives facing indigenous communities

DIGITAL SKILL JOURNEY SUMMARY OF RECOMMENDATIONS

Based on the findings, the following recommendations should be considered to support the workforce of the future:

Tri-Partite Collaboration

A mechanism to facilitate collaboration and alignment should be explored to create programs that promote career awareness, ensure students are provided with the appropriate skillset and level of experience prior to graduating. Additionally, efforts should be spent developing programs geared towards career awareness in elementary, secondary and post-secondary institutions in order to develop a robust interest in mining careers for years to come.

Micro-Credentialing

By enabling improved and innovative partnerships between educational institutions and mining organizations, the industry can move beyond conventional curriculum towards nimble educational strategies. Micro-credentialing programs would allow for the development of a modern curriculum to meet the needs of variety of stakeholders and emerging technologies.

REFERENCES

Fain, P. (2020, August 27). Interest spikes in short-term, online credentials. Will it be sustained? Retrieved from https://www.insidehighered.com/news/2020/08/27/interest-spikes-short-term-online-credentials-will-it-be-sustained

Fell, R. (2018). *Accelerating geological exploration using advanced technologies such as AI*. Lecture presented at Prospectors & Developers Association of Canada Convention.

Gallagher, R. (2013, August 30). Personal communication. Vancouver)

MiHR. (2018). *Canadian Mining Labour Market Outlook 2019* . Retrieved from https://mihr.ca/wp-content/uploads/2020/02/NationalOutlook2019_EN_Final-Chap3Fix.pdf

MiHR. (2018, November 16). Canadian Mining Labour Market Outlook Presents Picture of Industry in Recovery - MiHR: Mining Industry Human Resources Council. Retrieved from https://mihr.ca/news/canadian-mining-labour-market-outlook-presents-picture-of-industry-in-recovery/

MiHR. (2020). *The Changing Nature of Work: Innovation, Automation and Canada's Mining Workforce* . Retrieved from https://mihr.ca/wp-content/uploads/2020/05/MIHR_Innovation_Report_EN_WEB.pdf

Natural Resources Canada. (2019, January). Government of Canada. Retrieved from https://www.nrcan.gc.ca/maps-tools-publications/publications/minerals-mining-publications/minerals-sector-employment/16739#s4

Statistics Canada (2017, February 8). Census Profile, 2016 Census. Retrieved from https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E