HONEYWELL FORGE

YOUR JOURNEY TO INTELLIGENT, AUTONOMOUS OPERATIONS

Empower Your Smart Mining
And Mineral Operations

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INTRODUCTION

The mining and metals industry must apply digital transformation to a reality of delivering against new societal and shareholder obligations. Mining industry leaders are transforming the way their sites operate to become safer, more sustainable, and more productive.

Profitable improvement through digitalization is part of an overall journey to ultimately attain intelligent, autonomous operations in the future. A vision of this future state can encompass a combination of the solutions below, but the basis of any digital initiative should include practical data digitalization and an interoperable but cybersecure foundation. A move toward intelligent autonomy requires industrial grade software to provide greater intelligence, reliability, and trust.

Technology Enablers for Autonomous Operations

- Artificial intelligence (AI) and machine learning (ML)
- Digital twins to enable deep learning
- Cybersecurity foundation
- Integration with robots, drones, and machines
- Cloud and edge execution
- Open and interoperable systems

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CHALLENGES AND TRENDS IN THE MINING INDUSTRY

The mining industry continues to be challenged by familiar problems. A variety of business trends will continue to shape the future.

The ability of a company to utilize new technologies and advancements to help keep workers safe, reduce their environmental footprint, and meet production targets will be critical for long-term growth and success.

1. **THE NET ZERO ECONOMY WILL BE METAL-INTENSIVE**
   Mining companies will need to focus on reducing their environmental footprint while meeting the increased demand for raw materials brought on by the energy transition.

2. **LABOR SHORTAGES AND SKILL GAPS**
   Companies are forced to find new ways to attract and retain talent. better ways are needed to reduce training time and capture knowledge from existing experts.

3. **LICENSE TO OPERATE IS PARAMOUNT**
   Mining's contribution to surrounding communities will not only help strengthen their brand, but also impact access to resources, capital and debt.

4. **SUSTAINABILITY PRESSURES ARE INCREASING**
   Greater efficiency can improve both energy and emissions from equipment.

5. **OPERATIONAL AND PRODUCTIVITY CHALLENGES**
   Siloed operations and inefficient processes restrict the ability to efficiently operate. End-to-end optimization of people, processes, and assets can help reduce inefficiencies and maximize production.

73% of companies identified skills gaps in the local labor market as the biggest barrier to the adoption of digital technologies (2)

450% increase in demand expected for lithium, cobalt, and other metals critical for the energy transition. (1)

20% risk of displacement for mining and metals workers (compared to 14.2% in oil and gas, and 11% in food and beverage). (2)

77% of mining companies have set net-zero targets for scope 1 and 2 emissions by 2050. (1)

Quality of existing ore bodies continues to degrade while demand for raw materials increases. (3)

1. **https://www2.deloitte.com/uk/en/pages/energy-and-resources/articles/the-net-zero-workforce-mining-and-metals.html**
2. **https://www.weforum.org/agenda/2021/05/7-insights-mining-industry-prepare-workforce-future/**
3. **https://www.mining-technology.com/analysis/the-tipping-point-large-scale-challenges-for-the-mining-industry/**

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SMART DATA DRIVEN APPROACH

Digital imperatives driving technology advancement in the mining and minerals industry include safety, sustainability, people enablement, margin predictability, and reliability to reduce unplanned downtime.

From mining, to concentration, through smelting and/or refining, next-generation digital solutions help increase mineral recovery and consistent quality, maintain process stability and availability, and improve safety and profitability. A holistic, integrated data-driven approach alleviates challenges caused by siloed solutions.

Even ancillary operations involving utilities and water management and treatment can benefit from a smarter, more digitalized framework.

1 | **SAFETY CONTINUES TO BE A HUMAN NEED AND BUSINESS RISK**

2 | **SUSTAINABILITY DEMANDS A SHIFT TO PROTECT PEOPLE AND THE ENVIRONMENT**

3 | **PEOPLE ENABLEMENT FOR ENSURING INCLUSIVE GROWTH IS A BUSINESS AND SOCIETAL NEED**

4 | **MARGIN PREDICTABILITY WITH MARKET VOLATILITY MAKES IT DIFFICULT TO INVEST TO TRANSFORM**

5 | **RELIABILITY WITHOUT UNPLANNED DOWNTIME IS A CHALLENGING GOAL**

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PROCESS OPTIMIZATION

The end-to-end mining process is comprised of highly interactive individual process units. Operation of each unit can constrain total production, and all jointly influence inventories. Maintaining operational stability and maximizing production remains a challenge without an overarching solution to continuously coordinate and optimize site-wide operations and inventories.

Real-time end-to-end optimization should encompass the entire site-wide set of processes as a value chain. Optimization should coordinate supply chain constraints for operational changes, dynamically adapt to new operating envelopes, and ensure dynamic solution feasibility for maximum production and enhanced stability. It closes the gap between planning and execution, drives enterprise decision making in real-time, and enables autonomous operations.

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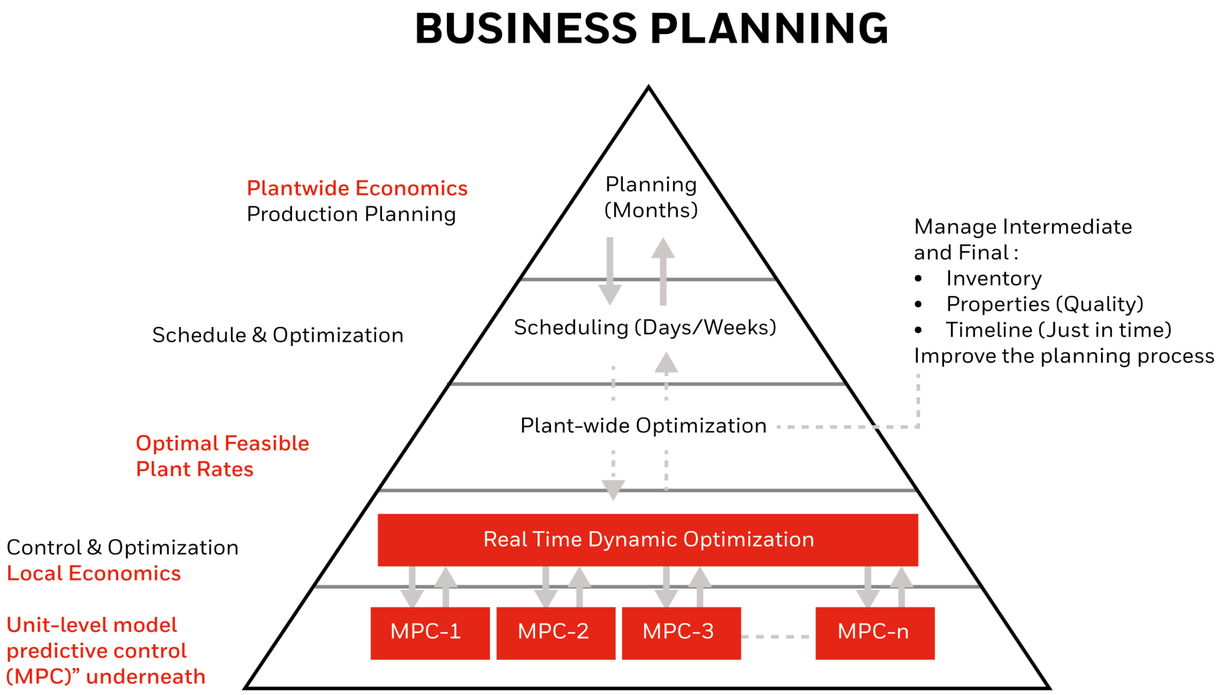
Leveraging artificial intelligence (AI), machine learning (ML) and digital twins, end-to-end optimization unlocks additional margin opportunity as it:

- Closes the gaps between various organizational silos responsible for optimization
- Maintains consistency between various optimization layers autonomously – from the unit level to site-wide coordination
- Reduces skills needed to sustain optimization benefits
- Responds to dynamic changes at a higher frequency, thereby increasing the opportunities for optimization



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EQUIPMENT RELIABILITY

Reliability solutions such as asset performance management (APM) deliver information about equipment health, plus predict failures so there is time to conduct maintenance and mitigate potential problems to avoid unplanned downtime. This APM software can provide insights so that equipment performance can be optimized over time, using AI/ML to deliver the best possible overall equipment effectiveness.

A complete reliability plan should consider assessments and asset strategy, a comprehensive product portfolio, through final program delivery and benefits realization.

From mining and comminution to flotation, thickening, filtration, and further processing, risk-based asset management can

- Monitor equipment health
- Accelerate time to value
- Predict potential time to failure
- Reveal opportunities for performance improvement
- Improve energy and emissions performance through efficient operations

HEALTH MONITORING

Machine Learning Modules & Rule-based diagnostics

PERFORMANCE OPTIMIZATION

Predictive Performance & Energy Calculations

MAINTENANCE STRATEGY

Risk & Cost Reduction

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WORKER PRODUCTIVITY AND COMPETENCY

A connected workforce can help companies to be competitive and keep safety practices heightened. Digital technology is transforming the way field personnel operate by empowering them to work smarter and safer.

Productivity solutions such as 1. digital inspection rounds and remote assistance software, in addition to 2. competency solutions incorporating simulation-based training, are important to day-to-day safe and efficient operations.

These digital workforce solutions support initial training, process and new equipment installation and commissioning, process validation and testing, audits, inspections, maintenance and repair activities, and ongoing training and process optimization.

THE COST OF LOW PRODUCTIVITY[1]

$47M

ANNUAL LOSS ASSOCIATED TO LOW WORK PRODUCTIVITY[1]

60%

Employees Have Difficulty Getting Relevant Information To Get The Job Done

5.3 Hrs/ Week

Average Time Waiting for Actionable Information

81%

Employees Frustrated Due To Lack of Access To Information

[1] Panopto Workplace Knowledge and Productivity Report

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Digitization standardizes the process workflow, helping to increase efficiency and minimize errors. “Over-the-shoulder” collaboration sessions with audio, shared live camera views, and contextual information provides the most relevant collaboration environment to support on-the-spot decision-making.

Integrated, holistic training approaches enable organizations to plan, deploy and manage training with relatable, accurate experiences crucial to teaching infrequent and high-consequence procedures, responding to abnormal situations, and optimizing and improving plant performance.

Digital workforce solutions can drive:

- Data integrity
- Real-time information
- Continuous improvements
- Increased learning, mentoring and knowledge retention
- Feedback of information back into systems for quality and work execution management

THE COST OF HUMAN ERRORS[2]

80-90%

INDUSTRIAL ACCIDENTS ATTRIBUTED TO HUMAN ERRORS

PRODUCTION HALTS

MAINTENANCE COSTS

EXPENSIVE FINES

LOSS OF REPUTATION

[2] Society of Petrochemical Engineers (SPE); Accenture – How The Human Factor Can Make Or Brake Growth

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SAFETY AND OPERATIONAL EXCELLENCE

Implementing and sustaining Safety and Operational Excellence practices can yield meaningful improvements in productivity, efficiency, safety and sustainability. Achieving these improvements will require a strong foundation across key areas including safety, operations management, production management & execution, as well as data collection, analytics, and reporting. With effective tools and procedures in place, mining operators are also empowered to achieve improvements in cost management, facilitate safety compliance and environmental regulatory requirements, and scale systems across a range of equipment.

Mining and minerals processing operations can safely reduce costs, maximize throughput and optimize energy usage through advanced analytics. Effective monitoring and control of health, safety and environmental variables; accounting and reconciling metal balances; and analysis of deviations from planned values are essential to Safety and Operational Excellence.

Process and equipment efficiency can benefit from:

- Digital Transformation – smart mineral processing operations
- End-to-End Metal & Consumable Balances – accounting and reporting, composition tracking
- Anywhere Remote Operations - remote and agile worker safety, training and productivity
- Reduced Energy Utilization - lower costs

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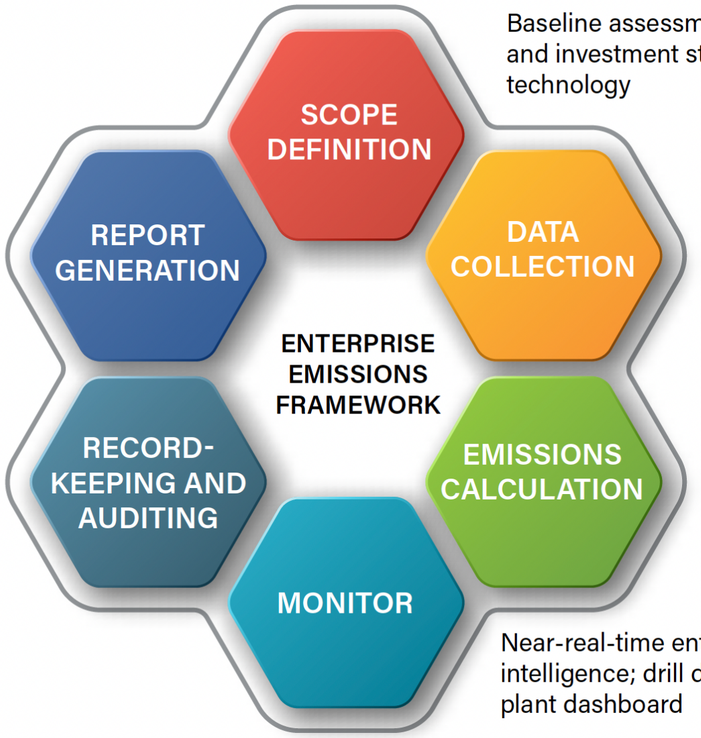
ENERGY AND EMISSIONS PERFORMANCE

Meeting environmental, social and governance (ESG) goals are increasingly important to corporate sustainability and decarbonization initiatives. Point solutions, manual reporting, and distributed emissions sources create challenges in maintaining a system of record that is transparent and supports operational improvements and audit compliance.

The solution is to implement an enterprise-wide, end-to-end scalable solution to optimize energy and emissions accounting. In addition, efficient energy usage improves both emissions and optimization of production processes. Both process optimization as well as equipment performance solutions can help to prevent operational losses and achieve improved equipment effectiveness, thereby decreasing energy use and emissions through more efficient operation.

Resulting benefits include:

- Near real-time process and fugitive emissions data and reporting
- Closed-loop energy optimization
- Improved compliance with corporate initiatives and regulatory standards



Baseline assessment; determine risk and investment strategy for green technology

Identify and categorize GHG emissions sources

Collect data and calculate and quantify emissions

Near-real-time enterprise-wide visual intelligence; drill down to site-wide and plant dashboard

Maintain a complete history of records created, modified, maintained, archived, retrieved, or transmitted

Generate environmental compliance report for mandatory and voluntary disclosure

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CONCLUSION

The most important part of the journey is to ensure acceptance of and engagement with new digital transformation tools. Personnel should feel comfortable and enabled by new solutions, rather than intimidated by operational changes. The right integrator can tailor a value-based roadmap to implement new technology, ensure understanding through training, and ensure that an enterprise is benefitting from updated software and data.

Honeywell's vision is to help you profitably improve safety, sustainability and productivity on your journey to intelligent, autonomous operations. Start your journey by consulting with experienced professionals with both industrial software and domain expertise who can prescribe an overall digital strategy to fit your needs.

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THE FUTURE IS WHAT WE MAKE IT.

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