Rockwell Automation

Enabling the **connected mine**

Rockwell Automation process solutions for mining

BEGIN

The world **needs mining**

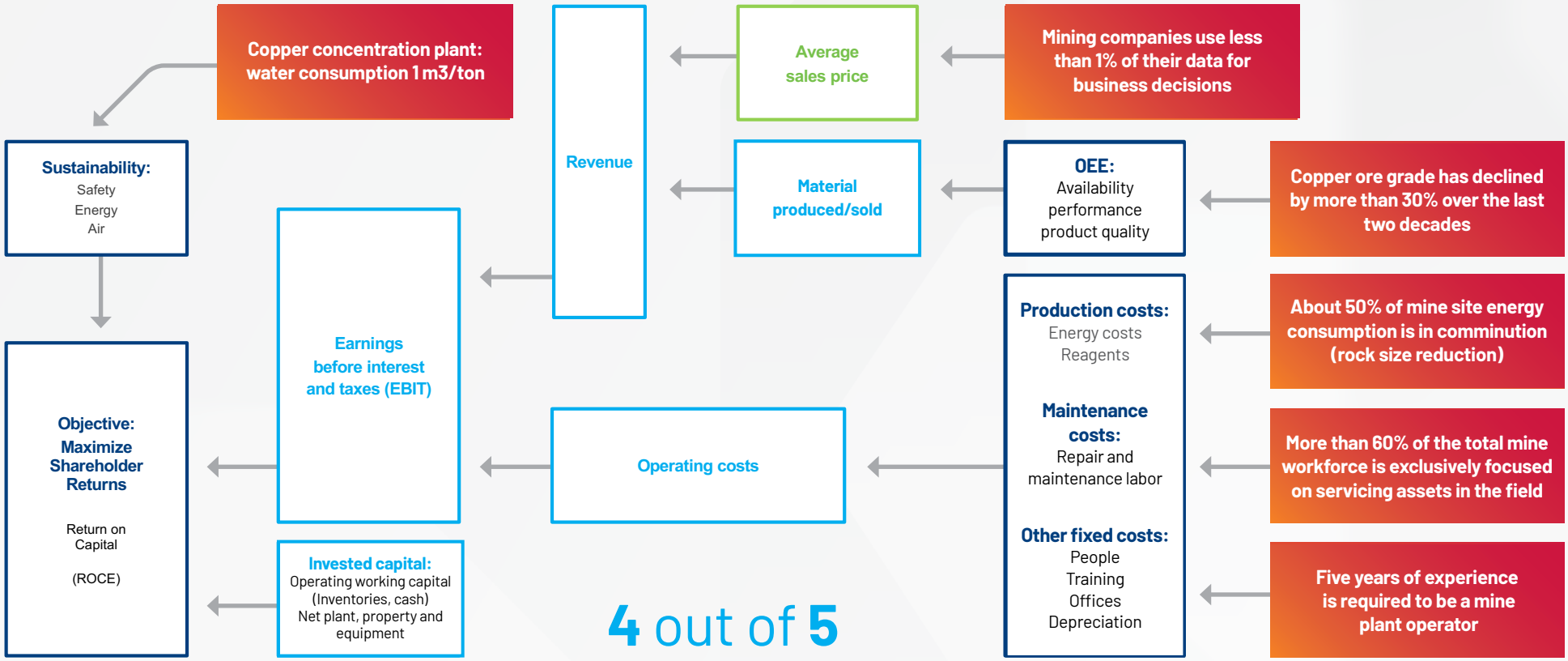
THE MINING INDUSTRY IS FACING:

- Market volatility (macro-economics, geopolitical)
- Ever-evolving legal, governance and operating risk issues/regulations
- Shareholder return (cash optimization, pay debt)
- Changing workforce demographics

The world is seeing incredible changes that require resource-intensive goods of all sorts. Overall population is growing and shifting to urban areas. The middle class is expanding, infrastructure development is increasing and with this growth comes a need for resources. Metals like iron, copper, aluminum and nickel will be in much higher demand. In addition, the quest for a less carbon-intensive future has spurred growth in electric vehicles — and lithium, magnesium, cobalt and other minerals used in battery production. Likewise, bigger and better energy storage batteries are flooding the marketplace to support wind, solar and other clean sources of power. Our world is changing before our eyes, and these changes must be met through the support of mining.

Operational challenges

and how they affect mine profitability



4 out of **5**

mining projects are completed late with budget exceeded by an average of 43%

Source: Codelco, Cochilco, Mining Global, Core, McKinsey & Company

Operations use cases
are top priority for digital transformation in mining

THE NEXT THREE YEARS
process and assets

58% Increase throughput

53% Enhance traceability

53% Improve compliance and data integrity

53% Increase equipment reliability and reduce unplanned downtime

50% Improve yield

BEYOND THE NEXT THREE YEARS (DIGITAL)
supply chain and workforce

47% Achive supply chain integration and visibility

44% Improve workforce productivity

44% Improve compliance and data integrity

Source: Executive Perspectives: Digital Transformation in Industry study, Fall 2019

The connected mine

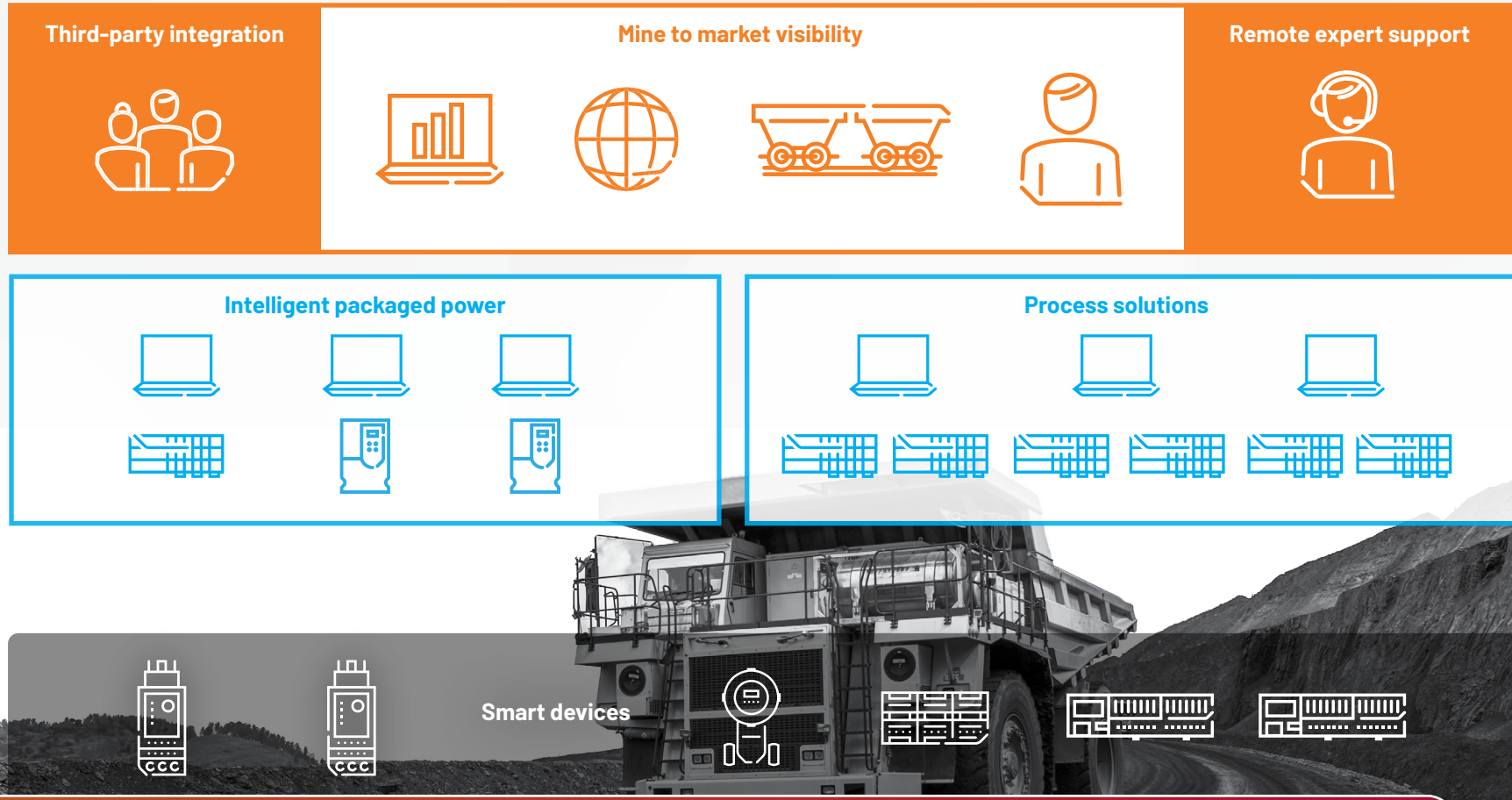
turns data into business decisions

When you collect, aggregate and analyze data across operations, you can spot trends and interdependencies that are missed when data lives in silos. With this type of information, you can make more informed decisions.

Connected workforce
Modern digital tools help deliver better insights and improve field experience

Knowledge-driven operations
Solutions that enable better decision-making

Operational efficiency
Modern technologies improve performance of process, equipment, and people

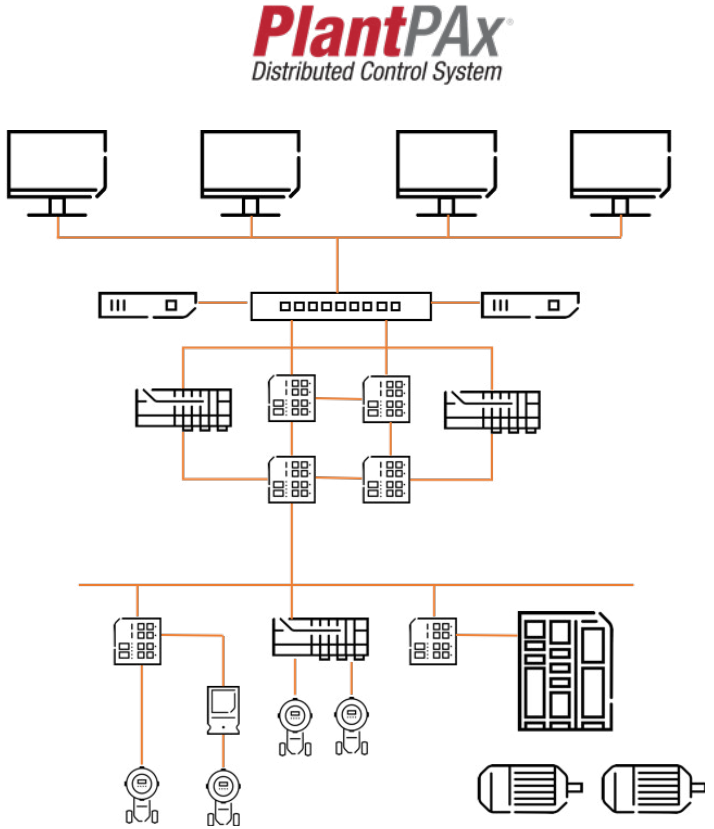


Process solutions

PlantPAx®: The modern DCS for mining applications

Miners have a lot to keep track of. Energy management, asset management and machine and process safety are just a few. PlantPAx DCS is the core system to help you achieve your production goals in a smart way, combining several disciplines in a unified system:

- System architecture
- Control and I/O
- Networks and virtualization
- Engineering
- Operations
- Field device integration
- Asset management
- Batch management
- Information/Production intelligence
- Machine safety
- Process safety
- Model predictive control
- Cybersecurity



<1%

of project capital cost comes from the control system, but it is the core of your production

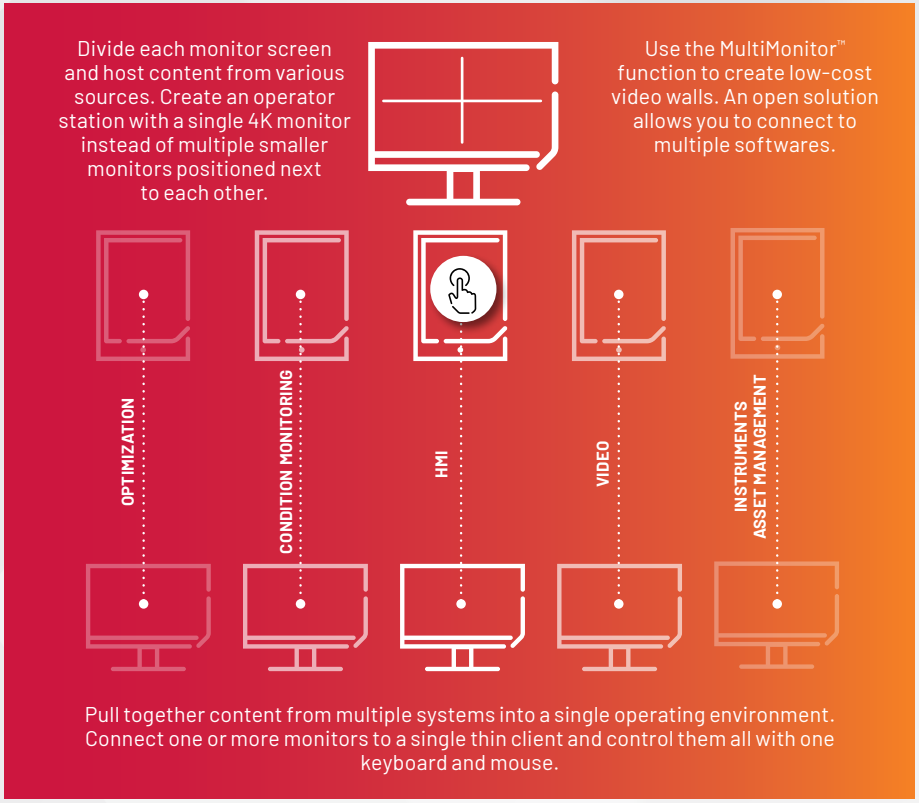
SOLUTION AT A GLANCE

Integrated visualization

Link content to the terminal by geolocation. Only allow access to screens for the electrical panels from inside the electrical room.

Prevent operator errors by only allowing access to relevant content. Enhance security by requiring operators to log in with fingerprint ID or a retinal scan.

Accessible through cell phones and tablets to enhance employee mobility.



Process solutions

Process solutions benefit each application area of your mine

- Comminution
- Concentration plant
- Pyrometallurgy
- Material handling
- Compressors
- Mine electrification

Comminution

Energy efficiency, reduced maintenance costs, extended equipment life

Get the most of your LV/MV motors with a unified process and motor control approach for design productivity, safety, visualization and predictive analytics. Optimize your crusher and mill application with **integrated** solutions for model predictive control.

Variations in feedstock hardness, grade and rock size lead to fast and frequent disturbances

Concentration plant

More throughput, better recovery, less variability — all while minimizing use of consumables

Our flexible process control platform can address all ranges of plant sizes and includes powerful and seamless integration from field instrumentation and third-party devices up to operator level (enhancing productivity).

Integrated model predictive control (flotation and thickener optimization) helps operators make better decisions.

Variability is minute by minute and processes are complex and hard to optimize with many recirculating loads

Delivering ore ahead of schedule and at a lower cost

USE CASE

Mine-wide process control system

Standardizing operation and control across process areas: Iron ore mining, Brazil

The control system is split in four parts: the mine and the concentration plant, the pipeline, the filtration plant, and the port.

The control system has more than 20,000 instruments and is connected with 800 motors. Of these, more than 1500 intelligent instruments are connected to the system via PROFIBUS PA or HART.

A modern asset-management system, implemented in all parts of the distributed control system, facilitates the parameterization of intelligent instruments.

An enhanced alarm system allows operators to identify problems and act quickly to solve them.

Powerful reporting capabilities including water management, production vs. energy consumption, management of motor use, along with others, **allow for optimal resource use.**

At the end of the project, the user made its **first shipment of ore ahead of schedule** and at a lower cost than estimated.

Model predictive control

Controller-based or software

Crusher

CHALLENGES

- Poor level control in the secondary and tertiary crushers
- Inability to keep secondary and tertiary crushers choked to maximize efficiency and minimize wear
- Loss of throughput
- Frequent shutdowns
- Poor balancing of secondary and tertiary crushers

POTENTIAL BENEFITS

- **Increase** throughput by 2%
- **Increase** efficiency by 5%
- **Decrease** equipment wear by 5%

Grinder

CHALLENGES

- Oscillatory behavior and deviation from setpoint
- Poor control of product quality (size)
- Reduced throughput due to constraints
- Unnecessary mill wear (steel-on-steel)
- Mill not running at maximum energy efficiency

POTENTIAL BENEFITS

- **Maintain** product quality (size)
- **Increase** throughput by 2%
- **Decrease** energy usage by 2%
- **Decrease** maintenance cost by 2%

Flotation

CHALLENGES

- Poor control of concentrate grade
- Lack of metal recovery control
- Excessive use of reagents

POTENTIAL BENEFITS

- **Maintain** concentrate grade to reduce product give-away or off-spec by 3%
- **Increase** metal recovery by 2%
- **Reduce** reagents by 3%

Thickener

CHALLENGES

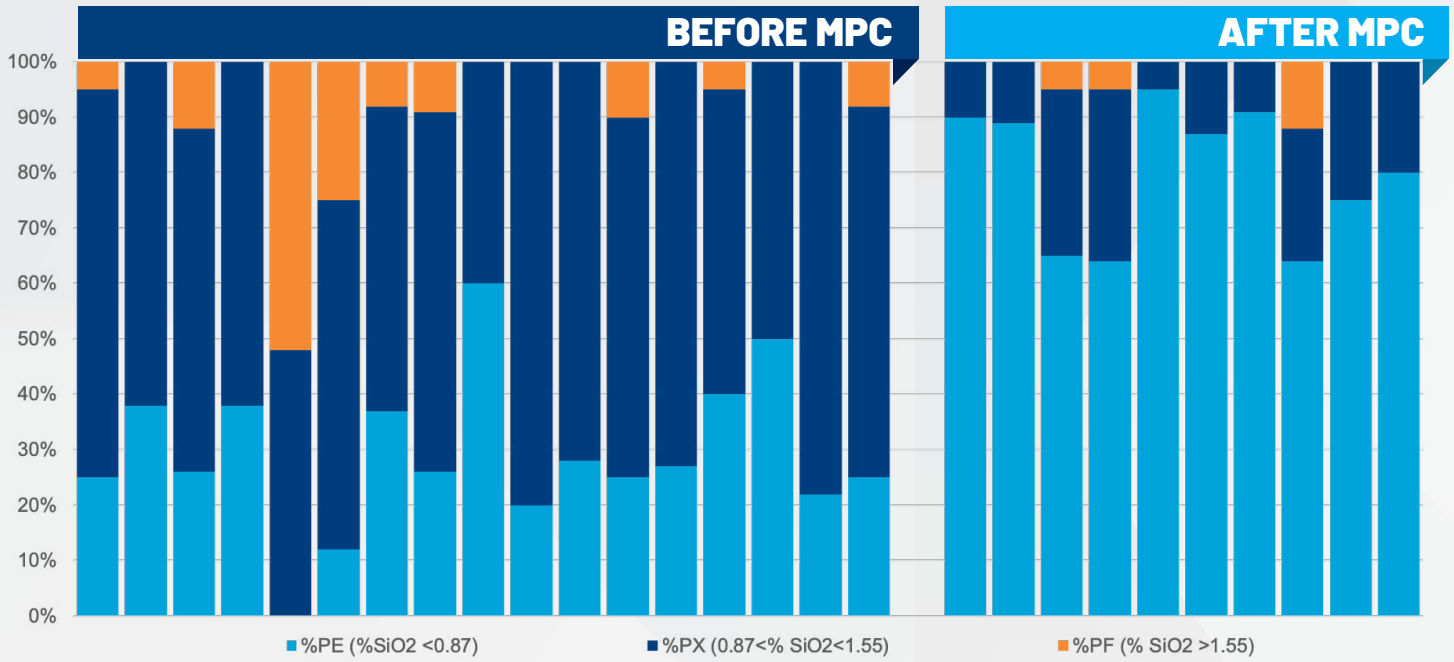
- Fresh water availability and cost
- Reagent cost
- Existing conventional control is inefficient (long residence time, large disturbances and non-linear behavior)
- Thickener shutdown may stop the production line

POTENTIAL BENEFITS

- **Increase** water recovery by 3% (typically 9000 m3 /day)
- **Reduce** flocculants by 2%
- **Reduce** possibility of emergency feed shutdown

Model predictive control (continued)

Controller-based or software



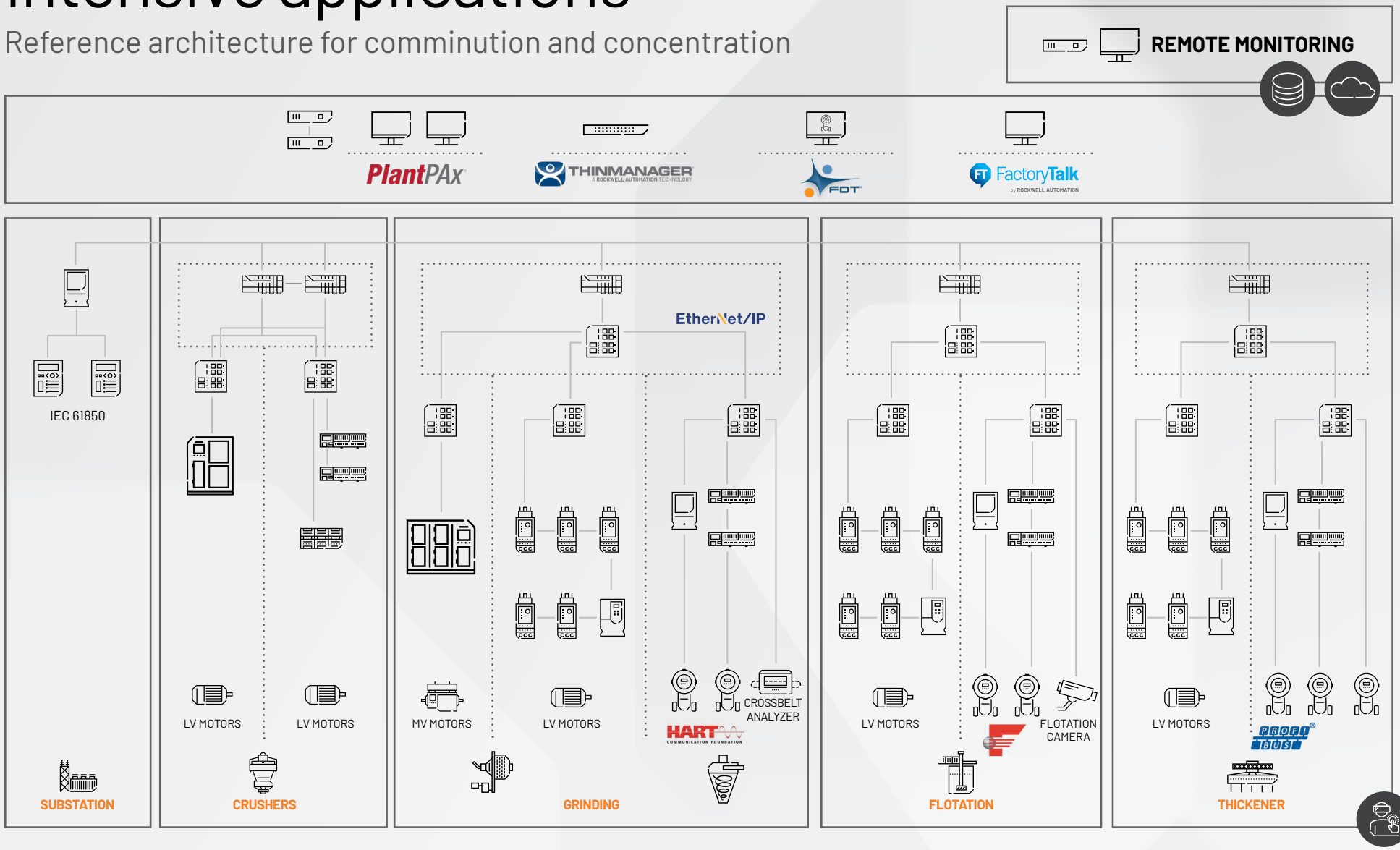
USE CASE

Pellet feed concentration

On average, 100 gr less amine was used per feed SiO2 ton yielding significant USD savings. This allowed the user to step up production of the most valuable concentrate type from 46% to 73% on average.

Optimal solution for process intensive applications

Reference architecture for comminution and concentration



Pyrometallurgy

The process solution is scalable, flexible, and easy to integrate to help you increase productivity, lower costs, reduce energy consumption, and improve safety.

Dryer/roaster, smelter, slag furnace

Converter, anode furnace, electrolytic refining

Oxygen plant

Acid plant

Harsh environment where production is often disturbed by unexpected events and recurrent maintenance operations

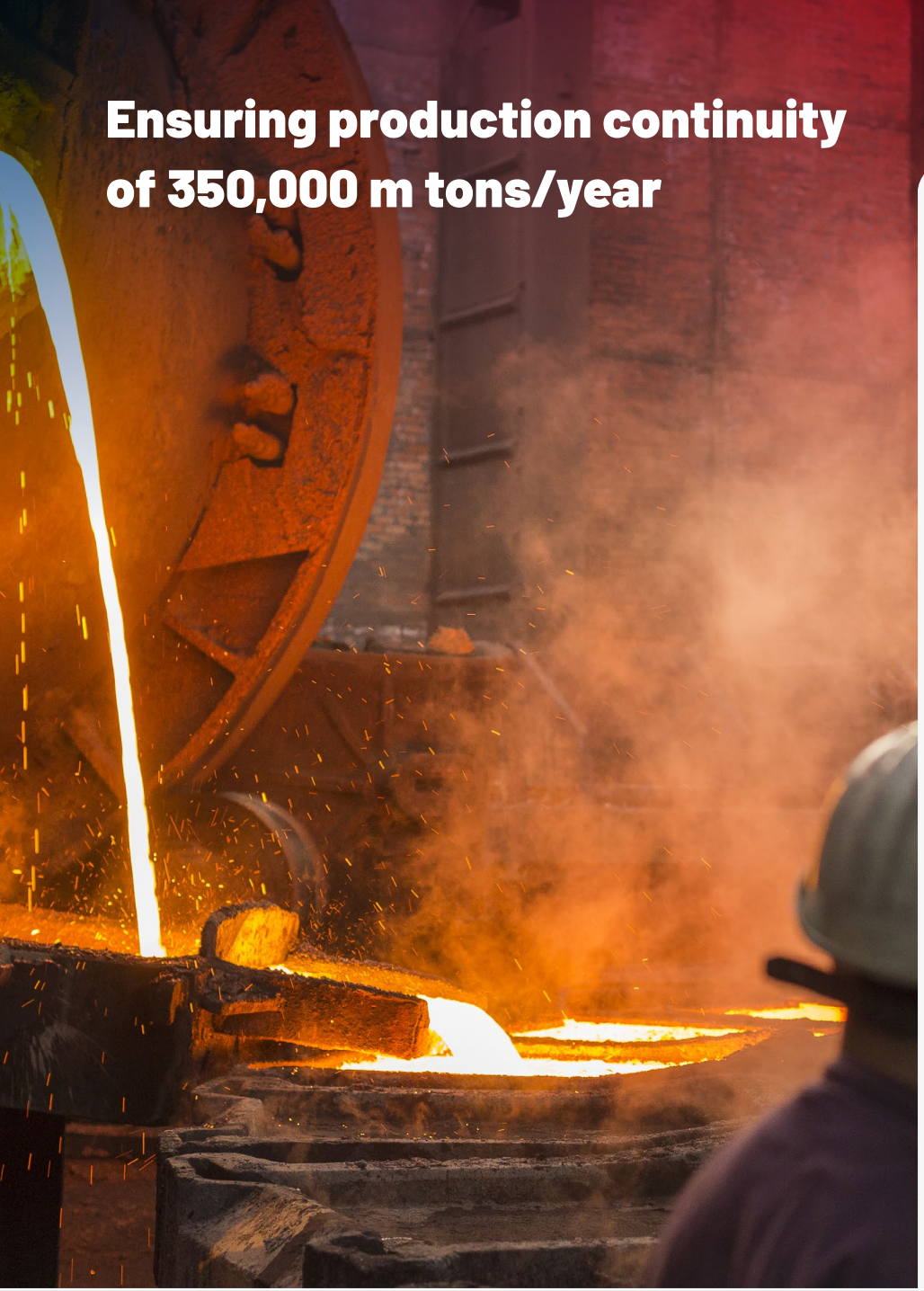
Material handling
Conveyors and stacker reclaimers

Reliability, performance and safety

Gain efficiencies by using one automation platform to control your process plant and material handling assets. Use premier integration to connect process control with motor control and manage both standard and safety systems in one place. The platform also includes integrated and distributed safety solutions, essential for e-stop for conveyors.

Automation **Motor control** **Safety**

If poorly maintained, a conveyor may experience rapid component failure, with consequent stoppages and downtime and a corresponding negative impact on productivity



USE CASE

Copper smelter DCS modernization

CHALLENGE

Obsolete 8000 I/O DCS system (lack of spare parts, lack of system support, no scalable, obsolete operation and engineering stations, no historical data/alarm management, obsolete field device communications)

THE SCOPE

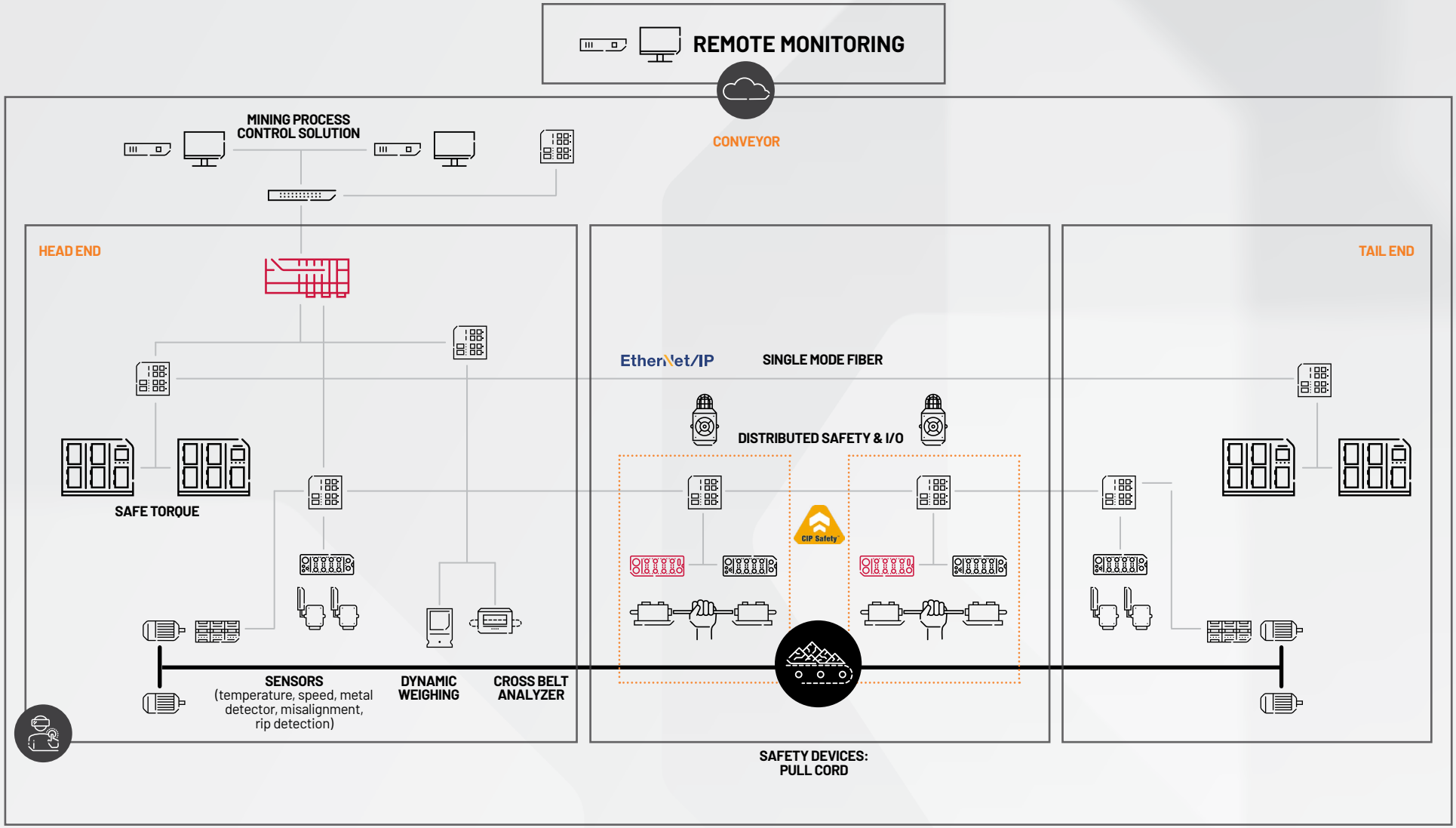
Operator stations, cabinets, historian replacement, engineering drawings and services, factory acceptance test (FAT), site acceptance test (SAT), configuration of HMI and controls, fiber-optic network installation, commissioning and startup, as well as operations and maintenance training

SOLUTION BENEFITS

- A holistic plant view of its process, real-time data, key performance indicators (KPI) and dashboards;
- A modern control system with easy maintenance, strong diagnostics and alarm capabilities, data management to support business decisions, and support for operational improvement

Safety and high performance in a single solution

Reference architecture for conveyors



Mine electrification

Experience the benefits of a seamless architecture where process, intelligent motor control and intelligent electrical control are represented through one control, visualization, and reporting system.

Process — Motor control — Electrification

Integration of intelligent electronic devices (IEDs) via IEC 61850

Benefits from **system design** to **expansion**

Process solutions

Solutions across the lifecycle

design

Easy to design and configure

Streamlined workflows

Consistent project delivery

build

Easy to integrate

sustain

Operations and maintenance centric

System-level decisions

Safe and cybersecure

improve

Scalable

Future-ready technology

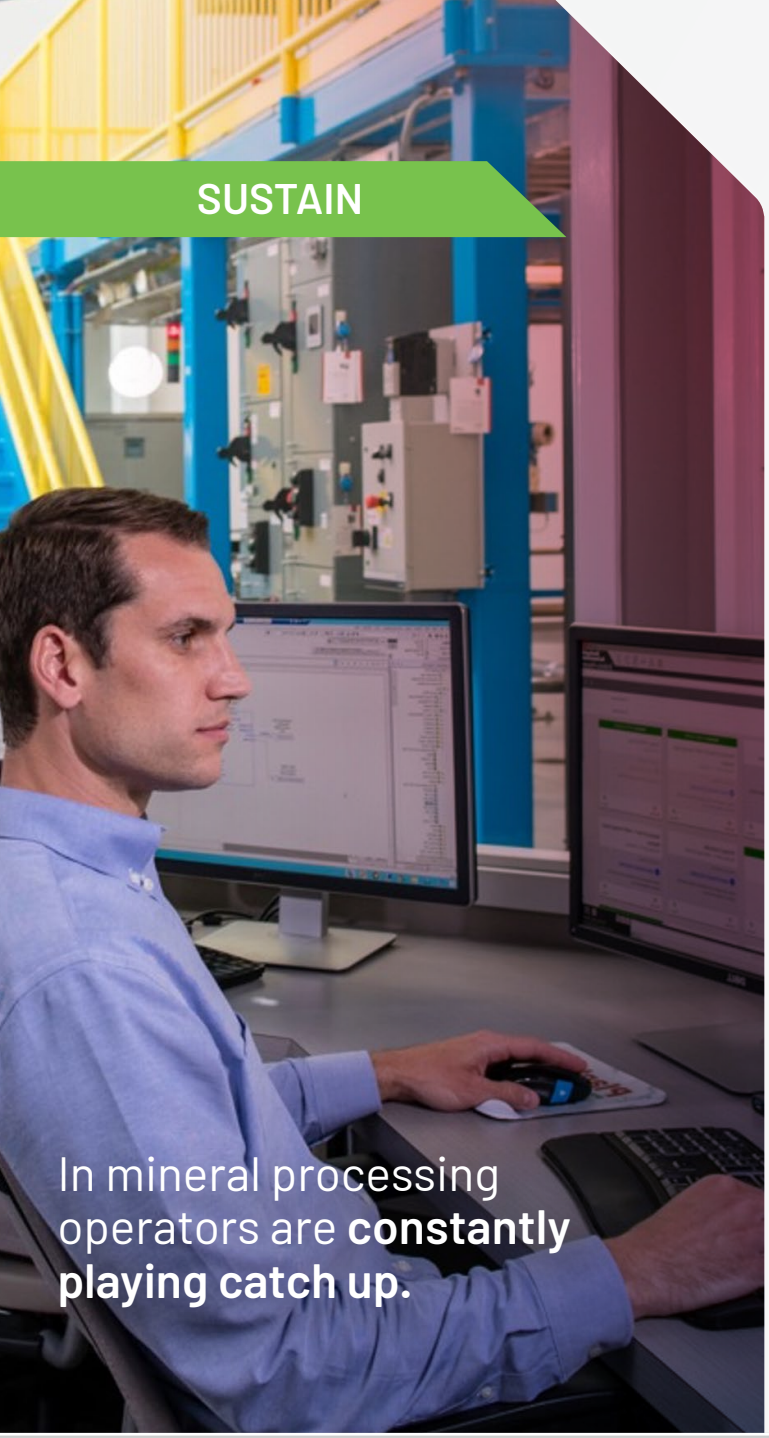
Analytics enabled

DESIGN AND BUILD

Easy to design, configure and integrate

Save engineering costs and reduce commissioning hassles

- Characterized systems and validated architectures for optimal performance of the DCS servers, controllers and required memory.
- Speed and ease of programming and system configuration including preconfigured virtual templates and process libraries.
- Embedded process instructions reduce system footprint, drive consistent product delivery, and streamline workflows (reduce tasks and clicks).
- Premier integration with motor control and field instrumentation.
- Easy to integrate main processes with other OEMs (no data remapping).
- Reduce rework by simulating plant response — identify and mitigate operational problems before being brought online.



Improve operations

Empower operators and reduce training costs

- Graphics focused on simplicity and situational awareness allow users to understand the state of equipment immediately.
- Real-time display of all process variables, alarms and trends provide up-to-date information. Integrated reporting tools convert data into information on a real-time basis.
- Multilingual support and multiple user modes cater to user roles.
- View need-to-know trends with optimized display of event information with real-time and historical data.
- Effective alarm management directs the operator's attention to their job.

Improved maintenance

Maintain availability in critical areas

- High-availability servers, controls and networks, and out-of-the-box diagnostics for system issues.
- Seamless visibility of devices for asset management, motor control and other instruments.
- Breadcrumbs highlight modules that are in an abnormal state and quickly determine what has been changed or needs attention.

Maintenance costs in the mining industries are commonly between 30% to 50% of mine site total operating costs.

Enable decisions at the system level

Vast availability of in-chassis capabilities

- Artificial intelligence/machine learning
- Model predictive control
- Compute module (for custom applications)
- Embedded historian

Cybersecure

Enhances security and compliance with ISA99/IEC62443

- Certifications for product development
- Certifications for system components
- Validated system reference architectures
- Projects delivered by Rockwell Automation following process and certifications for cybersecurity

In March 2019, one of the largest aluminum producers in the world experienced a crippling cyberattack by the LockerGoga malware. It paralyzed the company's computer networks, forcing it to isolate plants and switch some operations to manual.

Scalable

Future-proof technologies

- Same system for process, equipment, large and small systems
- Easy to evolve and expand
- Open Ethernet IP uses standard open hardware/software network infrastructure
- Analytics-enabled solutions

PlantPAx DCS Advanced mining solutions

Delivered by Rockwell Automation solutions and systems business

Program management capability

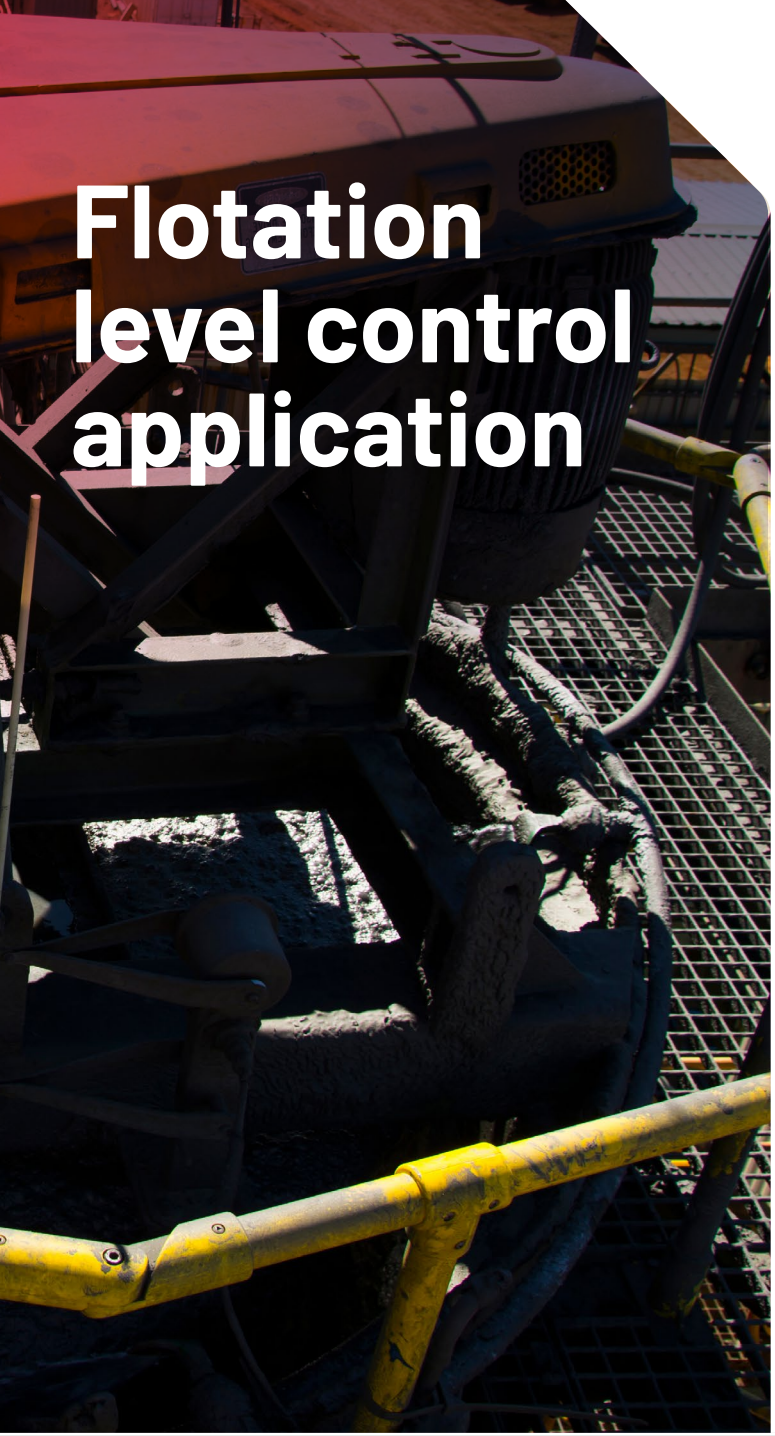
Reduce project risk for your mining project

Some projects are more complex and demanding. An automation vendor can help coordinate the pieces to keep the project on track and on budget.

- Reduce project risk and workforce efficiency through a standard delivery methodology and repeatable workflows.
- Reduce commissioning and gain process optimization during FAT simulation strategies.

Industry domain expertise:

- Thirty-two application centers
- Proven project management methodology
- Experience delivering projects across all industries



Flotation level control application

THE CHALLENGE

The level control of coupled flotation cells is a complex task because of high interactions between the variables — if something impacts an upstream cell, it creates implications for downstream cells.

Flotation level control

The level control solution builds an internal response model for each individual cell, minimizing disturbances.

- Fast response to disturbances
- Adaptive control that accommodates deteriorating valve performance
- Reduced dependency on specialized software and expert engineering labor
- Consistent level control: better optimization of other variables such as air and reagent addition
- Control-based solution allows for fast integration and high availability
- Operational settings and diagnostics available on the supervisory system

Transfer control application for conveyors

THE CHALLENGE

- Proper distribution of material along the conveyor (overload)
- Material transfers (chutes) can be executed only if there is proper clearance
- Some mining operations manage multiple ores and use the same conveyor — making the loading process even more complex

Tracking

Accurately model the loading and positioning of product on a conveyor system

Gap control for chute switch

Automatically switch a chute once the appropriate gap is present

Gap control for multiple products management

Handle multiple products on the same conveyor by creating a controlled gap between the products to increase belt throughput and operating efficiency

USE CASE

Transfer control

Manage multiple products: PGM Mining

Prior to solution installation, the typical time to empty the entire conveyor system and load a different product was about 27 minutes for a 2.4 km long conveyor system.

With the control installed, this delay was reduced to three minutes before loading a different product onto the conveyor system.

80%
Reduction in material changeover time

6%
Increase in production

Compressor packaged solution

THE CHALLENGE

- Match the compressed air supply with system demand
- Control of multiple compressor systems (network)
- Aging installations
- Compressor surge can result in major mechanical failure and unsafe operations

Master control for multiple compressors

Solution that delivers centralized compressor control by applying optimization algorithms that reduce energy and maximize equipment output across the compressed air network

Anti-surge

Safe and efficient way to control compressor surge — the solution is based on an advanced surge control algorithm

Our solution uses a dynamic setpoint value that is a function of the compressor's operating point and surge control line values

Improved equipment utilization and energy savings

USE CASE

Compressor packaged solution

22%

Reduction in utilized equipment

Case 1

- Aluminum smelter
- 9 x 1 MW machines
- Upon completion only seven required

63%

Reduction in energy (savings of 4.8 MW to 1.8 MW)

Case 2

- GHH axial compressor
- Control of guide vanes

Device check application

THE CHALLENGE

Safety checks can be overlooked and most of them are paper-based. This can result in unsafe operations and/or unexpected downtime.

Device check testing

- Designed for simplification of checking from field device to control room
- Helps to ensure that devices are tested to deliver a reliable equipment operation
- Can be interlocked with controls in order to prevent a system from operating
- Provides a current record of which devices were and were not tested in a specified time period
- Generates automated and customizable reports for plant managers and engineers, as and when needed

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