Enabling the connected mine

Rockwell Automation process solutions for mining
The world needs mining

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.

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
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%
Operations use cases are top priority for digital transformation in mining

**THE NEXT THREE YEARS**

- **58%** Increase throughput
- **53%** Enhance traceability
- **53%** Improve compliance and data integrity
- **50%** Improve yield

**BEYOND THE NEXT THREE YEARS (DIGITAL)**

- **47%** Achieve 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

Third-party integration
Mine to market visibility
Remote expert support

Intelligent packaged power
Process solutions

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Benefits from system design to expansion
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PlantPAx DCS
PG 24
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

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

SOLUTION AT A GLANCE

**CONTENT**
- HMI, ERP, MES, CMMS™
- WEB CONTENT
- IP CAMERA
- USB CAMERA
- PANELVIEW™ PLUS
- PANELVIEW™ 5000

**CONFIGURATION**

**CONSUMERS**
- AREAS
- USERS & GROUPS
- DEVICES

Provides secure configuration and content delivery.

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.

Divide each monitor screen and host content from various sources. Create an operator station with a single 4K monitor instead of multiple smaller monitors positioned next to each other.

Use the MultiMonitor™ function to create low-cost video walls. An open solution allows you to connect to multiple softwares.

Pull together content from multiple systems into a single operating environment. Connect one or more monitors to a single thin client and control them all with one keyboard and mouse.

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Process solutions

Benefits from system design to expansion

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Process solutions benefit each application area of your mine

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

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.

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.
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

## 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

## Flotation

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

## 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

### Crusher
- Increase throughput by 2%
- Increase efficiency by 5%
- Decrease equipment wear by 5%

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

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

### Thickener
- 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

REMOTE MONITORING

IEC 61850

SUBSTATION CRUSHERS GRINDING FLOTATION THICKENER

LV MOTORS LV MOTORS LV MOTORS LV MOTORS LV MOTORS LV MOTORS

PlantPAx THINMANAGER CROSSBELT ANALYZER

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**Pyrometallurgy**

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

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**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.

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

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.
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
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.

In mineral processing operators are constantly playing catch up.

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

Complex ores make process optimization more difficult.

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
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
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.

PGM Mining is now able to switch to a different product in just three minutes.

80% Reduction in material changeover time
6% Increase in production
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
USE CASE

Compressor packaged solution

Improved equipment utilization and energy savings

**22%**
Reduction in utilized equipment

**63%**
Reduction in energy (savings of 4.8 MW to 1.8 MW)

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

**Case 2**
- GHH axial compressor
- Control of guide vanes

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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