

Mining and IIoT

Markets

Suppliers

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The Mining IIoT and Remote O&M Outlay in 2017 will be \$11 billion rising to \$56 billion by 2030

- Presently many mining trucks are automated and remotely controlled. By 2030 many of the processes to separate and beneficiate the ores will also be operated remotely. The incentive is high due the remote locations and harsh conditions encountered at many mining sites.
- Mining companies now spend \$25 billion for treatment chemicals. Twenty percent of these expenditures are in reality purchases of knowledge from the chemicals suppliers. This revenue from the Industrial Internet of Wisdom is considered to be part of the IIoT and Remote O&M opportunity.
- The mining industry is looking to IIoT and Remote O&M for safety improvements. Manual measurements of oxygen and hazardous gases will give way to highly automated systems which also control ventilation fans to minimize energy consumption while maintaining safe levels of hazardous gases.
- Monitoring and control of the tailings storage minimizes the risk of a breach. The grinding and flotation circuits for some plants are monitored by FLSmidth from a remote monitoring center in Denmark. They have also introduced a gain sharing program. A bonus is paid when costs are below the targeted level.

Markets

Mining Revenues for the Largest Companies in 2015/2017

| Number | Company | Revenue (billion US \$) | Headquarters |
|--------|----------------------------|----------------------------|------------------------------|
| 1 | Glencore Xstrata | 209.2 | United Kingdom |
| 2 | BHP Billiton | 69.4 | United Kingdom, Australia |
| 3 | Rio Tinto | 45.1 | United Kingdom, Australia |
| 4 | China Shenhua Energy | 40 | China |
| 5 | Vale | 33.2 | Brazil |

The situation changed in 2017 when Glencore revenues dropped to \$159 billion. Its market capitalization is less than \$30 billion whereas the BHP market cap is \$75 billion.

The top 50 mining companies have a market capitalization of \$700 billion. Mining costs are approximately \$1 trillion per year.

The current IIoT expenditures are \$11 billion which is only equivalent to 1% of costs.

Relatively Few but Large Mining Companies

- The top ten iron ore producers account for over 90% of the world's total iron ore output.
- Codelco, the state-owned Chilean group is the world's single biggest copper producer, controlling about 20 percent of total global reserves.
- China is the chief coal producer while the United States comes in second. Other major coal producers are India and Australia. Five countries, namely China, the United States, Russia, India and Japan account for over 75% of worldwide coal consumption. Despite the swift deployment of renewable energy, mainly in the background of debates around climate change, it is coal that is responsible for the largest upsurge in energy requirement of all energy sources.

Global Sourcing Companies are Impacting Flow and Treat Sales

Source One has decades of experience developing strategic sourcing solutions for mining and natural resource extraction companies, and has expertise in sourcing a variety of categories critical to these industries, including:

- Heavy Equipment Maintenance
- Chemicals
- Conveyors, Belts and Fasteners
- Filtration Parts
- MRO
- Pipe, Valves, and Fittings
- Safety Supplies
- Vehicle Maintenance Parts and Aftermarket Parts
- Welding Gases and Supplies
- Utilities and Electric
- Environmental Impact Studies & Remediation

Source One's strategic sourcing team has experience within these, and hundreds of other, product categories, along with experience working with the leading suppliers in the mining and natural resource market. As market conditions become more competitive and demanding, the use of market intelligence in strategic sourcing has become increasingly important. Experience with mining organizations has given Source One valuable insight into the various suppliers' capabilities, and can ensure that the best-suited suppliers are properly aligned to the organization.



Mining Expenditures \$ billions

| Category | Capital Expend. 2017 | Installed Asset Value |
|---|----------------------|-----------------------|
| Mining Equipment | 80 | 1000 |
| Pumps | 2 | 30 |
| Sedimentation and Centrifugation | 3 | 45 |
| Liquid Filtration | 2 | 30 |
| Air Pollution Control Systems Except Fans | 4 | 60 |
| Ventilation and Process Fans | 2 | 30 |

If a mining equipment company sells autonomous equipment and self driving vehicles along with remote O&M the \$80 billion opportunity rises to \$ several hundred billion

Electrical costs are significant.

Labor costs are falling.

Chemicals are \$25 billion/yr.

Safety costs will fall as people are removed from the operations.

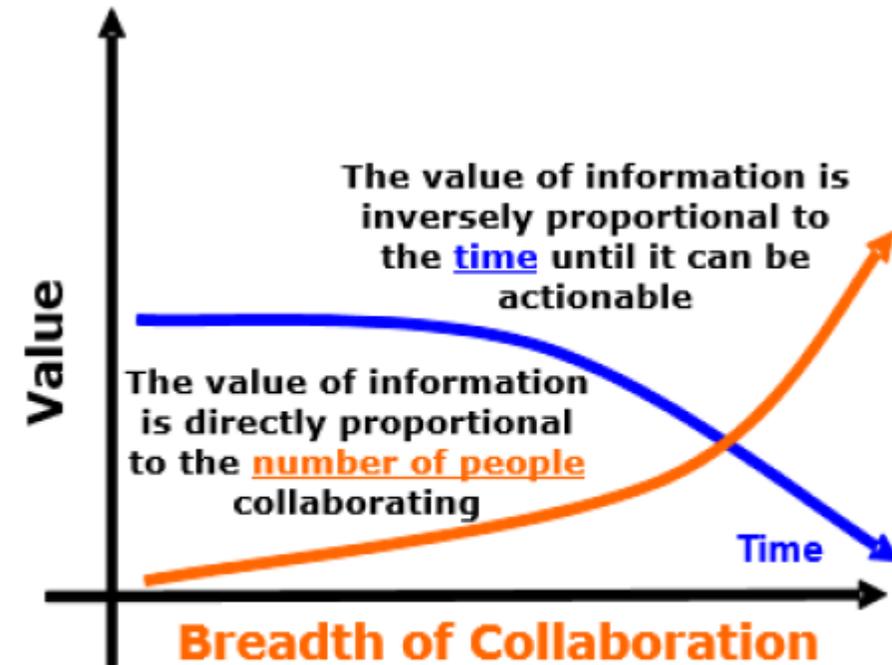
Environmental costs are increasing but IIoT promises to reduce these outlays.

This year fan companies will generate sales of \$2 billion to the mining industry for both ventilation and process fans.

This revenue potential triples with a solution rather than just hardware. Howden provides O&M for all the mine ventilation. Total energy costs are reduced and labor to periodically measure contamination at many locations is eliminated.

Collaboration is the Cornerstone of IloW

The suppliers of systems, products, and services need to interconnect with the plant personnel. Breadth is important. All the relevant personnel in a mining operation who have insights on a process or product should be in the loop. At a supplier company, sales and technical people representing each product also should be interconnected. The need to quickly deliver actionable information has been addressed by Mcilvaine in systems which supply the 4 knowledge needs: Alerts, Answers, Analysis, Advancement

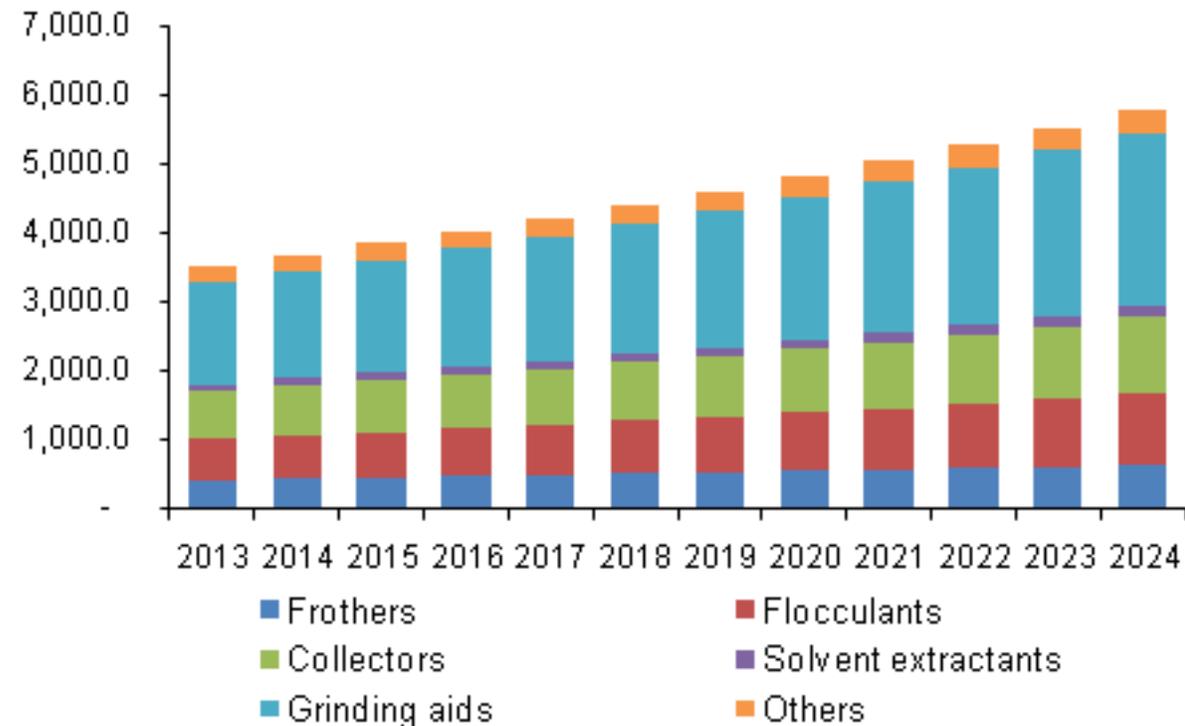


Value of Collaboration
(Source: ARC Advisory Group)

Treatment Chemicals are Important Factor in Mining IIoT

The Mining IIoT and Remote O&M outlay in 2017 will be \$11 billion rising to \$56 billion by 2030.

Presently many mining trucks are automated and remotely controlled. By 2030 many of the processes to separate and beneficiate the ores will also be operated remotely. The incentive is high due the remote locations and harsh conditions encountered at many mining sites. Sales of chemicals will rise to \$30 billion in 2030. Of this total 20% will be for water related chemicals. Flocculant use will grow and reach \$1 billion in 2030. Remote adjustment of chemical injection will result in improved performance and lower costs.



IIoT already Established with Autonomous Mining Trucks

In the Pilbara region of Western Australia, Rio Tinto has been using autonomous, self-driving mining trucks since 2008. Fifty three massive Komatsu driverless mining trucks navigate routes and respond to local conditions using over 200 sensors on the truck, GPS, and a radar guidance system. This Autonomous Hauling System (AHS) is a highly proven system. Rio Tinto's driverless trucks have driven almost 3 million miles and hauled nearly 250 million tons of ore. The trucks are connected wirelessly and overseen by controllers in Rio Tinto's operations center in Perth over a thousand miles away.

Benefits of Driverless Mining Trucks

- Safety is improved by eliminating driver fatigue and error and by reducing the number of people at the mining site.
- Autonomous trucks also enable more predictable, continuous, optimized operation, all day and night, without need for lunch breaks or shift changes. They have shifted the types of skill sets needed by Rio Tinto, who now needs more technical people sitting in their operations control center.
- Those workers have the advantages of living comfortably in a major city rather than out in the middle of nowhere.

Rio Tinto Mine of the Future

- Rio Tinto has also been trialing its Autonomous Drilling Systems (ADS) in its West Angelas mine and they have invested over half a billion dollars to automate driverless trains that haul the ore from the mines to the ports.
- Rio Tinto's 'Mine of the Future' vision includes not just automated haulage and drilling but also automated mining operations, remote monitoring of mining operations and processing plants, condition monitoring of stockpiles, computer-optimized flotation tanks (for extracting minerals), and autonomous trains, all controlled by centralized operations centers.
- James Petty, general manager of Mine of the Future for Rio Tinto Iron Ore, put it this way: *"It's a total system. The whole mining operation is planned in advance and is dynamic. It has a memory. It learns. It anticipates trouble and responds. Its neural paths interlink at light speed. It functions like a brain the size of an iron ore province, coordinated by the 'control tower,' the Operations Centre in Perth."*

Mining Industry is Moving Forward with IIoT

- IC. Prasanna Venkatesan, Business Development Lead for Internet of Things Group in Mining at Oracle, says that mining companies are increasingly deploying IoT solutions to improve their operating environments. These solutions range from Big Data analytics for predictive maintenance to digital tailings monitoring for operational safety to ventilation controls to reduce costs and their energy footprint.
- The industry has been deploying programmable logic controller (PLC) and supervisory control and data acquisition (SCADA) systems for industrial processes and automation for years, including at mine sites. However, despite the complexity of these systems, they were never quite designed to communicate with each other or within a larger system.
- As Graham Churchill, Canadian Mobile First & IoT Software Leader at IBM, observes, changes are beginning to happen. “What you see today is a world where, particularly in SCADA systems and so forth, companies will try to build complete solutions. And if you want to get any of the data out of that, you’ve got to write proprietary programs to get at the data. Typically, you’d only get a part of it. What’s happening in the marketplace is that we’re starting to see the formation of web services or open standards for industrial equipment and industrial communications,” says Churchill. In many ways, the evolution of technology uptake in mining control systems shows a parallel with the changes the IT industry saw in the past 20 years.

Suppliers

ABB
Andritz
BAGGI
Cisco
Eaton
Emerson

Evoqua
FLSmidth
Grundfos
Honeywell
Howden
ITT

Kemira
Nalco
Siemens
Solenis
Symboticware
Xylem

ABB Remotely Monitors and Controls Dragline Health

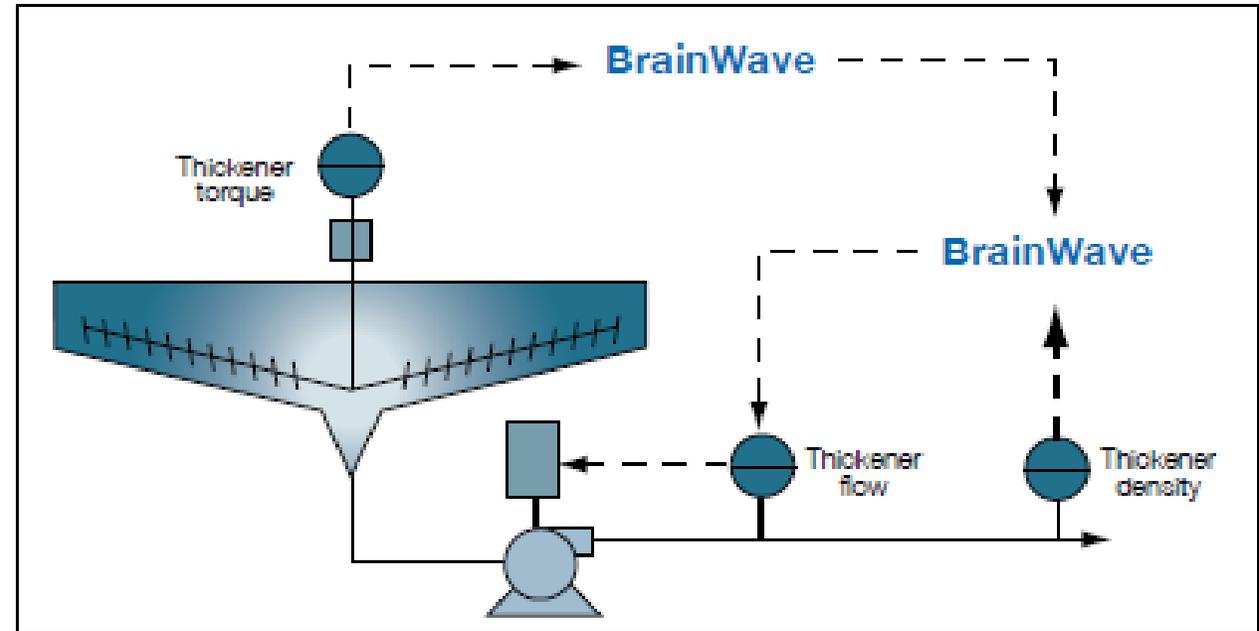
- DraglineScan™ allows site engineers to collaborate with ABB experts on a continuous basis to achieve optimal dragline availability and improved performance. An important aspect of draglines monitoring is the observation of changes over extended periods of time, which allows ABB to suggest preventive actions to keep draglines at peak performance.
- The DraglineScan™ remote service includes three components: remote connectivity, hardware and software for data analyzing, and ABB's technical experts available 24/7. It offers the following levels of remote services: Remote troubleshooting On-demand, 24x7 technical support and visibility allowing ABB specialists to connect to the system and investigate draglines operation issues as they arise, diagnose, and support the implementation of corrective actions. Remote periodic maintenance Scheduled quarterly analysis of archived data against established performance benchmarks and identification of potential performance improvement opportunities.
- Some corrective actions can be implemented utilizing the remote session. Associated reports are provided to summarize intervention and recommendations.



Model based Predictive Control Algorithm used for Andritz Thickener in Mining

Concentrate thickeners pose a challenging control problem, as both a nominal bed depth and product density must be maintained for proper operation. Using BrainWave, both of these objectives can be satisfied. Bed depth is controlled by monitoring rake torque and making continual adjustments to the target density, within a preconfigured range. In turn, the product density is maintained by varying the pulling rate from the thickener unit.

Thickener density control schematic ▾

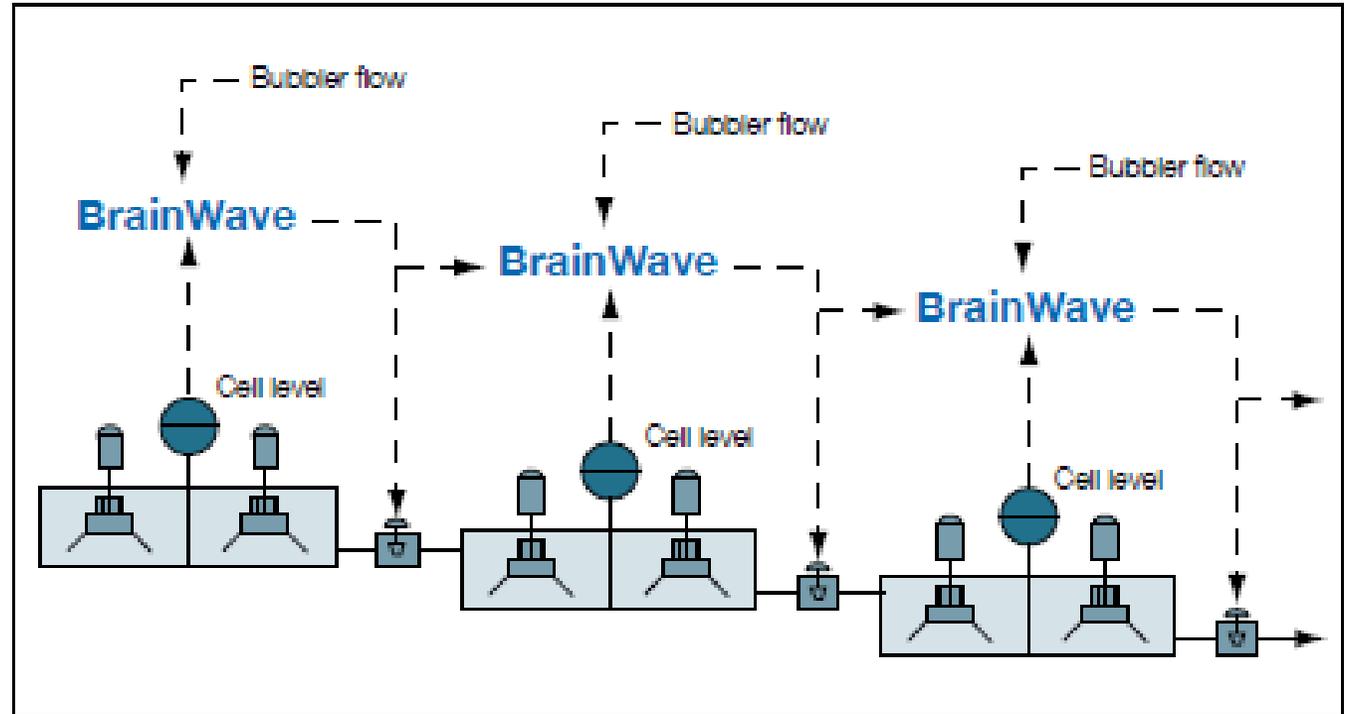


Conventional controllers struggle with handling the slow dynamics that are inherent in concentrate thickeners. BrainWave, however, is able to account for these slow dynamics due to its model based predictive control algorithm. Dynamics may slowly vary over time, due to such factors as build-up in the thickener vessel. BrainWave accounts for these changes by using its built-in model adaptation algorithm. This algorithm enables BrainWave to adjust its internal model of the process based on real-time observations of the process and to maintain tight control

Flotation Control System from Andritz

BrainWave is a proven control system that stabilizes the operation of all types of rougher, cleaner and scavenger flotation cells, resulting in more efficient operation and improved mineral recovery. BrainWave flotation is a unique control package using patented model-based predictive adaptive control technology, widely used by many primary processing industries. BrainWave is used to maintain the level in each of the flotation cells. By using its model based predictive control algorithm, coupled with its unique integrating control algorithm, BrainWave will reduce the variability in the cell level control so that cell operation can be optimized.

Flotation cell level control schematic



BAGGI Controls Reagent Rate and Aeration in Flotation Systems

- SYS-FLTN is part of the BAGGI SensEvolution® System series. The SensEvolution System® product line has been developed for providing turn-key systems for industrial process analysis and control in the more varied application fields.
- They are the result of combining the latest state-of-the-art-technology with over 60 years of industry experience. This real time analyzer and controller is designed for stabilizing the flotation levels (froth depth) in the flotation circuits used in the mining industry. This goal is achieved by controlling the aeration rate and the reagents addition. Furthermore the temperature of the reagents is stabilized. The system is also in charge of monitoring all the physical quantities and to raise alarms, when necessary.
- Due to its modularity, the system can integrate any additional sensors when required by the application (e.g. a radio-isotopic type density analyzer). An embedded computer implements the closed-loop control algorithms; the software package is tailored according to the Customer's specific requirements. A typical application is in the Copper and Molybdenum mining industry.

Cisco Connected Mining

- Cisco's Connected Mining solutions enables a plant to manage multiple applications, including dispatch, safety, telemetry, voice and video on a single reliable, secure network. Solutions have been proven across thousands of installations worldwide. It's all made possible through unified, secure access from any device and any location.
- **Connected Predictive Maintenance:** Boost equipment reliability and control maintenance costs with actionable predictions for preventive asset maintenance. Predict impending equipment failures weeks before they occur using Cisco and partners' solutions. A plant can schedule maintenance in advance, saving precious production time and avoiding disruptions due to unscheduled maintenance.
- **Digital Tailings Monitoring:** Control onsite costs and improve safety with real-time video and in-ground sensor monitoring and analytics. Reduce risk of tailings breach with solutions that have been proven in critical environments such as dike monitoring in the Netherlands.
- **Secure Mine Operations:** Safeguard your organization and control compliance and safety costs with "process control security as a service." No more guessing about which equipment is connected to your network - and its security and compliance. Cisco Secure Mine Operations features built in collaboration with the world's leading automation vendors. So you can rest easy with real-time visibility into the status of your operations from a single pane of glass.
- **Asset Visibility and Monitoring:** Improve employee safety, protect valuable assets, and reduce energy costs with real-time visibility, monitoring, and ventilation control. Cisco's Mine Asset Visibility solution lets you track personnel at all times. Respond to emergencies immediately, locate your equipment fast, and manage your energy usage in underground mines with "ventilation-on-demand." It all resides on a single, multi-service IP network built to withstand harsh industrial conditions.
- **Connected Plant:** Connect end-to-end operations of the mine with a multi-service, reliable network, ruggedized for the physical conditions of your mining operations. Cisco Connected Plant is installed in thousands of processing plants, open cut and underground mines, mills, smelters and refining operations worldwide.

Cisco Connected Mining Solution in use at Goldcorp

- Goldcorp implemented Cisco's Connected Mining solution, at the center of which is a robust underground network. The solution at its Northern Quebec mine allows Goldcorp to manage communications with personnel via a single, multiservice, secure IP network that workers above- or below-ground can access via a variety of wired or mobile devices (smartphones included).
- The intelligent ventilation system detects miners' and vehicles' location, turning on ventilation fans only as needed. Further, the system identifies the type of vehicle passing into an area and adjusts the fans' speed based on that vehicle's emissions.
- Goldcorp estimates that the new ventilation system will generate between \$1.5 million and \$2.5 million in savings over conventional ventilation systems. A reduction in greenhouse gas emissions is an additional important benefit. The intelligent ventilation system is proving so successful in the Éléonore mine that Goldcorp is planning to expand its use in its other facilities, including the Cerro Negro mine in Argentina.

Cisco EttF installed in all Process Plants of Anglo Platinum

- Anglo Platinum developed a strategy to integrate the radically disparate worlds of the process control networks and the corporate data network into a secure platform for enterprise-wide dash-boarding and decision making at all levels of the operation. The strategy addressed key objectives including business continuity, security, total cost of ownership, skills availability, and reduced complexity. In addition, Anglo Platinum wanted to establish standards and a plan for scalability and future integration with process-oriented Supervisory Control and Data Acquisition (SCADA) solutions.
- The first step had already been taken a few years ago when Anglo Platinum deployed a Cisco® Wide-Area Application System (WAAS) between the company's headquarters and several remote sites. Then, in 2007, Anglo Platinum adopted Cisco Borderless Network Architecture to design advanced network capabilities into its network infrastructure.
- This network architecture with three interconnected layers (everything over IP; virtualization; and service orientation) creates a customized, easily manageable bridge between network hardware and mission-critical enterprise applications. The critical technology deployment, however, was to link enterprise IT networks with production process control networks. Process networks typically utilize multiple protocols at different network levels (device, control, information). Furthermore, the various automation vendors that are used deploy different controls and communications protocols. Anglo Platinum also opted for the Cisco Ethernet-to-the-Factory (EttF) solution, because it provides an end-to-end infrastructure that includes support for industry standards and ruggedized hardware for harsh environments. EttF is part of the suite of Cisco Smart+Connected Manufacturing solutions designed to help manufacturing companies successfully connect plant and business systems. EttF also provides real-time visibility into production systems and offers predictable performance and system resiliency. In fact, the decision to adopt EttF centered on a number of reasons, including: o Increased complexity in the plants and increased data logging with a requirement that this data is made available to the engineers and other systems. The need for remote access, for example, is key to a metallurgist getting his/her job done. The networks went from isolated networks to being connected to the IT network at the same time as the threats to networks in general were increasing from viruses and hackers.
- Cisco EttF has been installed in all process plants in Anglo Platinum. Some of the benefits for the company include: ● more standardized, scalable solution that can be expanded at lower cost, ● flexible infrastructure that improves responsiveness and faster decision-making, ● ability to maintain quality and production uptime with better visibility, and ● mitigated security risks such as unauthorized access, unauthorized actions by authorized individuals, and interception of data.

Eaton provides many Products and Services for Mining

- Eaton offers a broad, unique mix of electrical, hydraulic and filtration components, assemblies and services, including safety solutions designed for critical operations.
- Field-based service capabilities offer system analyses, equipment testing and a host of life-cycle extension solutions to support site-installed products.
- For more than 30 years, Eaton has provided complete wireless monitoring, control and networking solutions for the mining industry.
- This includes a complete wireless solution for surface and underground mining operations. Industrial wireless mesh I/O radios, gateways, serial products, cellular routers, Ethernet modems and industrial-grade Ethernet switches meet the demands of rugged long distance applications of the mining industry. The Eaton network management system lets you easily manage network complexities and the interoperation of diverse wireless and wired LAN equipment from a single location.

Eaton Wireless Monitoring for Surface and Underground Operations

Surface

- Remote control operation of excavators, load/haul/ dump trucks, conveyors, bulldozers, mobile drills • Surface extraction
- Ore treatment plants and quarries • Security video monitoring
- Access control systems
- Power network monitoring • PLC (Programmable Logic Controller) connections
- Fuel tank gauging, leakage detection
- Alarm monitoring of portable machinery • Treatment plant monitoring
- Automated collection of mine slope wall data
- Emergency shower monitoring
- Water supply control systems

Underground

- Underground utility services
- Longwall mining
- Ventilation fan monitoring
- Conveyor monitoring and interlock • Tunnel boring
- Detection of moving machinery
- Gas detection systems • Remote control and alarm for emergency generators
- Compatible with leaky-feeder antenna systems



Self Cleaning Filters for Process and Water Intake can be Continuously Monitored and Cleaning Cycles Changed Remotely

Amiad and Eaton are two of the largest suppliers of self cleaning filters for the mining industry. As in this Amiad installation, there are often large numbers of filters in cluster. Those filters at water intake locations may be remote to the other operations. Therefore the benefits of wireless transmission of filter health are substantial.

| Industry | Gold Mine |
|---------------------|------------------------------------|
| Country | Australia |
| Application | Litching |
| Flow Rate | 700 m ³ /h; 3,080 USgpm |
| Filtration Degree | 200 micron |
| Water Source | Process water |
| Filtration Solution | 3 x 12" ABF-Y Filters |

Mining operations also utilize bag filters, hydrocyclones, strainers, filter presses, drum filters, cartridges and membranes for water, process, and wastewater applications. The companies supplying these devices often also supply clarifiers, centrifuges, thickeners and flotation separators. Filtration and separation is an important process in mining. Therefore remote O&M is an important option.



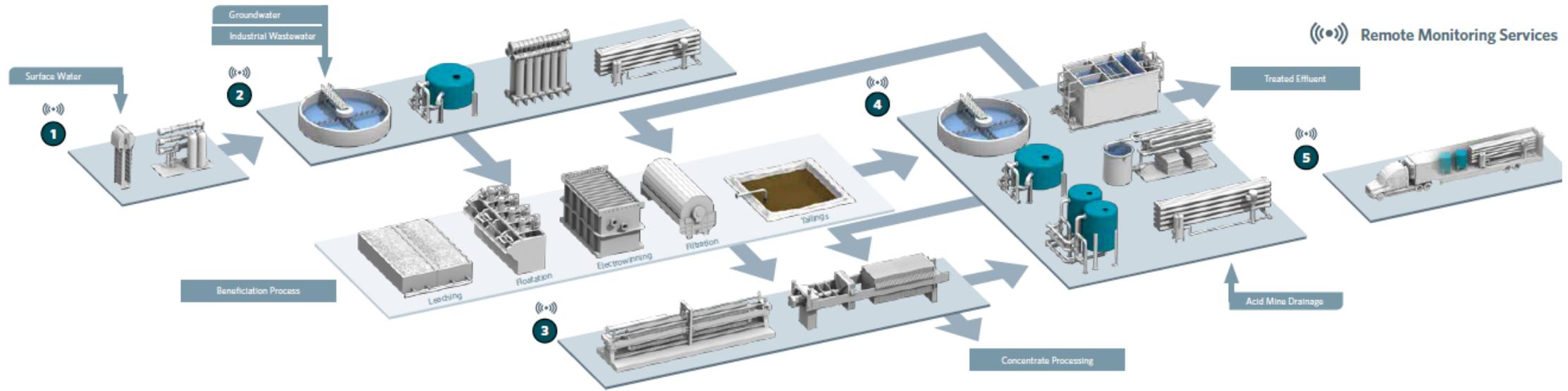
Emerson's Online Machinery Health Monitoring helps Phosphate Mine Protect Critical Assets, avoid Downtime and Repair Costs

- **RESULTS** • Cost savings of \$5,832,000 per year based on 36 hours of availability gain due to direct time savings during data collection. • Improved reliability and had a savings of \$1.3 million in cost avoidance during one eight-hour downtime event. • Safety has been improved, because technicians no longer collect data manually on a moving/operational dragline.
- **APPLICATION** Online Machinery Health Monitoring of three draglines in a phosphate mining operation. **CUSTOMER** A phosphate mine in the Mid-Atlantic area has three draglines that are in use 24/7. The mine is part of the world's largest fertilizer company by capacity and produces the three primary crop nutrients: potash (K), nitrogen (N), and phosphate (P). The mine produces – 6.0 million tons phosphate rock, 1.2 million tons phosphoric acid, 0.3 million tons purified acid, 0.1 million tons phosphate feed per year.
- **CHALLENGE** The mine needed best-in-class vibration monitoring solutions and predictive maintenance capability to be installed on vital heavy-duty draglines at the phosphate mine. The team needed to improve its ability to identify equipment issues early and safely, allowing adequate time to plan repairs, while minimizing costly downtime. Continued major failures deemed Predictive Maintenance not only desirable, but necessary for operational health. Technicians had to be on the moving dragline, collecting data around moving components and nip points in a manual process that took 1.5 hours per dragline per month. Traditional “walk-around” monitoring was remote, dangerous, inconsistent, and interrupted production.



Evoqua has a Diversified Range of Mining Equipment with Remote Monitoring Capabilities for each Process

PROCESS WATER AND WASTEWATER PRODUCT AND TECHNOLOGY OFFERINGS



1 WATER INTAKE

- Intake Screening
- Trash Rakes
- Traveling Water Screens
- Rex® Modified Ristroph Fish Handling Screens
- Chlorination
- Chloropac® Systems for Seawater Electrochlorination
- Gas Chlorination Systems
- OSEC® On-Site Electrolytic Chlorine Generation Systems

2 PRETREATMENT

- High-Rate Clarification
- CoMag® Systems
- Media Filtration
- Vantage Multimedia Filtration Systems
- Vantage Carbon Filtration Systems
- Membrane Filtration
- MEMCOR® Ultrafiltration Systems
- Vantage Ultrafiltration Systems
- Memtek® Microfiltration Systems
- Vantage Nanofiltration Systems
- Vantage Reverse Osmosis Systems

3 DEWATERING

- Pressure Filtration
- J-Press® Filter Press
- MC Press® Filter Press
- Clarification
- J-Press Filter Press

4 WASTEWATER TREATMENT, RECLAIM AND REUSE

- High-Rate Clarification Systems
- Media Filtration Systems
- Membrane Filtration Systems
- Ion Exchange
- PERMUTIT® XPS & NS Non-Regenerable Demineralizers
- Vantage Softening Systems
- Electrodeionization
- Ionpure® VNX Electrodeionization Systems
- Cyanide Destruction
- Chlorine Dioxide Systems
- Chemical Precipitation Systems
- Multi-Stage pH Neutralization Systems
- Acid Mine Drainage/Sulfate Removal Systems
- Pironox™ Advanced Reactive Media System

5 ANCILLARY EQUIPMENT AND SERVICES

- Equipment and Systems
- RO/UF Clean-In-Place Systems
- Integrated Instrumentation and Control
- Pumps
- Storage Tanks
- Services
- Intake Inspection and Repair Dive Team
- Maintenance Contracts
- Metals Polishing Systems
- Mobile Filtration, Demineralization and Reverse Osmosis Systems
- Off-Site Resin Regeneration
- Process Evaluation and Optimization
- Spare and Replacement Parts
- Remote Monitoring
- Link2Site® Monitoring and Control Systems



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www.evoqua.com/mining

FLSmidth Process Expert System for Grinding and Flotation

- An unstable grinding circuit operation and process can result in poor overall minerals plant performance. The ECS/ProcessExpert system analyses a wide range of signals and actuates automatic adjustments to manage the equipment and process performance resulting in improved grinding efficiency. Benefits • Up to 6% increase in production • Up to 6% reduction in grinding specific power consumption • Up to 30% reduction in quality and process variability.
- The ECS/ProcessExpert system monitors operational and process conditions and makes constant automatic adjustments necessary to stabilize the process flow, balance the load of the circuit and protect equipment, all while ensuring that the circuit delivers a product that matches the required quality. The result is stable operation, reduced energy consumption and increased production.
- The FLS advanced process control application for flotation circuits is designed to manage the material flow through the flotation circuit and the levels of pulp and froth. The system monitors several signals originating in the plant control system and manipulates a series of key actuators to achieve maximum recovery and concentrate grade. Benefits • Improved recovery and/or grade control • Decreased reagent consumption
- Parameters controlled • Froth height • Pulp level • pH • Flow rate of concentrate
Parameters monitored • Tailing flow rate • Aeration rate • Lime addition rate • Collector flow rate • Frother flow rate

Grundfos Pumps for In Situ Leaching

In situ leaching or solution mining is a process of recovering minerals such as copper and uranium through boreholes drilled into the formation, without the need for conventional mining. Grundfos can supply submersible and end-suction pumps that ensure the effective pumping of barren or pregnant solutions into the formation and back up to the mineral processing plant.

. A Grundfos pumping solution can handle very low pH levels and sulphuric acid at low concentrations or high concentrations above 90%. A complete range of dosing pumps systems are for large or small volumes and based on different technologies, and Grundfos can also supply electronic and electrochemical accessories for complete control as well as PLC-controlled, fully automatic systems for dry material preparation and reliable dosing.

With possible great fluctuations in demand for performance and multiple pumps installed, adding variable frequency drives will equalize the hydraulic load to the wells, automatically adjusting pump speed to demand. This ensures the optimum delivery of pregnant solution to the formation.

Grundfos motor protection is developed for pumps and not just the motor, and used together with an Interface Module ensures dedicated level control that offers greater protection, because parameters other than electrical conditions in the motor are measured. This makes possible timed stop/start routines that don't damage the pump or motor and helps avoid sudden outages.



Honeywell

Honeywell's Experion Process Knowledge System (PKS) control applications within mining including: • Crusher level control • Conveyor load-out • Inventory monitoring • Flotation and separation • Concentration • Digestion • Leaching • Slurry pumping • Process water • Smelting and refining • Blast furnaces • Coal preparation • Bulk material handling.

BeltAIS solutions address numerous conveyor belt maintenance requirements to deliver complete monitoring, including:

- **Cover Defect Monitoring:** a video-based decision support system that detects problems associated with the surface of a conveyor belt such as rips, splices and other defects.
- **Idler Monitoring:** a patented in-belt plug monitoring the health of all idlers on a conveyor from a single device in real time.
- **Belt Wear Monitoring:** an adaptation of Honeywell's technologies to cost effectively measure the belt wear online.
- **BeltAIS** provides an integrated solution set to users as an easier-to-maintain alternative to multiple standalone solutions. The conveyor belt monitoring suite offers a continuous, online view of conveyor operations via an intuitive, user-friendly interface to improve the effectiveness of plant maintenance and operations personnel.

Howden Software and Monitoring provide Mine Ventilation Solution

- Howden provides mine ventilation optimization. The result is both healthy air and safe levels of combustible gases at each point without excessive energy use.
- While the foundation of the SmartEXETM system is the software that allows conditions and demands to be mapped throughout the mine, it works in conjunction with highly advanced monitoring, feedback, control and communications tools to deliver optimum results. At the top level, the software runs in two separate servers, one providing the control system and the other the Human Machine Interface (HMI). If the tagging and tracking option is used, it operates via a third server. As an alternative to tagging and tracking, motion sensors at each defined ventilation area will detect the movement of people or vehicles into that area and adjust the ventilation accordingly.
- Tagging and Tracking is the state-of-the-art path to optimizing a Ventilation-on-Demand system. Underground workers and vehicles all carry electronic tags, and their movements through the different sectors of the mine are detected. The engine sizes of the vehicles are programmed into the system. When individuals or machines enter or leave a sector, the software adjusts the airflow to take account of local needs



Howden - Level 5 Optimization delivers the Right Amount of Air and eliminates Energy Waste

Level 3 Automatic flow control with the use of flow sensors allows more precise adjustment of the ventilation. Desired airflow is set by schedules or set by the operator, to switch fans on or off, or adjust their speed, as necessary. Sensors for gas concentration can be added to ensure that contaminated air is safely removed.

Level 4 Introduces a tagging and tracking capability. When a person or a vehicle moves out of one defined area and into another, local ventilation is adjusted to compensate. Every vehicle is tagged with information about engine size, creating a complete overview of the requirements of all personnel and plant.

Level 5 Brings complete system optimization. By building a fully comprehensive, real-time picture of the actual requirements, and directing the available air to where it is required, the system adjusts the main fans to deliver exactly the volume needed, eliminating energy waste and bringing considerable cost savings.

Adding Other Colfax Products to Howden Initiative

- Howden is a division of Colfax. Other divisions make the lubrication pumps needed for the rotating equipment in mines. With Cloud based O&M systems the other products can be integrated. Condition monitoring is one example
- Engineered to keep small problems from becoming disasters, the Colfax IN-1000 is an essential tool for total pump system visibility. You can assess expected performance on key indicators such as leak detection and bearing temperature, vibration, suction and discharge pressure against actual performance – and detect anomalies. This enables remedying dangerous seal leaks before they happen. When you're handling combustible fluids, you can't afford the trouble caused by an unmonitored mechanical seal leak. What you can afford is the safe and cost-effective operation of your plant with an aftermarket investment in the IN-1000, the market's most advanced solution for condition monitoring of thermal transfer pumps.



ITT i Alert 2 Equipment Health Monitor for Mining Valves and Pumps

ITT supplies slurry pumps, knife gate valves and other flow and treat productions for the mining industry. This equipment can be continuously monitored with a system which

- Tracks vibration, temperature & run-time hours 24/7/365.
- Alarm Checks every five minutes & alarms if equipment is outside normal operating conditions.
- Stores data once per hour & on alarm for 60 days. Stores the weekly average, minimum & maximum up to 5 years.
- Analyze Diagnose machine faults with vibration tools Fast Fourier Transform (FFT) & Time Wave Form Analysis.
- Rated for any industrial environment. IP67 water & dust resistant.
- Intrinsically Safe with a 3-year battery life (use dependent).
- Wireless Sync data via Bluetooth Smart enabled smartphones and tablets.

Examples in mining

ITT delivered nine, all stainless steel horizontally split case pumps to Phelps Dodge Morenci to assist in the SX/EW process. These pumps handle an acid bearing leaching solution used to recover copper from the low-grade ore. ITT now has 90 of this type of pump at the Morenci operation.



Kemira has Solutions

- Mineral processing is an energy- and water-intensive process. Together with urbanization and the rising demand for mineral-based products, mineral activities are increasingly taking place in water- stressed areas across the globe. Diminishing ore quality leads to higher consumption of water for extraction and processing in these already sensitive environments.
- Kemira states that it understands the needs for increased recovery of the mineral or metal and the importance of water recirculation and reduction in operations. Kemira's expertise in water quality and quantity management enables it to add value to water-intensive processes and optimize water use and re-use. Through extensive knowledge of full mine-to-mineral or metal processing and tailings management, along with in-house manufacturing of quality chemical products, it can tailor a solution to help improve production yield and reduce overall costs.
- Kemira offer solutions for producers of alumina, copper, nickel, gold, iron ore, coal, phosphate, white pigments, ceramics and aggregates.

Nalco Remotely Monitors and Controls Deposition at a Gold Mine

- The automated scale control system includes site-specific anti-scalant (developed after a series of water quality tests), a regulated dosing point and a remote deposit monitoring (RDM) control center, cross-linked to Boddington's processing circuit DCS.
- Described by Nalco as "a step change in scale control", the proprietary RDM technology measures scale formation rates in real time in a process side stream.
- The new technology provides 24-hour remote monitoring, by the Boddington metallurgical team and the system supplier, and means any responses to adverse scale events can be initiated with minimum delay, reducing the potential for any production interruptions or possible plant shut down.
- The system can also be configured to measure temperature, pH and conductivity of the process water to build up a picture of scale formation and the chemical drivers behind it.
- At Boddington, the integrated system the first system of its type in Australia, says Nalco has meant a tangible reduction in scale frequency and impact.
- "It (the RDM system) has been a good solution to the scaling problem," said Paul Petrucci, senior metallurgist at Boddington.
- He said that prior to the RDM commissioning Boddington was inadvertently dosing excess lime into the process water system during brief, unplanned outages and experiencing scale build-up.
- "As a result of the data from the RDM we can identify this previously misunderstood scaling event and alter the control scheme to prevent its occurrence.
- "The data the system is providing means we can be more aggressive with optimizing our anti-scalant dose rates and critically, match the required dose to the quality of the feed water." he said. "This is saving us money reducing anti-scalant purchases and improving operation of the process circuit."
- The pro-active treatment of potential scale problems has also benefitted the process water systems, improving the availability of water within the plant.
- "The RDM system is giving us a total understanding of the scale process and, ultimately, improving process water quality," Petrucci added.
- According to the manufacturer, the scale control program at the Boddington process plant is, in common with scale control in any mineral processing plant, a dynamic process. The company argues that water quality and consumption rates will impact on the frequency and intensity of scale events and require an equally flexible management system

Siemens

- Siemens provides process instrumentation for all types of mining. It provides automation of flotation cells. One aspect is controlling air flow to flotation cells. Maintaining the correct air flow to the flotation process is important for operating at maximum efficiency and optimizing recovery rates.
- Electro-pneumatic positioners are used to operate valves for optimum air control. These devices also save energy because they do not continuously bleed air. SIPART PS2 valve positioner offered by Siemens is said to have the following advantages
 - The industry benchmark for linear and rotary valves, double and single-acting actuators
 - Easy retrofit with a variety of mounting options including remote mounting
 - Simplified programming due to automating spanning capability
 - Advanced diagnostics including predictive maintenance

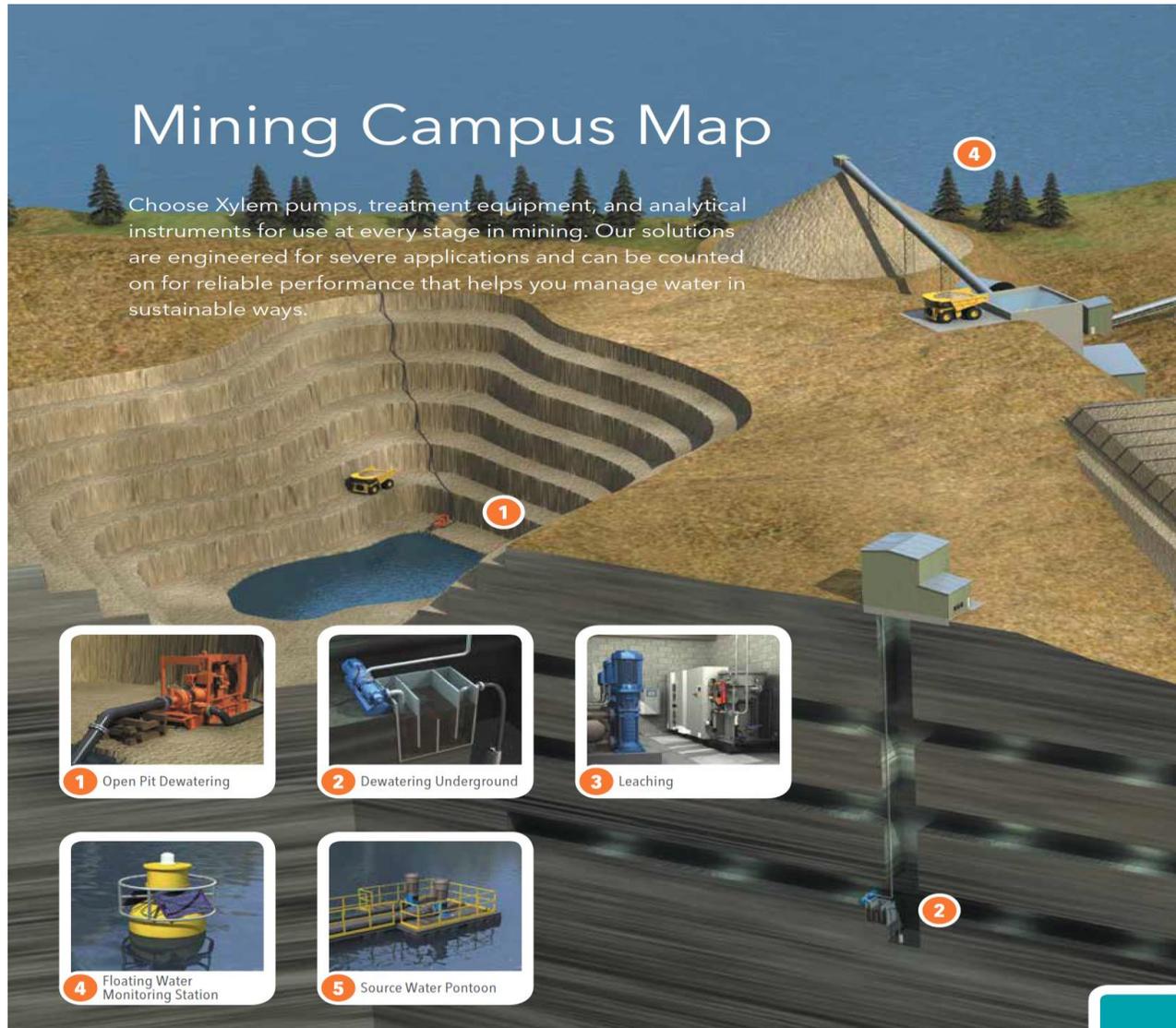
Gold Mining Operation more Profitable with Solenis Chemicals – Reason Less Downtime for Cleaning

- A gold mining operation in the Western United States was having difficulty regulating the acid and lime feeds in its process water system, leading to scale deposition in the water lines. Solids in the reclaim water were also contributing to the deposition problem, which required significant downtime for removing scale.
- The mine contacted Solenis for help because every hour of lost production cost the mine approximately \$70,000. After conducting a thorough system review, the Solenis team recommended that the mine implement a new treatment program using Zalta™ antiscalants. Despite pH swings and variable process flow rates, the Zalta antiscalant program significantly reduced scale deposition in the water lines and reclaim water. As a result, downtime for cleaning was reduced by more than three hours per month, which improved the mill's profitability by more than \$2 million a year.
- *If Solenis were remotely monitoring the operation and there were sensors at all critical points could downtime be further reduced. An additional 15 hours would be worth \$1 million*

Symboticware offers Underground Mining Solution

- Symboticware was founded in 2008 and is based out of Sudbury, Ontario, operating in the technology epicenter of underground mining.
- Symboticware's core product is the SymBot[®], a monitoring and data solution that delivers standardized information-based technology that enhances the productivity, safety and efficiency of mobile and fixed assets.
- Solutions leverage the customer's existing infrastructure and data reporting and visualization systems. Using open, standards-based solutions allows customers to leverage their current investments and knowledge, while facilitating interoperability and ease of integration.
- The evolution of the industrial IoT strategy, incorporated the development of a first-class ecosystem of partners, including Schneider Electric, OSIsoft, GE Intelligent Platforms, Toromont Cat, Wajax Power Systems, Valor TPMS and others.

Xylem Mining portfolio - The potential with IIoT to Leverage the Capabilities of Many Products in an Application



Aanderaa Data Instruments offers more than 40 years' experience in designing, manufacturing and selling robust, reliable instruments for measuring and monitoring in demanding environments.

A-C Fire Pump Systems has manufactured fire pumps and systems since the 1880 and today builds state-of-the-art fire pumps and turnkey systems for commercial and industrial applications. Flowtronex designs and manufactures a wide spectrum of packaged booster systems and controls, including RO membrane systems for industrial markets.

Flygt was founded in 1901 and is a world leader in the design and manufacture of dry and submersible pumps, mixers and related intelligent controls systems.

Godwin has led the industry for more than 30 years in the supply of fully automatic self-priming pumps, offering diesel and electric pumps to rent or buy for dewatering and transport.

Goulds Water Technology manufactures energy-efficient centrifugal and turbine pumps, controllers, variable frequency drives, and accessories, building on more than a century and a half of experience.

Leopold is a worldwide leader in the design and supply of systems for gravity filtration, clarification, denitrification, sludge collection and backwash water recovery for water and wastewater plants

Lowara is a world leader in stainless steel pump manufacturing technology, offering nearly 50 years of excellence in design and production for residential and commercial applications. Now includes Vogel series of pumps for heavy industrial applications

Xylem, cont.



PCI Membranes specializes in custom-built crossflow membrane filtration systems for liquid separation in the process industries, building on a 40-year legacy. MJK is a global leader in manufacturing flow, level and analytical instruments and controls for water and wastewater applications, with a more than 30-year history of innovation.

OI Analytical designs, manufactures and supports analytical instrumentation used to detect and measure chemical compounds, building on nearly 50 years' experience. Sanitaire innovative wastewater treatment solutions, introduced in 1967, include diffused aeration, sequencing batch reactor systems and membrane bioreactor systems for municipal and industrial use.

SI Analytics developed the glass electrode 75 years ago and continues to provide innovative sensors and instruments for precision measurement.

Sontek invented the acoustic doppler velocimeter in 1993 and offers diverse high-technology instruments to measure water velocity, flow, discharge, currents and waves.

Standard Xchange builds on a 50-year legacy to provide industrial heat transfer products that enable the efficient exchange of energy.

Water Equipment Technologies (WET), an early membrane technology innovator, has provided reliable membrane-based water purification technology and components worldwide since 1975. WaterLOG has designed and manufactured precision instruments for more than 40 years to measure water level, temperature, relative humidity, rainfall and other hydrometeorological measurements.

WEDECO has been a leader for more than 30 years in the environmentally friendly treatment of drinking water and waste water with ultraviolet light and ozone.

WTW offers the world's most complete line of instrumentation products for measuring and controlling wastewater, drawing on a 60-year history of proven sensor and analysis technology.

YSI provides sensors, instruments, software, and data collection platforms for environmental water quality monitoring and testing, building on a legacy that reaches back to 1948.