

Automation Technologies for Next-Level Crushing

How digital & data driven solutions deliver higher productivity, lower costs per ton, and zero harm.



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**Automation Technologies for Next-Level Crushing:
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What are the latest advancements in automation technologies? How do automation packages propel crushing circuits to the next level of productivity? And, how do crusher automation systems protect both human and equipment resources, allowing greater safety? Why is it imperative to track machine data and analyze key performance indicators within the crushing circuit? And most importantly, how can mining operations develop a culture that adapts to new solutions and strategies? This Telsmith-sponsored white paper addresses these key questions and more.

**An Introduction from Matt Haven,
President of Telsmith, Inc.**

“Telsmith is proud to present the second in our series of industry white papers. Looking back, our inaugural paper examined best practices within the permitting process. While the latter is an issue that’s integral to expansion, it’s a challenge that operations may face a finite number of times. Alternatively, this paper offers valuable automation technology solutions that directly affect productivity, profitability and safety, day after day.

To address these key questions, we’ve gleaned expertise from the mining management consulting realm. We’ve also reached out to several of the major automation component and system suppliers. Lastly, we’ve tapped into our own engineering team to outline how automation enhances cone crusher performance specifically.

Throughout this MINExpo® 2016 season and into the future, our mission is *“All In for Mining.”* That’s not just a slogan, but rather an ongoing commitment to our customers, particularly at a time when the mining industry faces ever-changing challenges.

As we share this solution-oriented white paper with you, we welcome your questions and feedback at the show, in the field and at the factory, and via our website. In partnership with you, we’re all in for mining.”

What's driving automation solutions?

Mining operations face a long, long list of challenges – which may include low commodity prices; declining deposit grades; aging equipment; strict environmental regulations; shrinking labor forces; spiking energy costs; and more. To remain profitable, it's never been more critical to minimize downtime, optimize processes, and reduce energy consumption, while complying with regulatory requirements, ensuring safe operations, and meeting production demands. Consequently, more operations are turning to automation solutions – whether within one or more circuits, or throughout the entire plant. The mining industry is moving step by step, and sensor by sensor, toward a greater investment in the digital technologies that drive greater productivity, safety, and lower operating costs.

Accelerating the future –

Digital innovation & the role modeling of new behavior

“Technology alone is not a cure-all. It's the people applying the technology in their daily jobs who will create the additional value,” says Richard Sellschop, a Stamford, Connecticut-based partner at McKinsey & Company, a global management consulting firm. “In the metals and mining industry, we work with companies worldwide to create strategies toward operational and productivity improvements,” he says. “Across all markets, there is the topic of digital analytics, and how the power of data can impact how companies perform. In essence, we work with our clients to ‘accelerate the future’ – helping them to make much better use of predictive analytics, and increased automation.”

Often, gaining productivity via automation is not hindered by the technology, says Sellschop, but by the company's organizational structure, and lack of specific capabilities. “A lot of companies have people who are good at what they do, but now they're being asked to do something different, something that is out of their comfort level,” he adds.

Sellschop and his colleagues have published numerous articles focused on digital innovations and mining productivity. Their article, *How Digital Innovation Can Improve Mining Productivity*, points to a decade of decline in the mining industry, and that achieving a breakthrough in productivity performance demands rethinking how mining operations work. The article describes digital technologies that are available and affordable enough to become operational across the mining industry. The deliverables include building a more comprehensive understanding of the resource base; optimizing material and equipment flow; improving anticipation of failures; increasing mechanization through automation, and monitoring performance in real time.

Sellschop says that we're at a point in the mining industry where we can finally grasp these breakthrough opportunities – yet companies pose many questions. How quickly do you adopt technologies? And, how quickly do you reap the value of it? How do you drive automation within companies, especially since the focus for so long has been doing more with less?

“Every CEO says ‘we focus on productivity,’ but so many operations do not have the strategies in place to monitor and measure that productivity. And, so many operations are focusing on one element of productivity, such as capital productivity, but it’s very rare that you find someone who is looking at the whole picture,” says Sellschop.

Just one of the issues that the article examines is that of improved anticipation of failures via condition monitoring. Noted is the fact that mining operations use less than one percent of the huge amount of data collected from their equipment. Using this data to predict component failures – rather than using a traditional time-based approach – helps reduce maintenance spending and prevent unplanned and costly downtime.

In their article, *The Dirty Little Secret About Digitally Transforming Operations*, which was recently published in *Harvard Business Review*, Sellschop and his colleagues discuss the challenges of changing human behavior. They point to the example of the “lean manufacturing” initiatives of the 1990s. The article reports that “everyone was learning new tools with Japanese names, but too many companies’ efforts to ‘become lean’ stopped at the tools – when it was actually the ideas underlying the tools that gave ‘lean’ its power by helping people become more effective.” They go on to stress that the exceptional organizations that succeeded understood that ‘lean’ requires a massive effort involving many changes at once, mostly centering on people and the role modeling of new behavior, the transparency of communication, and the fostering of new capabilities.

In a nutshell, Sellschop and his colleagues sum it up this way: “At many mining companies, there is often no executive designated as the clear owner of innovation. Going after these opportunities with the existing capability set will likely result only in a continuation of the status quo. To make these changes happen, a mining company must adapt their organizations by creating a clear ownership of automation among the top executive team; by refining the organizational design to create meaningful senior roles for people with technical skills; and by redesigning the annual planning and performance-management process to create a space (and a budget) for innovation.”

Automation innovators – What’s trending now & into the future?

Working with crushing OEMs, and also directly with mining operations, companies such as B&R Industrial Automation, IFM, and Siemens provide automation system innovations, and digital solutions – as well as the components, hardware, and software that makes mining automation work. Next, experts from these companies share their perspectives on the value of automation to the mining industry. Telsmith is proud to partner with each of these automation innovators to create cone crusher automation packages that deliver seamless operation within the plant.

B&R Industrial Automation

According to B&R, the company is committed to developing uniform and comprehensive automation solutions based upon 100-percent scalable hardware. “We offer mobile-rated products that meet the harsh, abrasive conditions typical to the mining industry; and we’re able to bridge the gap between the mobile and industrial worlds with one software package,” says Steve Boelte, territory sales manager for B&R. He is referring to the B&R-developed software called POWERLINK, which combines multiple devices under one platform.

Boelte says that Powerlink is an advantage for manufacturers such as Telsmith, as now they can standardize in ‘one world,’ versus the hassles of having to set up communications between different programs,” he adds, stressing that, “this brings costs down for mining customers, as they don’t have to buy multiple software programs; and they don’t have the time and labor involved in ‘marrying up’ certain software programs.”

B&R literature says that Powerlink lets system designers build completely integrated architectures with all remote I/O connected to one network. And because it is an open standard, it gives OEMs access to a wide range of devices such as sensors, motors, actuators and vision systems when developing high-performance networks, without being limited to a single component provider.

Telsmith’s TRAC10® automated cone crusher controls system is based upon the B&R Ethernet Powerlink platform. This integrated system is a successor to classic fieldbus technology, which often required different fieldbus systems for different automation tasks. Alternatively, Ethernet Powerlink allows even the most demanding tasks in the areas of controls engineering and motion control to be combined in a single network. “It provides an ideal foundation for future upgrades and modular machine concepts,” says Boelte. “Also, Powerlink has the bandwidth to communicate quickly from device to device with a simple cable,” he adds.

As to the adoption of new technologies, Boelte says that often customers are resistant to change. “To many, change means more work, and especially, change means ‘risk,’” he says. Perhaps they aren’t familiar with our software, he explains, so they assume they won’t know how to program it. “In reality, we offer many different programming styles, one of which will typically be similar to the way they are currently programming.”

When changing to a new protocol, Boelte stresses that it’s imperative to eliminate those risks, and find a new comfort level. “We do that by staying close to the customer and its engineering staff, to provide assistance in code development and training. Also, as they are considering automation, our local applications engineers will work with the mining operation to develop an understanding of how the automation system will work and what it will deliver, giving the customer a comfort level even before they decide to upgrade,” he says.

IFM Efactor, Inc.

Founded in 1969, IFM has shaped industrial automation with its focus on continual new developments in the field of sensors, controllers and systems. Bob Drexel is the IFM product manager for vibration monitoring, level control, and temperature control. Among its product lines, IFM provides temperature and pressure sensors, and mobile vehicle controllers to a variety of industrial customers, and to OEMs such as TelSmith.

“Versus ‘old-technology’ sensors which are mechanical or hybrid electromechanical devices, today’s sensors use solid state electronics, making them a far more durable product than those of the past,” says Drexel. He explains that sensors are integral to *condition monitoring and predictive monitoring*, which assesses the operational worthiness of the machine; tracks its performance; predicts production outcomes; and helps companies develop solid preventive maintenance programs, while preventing costly downtime due to component failure.

Consider the following: In a recent industry paper, a coal mining operation reported that their condition monitoring system identified at least ten pending failures per year, preventing costly damage and saving an average of 100 hours of maintenance downtime and labor annually.

Sensors gather data and send digital information to the controls system where it can be merged with other operational and business information to relay a complete, detailed picture of machine, plant, and company performance. From the specific to an overview, the digital information delivers a complete operational and production history – answering questions such as:

- What’s it cost to run the machine at full capacity?
- What’s the cost in wear and tear at 80-percent or up to full capacity?
- How much production can we get while still protecting the machine?
- What’s the “sweet spot” for operation?
- Are we meeting daily and hourly production targets?
- Where do we get the best cost yield?

“Today, this collection and analysis of digital information is what the industry calls ‘analytics’, or ‘Big Data’, or mining information from ‘the Internet of things,’” says Drexel. He explains that the trend is streaming digital information from the equipment to create algorithms by combining data from the machine, with key production and business data, to create a performance indicator that conveys a better understanding of operational costs, price performance and returns.

“All of our sensors have a micro-controller in them, which means you have complex information that is being calculated and shared between devices,” says Drexel. For example, he says, the pressure sensor gives a pressure value or PSI; maximum and minimum pressure; pressure spikes; and the temperature measurement of the electronics. “All of that information is in the micro-controller, and is communicated digitally to allow an analysis of the complete process,” he says.

Siemens

Siemens offers mining industry-specific, integrated automation solutions from the sensor level to complete process automation. Based out of the Siemens AG offices in Karlsruhe, Germany, Mark Yseboodt is the industry sales development manager for minerals and energy. When talking with customers, he frequently discusses “the value chain of electrification, automation, and digitalization,” and the opportunities it offers to today’s mining operations.

“Siemens can not only automate the mine – we can also electrify the mine by designing systems that generate, distribute, and use energy as efficiently as possible. We also provide digitalization that seamlessly connects hardware, software and data across all domains, while turning that data into a powerful tool,” he explains.

Ensuring adaptability to existing mining systems, Yseboodt says that Siemens automation solutions are highly scalable and are designed with open standards for easy integration of electrical devices, drives, and process instrumentation; and with a standardized approach for shorter engineering timeframes and faster equipment startup.

Regarding crushing, Yseboodt stresses that automation and digitalization allows mines to monitor and optimize all crushing processes via “data mining.” Captured data provides accurate, real-time machine condition monitoring by tracking a complete set of key performance indicators, from feed rates to power consumption, and production output. Condition monitoring also allows operations to compare one crushing circuit against another, for example, while determining true maintenance intervals, and the potential need for wear parts replacement. “Not until recently have mining operations started to mine that data effectively,” he adds.

One has to admit, says Yseboodt, that within the mining industry, automation has not been driven to its highest potential thus far. He stresses that an acceptance of automation solutions is not related to certain regions of the world’s mining industry; but rather to the “culture” of the particular mining company. “With a mindset toward modern technologies, some companies lead, while others lag behind. It always takes someone to open the door, set an example, and others will ultimately follow. That is the traditional way of transforming an industry that has arguably been in crisis,” he says, adding that, “unfortunately, it sometimes takes a crisis for certain mindsets to change.”

Operations must continually innovate to remain competitive. “Automation and the collection of key performance data is so very important, as without it, the operation is blinded and it cannot optimize its processes to the fullest extent,” says Yseboodt.

Cone crusher automation – what’s in it for you?

Utilizing the right cone crusher automation system optimizes and protects the machine, while also relieving any burdens on a total plant automation system. Importantly, the right cone crusher automated controls package will allow integration into the network of any plant controls system, old or new, and regardless of type or brand.

Accessing the right automation package makes it easier for plant automation engineers, and maintenance personnel to focus on controlling the flow of the entire plant, while knowing that the cone’s automation program is doing its job to optimize and protect that machine.

Cone crusher automated controls systems deliver a number of benefits, which ultimately result in higher productivity, lower costs per ton, and increased safety.

Optimum production capacity

Automation allows operations to utilize crusher horsepower to the fullest extent while protecting the crusher.

Optimum closed-side settings

Without automation, operators will typically run at a “safe” setting that is not likely to pose an issue; or require close monitoring. With an automated cone, the provided data and the protection features means that operators can run at the optimum or tighter setting, while knowing that they will not damage the machine – and that means more production out of that machine.

Remote operation

Monitoring and operation can be done entirely from the control tower; further increasing safety practices by minimizing human interaction around the machine. Importantly, optimum crusher settings can be maintained and/or modified remotely at any time, even while crushing – allowing greater productivity and higher quality products.

Automatic liner calibration & wear tracking

The automation system calculates and tracks the liner wear rate, and automatically adjusts the crusher (without interrupting the crushing process) based on that wear rate throughout the daily production cycle, to ensure in-spec products. Optimum crusher settings are consistently maintained. Operators can initiate an automated calibration process via a touch screen monitor that will automatically “zero-out” and reset to the proper setting.

Real-time monitoring

Sensors continuously monitor oil temperature and flow; hydraulic temperature and pressure; amp draw; and electrical systems – while making adjustments and providing advance warnings to operators well before any potential harm to the machine could occur. The automation

system provides automatic overload protection and prevents damage due to potential upper frame bounce and high motor load.

Automatic data logging & trending

Automation systems log and store operating data on the motor, hydraulic relief, anti-spin, lubrication temperatures and pressures, and closed-side settings. Historical records and trending data provide additional troubleshooting tools; as well as the capability to create solid predictive maintenance strategies. Trending data allows operations to properly analyze productivity, while maximizing machine performance.

Easy & accurate troubleshooting.

Alarm histories and trending reports can be accessed from the control room or from a remote location outside the mining facility. This data allows instant troubleshooting from the manufacturer, while also allowing operators to conduct troubleshooting onsite, and communicate high-level operational data to their central headquarters.

Minimal installation costs

Stand-alone crusher control systems can be installed economically into any plant, while providing operators with the many advantages of automation, while eliminating the time, labor and costs of a complete rework of plant controls.

Next-level crushing – Optimize utilization & performance

“If you’re not utilizing your crusher to its fullest extent, it’s like wasting capital by buying a machine that’s too big. We want an operation to ‘run right up to the edge’ all day long without damaging the crusher. The automatic protection system on the controls package allow you to do that as it monitors horsepower, and protects the machine from upper frame bounce or high motor load,” says Telsmith Engineer Shamus Coughlin as he discusses the design features of the latest version of TRAC10®, which is Telsmith’s automated controls system for its T-Series™ Cone Crushers. The system includes the ability to run up to four crushers with a single touchscreen; as well as the capability to connect to the system via a Wi-Fi hotspot and laptop, or with a Smartphone.

Coughlin notes that the Telsmith engineering team has designed its controls system based upon the latest digital advancements and the need to provide solutions that optimize utilization. For example, he points to a new auto-power feature that automatically maintains the desired horsepower level on the crusher, while an auto-wear feature automatically tracks liner wear and makes closed-side setting adjustments on the fly without the operator having to input anything. Also, the system allows operations to run at an optimal closed side setting. “There is enough protection provided on the machine that operators can run at a tighter setting and get a percentage more in production without damaging the machine. Without automation, you don’t have the data to know if it’s safe to run it tighter, so the operation stays in what they know is a safe setting,” he says.

In order to track liner wear, it's necessary to periodically calibrate the cone crusher, explains Coughlin. Calibration is quickly completed by allowing the hydraulic anti-spin system to detect a zero setting. Upon each calibration, liner wear is calculated, allowing the system to provide warnings when liner wear reaches levels from 50-percent, and in increments up to 100-percent. "Also, the system takes calibration to the next level by trending what the average wear rate is over many calibrations," he adds.

Among a number of screens on the touchscreen control panel is the crusher status screen which is considered the "mission control," for the system and provides the management of the crushing circuits. The status screen provides data on the lubrication and hydraulic systems, crusher settings, percentage of liner wear, operating hours, and links to other informational screens. Data is stored on an 8G USB; and the PLC stores one year of data per machine.

As the system is based upon the Ethernet Powerlink protocol, digital communication is reliable and in real time, which is its biggest benefit, says Coughlin. "All the data from the crusher comes back to the PLC over Powerlink, and the more real-time that data is presented to the PLC, the better that we can optimize and protect the machine," he says.

With this level of automation on a crusher, operations can get remote access from outside the pit or mine. They have access to troubleshooting from the manufacturer; or they can pull data off their memory card at the crusher level and easily troubleshoot at the facility.

Importantly, Coughlin says that the TRAC10® system allows integration into any plant. "No matter what the network of the plant, our system will be able to 'talk' to their system," he says.

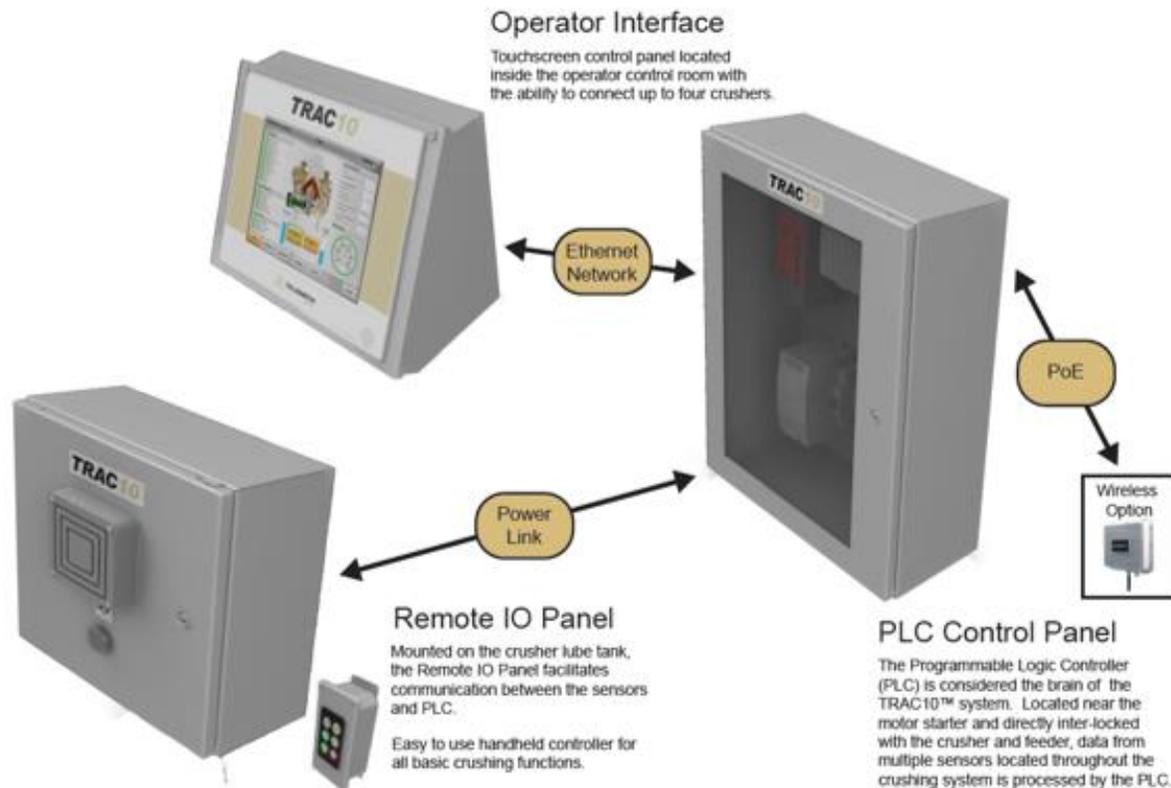
What are the typical components in the automated controls system package?

A typical system is comprised of a Programmable Logic Controller (PLC) Panel; an Ethernet Communication Hub; an Ethernet Network; an Operator Interface Terminal (OIT); and a Crusher Panel.

The PLC is where the base program resides and where all the calculations are made. Hardware connections are made to motor starters that supply or receive instructions from the PLC. The PLC and the communication devices are supplied in an enclosure for mounting inside the motor control room. The Ethernet Communication Hub is located inside the PLC enclosure.

Located inside the operator control room, the Operator Interface Terminal (OIT) or the control panel is a touchscreen crusher operation unit. All trending data is stored in the unit on a memory card.

The Crusher Panel is located at the crusher lube tank. It centralizes the communications from the many crusher sensors and routes them to and from the PLC, which is located in the motor control room.



Make automation work for you

The benefits of automation are many, but sometimes these benefits are not realized, due to poor planning, insufficient training and a lack of understanding regarding certain maintenance requirements. Consider that automated controls systems incorporate computers and sensors of various types, and this often requires a different level of expertise and training.

Processors, sensors, and software have typically not been a strength for the industry's "hard contact" electrician. As such, it's important to develop expertise within your organization. Even if you rely upon outside vendors for troubleshooting and repairs, your workforce should be trained on operating the system and maintaining the electronic components.

It's important to develop a strong relationship with your crusher and/or automation system supplier. Choose a reliable, service-oriented company whose experts know your systems, and can solve problems quickly. A stable, long-term relationship with that "go-to" company will also assist in establishing valuable, pre-planned strategies for support and maintenance, which includes training, parts inventory, and the availability of local expertise.

To make automation work, there must be a commitment at the top, and an eventual buy-in at all levels of the operation. The appointment of an in-house company systems specialist and a close relationship with the manufacturer will pave the way for ease of transition, overall

acceptance, and a successful automation program that leads to higher productivity, lower costs per ton and zero harm.

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About the Author

Carol Wasson is a veteran freelance writer for the aggregate, mining, and construction industries. Her focus is working with equipment manufacturers, and their marketing, engineering, and application specialist teams to develop valuable content for both print and digital marketing, advertising, and PR materials; and to create expert feature editorial submissions for the global trade press. Over nearly two decades, she has authored hundreds of processing solutions case studies, and technical articles which appear in major industry publications worldwide.

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