

Complete Digital Factory Integration and the IIoT



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INTRODUCTION

Tomorrow’s factories will use Multi-Tasking machines, advanced manufacturing cells, and robotic automation systems together with complete digital integration to achieve free-flow data sharing. In such an environment, connectivity of machines and devices allows for enhanced process control, operation monitoring, and analytical capabilities — all within a plantwide or multi-plant cybersecure network connected to the Industrial Internet of Things (IIoT).

Joint efforts of machine tool builder Mazak Corporation, manufacturing communications platform provider MEMEX, Inc., and IT leader Cisco have achieved a significant leap forward with the successful digital integration of the Mazak factory. Mazak now accesses and uses real-time manufacturing data to improve overall productivity and agility along with responsiveness to customer and market changes. This project also resulted in the development of a launch platform, called SmartBox, for an easy and secure entrance into the IIoT.

SMARTBOX PROJECT OBJECTIVES

With this launch platform, Mazak sought to achieve the following project objectives:

- Create a digitally integrated platform to further improve manufacturing efficiency, particularly in regards to machine utilization and associated downtime
- Track machine utilization accurately using Overall Equipment Effectiveness (OEE) as a standard measurement
- Produce machine, machine operator and plant productivity analytics and KPI reports management and production teams can act on
- Establish a secure and scalable plantwide network to connect machines (new and legacy) and other equipment to track OEE
- Provide the means to grow the use of sensor technology for monitoring the cutting characteristics of machines, thereby enabling predictive maintenance

TECHNICAL/TECHNOLOGY APPROACH

The SmartBox launch platform project incorporates several advanced technologies, one of which was the communications protocol MTConnect.® On the software and hardware side, the MERLIN manufacturing communications platform works in tandem with hardware elements that included the Industrial Ethernet 4000 Series Switch.

MTConnect

The open, royalty-free MTConnect manufacturing communications protocol fosters greater interoperability between manufacturing devices and software. The MTConnect standard provides connectivity and the capability to monitor and then harvest data from the entire production floor: machines, cells, devices, and processes. The standard makes this possible, because it’s based on XML and HTTP Internet technology for real-time data sharing.

MERLIN

MEMEX’s full-featured MERLIN manufacturing communications platform monitors and provides operational metrics and KPI reports on operations, analytics of machines, test stands, and other equipment in a manufacturing plant. The software connects to any machine, old or new, using the native MTConnect protocol or hardware adapters for older machines that permit them to communicate via MTConnect.

The MERLIN software generates numerous operational metrics and the standard reports and automatically sends them to a variety of departments, cells and managers. Reports can be generated on a daily, weekly, or monthly basis through an email alert engine, including daily production, quality, constraints, throughput, operator and utilization metrics.

Typically, MERLIN metrics and reports focus on a specific machine, and display performance-based gauges and readouts, which often resemble automobile speedometers. Other reports use graphs that compare all connected machines and that are often based on a variety of critical metrics categories, such as uptime and stoppage.



ANALYTICS



MONITORING



SECURITY



The SmartBox is one of many innovative components in Mazak's dynamic iSMART Factory™ concept, which enables complete digital integration of advanced manufacturing cells and systems to achieve free-flow data sharing in terms of process control and analytics.

Industrial Ethernet 4000 Series Switch

The Cisco® Industrial Ethernet 4000 Series Switches offer an industrial machine connectivity solution for a secure, scalable way to connect machines to OEE platforms. The 4000 switch supports the MTConnect open standard that's used to track machine operation, utilization, and overall efficiency.

The all-in-one 4000 not only connects machines to OEE solutions, but it also provides security and computing capabilities. The switch's technology resolves the problems typically associated with access, management and scalability, thus enabling both IT and manufacturing-operations people to work together to drive machine efficiency and visibility.

SmartBox

Combining MTConnect, MERLIN, and the 4000 switch, the SmartBox from Mazak provides connectivity of machines and devices for enhanced monitoring and analytical capabilities along with cybersecurity. The unit mounts to the side of a machine without the need for a direct connection to a machine's electrical cabinet. With several standard input or connecting ports, the SmartBox quickly and easily connects any standard off-the-shelf sensors to the system for machine-data gathering and condition monitoring. One SmartBox can serve several machine tools, along with other associated manufacturing equipment, depending on the application.

The SmartBox offers network isolation, which prevents unauthorized access from both directions, that is, to or from the machines and equipment on a network. SmartBox also satisfies the critical security concerns of IT departments when connecting legacy equipment to a plant's main network for the purpose of gathering manufacturing data through the MTConnect protocol.

The SmartBox is one of many innovative components in Mazak's dynamic iSMART Factory™ concept, which enables complete digital integration of advanced manufacturing cells and systems to achieve free-flow data sharing in terms of process control and analytics.

The iSMART Factory™ concept also incorporates Mazak SMOOTH TECHNOLOGY, a complete process-performance technology platform that includes the various levels of the new Mazak MAZATROL Smooth CNC as well as advanced machine

hardware and servo systems. SMOOTH TECHNOLOGY represents a key first step towards digital factory integration.

MACHINES AND OTHER EQUIPMENT

Of the 65 machines, paint test stands, and other devices connected through MTConnect at the Kentucky Mazak factory, the initial complete installation of a machine-monitoring system encompasses SmartBoxes, six horizontal machining centers (HMCs) in an automated flexible manufacturing system, three other HMCs in a similar automated system, and six large bridge-type milling machines. This beta test section of the plant represents a cross-section of equipment and has helped establish a performance benchmark and related training protocols that easily expand across the entire machine-tool manufacturing plant.

A series of 60-inch display monitors presents real-time utilization data in the test section of the plant and cycles through a series of KPI reports that are viewable for short periods of time using MERLIN. The Cisco switch enables network isolation, which creates a higher level of cybersecurity for enhanced machine monitoring and analytics. The majority of reports focus on a specific machine, and display performance-based gauges and readouts. Other reports compare all connected machines according to a variety of critical metrics, such as uptime and stoppages by category.

PROJECT RESULTS

Almost as soon as Mazak produced reports on its plant floor, the company experienced a six-percent increase in utilization. Without any other actions taken, these immediate gains resulted from operators simply being aware of how their time management affected machine utilization. To date, efforts to reduce downtime — as based on factory-floor report data — have yielded a more than double-digit percentage improvement in machine utilization for the monitored machines. As a result of this windfall machine capacity, Mazak reduced operator overtime by 100 hours per month and brought 400 hours per month of previously outsourced work back in house.

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The most significant gain is Mazak's capability to perform predictive diagnostics through monitoring sensor packages on machines and other equipment. Instead of having to reconfigure an entire system's network software (past requirement for incorporating such sensors), the company uses predictive diagnostics through a SmartBox, regardless of machine type, model, or age.



Also a first for Mazak, top management, as well as everyone across the company's shop floor, has access to the same actionable reports and/or monitored data through mobile devices. Shop floor employees now have easy-to-interpret, visual report formats that give them at-a-glance information about how machine tool conditions are influencing efficiency. Bar graphs that summarize activity across several machines simultaneously inform supervisors and managers of trends useful for decision making and long-term planning, such as when additional operator training may be needed.

The company is now fully aware of program stops, feed holds, spindle overrides, tool changes, and other reasons why a machine is idle. By analyzing collected data, Mazak personnel are able to identify and easily fix such downtime-related inefficiencies to improve overall utilization. Mazak has also gained a security strategy for individuals outside its facility network as a result of the network isolation the Cisco technology provides. Another new advantage is that individuals, such as equipment suppliers, can log on to Mazak's network and have access to only those machines Mazak permits through SmartBox technology.

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SUMMARY

The results of the collaboration among Mazak, MEMEX, and Cisco, utilizing the MTConnect standard, represent groundbreaking progress toward the total digital integration of factories, where access to real-time manufacturing data is used to improve overall productivity efficiency and responsiveness to customer and market changes.

About Mazak

Mazak Corporation is a leader in the design and manufacture of productive machine tool solutions. Committed to being a partner to customers with innovative technology, its world-class facility in Florence, Kentucky produces over 100 models of turning centers, Multi-Tasking machines, and vertical machining centers, including 5-axis models. Continuously investing in manufacturing technology allows the Kentucky iSMART Factory to be the most advanced and efficient in the industry, providing high-quality and reliable products through its Production-On-Demand practice. Mazak maintains eight Technology Centers across North America to provide local hands-on applications, service and sales support to customers.

About Memex

MEMEX Inc. is a leading Industrial Internet of Things (IIoT) technology platform provider that connects to any machine and delivers real-time manufacturing productivity metrics. Industrial strength MERLIN software provides Overall Equipment Effectiveness (OEE) efficiency metrics in real time, from shop floor to top floor. MERLIN connects to any machine, old or new, utilizing MTConnect, other protocols or hardware adapters. The MERLIN magic delivers a 10% to 50% average productivity increase so that any manufacturer can achieve world-class standards of excellence. Based on just a 10% increase in OEE, customers see profit improvements of 20%-plus and payback in less than four months.

About Cisco

Cisco is the worldwide leader in IT that helps companies seize the opportunities of tomorrow by proving that amazing things can happen when you connect the previously unconnected. At Cisco, customers come first, and an integral part of our DNA is creating long-lasting customer partnerships and working with them to identify their needs and provide solutions that support their success.



