

Tracking tooling data with TDM Systems' tooling management software helps manufacturers optimize tooling lifecycles and toolroom resources.

Taking the Factory's Pulse with Shop-Floor Monitoring

Implementing the latest machine tool data collection and monitoring systems gives manufacturers key insights to improve factory processes

Patrick Waurzyniak
Senior Editor

To run factories at optimal efficiency, plant managers need to mine real-time shop-floor operational data as fast as possible, to quickly determine where and when any manufacturing process bottlenecks occur. With today's shop-floor data management software and related hardware solutions, manufacturers can leverage more key production performance data than ever in order to fine-tune their manufacturing processes.

Machine tools are much more connected today than in the recent past, with more networking options available through the rising popularity of MTConnect, an open-architecture machine communications protocol that is becoming more

available with new machines. The MTConnect protocol also is easily adapted to older legacy machining systems through the use of MTConnect adapter hardware and software agents. With the more cost-effective software options offered by newer cloud-based monitoring systems, manufacturers also have easier-to-implement, cheaper solutions for collecting and monitoring machine tool process data.

Gaining a Foothold

In spite of the many advantages offered by monitoring machine tools, the vast majority of machine tools today still run without being connected to the latest shop-floor data collection and monitoring systems. With an effective monitoring program, shops can see exactly what any machine tool is doing at any time, gathering data on overall equipment effectiveness (OEE) and many other key operational statistics. “It all starts off with connectivity—if you don’t have connectivity, you don’t have anything,” said David McPhail, president and CEO of Memex Automation Inc. (Burlington, ON, Canada),

MERLIN MES, Memex manufactured the first configurable MTConnect hardware adapter, called a Universal Machine Interface, McPhail noted. The company has several ancillary products that work in conjunction with the interface to help get the signals out of the machine a lot quicker, he said, and Memex’s systems work with communications protocols including MTConnect, FANUC FOCAS (FANUC OpenFactory CNC API Specifications) and OPC (OLE for Process Control).

At IMTS, Memex introduced a new MTConnect-capable board that McPhail said is plug-and-play on the FANUC I/O Link. “It’ll basically pick up any discrete signal within the FANUC control in the X and Y plane,” McPhail said, “so pretty much anything that you can get digitally out of the control, we can actually map to an MTConnect tag.”

What Shops Want

While every machine shop manager wants to boost productivity, most manufacturing operations actually overestimate machining efficiency, notes McPhail. Without effective

shop-floor data monitoring, they’re essentially operating in the dark. “They’re looking to know what they don’t know,” McPhail said of those that add machine data-monitoring systems. “When you ask most people where they think their efficiency is, the actual number is really quite different. There is a perception-reality disconnect.”

A common refrain among industry quality gurus and data management suppliers is: “You can’t improve what you can’t measure.” According to many industry estimates, only about 3% of machine tools today are monitored, leaving

a huge chunk of the industry without a true statistical view of their manufacturing operations. “I frankly think that’s an overestimation,” said Ron Pieper, manager, VizProducts, for manufacturing consulting firm TechSolve Inc. (Cincinnati). “The forward lookers are right in the assessment of what could be. The reality is we just need more connections.”



Photo courtesy Mazak Corp.

After installing the MERLIN MES system from Memex Automation, Mazak’s machine tool manufacturing facility in Florence, KY, saw a 42% improvement in overall equipment effectiveness (OEE) and 100 hours of reduced operator overtime per month.

developer of MERLIN (Manufacturing Execution Real-Time Lean Information Network), a manufacturing execution system (MES) and shop-floor monitoring solution.

With monitoring systems from companies like Memex, machine shops get data that show each machine’s efficiency and also gauge overall shop productivity. In addition to its

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Simpler, less-expensive monitoring tools are now available, leveraging the established protocols to make installation at shops easier. “When I go into a company, I get the guys that are bought in,” Pieper added. “But there are some that are going to be overwhelmed with some of this, so we try to get to the basics.” The TechSolve MTConnect-compliant Viz line of shop-floor monitoring products include the more full-featured ShopViz, and the MiniViz announced at the MTConnect Conference in April.

“It all starts off with connectivity—if you don’t have connectivity, you don’t have anything.”

The MiniViz solution is more limited in scope and it’s designed to be more of an introductory data-monitoring tool, Pieper said. Automated collection of two or three pieces of data from each machine is a good start in many cases, Pieper added, noting that part of the battle is changing the culture. “There’s shops out there that are still running tapes and using floppy disks,” he said.

More people than ever are looking to automate their processes, said Greg Mercurio, president of Shop Floor Automations Inc. (La Mesa, CA), a reseller of Predator Software’s manufacturing data collection suite and of the cloud-based Scytec data monitoring solution. “Time is money, and now there’s more in-process probing and automatic collection of data,” he add. “The key is everything is done at the machine tool.”

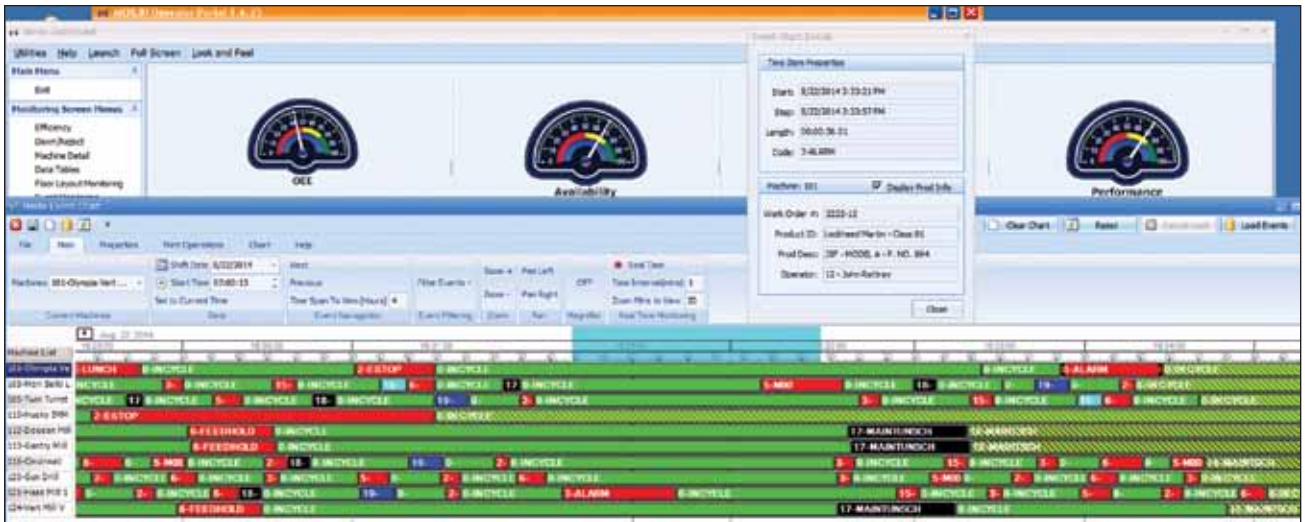
The MTConnect protocol is a great solution, Mercurio noted, but he said it will take some time to become more fully accepted in the industry. “The biggest problem is that the machine builders haven’t fully embraced it,” said Mercurio, adding that even some of the machine builders that have endorsed MTConnect don’t promote the protocol as much as they could. “In two years, I think people are going to understand what MTConnect is and we’ll see more people embracing it. The challenge is educating people about it.”

Using either the Scytec or Predator solutions, customers can immediately start collecting data on the status of their machines, with the systems automatically telling shop managers what they need to know about part counts, cycle time, program number, and many other key variables, Mercurio said. “The new trend is for PCs on the shop floor and leveraging paperless manufacturing solutions,” he added. “The factory floor is going digital and embracing wireless, leveraging Windows tablets, iPads and thin clients, which offer lower cost of ownership, flexibility and ease of deployment. With this new trend comes software to manage, control, view and deliver a complete ‘digital package’ to the shop floor for the operator to streamline the process. This provides complete revision control to shop floor.”

Real-Time Data Delivery

For shops looking to improve performance, getting data off the factory floor in real time is critical. “Real-time information is probably the Holy Grail of manufacturing,” said Memex’s McPhail. In many cases of smaller shops, an operation with

Image courtesy: Memex Automation



The Memex MERLIN system's operator portal shows a wide array of key real-time plant-floor operational metrics that help manufacturers improve factory productivity.

only five or so machines can view performance through the manager's window, he said, while larger operations require an

automated solution. "It's important that the company has a scorecard," he said. "Without having a baseline, how do you know you're improving?"

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A typical Memex customer has 12 or more machines, he added, making that type of operation more difficult to monitor without an automated system. Monitoring systems now are fairly nominal in cost at about \$3000-\$5000 per machine installed, McPhail noted, and they typically pay themselves off quickly with performance improvements that easily outweigh installation costs.

At machine tool builder Mazak Corp.'s Florence, KY, plant that builds multitasking and five-axis turning and milling machines, installing MERLIN helped the plant improve OEE by 42%, reduced operator overtime by 100 hours per month, and returned 400 hours per month of previously outsourced work to the factory. "Capacity utilization is probably the lowest-hanging fruit in the plant," McPhail stated. "The reality is you can take the information, put it through some pretty simple things and get improvements." These metrics include OEE, which is probably the most all-encompassing, McPhail said, and

machine utilization, of which achieving 85% is considered world-class.

Whether a shop is large or small, automating with real-time delivery of shop-floor data is key. “One of the trends obviously is to try to get your data as accurate, as timely, and as unbiased as possible,” said Jim Finnerty, product manager, ShopFloorConnect, at Wintriss Controls (Acton, MA). “A lot of the shop floor data—when was the machine running, when was it not running, how many scrap parts did you have, how many good parts were produced over a given time period—has to be manually entered. And oftentimes, it’s manually entered by the very people that are going to be judged on the results of that data. Even if it’s not your fault, nobody wants to be the low production guy for that shift.”

Working primarily with fabrication shops in the metalforming market, Wintriss developed its ShopFloorConnect software that teams with the ShopFloorConnect Machine Interface (SMI), a simple touchscreen operator terminal that along with the software tracks the performance on any machine tool or related equipment. The system has built-in Ethernet capability, Finnerty said, and it can connect with barcode readers or any other type of machines found in fabrication shops.

“They’re looking to know what they don’t know.”

Automatically collected data is inherently less-biased than manually reported data. “The trend is toward more and more machines communicating with some sort of software to let them know what they’re doing,” Finnerty said. “One of the impediments to that though is that people don’t generally

throw away or replace perfectly good machine tools just to get the latest one that can communicate.”

Wintriss’ first machine-mounted data-collection terminals were sold in the 1990s. The latest version, the SMI, works in



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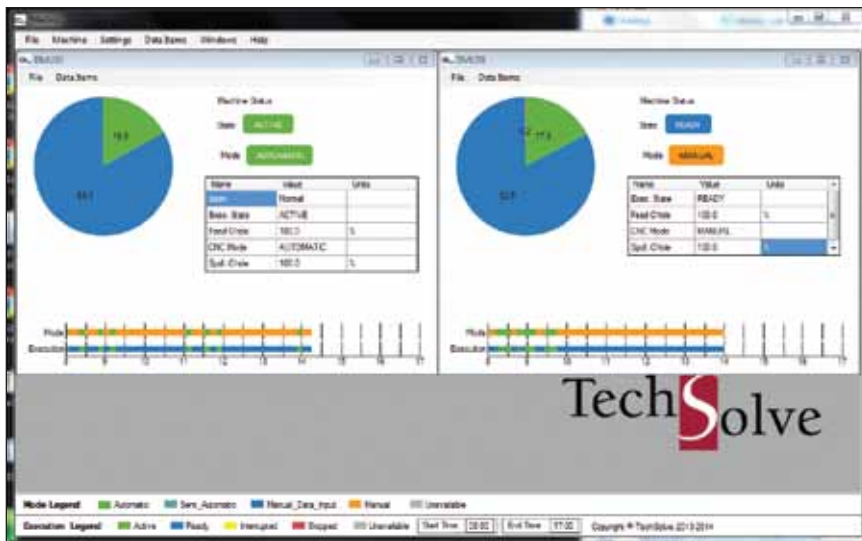


Image courtesy, TechSolve Inc.

The MiniViz shop-floor data monitoring solution from TechSolve serves as an introductory tool for shops looking to implement data-collection and monitoring systems.

conjunction with the ShopFloorConnect OEE tracking software, which can be used on newer machines or retrofitted onto older, legacy machine tools, noted Finnerty. “We’ve developed a simple device, what I like to call a data-collection appliance, that you can install on literally any machine—these are installed on everything from multiaxis CNC machines all the way to an air compressor tucked away in a back room.”

Envisioning the Smart Factory

With today’s factory production tools, manufacturers have more ability to link machines together with sophisticated software and sensors that tell an immense amount of detail about factory processes. “Forcam has a vision for factories of the future. We want to create a world where machines are ‘talking’ with the products that they are producing,” said Franz Gruber, founder and CEO of Forcam GmbH (Friedrichshafen, Germany), developer of the Factory Framework MES software. In such environments, production systems can leverage smart machines and components that can “talk” to each other, he noted, using data on the cloud and communicating with people in the factory and to others connected to manufacturing networks via smartphones or computers.

“The new world of ‘smart factories’ places enormous demands on information technology,” Gruber said. “The first step to its creation must be to form a ‘Cyber Physical System.’ Every event that occurs in real terms must be ready virtually and in real time. These events must be read with great effort from signals and information collected from controllers of various systems and machines. In addition, the entire production system must be ‘cloud capable,’

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Shops today are looking to use advanced shop floor management to unite production and planning as closely as possible, Gruber said. “Near-zero downtime and worry-free productivity is the motto—no standstill and no equipment failure,” he said. “With the right shop-floor management technology, machines can report themselves when they come to an ‘abnormal condition,’ then we can take the right precautions at the right time to quickly eliminate wastes and errors. They are looking for software that crunches big data in real time, and one that uses complex event processing and in-memory technology and the power of the cloud to gather and process information in real time to accelerate shop-floor performance.”

Such systems can display shop-floor performance indicators such as OEE for any factory in any location or time zone in the world and in the right language, Gruber added, and that data can be displayed on the Web and on mobile or shop-floor displays, in a world-class shop-floor management system. “Forcam’s technology offers a machine data-collection engine with seamless integration with all machines, regardless of the manufacturer, control type or age of the machine,” said Gruber.

The MTConnect protocol has successfully emerged as a standard machine interface protocol that has been widely distributed in North America and some industry leaders in Europe, including Forcam, have begun to globally use this royalty-free standard, Gruber noted. “MTConnect standardizes links between systems, applications, and entire factories with each other to provide an integrated overall manufacturing system. In addition to MTConnect, Forcam’s technology supports a variety of real-time plug-ins to machine CNCs and PLCs, including manufacturer-specific drivers such as

FOCAS for FANUC, THINC for Okuma, OPC-UA and OPC-DA for PLCs, and many other drivers for Haas, Heidenhain, Siemens, and Allen-Bradley.”

With Forcam’s Factory FrameWork software, users get more than just a management tool, he added. “It is a system and a philosophy that the whole team, from shop-floor workers and supervisors to senior managers, can employ to create a more productive, competitive, secure and profitable business,” Gruber said. “This is a rational response to the challenges from

globalized manufacturing that can create a sustainable competitive advantage for manufacturing in advanced economies.”

Tracking Tooling Data

Another critical piece of shop-floor data management is the ability to track manufacturers’ tooling usage, and new systems are available to help manufacturers view and access digital tooling data rather than using outmoded paper documentation. “A trend we see is the focus on the entire tool lifecycle,” said Daniel Speidel, director of sales, TDM Systems (Schaumburg, IL). “TDM Systems’ Tool Lifecycle Management

[TLM] solution is the IT strategy for production resources and includes tool organization in all phases of planning, simulation, order preparation and production. In doing so, TDM-TLM is a link between ERP, PLM and MES, and it ensures communication between planning and production systems.”

TLM involves not just capturing and providing tool data and tool graphics in CAM and simulation processes, but it also includes the physical organization of tool circulation on the shop floor. “TDM-TLM is not oriented towards individual departments and single processes, but rather it consists of continuous communication and data exchange between the involved systems,” he said. “In today’s environment, manufacturers are looking for transparency in the tooling data needed



Image courtesy Wintriss Controls

With Wintriss Controls’ ShopFloorConnect Machine Interface (SMI), manufacturers get an easy-to-use touchscreen interface that links with the company’s ShopFloorConnect data-monitoring software.

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to put their tools together in a consistent way as well as to have the ability to track them logistically. This is a common daily struggle I see every day. Most shops have only part of what is needed to accomplish this."

Shops first need to have a central tooling database, a knowledge-based system, he added. "They need the ability to know where the tools, fixtures, and gauges are to put them together and deliver them to the machine or cell area," Speidel said. "Another part of this is how to assemble the tools consistently; this is done with a tool presetter such like a Parlec presetter." A logistics system, like the one that TDM-TLM offers, gives manufacturers the ability to find or request replacements as the tools wear out.

"TDM-TLM manages this data from cradle to grave," Speidel said. "The focus of TDM-TLM is linking and traceability. The major strength of the TDM software is the ability to become highly integrated into the existing system landscapes of a machining company." The system offers comprehensive controlling of tool assignment and tool use through crib inventories and inventory turnover, as well as through the results of machining operation. With the results, Speidel said, the use of resources in production can be tracked and continuously improved. **ME**

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