

# A New Age In Manufacturing Is At Hand

**THIRTY CRITICAL MACHINE TOOLS** at ITAMCO have been selected to provide real-time, accurate information about their performance. Improvement opportunities will become apparent to everyone, from machine operators to the Chief Financial Officer. “Right now, we don’t know what we don’t know,” said Joel Neidig, an engineer at ITAMCO. That’s a typical problem for manufacturing facilities that rely on verbal and paper records to evaluate machine performance and workflow. Machine statistics are very difficult to gather and organize into any kind of coherent picture. If machine data is tracked manually, the information might be outdated before it’s compiled or inaccurate.

## Making Their Machines Talk

ITAMCO’s IT and engineering staff had made a commitment to plant data gathering and job scheduling software. What they lacked was the tool to pull the information from a diverse equipment inventory, including their shot peening machines, into a format that was readable by the software. Initial proposals for expensive and proprietary products were rejected because the ITAMCO staff didn’t like the idea of being tied to one vendor and not having enough control over the system.

Joel found a solution at the 2008 International Manufacturing Technology show when he attended a presentation on a fledgling communications standard called MTConnect. MTConnect was the answer to a wake-up call at the 2006 Association for Manufacturing Technology (AMT) conference. David Patterson/ University of California, Berkeley and David Erdstrom/Sun Microsystems presented the need for an open communication standard to enable Internet connectivity for machine tools. Without it, they warned, the lack of control over manufacturing processes would hinder manufacturing’s ability to keep up with global demand. AMT took on the challenge and invested \$1 million in the MTConnect project.

When the MTConnect standard reached an acceptable maturity level, ITAMCO was ready to become one of its first implementers.

## MTConnect Is a Free and Open Bridge

*“To say MTConnect is revolutionary is a gross understatement. Connecting machines and collecting data using the same protocol not only gives in-plant management far greater agility and control; it also allows for a level of communications between suppliers, customers, OEMs, sales and international partners that could easily be the greatest achievement for manufacturing since CNC. Or even the Internet itself.”*

—A.J. Sweatt

AJ Sweatt Logic and Communications

AMT’s MTConnect developers wanted a universal shop floor communications protocol and their solution was MTConnect’s plug-n-play approach. We all appreciate the ease of plugging in a printer, cable modem, or thumb drive to our computer—MTConnect does the same thing for numerically controlled machine tools.

MTConnect is an open, extensible and royalty-free standard. Simply put, the MTConnect protocol is based on standard internet technologies: HTTP (Hypertext Transfer Protocol) and XML (Extensible Mark-Up Language)—the underlying language of most web sites. Extensibility, the consideration for future growth, is a key feature of the MTConnect standard since one standard can’t address every data type needed on the plant floor now, or in the future. And to ensure MTConnect’s acceptance in the manufacturing community, the MTConnect standard is free. It can be downloaded from the internet.

A system that uses the MTConnect standard is made up of five fundamental components.<sup>1</sup> (See Figure 1 on page 8.)

### Device

The CNC machine tool.

### Adapter

Think of it as a translator. The adapter is a software program that enables shop floor equipment to speak MTConnect’s language—an adapter extracts the CNC’s data and makes it

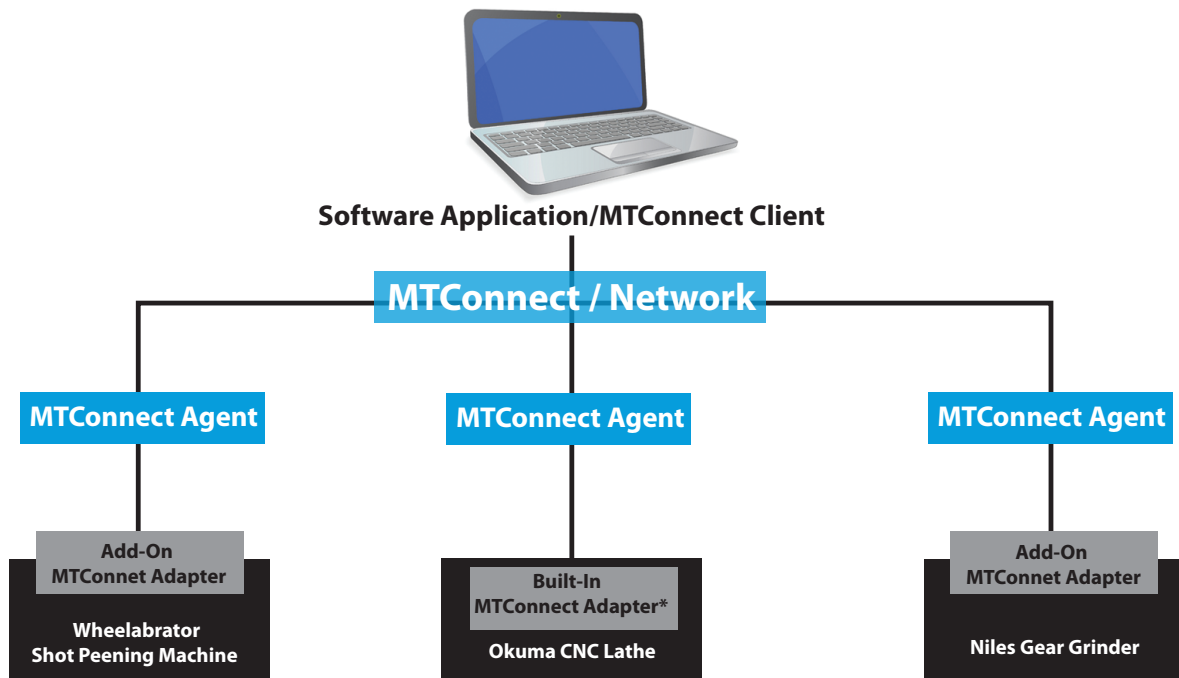


Figure 1. The fundamental components of a system with the MTConnect standard, using ITAMCO machine tools as examples.  
*\*More and more OEMs, like Okuma, are building MTConnect adapters into their equipment.*

available to the MTConnect agent. For legacy machines, the adapter is a piece of hardware (see Figure 2). Many machine tool OEMs, like Okuma, are using MTConnect as their native language and adapters aren't needed with their products.

**Agent**

A software program that collects, arranges, and stores data from the adapter (or directly from the machine tool if it has a built-in adapter). The agent then takes data from the adapter, converts it into the terms and format defined by the MTConnect standard, and makes the translation available on the network in the same way a website makes data available. This formatting enables the data to be collected and transmitted by the corresponding MTConnect agent for use by an application.<sup>2</sup>

**Network**

The physical connection between a data source (machine tool) and the data consumer (software application). The communication on the network normally uses HTTP protocol, a standard network communications method. MTConnect structure is adaptable, however, and can be implemented in conjunction with other networking solutions other than Ethernet and internet protocols.

A connection from a machine tool to the MTConnect network can be as simple as an ethernet cable or a wireless network. A common question is, "Will my machine be connected to the internet?" No, HTTP is only a communication method

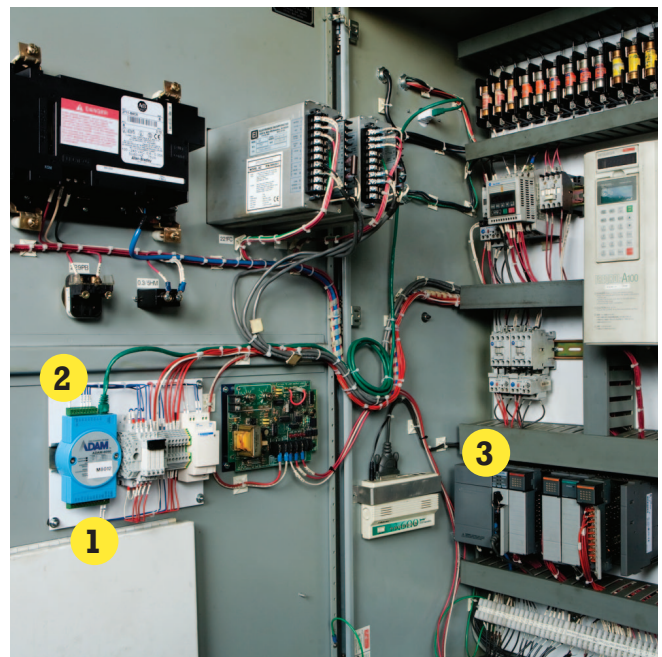


Figure 2. The adapter configuration for the Wheelabrator:  
 1. The adapter - the Wheelabrator is a legacy machine and requires a hardware adapter  
 2. An ethernet cable connects the adapter to the network  
 3. The adapter connects to the machine's PLC

and your data is protected by your network security standards, including firewalls or other popular security methods. If you want to collect and share data with your facilities in several countries, that is entirely possible and the data will be protected.

## Application/Client

The application is the actual requestor and consumer of MTConnect data. Typical functions of the application are to request, store, manipulate and display data. The application includes a function called the client which initiates all requests for MTConnect data. Popular applications are shop floor monitoring and energy consumption tracking. An important fact to remember is that MTConnect isn't software specific, it can be used with a smartphone app or plant data acquisition software.

## What Problems Will MTConnect Solve?

ITAMCO's machine monitoring system—MTConnect and shop floor data acquisition software—will provide “machine truths” so ITAMCO can make accurate assessments on production cycles. For example, a machine with excessive downtime and the reasons for downtime will become apparent. ITAMCO can then schedule repair and ongoing maintenance for the machine, evaluate upgrading or replacing the machine, or add an additional machine to accommodate heavy workflow.

ITAMCO's data will be available on office computers, LCD monitors on the shop floor and even iPhones and Androids. Joel developed a MTConnect smartphone app that displays

machine status, cycle lengths, number of parts ran and tolerances. The data from the MTConnect app can be exported into an Excel spreadsheet.

After the monitoring program is implemented, ITAMCO will integrate the manufacturing equipment data with their ERP (Enterprise Resource Planning) system to provide a complete view of their business operations and to compare the machine performance data to projections and targets.

The following are some of the additional applications for data as available from current system integrators and software vendors.<sup>1</sup>

## Dashboards for the Shop Floor

A shop floor dashboard, named for the dashboard of an automobile, provides at-a-glance views of key performance indicators (KPIs) gathered from software monitoring operations on the machine tools. Just as the driver can easily monitor the major functions of his car from its dashboard, every one on the shop floor can see what is going right and what is going wrong and quickly make adjustments. Dashboards are usually a series of graphics, charts, gauges and other visual indicators and can either be strategic, analytical, operational or informational. While a car's dashboard is the same on every car of the same model, business dashboards are unique to each business and the dashboard's design is driven by the business and the performance metrics it needs to track.

## Alerts

Alerts are notifications of changes on the shop floor that



*This LCD monitor on a shop wall at ITAMCO displays a dashboard with easy-to-read performance indicators of the gear grinding, milling and turning machines that are connected to its monitoring software. ITAMCO can customize their dashboards to display the performance metrics they want to track.*



require the attention of management, maintenance, etc. Alerts are provided by alarm displays on a computer, email or text notices, or on a dashboard. Alert examples include:

- Machine down
- Parts running low
- Filters becoming clogged

A noteworthy point regarding alarms was made by Stephen Luckowski, Chief of Materials, Manufacturing & Prototype Technology with US Army ARDEC at the 2011 MTConnect conference: “Typically when the machine alarms, it’s too late, the tool is already broken. That means that just collecting and reporting alarms is only part of the problem. To prevent alarms that relate to downtime, we need to use MTConnect to understand the alarm and develop a pattern of what causes the downtime.”

### Equipment Availability and Usage

An analysis of each machine shows how effectively the machine is being used. Multiple machine states are typically pre-defined based on machine and process requirements. The machines are monitored by the data collation system and the time that a machine is in each state is accumulated for reporting.

### Machine Downtime Analysis

From the machine usage information described above, each non-productive machine state can be further analyzed to determine the causes for lost production time. The downtime analysis can be broken down into planned and unplanned downtime with the unplanned downtime segregated into specific causes for the downtime.

### Overall Equipment Effectiveness

Overall Equipment Effectiveness (OEE) combines machine usage information with quality measurements to gauge the end-to-end effectiveness of any process or machining operations. OEE is used to measure how a production operation changes over time, determine the impact of changes made on the shop floor, and to compare the effectiveness of different processes or machines.

### Production Reporting/Tracking

Near “real-time” or periodic reports can be developed based on production data directly from the plant floor. Monitoring production levels, managing product flow through the production process, tracking inventory and raw material queues are a few of the possible applications.

### Maintenance Tracking/Planning

Maintenance issues typically fall into two categories: Machine/Process Faults and Preventative Maintenance. Alerts warn maintenance staffs of issues that need immediate attention on the shop floor. Preventative maintenance plans have often been based on calendar time (monthly, quarterly and annually)

with no consideration of actual production status or machine usage. Measuring operating times or number of operations directly from the machine will enable plant managers to effectively plan preventative maintenance programs.

### Wheelabrator Shot Peening Machine Is One of the Chosen

Out of their inventory of 150 machine tools, ITAMCO chose 30 critical machines for the first phase of the machine monitoring system, including a 60-inch diameter Wheelabrator shot peening machine. “Since many of our products are shot peened, the shot peening machine is an integral part of the plant’s workflow,” said Joel. He explained the process to capture and identify the machine’s productivity as follows: The machine operator will use an iPod Touch to scan the machine’s barcode ID. He will scan his employee ID tag and then the barcode on the manufacturing order paperwork. He enters the quantity of parts to be peened in the iPod Touch and starts the machine. ITAMCO will track number of parts processed, cycle times, shot breakdown and maintenance scheduling for consumables like filters.



*These transmission carriers are ready to be shot peened at ITAMCO.*

As shot peening OEMs embrace the MTConnect technology, software applications will display, capture and record data on all shot peening parameters, thereby providing an electronic audit train to verify conformity to specifications or other process instructions. Members of the MTConnect Institute are already addressing topics relevant to shot peening OEMs including pulling data from closed-loop systems and sensors that aren’t part of a CNC system, compliance testing/certification and robotics.

### MTConnect’s Early Adopters

The following organizations are members of the MTConnect Institute and are evidence of MTConnect’s growing influence. Where available, implementation information as of November 2011 was added.

**AMT - The Association For Manufacturing Technology**

**Bosch Rexroth Corporation**

**Curtiss Wright Controls Flight Systems** *Eleven machines*

**FANUC FA America**

**Foxconn Technology Group-China**

**FREBO-The Netherlands**

**GE Aviation** *Over 1800 machines in multiple facilities*

**General Dynamics**

**Gleason Works, The**

**IM Gears, India**

**ITAMCO** *Thirty machines as of summer 2012 with 100 more to follow*

**Jet Machine and Manufacturing Co.** *Three machines as of November, 2011 with five more to follow*

**Kennametal Inc.**

**Lockheed Martin Electronic Systems**

**National Center for Defense Manufacturing and Machining (NCDMM)**

**National Institute of Standards and Technology (NIST)**

**Okuma America Corporation**

**Optical Gaging Products, Inc.**

**Remmele Engineering** *Thirty machines*

**Sandvik Coromant Company**

**SCADAware**

**Task Force Tips** *Sixteen machines*

**TechSolve, Inc.**

**US Army ARDEC Materials, Manufacturing & Prototype Technology Division**

**US Army/Benet Laboratories**

**Yaskawa America, Inc., Motoman Robotics Division**

A complete list of MTConnect Institute members is available at <http://mtconnect.org/members.aspx>.

## The Experiences of an Early Adopter: The U.S. Military

As referenced earlier, Stephen Luckowski with U.S. Army ARDEC gave a PowerPoint presentation at the November, 2011 MTConnect Conference. Mr. Luckowski outlined ARDEC's trial run with MTConnect at Picatinny Arsenal, an ARDEC military base located in northern New Jersey.

For the test, ARDEC chose a Citizen lathe that builds 40 mm parts for Special Operations Command. Consistency and high production rates are expected from the lathe. The ARDEC staff felt the strain of machine downtime during the MTConnect installation and they had a steep learning curve on ethernet connections, MTConnect agents and adapters. The installation also had many positive benefits including:

- Achievement of 24/7 production monitoring
- Demonstrated 7% gain in cycle time and power
- Management of downtime to maintain production rates

- Development of a machine-specific adapter for Citizen lathe
- Acquisition of a knowledge base for future MTConnect installations

According to Mr. Luckowski, the ability to reduce downtime, analyze data, achieve higher part accuracy, get a real-time picture of capacity and capability, and plan for surges in need (i.e., wars, natural disasters, etc.) with MTConnect-enabled machinery is very real.

From an outsider's viewpoint, the boost to an anemic economy by the implementation of MTConnect technology in the U.S. Defense industrial base is also very real. Imagine the opportunities for OEMs, application developers and system integrators in a market as outlined by Mr. Luckowski:

- Tens of thousands of companies and their subcontractors
- Millions of square feet of manufacturing space
- Hundreds of machine tools and tens of thousands of machine controllers, from new to legacy machines
- Industrial bases ranging from shipyards to "mom & pop" shops

The payoff for facilities in the U.S. Defense network would be a competitive edge due to increased productivity and profitability and the ability to provide an electronic trail for military specification compliance and auditing. Then consider that the MTConnect Institute estimates that there are over 1.2 million machine tools that could be enabled with MTConnect and only four to five percent of all machine tools worldwide are connected to a data collection system.<sup>1</sup>

## Will Shot Peening Make the Connection?

While the list of companies that have made a commitment to MTConnect is impressive, MTConnect and machine monitoring systems have to be cost-effective and economical for small shops, not just GE Aviation and the U.S. military. Even ITAMCO is not a typical facility as they adopt technology at a faster pace than companies twice their size. Yet the implementation of the standard and its components is within the skill level and resources of most facilities. It was designed with that intent and the ever-growing MTConnect community of manufacturers, application developers and educators is capable of supporting any organization that is ready to embrace it.

Please be encouraged to learn more about MTConnect and evaluate how it could benefit your company. A good place to start is [www.mtconnect.org](http://www.mtconnect.org). The opportunity to participant in a new age in manufacturing is truly in your hands. ●

<sup>1</sup>Getting Started with MT Connect, Connectivity Guide. October 1, 2011.

<sup>2</sup>The Need to Know is Basic. Mark Albert, Modern Machine Shop, October, 2011.