“Internetworking” the Factory Floor to Your World

Automate the automation using the internet to “Internetwork” your machine tools on the factory floor. This form of computerized networking for machine monitoring and control can provide manufacturers with relevant production information in real-time, boosting efficiency by up to 20 percent with minimal capital investment.

By Tom Gaasenbeek, CEO of Memex Automation, Inc.

In the past, the key to maximizing productivity on the manufacturing shop floor was to automate machines, thereby minimizing costs and maintaining consistent quality. Process manufacturers have met the challenges of today’s extremely competitive world by achieving a high degree of automation. For discrete manufacturers, the question becomes: can the advances of the process control world and the networked office be applied to automated machines on the shop floor? In other words, can the automation be automated? For certain discrete manufacturers, the answer is clearly “yes”. The productivity of these companies has been greatly enhanced when new technologies that shave off machining time, optimize labour efficiency, and extract high levels of quality are applied to existing automated machine tools.

Modern machine tools remain largely closed “islands of automation” whose isolation hinders the establishment of a fully connected, enterprise-wide information system. Unfortunately, largely because of the proprietary nature of the applications used by the 60 plus machine tool manufacturers, the Computerized Numerical Controls (CNCs) that run most modern machine tools do not communicate adequately with each other or with management information systems. Rather, these machines are primarily passive recipients of part program data.

This lack of connectivity is a huge constraint on productivity—a problem recognized for many years by the machine tool industry. In September 2008, the Association of Manufacturing Technology (AMT) spent millions of dollars to establish a consortium, called MTConnect, whose mandate is to generate an internet-based networking standard that will result in every machine tool becoming a node on the corporate network. The implementation of this standard connection will allow a manufacturer to identify and monitor every machine on the factory floor, and thus optimize total production throughput. The goal is to make every machine tool a vital part of management’s information system, and to integrate e-manufacturing into the enterprise-wide profit process.

Connecting machine tools on the shop floor to create an overall plant nervous system unleashes the valuable information trapped in each machine. To quote from a 1998 ARC Survey Report: “The largest reservoir of untapped operational information is locked in the machine tools on the manufacturing floor. Employing Open Architecture CNCs in a plant is fundamental in gaining a competitive advantage. Open architecture CNC integrated into the Information Technology mix is equally critical in optimizing production in both job shops and high production lines.”

Once a company gains access to machine tool data, it can manage this information to increase profitability. The dynamic nature of internetworking extends the availability of production information far beyond the factory floor. Machine tools become active servers of information in real-time, feeding their data to other functions within the corporation anywhere in the world. This increase in information dissemination leads to enhanced productivity and a sustainable competitive edge due to improvements in six key areas: increased machine utilization, continuous improvement, business systems integration, establishment of OEE metrics, web-enabling, and ease of service diagnostics.
INCREASED MACHINE UTILIZATION

Operations on any factory floor are linear (or sequential) in nature, with one event usually dependent on a preceding one and with considerable variation in time consumed. Machining is thus currently a start-stop-wait-repeat process. Internetworking allows managers either to reduce or eliminate these wait periods or to exploit them by making key machine tools productive during these gaps. Access to real-time data, including the monitoring of specific factors such as spindle load and cutting temperature, as well as DNC program loading, are necessary to accomplish this type of integrated systems optimization. Internetworking also eliminates or significantly reduces the “wait-periods” now common in the manufacturing information process. Instead of having to wait for program delivery, tool offsets by hand, setup, management approval, and the realization by front office accounting that inventory is ready to ship, the seamless integration of machines and management information systems turns “just-in-time” processing into “just-in-seconds” processing.

CONTINUOUS IMPROVEMENT

The Theory of Constraints, as articulated by E. Goldratt, teaches us to “identify, monitor and optimize” bottlenecks in a supply chain process. Internetworking automates the application of this theory. Manufacturers are no longer restricted to simply improving the operation of an isolated machine or work cell, but rather can optimize the entire production system. The capture of data from all machines, including historical analysis and quantifying events, enables managers to implement a feedback mechanism that facilitates continuous improvement programs and thus achieves a truly lean and focused manufacturing process.

BUSINESS SYSTEMS INTEGRATION

Imagine placing an order over the internet to a manufacturer and having it filled and shipped all automatically without human intervention. By establishing machine tool internetworking on the factory floor, the point of production can be connected directly to the supply chain on the one hand, and to the demand chain on the other. Ultimately, the factory floor can be linked to information systems already in place, such as enterprise resource planning software and standard accounting packages. The most common stumbling block to achieving such synchronous e-manufacturing integration between management planning, purchasing, production, operations, sales and service is establishing the direct link to the machine tool.

ESTABLISHMENT OF OEE METRICS

Overall Equipment Effectiveness (OEE) is a percentage value that reflects a composite of machine availability, performance and quality. Companies aiming for a lean manufacturing process strive to implement OEE as a corporate-wide key performance indicator of company, division, plant and individual machine productivity. Currently, if OEE information is captured at all, it is typically written down on clipboards by
hand and later transposed to a computer spreadsheet. The process is thus labour-intensive, subjective, and prone to errors and delays in the reporting of results. Real-time OEE determination allows for timely reporting and an immediate response if necessary. Ideally, OEE information should be captured directly from a machine and conveyed electronically in real-time to both operators and management. Internetworking allows the automatic capture and integration of OEE information from each machine, giving a complete digital picture of plant productivity at any given moment. This picture can then be viewed via the internet by company personnel anywhere in the world.

**WEB-ENABLING**

To date, very few manufacturers have adopted an e-manufacturing paradigm in which machine tools function as web-enabled appliances. However, all that is required to achieve web-enabling is to give every machine tool hardware and software upgrades that allow it to host Internet Protocol (IP) addresses. The machines can then be connected to each other and to the wider world, shattering the glass wall between the factory floor and the management functions that depend upon it.

**EASE OF SERVICE DIAGNOSTICS**

Making a machine tool smart and a node in the corporate network introduces intuitiveness and transparency to the manufacturing process. Internetworking can allow the neural network on the shop floor to continuously optimize itself, bringing a new level of service to the entire corporation. Using a standard TCP/IP connection, remote monitoring of any machine can be done from anywhere in the corporation at any time, meaning that diagnostics and parts program recovery can be carried out from any location. Moreover, these services can be provided automatically, if and when the machine tool control itself sends out an alert to the corporate network. This concept of machine self-healing, along with predictive and preventive maintenance, empower the operator to focus on more important details such as reducing bottlenecks and increasing availability.

The machine tool industry recognizes the need for internetworking machines on the factory floor and is moving to a set of standards that will permit integration with existing corporate information systems. Over the last ten years, the OMAC (Open Modular Architecture Controls) Users Group of the ISA, along with similar organizations in Europe and Japan, have been working on defining an open standard for machine internetworking. At the September 2008 International Manufacturing Technology Show in Chicago, a consortium of major industry players that was spearheaded by the AMT and included the top machine tool manufacturers launched an advisory group called MTConnect to develop a set of standard protocols for machine tool connectivity. The goal of these protocols is to extend open architecture to all CNC machines and facilitate internetworking.

Companies in the manufacturing automation sector, such as Memex Automation Inc., have developed an open architecture platform that
addresses the limitations of current CNC communication and allows different machine tool systems to be configured into a contiguous, enterprise-wide information system. The configuration utility takes the form of a hardware circuit board packaged with the appropriate software, and acts as a universal machine interface device that connects the machine tool via Ethernet-based networking to standardized communication protocols such as XML. Used in every machine, whether it is a legacy machine or of an older vintage, the internetworking tool configures each component independently to provide virtually any combination of direct input and output signals to and from each machine. All machines are thus monitored and controlled both individually and in concert, allowing effective and powerful manipulation of production information throughout the entire plant.

Extending network connectivity to the factory floor brings the following benefits:

- **Cost savings:** Inventory and operational expenses are reduced;
- **Increased uptime:** OEE information is provided to allow for continuous improvement. Preventive maintenance can be based on actual tool usage;
- **Faster production:** Machine operators and management can be alerted to adverse operational events and react to them very quickly. Increased bandwidth and speed of internetworking decreases part program cycle time and aids production optimization; and
- **Improved service:** Operational problems can be solved using remote diagnostics, decreasing downtime. In terms of concrete figures, a company that implements internetworking can expect to increase its productivity by up to 20 percent.

Humans originally built machines to make manufacturing easier. The time has come to let machines do what they do best—repetitive, high-volume and even dangerous tasks. This frees humans to do what we do best—create, design, build and dream. Just as e-mail has dramatically changed the way we communicate, and e-commerce has fundamentally altered the way we do business, e-manufacturing will allow us to thrive on the modern world’s rapid rate of change while leveraging the investments we have made in automation and people. An internetworked factory floor is an advance that will enhance a manufacturer’s bottom line and give the company a sustainable competitive edge. A whole new world of business productivity awaits.

Tom Gaasenbeek is the CEO of Memex Automation Inc. He is the company founder, starting Memex Electronics in 1992 with a vision to improve the way automated machine tools work and connect on the factory floor. He took his knowledge of embedded system programming and developed an expanded memory circuit board for a computer numerical control (CNC), the component that holds the part programs for machine tools such as lathes, mills, punch presses and grinders. For more information go to www.memex.ca.