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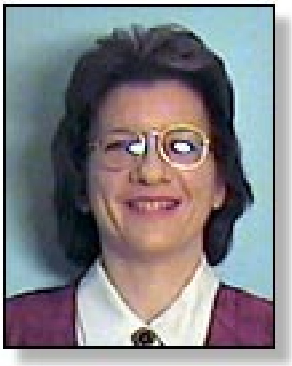

# Artificial Intelligence and the Internet: An Integral Part of the Factory of the Future

**By Marla P. Rogers**

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Factory operations will change significantly during the next 10-20 years due to advances in artificial intelligence and the Internet. Artificial Intelligence will place machines capable of automatic reasoning on factory floors providing instantaneous solutions to manufacturing problems during the production process. As older machines are replaced with internet-ready tools the machines will be capable of reporting production information to managers and maintainers through the Internet. Current developments and technological forecasts indicate that machine-controlled operation and machine to person communication is a reliable and tangible expectation.

Will manufacturers be ready for the future? Yes, if they begin preparing today. Manufacturers will require reliable computer hardware and software on the factory floor and up-to-date communications equipment with Internet access. Highly skilled employees will be a critical requirement in all factories and recruitment and training of operators should begin now! Upgrading and replacing manufacturing equipment, computer hardware and software, and Internet capabilities should be pursued today. Waiting to upgrade will lead to production failure and loss of competitiveness.

## Artificial Intelligence

Artificial Intelligence or automated reasoning is the next step towards implementing more efficient factories. " … AMR Research Inc. in Boston estimates that 40% of all new manufacturing-related software now incorporates some form of AI" (Port, 2000). In the near-distant future all manufacturing will become digitized. Supply chains are already converting software to "smart modules" that communicate with each other. Embedded web servers are in many new devices purchased for plant operations allowing machinery to relay data to computers on the Internet. Collaboration will allow manufacturers to respond to initial customer reactions to products and increase service levels.

The "lights out factory" is a long-term goal of factory automation proponents. Port (2001) found that the newest machine tools from Milacron Inc. have "learning engines" and Gensym Corp. has software neural networks capable of comprehending intricate manufacturing procedures. Future factory production will be substantially efficient due to the inherent speed of new programs and machine tools. Today's manufacturers need to examine and update factory applications to be competitive with future factories.

## Connectivity example

The product line of e-Manufacturing Networks Inc. (2001) provides a suite of shop floor connectivity solutions designed to optimize information flow from the factory floor and CNC controlled machines. Their products include an open architecture platform to provide communication between CNCs and from CNCs to management by directly accessing operational information from machines on the floor through hardware and software upgrades providing Internet capabilities for each machine tool.

E-Manufacturing contends that machine monitoring should provide timely information to managers, maintenance workers, and operators enabling effective productivity decisions to be rapidly to meet higher production requirements. Machine monitoring is provided by software and browser-based reports. During software monitoring information is automatically collected at the CNC, forwarded to the server, and saved in an SQL database. Routine data is readily available to programs capable of SQL database calls. Data indicating critical problems immediately triggers email or pager notification.

Browser-based reports are created for non-critical notification and can be distributed as appropriate. Browser reports can be accessed from anywhere in the world providing less downtime and higher productivity as events occur that managers need to be aware of during travel.

## Implementing artificial intelligence

The article, "Software Trends for a New Manufacturing Environment," (Melnyk & Martin, 1995) summarizes the required steps for implementing artificial intelligence or automated response in manufacturing. The first step for implementing automation in manufacturing is to acquire employees capable of executing plans, analyzing problems, and formulating and implementing solutions. Highly educated, dedicated employees reduce manufacturing overhead allowing function integration to be emphasized. Headquarters staff placed in geographically separated factories must be instantly available to others within the company. The final step of implementation is maintaining focus on the core skills and knowledge required to create value for customers. Meeting these challenges will result in a manufacturing process that will be accomplished in-house and by outsourcing elements of production outside of the manufacturer's core skills allowing collaboration with suppliers to yield a seamless, integrated virtual factory.

Melnyk and Martin's (1995) response to these implementation steps is new categories of software. Groupware is software allowing different people located in different places to work together. Visually oriented simulation packages allow the user to build a visual representation of a factory on the computer screen that can be animated for testing job operations. Business process reengineering packages document and analyze business processes and result in the identification of redundancies. These are just a few examples of the software solutions available for automated reasoning. Software solutions are expanding exponentially and will allow full automation of factories in the near future.

## *The Internet*

To accomplish e-production the Internet must be looked upon as a working tool on the factory floor, instead of a selling tool according to Lance Gordon (2000). The Internet is an information accessing tool that will allow manufacturers to access production machines remotely in real-time. In the article, "The Cyber Factory: A Web of Intelligent Machines" the author states that the most important development in communications technology will be simplified and standardized interfaces between machines and humans. The low cost and world coverage of the Internet allows a cost effective method for remotely monitoring machine status and allowing the user to analyze machine processes and implement corrections at any time. Using networked intelligent devices on the factory floor provides the advantages of minimum cost, optimum competency, equipment sharing, and real-time organization of production.

## *Internet based solutions*

Manufacturers are already incorporating support for Internet manufacturing. Solutions range from software for determining customer purchasing needs to monitoring and controlling production from remote locations. "The advent of the Internet has forever changed the structure of the supply chain … Today, the Internet enables several suppliers to chime in on an order, allowing them to compete for a contract in cyberspace" (Haren, 2000). Implementation of an e-supply chain requires full integration of supply components with Internet components according to Haren (2000). Haren's software company, ILOG, provides software solutions that include web-based purchasing and support for the Internet human interface.

The US-Japan Center at Vanderbilt University has created a Virtual Manufacturing Village (VMV) consisting of researchers and practitioners who develop manufacturing concepts in an on-line community. Some of the areas they have focused on are intelligent manufacturing, environmentally conscious design and manufacturing, and remote manufacturing systems.

## *Projection*

Web-enabled machines on the factory floor will control industrial Internet communication in the future. Factories will be refurbished and more efficient than today's resulting in a smaller and more effective staffing standard. The Internet will allow fast, efficient, reliable communication resulting in increased productivity and safety. Installation of wireless systems will create greater flexibility and eliminate episodes of extended down-time required for wired systems when troubleshooting. Wireless applications will also allow greater worker mobility. The manager of the future will be able to access process information at all times resulting in the ability to address deviations in productions in real-time.

## *Today's Applications*

Texaco has four 3-D Visualization Centers and Giselle Smith (1999) reported on the Houston center. Geologists and geophysicists use the facility to analyze seismic data and predict oil well placement more accurately. Facilities like Texaco's have the potential to dramatically reduce the number of low or non-producing wells drilled. The 3-D visualization technology allows information to be processed in 1 day instead of 2 weeks dramatically decreasing the time from data collection to projection. Most 3-D visualization centers use Silicon Graphics computers, but there is no industry standard for software.

Peter Burrows (2001) states that Colgate-Palmolive Co. has installed SAP corporate software to allow the company to have a real-time direct connection to cash registers at Wal-Mart Stores and Kmart. The software allows production rates to be modified immediately based on real-time sales monitoring. The company only ships products the stores are selling.

Unifi Inc. company headquarters is located in Greensboro, NC and all factory equipment in its 22 locations is accessible from headquarters. Customers may access data through the company's web site.

## *Benefits*

The benefits of artificial intelligence in manufacturing devices combined with Internet connectivity are emerging on a continual basis. Embedded Internet working products enable existing CNC to communicate over an Ethernet network providing real-time manufacturing information. Video over IP technology allows users to remotely monitor the production process by allowing the computer network to function as a video network allowing real-time pictures to be viewed on any PC. This technology also allows rewinding, pausing, and replaying of video.

Continuous operation, breakdown avoidance, and remote control of distant factories are three of the chief benefits of remote monitoring with automated reasoning devices on plant floors and Internet connectivity.

## Required Components

Computer hardware and software at the remote site can be any computer with a web browser. Computer hardware at the controlled machine site must be rugged and reliable. Control actuators, measurement sensors, safety switches, and fast communication equipment will also be required. Software at the controlled machine site must have flexible, well-designed controlling and communication capability (Jim Henry, personal communication, November 18, 2001).

## People

Highly skilled operators will be critical in the automated factory of the future. People will continue managing production and performing complex maintenance on equipment to allow peak operation. Employee responsibilities will consist mainly of supervision as opposed to completing manufacturing tasks. Academia must collaborate with manufacturers to prepare students for current and projected technology requirements within industry by emphasizing skills application to produce an adaptive workforce. Preparation requires learning situations that utilize today's technology to acquire knowledge and complete application projects resulting in workers prepared to access the factory of the future from remote sites without trepidation.

## Conclusion

Manufacturing will change by leaps and bounds over the next 2 decades due to advances in artificial intelligence and Internet connectivity rates. Productivity can already be measured from distance locations over the Internet and wireless communications have the ability to provide increased access. Wireless communication will eliminate wired operations once a backward compatible standard is created and implemented worldwide.

We must begin preparing today in order to be ready for the future. Manufacturers must begin purchasing updated machinery with embedded technology and acquiring software for interfacing machines and the Internet. Educators must return to the basics with real-world application of acquired knowledge to prepare people to function in the factory of the future.

## References


Burrows, Peter (2001). The Era of Efficiency. *BW Online*, June 18, 2001. Retrieved November 28, 2001, from http://www.businessweek.com/magazine/content/01_25/b3737701.htm

Gordon, Lance (2000). The Industrial Internet. *Education at a Distance*, June 2000. Retrieved November 28, 2001, from http://www.usdla.org/ED_magazine/illuminactive/JUN00_ Issue/story01.htm

Haren, Pierre (2000). Editorial. *ILOG Connection*, Autumn 2000. Retrieved November 28, 2001, from http://www.ilog.com/corporate/connection/autumn_2000/

Melnyk, S., Martin, M. (1995). Software Trends for a New Manufacturing Environment. *Intelligent Manufacturing Report*, January 1995. Retrieved November 20, 2001, from http://www.lionhrtpub.com/IM/IMsubs/IM-1-95/software.html

Port, Otis (2000). Thinking Machines. (n.d.). Retrieved November 26, 2001, from http://www.businessweek.com/2000/00_32/b3693096.htm

Port, Otis (2001). Brave New Factory. *BW Online*, July 23, 2001. Retrieved November 26, 2001, from http://www.businessweek.com/magazine/content/01_30/b3742096.htm

Product Lines. (n.d.). Retrieved November 28, 2001, from http://www.e-manufacturing.com/ products/nervoussystem.htm

Smith, Giselle (1999). Texaco's 3-D Pod Improving Oil Exploration. *ABCNEWS.com*, September 10, 1999. Retrieved November 20, 2001, from http://abcnews.go.com/sections/business/WorkingWiser/texaco990910.html

U.S.-Japan Center at Vanderbilt University. (n.d.). Retrieved November 28, 2001, from http://shogun.vuse.vanderbilt.edu/usjapan/vmv.htm

Unifi Inc. (n.d.). Retrieved November 28, 2001, from http://www.unifi-inc.com

Web Based Reporting. (n.d.). Retrieved November 28, 2001, from http://www.e-manufacturing.com/solutions/webreporting.htm