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Connecting the Plant and the Enterprise:

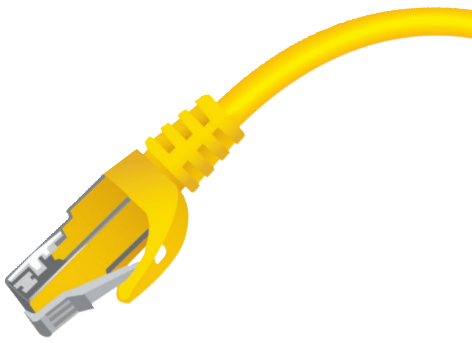
If you thought advanced robotics and high-speed machine automation systems were cool, wait 'til you see factory automation at the next level!

Mitsubishi Electric Corporation (MELCO) recently hosted journalists from all over Europe and this reporter from North America to exclusive, full-access tours of several highly automated Japanese industrial plants. This article takes a look at the state-of-the-art automation we found and how Japanese industrial-automation engineers are working to link the shop-floor with enterprise-level networks.

Any world-class manufacturing business is really a single system made up of a number of elements. In the days before computers, manufacturing and executive-level elements were closely interconnected by paper trails. As the different parts of the enterprise have become computerized, however, a disjoint between enterprise and shop floor business elements has arisen. Or, more accurately, as enterprise and shop-floor systems have grown, the connections between them have not kept pace, leaving a chasm to be bridged.

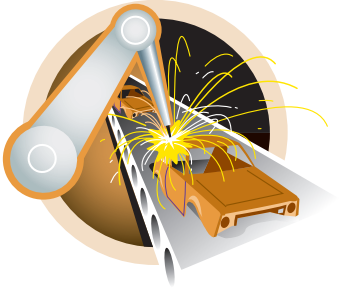
According to Satoshi Takeda, manager of the controller marketing section at MELCO Nagoya Works, present networks in manufacturing enterprises exhibit a disjoint between enterprise management systems operated by information technology (IT) departments and production management systems on the shop floor.

Historically, integration of business systems has gone forward independently of integration of automated systems. At the enterprise level, networking involves development of a massive intranet made up of personal computers and workstations under the auspices of information technology (IT) departments. These intranets link directly to the World Wide Web through



Taking Automation to the Next Level

C.G. Masi
Control Engineering



carefully constructed and maintained firewalls.

At the shop floor level, on the other hand, individual automated machines operate independently, sharing data or control signals over a number of factory-automation network protocols. The present challenge for factory automation engineers throughout the world is integrating shop-floor islands of automation together and into the enterprise-level intranet.

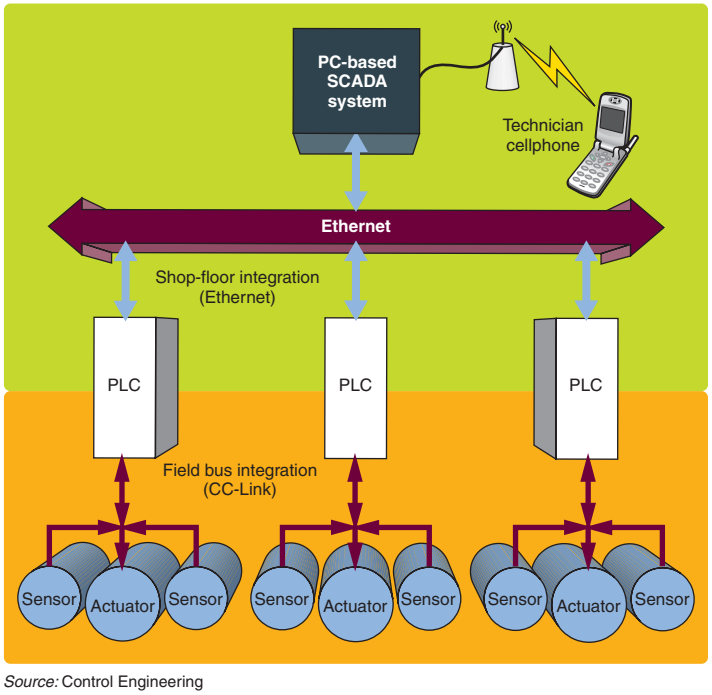
The present state of automation at the shop floor level is fairly complete in world-class operations. A case in point is Asahi Breweries' Suita Brewery in Osaka, Japan. Like most production facilities, this brewery's factory-automation network is organized in layers.

At the lowest level, individual machines act as complete work cells. Each machine has its own analog and digital sensors to monitor process variables, such as temperature. Values from these sensors are the starting points for control loops orchestrated by programmable logic controllers (PLCs). The PLCs provide actuator control signals, such as to turn heaters on or off. This is the fieldbus level, which at the Asahi Brewery runs over CC-Link.

At the next level, the brewery uses Ethernet to tie the individual PLCs together with a supervisory control and data acquisition (SCADA) system. The SCADA system's primary functions are to gather process and production data for mananagement review and archiving; provide control information to keep all the individual workcells coordinated; and monitor the entire operation for anomalies requiring human intervention.

Should human intervention be needed, the SCADA system issues alerts and instructions via wireless communication. "We have gone entirely to wireless because we don't want our techni-

Asahi brewery factory automation architecture



Source: Control Engineering

World class facilities use layered networking to keep operations humming along smoothly.

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cians tied to land lines," says Yutaka Henmi, manager of the engineering section at Suita Brewery. "Each technician carries a mobile phone that the SCADA system can call. It can also send text messages with detailed information on the problem and instructions on how to fix it."

In addition, each mobile unit is equipped with global positioning system (GPS) as well. "Since we have so few workers covering such a large area, we must be able to track where each worker is and exchange information with them at all times," Henmi says. "With a direct, GPS-enabled wireless link into our SCADA system, workers feel confident that they are not alone, even in the most remote part of the plant."

The next level

While world-class manufacturing operations have linked earlier islands of automation together through the SCADA level network, communication links with the enterprise level are still problematic. The problem, according to Mitsubishi's Takeda, is that existing manufacturing execution systems (MES) use a classic "gateway" architecture. To gain access to this vital data, management must manually create queries to SQL databases that concentrate and archive it.

Such systems bog down as the manufacturing operation gets bigger and generates more data. Gateway architectures are also very expensive to develop and maintain. There are too many system levels to go through and it becomes hard to integrate raw control data into server-side procedures. The result is factory management that does not operate in real time.

Nagoya Works has pioneered an integration approach it calls "e-Factory," which fills the gap with a "MES Interface Module" (MIM). This module operates as a data collection "appliance," providing sophisticated capability and eliminating costly issues of PC-class computers related to complexity, security, reliability and maintenance. The MIM software can reside directly on a Mitsubishi Q series PLC backplane, where it has direct access to process data generated in the normal course of operation by PLCs at the fieldbus level. It automatically captures data in real time and uploads it directly to the enterprise level MES database. There it is instantly available to the MES applications that align factory operations with enterprise goals.

For example, a SCADA system can coordinate production line speeds for components A and B with the assembly line that combines A and B into assembly C, maximizing productivity while minimizing work-in-process inventory. What happens, however, when a big order comes in? Management would like to speed up all three lines, but, because of the present lack of real-time visibility into what's going on at the shop-floor level, they don't really know if they can.

The e-Factory system provides that real-time visibility, so management sees that if the plant is operating at 80% capacity, ramping it up to, say, 90% capacity allows them to rapidly fill the order without delaying shipments to other customers.

Lacking this visibility, the enterprise cannot react quickly to changes in customer demand without maintaining expensive inventory of finished goods. Inventory represents a dormant capital investment, which increases the base for the return-on-investment (ROI) calculation so near and dear to stockholders' hearts.

No wonder management teams in large, world class enterprises like Mitsubishi and Asahi are so keen to extend automation throughout their operations. Linking enterprise resource planning (ERP) and manufacturing execution systems to shop-floor automation in real time has a strong positive effect on the business' operational efficiency. More efficient operations make better use of their resources, and react faster to changing business conditions. **ce**

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