Conner's Investment in Opto 22 Paid For Itself While the First Machine Was Still Ramping Up

Background

Since its founding in 1986, Conner Peripherals has grown to be a $2.2 billion storage solution company. Hard disk drives are the largest section of Conner's business. The Conner Disk Division was spun off as a separate business unit within the company in 1990. It produces the media (the actual disks) for Conner's hard disk products and sells disk media to other hard disk manufacturers. Producing more than seven million disks per quarter, Conner Disk Division is the second-largest media manufacturer in the world. (In early 1996, Conner was acquired by Seagate as a separate division.)

In 1989, Conner acquired Domain Technology and with it a large media "sputtering" machine called a MINT (Magnetic Information Technology) which Domain had been developing.

This was the machine used when Conner established its Disk Division in Milpitas, California, in 1990. The first MINT machine had been built with PLC technology - Allen-Bradley 5/60 PLCs, Digitronics Sixnet I/O, Berkeley axis motion controllers, and Intellution operator interface software.

The system worked and Conner Disk Division produced 10 million disks within the first two years, but when the time came to expand its disk capacity, Conner Disk Division decided against replicating the control system on its new machines. There were simply too many problems with the PLC/ladder logic approach in a high-technology environment.

Environment

The hard disk drive business is world-class, high-technology, capital-intensive, international, ferociously competitive, and marked by short product life cycles. This puts ever-increasing demands on manufacturing technology to make disk capacities increase and disk sizes shrink. Staying competitive requires a relentless drive for manufacturing excellence, a willingness to innovate, and a mandate to improve process and control at every point.

From a manufacturing standpoint, the disk drive business is like any other manufacturing business — only more difficult. All the problems of ordinary manufacturing are magnified by the demands of Conner's processes, the nature of the product, and precarious profitability margins of the market. An unprofitable high technology manufacturing operation doesn't just lose money, it hemorrhages cash.

Profitability in the hard disk business hinges on two things: yield and time to market.

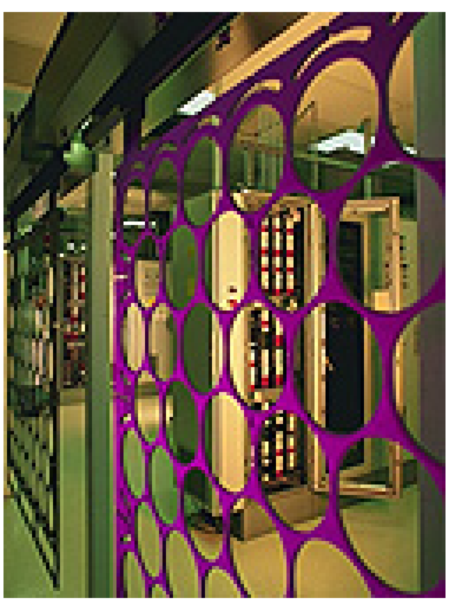
Yield (the percentage of acceptable products produced) is important because it maximizes return. A disk that doesn't pass inspection not only represents a waste of resources, it wastes precious process time. It is the most expensive product a manufacturer can produce.

Yield also depends on system reliability.

At Conner Disk Division, downtime on one of the sputtering machines costs the company $12,000 an hour, mostly in lost production.

Time to market is critical because the product life cycles are so short and competition constantly drives down prices.

It is a truism in high technology manufacturing that a unit of a new product shipped today is worth several times as much to the company as a unit shipped six



months from now. Another truism is that a product that slips its introduction date by three months may have lost one-fourth of its projected return to the company.

In manufacturing, it is absolutely critical to get the manufacturing process up, running, and fine-tuned to maximize yield in as little time as possible. This is one of the areas where Opto 22 helped Conner.

Problem

In control automation terms, that means maintaining rigid control over critical processes and tweaking them for the best possible yield as fast as possible. Conner required a flexible, powerful control system that could adapt to the high-technology manufacturing environment. PLCs and ladder logic were not flexible enough, nor powerful enough, and simply could not adapt well enough to meet Conner's needs.

In high technology manufacturing, Conner Peripherals' Lindsey Eastburn says, "The name of the game is change."

Conner is constantly tweaking the system for best performance. One big problem with the MINT I sputtering machine was complexity. The PLC system was programmed in ladder logic, which made changing the software difficult and time-consuming. "Ladder logic was a major limit," Eastburn adds.

The difficulties of ladder logic emerged in several ways. Not only was it hard to write programs, but it was hard to maintain them and hard to understand them after they had been written. The documentation was inadequate (an almost universal problem with complex systems) and ladder logic tended to obscure rather than highlight the program logic and flow of the control system. For example, Conner found that some of the changes to the programs had made whole sections obsolete, but with the ladder logic-based programming language, this wasn't obvious, so the unneeded code was never taken out.

"I had spent a lot of my time documenting legacy code and a lot of it wasn't being used any more," Eastburn recalls. "With a flowchart-based language, you can see that."

Another real problem with ladder logic was that the PLC control system didn't integrate well. It was essentially stand-alone and it was hard to get it to talk to the rest of the factory or to get the rest of the factory to talk to it; both are important considerations in high-tech manufacturing.

The overall control system wasn't modular and expandability was limited. This was especially frustrating because the Conner engineers realized that in spite of the MINT's size and complexity, it was essentially doing several repetitions of the same thing down the length of the line.

"I felt our application wasn't too complex if we could break it down because it is mostly the same thing or almost the same thing operating on a long machine," Eastburn says.

On top of all this, the costs of operating, updating, and maintaining the control system were too high.

Eastburn started his search for a control system for the new machine by outlining his requirements for hardware and software. Interestingly, replacing ladder logic was not a requirement. To make his search easier, Eastburn scored the competing control systems objectively. "I did a matrix and scored each of the categories. Opto 22 ranked the highest."

When Eastburn finished his search, ladder logic was out and Opto 22 was in.

The sputtering process starts with a texturing operation to produce a consistent surface on the incoming disk blanks. Next comes a two-step cleaning to eliminate defects and voids from the finished disk. Then comes sputtering — the heart of the disk media production process.

Modern hard disks are made by sputtering layers of material on the textured, cleaned blanks. Successive layers of chrome, magnetic material and carbon are laid onto the blanks in vacuum furnaces. Getting the layers uniform across each blank and of the right thickness is critical. Uneven layers or layers that are too thick or too thin mean rejected blanks and decreased yields. In addition, the coatings on the sputtered disks must meet rigid standards for material hardness, grain structure and magnetic characteristics.

Controlling the sputtering process means controlling chamber vacuum, furnace temperature, electrode and blank voltage and many other parameters very precisely. All of these elements and more interact in complex ways to affect the layers laid down on the disk blank. The more tightly they can be controlled and the more quickly they can be adjusted, the more precise the layers can be.

After sputtering, the coated disk blanks are lubricated and tested. At that point, they are ready to be sent to the manufacturing line to be installed in hard disk drives.

Solution

Conner Disk Division decided on an Opto 22 hardware and software solution. System integrator IDAC was contracted to design the control program layer using the Opto 22 control software and to build the operator interface screens using Opto 22's MMI. Opto 22's flowchart-based design made it easy for Conner Disk Division engineers to learn. Since the flowchart-based language is inherently multi-tasking, Conner was able to divide the project among several engineers. This saved precious time in software development.

Although the new 32-bit versions of Opto 22's software weren't available when Conner got its MINT machines running, they will make such jobs even easier, thanks to greater power and more flexibility.

The resulting MINT II system is a 66-foot long machine that runs with eight Opto 22 classic controllers. Each controls an average of 60 digital and 16 analog local I/O points. The processors are interfaced to Opto 22 Bricks - integrated I/O racks, each with its own microprocessor (Brain Board) - to provide distributed local intelligence for the system. The Bricks control servomotors that run the conveyors, sense product location with inductive proximity sensors, control power supplies and monitor process conditions.

Part of the secret of the systems' success is that each Brick contains an Opto 22 Brain Board - a co-processor that distributes intelligence down to the rack level. As a result, jobs such as PID loop control, counting, analog alarming and thermocouple linearization can be performed without the intervention of the host controller. This reduces the load on the network and speeds up processing.

The Opto 22 controllers are tied together on a LAN. High-speed RS-485 fast serial communications links from the controllers also directly control several other parts of the system, including the Granville-Phillips vacuum gauge and Eurotherm heater.

With the Opto 22 control language, Conner is able to use modern programming methods to cut the time and effort needed to develop and maintain software.

"We write most of our software so the majority of the code doesn't need to be changed," Eastburn explains. "We've probably got 80 charts in our process and probably no more than 10 of them at most need to be changed on a regular basis if we really have to change things on the process."

"We're writing the charts in such a way that they are generic. The chart associated with every chamber (of the furnace) has the logic to handle all possible configurations of the chamber and all devices not present are excluded by a variable. Basically, we can pre-configure the system without changing code." Instead of changing code, the operators use the MMI to change the appropriate variables and that changes the process.

Although this shows up on the MMI screens, this is really a function of the control language rather than the MMI, which is another reason why Opto 22 recognizes the paramount importance of the integration of the control language and the MMI in building effective control software solution tools for its customers.

Another important step was to put the low level functions, such as interlocks, on the chamber doors, in separate charts. "Most of that code doesn't have to be touched," Eastburn says. "So you end up with a dozen or less high-level process charts and most of the functions in them are interface functions to the code below them. It's a lot better to make changes there at the high level because you're not going to cause the system to become unsafe."

The Opto 22 control language is very easy to learn, especially for anyone who has been exposed to flowcharts before. Eastburn cites the case of one programmer who came to work for Conner and dove right into the language.

"He sat down with the book, read it overnight, and he was putting charts together the next day."

Results

The first of the two new MINTs, MINT II, was up and running within nine months of the start of the project, compared to the 15 months it had taken to bring the PLC-based MINT I into production. The second new MINT, MINT III, was up and running within three months. This was due in part to the ability to duplicate the flowchart-based code developed for the MINT II. This would not have been possible with PLC-based ladder logic code.

"The first [unit] took about nine months, compared to about 15 for the original. The second unit was up in three months. So we probably shaved nine months total off our development cycle."

According to Eastburn, the Opto 22 control system probably paid for itself while the first machine was ramping up for production. The ease of making changes to the Opto 22 system saved a lot of time.

"Four hours of downtime is probably about $70,000," Eastburn points out. "It doesn't take many four-hour blocks at those rates to pay for the cost of the control system."

In its first month of operation, MINT II broke the old production record at Conner Disk Division, a record that had taken five years to achieve with the PLC-based MINT I. The Opto 22 control system has continued paying off ever since.

Conner Disk Division's Milpitas plant now provides 90 percent of Conner Peripherals' disk media requirements - up from 40 percent - and is the largest disk media production facility in the United States.

Meanwhile, Conner Disk Division is adding three more MINT lines with Opto 22 control systems at its new plant in Singapore. They are going on-line quickly. For example, Eastburn says, the basic software for the new machines was cloned from the existing ones in the United States and modified as needed.

"We had the software well before the hardware and we needed hardly any time to debug it before we shipped it overseas," Eastburn says. In addition, training the engineers in Singapore on the Opto 22 hardware and software was easy, according to Eastburn.

"We sat the engineers down and explained how the system worked. Basically, we were able to focus on about 10 percent of the software related to the processes. We told them that eventually they could get into the low-level development stuff but that they wouldn't have to. It's like with an operating system where you can focus on the application rather than on the BIOS routines."

About Opto 22

Opto 22 manufactures and develops hardware and software products for applications in industrial automation, remote monitoring, and enterprise data acquisition. Using standard, commercially available Internet, networking, and computer technologies, Opto 22's SNAP systems allow customers to monitor, control, and acquire data from all of the mechanical, electrical, or electronic assets that are key to their business operations. Opto 22's products and services support automation end users, OEMs, and information technology and operations personnel. Founded in 1974 and with over 85 million Opto 22-connected devices deployed worldwide, the company has an established reputation for quality and reliability. Opto 22 products are sold through a worldwide network of distributors, partners, and system integrators. For more information, contact Opto 22 headquarters at 800-321-OPTO or visit our Web site at www.opto22.com.