CONTROL
For the Process Industries

Cover Story: SPEAK! New Tricks to Get Information Out of Legacy Systems

How to retrofit your system for modern communications

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Dealing with legacy equipment is occupying many engineers these days as they struggle to bring ancient control systems into the 21st century and meet the ever-increasing hunger of information technology (IT) software.

Everybody wants that data: accountants, bean counters, upper management, plant engineers, process engineers, operations engineers, maintenance people, and even the governor of New York. Some of the software packages you must feed include process historians, asset management, ERP, MES, LIMS, CMMS, SCM, and SPC, to name a few.

The Catch-22 is that many of these old systems, despite their inadequacies, are still performing incredibly well the jobs they were designed to do. It's hard to discard or even alter an old system that's in the midst of setting a reliability record. In this article, we'll look at a few ways that may help you extract data from your legacy systems.

Still Controlling After All Those Years

Foxboro Spec 200 process control systems (Figure 1) were installed at the PCS Nitrogen facility in Augusta, Ga., in 1977. They performed admirably over the years, according to Walter Anderson, instrument and electrical maintenance engineer. "In October 2001, we set a world record for running an ammonia plant: For five years, we made ammonia every day," he reports, proudly. "So when we set out to modernize the plant, the operators were understandably nervous."

In 1999, in the middle of that record run, Anderson was given the task of modernizing the system. "We had two black and white monitors with unbelievably terrible stick graphics, yet that system did supervisory control, trending, and data logging," says Anderson. Alas, time was taking its toll. "Every other week we had a problem of some kind. We had to improve reliability, provide redundancy, and speed up the response."

Figure 1: Still in Control

This Foxboro Spec 200 control system had been running since 1977 when a PCS Nitrogen facility decided to upgrade it in 1999. Problem was, the system was in the middle of setting a five-year reliability record for producing ammonia.

The biggest problem was the proprietary Foxboro system. "Foxboro's analog input modules [AIMs] produced a 0-10 V signal that was converted to a proprietary digital signal," says Anderson. "We couldn't economically add additional flow, level, or pressure data points to the Foxboro system."

Sound familiar? Scores of engineers with legacy systems face similar situations. Like PCS Nitrogen, their process control systems are still working after 15, 20, even 50 years. Many engineers ask, "Why replace a perfectly good control system?" They would rather just extract data from a legacy system and use it to analyze the process, perform more advanced control functions, feed the voracious IT software machines, and preserve the original investment.

Lee Ready, president of Spruce Grove, Alberta-based Ready Engineering (**http://www.readyengineering.com**), helps his clients extend the life and functionality of legacy Bailey (now ABB) DCSs. "We replace legacy operator consoles with modern HMIs and plug into the same DCS communications modules," reports Ready. "The DCS hardware, software, and configuration is unchanged."

Likewise, Cytec Industries, a specialty chemicals manufacturer in Stamford, Conn., is sticking with its Moore Products (now Siemens) APACS+ legacy systems. "Cytec's goal was to increase the facility's output utilizing mostly existing equipment by maximizing process efficiencies and reducing waste," says John Ward, manager of automation. "Adherence to the S88.01 standard for batch recipe management would be a critical part of the venture."

Clearly, it can be done. We've heard from engineers who are working with nuclear plant control systems dating back into the 1960s, and from one steel mill that is extracting data from equipment installed before World War II.

That doesn't mean it's easy.

Down the Upgrade Path

For our purposes here, let's define a legacy system as any process control system that does not have a modern open architecture. This can refer to a DCS you bought 27 years ago, or one that you bought yesterday. If you can't simply plug into the system's database or SCADA/HMI software and get what you want, then it's a legacy system.

To get data out of a legacy system, you probably have to upgrade it in some way. This ranges from simply installing an I/O board or software module that extracts data from the old system, to upgrading the control system to the latest version.

In most cases, you do not want to "bulldoze" your legacy system (i.e., replace it with all new hardware). Your first step, therefore, is to see if you can easily upgrade to a more modern version of the original system.

Obviously, any legacy system equipped with elements of open systems, such as Ethernet or fieldbus communications, or any system with reasonably modern PC-based HMIs, poses much less of a problem. For example, APACS+ and Bailey systems, noted above, appear to be easy to deal with because they were built with early versions of open architectures.

"The legacy systems that are easiest to upgrade are ones that were forward thinking, with standards like OPC, ActiveX, or common protocols like Modbus or serial," says Dave Quebbemann, industrial automation product manager at Omron Electronics (**http://www.omron.com**).

The worst systems to deal with are those that put up proprietary barriers in both hardware and software. "Many legacy systems are, in effect, standalone 'islands of automation' that might not have any capability of connecting to the outside world," says Don Holley, industrial automation manager at National Instruments (**http://www.ni.com**). "Even if the legacy system does have external communications, it is most likely based on proprietary hardware interfaces and communications protocols that are not well documented."

"The problems caused by proprietary architectures are wide ranging," adds Greg Nelson, product manager at Schneider Electric (**http://www.squared.com**). "It ranges from something as simple as the types of cabling to the protocol or software involved. Often, the system was programmed by former employees or by software companies that are no longer in business."

In all fairness, many DCSs were built long before the days of PCs and open architectures. In the 1970s, it was impossible to buy suitable hardware off the shelf, so companies like Honeywell, Foxboro, Fisher Controls, Bailey and others had to invent it themselves. Once they developed their own proprietary architectures, it was very difficult for the vendors to change gears and move over to open systems. That's why we have 27 years worth of proprietary DCSs to deal with. Alas, support for these old systems can be spotty.

"Getting support out of manufacturers for old hardware and control systems tends to be difficult," says Jacky

Lang, senior technology developer at Citect (**http://www.citect.com**), "Manufacturers tend to not want to deal with any legacy system older than a few years."

"The industry does not have a good record of updates," says Pat Kennedy, president of OSIsoft (**http://www.osisoft.com**). "It is the vendor's responsibility to construct this upgrade, because it is not simply a matter of changing an operating system. There are lots of configurations, reports, displays, and history that have to be moved over as well."

Kennedy practices what he preaches about vendor responsibility. "We have systems installed 20 years ago running our current version," he says. "If a vendor does not maintain a system, it dies in four to five years."

"Developing drivers for the old hardware is difficult because although the manufacturers don't want to support them, they still don't want to release the technical details," adds Lang. "Or they cannot find the technical details anymore."

Some detractors say that the vendors don't want you to upgrade, and that's why they offer little help. They say vendors want you to replace your entire legacy control system with their expensive new hardware.

But others don't agree. Although Kennedy and Lang point out that the level of support is not what it could be, we see plenty of evidence that control system vendors not only continue to support legacy systems, they offer upgrade paths to keep their old systems compatible with newer equipment.

Thanks for Your Support
The first place to look for support is from the original control system vendor. As Pat Kennedy says, it's their responsibility, after all.

Honeywell, for example, claims that it still supports the very first TDC 2000 from 1975. David Novak, control system engineer at BASF in Monaca, Pa., is a Honeywell TDC 3000 user, and has been constantly upgrading his systems to keep up with modern technology. "Most of our changes are expansions, not total upgrades," he explains. "With very few exceptions, the control system has all the functionality of a new system."

If your old Honeywell DCS has been kept up to snuff, connecting it to a modern IT system appears to be a piece of cake. "A modern system can easily accommodate an integration strategy, keeping the existing application logic and user interface of the legacy system," says Garry Lee, information management & analysis product manager for Honeywell Industry Solutions (**http://www.acs.honeywell.com**).

Figure 2: Southern Comfort
Old Moore Products APACS+ systems are easy to upgrade. Cytec upgraded its Mobile, Ala., plant to run S88

batch software quickly. Afterward, it became the largest producer worldwide of emulsion polyacrylamides. (Source: Siemens)

Honeywell's recommended solution is to use its Experion PKS data historian, which can deal with Honeywell's networks, plus other industry standards such as Modbus, 4-20 mA, and RS-232/422 serial communications.

Foxboro/Invensys (**http://www.foxboro.com**) recently announced a series of IA software modules that work on legacy systems up to 15 years old. Foxboro also encourages its users to migrate their legacy systems over to fieldbus. "In situations where the existing system is already doing a good job controlling the plant, users should seriously consider upgrading to Foundation fieldbus [FF]," says David Shepard, vice president at Invensys. "It allows migration to be performed on a maintenance budget, and preserves the existing investment in hardware, software, training, and intellectual property."

Shepard says automation vendors are split on the fieldbus issue. "While some vendors are telling customers that they have to replace their systems to take advantage of fieldbus, other vendors provide a migration path to FF from existing systems." Each approach--bulldozing and migration--has its advantages and disadvantages.

Upgrading to fieldbus can be a bit expensive, especially if all you want is to get a process data value out of a field instrument. Walter Driedger, senior process control engineer at Calgary, Alberta-based Colt Engineering (**http://www.colteng.com**), says the cost premium is about $500 to $2,000 per point. "A standard 4-20 mA transmitter costs about $800. The same with FF is about $1,300," explains Driedger. "To get a valve with FF you have to get an FF positioner instead of a simple I/P. That adds about $1,000 to the cost. A simple switching valve has two limit switches and a solenoid. To connect these to an FF module, such as TopWorx, adds about $2,000 to the cost."

Emerson Process Management recently announced a migration path that not only upgrades old Fisher-Rosemount systems, it upgrades everybody else's systems, too. The path migrates legacy systems to Emerson's DeltaV platform, and leaves the original I/O intact. Emerson claims that this upgrade is often less expensive and faster to implement than upgrading to the latest version of a legacy system.

Emerson says it supports old Fisher Provox and RS3, Bailey Infi90 and Net 90, Honeywell TDC 2000/3000, GSI D/3, GE Genius I/O, Siemens Teleperm, Moore APACS, Taylor Mod 300, Yokogawa, and Foxboro Spec 200, Spectrum, and I/A control systems.

The Siemens/Moore Products APACS+ is fairly easy to upgrade. At Cytec (Figure 2), to add S88 capability, Ward says they expanded their existing system with the help of Siemens and systems integrator Avid Solutions (**http://www.avidsolutionsinc.com**) and then installed Siemens' ProcessSuite Batch Manage. "We were able to transition the plant to the batch manager system with minimal production outages using a series of short partial shutdowns followed by a one-week cutover," reports Ward. Once that was accomplished, they installed OSIsoft's PI historian. "This permits operators and engineers to gain access to current and historical data." The historian data is also accessed remotely from network and dial-up connections.

Over on the PLC side of the control business, similar support exists. "We have migration paths for products that were developed 20 years ago," says Nelson of Schneider. This is important, because changing out a PLC processor is much easier than replacing an entire process control system, so control engineers upgrade PLC systems all the time. "Going from an old PLC to a new one could cause you to lose all your application programming effort if the supplier hasn't provided a migration path,"

They Can Do Anything

If DCS vendors can find out enough about other vendors' control systems to offer a migration path, it seems that other companies should be able to do the same. As it turns out, many companies offer products and services to upgrade legacy systems.

One way to extract data from a legacy system is to install a process historian package to obtain all the data, and then just take whatever you need from the historian. A process historian typically consists of a separate computer and software package that acquires real-time data from sensors and the control system, and stores it into an historical database. The historian vendor supplies the interface to the legacy system and to IT software.

"A typical data model for users these days is to have a data historian connected to each legacy device," says Michael Paulonis, technical associate at Eastman Chemical, Kingsport, Tenn. "User-written applications will use the data historian's application program interfaces [APIs]. This removes the need for the user to be proficient in all operating systems and legacy APIs."

Process historian vendors have to be proficient in control system APIs, or they wouldn't sell any software. OSIsoft, for example, has been selling process historian software for 20 years. Over that time, the company has developed interfaces to just about every control system on the market. "We have more than 350 interfaces,"

says Kennedy.

Arcom Control Systems, Stillwell, Kan., and IBM UK, Hursley, England, have collaborated on an MQSeries "telemetry integration solution" (as IBM calls it), which connects to legacy control and SCADA systems. Arcom supplies its Director Series hardware and software interfaces to various legacy systems, and IBM UK provides its WebSphere enterprise software, which has links to SAP, Oracle, and similar IT packages.

Each Director module has protocol drivers that access data from field devices. Drivers available include HART, Modbus, TCP/IP, terminal server, UDP, PPP, Telnet, and other systems primarily used in oil & gas, electric utilities, water, and telecomm industries.

InStep Software (**http://www.instepsoftware.com**), Chicago , says it has installed its eDNA process historian on just about everything. The company seems to relish tackling tough and obscure systems. Anthony Maurer, a partner at Instep, says the company can reach legacy systems with file-based transfers, serial interfaces, parallel interfaces, TCP/IP socket reads, DMA, and printer device sniffing techniques.

InStep has been interfacing to control systems for 15 years, starting with nukes. "VMS-based systems are the easiest," says Maurer, "and dedicated nuclear-grade plant process computers are the hardest."

Although process historians do make your task much easier, we've heard that this convenience and process expertise comes at a very steep price, up to $1,000 per data point.

You Can Do Better?
Some plants have very little money available for bulldozing, complete system upgrades, process historians, and similar solutions. What they need is to extract the necessary data without spending a lot of money and without compromising their current control system.

Ready Engineering, for example, knows Bailey systems fairly well, and Lee Ready cautions users about going too far. "We see many end users replace their Bailey DCS with 'modern' equipment that has less functionality and with HMIs that are inferior," notes Ready. "An engineering study would have shown them that maintaining their Bailey DCS and installing a new, third-party HMI would have resulted in a superior system at a fraction of the price."

Dave Siever, APC project manager at Air Liquide America, Houston, agrees. "Bailey DCS systems are reasonably easy to upgrade to Wonderware HMIs, using DDE servers to get the data," he says. "Using DDE servers with Bailey Net90 and Infi90 allow integration with Industrial SQL server (iSQL), which is a good way to extract key data. We've done the same with Foxboro systems, but the I/A system is weak with DDE/OPC. Our best solution with Foxboro is to use OSIsoft's PI historian, although it is costly."

Siever calls in experts when needed, but usually does the work in-house. "We keep IT folks away from process control systems," notes Siever. "Vendor help is typically crappy for this, since they usually prefer to keep their legacy systems a closed architecture and want us to use their proprietary software and hardware. Fortunately, we have good in-house software capability and have developed our own DDE servers to interface with legacy systems. Vendors like Matrikon and Standard Automation have helped as well."

When he's not using historians, Paulonis at Eastman Chemical puts his control systems on networks. "It is certainly important to get a legacy system on the network," he advises. "This pretty much implies Ethernet. Most vendors have an application server of some sort that provides a network interface."

If not, how do you develop one? Few end users have the programming resources to develop their own APIs and DDE interfaces. "In most cases, 'you' do not," says Paulonis. "An IT supplier provides the interface. If there is a reasonably large installed base of systems, it is usually cost-effective for IT software suppliers to write an interface."

"Typically, the most significant cost for anyone wanting to convert from legacy systems is the programming development involved," cautions Nelson of Schneider Electric. "It's the programming, not the hardware, that requires the biggest investment. All the hassles, costs, and potential downtime associated with reprogramming is what keeps people from moving forward."

If you don't have programming talent in house, you may want to bring in a systems integrator who knows your particular system and knows how to write C code and APIs.

Of course, if you have clever people around, who needs outside experts? George Lister, computer technician at U.S. Gypsum, Sweetwater, Texas, has a sweet and simple solution. "Most legacy systems have a serial port. The trick is to figure out what data you want to export, format it for a serial stream, and then output the data," he says. Sounds easy. But how do you output it? "Port the legacy data to a printer port as if it were a 'print'

command. Format the print command in a form that will be accepted as a serial stream."

Lister connected his Foxboro Fox III SCADA system (circa 1975) to a Unix system that supported multiple serial ports. "We configured the serial port on the Unix box to accept the serial streamed data and imported it into a database record. We used Foxbase for Unix software. The database software writes the serial streamed data into a record delimited by spaces. Once we got the data into the database, we could do anything we wanted with it."

Walt Anderson at PCS Nitrogen wound up replacing his legacy Foxboro system (Figure 1) with another legacy system. In 2001, PCS Nitrogen closed down two nitrogen plants in Iowa and Nebraska, both of which had three-year-old Moore APACS+ systems. So Anderson shipped them down to Georgia to replace the aging Foxboro Spec 200 controllers. "In 2001, we upgraded 1970s technology to 1990s technology," quips Anderson. He also installed a Wonderware HMI/SCADA system to replace the old Foxboro Spectrum supervisory computer.

Figure 3: Thin Is In
Operators at PCS Nitrogen loved their Spec 200 controller faceplates. Installing touchscreens and thin client workstations with Spec 200 faceplate displays let operators work in familiar surroundings.

"We used the Internet to find specialized data conversion instrumentation," he reports. The system had been modified in the 1980s with a Transmation temperature monitor, Fischer & Porter MicroDCI single-loop controllers, and a Tensa Unix box with optimization software.

The operators were not entirely happy at the prospect of losing their familiar Spec 200 analog controller faceplates, so Anderson installed thin clients on the Wonderware system. "We formatted thin client displays so they looked exactly like a Spec 200 faceplate [Figure 3]," says Anderson, "and installed thin clients in place of Spec 200s. With a touchscreen, the operators could adjust the loops the same way they did on the old hardware."

The Cavalry Arrives
Define a need, and somebody will meet it. Hardware and software vendors and systems integrators are constantly solving your problems.

For example, new software makes it possible for you to extract all the data you need from your existing HART-based field instrumentation. Bud Adler, director of business development at Moore Industries (**http://www.miinet.com**), says there are six million HART-enabled instruments in process plants around the world, but only a handful of plants are taking advantage of the digital data contained in the 4-20 mA HART signal.

"The HART Foundation offers an OPC server that greatly facilitates connecting a large number of HART devices to a system," says Adler. "These systems are so simple to install and commission that often no system integrator is required. Software packages from companies including Citect, Iconics, Intellution, USData, and Wonderware all support such applications." (For more information on HART, see the insert in our September 2002 issue or at **http://www.hartcomm.org**).

Adler also notes that plants have used remote I/O for decades. Such systems have been installed in environmentally protected cabinets out in the refinery or plant, and often connect to the control system over a proprietary data highway. Upgrading such a system has been too expensive, until recently. Now you can upgrade with a wireless system. "There are industrial-grade spread-spectrum radio systems that may be easily adapted to field I/O modules," says Adler. "By purchasing the radio system and I/O system from the same vendor, compatibility can be ensured."

You could also use the Internet to send data from afar. In New York state, Governor George Pataki instituted a power curtailment program. As part of the program, all state facilities are required to reduce power consumption by at least 30%. So, beginning with the state prisons, diesel generators are being fitted with Opto 22 I/O systems to monitor operations and send data to a central location via e-mail messages. Project engineer Eric Breen of Marine Interface, Deer Park, N.Y., says he plans to use the XML capabilities of the Opto 22 system to make data accessible via Web Services.

Just as the plant historian vendors have their legacy interfaces, so do the HMI/SCADA software companies. Companies like Intellution, Wonderware, Citect, USData, and others have been around since the 1980s, so they have interfaces to many legacy systems.

"CitectSCADA comes with over 170 drivers bundled with the base product at no extra charge," reports Richard Bailey, product marketing manager, Citect. "More and more customers are extending the life of their legacy systems with add-on tools. Software modules connect seamlessly to the legacy system and allow bidirectional data transfer, including migrating legacy data into a format and location that is useful."

The beauty of an HMI/SCADA system or process historian is that once it's installed, you have access to all the data in the legacy control system, so you don't have to work with additional I/O hardware or software drivers. But if you need to work with the actual I/O, there is help available from hardware vendors such as Sixnet, Opto 22, and Lantronix.

"An Opto system can be added to the existing control architecture without affecting any of the core processes," says David Crump of Opto 22 (**http://www.opto22.com**). "The specific machines, equipment, and system components that are involved almost without exception have attachment capabilities to our hardware. And that attachment can be direct, via serial communication, or via analog, digital, or serial modules."

This worked at the Callaway Golf Co. ball manufacturing plant in Carlsbad, Calif. Callaway recently installed a modern control system in a brand new plant, but neglected to provide any data acquisition capability. Although it was a state-of-the-art control system, it wasn't "open," so getting data posed a problem. "The Snap Ultimate I/O system monitors thermocouples, pressure and conductivity sensors, and other equipment used in the production of golf balls," says Crump. "We didn't modify any of the actual production processes, but came in under the control layer, at the instrumentation level, strictly for the purposes of capturing data."

Such add-on I/O hardware is available from a host of companies. Unless you like contacting every vendor in the world, your best bet might be to prowl the Internet.

At some point, you have to ask yourself if it's worth the time, trouble, and expense of working with a legacy system. You might be postponing the inevitable, because all systems die eventually. However, if funding and other problems dictate that you work with what you have, remember that data in any legacy system can be

accessed. It just takes time and money.

TABLE I.

TOP 10 WAYS TO MAKE IT TALK

1. Got HART? If you have HART-enabled field instruments, a HART OPC server will extract digital data.
2. Print it out: If your old legacy system has a serial or printer port and a print command, just print the data out. Another computer can input the serial stream, extract the data, and put it into a database.
3. Get it on a bus: Check to see if your system has an old Modbus interface or any other early fieldbus network that's still supported.
4. Ask your control system vendor: Most vendors support their legacy systems. Maybe they have an easy solution.
5. Ask an HMI/SCADA vendor: Most HMI vendors have interfaces to dozens or hundreds of legacy systems. You can get anything you need once HMI software is installed.
6. Ask an historian vendor: Similarly, historian vendors have interfaces to everything. You can get anything you need once an historian is installed.
7. Intercept the I/O: Go directly to the field I/O and take raw signals you need via wireless interfaces, jumpering, fieldbus interfaces, or dual port devices.
8. Hire a systems integrator: Find someone who has experience upgrading your system and can work with you.
9. Upgrade to the latest version: Bite the bullet and pay the vendor to bring your legacy system up to date.
10. Bulldoze: As a last resort, start over with a new, open system.