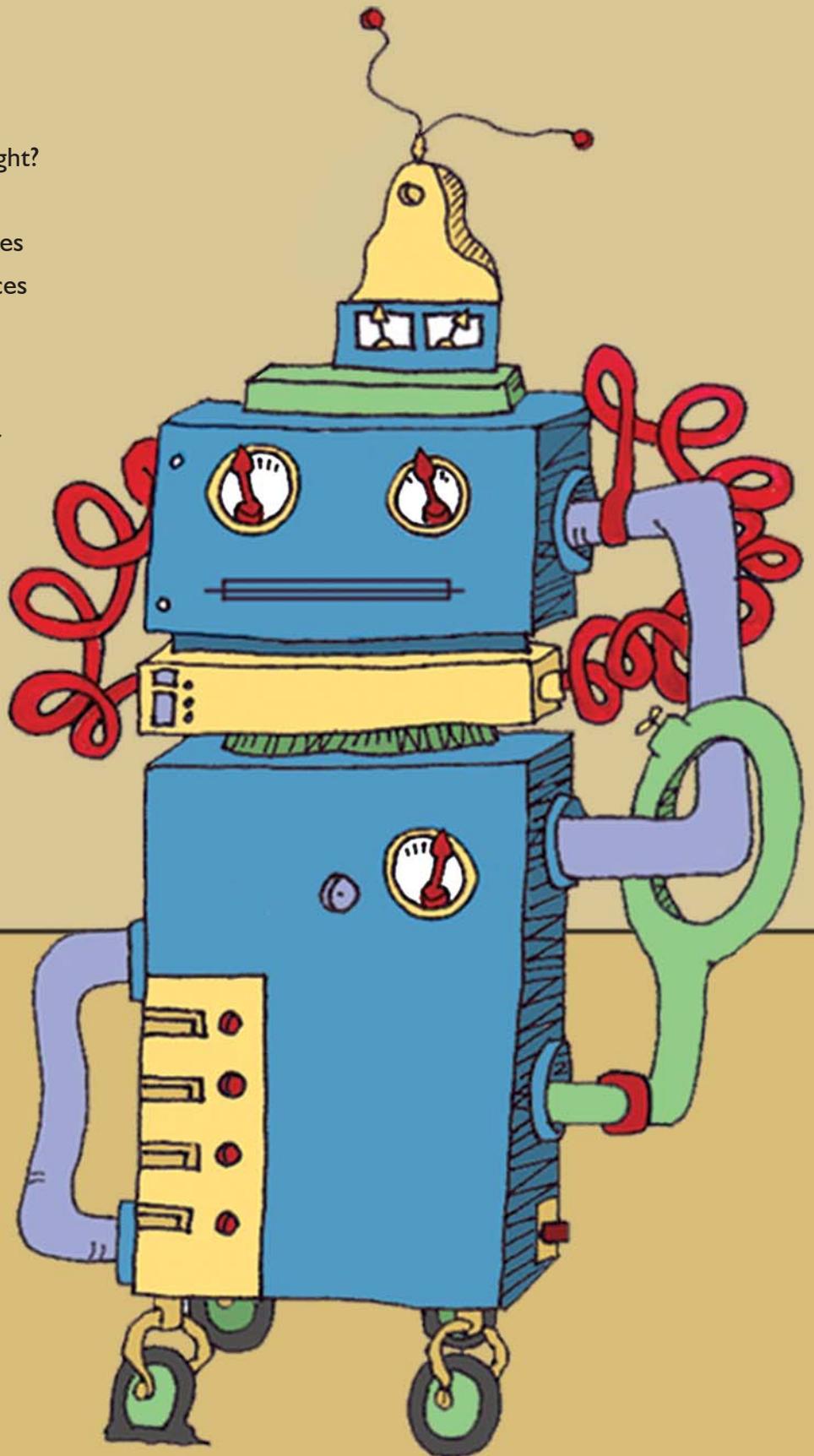


In the lands of pipes and pots  
Process people get the hots  
For a system new and bright  
How can they know which is right?

Take our tour of different choices  
See the problems, hear the voices  
DCS, PLC, PC, or PAS  
What it is? Or what it does?

By Bob Waterbury, Senior Editor



# DCS, PLC, PC, or PAS ?

**O**utside of a child's book of fiction, if you read about converging parallel lines you might be justifiably concerned that the world as we know it is about to end. But once parallel, now converging, control technologies are an important trend, and without cataclysmic results.

In fact, some control industry experts see technological convergence as an opportunity whose time has come. Larry O'Brien, senior analyst, ARC Advisory Group, Dedham, Mass., uses the generic term process automation system (PAS) to describe all forms of DCS, mini-DCS, and hybrid controls (Figure 1). He estimates the worldwide PAS market will grow to more than \$9.5 billion in 2005, up from \$7.8 billion in 2000 (Figure 2).

One of the issues obscured by this estimate is that unit cost is declining while functional capability is increasing. At the same time, overall hardware sales are actually falling, being supplanted by rises in software and services. Greater functionality at lower cost means more power for the dollar.

A more important immediate observation, however, is that the practical and technological boundaries between a distributed control system (DCS), programmable logic control (PLC), and personal computer (PC) control are blurring. Units traditionally associated with process control are being used in discrete applications. Likewise, traditionally discrete solutions are used increasingly in both batch and continuous process control.

"That's because a look at the underlying technology of today's solutions shows many similarities," says O'Brien. "Today's different types of control hardware are constructed from many of the same standard industry components such as Intel microprocessors. Thus, the only real differences in control systems may lie at the software level."

O'Brien points out that process and discrete suppliers are already encroaching on each other's territory. Increased competition between process and discrete suppliers in the hybrid

industries such as food and beverage, pharmaceuticals, and specialty chemicals are prime examples. In such applications, the requirements of process and discrete control are frequently interconnected, and thus combined in the control solution. "A prime example of a hybrid process is the brewing industry," says O'Brien, "which incorporates sequential, batch, and continuous process control in the brewing process and discrete control in the bottling, packaging, and distribution processes."

## A Changing Controls Market

Does technological convergence have users a little confused? A small, informal survey of Fisher-Rosemount DeltaV users found that, when asked to classify their control solution, some said it was a DCS. An equal number described it as either a mini-DCS or hybrid controller. One thought it might even be a process automation system (PAS), although he wasn't quite sure what that term meant (Emerson refers to it merely as a digital automation system.) But each user knew what control functions the system performs and how it fits into his overall control scheme.

A look at the blending of control functions among various industries, according to ARC, shows why users and suppliers are occasionally unsure of the form and architecture of control solutions (Figure 3). Process suppliers are entering the markets traditionally served by PLC suppliers through the introduction of hybrid controllers. And PLC suppliers are invading the process control markets with units that perform batch processing as well as discrete functions. The driving force in either case is industry needs for total solutions that not only provide control, but generate production, quality, and

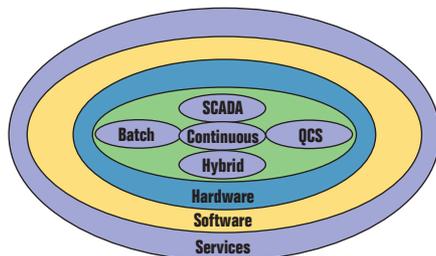
maintenance information for MES, ERP, and higher-level IT functions (Table I).

The world of process automation systems includes functions such as SCADA, batch, hybrid, continuous, and quality control. It is implemented through a combination of various types of hardware, software, and services. Traditional hardware solutions include DCS, PLC, and PC control. More recently, however, hybrid controllers have entered the market poised to capture business in both the process and discrete industries. This clearly fits the needs of hybrid industries such as specialty chemicals, pharmaceuticals, and food and beverage that typically comprise a mixture of discrete and process functions.

But even in the petrochemical and refining industries where continuous processes reign, there is often a number of smaller batch and discrete functions. In many cases these functions, along with the continuous processes, could just as easily be handled in a unified hybrid controller database. Ultimately, corporations could use this to structure networks and fuel the data needed for supply chain management, MES, ERP, and IT functions.

**FIGURE 1.**

## COME TO PAS



IN DEDHAM, MASS.-BASED ARC'S DEFINITION, THE PROCESS AUTOMATION SYSTEM IMPLEMENTS A SELECTION OF TRADITIONAL CONTROL SYSTEM FUNCTIONS THROUGH A COMBINATION OF HARDWARE, SOFTWARE, AND SERVICES.

Increasingly, manufacturing data that helps improve production efficiency is the lifeblood of companies in highly competitive markets. Such is the case for Equistar Chemicals, Houston. By installing MES systems in addition to its traditional DCS controls, Equistar has created statistical tools and algorithms for determining optimum feedstock, product run, and logistics strategies to boost yield and cut costs, according to principal engineer Robert Brown. Company expenditures for controls last year totaled more than \$50 million, but management is confident of a one-year payback because they know that control projects tend to be the biggest moneymakers, he says.

Furthermore, companies such as Atofina Chemicals in Philadelphia are using data storage and applied analytical software to better understand control parameters for quality or yield improvements. By establishing baseline data, the company can measure system performance and fine tune its

processes. Without detailed statistical analysis, process improvements may be misguided and lead to replacing a pump when the real problem was just a valve or a pipe.

### DCS: The Land of Giants

Continuous process plants such as refineries, petrochemicals, pulp and paper, steel mills, and textiles still rely heavily on DCS solutions. Some are moving new applications to hybrid controllers such as Honeywell's PlantScape or Fisher-Rosemount's DeltaV, but large-scale legacy systems still control most of the continuous processes. Even PLCs are not left out of the picture in large continuous process plants. They are often used for discrete control in such functions as conveyors, motion control, and machine control.

"DCS really grew out of the heavy process industries," says George Dolan, a Houston-based controls engineer and consultant with experience at Lonza Chemicals, Exxon, Nalco, Texas Instruments, STRG Controls, and elsewhere. "But the market and the equipment have changed considerably over the years. DCS and PLC worlds are blending as some DCS systems are now operating on Windows NT platforms and HMI is being added to PLCs. In fact, a PLC can do nearly everything today that a DCS can do. I know, because I have successfully crossed that line and put a PLC with HMI in charge of a continuous process control application. The DCS may still offer some advantages when it comes to redundancy and hot swap capability, but new PLCs can offer that today, too."

Dolan considers the PLC to be a less expensive solution to a given application than DCS. However, over the lifecycle of the application, say 15-20 years, this will even out as costs for troubleshooting, maintenance, multiple databases, and communications increase the long-term costs of PLCs. He confesses that new process software is even helping industrial PCs find a niche in mixed batch and discrete applications—especially where recipes and formulas are involved in paints, baking, blending, mixing, batch control, recording, reporting, and validating. This capability, he believes, is accelerating the trend toward more open systems, industrial PCs, and truly distributed control actually occurring in the field as opposed to a remote or centralized DCS control room. He still maintains, however, that higher-level integration with MES, ERP, and IT is easier done with a DCS than either a PLC or PC at this point in their evolution.

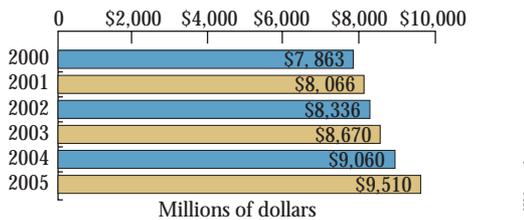
"For many years, we have used Bailey Infi-90 DCSs for process controls and motor starters," says Ben Fairweather, senior control engineer at Appleton Coated Papers, Combined Locks, Wis. "And we still rely on them quite heavily. Recently, however, we put in a DeltaV hybrid system for use on our paper machines to do vacuum control, flow control, level, temperature loops, and miscellaneous discrete functions such as valve on/off control. In addition, we use PLCs for motor controls and other discrete applications. DeltaV provides the HMI for the motors. Therefore, we leverage the

OPC flexibility of DeltaV to handle discrete PLC control as well.”

According to process systems supervisor Peter King, the Ultramar Golden Eagle refinery in Martinez, Calif., has just about every type of control setup under the sun. “You name it and we’ve got it,” says King, “but mainly our plant depends on DCS for continuous process controls—and a few PLCs for ancillary discrete service. We even have a few old panel control boards that we are in the process of replacing.”

**FIGURE 2.**

**PAS GO**



**THE PROCESS AUTOMATION SYSTEM (PAS) MARKET IS PREDICTED TO GROW TO \$9.5 BILLION IN 2005.**

In addition to continuous control, the facility does a small amount of batch control in blending various grades of gasoline. PLCs are used in remote operation of valves, emergency shutdown systems, and miscellaneous skid controls and emissions monitoring. PCs are scattered throughout the plant, but used mainly for HMI and some gas turbine controls. “But the DCS is really packaged to fit our particular applications—from hardware to software,” says King. “It’s a strong legacy to overcome.”

Marty Robbins, process control engineering manager, Georgia-Pacific, Palatka, Fla., uses DCSs to regulate three tissue and two Kraft paper lines, 13 digesters, power recovery, and a water treatment plant. “I have Foxboro I/A in power recovery and Honeywell TDC 2000/3000 for most all other processes, plus some Honeywell TotalPlant Solution (TPS) nodes,” says Robbins. Although Allen-Bradley PLCs are used for discrete applications, some of those functions are handled by DCSs as well.

“Overall, I generally use a DCS in applications involving chemicals, petroleum or petrochemicals, and other large-scale continuous processes,” says Dolan. “For discrete applications such as packaging, product transport, and other standalone applications, I’ll mix PLCs into the control equation. In addition to the industries already mentioned, the metals industry will often use a mini-VAX with PLCs for control. The plastics industry normally prefers its own proprietary controls for such things as injection molding, extru-

sion, etc. This may also take the form of PLCs and HMI. Plastics resin reactors, however, normally use a DCS with triple modular redundancy because the processes are so complex and difficult to re-start if anything goes wrong.”

**Hybrid Control: Emerging Solution**

Hybrid controllers are crossing the lines between DCS and PLC solutions. Not coincidentally, they are targeting the lucrative, fast-growing hybrid industries such as food and beverage, pharmaceuticals, fine chemicals, and semiconductors. These hybrid systems handle both process and discrete functions, and are well armed to compete in the batch processing and supervisory control and data acquisition (SCADA) markets.

Examples of hybrid control systems include DeltaV from Fisher-Rosemount, PlantScape from Honeywell, the Micro I/A series controller from Foxboro, Siemens Simatic PCS7, Rockwell ProcessLogix, and Centum CS 100 from Yokogawa.

As expected, the market is divided into two segments. One relies primarily on DCS for its process and discrete control applications; the other mainly on PLCs with single and multiloop controllers for process functions. Ideally, these control solutions are used in situations where there is a mix of process field devices integrated with PLCs—or a combination of PLCs and single and multiloop controllers.

ARCO Alaska, for example, made headlines several years ago when it purchased a Fisher-Rosemount DeltaV system to replace Siemens S5 PLCs. Other applications, such as a brewhouse, are also digital I/O intensive, according to ARC, and require hybrid systems that can handle large counts of digital I/O. Recently, hybrid control suppliers have also added to their functional capabilities in enterprise level and supply chain management. This has helped stimulate new market interest and growth.

“Ideally, a hybrid controller performs regulatory continuous process (DCS) and discrete (PLC) control as well as batch and

**TABLE I.**

**DIFFERENT FOLKS**

	Factory automation	Hybrid industries	Continuous industries
Automation market growth	4–5%	5–7%	2–3%
Demand for total solutions	low	medium	high
Need for total solutions	high	high	high
Supplier loyalty	medium	medium	high
Advanced software installed base	low	low	high

logic,” says Paul McLaughlin, director of PlantScape engineering, Honeywell Industrial Control, Fort Washington, Pa. “The only real difference is in the algorithms that are used.” Hybrids can provide a DCS-grade infrastructure as well as a SCADA infrastructure, and be used in process automation as well as discrete automation.

Hybrid systems are quite versatile. They can offer

HMI/SCADA functionality, complex continuous and discrete control, or demanding refinery and petrochemical functions; from less than 10 up to 20,000 or 30,000 I/O. Hybrids also offer use of open, interoperable bus technologies including Foundation fieldbus, AS-i bus, Profibus DP, and DeviceNet. They often feature open standards such as OLE for Process Control (OPC), XML, and ODBC. And they excel in integrating enterprise planning systems with lower-level devices such as wireless phones, pagers, and PDAs.

Tom Shaw, automation manager at Cargill/Vitamin E in Eddyville, Iowa, describes how his plant recently switched over from a combined DCS/PLC control environment to a hybrid control system to achieve a common configuration environment and a single integrated database. "Eliminating separate databases for discrete and process control is a major operating advantage," says Shaw. "Right now, the hybrid control system handles discrete, batch, and process control—plus it interfaces to our legacy DCS system and provides a unified database. Hybrid control simply meets all of our control and data needs. It's safe to say that all of our future control requirements will migrate to hybrid control as well."

Vernon Mills Textiles in Trion, Ga., is moving from a System 3 DCS to a hybrid control system. "Most of our textile dye and finishing operations are now controlled by a DeltaV hybrid controller," says process control engineer Randy McDonald. "We are making the move due to lower installed costs including smaller footprint, reduced installation and maintenance, fast configuration, and the wealth of information available using Foundation fieldbus and smart field devices. It is taking the place of a mix of 4-20 mA process and discrete control solutions regulated mainly by the System 3 DCS."

Gideon Richter Pharmaceuticals, Budapest, Hungary, recently installed a PlantScape hybrid control system to integrate a reverse osmosis (RO) water purification unit into its overall synthetic hormone production facility. The objectives of the installation were to create automatic batch reports, further develop and refine production technology, fulfill FDA validation requirements, and identify and correct production deficiencies. Specifically, the control system was implemented to reduce batch variances and to minimize operator failures.

It also had to integrate additional control elements without making major changes to existing facility hardware or software. As a result, a single PlantScape controller was dedicated to handle all of the data collection and control requirements of the RO water unit. PlantScape's rotary station capability allows engineers to log onto the system on their PCs to check data and monitor system performance.

### PLCs: Old Solution, New Twist

As we have seen, even in the land of the process giants, PLCs have played an important role in the many discrete control functions that necessarily support most continuous

process applications.

Mike La Rocca, senior process engineering specialist, Solutia Industrial Chemicals, Sauget, Ill., says his plant depends on DCS for continuous process operation—about 75% of the applications are continuous process control. But 25% are batch and discrete operations. For those (bagging, drumming, manufacture of solid pastilles, and batch mixing), he depends on PLCs. "I feel in the not too distant future it won't make any difference what controller you use, but how you configure it, program it, and what software you use to execute the functionality. We do a lot of batching, blending, and bagging in producing chlorines, chlorobenzenes, and other additives used in the manufacture of animal feeds, plastic bags, and wrappings. And most of that is controlled by PLCs."

The Climax Molybdenum Co. mine and mill in Parshall, Colo., uses a mix of PLC, DCS, and SCADA. "Our controls are probably 60% PLC/HMI and 40% DCS," says Al Spletstosser, control systems coordinator. The facility uses PLCs with HMI to control underground mining functions including water treatment, mine ventilation, and more than 15 miles of conveyors. DCS is used to control mill processes including cascade and ratio controllers to regulate loading, the mill power drive, paper feeders, water controls, and grinding functions.

## INTEGRATED SOLUTION ON TAP

Open process solutions are giving customers more functionality, ease of use, and the connectivity required for scalable, integrated solutions. The city of Hazel Crest, Ill., needed a potable water delivery system that could coordinate multiple remote pumping and metering stations as well as control chemical treatment of the water. "Ideally, the system should also integrate with a paging system to alert an on-call operator of critical situations," says treatment plant engineer Jerry Davis. "It also had to be affordable, flexible enough to meet changing requirements, and offer quick return on investment."

The solution features GE Fanuc 90-30 PLCs and Cimplicity HMI software, and provides communications through spread-spectrum radio. Cimplicity HMI provides the graphics and alarming capability, as well as standard historical evaluation tools.

"As PLCs and DCSs move toward each other technologically, GE Fanuc continues to add functionality to its existing family of products by offering process extensions or programming tools that can offer truly integrated system solutions," says Lance Miller, open process manager for GE Fanuc, Charlottesville, Va. The solution has provided a return on investment in less than two years. In addition, it generates daily reports for environmental compliance, virtually eliminates manual data collection and device control, and automatically logs system performance. "Best of all, it has cut overtime in half," says Davis, "and we can even monitor system performance from off site via phone."

The basic DCS system was installed in the early '80s mainly to control electric power usage. It then spread to other functions such as water and wastewater, pumping, and ventilation. In addition, Foxboro I/A is used to transfer information from the PLCs to DCS. The only batch application is blending some of the powdered reagent used in the processing. This is accomplished using PLCs.

"Because we use Allen-Bradley PLCs with HMI and historian software, we might consider installing Rockwell's ProcessLogix to integrate our databases and discrete and process controls in the future," says Spletstosser. "Until then, DCS is our primary continuous process control solution. It provides the power and applications we need without developing interfaces for incompatible products with different protocols."

Just as hybrid controls based on DCS technology are adding discrete control functionality, new PLCs are adding process muscle to their discrete control capabilities. "ProcessLogix is simply Rockwell's version of our PlantScape," says Honeywell's McLaughlin. "And its ControlLogix is a next-generation PLC product that features discrete networking via ControlNet. Furthermore, both can be applied as board-level products and added to a controller to provide a wide range of solutions—both discrete and process."

The Hexcel Corp. polymer plant in Decatur, Ala., recently installed Process-Logix on its polymer fiber line to optimize its mixing, stretching, chemical treatment, and extrusion processes and increase overall efficiency. The polymer line uses a mix of both batch and continuous process control. "We needed efficiency without high dollar investment," says plant engineer Jim Peppers. "ProcessLogix allows us to improve control and reduce engineering and maintenance costs at the same time."

Since ProcessLogix uses one common database for the server, controller, and operator interface, it is inexpensive to install and maintain. It also offers drag-and-drop function block programming, a library of process control functions, and a global database. Plus, it offers the control functions normally found in traditional DCS solutions.

Jeff Pierson, process engineer at BAE Systems Royal Ordnance North America, Kingsport, Tenn., also uses a mix of PLC/HMI and DCS solutions in the process of manufacturing high explosives. The facility's most recent installation uses PCS7 controllers (PLCs) from Siemens, which perform both discrete and process functions in the batch chemical manufacture of various grades of explosives. There is also a Foxboro I/A DCS system that controls distillation columns and related systems in the organic acids plant, and some older Siemens and Allen-Bradley PLCs that control switches, valves, and pumps in water, steam, and utility areas.

"In addition to the batch capability, one of the reasons we chose PCS7 was because we already had PLC I/O in many of

these scattered production buildings," says Pierson. "We also needed the hot backup capability provided by Siemens for exothermic chemical reactions, and wanted to use sequential function chart rather than ladder logic for programming our applications."

### PCs: Ready for Process?

The market for PC-based process control has grown remarkably during the last several years, encroaching mainly on proprietary PLC applications, according to YeeYeen Wang, national director for HMI and panel PCs, Advantech, Fremont, Calif. One must realize, however, that PC-based control is starting from a much smaller market share than PLC, DCS, and hybrid control solutions.

"Often, PCs are used today to control machinery using remote I/O modules as a linkup," says Wang. At higher levels of integration with MES, ERP, IT, and management databases, PCs have an open systems advantage over both DCS and PLC solutions. "We find this especially true in the food and beverage, water and wastewater, semiconductor, and pharmaceutical industries. DCS and PLC solutions make sense in continuous production of stable products in long-term markets. The inherent flexibility of PC technology, however, better accommodates constantly fluctuating markets, products, and services. And in the future, web connectivity for remote monitoring and control is a major plus for users."

To allow for market and technology changes, Advantech contracts stipulate that they will stock the customer's necessary hardware and software for a specified period of time, or provide a three to six-month advance notice of anticipated product or technology changes. This provides customers with replacement products to maintain current solutions, or an opportunity to plan an upgrade to the next level solution.

PC-based control made big news several years ago when Moscow-based AK Transneft, one of the world's longest crude oil transmission systems, installed 300 networked PCs to provide supervisory control and data acquisition to its pipeline network. The Windows-based PCs running Genesis HMI/SCADA from Iconics, Foxborough, Mass., generated savings of more than three times that of traditional UNIX and DCS systems, according to Victor Saenko, chief technical officer. It monitors more than 187,000 digital and analog tags, and also provides early warning of leak detection along the transmission system.

Since then, PC-based control has been used successfully in various process applications, especially water and wastewater, pilot chemical and pharmaceutical facilities, and food and beverage applications. Still, there are reservations about using PCs in large-scale continuous processing plants.

"It is certainly feasible to use a PC to replace a DCS or PLC," says Campa, "but not advisable for us at this point. If a PC is only collecting data and crashes, the production process continues on regardless. But if it is controlling the processes, shutdown and startup could be expensive—not to mention

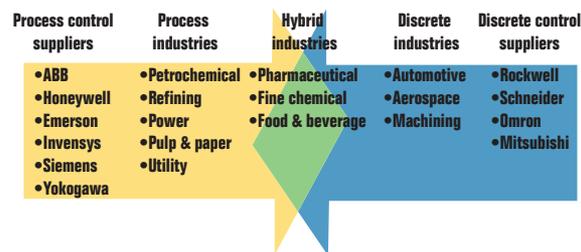
possibly hazardous for machinery as well as humans.”

“We use PCs for SCADA and data collection—and even some non-critical control applications,” says Cargill’s Shaw, “but I’m not ready to trust my plant to a PC just yet for reasons of safety, security, reliability, and mean time between failure.”

“At Solutia Industrial Chemicals, it’s against corporate guidelines to allow a PC to control production processes,” says La Rocca. “We deal with hazardous chemicals and the safety issues are too great—plus consistent, high-quality production is

**FIGURE 3.**

## LINES OF ATTACK



**CONTROL SOLUTIONS PROVIDERS THAT BEGAN IN THE PROCESS OR DISCRETE WORLDS ARE CONVERGING ON THE HYBRID MIDDLE GROUND AND ARE BEGINNING TO ENCROACH ON EACH OTHER’S TRADITIONAL HOME TURFS.**

vital. There are just too many occurrences of PCs locking up that require system shutdown and re-start.”

Nalco Chemical Co., how-ever, operates a large pilot plant in Illinois whose function is process development and scale-up to full production manufacturing. One of its processes uses a reactor whose reactants are fed at multiple feed points using positive-displacement pumps. To ensure accuracy, Nalco decided to integrate a PC-based SCADA system to control the speed of the pumps through a feedback PID loop. It used National Instruments Lookout HMI/SCADA software and Fieldpoint distributed I/O to implement the application. All of the hardware was installed in a NEMA 4 enclosure along with a Dell Pentium-based PC.

According to Vivek Nayak, president of Vista Technology, a system integrator in Schaumburg, Ill., the system was installed and commissioned with practically no operator training. In addition, the PC-based system provided accurate, automated logging of experimental data, easy data retrieval, and significantly increased the speed and efficiency of the entire developmental research process.

### Choices, Choices, Choices

In selecting the right process control solution, one can no longer assume that a certain type or class of product is the right answer. As technologies and control solutions merge, it is more important than ever to judge on the basis of functionality, affordability, and overall lifecycle costs.

As we have seen, there is a considerable amount of discrete control even in the large continuous process industries. Thus,

the capability to perform hybrid control functions will continue to be a moving force in the marketplace. But what really is hybrid control, anyway? Is it the ability to function through one unified control and management database? Is it the ability to do both process and discrete control? Is it both control and database capabilities—or those two plus something else? Even the suppliers and industry experts don’t agree on these points. Furthermore, what determines how efficiently and effectively control is implemented? If everyone is trending toward the use of the same (Intel) microprocessors, is it, as some would suggest, merely a matter of software implementation?

Until such questions are answered thoroughly and satisfactorily, it is more important than ever to carefully evaluate control solution functionality. Kevin Stively, senior process controls engineer with the engineering firm of Parker, Messina & Associates in Tacoma, Wash., attempted to answer that question for the pulp and paper industry several years ago. He began by postulating a theoretical application for a process unit that had 110 analog inputs, 68 analog outputs, 40 discrete (non-motor) inputs, 15 discrete (non-motor) outputs, 50 motors with three discrete inputs (ready, running, and over-load), plus one output (run), and 24 PID loops.

His conclusion? Large processes with more than 2,000 physical I/O points and a few hundred PID loops might be best served by a traditional DCS. Smaller processes could probably be controlled adequately by a mini-DCS, hybrid control system, or PLC/HMI solution. The cost of these other solutions were about equal, and ran 44-48% less than that of a DCS. One of the most important criteria is that of I/O selection and mix (analog, discrete, advanced process control, etc.).

But perhaps even more important than his conclusion is the methodology used to evaluate control selection. He begins with a thorough analysis of the process and its control needs, including types of control, I/O, and communications interfaces. He then considers the strengths and weaknesses of the various control platforms (DCS, PLC/HMI, mini-DCS, etc.). Design considerations follow with an analysis of control architecture and where and how control should be implemented (including scan times, system response, etc.). The inevitable capital cost comparison (per I/O point or other reasonable comparison) is followed by a benefits comparison based on both current and projected needs. A review of various solution limitations is linked to configuration requirements. And finally, training and service/maintenance considerations are discussed.

So there are no easy answers; simply lots of choices. Review them wisely and carefully. For the time being, at least, functionality rules! 