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June 2015

STATE OF TECHNOLOGY REPORT

Controllers and Control Systems

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Control goes where you need it

Welcome to our State of Technology Report on controllers and control systems. The industrial automation landscape is typically divided into systems based on one or a combination of programmable logic controllers (PLC), personal computer-based (PC) devices, or distributed control systems (DCS). While PLCs and PC-based controllers are commonly used in process control for end-of-line, individual machine and batch operations, the brain and central nervous system of the typical process plant is the DCS. We call it a DCS even when it's essentially an integrated system of PLCs and PCs.

This year marks the 40th anniversary of the DCS—40 years since the first Honeywell TDC-2000 beta-types were installed at Exxon's Sarnia, Ontario refinery in 1975, and Yokogawa introduced its version, CENTUM.

The PLC was invented in the late 1960s, and Honeywell had been working on a dedicated digital loop controller since 1969, but the Intel 8080, announced in early 1974, was the breakthrough event enabling multiple control loops to be handled with a single microprocessor.

In the 1980s, proprietary systems were opened and data began to be shared. Ethernet and PLCs were integrated into the DCS infrastructure, and plant-wide historians emerged to capitalize on the extended reach of automation systems.

The 1990s saw increased adoption of commercial off-the-shelf (COTS) components and IT standards, and the controversial move from UNIX to Windows. Even today, the real-time operating system (RTOS) for control generally remains on variants of UNIX or proprietary operating systems, but above that, applications tend to be based on Microsoft systems.

As DCS became increasingly network-centric, many suppliers built new "process automation systems" from the ground up to maximize functionality with Ethernet and fieldbuses.

Over the past 25 years, DCS has evolved from distributed control with centralized microprocessing, to "truly distributed control" with centralized supervision of microprocessors in the field, to today's rise of virtualization, where critical and non-critical functions coexist in servers (or even the cloud). Control, safety, supervisory, historian and business functions are increasingly distributed as needed in network-based architectures across field devices, controllers, thin clients, central processors and the web.

With increasingly inexpensive and standard COTS hardware and operating systems, the heart of DCS is moving from equipment to software and services. Applications now include production management, model-based control, real-time optimization, plant asset management (PAM), real-time performance management (RPM), alarm management and more. Indeed, much of today's most exciting activity is in wireless networks, mobility, remote access, business optimization and real-time decision-making, which largely run on hardware that's independent of the DCS.

As we look to the future, we see rapid changes coming in operator interface, computing, data analytics and virtual reality. The following set of articles from the past year of Control shows the breadth of application of our existing control systems, and demonstrates the strength of the foundation they offer for future developments. We hope you'll find insights, information and inspiration you can use to improve control in your process industry facility.

-- The Editors

IT tools raise expectations of DCS

Fewer rivalries and better collaboration are allowing distributed processes to apply more IT-based expertise, software and networking to streamline operations—and may even enable more BYOD, if security can be maintained

By Jim Montague

There's an inevitable progression when process applications and their distributed control systems (DCSs) get their first fieldbus connections, Ethernet ports and Internet protocol (IP) addresses—and they all move toward information technology (IT) and its debatable focus on authentication over uptime. Luckily, despite past prejudices and rivalries, there are many useful tools and friends in IT, who can help DCSs take advantage of their increasingly broad and mobile network ties and Internet links.

For instance, Byworth Boilers in Keighley, U.K., builds industrial steam and hot-water boilers and accessories, including its Unity intelligent boiler-house control system. The company recently sought to improve its controls by reconsidering a boiler as one complex process, which could be better controlled as a single system, instead of depending on several, discrete, standalone controllers for each loop, such as water-level maintenance. Combined with improved sensors to improve control quality, Byworth reports its unified approach to control allows all critical loops and discrete measurements to be combined to produce a holistic system with cross-coupled and feed-forward actions, which produces optimized boiler control at all times, regardless of external variables and disturbances.

To achieve its single-control vision and adopt the most useful control hardware, functional specification, software design and initial commissioning, Byworth evaluated several supporting control systems, and selected ABB'sFreelance because of its DCS-structured, all-in-one database for control and graphical display, compact size, ease of programming and lower cost, and then integrated the new DCS into its own functional control system design (Figure 1). So instead of the usual, fragmented PLC/SCADA solution, Byworth implemented multiple Freelance controllers, usually one per boiler, and then integrated them into its boiler-house system by duplicating Freelance's system code and making slight changes needed by particular boilers. No master supervisory controller is needed because ABB's network connection between controllers provides one system view from any control position.

Photo courtesy of ABB

BIGGER, SMARTER BOILERS

Figure 1: Byworth Boilers recently added ABB's Freelance DCS to its Unity intelligent boiler-house control system, which has an all-in-one database that enables operators to access data analyses and trends from a central user interface or touchscreen, or remotely via PCs, tablet PCs or smartphones.

Freelance and Unity's system consists of a Freelance 2013: PM 783F controller running on a 2-MB central processing unit, as well as two DC 732F digital I/O modules, one AI 723F analog input module, one AX 722F analog I/O module and Control Builder F Professional software with DigiVis process visualization. Also, a touchscreen PC is used for local display and operations.

"Current integrated systems simply aren't using the data

they collect in an effective manner," says Jason Atkinson, Byworth's control system developer. "With Unity, we thought about how all of these discrete signals can be brought together and made to work in a user-friendly system that's far greater than the sum of its parts. What we're offering is a boiler house that makes intelligent decisions based on multiple pieces of information."

As a result, Unity operators can view boiler-house data analyses and trends relating to many values from a central user interface, built-in touchscreen, or remotely via PCs, tablet PCs or smartphones. These values include Byworth's boiler and manifold pressures, boiler water levels and conductivity, hotwell levels and temperatures, blowdown temperatures, flue temperature and gas analysis, and other ancillary values, depending on boiler configuration.

In addition, all alarms and tests conducted are logged and can be exported to a printer if required, while a straightforward traffic-light warning system alerts users to any changes in plant conditions and draws focus to areas requiring attention or adjustments.

Atkinson adds this comprehensive, joined-up approach to managing multiple processes gives Unity a unique advantage over other control systems, which typically employ third-party applications to control each aspect of the boiler house. Also, several options are available to connect Unity remotely by local area network (LAN) or wide area network (WAN), or more recently, via 3G connectivity. These links help Unity to quickly integrate into machine-to-machine (M2M) architectures, which allows more productive service visits via predictive maintenance and pre-accessing problems as they develop, as well as avoiding expensive, unplanned downtime and costly, energy-wasting, abnormal running conditions.

"There's a need to continuously increase productivity, move equipment closer to processes for better quality and cost effectiveness, and locate people further away from processes for safety, reduced costs and greater efficiency," says Bernhard Eschelmann, technology manager of ABB'sprocess automation division. "The impact of these goals drive advances in fieldbus and wireless communications; improve cybersecurity; integrate horizontal and vertical systems and automation and electrical applications; enhance operator efficiency in central control rooms with remotely integrated operations; improve value-added functionality such as analyzing data from control systems; and increase uptime by using remote access, diagnostics, services and asset management.

"So, control may be found on any one or multiple levels, such as drives, controllers, server and smart fieldbus devices, depending on their time, safety and availability requirements. However, there's still a requirement to separate critical process control from IT, but simultaneously more data needs to be provided to the IT environment in a secure way, so more components like routers/switchers, will require IT knowledge at the control level."

Cooperation Cures Misunderstandings

Of course, the improvements in Byworth's boilers are directly assisted by mainstream, IT-supported data processing, networking and software, and these gains are indirectly aided by better working relationships between plant-floor and IT personnel and closer ties among the systems and networks they use.

"There are still big chasms between IT and automation infrastructures, but they're getting smaller because today's DCSs have more commercial, off-the-shelf (COTS) hardware and software than ever. And because COTS comes from the IT space, more IT is getting into the control world," says Peter Martin, vice president of business value consulting at Schneider Electric and a member of Control's Process Au-

tomation Hall of Fame. "In fact, the physical platforms used by process control systems (PCSs) are close to becoming indistinguishable from their IT counterparts.

Plant-floor SCADA systems used in PCSs look just like a lot of business hardware and software. So the opportunity now is less integrating two sides because technology has already brought them together, but more rethinking their remaining functional separations. IT is based on business transactions and human-scale schedules, but plant-floor control and computing is based on real-time timeframes relative to processes being controlled. What needed is for IT and automation to be less enamored of new technologies like the cloud, big data and the Internet of Things, and concentrate on specific problems they can solve with them."

Claudio Fayad, marketing director for DeltaV and DeltaV SIS at Emerson Process Management, reports that, "Process control got the IT world's attention when we began using Ethernet and then wireless, but IT and automation soon realized that process applications require different policies than the current IT policies since, for instance, they can't be routinely stopped for software patching. We test patches at Emerson, determine which are critical and which can wait, and work with users to apply them based on their schedules, required latency and service levels. Now the big push is in monitoring networks for threats, so users also need to have the right permissions. So we think the control side won't be invaded by IT, but instead we'll have more IT-friendly capabilities on the plant floor, such as providing reports showing that all users have passwords, or confirming IP addresses for all connected devices. In fact, DeltaV already locks all unused ports, controls MAC addresses and registers workstations on a database according to predefined assignments. Also, our year-old DeltaV firewall contains automation oriented firmware, so it and its users can pick only the servers and communications that they want to exchange data with, document activity, and set up alerts and alarms."

Mark Wylie, global vertical marketing manager at Belden, agrees that IT and controls have converged around Ethernet, but each still retains different priorities. Control systems protect the availability of their processes, but IT protects confidentiality and data integrity. So what they're trying to develop now are hybrid experts that can speak to both worlds, manage their requirements and priorities, and develop well-planned Ethernet networks that can use the strengths of both sides."

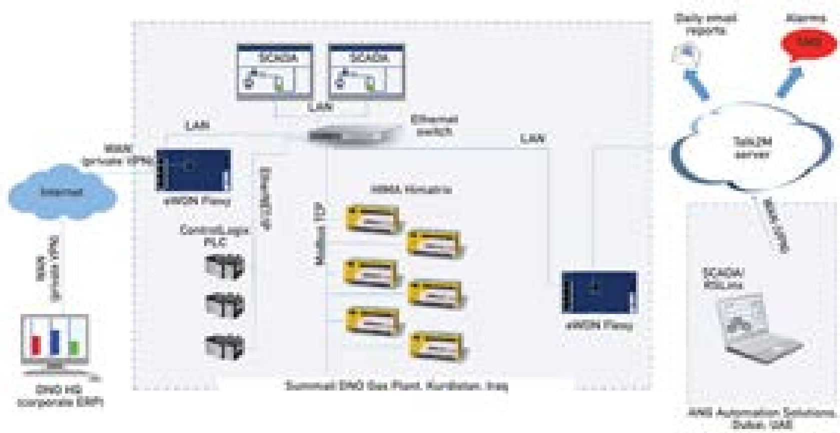
Collaboration + Cloud = Efficiency

Similarly, many recent innovations can also help distributed control applications maximize the benefits of cooperation between IT and the plant floor. "There's stronger integration between process control and IT now, but it's still very different than what goes on in the traditional IT world," says Jack Gregg, director of Experion product marketing at Honeywell Process Solutions. "And the latest technical innovations, like virtualized computing and cloud-based engineering, are integrating us even closer. Honeywell and our customers are executing many projects in the cloud. In the past, control engineering work had to be done in one place, but with the cloud, we can work and collaborate from wherever we're at, which also means we can leverage resources anywhere in the world."

Gregg explains that Honeywell and its clients use its cloud-based Virtual Engineering Platform (VEP), which lets users perform design and engineering tasks in a simulated, design-independent environment. This is accomplished by separating physical design and functional design. The functional design can be performed in the cloud or VEP, while the physical design is completed separately, and evolves

through the project. "This means functional design engineers can see simulated in the cloud all the displays, I/O points, controls and software they're going to use, and it behaves like the dedicated controls their systems will actually employ later," says Gregg. "So instead of spending a year on a traditional factory acceptance test (FAT), many engineers can now do it in a virtual environment and wait to order hardware until later in their job, which gives them a lot more flexibility and means they won't have to refresh equipment as soon."

Gregg adds that IT staffs understand that patch management is key to a secure and reliable control system, and so tools that help the to deploy software patches safely on the plant floor are crucial. Honeywell's control system patching tool assist in this area by checking that all nodes on a network are up to date, and then applies patches where needed. Honeywell also introduced its Secure Communications capabilities option this past April, which provides encrypted communications between control system nodes, preventing intruders from seeing what users are doing on their networks and stops man-in-the-middle attacks as well. "This is a control system perspective with an IT hat on," says Gregg. "Our technologies are evolving toward virtualization and the cloud. However, to apply them to process controls, safety and security have to be accounted for, risks assessed and addressed, and not just handled afterwards."



PLCS PLAY NICE

Summail Gas Plant in the Kurdistan region of Iraq uses three of eWon's Flexy 201 base modules to communicate between HIMA and Rockwell Automation PLCs and one Flexy 201 base module with a WAN extension card to provide remote access, support and troubleshooting from the plant in Iraq to the company's headquarters in Dubai.

Streamlining Longer-Distance Links

Besides cozying up to IT systems in individual process applications and facilities, some DCSs are using their new and improved relations with IT to cooperate on aiding more remote functions. For example, the Summail Gas Plant in the Kurdistan region of Iraq is being developed for power generation by DNO International in Oslo, Norway, which holds stakes in oil and gas blocks in various stages of exploration, development and production in Kurdistan, Yemen, Oman, United Arab Emirates (UAE), Tunisia and Somaliland. Raw wellhead gas is processed to remove toxic gases and moisture content, and a high-capacity compressor builds up the gas pressure required to fuel its power station.

DNO uses an integrated control and safety system at the Summail plant, which includes process controls, emergency shutdown, fire and gas detection and alarm annunciation systems, and a fully redundant SCADA server. However, as part of new factory acceptance test (FAT) requirements, the plant's engineers recently learned that safety and control components from HIMA and Rockwell Automation, respectively, needed to communicate to exchange critical information.

Consequently, system integrator ANG Automation Solutions in Dubai, UAE, suggested usingeWon's Flexy modular M2M routers for remote access and PLC programming, protocol conversion, SMS alarms to field engineers and daily reporting to DNO's headquarters. Because it can link up and exchange data regardless of the protocols used by the devices it's connecting, Flexy routers were installed and fine-tuned by ANG in several cabinets before they were shipped to the Summail plant. Functioning as a Modbus TCP gateway, three Flexy 201 base modules were used for communication between the HIMA and Rockwell Automation PLCs, and one Flexy 201 base module with a WAN extension card provided remote access, support and troubleshooting from the plant in Iraq to the company's headquarters in Dubai (Figure 2). Combining a WAN card and Flexy gave the main office remote access to its LAN network, including PLC programming, emergency shutdown system, SCADA software and modifications.

Balaji Vedanarayanan, ANG's managing director, reports that eWon's solution was seven times less expensive than a standard system using a gateway and VPN server. "So we were more than happy to take eWon into an oil and gas application," added Vedanarayanan.

Bring Your Own—Securely

Because smartphones and tablet PCs have invaded every area of mainstream life, they're also inevitably showing up in many process facilities. However, the presence of BYOD handhelds is usually tightly regulated to avoid unauthorized communications and access, and the potential for intrusions and data loss.

"Many businesses allow employees to bring personal devices to work and link to their corporate networks, but we're not seeing much of this in the process industries. Most of the BYODs we're seeing are dedicated, secure, point-to-point devices, such as companies giving out tablet PCs, but requiring them to be tied securely to the firm's secure server, and only allowing them to be used for company business," says Roy Tanner, global marketing manager for 800xA distributed control platform at ABB. "We have heard of some smaller sites and system integrators that use 800xA on their tablets via VPN connection, but these should have at least three to six layers of protection, and probably still shouldn't allow access to control functions. Just like in Jurassic Park, "Nature will find a way," in this case to have control via BYOD and virtualized computing, but they'll first have to prove they have the right security layers in place. For instance, ABB Tropos wireless communications can put different security levels and priorities on different virtual local area networks (VLANs), so users can have different VLAN for controls, video, guests and other functions, and this make it easier to secure multiple devices."

Once security is achieved and maintained, Tanner adds that ABB can display KPIs in a 3D format on 800xA's collaboration table, on energy-harvesting wireless instruments, or on augmented-reality interfaces such as tablet PCs or Google Glass that overlay value-added information onto existing display images.

Jim Montague is the Executive Editor at Control and Control Design.

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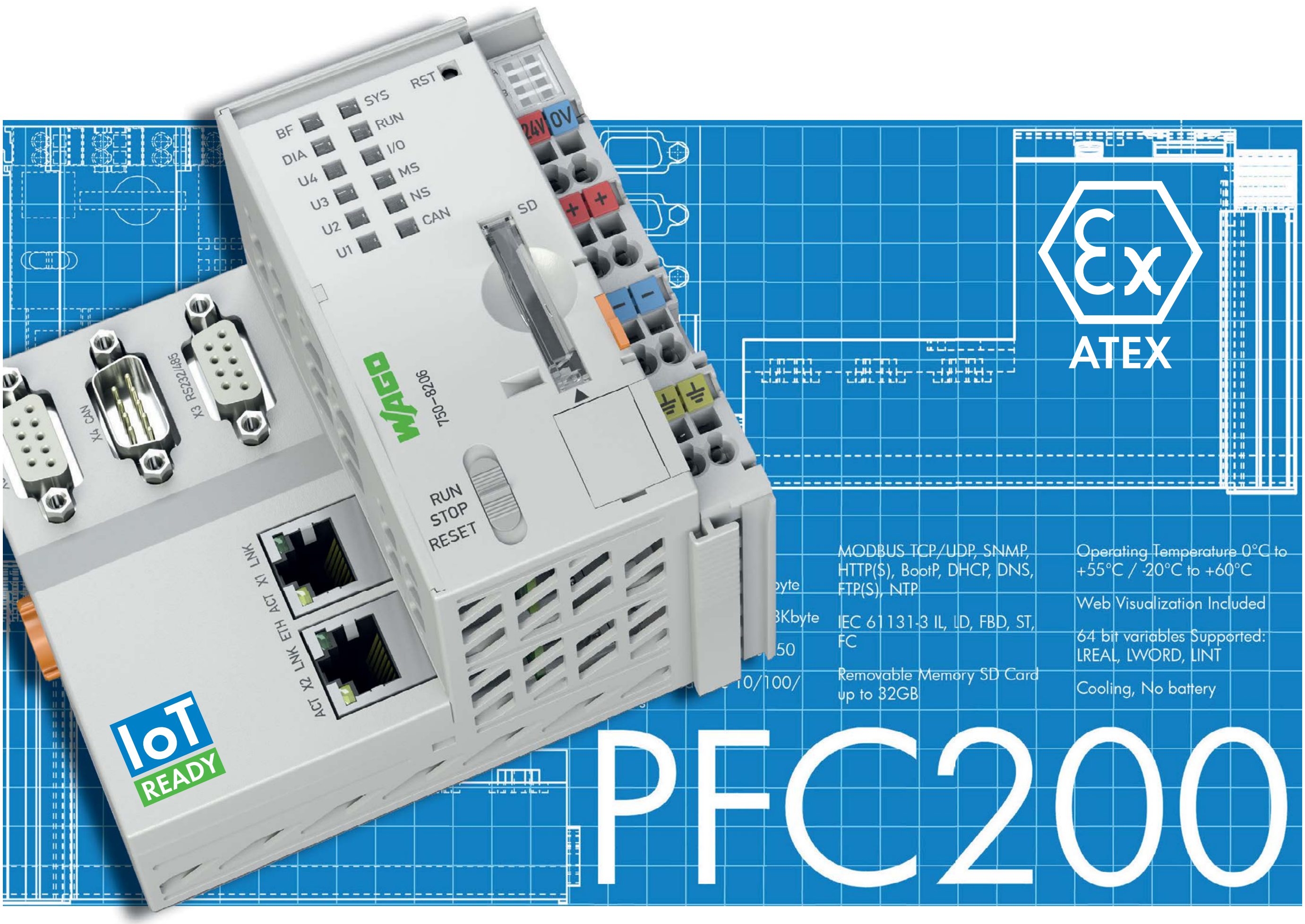

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Blending control with enterprise applications

Improved enterprise connectivity solutions bring process applications closer to upper-level systems and enable faster, better decisions and more efficient operations.

By Jim Montague

Just as the express train is faster than the local, and taking an elevator is quicker than climbing stairs, several new methods and tools are shortening and speeding up trips between plant-floor process applications and their enterprise levels—often with help from cloud-based services. Formerly separate software and programming areas that divided these functional realms and required multiple steps to travel from one to the other are steadily consolidating and enabling even small process control applications to benefit from closer ties with their upper levels, just as their larger counterparts do.

For instance, Coca-Cola Refreshments in Atlanta has been using GE Intelligent Platforms' Proficy HMI/SCADA software for many years, but recently revamped it at 70 manufacturing facilities. "We focused on reducing complexity in our supply chain, pushed back against inefficient customization, did a lot of root cause analysis and concentrated on useful action," says Ioan Batran, automation engineering director at Coca-Cola, who presented at GE's 2014 User Summit this past October. "In our line information systems (LISs), we sought to better track line assets, increase efficiency, reduce equipment losses and downtime, and improve our decisions. Our LISs basically tell us if we're meeting our promises."

Batran adds that all levels at Coca-Cola's production facilities need data from their LISs, so simplifying their software and standardizing their control architectures makes them easier to deploy and support. This 70-plant renovation began by updating the LIS server at each facility with Proficy Historian, iFix HMI SCADA and Portal dashboard software. These solutions allow each LIS to deliver real-time and historical data, and then push reported KPIs to an SQL enterprise database via Sync Agent software and Microsoft Azure to Coca-Cola's cloud-based server.

"We started this program last year, and now we can compare the performance of plants, lines and even individual machines," explains Batran. "LIS management routines and practices measure and manage our manufacturing processes to maintain and improve performance. We're also implementing paperless guidance, so we can further un-cloud our crystal ball and focus our decisions more precisely on what we need to do."

These improvements enable the LISs to generate tactical reviews that let users respond to specific operational events, and produce strategic reviews that let them address continuous improvement efforts by identifying trends, patterns and root causes. "The reviews help us implement better management routines, which need to be backed up by appropriate levels of change management," adds Batran. "You also have to secure leadership support and stakeholder buy-in."

Views available on Coca-Cola's LIS-based system include plant overviews, production line layouts, historical machine status, short-interval control reports, enterprise-level displays and others. These displays can be presented on PCs, tablet PCs and smart phones. "The enterprise LIS even lets us see selected KPIs on multiple lines, so we can compare the performance of different machines," adds Batran. "Next steps include implementing more paperless capabilities and autopilot management routines, as well as improving overall management routines, coaching and auditing."

Simpler Steps to New Projects

Besides reducing steps in existing facilities, integrating enterprise and plant-floor applications more closely can be

Assmang and Invensys

EYE ON ORE

Figure 1: Assmang's Khumani iron ore mine in South Africa's Northern Cape province drills, blasts, hauls, crushes, washes, grades and ships about 34 million tons of ore per year with help from Wonderware's

especially useful when implementing new processes.

For example, Khumani iron ore mine near Sishen in South Africa's Northern Cape province drills, blasts, hauls, crushes, washes, grades and ships about 34 million tons of ore per year from a series of open pits (Figure 1). The operation includes eight Geoscan online analyzers to monitor the ore's chemical composition in real time, so immediate remedial action can begin if the ore deviates from grade requirements. To improve monitoring and operations, Assmang worked with contractor DRA Mineral Projects and system integrator Iriton to implement Wonderware ActiveFactory and real-time Historian software, Information Server web portal, InTouch HMI and Wonderware System Platform based on ArchestrA service-oriented platform from Schneider Electric and the ISA-95 standard.

"The SCADA/HMI applications serve some 44,000 I/O tags," says Johann Pienaar, Iriton's director. "Also, we used Topserver I/O servers from Software Toolbox to communicate between the PLCs and the system platform as well as MDT Software's AutoSave for the change control management of all 63 Allen-Bradley ControlLogix PLCs."

Marius Malan, Assmang's control systems supervisor, adds, "These solutions give us comprehensive data analysis, so we can check production status and identify potential problems at any time. We also need continuous operation without loss of control or data, as well as web access facilities and links to our planning and ERP systems. Most importantly, it all has to work through a user-friendly and intuitive operator interface. This is a new mine with a long future, so we'll need to adapt production to meet with market demands, expand the system as required, and do it quickly and at minimal cost. Also, the ISA-95 standard was implemented and adhered to throughout the project and will greatly facilitate integrating the mine system's data with Assmang's planning and ERP systems."

Plenar adds, "For us, the most significant aspect of this project was that ArchestrA gave us a multi-user development environment that allowed us to design, develop, implement and maintain a large project in one year. This development environment gave us the tools to develop complex applications without bothering unnecessarily about the details of interfacing with PLCs at one end of the spectrum and ERP systems at the other, while providing the functionality to do both."

Similarly, engineers at Ypé Quimica Amparo in Sao Paulo, Brazil, recently helped build their new factory in just 12 months in Anapolis, which is located about 600 miles north of its headquarters, and produces liquid detergents and fabric softeners. Founded in 1950, Ypé also makes bar soap, powdered detergents, steel-wool pads, multi-surface cleaners and scrubbing sponges. Ypé recently integrated the Anapolis plant's operations with its SAP-based enterprise system by implementing PlantPAx process automation system with help from Iastech, a system integrator and Rockwell Automation Solution Partner.

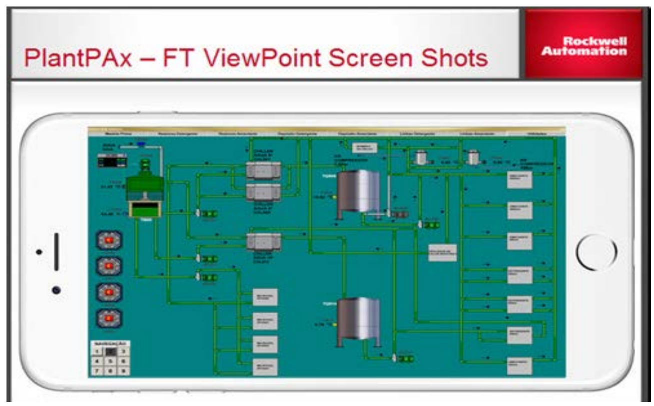
"Our innovation department focuses on engineering Ypé's manufacturing execution system (MES), instrumentation, mechatronics and automation," says Cláudio Fernando de Jesus, Ypé's innovation manager, who presented at Rockwell's Process Solutions User Group this past November. "We research and build new technological models; approach, integrate, facilitate and connect people to processes and equipment; research new technologies and techniques; carry out development projects; and look to the future to realize these dreams. In the department's 14 years, we've developed and built more than 200 projects, including 115 specialized machines and 10 factories. For the new plant in Anapolis, we needed a main core that integrated our MES and the plant's operation and centralized SCADA system. PlantPAx gave us an all-integrated solution that shortened our development time and gave us much better production."

The Anapolis plant's MES manages its raw material storage, dishwashing liquid detergent and warehousing functions, while its SCADA system runs its utilities, liquid softener, IT and SAP tasks. The dishwashing liquid detergent and liquid softener areas consists of separate dosing units, mixer units, storage and filler lines, while its utilities area includes air, water treatment and steam equipment. The factory's organizational levels include Level 4 with its corporate management and SAP enterprise resource planning (ERP) system, while Level 3 has the MES with its Microsoft Windows Server 2008 Hyper V and five physical HP Proliant BL460C computers and nine virtual computers. They run Microsoft SQL Server software and Rockwell Automation's FactoryTalk Directory, Transaction Manager, ViewPoint, HMI Server, Data Server, Redundant HMI/Data Server, Engineering FactoryTalk View Studio and other software. Level 2 is occupied by automation processing function, and Level 1 is the plant floor.

"PlantPAx helps integrate all four of these levels," says de Jesus.

The plant also uses two ControlLogix 5562 PLCs for overall control, five CompactLogix L35E PLCs to automate its filling lines, and a dozen Powerflex 40 motion controllers to run its conveyors and other equipment. Plant-floor devices are networked with a combination of 10 DeviceNet networks and three ControlNet networks, while the upper-level enterprise systems are networked with Ethernet. The facility's total I/O points consists of 1,032 digital inputs, 792 digital outputs, 92 analog inputs, 160 analog inputs running HART and 60 analog outputs.

"We also use FactoryTalk View Site Edition Server 100 Display with RSLinx and 11 clients," added de Jesus. "This lets us view screen shots of our liquid detergent preparations, storage tank, demineralized water, integrated filler lines and other processes, quickly generate production and overall equipment effectiveness (OEE) reports and even view them on our smart phones (Figure 2). And, our close integration between MES and controls means we can view and take orders right from SAP, immediately input them right into



Ypé and Rockwell Automation

SEEING SOAP

Figure 2. Operators and managers at Ypé's liquid detergent and fabric softener plant in Anapolis, Brazil, use FactoryTalk View Site Edition software to view screen shots on PCs and smart phones of their production lines, quickly generate production and OEE reports, and even take orders right from SAP, immediately input them into the production system, and discharge raw materials needed for production.

the production system, and discharge the raw materials needed to produce them. PlantPAx's full integration with SAP means greater system reliability and better control over our orders and production.

Doug Weber, business manager for remote monitoring services at Rockwell Automation, adds, "We've spend the past few years investing in a cloud platform based on Microsoft Azure and ported our VantagePoint solution to the cloud, so users can store dashboards in the cloud and get to them from anywhere with little capital investment. The beauty of the cloud is that Microsoft maintains it, and we're comfortable putting our data on it because they work hard to secure data moving from the plant to the cloud. They encrypting all of it and only allow data to be transmitted one way."

More Cloud Cover

Beyond reducing and simplifying steps between the plant floor and the enterprise, virtualized computing and cloud-based data processing and storage services also are bringing operations and management closer together.

For instance, the specialty chemicals division of Amsterdam-based Akzo Nobel has long used remote monitoring and operations to bring it closer to its end users, but its chemical manufacturing division recently also rolled out a manufacturing execution system (MES) to 30 remote plants in just 12 months, and relied on cloud services and GE Intelligent Platforms to do it, according to Stefan Malmsten, Akzo Nobel's global industrial IT leader. The specialty chemicals division, where it's implementing cloud-enabled MES, delivers performance based on sustainable chemical platforms, driving profitable growth in selected markets, and it also relies on social media-based networking by its personnel.

"We maintain a social manufacturing network worldwide that enables both our people and their devices to interact with each other, and we're building solutions that let them talk about important things and share best practices, especially over long distances and worldwide " says Malmsten, who also presented at GE's users event. "We started bringing people together using remote technologies in 2000. We use a lot of GE's Proficy software, and so we've gained a lot of experience over that time. Now, our MES and private cloud server is located at our Amsterdam headquarters, so it's our responsibility to take ownership of the applications we provide to our users. At the same time, we'd also like to see more dynamic networks, plants and users, and it's starting to happen by using more of these tools in the cloud. This is a very sound way they can all be more competitive, but they need a common language among people at different sites."

Consequently, AkzoNobel worked with Proficy along with solutions from Accenture and SAP to develop its Enterprise Process Information (epi) Connected program, which it's been implementing at more than 100 of its own customers' sites that include about 2,000 global users and billions of daily data transactions. "Working with an external partner, we host epi on one central server," explained Malmsten. "This is much simpler than the four or five servers per site that we used to have to handle. We just need two or three clicks, and we can move from a chemical manufacturing plant in Canada to a paper factory in Italy. With epi, we can examine their supply, production, distribution and usage steps, as well as the buying power, agile operations and supplier power between each.

Likewise, Malmsten reports that Akzo Nobel even uses epi and the cloud to help run a partially unmanned hydrogen peroxide plant in Norway from its office in Sweden about 500 kilometers away. "This plant runs 24/7, but we only have staff there on weekday," said Malmsten. "They run and prepare operations, and then it runs unmanned on nights and weekends. It's been doing this for more than 10 years, but we can still deploy experts when needed."

Finally, because it used a Global MES Template (GMT) to roll out its new MES to its initial 30 facilities, AkzoNobel is planning to add another 10 sites this coming year. "These cloud-based tools give us numerous benefits, including reduced production and delivery expenses, and also lessen the costs of using our products," added Malmsten. "However, all these efforts start and stop with having the right people."

Jim Montague is the Executive Editor at Control and Control Design.

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Real-time control for enterprise optimization

Control engineering branches out to manage critical business variables such as profitability, risk, asset management and cybersecurity

By Peter G. Martin

Most process engineers I talk to look back on the 1970s and 1980s as the heyday of control engineering, and in many ways it was. More engineers were focused on the applications of real-time control theory then than now. And when you look at how far they have brought control strategies and technologies, it would be easy to conclude that the science of control engineering had been saturated. But as I look around today and see the good work control engineers are still doing and the value they are creating for industrial companies, I cannot help but believe that there is still considerable potential for advancement and expansion. In fact, I believe that industry has just scratched the surface of control engineering, and that perhaps the day of the control engineer is just dawning.

The growth potential of any technology or technological approach should be analyzed from two perspectives, the capability of the technology and scope of application. In the field of process control, for example, the introduction of multivariable predictive control provided a major leap forward in capability, but its scope of application was actually a bit narrower than traditional feedback control, primarily due to the cost and time required to apply it.

In fact, over the years, many advances in control technology have been based on capability, more so than scope or enhancements. Process control technologies were developed to enable efficiency improvements in complex industrial production processes. Efficiency refers to process control applied to meet the production requirements of industrial operations safely while simultaneously working to reduce energy and material consumptions. The word control as used in industrial organizations is generally assumed to mean process control for improved efficiency.

Today, control strategies are still largely focused on improving efficiency. To date, there has really been very little effort to formally apply real-time control to other industrial challenges beyond the scope of efficiency improvement. There is considerable evidence that this is about to change in a very big way.

A number of market-driving forces are causing industrial companies to consider the application of real-time controls in new domains. Perhaps the most influential driving force has been the transition of some critical business variables of industry toward real-time variability. Two decades ago, most of the critical business variables of industry changed very minimally or not at all for months on end. For example, the price industrial companies paid for the electricity they consumed was essentially and contractually a constant value for months at a time. When this was the case, there was no need to control the price of electricity because it seldom changed. All industrial companies had to do was apply real-time controls to reduce the consumption of electricity without any concern for its price, and the cost they paid would be correspondingly reduced.

Not anymore! With the deregulation of electric power grids, the price of electricity started to fluctuate in much shorter time frames, and those fluctuations have become larger over time. For example, today in the United States, the price of electricity can change on the open grid every 15 minutes. This means that consumers such as industrial plants need to control more than just the overall consumption of electricity. They need to control the consumption within very short pricing periods. If they don't do this, they

"Is control engineering an obsolete discipline? No way."

may reduce the overall consumption of electricity over a day, while the price they pay for the consumed electricity over that day actually increases because they consumed during high-price periods.

The real-time variability of electricity prices has triggered a domino effect across other energy sources and raw materials used throughout industry. Production processes consuming a significant amount of electricity have transitioned to a similar level of real-time variability. Today in the U.S., the price of natural gas on the open grid changes every 15 minutes, and the price of some raw materials used in industrial production, such as base minerals, may change as fast as multiple times each minute. The point is that some of the critical business variables associated with industrial production have transitioned to real-time or near real-time variability.

The traditional approach taken by industrial companies has been to manage business variables on a monthly, transactional basis while controlling operational variables, such as flow, pressure, level and temperature, in real-time frames. This worked fine as long as all business variables changed only on a monthly or greater time frame. As some of the business variables have shifted to real-time variability, traditional business management approaches and time frames prove insufficient. In fact, a number of industry executives I interviewed suggested that their production processes were in control, but their business processes were out of control.

This presents a daunting challenge to industrial companies. What is required to effectively meet this challenge is the application of real-time control on real-time business variables. This application is directly targeted to bring the real-time components of business profitability under control again. Therefore, the scope increase required to meet this challenge is the application of real-time control strategies to business profitability—real-time profit control. This requires development of real-time business measures for the real-time components of profitability because such measures are a prerequisite for real-time control.

When all the critical business variables directly associated with the profitability of business operations were stable for months at a time, industrial engineers applied linear and nonlinear optimization software to optimize to a selected business objective. The optimization software is designed to maximize or minimize to a particular objective (such as maximizing production value or minimizing energy cost) while not exceeding critical constraints, such as safety and environmental requirements. As key business variables have transitioned to real-time variability, control strategies are required to bring the business under control, but the objectives of these control strategies, the setpoints, must be set so as not to exceed the critical constraints, much in the same way as traditional optimization software.

Unfortunately, some constraint functions, such as the functions associated with safety and environmental risk, also tend to vary with the maintained state of the production equipment, quality of raw materials and phase of production. This has led to real-time variability in these constraint functions also requiring the application of real-time control. Therefore two additional potential scope increases for real-time control are safety and environmental risk control. Both of these require real-time measurement approaches to measure the risks associated with production processes.

Industrial operations are comprised of assets from physical process equipment right through critical business assets. In industrial operations, the phrase asset management has been co-opted to mean equipment maintenance. Maintenance departments are measured on the availability of the equipment assets and operations is measured on the production throughput realized from the operation of the assets. The challenge is that the production assets must continually operate at peak performance to drive optimal results for the business and operation. Neither asset availability nor production throughput directly measure asset performance. For optimal performance, the asset performance of every equipment asset in industrial companies must be measured and controlled in real time. Applying real-time control to asset performance of equipment assets provides a strong foundation for safety, environmental, efficiency and profitability control. This domain is referred to as real-time asset performance control.

One final, increasingly significant area where real-time control theory needs to be applied going forward is security control. Security in industrial companies has many facets. Perhaps the one in most urgent need of attention is cybersecurity. As industry pushed for more openness, standards and commercial off-the-shelf technologies (COTS) in automation systems, these systems were opened to cybersecurity risks. Openness is a desired characteristic of automation systems, but a high level of security is absolutely essential. Implementing an effective cybersecurity strategy involves bringing the security risks to industrial companies under control. Once again, this involves real-time measurement of cybersecurity risks and the application of real-time control.

Industry does not typically position profitability, safety, environmental integrity and security as real-time control challenges, but they are. I believe industry is at the dawn of a new era in the field of controls in which real-time measurement and control continue to be applied to process efficiency, but also to safety risk, environmental risk, security risk, asset performance and profitability. The knowledge and skills of control engineers are going to be the exact knowledge and skills industry requires moving forward.

The topological scope of the control problem is also increasing in multiple dimensions. Traditionally, process control was directed toward the control of process units or plant areas. Today, that control model must extend down the plant architecture to individual industrial assets and up the industrial hierarchy to include plants, enterprises and entire value chains. Extending both the functional and topological scope of control will result in huge improvements in efficiency, profitability, safety and environmental friendliness of industrial businesses. The talent required to lead the way is control engineering, but control engineering redefined for the future.

Is control engineering an obsolete discipline? No way. Control engineering will define the path for successful industrial companies that rise to meet the challenges of today and tomorrow.

Dr. Peter G. Martin is a Process Automation Hall of Fame (2013) member.

Combining building and process automation systems

Combining building and process automation systems can ease plant support, but be prepared to ante up

By Dan Hebert

Most process plants have a need for some type of facilities management and corresponding building automation systems. The degree of sophistication ranges from very simple for a plant with mostly outdoor equipment, such as a petrochemical facility, to quite complex for pharmaceutical and other plants where climate control and air quality are integral parts of the process.

These degrees of sophistication, along with other factors, drive the decision to use one system or two for process control and building automation. Other key factors include up-front costs, operating expenses and staffing requirements.

Sometimes there's no choice. Paul Darnbrough, engineering manager at system integrator KDC Systems in Los Alamitos, California, explains, "Most places we go already have an embedded building automation vendor, and future work almost always goes to that product line. For larger projects we typically are involved with, the specifying engineer seems to drive the choice of using a single, common system or multiple independent systems for manufacturing and facility automation."

But if there's a choice, some plants find a unified system to be the preferred solution for their specific applications.

One System Is Simpler

End users are looking hard at single-source solutions, and in all cases, it's a process automation system controlling both the process and the facility. Building automation systems simply aren't capable of controlling anything but the simplest processes, and thus, aren't used as a single system for both process and building automation.

"I've been involved with co-gen power plants where they had four different systems, including their chilled water

PART OF A SINGLE SYSTEM

Figure 1: Used for underground ventilation at a U.S. DoE nuclear waste isolation pilot plant in New Mexico, control of this air handling unit is incorporated into a single automation system.

system, all on separate control systems with their own HMIs," says John Boyd, technology leader at Maverick Technologies, a systems integrator in Columbia, Illinois. "We finished one plant project about two years ago where everything was integrated into a single control system. It may actually have separate processors, but it's all with one supplier, and it looks like one system to the operators."

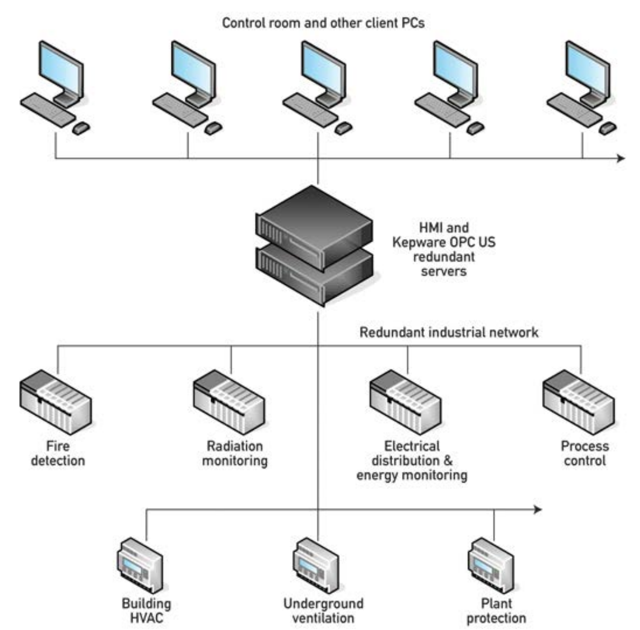
All plant subsystems should be integrated into one overall monitoring and control solution, says Dennis Runo, president of Custom Automation, a system integrator in Mesa, Arizona. "Successful plant processing is inextricably linked to the supporting building facilities. With two separate systems, information can be made to bridge the gap, but it's much easier when you have a unified system."

One reason is to reduce operator confusion. "A well-executed system will have predictable equipment control and alarm behaviors," he notes. "Pop-up information, alarm and control windows will be consistent across all equipment and subsystems. Many HMIs have templates to make this easier. Multiple systems could theoretically achieve this as well, but think of the added work and expense to get them there and keep them synced."

The U.S. Dept. of Energy's Waste Isolation Pilot Plant (WIPP) in the Chihuahuan Desert of southeastern New Mexico, some 26 miles east of Carlsbad, processes radioactive waste and safely entombs it in deep underground chambers (Figure 1). Thirteen critical subsystems are managed in the control room on a single system that handles everything including ventilation, electrical distribution and energy monitoring, HVAC, fire protection, radiation monitoring and plant protection (Figure 2).

The WIPP site uses redundant KEPServerEX servers with OPC and OPC UA to communicate with numerous subsystems using BACnet and other protocols. The interconnected subsystems talk to each other and accept commands from the operators on duty. The system is also designed to act independently to maintain a safe environment.

Reasons for choosing a single system typically involve simplicity, single-vendor responsibility, reduced maintenance costs and standardized operations.



HOW IT ALL TIES TOGETHER

Figure 2: At a U.S. DoE waste isolation pilot plant in New Mexico, control, building automation, safety and monitoring systems reach the control room via redundant networks.

"If the process has many different solutions in place, it can be expensive to support and maintain," says Paul Matatall, network specialist at Optimation, a system integrator in Boston. The facility will need support staff that understands how all this equipment works and how to resolve any issues that arise. It will increase their training budgets because their support teams will need to be trained on the different equipment used in their facility. They'll also have increased cost in their spare parts inventory because of the need to have many different products on hand.

Erik Dellinger, product manager at Kepware Technolo-

GOING SOLO

Figure 3: Operators of this cogeneration plant in Ripon, California, can run it more efficiently now that it is on a single system.

gies in Portland, Maine, adds, "The one-system approach affords the facility the expected benefits of minimized spare part requirements, consolidated training, integrated communications and a common look and feel."

Ripon Cogeneration (Figure 3), a power plant in Ripon, California, had multiple systems, but saw the advantage of bringing them all together, so the operators could run the system more efficiently.

"Customers ask us to integrate all the systems into one," says Boyd. "For companies looking to be more efficient, that's a positive thing. The benefit of one system is the ability to be more efficient, and that's in the context of large, enclosed plants where they have extensive HVAC and climate control units.

Those systems now are very intelligent and automated, and they have their own web portals and pages to control them. It doesn't make sense to keep them separate if you can bring them into one. I don't know any reason why you would want to keep them separate unless the operators are already so busy that they can't be distracted by the building control system."

Another advantage of a single system is simplified communications, making it easier to perform integrated control, obtain cost and operating data across the plant, send data to a historian and allow building controls to handle load changes smoothly and efficiently.

But it isn't all rosy in single-system land. Dellinger points out, "If it's all in one system, and that system goes down, you lose control of manufacturing and the building. If an operator on the manufacturing floor logs in and accidentally turns off the HVAC, that could be a problem."

Another drawback arises during system upgrades. "Obsolescence is a big reason against consolidating process automation, building automation and utilities," says Kelli Malloy, leader of U.S. process automation at Turck. "While many DCS companies have obsolescence plans and product support, the reality is that one day these products will need replacing. In addition to the cost of replacing an entire system, there are other disadvantages to forced migrations when everything is on a single system. These include extensive reprogramming and possible operational disruption, as well as the potential for point-by-point revalidation on particularly sensitive DCS changes."

Another reason for separates is that building automation suppliers understand climate control much better than process control vendors, making several companies lean toward the two-system approach.

Separation Can Be Sensible

Can standard process control equipment and systems handle building automation? Yes, but Darnbrough points to a harsh reality about using them for that: "Building automation systems offer preconfigured features specific to HVAC and other extended capabilities, such as calendar scheduling, that make sense for the application. These same options might need to be manually created and coded into a PLC or DCS system at great effort. We rarely use PLC controls for building automation." Furthermore, building automation systems are much cheaper than process automation systems—often less than half the price.

Matrix Technologies, a system integrator in Maumee, Ohio, prefers using two systems for process control and building automation. Charles Sheets, director of the industrial systems division at Matrix, says, "Since standard automation components can perform many functions, the same hardware and software can be used to control many different devices including HVAC, boilers, security access, compressors, water, etc."

Sheets adds that the physical separation is beneficial for maintenance, security and to ensure that a problem with one system won't affect the other. But he wants to use the same components. "Using standard automation components such as PLCs allows one service organization to support both systems for troubleshooting and spare parts."

Support problems often come up with existing plants that have older controls. "One of our projects involved an industrial power plant where the original HVAC controls had been subcontracted to a third party," Sheets explains. "Technical support was very difficult to obtain for their proprietary systems. Some of their equipment used PLCs, and those could be readily supported. The systems with proprietary hardware could not." Using the same controls—but in separate systems—eliminates the problem.

"Another project of ours involved optimizing energy recovery from both HVAC and process equipment for a major food manufacturer. In this case, both systems use PLC controls developed by Matrix Technologies. Since the two systems communicate, we orchestrated a strategy based on real-time process and HVAC conditions to optimize overall plant performance, resulting in significant savings."

Control and security issues are different between process and building automation. "For example, if third-party monitoring of fire, emergency and security is needed, then it might be better to use a full-service building controls organization," Sheets says.

There's also some value in dealing with experts in the field. "Proprietary building control systems virtually eliminate unauthorized access," Sheets notes.

"Building control companies typically have established knowledge of environmental and other control equipment, and often use a pricing model of lower initial costs with guarantees of a long-term service/monitoring contract. Depending on cash flow, this could be a benefit."

Process control vendors and equipment can perform building automation, too, but maybe not as well. "Often, the intellectual property of building control vendors is concealed as part of their offering. It's just part of the magic. But there aren't any building automation functions which can't be readily handled by process automation HMIs, PLCs and sensors," Sheets says. "The challenge is in having the application knowledge to implement the functions."

Using one system also might put a strain on building automation vendors. "Building automation system vendors typically have a standard hardware and software solution and would have to modify their controls to support process industry equipment and standards," says Optimation's Matatall. "Having them change their technology to the process standard might raise the cost of their equipment, and even eliminate them from bidding a project completely."

WHY COMBINED SYSTEMS CAN WORK BETTER TOGETHER

- One system to learn and maintain
- Same HMI displays
- Similar control programming
- Single-vendor responsibility
- Simplified maintenance and spare parts stocking
- Easier integration of data between systems
- More open than using proprietary building automation systems

The need for environmental control varies across the process industry. "Even within a particular facility, building management requirements differ based on the type of space. Regulated industries, such as life sciences, must report on conditions that could impact production, including humidity and temperature. These applications require industrial-grade, precise measurement and control," says Bob Lenich, global Syncade business director at Emerson Process Management. "In these same facilities, gray spaces, such as offices and corridors, have less stringent reporting

requirements, in which case, commercial-grade instrumentation and controls may be more appropriate and less expensive. For these spaces, a building management system makes sense.

"There's growing interest in understanding how building environments affect production in the food and beverage and specialty chemicals industries. The two-system approach is an effective one for them as well. They get the benefits of best-in-class technology for both process control and building management without the expense of a single, combined system."

Every industry segment has its own requirements for process control and building automation, says Malloy. "In some cases, such as with small chemical manufacturers, light industry or non-GMP processes, one system could potentially do it all. However, for large processing facilities in biotech, pharmaceutical and semiconductor, where building automation plays a role in the quality of the end product, multiple levels of control systems are standard and for very good reasons."

Different Strokes

Choosing between a single or multiple systems isn't an easy choice. "Conceivably, with the right servers and processes in place, all manufacturing and building automation data could be tracked by one system and integrated in one place," says Malloy. "However, for most industries, this isn't possible or not a good idea."

For example, pharmaceutical manufacturer Bayer HealthCare, Berkeley, California, keeps its process and building automation systems separate. The company has several operational areas, and most use a combination of control platforms. At the Berkeley site, it uses ABB DCS controllers for process automation with a combination of Rockwell Automation and Siemens PLCs, plus a few proprietary systems for specialty processes. With the DCS, the plant has the redundancy and control capability a major pharmaceutical facility needs. The PLCs give it the flexibility to add small systems when needed.

REASONS TO KEEP PROCESS AND BUILDING AUTOMATION SEPERATE

- Lower upfront costs because building automation systems are cheaper
- Building automation systems have built-in building-oriented control schemes
- Each system is simpler than a combined alternative
- A failure in one system doesn't take the entire plant down

"Getting the MES and building automation system to communicate all information with the DCS is a large and complicated undertaking, and gets more complicated when the data is then fed to a historian. But having the systems run separately gives flexibility to the control system that's beneficial to revalidation," notes Chris Williams, associate director, API engineering at Bayer.

"It's not that we don't see the advantages of using a single control system; it's that the disadvantages for our different process areas are costly. One of the larger operating costs we have is software and tag licensing. We can save some significant costs by keeping non-GMP processes off our DCS and operating on a lower-cost-of-ownership SCADA. However, the primary expense regards replacing equipment in a validated process. Using equipment that can communicate over multiple processors is one thing that interests us, and having partners with that kind of equipment to make validations easier is advantageous to us."

On the other hand, the ability to integrate multiple control platforms and islands of control in a plant is becoming easier and more commonplace, says Malloy. "It will become even more feasible in the future for multiple controllers to talk over open protocols and integrate over non-proprietary boundaries. This will minimize the risk of how controllers communicate, how resources are allocated along operational unit lines, and how to mitigate obsolescence of technology."

One system can work well for companies that are dedicated and vigilant about maintaining the single system. One successful example is a large food manufacturer that opted to switch to a single PLC manufacturer, a single platform and, whenever possible, a single bus protocol at its facility.

"The company has seen single-system benefits through having dedicated programmers familiar with the PLC programming language, consolidation of spare parts and the ability to train technicians on a single platform for troubleshooting purposes," says Malloy. "There are challenges, but the company is committed to the success of this single system. Management is made easier because the manufacturer does not require revalidation. One potential problem for manufacturers considering this switch is heavy reliance on one vendor for technical support."

Even when systems are separate, they can be presented to the operator as one. Boyd explains. "A Quaker-Muller yogurt plant we completed in Batavia, New York, was originally designed and built with two separate systems, but they asked us if there was a way to integrate the two, so that the HMI screens and parameters on the HVAC system could be integrated into the process automation system. At Quaker-Muller, the climate control system is very important and really integral to the process itself, and we were able to fulfill their request."

In either case, companies are interested in how long they'll be able to operate before the equipment is obsolete. Proprietary controllers increase the risk of obsolescence, while non-proprietary controls open opportunities for companies to gain functionality while minimizing reliance on a single manufacturer.

"Can We Talk?

One problem with a two-system approach is that building automation systems have adopted BACnet communications, while process control systems use fieldbus and Ethernet networks, such as EtherNet/IP and Profinet. Can the two talk to each other?

"Companies like ProSoft Technologies make cards that talk to the majority of building automation systems," says Maverick's Boyd. "We used the cards to integrate the HVAC systems at a Sun Chemical plant into the main control system."

Boyd believes ProSoft would not have designed and manufactured a series of products designed to interface with building control systems if no demand for that capability existed.

Sheets agrees. "We're seeing two trends—a movement of the building automation system manufacturers to use more standard protocols, such as the Internet of Things, and more tools to integrate them."

Dellinger adds, "There's no ideal solution here, but a good one we routinely see is two separate systems that only share the data they need. For example, PLCs and software on the manufacturing floor might be communicating via EtherNet/IP, and the building system might be using BACnet. These are two different systems, but an OPC server can communicate both BACnet and Ethernet/IP, and provide access and translation of only the data needed between systems.

"Today, it's less common to see manufacturing and building automation tied together into a single system. As for the future, we'll see—but I would bet we move more toward consolidation."

There certainly is a trend toward consolidating process control and building automation systems, especially in new plants. This consolidation can range from using one system to control everything to using two systems with tight integration via digital data networks.

In older plants, a building automation system probably already exists, may be doing its job very well, and justifying its replacement may be difficult. Instead, an existing building system can be easily integrated into a new process control system with tools like BACnet interface cards, OPC and Ethernet.

In newer plants, either approach will work, with selection of a combined process and building automation system or separates driven by the application requirements.

Dan Hebert is senior technical editor at Control.

SCADA systems: Easier to deploy and operate

SCADA systems are easier to deploy and operate now, which is good because they're being called on to manage ever larger and more widely distributed process applications.

By Jim Montague

The downside of being responsible for everything is obvious—even more so when jobs and jurisdictions swell in size and scope. However, just like responsible parents, plant operators and their supervisory control systems don't walk away from their duties when stressed or tired out.

Luckily, just as moms and dads are spelled by relatives, babysitters and daycare providers, better supervisory control and data acquisition (SCADA) tools are arriving to help users and supervisory systems cope even as they take on new and bigger jobs. And, as usual, wireless, tablet PCs and the cloud are getting in on the act.

For instance, Solvay Chemicals' trona ore mine and refinery in Green River, Wyoming, recently migrated from Yokogawa Corp. of America's Centum CS3000 distributed control system (DCS) to its new Centum VP-R5 control system, and updated 21 field controllers and numerous other support components. Trona ore contains sodium sesquicarbonate, a relatively rare, sodium-rich mineral that's used to make soda ash, an essential ingredient in glass containers and other products, chemical manufacturing, soaps and detergents, flue gas desulfuring, pulp and paper and water treatment. Solvay mines about 11,000 tons of ore per day from the mine, which is refined into about 6,000 tons of pure trona. This also frees about 6 million cubic feet of natural gas per day, which used to be burned off, but is now used to run the refinery's kilns.

Solvay's control system at Green River has about 7,000 individual, hardwired I/O points and about 3,000 communication I/O points for its SCADA system, PLCs, Honeywell FSC system and other packages. Its controls cover processes that are up to 20 miles apart, and its Yokogawa system resources include two domains, 21 reconfigurable I/O (RIO) and field-network I/O (FIO) field control stations, 17 operator stations, six engineering stations and eight different plant servers (Figure 1).

"We had to upgrade because our Microsoft Windows XP components were no longer supported in 2014, and so their costs were going to go way up," says Kevin Kelley,

Photo Credit: Yokogawa and Solvay

OVERSEEING ORE

Figure 1: Solvay Chemicals' Green River trona ore mine in Wyoming recently migrated from Yokogawa's Centum CS3000 DCS to its Centum VP-R5 control system and updated 21 field controllers and support devices.

process control foreman at Solvay Chemicals. "We were scheduled for a five-year, total plant outage, and we needed update our RIO field control stations with new templates and offline downloads that had never been done since they were initially installed. We also needed to upgrade our system security to meet Solvay's overall, corporate IT standards."

Streamlining SCADA

Besides installing servers, cabinets, control room equipment and other VP-R5 components that were much less cluttered than their CS3000 counterparts, Kelley adds that some of Solvay's staff traveled to Yokogawa's Houston offices for Centum VP graphics evaluation and training. They determined what their new graphics would look like and evaluated Solvay's existing CS3000 database of over 350 graphics to make sure it would cut over to VP's graphics.

"With our short cutover timeframe, it was important to maximize our time to do the offline downloads and operator station replacements," reports Kelley. "This meant that we needed all the infrastructure in place as much as possible when Yokogawa arrived. It involved months of prep work, specking out parts and installing cabinets with UPS power, fiber runs for the keyboard, video, mouse (KVMs) and Vnet routing. We also pre-mounted the KVM units under the control desks. All we needed to do during the outage was to slide new machines in the racks and hook them up."

The upgrades three main phases included pre-loading and staging workstations in new cabinets; cutting over by downloading software to field control stations, and running reports to compare changes to block nodes; and upgrading and verifying that Green River's OPC server was up and that it was gathering data in its AspenTech plant historian. The team also upgraded and verified that their VTSPortal was fully functional and that other EXA and PRM software had the latest revisions.

U.S. Army Corps of Engineers and Rockwell Automation

SCADA FOR STORM SURGES

Figure 2: The GIWW-WCC protects three New Orleans parishes from flooding, includes the largest drainage pumping station in the U.S., and uses Rockwell Automation's hot-standby SCADA servers and dual, hot-standby ControlLogix PLCs for redundancy, as well as FactoryTalkView SE software for monitoring, control, data logging and reporting.

"Finally, our operator and engineering stations were changed out live, one at a time," adds Kelley. "Each operation area has two HISs. We changed out one station at a time, until each area had one VP station and one CS station. This took two days to complete, and it gave the operators time to get accustomed to the new stations. After the two days, we went around again and changed out the remaining stations. This worked well.

"For the total upgrade, we experienced no loss of production, and the plant came back online without any problems. About one month after the outage and cutover, a Yokogawa engineer returned to the site to do a follow-up. This gave us an opportunity to ask questions about VP-R5 and to tie up any loose ends. Next, we're undertaking a project to convert our graphics from the old 1990s style graphics to more high-performance, alarm-oriented graphics."

Strengthening Outsize Infrastructures

Besides assisting plant operations, improved SCADA systems can also meet the needs of more geographically distributed process applications.

Following Hurricane Katrina in 2005, the U.S. Army Corps of Engineers started building the $1-billion Gulf Intercoastal Waterway—West Closure Complex (GIWW-WCC) to protect three parishes in the New Orleans District with levees, floodwalls, water control structures, navigable floodgate, foreshore protection, dredged material, environmental stewardship and the largest U.S. drainage pumping station (Figure 2). When the floodgate closes during a storm, this pumping station must evacuate rainwater pumped to it from other stations in the system. To handle a 100-year storm surge, original specifications for the station called for 11 5,500-hp pumps capable of moving nearly 20,000 cubic feet of water per second.

As a result, GIWW-WCC needed a reliable and secure SCADA system before its scheduled completion in 2013, so the Corps worked with system integrator Prime Controls and consultantArcadis to implement a redundant Integrated Architecture platform from Rockwell Automation, which includes Allen-Bradley ControlLogix PACs and FactoryTalk View SE visualization software running on a redundant Ethernet ring network. Also, Allen-Bradley CompactLogix PLCs manage the fuel delivery and return system's distributed I/O.

"The critical nature of the pump stations requires redundancy in every system," says Gary McNiel, senior vice president at Prime Controls. "Hot-standby, dual ControlLogix controllers and hot-standby SCADA servers supply the necessary backup. We chose FactoryTalk View because it provides monitoring and control graphics as well as required reporting and data logging."

The resulting SCADA solution supplies all information needed to operate GIWW-WCC's pumping stations, including pump, engine, electrical generator and water-level data from the intake and discharge areas. The system also monitors the pump's diesel-fuel levels and incorporates weather information and closed-circuit television (CCTV) surveillance for security. Also, the same SCADA system controls the sector gates that regulate the water level across the navigational waterway.

Finally, when Hurricane Isaac and its 12-foot storm surge arrived in 2012, GIWW-WCC withstood the test, and successfully protected much of New Orleans.

"Wi-Fi and iPads aren't new for many users, but they're still very new for operators in many water treatment plants and other process applications. To them, getting process data from a smart phone is still Star Trek stuff," says Dennis Wylie, product manager for ControlLogix at Rockwell Automation. "However, tablet PCs and smart phones are available, so they just need some enabling technology. Security is the key. SCADA was historically open to mildly secured systems, so hackers gaining access wasn't uncommon. But ever since Stuxnet, SCADA has been viewed as critical infrastructure by the U.S. Dept. of Homeland Security. To provide all the data that users want, but still meet security and validation requirement, SCADA has been evolving. We're adding more and faster embedded communication throughputs, new ways to handle I/O data, enhanced diagnostics and more security measures. This means we can identify what's happening, know what's wrong and take action sooner."

Green and the Cloud

Beyond managing routine operations and larger infrastructures, some supervisory control solutions are spreading their wings to help out with sustainability in their applications and even using cloud-based data processing services to do it.

For example, PML Exploration Services in Houston, Texas, provides real-time gas analysis to its clients by using web-based tools in InduSoft's Web Studio SCADA software. Previously, PML could only provide gas and geologic updates from rigs twice per day, so delays could be as long as 12 hours between analysis and reporting. Now, well operators use PML's up-to-the-minute gas analysis and detailed, web-viewable geological information to optimize their time, protect well investments and ensure operational safety.

Web Studio also allows users to store their information on a cloud-based service, so rig operators and site managers can have ready access to data, even when they're at remote locations. In fact, PML reports that 60 active rigs are using Web Studio for data acquisition, control and display of well-site data. Operations are constantly monitored by PML employees at well sites, and data is sent to each client and PML via satellite connections. Managers can review data on their smart phones, tablet computers or via text messages and SMS, while well operators can keep track of changes by using InduSoft's Web Thin Client web browser and pulling reports from the cloud.

"One of the main advantages of Web Studio was that we didn't have to write code from scratch for cloud-based technology," says John Parsons, PML's president and CEO. "It was all right there in the software. This allowed us to put the information directly in the hands of the customers by providing a good web solution."

Likewise, Sofidel reports it recently needed to upgrade automation at its Délipapier plant in Frouard, France, so it decided to work with Metso to virtualize the DCS and quality control system (QCS) on its Tissue Machine 1 to help reduce computer hardware needed by the upgrade and reduce the cost of maintaining multiple operating platforms at the mill.

Virtualization allows the tissue machine's physical computer hardware to be separated from the software by creating virtual machines (VMs) in a host server to provide a more fault-tolerant and stable environment for critical applications. Fabrizio Lapucci, Sofidel's corporate automation manager, reports that its upgrade at Délipapier is the world's first virtual process and quality control system on a tissue machine. "An additional advantage is that the servers are now located in a clean and controlled environment, which will maximize their service life," adds Lapucci.

To improve process visibility, new tools on Tissue Machine 1 include Metso's DNA Historian software, which is a data management system that collects real-time process data, including all measurements, setpoints, controller outputs, device statuses, motor starts, alarms and operation tracking, and sends them to the history database. "We have immediate access to details about a problem whether it occurred at the weekend or six months ago," adds Stephane Bonnet, Délipapier's production manager. "We use it all the time to improve the process. Recently, during a problematical color change, it made it easy to see that a small mistake had been made with consistency, and in the future we'll be able to avoid it. Previously, this problem with a consistency setpoint would not have been seen. Now we know what to do and have changed procedures for future color changes. Improvements like this have a big impact on our production."

Jim Montague is executive editor at Control.

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How to run your process control applications far out in the field

Establishing process automation projects in developing economies and other remote locations requires better preparation, stronger supply chains, more accessible expertise, simpler controls and added training. Here's how veteran players make it happen

By Jim Montague

Start packing. In remote locations and extreme environments, it can be harder to get what you need to run your process control applications. Supply lines can be stretched thin, if they exist at all, and your usual system integration services aren't just around the corner either. Staffing is likely to be a challenge, too. You must bring in know-how from much further away and provide more extensive education and training to local personnel.

These challenges can seem insurmountable at first. However, if you stop and look at them closely, they're more difficult in degree, but not different in kind from the plans, specifications and punch lists of any other process control project. Certainly, there can be many tricky curveballs to deal with, but many engineering procurement contractors (EPCs) and other experts can help. And almost all the recent advances in process controls and their supporting networks can also enable users to build and operate applications in less developed regions, fulfill local requirements and even help Third World markets and consumers secure more advanced capabilities and benefits.

For instance, Vale Nouvelle Calédonie on the island of New Caledonia, a French island territory in the southwest Pacific about 750 miles east of Australia, has been working with ABB to install new controls and help upgrade its plant for processing minerals from the open-pit Goro deposit, which is one of the world's richest undeveloped laterite bodies with an estimated 55 million tons of measured and indicated nickel ore reserves (Figure 1).

Besides implementing one of the world's largest System 800xA automation applications without incurring downtime, Vale and ABB also had to develop and submit all project documents and drawings in French as well as English to comply with local regulations. The 800xA system includes 48 operator workstations, 10 engineering workstations, 8,000 HART-capable instruments, two OPC clients, 33,000 history logs, 23,000 redundant 800xA tags, 50 AC800M redundant PM 864 controllers and many other components. This 800xA application also has a burner management

Codelco and Honeywell

PACIFIC ISLE NICKEL MINING

Figure 1. Vale Nouvelle Calédonie implemented one of ABB's largest 800xA automation systems to improve nickel ore processing at the huge, open-pit Goro laterite mine.

system (BMS) with three AC 800M HI controllers for three new coal-fired boilers producing electricity and steam for the plant.

In addition, ABB delivered a safety instrumented system (SIS) with its TÜV-certified Functional Safety Management System (FSMS), which uses five more AC 800M HI controllers for processing LPG during ship unloading and port handling. Finally, ABB provided Vale's ore-processing plant with purpose-defined software libraries, which enabled a framework for standardized alarms and events, and allowed English-to-French translation functions by the plant's operator terminals.

Also Read "Are You Ready for Process Control?"

"Overall good planning and preparation are what resulted in a successful execution of this upgrade," says Ghislain Belmonte, Vale's technical services manager.

Simpler Plans, Lighter Luggage

Similarly, Perenco recently undertook the largest surface redevelopment project of its onshore and offshore production operations in Gabon on the central west coast of Africa, which required it to build new infrastructures, and reorganize and coordinate numerous platforms, control facilities and industrial networks. "Perenco began production operations in Gabon in 1992 with the acquisition from Total and Marathon of developed, offshore fields near Port-Gentil," says Laurent Mollard, Perenco's senior automation and control systems engineer. "Twenty years later, our yearly average production reached 62,500 barrels of oil equivalents per day (BOEPD) in 2012. This growth was sustained by continuous development of mature fields, an aggressive acquisition strategy and successful exploration, but we really needed to streamline all these production operations and overhaul our infrastructure."

Based in Paris, Perenco is an independent oil and gas com-

TRAVEL BAG OF TRICKS

Constructing and operating process applications in undeveloped and remote locations is no picnic, but they do have the same overall goals as regular projects—produce oil and gas, mine metals and other materials, generate power, provide clean water, etc. They just need more preparation and have longer to-do lists. Here are some likely high points:

- Planning and design must include comprehensive research about physical sites, exploitable resources, production goals, facility and application designs, local regulations, cultural issues and environmental impacts.
- Partnerships with local distributors, system integrators, contractors, governing bodies, educators and other groups can help secure equipment and supply streams, regulatory compliance, potential staff and other vital people and components.
- Sourcing and supply mainly requires adding time to find required equipment and raw materials, arrange transportation and delivery schedules for new equipment, and coordinate on-site setup, configuration and testing.
- Training consists of evaluating skills needed to run applications, arranging to bring in experts to instruct new employees, scheduling online courses if available, working with local schools and colleges to help recruit staff as needed, and implementing as much hands-on and continuous training as possible to keep everyone's skills updated.
- Post-production involves arranging transport and distribution for end products, coordinating maintenance and repairs for equipment and facilities throughout their lifecycles, and reexamining applications to add useful innovations and upgrades.

pany with onshore and offshore operations in 16 countries in northern Europe, Africa, South America and Southeast Asia. In Gabon, Perenco runs 27 oil production sites, including 12 offshore and 15 onshore. Each offshore site can include three to six platforms. The production sites cover an area that's about 400-kilometers long, running north to south off Gabon's coast, and they're networked via a combination of fiber-optic cabling, radios and satellite communications. The company also operates a 450-kilometer, mostly underwater, natural gas pipeline, which covers two production fields, one gas treatment plant and two distribution sites. It also operates two floating storage and offloading (FSO) units to store and export crude oil, and supplies natural gas to the local power plants at Libreville and Port-Gentil (see "Travel Bag of Tricks").

"To optimize operating expenditures in our crude oil production areas, we required scalable automation solutions that could handle both process control and safety control on our production facilities, which produce hundreds to thousands of barrels of oil per day," explains Mollard. "We needed to reduce operator presence on small production plants by fully instrumenting offshore platforms and onshore sites, interconnecting all the automation systems and remotely operating several production facilities from one main control room. We also needed to rationalize our maintenance efforts by reducing local electrical production units and centralizing electricity production; managing our power plant operations, load shedding and electrical network monitoring; and remotely accessing diagnostic information to prevent unsuccessful trips."

Besides coordinating and streamlining existing operations, Perenco also needed new infrastructure to development its nearby Olende and M'Polunie fields; construct two 14-megawatt power plants with high-voltage electrical distribution; install a distribution network linking Libreville and Port-Gentil to gas reserves; and implement a dual-product, 2-million-barrel offshore terminal. "Our project objectives were to centralize operations in two main control rooms to minimize local presence and reduce logistics costs, such as helicopters and boats," adds Mollard. "We also sought to electrify all of our production facilities by installing the two main power plants to reduce local electricity generation and maintenance costs. We also wanted to further optimize production by acquiring production well information that could be analyzed by the geophysical department in its main office and remotely." To accomplish its diverse goals and simplify its operations, Mollard reports that Perenco was going to need some outside assistance.

Technical Tour Guides

Of course, whenever you journey to an unfamiliar place, it's good to go with someone who knows the terrain, and it's even more important if you're going to do business and build manufacturing facilities there.

"We've been implementing automation and process, building and combustion controls in Brazil and other parts of Latin America for more than 50 years, and even installed some of the first DCSs in Chile's copper mines and Venezuela's oil fields in the 1980s," says Gustavo Galambos, mega-projects director for Latin America at Honeywell Process Solutions. "We've seen that one of the best ways to develop and support far-away process applications is to have a government in that region that provides incentives to develop local resources. For example, Brazil built many of its oil and gas refineries in the 1970s, but it also encouraged its universities to create the electronics and controls curriculum that could be used in its process applications, and now it's a leader in the deep-water oil and gas industry."

Likewise, Garalambos adds that Honeywell's history and foundation in many developing economies helps its users gain efficiencies as well. For example, Alcoa has worked with

DEVELOPING COMMUNITIES, PROTECTING ENVIRONMENTS

Beyond its regular extractive operations, Perenco reports it's implemented many projects to support Gabon's residents and their communities. "Although most of our work is devoted to exploiting oil and gas deposits, we're also very much aware of our social responsibility with regard to the communities that are directly affected by our operations," says Christian Moullard, Perenco Gabon's general manager.

For example, working with Gabon's Société d'Energie et d'Eau du Gabon (SEEG), Perenco has supplied natural gas to local power plants at Libreville and Port-Gentil since 2007, allowing them to switch from fuel oil and reduce carbon emissions. The 400-kilometer pipeline transporting gas to Libreville and Port-Gentil runs mainly underwater, doesn't cross fishing zones, maritime corridors or anchorage zones, and skirts the coasts at minimal distance between Batanga and Port-Gentil.

In 2008, Perenco laid underground electrical cables to electrify 80 homes in Batanga, which is an isolated village about 160 kilometers southeast of Libreville. Perenco also built a health center in the village. The community borders the onshore Batanga oilfield, and its electricity comes from the nearby oilfield's generators.

To be ready for any potential spills or other emergencies, Perenco maintains and regularly trains on a variety of spill-response equipment at its Victor Response Base, which is also centrally located onshore in Batanga. Offshore devices include a 1,000-meter-long floating and rigid boom, a transportable dam or boom bag that can be towed at 15 knots for rapid deployment, five skimmers for collecting oil and a dedicated towing vessel. Onshore equipment includes absorbents, collection pumps and temporary effluent storage facilities. Protected command posts and helicopters are available for both offshore and onshore incidents.

"Gabon possesses extraordinary natural wealth, and I'm personally committed to ensuring that our operations respect its environment," adds Moullard. "My dearest wish is to leave more wealthy, more independent communities behind us when our operations are finished, with no visible mark of our former presence. In this way, Perenco will continue as a trustworthy partner of Gabon."

Honeywell for several years on their joint Quality Automation Solutions for Alumina Refineries (QUASAR) program, which has standardized process controls and infrastructures and reduced emissions at multiple Alcoa refineries in five countries, including three in Australia and one each in Jamaica, Suriname, Brazil and Spain. QUASAR began by collecting and combining best practices from each plant, and setting up a centralized monitoring system that allows experts to analyze and rectify controls performance. Next it established a co-sourced support center available 24/7 to provide integrated support and maintenance to help reduce downtime, and organized a dedicated implementation team for rapid QUASAR deployment at each location to reduce costs, improve quality and minimized plant interruption.

"To accomplish this never-before attempted feat, we needed to partner with someone that had the process control products and solutions expertise, but also understood the cross-cultural challenges affecting seven different sites, multiple countries and cultures, and four different languages," says Dennis Mason, process systems manager for global refining at Alcoa. "Working with Honeywell under the QUASAR program, we expected to see improved alumina production rates, reductions in our raw materials consumption and costs, and increased technology transfers between our refineries. We've consistently exceeded expectations in those areas. What took our combined team just five to six years to accomplish

ABB and Vale

CHILEAN DESERT WATER DATA

Figure 2. Codelco uses Honeywell's OneWireless components to optimize water recovery in the huge thickener pools at its Norte mine in the Atacama Desert in Chile.

would have taken us more than 20 years internally."

Experience Extends Innovation

While it's crucial to know what developing and remote applications need, in many cases, only recent technical innovations such as wireless networking can solve their challenges.

Galambos adds, "Large projects in developing areas require a lot of research and generate a lot of best practices over the years. So because we've learned a lot from earlier projects, we can better assess requirements and infrastructures on new projects and make sure they get the communications and life-cycle support they'll need."

Similarly, world's largest copper producer Codelco also maintains a common support center in Santiago, Chile, for four—soon to be five—of its remote mines. This center also runs 24/7 and provides real-time support, video conferencing, intranet and other services. Recently, the company's Norte mine in the Atacama Desert needed to optimize the water recovery process in its thickener pools (Figure 2). The Norte facility consists of three open-pit mines producing approximately 896,000 tons of electro-refined and electro-winned cathodes per year.

Water used in mineral processing is recovered for reuse, so the thickeners need accurate level gauging and reliable communications from the field to the central control room. Without this data, the remote mine's multivariate predictive application based on Honeywell's Profit Controller software couldn't optimize water recovery. As a result, Codelco installed Honeywell's ISA100-compliant OneWireless network with Modbus to reach the remote Siemens S7 300 PLCs that manage equipment and instruments at each pool. Seven OneWireless multi-nodes cover the pools, and one gateway sends Modbus data from PLCs to Honeywell's existing TPS control system. This allows Norte's control room operators to call up information from the PLCs using TPS, and this data can be fed into Honywell's Profit Controller software to optimize process control at the pools.

"The former inability of gauging online and the high cost of maintaining the wired traditional network, which was frequently broken by heavy trucks and machinery, caused very low availability of measurement," explains Guillermo Cortés, concentrator automation leader at Codelco. "OneWireless offered the most dependable solution for both our complex operation and advanced controls because it supports real-time gauging and instrumentation. Our desert zone has many challenges including topography, long distances between the thickeners and control room, and the extreme environment conditions of radiation, wind and temperatures. OneWireless allows us to gauge multiple variables and transmit them in real time with high availability until we gain consequent improvement in our water recovery process. We can now gauge and manage the thickeners' levels and flows, and the efficiency of the whole process has greatly improved."

Galambos adds, "Operating these mines is a lot like running an offshore oil rig because everything has to be tested first before it can go out their remote sites. They also need extremely reliable communications, DCS support and backup, and advanced process controls (APCs) with remote training. Wireless instruments and networking are especially helpful because users don't need to bring so much cabling and connectors to remote and undeveloped areas. They can reduce labor while they're in the field, and it's simpler to get the data they need for routine operations, analysis, multivariable control and future simulations."

Jason Nicholl, business development manager for I/O and networks at Phoenix Contact, confirms the long distances and mountains between Chile's mines can stretch vendor supply lines and system integration services very thin. "Consequently, we have to gear up our subsidiaries to be technical experts with Power Points, and especially with hands-on demonstrations. So we go on the road with them to visit their partners and help them train their distributors, system integrators and end users. Touching base a lot helps because it can prevent a lot of unplanned downtime and eleventh-hour crises. It also helps to plan ahead, keep on seeking potential new partners and remember to bring your steel-toed boots. Developing economies are all about developing relationships and trust first, then providing basic technical training and only pitching a solution at the end. Outside the U.S., it's even more important to be patient, listen well and be willing to adapt to local cultures and traditions."

Take-Along Intelligence

Just like back home, it's critical to have ready access to detailed know-how when building, operating, maintaining or renovating process applications in remote or developing regions. As a result, many suppliers and other support organizations simply set up local service and knowledge centers that can fast-track equipment and provide onsite or online training as soon as needed.

"The biggest problem automation engineers in developing countries face is lack of knowledge," says Carl Henning, deputy director of PI North America. "PI helps by providing local PI Competence Centers (PICCs). There are over 50 now. Naturally, there's a concentration in Europe and North America, but South America, Asia, Australia and Africa are well-represented, too. Lebanon, Saudi Arabia, India, Chile, Brazil and other countries have PICCs, which are certified by PI and audited every two years to ensure they're providing a high level of advice to users, system integrators and manufacturers. The international language of engineers is English, and that's PI's standard language, but regional PI associations (RPAs) often translate the specifications, white papers and newsletters into local languages, so when these folks need help with Profinet or Profibus, they can find it locally in their own language."

Likewise, when it finds that a major customer needs support in a new or less-developed region,Emerson Process Management reports it will open a service and support center right there. "Over the past couple of years, we've been making a big effort worldwide to talk to end users and expand our service locations to where they're especially needed," says Erik Lapre, vice president for lifecycle services at Emerson Europe. "In addition to field service and repairs, these centers have quick shipping capabilities and offer ongoing training." For instance, to support its expanding oil and gas applications, Lapre says Emerson recently opened several service centers in Central Asia, specifically in Atyrau, Kazakhstan, and in Baku, Azerbaijan.

However, because many users can't get to a particular center, but still have Internet access, Emerson also offers virtual training programs that can instruct attendees in a variety of job roles and technologies. "We send curriculum materials and a PC-based headset for voice over Internet protocol (VoIP), so they can ask questions," says Mark Dimmitt, educational services consultant at Emerson. "We offer 20 different classes just on DeltaV, and students can take them anywhere there's high-speed Internet. This gives them bidirectional audio and video, so it's just like being in an in-person class, but our virtual class means they don't have to travel."

Standardization Streamlines Support

Back at Perenco's project in Gabon, Mollard and his colleagues turned to longtime partner Rockwell Automation, which has been assisting Perenco since it started working in Gabon. "We used a global standard approach with PlantPAx redundant servers for main production facilities and combined them in multi-server applications. We implemented ControlLogix process controllers, SIL 2 safety controllers and power distribution controllers. Next we installed rack-based I/O for our main plants, and Flex I/O and Point I/O for remote installations. We also used Ethernet for Level 2 and peer-to-peer communications, and adopted ControlNet for our I/O components. Again, we also used fiber-optic, wireless, satellite or GSM networking, depending on an individual site's needs."

Mollard added that all these updated components give its offshore platforms and onshore operations multi-server capabilities, which allow the Gabon facility to easily centralize operations in its central control room. "ControlLogix's multi-discipline capability lets us apply a global standard over every site," explains Mollard. "Likewise, smooth integration to the IT environment enables us to secure remote access via satellite from any location, while PlantPAx's scalability allows us to carry out projects in a phased approach. Rockwell Automation's information-oriented solutions also give us easy access to production data for analysis, which helps optimize our financial investments."

Because Perenco's redevelopment project meant it was often dealing with developed fields and managing existing equipment, many of its new projects didn't involve building complete platforms or plants, but instead required it to add new components to older facilities. "It could be difficult to remember where all the existing equipment was, so it helped that we could make all our fire and gas (F&G) connections directly to our PLC too," reports Mollard. "We can also manage our power generation with a PLC for power management. All these interconnections let us monitor everything from one central control area."

Mollard adds that Perenco has also been standardizing its safety instrumented systems (SISs), emergency shutdown systems (ESDs) and F&G systems on the same PLCs from Rockwell Automation, and monitoring them together on PlantPAx. In addition, it's also standardizing its HMIs and SCADA programs, which will allow staff to work on uniform displays and simplify training for them.

"The real value of this simplification and standardization is that common platforms can reduce the cost of spare parts. However, we're also getting uniform well analytics and production dashboards that are allowing us to follow operations trends in Gabon from our offices in Paris, and then react and make better decisions in real time," adds Mollard. "These standard solutions from Rockwell Automation are going to be deployed further in Gabon and also in Congo, Democratic Republic of Congo, Tunisia, Peru and Cameroon. They'll be easy to remotely support, and they'll help our site maintenance and project engineers optimize operations and improve production turnover in any of these locations."

Jim Montague is executive editor at Control.

System 800xA Control Rooms
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Many companies claim that people are their most valuable asset, but it isn't usually reflected in their work environment. That's why ABB and CGM have joined forces to offer three pre-packaged control room design studies to start you on a path toward building a high performance, ergonomic environment that attracts and keeps young talent.

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Control systems of the future

Through the looking glass of emerging technologies.

By William L. Mostia

How might we expect emerging technologies to play out in the world of process control? Successfully predicting the future is difficult at best, so we sought out and consulted with industry visionaries and long-term planners to see where there is consensus about how rapidly developing operator interface, computing, data analytics and virtual reality will change our craft. Their informed speculation indicates these emerging technologies and others will be impacting our industries at an increasing, even amazing, rate.

Our list is by no means exhaustive, as many technologies are just now emerging out of their cocoons, and there's no telling what else might be lurking out there, in companies big and small, and in the garages of the DIY'ers.

Of course, the process industries are notoriously conservative, with a large installed base of equipment that ranges from pneumatic to sophisticated digital control systems, all of which are currently making money. So while we will see rapid changes in commercial technology, adaptation by the process industries will be on a value-added basis, and always dependent on the cultural acceptance of the involved personnel.

Current Trends Are Safe Bets

First, we can expect continued incremental improvements in our currently available control systems technology. Many of our DCS systems are underutilized, and their future may already be lurking within them or with the DCS vendor's current offerings.

Moore's Law, "the number of transistors in a dense integrated circuit doubles approximately every two years," is expected to continue into the next decade or so, but may slow from doubling every two years to doubling every three years. Coming developments in carbon nanotube field-effect transistors, junctionless transistors, single-electron transistors and memistors may well extend Moore's Law's life. So we will continue to see improvements in computing and memory, which will support the emerging technologies. We'll get larger operator screens with higher resolutions, and control hardware platforms will run faster, smarter and with more memory.

Network capacity will have to expand to meet demand, placing pressure on the existing infrastructure. Process control algorithms will advance in sophistication, but the next generation of systems will see self-aware controllers and sensors incorporating artificial intelligence (defined as capable of cognitive and memory functions, resilience, awareness of its environment and its place in the process context, etc.) to develop advanced control strategies to achieve the controller goals. Cloud computing will play a part in the next generation of DCS/SCADA, but the extent and balance between the virtual and the hardware/software world is unknown and controversial.

Control Rooms Center on the Operator

The trend of centralization of the control room remote from the process area is likely to continue, says Pierre Skonnegard of CGM in Sweden, a partner with ABB in designing the control rooms of the future. Skonnegard also felt that operator attentiveness, awareness and health would be given greater consideration.

The video arcade environment, with the operators sitting during a substantial portion of their shifts looking at video screens, can lead to operator health concerns. Chairs are being developed that will automatically adjust to the operator's physique using biometric sensing, and in the future, will be able to monitor the operator's health and attention level. DCS consoles are already available that have two positions to accommodate the operator sitting down or standing up, with an easy transition between the configurations. Biometric sensing will be used to support security, and to allow the

control room to adapt to the people currently in it. Ambient intelligence, where electronic systems and environments are sensitive and responsive to the presence of people, will be given greater attention.

Displays to Expand and Collaborate

Our displays will become even larger and in some cases curved, with higher definition allowing us to display larger amounts of data with higher resolution, which we'll be able to see from farther away. We can display more than P&ID-based and physical process graphics to help operators deal with Big Data and abnormal situations by providing rapid access to information without having to navigate screens for improved situation awareness. It is reasonable to assume that operators will interact with the control system by talking (using natural language processing and Bluetooth technology), as well as hand gestures, touch and the traditional pointing device and keyboard.

Using large edgeless displays, we can now build movie theater- or wall-sized panels. For example, Saudi Aramco has installed a wall of video 67 meters (220 ft) long by 3 meters (10 ft) tall with 150 screens by Barco—in its Operation Coordination Center. It serves as a nerve center for all Saudi Aramco operations and can display all their operational data. Shades of full graphic panels!

Currently available displays embedded in tables, such as the ABB 3D KPI dashboard, have horizontal or a vertical modes of operation and can be used as collaborative workstations. Microsoft is introducing an 84-in., 4K Surface Hub with state-of-the-art digital whiteboarding that could be used as a collaborative workstation in the control room and conference rooms.

Clouds Work Better with Fog

Cloud computing refers to remote, public Internet- or private intranet-based virtual servers where application software and data may reside rather than in local computers. These applications may share resources and provide redundancy (dedicated and just-in-time). Some of this represents virtualization of local hardware, e.g., control functions in the cloud while I/O is local. Cloud computing for process control would have process control applications, other virtualized control functionality and data residing in the cloud.

Issues of privacy, security and reliability will delay the adoption of this technology, even in local clouds. Still, some cloud-based DCS products are appearing, such as the Invensys Industrial Cloud Historian, designed to deal with big data.

The cloud, in any case, will probably hold the key to the next generation of DCS/SCADA. Of interest in this area is

XXXXXXXXXXXXX

PARKINSON'S LAW AT WORK

Figure 1. A corollary of Parkinson's Law says, "Data expands to fill the space available for storage." As sensors become cheaper and smarter, we have become data-rich, but information-poor and risk being overwhelmed by the quantity, velocity, noise and uncertainty in the data.

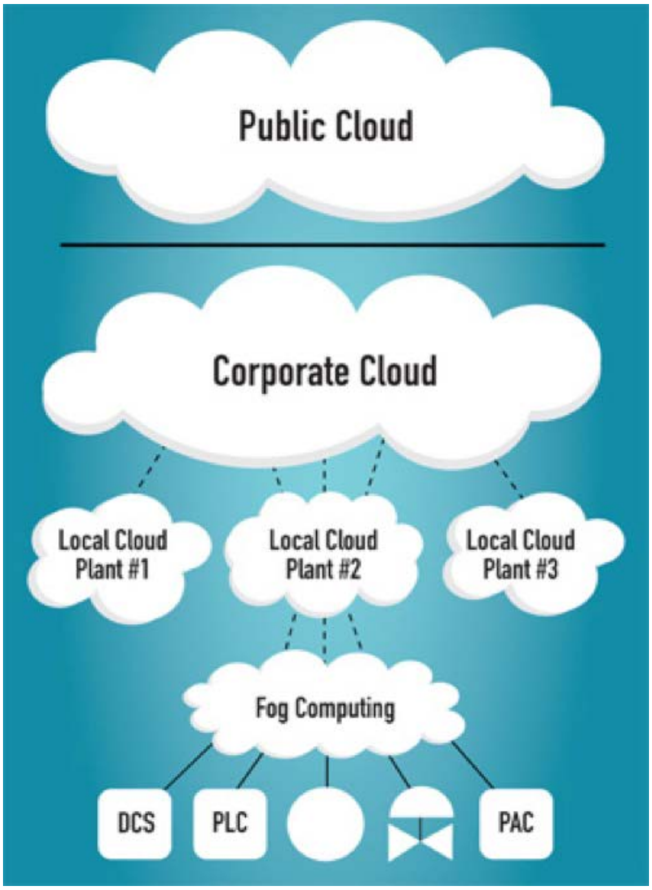
the Architecture for Service-Oriented Process (IMC-AESOP) project (http://www.imc-aesop.eu/), whose goal is developing the next generation of SCADA/DCS systems. The plant and corporate IT side will likely adopt this long before the control people.

Our ability to store information also has risen exponentially and the cost of memory has come down tremendously. In 2004, the cost of a megabyte of storage was about \$0.175; in 2014 it was \$0.0085, a reduction of 95%. Moore's Law predicts that memory costs will continue to fall.

On the other hand, one of the corollaries to Parkinson's Law is, "Data expands to fill the space available for storage." Sensors are becoming more pervasive and cheaper as well smarter, offering more data. Digital bus communication will become the norm even within legacy systems. Wireless is expanding, allowing instruments to be placed in many heretofore unavailable locations, powered by batteries or by power harvested from the environment.

We cannot leave out the final elements, where increased diagnostic data has become available. Video cameras and other sources only compound the problem of overflowing data. For example, a plant with just 300 tags, each transmitting just one measurement per second, generates more than 9 billion data points in a year. For the operator, engineer, manager or control system, having all the necessary data to make decisions is great and desired, but there's no such thing as a free lunch. With this big flood of data, we have become data-rich, but information-poor, and can be easily overwhelmed by the quantity, velocity, noise and uncertainty in the data. It's a lot like the old joke about the dog that chases cars—what would he do if he caught on one? We risk putting our operations in a similar situation (Figure 1).

This is where the cloud and data analytics come in. The common definition of cloud computing—using a network of remote servers hosted on the Internet—is too simple for the process industries. We are averse to using the Internet to store proprietary company information, and concerns about cybersecurity, reliability, safety and liability are big issues. Our more likely configuration resembles a cloudy day, where multiple external clouds use the public Internet, private corporate clouds use the company intranets, and local plant clouds, each providing cloud computing functions at their level, share applications, computing and memory resources as needed to provide data analytics on demand and dynamically.



HIGH PROBABILITY OF FOG

Figure 2. Rather than the cloud of commercial computing, industry will prefer a set of private, corporate clouds, with a "fog" level near the local control systems and instrumentation to ensure speed, support mobility and enable local control.

In addition, as has been proposed by Flavio Bonomi, et.al., Cisco Systems, in their paper, "Fog Computing and Its Role in the Internet of Things," we need a "Fog" layer with low latency, location awareness, widespread geographical distribution, mobility, a very large number of nodes, predominant wireless access, a strong presence of streaming and real-time applications, and heterogeneity. This concept is shown in Figure 2.

Data Analytics Poised to Explode

Data analytics is the science of examining or analyzing large, small and sparse quantities of raw data with the purpose of drawing conclusions, finding relationships and converting the data into useful information. Data mining is an example of this. Data predictive analytics extract information from existing large data sets to determine patterns and predict future outcomes and trends.

ANALYTICS TURN DATA INTO INFORMATION

Figure 3. Once analytics have massaged, manipulated and crunched the data, and analyzed, collated and organized the information, they must present it to the operator. Here, Honeywell's MAXPRO VMS analyzes and prioritizes video to support safety and security.

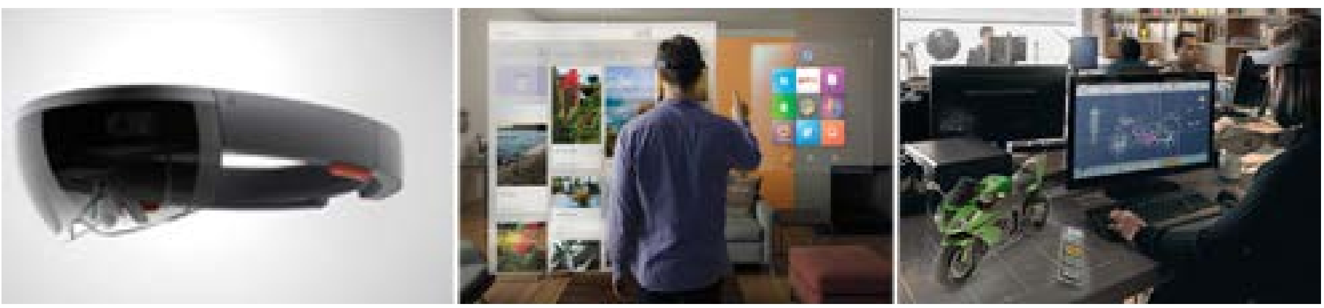
Data analytics will be used to take the Big Data in the fog and/or cloud and extract useful information for plant operators, engineers, supervisors and managers, as well as people at the enterprise level. Data analytics also will be used to analyze video for security and safety, in collaborative operations and in support of artificial intelligence applications and operator on-line and personal advisors.

Data analytics are already available—one example is Honeywell's MAXPRO VMS for safety and security (Figure 3)—but wider use is expected when the flood of data begins to overwhelm the existing systems. Once the data analytics have massaged, manipulated and crunched the data, and analyzed, collated and organized the information, they must present it to the operator or other plant personnel using graphics and visualization tools. Processing speed will be of the essence where real-time information is required.

AI beyond Siri

We've become familiar with artificial intelligence (AI) in the form of smart, virtual personal assistants (SVPAs), which entered the market in 2013. Examples include Apple's Siri and Microsoft's Cortana—software agents that can perform tasks or services for an individual. In process control, operator SVPAs will be more sophisticated, with an inherent understanding of the process, the operating context, the operating environment (using plant historical database), operator preferences and practices, data analysis, case-based reasoning and the ability to learn and remember. It is reasonable to expect that an operator can have such a mobile personal assistant, as well as more sophisticated plant digital advisors with more capability and a larger knowledge base, all connected through the local cloud or fog. IPSoft's Amelia software might serve as a prototype for such a personal assistant or plant advisor.

Artificial intelligence will be increasingly embedded in the process control world. It's currently in limited use, typically due to past failures and support issues (and support will still be an issue in the future). Some model-predictive, multivariable control may have an AI-based model or use AI and collect data to create a dynamic model. Fuzzy logic is already in use, and the future should bring self-aware sensors and control systems that automatically determine their relationship to variables and control loops, understand the effects of disturbances, be goal-orientated, spot and analyze



PREPARE TO SEE YOUR REALITY AUGMENTED

Microsoft's HoloLens augmented-reality goggles merge the physical world with virtual reality by projecting holograms into the user's view of physical space. The holograms may be of three-dimensional objects, a virtual physical space or operator displays.

A built-in camera, computer, lenses and microphone enable the goggles to place the holograms appropriately in the operator's view of real space, and allow the operator to manipulate them via gesture, voice and gaze. Holograms also may be pinned in place so operators can move around them or through a virtual landscape.

According to Wired magazine, HoloLens will be introduced this year to developers and commercial partners, who will create applications and help Microsoft refine its design and performance. When its performance and value are proven, you might expect to start seeing it in control rooms and on the plant floor as a tool for engineering and operator interface, equipment maintenance and more.

patterns, do case-based reasoning, know the past and project the future as well as a human being.

More Help for Operators

Many people feel that the operator is the weak link in the control system, which is another way of saying the human factor is the weak link in the whole system. Warren G. Bennis (1925-2014) proposed that, "The factory of the future will have only two employees, a man and a dog. The man will be there to feed the dog. The dog will be there to keep the man from touching the equipment." It is doubtful that the role of the operator will be diminished in the near to intermediate future, as they are the primary element that provides resilience (flexibility) in the system, but a long-term trend is there.

Inexpensive computing power and memory, and advances in computing technology have made virtual reality (VR) more technically feasible. The Oculus Rift, a head-mounted VR display, so interested Facebook that it shelled out $2 billion for the company. It seems unlikely that operators will be wearing a one-pound set of goggles all day long and living in a virtual world (though the goggles have cameras that allow you to "see through" to the real world). There may be short-term activities where VR will excel, such as in collaborative efforts in engineering or with people who are in remote locations, during data visualization or interacting with virtual objects within the control system.

The next new technology is Google Glass, a form of augmented reality where a view of a physical, real-world environment is augmented by computer-generated sensory input such as text, sound, video or graphics to provide additional information. Google Glass's basic technology has been around for awhile, but the packaging and capabilities are new. It has the potential to provide operators with a continuously available heads-up display of important data and additional information on demand.

Google Glass exploded on the scene in 2012 with a large fanfare, but was recently pulled off the market. It appears

that Google released it before its time to the wrong people for a stiff price and, like a turtle with problems, it has withdrawn its head back into a shell of secrecy. The Google Glass website says, “The journey doesn’t end here,” and has a place to sign up for updates, so stay tuned.

Microsoft recently announced its answer to Google Glass, called HoloLens, which will be bundled with Windows 10 for release to developers this year. (See sidebar.) This device has the potential to revolutionize the operator interface by providing data visualization and a collaborative operating environment for operators, engineers and corporate experts, as well as trusted third parties and vendors. It will allow engineering and maintenance to easily access system drawings, equipment manuals and specifications; to have third-party or vendor assistance in troubleshooting and repair; and to visualize design activities and perform virtual design tasks and modeling. It is unlikely that standard displays will be replaced by the HoloLens, but the technology can help operators deal with Big Data, alternate visualization of process data, virtualization, video data and collaboration.

Safety Systems to Get Proactive

Today’s safety systems are typically reactive, based on safe operating constraints; e.g., they react when a variable or condition reaches a critical point. In the future, we will see more use of predictive (anticipatory) safety systems to complement the reactive system. These systems may be hardware/software based or may be virtual in nature. They will be able to look at a wider range of variables, their properties and plant history to detect emerging faults and developing patterns and conditions to track and predict developing hazards before the critical limit of the reactive safety system is reached to “head them off at the pass” (predictive) while still guarding the pass (reactive).

Predictive data analytics and artificial intelligence such as expert systems and artificial neural nets (ANN) will be used to catch incipient and degraded conditions, and alert the operator to developing hazards. Systems will be able to detect degraded process equipment or operating conditions that might move a process closer to the safe operating constraint line, giving the operator an early warning. Big, small and sparse data analytics can be used to dynamically identify, online and in real time, when a system is approaching the cusp point of an incident, much like a surge controller identifies approaching the surge line.

Cybersecurity: The Killer App

New control system growth will be constrained by cybersecurity concerns. Users will expect cybersecurity to be built in, not just added on. While it will retain its reactive nature, cybersecurity will also become predictive, based on artificial intelligence, and will use data analytics, case-based reasoning, cognitive functionalities and other AI methodologies to prevent access, detect and block or eliminate intruders, learn from its mistakes and the mistakes of others, find system vulnerabilities, and eliminate or place roadblocks to intruders.

It’s hard to predict the future, but it’s clear that a number of emerging technologies—augmented and virtual reality, artificial intelligence, cloud and fog computing, and data and predictive analytics—are poised to change the industry.

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How the DCS has spread into every aspect of factory control

For 25 years, we've watched in wonder the progress of our most powerful systems

By Paul Studebaker

In 2015, the distributed control system (DCS) will mark its 40th anniversary—40 years since the first Honeywell TDC-2000 beta-types were installed at Exxon's Sarnia, Ontario, refinery, and Yokogawa introduced its version, CENTUM. By 1980, Bailey (now part of ABB) introduced the NETWORK 90 system, Fisher Controls (now part of Emerson) introduced the PROVoX system, and Fischer & Porter (now also part of ABB) introduced DCI-4000.

During this period, the DCS swept alternative process control technologies from the field. "In the late 1970s, market analysts projected the decline of analog control, but no one anticipated the speed or completeness of this transformation," wrote Terry McMahon in April, 2005. "At least two generations of process control engineers have matured during the DCS era, which has endured much longer than earlier technologies."

Honeywell had been working on a dedicated digital loop controller since 1969, but the problems of reliability and cost seemed insurmountable. The emergence of the integrated-circuit microprocessor in the early 1970s solved these problems. The Intel 8080, announced in early 1974, was the breakthrough event enabling multiple control loops to be handled with a single microprocessor.

At the time, "Foxboro's analog controllers were generally considered the class of the industry," McMahon wrote. "The SPEC 200, announced in 1972, was the high-water mark of analog electronic technology, and ISA's 4-20 mA standard [SP50] was approved in 1975 just as this technology was being rendered obsolete by digital controllers."

In the 1980s, users began to look at DCSs as more than basic process control. If proprietary systems were opened, data could be shared and greater things could be achieved. This led to adoption of UNIX operating systems and Ethernet-based networks. The full TCP/IP standard was not implemented, but using Ethernet allowed object management and global data access.

PLCs were integrated into the DCS infrastructure, and plant-wide historians emerged to capitalize on the extended reach of automation systems. The first DCS to adopt UNIX and Ethernet networking technologies was Foxboro's I/A Series.

The 1990s saw increased adoption of commercial off-the-shelf (COTS) components and IT standards, and the controversial move from UNIX to Windows. Even today,

the real-time operating system (RTOS) for control generally remains on variants of UNIX or proprietary operating systems, but above that, applications tend to be based on Microsoft systems.

As the DCS became increasingly network-centric, many suppliers built new "process automation systems" from the ground up to maximize functionality with Ethernet and fieldbuses. These include Rockwell Automation's PlantPAx, Honeywell's Experion, ABB's System 800xA, Emerson's DeltaV and Siemens' Simatic PCS 7.

Since the inaugural issue of Control magazine in October, 1988, we've made the DCS the center of our process control coverage. Over the past 25 years, we've described how DCS has evolved from distributed control with centralized microprocessing, to "truly distributed control" with centralized supervision of microprocessors in the field, to today's rise of virtualization, where critical and non-critical functions coexist in servers (or even the cloud). Control, safety, supervisory, historian and business functions are increasingly distributed as needed in network-based architectures across field devices, controllers, thin clients, central processors and the Web.

With increasingly inexpensive and standard COTS hardware and operating systems, the heart of the DCS is moving from equipment to software and services. Applications now include production management, model-based control, real-time optimization, plant asset management (PAM), real-time performance management (RPM), alarm management and more. Indeed, much of today's most exciting activity is in wireless networks, mobility, remote access, business optimization and real-time decision-making, which largely run on hardware that's independent of the DCS.

The words we used in 2013 to describe the latest permutation of the original DCS, Honeywell's TDC 2000, sum up the best of today's systems: "You'd think a DCS as useful and successful as Experion PKS Orion R2 might stop for a well-deserved break, or at least pause to catch its breath and allow its many fans to catch theirs," wrote Jim Montague. "But that's just not how its developers operate. Together, they just keep churning out an unrelenting stream of improvements, capabilities and innovations, until it seems like there's nothing that Experion can't do—and maybe that's the point."

Paul Studebaker is chief editor of Control.