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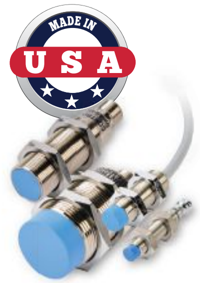

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From Digital Transformation to Business Agility

By Renee Bassett, *InTech* Chief Editor

Digital transformation—the integration of digital technology into all areas of a business to fundamentally change how it operates and delivers value—is a profoundly important concept for industrial businesses. It has been for years, and it remains a key enabler of a change in corporate culture that seems to suddenly have a new name: business agility.

You can thank software companies and IT departments for popularizing concepts like “the agile workplace,” “sprints,” and “a minimum-viable product (MVP) mindset.” Management consultancy McKinsey & Company calls agility “the greatest change in approach for a generation.” Buzzword hyperbole aside, automation engineers are probably already being agile as they make operational improvements, enhance run activities, contribute to long-term planning, and augment important safety standards.

Agility is a method of continuous improvement, a way of getting things done that removes friction or obstacles to the core processes. Agile also is lean. “Lean and agile ways of working complement each other, and the magic is in the combined recipe from both,” according to a recent essay by McKinsey on agility in heavy industries. “[B]oth systems have been successful across a range of environments, and both share a similar set of foundational objectives: transparently connect strategy and goals to give teams meaningful purpose; discover better ways of working to continually learn and improve; deliver value efficiently for a customer; and enable people to contribute and lead to their fullest potential.”

When run together, say the authors, “lean processes bring the holistic view and basic principles, while agile processes bring the flexibility of short-cycle implementations (sprints) for continuous improvement. The lean approach tends to be more applicable to continuous improvements, providing directions or outside-in solutions to the value stream as part of the daily operational routine. The agile approach can bring the alignment and transparency of objectives to combine the expertise from the shop floor with short-cycle improvements.”

Leading companies are applying both lean and agile thinking to use digital technology to quickly improve both operational efficiency and business outcomes. McKinsey cites detailed examples of agile thinking and working practices at bp and at Freeport. Last month’s InTech cover story described the ARC Advisory Group’s “Digital Transformation Top 25,” the consultancy’s list of agile companies that have shown substantial progress in transforming their cultures.

ARC’s top five companies are Tesla, Intel, BMS, Johnson & Johnson, and 3M. The community will be celebrated at ARC’s 26th annual Industry Forum, postponed from February and now being held 6–9 June in Orlando. Petrobras, another digital transformation leader, will be sharing its challenges and successes at a new ISA-created virtual event, Digital Transformation—Brazil on 29 March.

McKinsey advocates “the value of being agile as distinct from doing agile” and encourages developing “a shift of mindset from certainty to discovery, control to collaboration, and scarcity to plenty.”

Is that a transformation you and your company have taken on? Talk to me about it via rbassett@isa.org. ■

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A Mouse, a Cookie, and OT/ICS Asset Inventories

By Rick Kaun

ABOUT THE AUTHOR

Rick Kaun is VP solutions of Verve Industrial. He is an OT cybersecurity thought leader, evangelist, advocate, and solution provider with more than 20 years in the identification, development, and provision of all sizes and shapes of security programs.

Many industrial organizations seek an accurate asset inventory within their operational technology/industrial control system (OT/ICS) environments. But what should an OT/ICS asset inventory include? The answer depends on the objective. The common phrase used is "you can't protect what you can't see." But this phrase and many inventory efforts miss the fact that an asset inventory should be the foundation upon which the whole ICS cybersecurity program rests.

In contrast to an asset inventory that provides a one-time or infrequent list of hardware, a robust foundation for OT/ICS security requires real-time visibility into all of the hardware, software, and firmware in your network, all of the users, accounts, patches, vulnerabilities, network device configurations, Windows settings, embedded device backplanes, and the status of various security elements such as application firewalls, whitelists, and antivirus software.

In information technology departments, security practitioners are used to having robust asset information because of the many tools available to gather it. They use this data as a foundation of security in the following ways:

- patch management, which is impossible without a comprehensive software inventory
- secure configurations, which are essential to security
- robust recovery processes, which require visibility into the backup status of each device to ensure it is recent and accurate.

In OT/ICS departments, however, users typically do not have the tools to gather and maintain such an inventory. As a result, OT/ICS cybersecurity programs have historically relied on perimeter defenses and passive detection of anomalous events. Without comprehensive asset inventory management, OT organizations do not know the true security status of their environments and cannot conduct effective security management at scale.

Each step of security builds on the last. A robust asset inventory is the foundation upon which the whole ICS cybersecurity program should rest.

The situation reminds me of the children's book, *If You Give a Mouse a Cookie*. It is a fanciful tale of a boy and his pet mouse. The boy gives his mouse a cookie, which leads to the mouse wanting a glass of milk. The mouse wants to make sure the milk did not give him a mustache, so he asks to look in the mirror, which turns into a need for a trim. There is a series of things the mouse wants next until he is reminded again of milk, and then asks for another cookie.

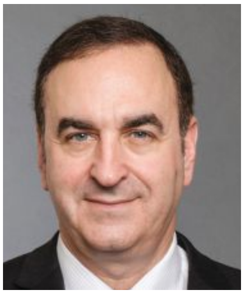
A cybersecurity program is very much like giving a mouse a cookie. For example, if you start with a basic asset inventory to understand what you have, your next step is to gather vulnerability data about that inventory. The vulnerability information tells you to patch, which is not always possible in OT environments, so you will ask to see a report on compensating controls for those unpatched assets. But those compensating controls are always backstopped by the OT safety net—a full backup or restoration point. Now you realize the asset inventory view needs to include plans for restoration and recovery, bringing you back full circle to where you started. All the while, the world and the cyberrisks within it continue to evolve, which means the introduction of new vulnerabilities.

When a new vulnerability is discovered, you rely on your asset inventory to determine how many ICS assets are in scope for this risk, how many can be safely patched, and how many vulnerabilities can apply compensating controls. If there are too many nonpatchable assets, you will soon be asked if upgrading the assets is possible. The answer is yes, but how do you decide which assets to upgrade? ■

A version of this article appeared in January 2022 on Automation.com.

Power Versus Energy When Designing Smart Wireless Devices

By Sol Jacobs



ABOUT THE AUTHOR
Sol Jacobs is vice president and general manager of Tadiran Batteries. Jacobs has more than 30 years of experience in powering remote devices. His educational background includes a BS in engineering and an MBA.

Battery-powered solutions for industrial-grade wireless devices need to be intelligently designed to minimize size and weight without compromising overall performance. This objective is especially important if the industrial-grade wireless device needs to operate for extended periods in remote locations or extreme environments.

Certain applications permit design engineers to think short term and choose a low-cost battery that reduces the initial purchase price. Conversely, if a remote application requires a long-term power source to reduce the total cost of ownership, you need to apply a far different calculus.

Battery power is a measure of short-term energy consumed. This term should not be confused with the cell's total amount of energy or nominal capacity. Certain types of devices require high amounts of power (high pulses) for short bursts without exhausting a large amount of total energy. These applications include surgical power tools that operate for minutes, cells that actuate an electromechanical device, and military applications that draw large amounts of energy for limited periods (i.e., guided munitions).

Such specialized applications are not well served by ordinary battery technologies that cannot deliver a high power-per-energy ratio. Such specialized requirements could demand more and larger cells to compensate for their low pulse design. This often leads to a compromise solution of using larger or more cells with unused energy capacity. One alternative is to use lithium metal oxide batteries that have a very high power-per-energy ratio.

High pulse requirements

The Industrial Internet of Things is increasingly reliant on remote wireless devices that require high pulses to power two-way wireless communications. Alkaline batteries are ideal for delivering high pulses due to their high-rate design. However, they have major limitations in industrial applications, including low voltage (1.5 V), a limited temperature range (0°C to 60°C), a very high self-discharge rate that shortens their life expectancy, and crimped seals that may leak. Alkaline batteries often need be replaced every few months, making them totally unsuited for long-term deployment in remote locations.

Standard bobbin-type LiSOCl2 battery chemistry is overwhelmingly preferred for low-power remote wireless devices. The major drawback of this chemistry is its inability to deliver high pulses, as it can experience a temporary drop in voltage when first subjected to a pulsed load—a phenomenon known as transient minimum voltage (TMV).

A way to circumvent TMV is to use a battery that combines a standard bobbin-type LiSOCl2 cell with a hybrid layer capacitor (HLC). The battery and the HLC work in parallel—the battery supplies low-current background power in the 3.6- to 3.9-V nominal range, while the single-unit HLC delivers periodic high pulses to power two-way wireless communications. The HLC also has a bonus: a unique end-of-life voltage curve plateau that can be interpreted to generate low-battery status alerts.

Supercapacitors are commonly used to minimize TMV in consumer electronics but are ill-suited for most industrial applications due to drawbacks like bulkiness, a high annual self-discharge rate, and an extremely limited temperature range. Moreover, when multiple supercapacitors are combined, they require expensive balancing circuits that add expense and draw additional and greater current to further shorten battery life.

Industrial-grade Li-ion rechargeable cells

If your low-power application draws enough energy to prematurely exhaust a primary (non-rechargeable) lithium battery, then it may need an energy-harvesting device in combination with a rechargeable lithium-ion (Li-ion) battery. Consumer-grade rechargeable Li-ion cells have limitations for industrial applications, including a maximum battery life of roughly five years and 500 full recharge cycles, a narrow temperature range with no ability to discharge or recharge at extremely cold temperatures, and the inability to generate the high pulses needed to power two-way wireless communications. ■

Our Cobot Co-workers

By Lynn DeRocco

ABOUT THE AUTHOR

Lynn DeRocco (lderocco@automation.com) is a content editor for Automation.com. She is a journalist and digital media specialist with an MA in communication from Rutgers University.

Cobots, shorthand for collaborative robots, are coming to a factory near you, if they are not there already. These autonomous helpers are designed to work alongside humans to increase production, and to do so safely. But amid concerns that they will eliminate human jobs, cobots are now being promoted as a sort of compassionate technology. For instance, on a recent *Cheddar Innovates* broadcast, Tom Bianculli, chief technology officer for Zebra Technologies, said that cobots can reduce the miles walked by a warehouse worker from 12 or so miles a day to about three miles. He stated that using cobots could be about "having empathy for that worker, increasing their job satisfaction, and improving efficiency of the operation all around—a win-win."

So, it seems that the future of humans collaborating with robots is meant to be one that workers feel good about, not threatened by. In factories, warehouses, and distribution centers, they are being used to literally lift the load that employees have had to carry. "A robot can do what it does best, which is transport, the movement of goods, and the human worker can do what it does best, which is the articulation, the actual picking of goods," said Bianculli.

The goal is "deploying those technologies together, where the robot can autonomously navigate an environment and [a worker is] able to take a picked order, put it in a bin, and then bring that over to where it needs to be shipped," he said.

Of course, like human workers, cobots come in a wide range of types, and they will be able to do more complex tasks with new innovations, especially in conjunction with other available platforms and technologies. A perfect example is what we are seeing in the medical field—cobots being specialized for medical instrument manufacturing while patient care is left to medical professionals, with their education, expertise, and ability to make critical, informed decisions.

Bianculli's position corroborates this: "One statistic says 50 percent of work can be automated, but less than 10 percent of jobs can be automated more than 90 percent." He adds that while tasks within a workflow can be automated, automating a complete workflow end to end is not likely.

When asked about the outlook for cobots in the manufacturing and logistics markets, Bianculli cited three factors that contribute to their adoption:

- shortage of labor
- creation of new types of cobots
- "need for speed."

One statistic says 50 percent of work can be automated, but less than 10 percent of jobs can be automated more than 90 percent.

Bianculli said "94 percent of retailers will invest to help drive automation to meet the expectation of customers" at the "velocity at which consumers expect things to be delivered." That bodes well for the greater adoption of cobots in factories and distribution centers and provides hope for easing supply-chain constraints.

Like human workers, "upskilling" is possible for these types of co-workers, too. Robots are becoming smarter every day thanks to advances in technologies such as machine learning and artificial intelligence. As new cobots are designed to perform additional functions, factories and plants will have few reasons not to invest in them, and employees will likely come to appreciate the helping hands, even if they are robotic. ■

Automation Development: Change the Industry, Not Just Your Company

By Sandy Vasser

ABOUT THE AUTHOR
Sandy Vasser (http://www.linkedin.com/in/sandy-vasser-9699528b), retired IC&E manager from ExxonMobil, has 38 years of experience in the upstream oil and gas industry with an emphasis on design, construction, commissioning, operation, and maintenance of automation and power facilities.

A company can take several different approaches when developing new automation technologies related to purchased production equipment. But all approaches are not created equal. Automation is not a core technology for most businesses, meaning most companies do not design and manufacture automation systems. However, automation is a very important and necessary tool for any company that depends upon an automated process to manufacture or produce its final products. The intellectual property (IP) related to the development of automation is a valuable asset that can change not only one company, but an entire industry.

My experience is in the upstream oil and gas industry. Before my retirement, I led a team of instrumentation, control, and electrical professionals within ExxonMobil Upstream. We partnered with our suppliers and engineering firms to develop new enabling technologies and project delivery practices and procedures for capital projects. Here is what I learned about the advantages and disadvantages of three approaches to automation project development:

- Approach 1: Owner works with a single supplier and develops new technologies specifically for internal company use only. The owner owns the IP or shares the IP with the single supplier. The owner decides whether to only use the technology internally to achieve an advantage over its competition or to sell the technology for others to use. In the latter case, the technology is typically sold to users who are not direct competitors. This is a very exclusive approach that brings changes to only the single owner's company or the few companies that purchase the technology.
- Approach 2: Owner works with a single supplier and develops technologies that the single supplier can sell to its other clients. The single supplier owns the IP.
- Approach 3: Owner works with all the suppliers that can develop the technologies, and all the suppliers can sell the developed technologies to all their clients. Each supplier owns the IP for the specific technologies it develops. This is a very open approach that can bring changes to multiple industries.

The competitive advantage comes from how it is applied, how broadly it is applied, and how the technology is integrated with other related systems.

Pros and cons

Each approach has advantages and disadvantages. Approach 1 can and has been very beneficial to companies with large automation staffs. They can develop technologies that only they can use, and these technologies can and have provided strategic advantages over their competition. However, there are downsides.

First, the single supplier that is manufacturing the technology will only be selling this technology to one client. That gives the supplier little financial incentive to develop a low-cost solution, to develop and maintain expertise on the technology, to sustain the technology, and to continuously improve the technology. Typically, the user or client must develop the expertise in-house to sustain, maintain, and improve the technology. The user may also have to develop internal expertise to deliver the technologies to all its new facility projects. Lastly, the single user does not learn from the experiences of others using and improving the technology.

Companies that routinely develop technologies this way must continuously grow their automation organization to support all their exclusive technologies. This results in a continuously growing automation organization that depends upon an aging workforce for the technologies not supported and sustained by the single supplier.

In the case of approach 2, the supplier can sell the technology, but has no competition in developing and manufacturing the technology. Competition provides an incentive to lower the cost of development and manufacturing, and also to accelerate the development of the technology.

With approach 3, a company may lose some competitive advantage by not having exclusive use of the technology, but it realizes a number of other benefits. First, with all the possible suppliers developing a version of the technology, competition is maximized. This competition accelerates the development of the technology.

It also ensures the lowest possible price for the technology. Second, the technology becomes an industry technology that will be sustained, cost effectively maintained, and continuously improved by the manufacturers and not the users. Lastly, with multiple users, all user companies benefit from the collective experiences.

The competitive advantage of a technology does not come from just having the technology. The competitive advantage comes from how it is applied, how broadly it is applied, and how the technology is integrated with other related systems. A company can have the technology but not use it properly, not use it broadly at all facilities, or not fully integrate it within its systems. A technology can be an industry solution, but only a few companies may fully benefit from the solution.

Approach 3 in practice

I can give a real-life example of the benefits of approach 3. For decades since the beginning of project work, project teams have dealt with the historical ways that automation systems were installed. The historical ways included marshalling cabinets to separate field wiring from the wiring connected directly to automation I/O and controller cabinets.

Historically, all junction boxes, marshalling cabinets, I/O cabinets, and controller cabinets were individually designed such that no cabinet or junction box was identical. For a large facility, there could be 500 cabinets and junction boxes related to the automation system that had to be engineered and manufactured separately. Every time a change occurred—such as the addition of a single instrument loop—literally hundreds of drawings had to be changed to reflect the simple addition.

For smaller projects, this approach was acceptable or at least tolerable. For large, megaprojects, this approach was unacceptable. It created many delays from the almost unending changes, demanded adding resources to support the number of changes, extended the project schedules, and dramatically increased the cost of the project. Simply perfecting this historical approach or using the very best engineering contractors and suppliers would not fully mitigate the historical problems. Totally different technologies and approaches to executing projects were absolutely necessary.

The group I managed before I retired wanted to challenge *all* the historical methods to deliver automation for major projects. Rather than developing proprietary solutions only for our company, we felt we needed to change the industry. We wanted the solutions to be adopted by all our automation suppliers, including ABB, Emerson, Honeywell Process Solutions, Schneider Electric, and Yokogawa. We also wanted all the engineering, procurement, and construction (EPC) firms to adopt and perfect the execution of the new solutions. The only way to do this was to change the way all participants in oil and gas projects delivered the projects.

Incentivizing suppliers

We engaged all the automation suppliers, defined in detail all the historical problems with delivering automation for major projects, and encouraged them to develop the necessary solutions with one prerequisite: the solutions developed could not be ExxonMobil-only solutions. The solutions developed had to be products that could be sold to all the supplier's clients. Because we created a very competitive environment and the market for the new solutions was all industries that relied upon automated processes, all the suppliers were incentivized to develop the necessary solutions in an expedited and cost-effective manner.

Every one of the suppliers developed a version of universal I/O, eliminating the need for marshalling cabinets. They developed completely standard and smart field junction boxes and standard control cabinets that could all be ordered with a part number and mass produced for a project. They developed virtual commissioning of complete systems, eliminating the need for staged checkout of systems, and they developed automatic commissioning tools.

All these technologies and tools are now used by thousands of companies that are clients of each of the suppliers. These were truly industry-changing technologies and delivery methodologies. ExxonMobil benefited greatly, because all automation suppliers and almost all EPCs used by ExxonMobil have adopted them.

Clearly, approach 3 is not a one or the other decision by companies when it comes to automation projects. Many different approaches can be used by a single company depending upon the technologies and the applications involved. However, my personal opinion is that developing industry-changing solutions has a lot of immediate and long-term benefits, and the exclusive use of proprietary technologies should be limited to select core applications and technologies. ■

Automation Standards Still Need Work

By Bill Lydon

ABOUT THE AUTHOR
Bill Lydon is an *InTech* contributing editor with more than 25 years of industry experience. He regularly provides news reports, observations, and insights here and on Automation.com.

Can another standards war be avoided with exciting new industrial multivendor interoperability and plug-and-play standards? With a growing number of standards to support industrial digitalization, perhaps the automation industry is mature enough to avoid the "fieldbus wars" of the 1990s, when the proliferation of multiple industrial network standards created divergence rather than convergence.

After fieldbus networks started to appear in the 1990s, there were soon more than 20 industrial network "standards." This led to the observation, "Standards are great; everyone has their own." It has taken a long time for convergence into a handful of mainstream industrial network standards, most recently on Ethernet with distinct industrial protocols. These include EtherNet/IP, Profinet, and EtherCAT. Native multivendor interoperability is still not possible, but the developing OPC Foundation Field Level Communication initiative has the potential to solve this issue for users.

During an October 2021 press conference about the 2022 Hannover MESSE trade fair, Gunther Kegel, PhD—and CEO of Pepperl+Fuchs, vice president of VDE, and president of ZVEI—discussed the importance of standards and semantic data models used for Industry 4.0 and industrial digitalization. He expressed concern about the proliferation of multiple competing standards. I asked Kegel about achieving worldwide adoption and cooperation given the difficulty, for years, of harmonizing basic electrical standards, such as the term "explosion proof."

Kegel said that adoption of standards now is going to be even more complicated. Electric engineering in the past was a relatively simple landscape of standardization bodies, including IEC and CENELEC. With the application of new digital technologies, he said industry now has more than 20 standard-setting organizations. The big opportunity—and biggest challenge—is organizations cooperatively working to achieve an international approach.

Kegel noted, "It is not getting easier. We see there is a tendency to come up with regional standards. China, for example, has said goodbye to the international standardization for explosion protection and has now come up with a country-specific regulation. There is a tendency to move apart for economic protection and political reasons, making harmonization more difficult. We are fighting against this by doing standards work together with other associations and synchronizing our efforts."

What's next

Industrial automation continues to lag the computing industry, which went through this transition much earlier after long-running debates known also as the "protocol wars." From the 1970s to the 1990s, engineers, organizations, and nations became polarized over the issue of which communication protocol would create the best and most robust computer networks.

Industrial automation and controls have not yet achieved multivendor plug-and-play capability, which our computer systems have enjoyed since the 1990s. Despite this lag, users are getting more involved with standards and semantic data model development, because it is essential to achieving Industry 4.0/industrial digitalization and to remaining competitive and profitable. ■

"It is not getting easier. We see there is a tendency to come up with regional standards. China, for example, has said goodbye to the international standardization for explosion protection and has now come up with a country-specific regulation."
—Gunther Kegel, PhD

Smart Instrumentation for the Digital Present

By Nathan Hedrick

Instrumentation selection for plant applications is a multistep process, requiring companies to consider process type, industry standards, approvals, sizing, and more. Although vendor experts and online applicator tools can help specify the right instrument to meet process requirements, digital data capabilities are now another topic to contemplate.

Five case studies show how diagnostic data used with multivariable process data increases process efficiency and uptime.

In today's data-centric landscape, smart instrumentation provides a wealth of diagnostic and other information, so plant staff can get more from their instruments than simple 4–20 mA process variable measurements. Plant personnel can use this information—transmitted via digital communication protocols—to improve plant efficiency and avoid unplanned shutdowns, because they are empowered to implement proactive maintenance and predictive monitoring.

Many factors can interfere with the accuracy of a traditional instrument's analog output, and operators may not know whether the 4–20 mA current signal processed by a programmable logic controller, distributed control system (DCS), asset management system, or other host system is accurate. Each circuit scales a single process value as electrical current, omitting the ability to transmit secondary variables such as temperature on a pressure instrument. Communication is one way only, so there is no way to send commands from a controller to the instrument.

Traditional analog instrumentation also lacks diagnostic information, making it nearly impossible to foresee instrument failure. These failures can cause unplanned downtime and costly instrumentation repairs in the best cases, or catastrophic equipment damage and safety hazards in the worst. Bound by analog electronics, these instruments must be hardwired to a host system, limiting placement in hard-to-reach areas of a facility, and especially in offsite remote locations.

Optimization made easy

When smart instrumentation is integrated into plant designs, facility operation and optimization become manageable tasks. Smart instruments incorporate digital communication protocols, sometimes in place of—and other times on top of—traditional analog communication protocols. This greatly increases capabilities and value.

For retrofitted and new applications where hardwiring transmitters back to a host system is convenient, instruments can use the two-way digital HART communication protocol. The protocol is superimposed on the analog current loop, so a calibration device or a host system can send and receive data. The data exchanged includes diagnostic, calibration, maintenance, and process information, increasing configuration ease and operational process insights compared to traditional 4–20 mA, analog-only instrumentation.

These HART-enabled instruments can transmit multiple process values to a controller via a single loop. This provides the flexibility to continue using existing analog loops for real-time control, while making process and diagnostic data available via HART for data-driven decisions in the facility.

Data transmission is available via many fieldbus and Ethernet-based protocols. These have many of the same benefits as HART, but typically operate at much higher speeds, so they can include much more information.

Where wired implementations are impossible or inconvenient, wireless smart instruments provide solutions via 2.4-GHz radio wave protocols, notably *Wireless*HART, WLAN, and Bluetooth. Many smart instruments have these connectivity options natively, and adapters can be added for those that do not. These capabilities can be used to create a mesh network of sensors around a plant and in the field.

*Wireless*HART and Bluetooth instruments typically send and receive as much or more diagnostic and process data as their wired HART counterparts. Although this data can bring immense benefits to a wide range of host systems and applications—such as maintenance management, asset information and health management, inventory control, and enterprise resource planning systems—many facilities do not take full advantage of what this data has to offer.

Automation systems regularly use flow, pressure, temperature, level, and other process data to monitor and control processes, but they often discard status and diagnostic data. By not using this data, facilities miss out on opportunities to optimize, simplify, and safeguard their plant operations.

When this data is ingested by intelligent plant analysis systems, facilities increase their ratio of proactive to reactive maintenance, thus reducing unplanned downtime, as well as equipment and human safety hazards. For example, instead of waiting to get an alert indicating a high-temperature condition, process data can be used to give an alert when conditions are detected that lead to this type of issue.

By integrating this diagnostic data into host systems, it can be analyzed to give advance warning of instrument failure or a troubleshooting insight in the event of failure. Because calibration and nameplate information are also internally stored in each instrument, tracking and managing assets is easier throughout plant lifecycles.

Consider the following five case studies where diagnostic data was effectively used in conjunction with multivariable process data to predict or identify failures and to increase process efficiency.

Specialty chemicals: Calibrate online

By replacing legacy flowmeters with smart instrumentation, a producer of specialty chemicals used built-in self-diagnostics and in situ verification to reduce calibration costs and process disruptions. The producer must monitor the flow of the individual components within a tank farm. Previously, the mass flowmeters used to make these measurements were manually calibrated each year. This was done by pumping a defined quantity of product from a tank into a rail tank car and validating the weight.

For each of the 19 mass flowmeters installed, plant personnel were required to take a tank offline, fill a rail tank car, weigh it, drain it, and often dispose of the product, amounting to planned downtime and waste. The exercise also carried operational risk for personnel executing the chemical transfers.

By installing Coriolis mass flowmeters with self-diagnostic technology (figure 1), the producer eliminated the time-consuming and risky annual manual calibration, replacing it with in situ verification and documentation of each measurement point, without interrupting the process. The self-diagnostics provide insight on instrumentation and process health, reducing manual diagnostic and maintenance effort and increasing profit margins and personnel safety.

Life sciences: Trust the temperature

A pharmaceutical supplier replaced its steam-in-place (SIP) process temperature sensors with smart instrumentation to increase process accuracy and automate calibration. To maintain high quality and control risks in bioproduction, frequent instrumentation calibration is critical. However, calibrating the old temperature sensors required great manual effort

Figure 1. For specialty chemical manufacturers, Coriolis mass flowmeters with self-diagnostic technology support in situ testing and verification. (Shown: Promass F 300 with Heartbeat Technology)

and frequent downtime. By upgrading to self-calibrating temperature sensors (figure 2), the supplier eliminated these costs and roadblocks to production.

Because processes are highly controlled in the life sciences industry, the supplier underwent validation over four months, using a buffer tank in its bioprocess plant to prove instrumentation accuracy. The new sensors reliably performed automated inline self-calibration at 118°C (244°F) during each SIP process, reporting any deviations to the DCS via the HART protocol. The instrumentation upgrade improved process accuracy, with the average deviation of 0.03°C (0.05°F) during validation outperforming the maximum permitted error of a standard Pt100 (100-ohm platinum) class AA sensor by a factor of 10.

These sensors give the supplier early detection of temperature drifts, straightforward visual monitoring with an LED display, fully automated and traceable storage of the last 350 calibrations, and short calibration intervals. These functions reduce the risk of incorrect temperature measurements during SIP, directly preserving high production quality.

Figure 2. For life sciences manufacturers, self-calibrating temperature sensors eliminate manual calibration downtime by self-checking during every SIP operation. (Shown: iTHERM TrustSens)

Figure 3. Coriolis flowmeters handle the viscosity fluctuations of nitrogen processes and can wirelessly transmit multiple process values and instrument diagnostic data via HART, *Wireless*HART, and Bluetooth. (Shown: Proline Promass I 300)

Nitrogen processes: Multivariable accuracy

In the pursuit of a more cost-effective flow measurement technique, a nitrogen services company specializing in the hydraulic fracturing industry standardized on Coriolis flowmeters to accurately measure non-Newtonian fluids. Accurately measuring the flow of these fluids is difficult due to their viscosities, which fluctuate with the changing shear rate. This same characteristic makes accurate measurement important. If equipment is not properly adjusted to the current viscosity before pumping fluid and frac gel down a wellbore, it can cause product, environmental, or personnel harm.

The company's previous method of compensating for viscosity fluctuations involved a manual measuring process. Although workable, it required intense attention to detail. Operators obtained manual samples every 10 minutes and ran multiple tests to gauge the viscosity measurement and maintain exact product quality.

Because the Coriolis measuring principle operates independently of physical fluid properties—like viscosity and density—the new flowmeters measure reliably regardless of process conditions. Manual testing is therefore not necessary (figure 3).

The new flowmeter makes multivariable measurements, including flow, temperature, density, and viscosity. The automatic collection of these data points by a single device freed the company's operators to focus on other tasks, because the control system now makes automatic corrections based on these process values. The change brought improved control, accuracy, and quality, and it eliminated the need for multiple transmitters.

The company can now view its process and instrument diagnostic data remotely via any device capable of hosting a web browser by using the flowmeters' built-in web servers. With less effort required to take manual samples and measurements, and more time to monitor operation, the company is making additional observations and preventing issues like leaks and spills.

Acrylics: Automatically diagnose failure

A designer and manufacturer of acrylic-based products was experiencing a critical error with a flowmeter downstream of a reactor vessel. The instrument sporadically indicated zero flow through the pipeline, causing the process to shut down as a safety precaution. This false reading was eroding business continuity and profitability.

After several manual efforts to troubleshoot the problem, the company turned to the flowmeter's original equipment manufacturer (OEM) to examine the issue. By running an

Figure 4. For an acrylics-based products manufacturer, a configurator tablet creates a mobile field workstation, enabling diagnostic work without interrupting a process. (Shown: SMT70 Field Xpert)

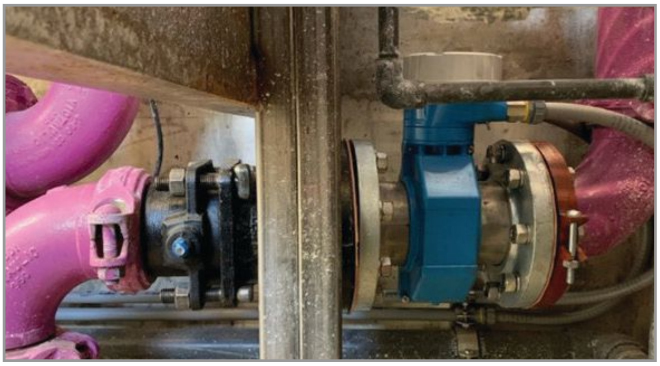


Figure 5. Smart electromagnetic flowmeters enable flow measurement in tight spaces, such as those found in water treatment plants. (Shown: Proline Promag W 400)

automated onboard diagnostics verification within minutes of arriving on site, the OEM's engineer determined the cause of flowmeter failure to be a problem with empty pipe detection (figure 4).

Further investigation of the installation and process indicated a better long-term solution was available, and the team replaced the unit with a flowmeter made to withstand higher temperatures. The insulation around the device was also adjusted to keep the electronics cooler.

Water treatment: Handle challenging pipe layouts

Maintaining water safety and quality while lowering energy consumption and meeting city, state, and national regulations is challenging enough, but throwing unreliable measurements into the mix makes meeting these objectives nearly impossible for water and wastewater agencies. With reliable measurement, technicians can better control the process, make better decisions, implement predictive maintenance, and save money and energy.

One wastewater treatment agency needed to measure flow to better control its process, but the required location for the flowmeter was a tight and restrictive space, with short pipe runs and sharp bends (figure 5). This greatly limited instrumentation options. Typical electromagnetic flowmeters require a straight pipe run of multiple pipe diameters upstream of the meter, and one to two diameters downstream.

Due to limited space in the facility, modifying the piping was not a viable choice. Other instrumentation options, like an electromagnetic reduced-bore flowmeter, create a pressure drop. This causes higher energy costs and lower plant efficiency.

The agency had estimated the flow coming through this section of pipe for years, but workers could not obtain exact numbers. By installing an intelligent electromagnetic flowmeter that could measure flow independently of mounting location and profile without sacrificing pressure or efficiency, the facility finally measured the flow through this pipeline accurately.

The agency installed the flowmeter without having to tear up or extend the pipe's run length, saving on installation costs. Knowing this flow rate helps workers monitor for system leaks and initiate repairs more quickly, saving energy and reducing water waste.

Elsewhere in the facility, intelligent radar level transmitters help detect foam buildup in wet wells, automatically determining the ideal time to dose additives, and the optimal quantity. Foam buildup in wastewater plants occurs when bacterial composition becomes destabilized, requiring expensive chemical additives to manipulate concentrations. By dosing at exactly the required levels, the agency reduced additive usage by 30 percent and efficiently controlled bacterial composition at a greatly reduced cost.

The present and future are digital

When organizations want to optimize plant processes, smart instrumentation provides host systems with indispensable data, which can be used for operational and maintenance insights. This is done using two-way communication from smart instruments to host systems, providing multivariable process values and diagnostic information. These insights help improve process efficiency and help avoid unplanned shutdowns by supporting proactive maintenance procedures.

Whether an organization is far along or just beginning to consider its digitalization journey, industry reliance on digital data and the Industrial Internet of Things is only becoming more pronounced. ■

All figures courtesy of Endress+Hauser

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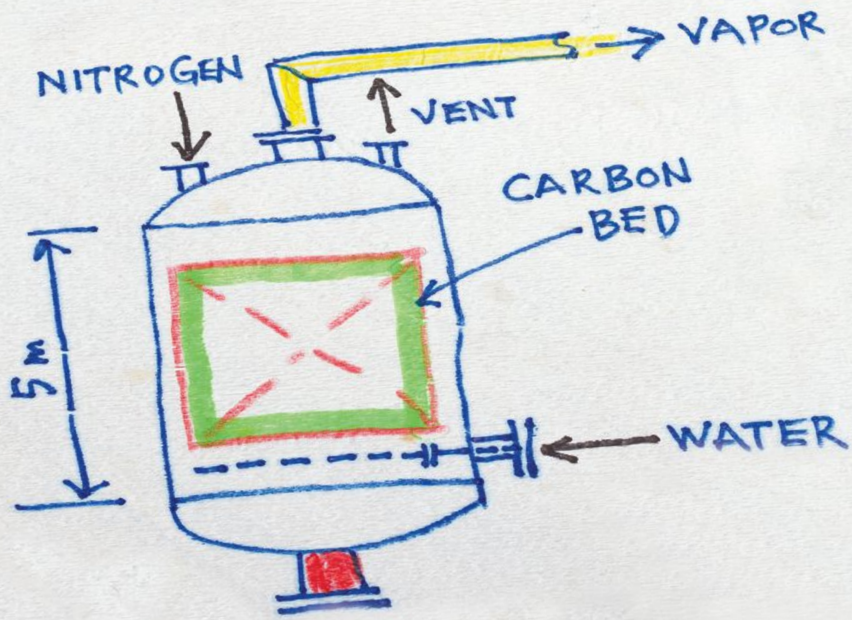

IMPROVING PROJECT DOCUMENTATION + CHANGE MANAGEMENT

By Vilas Desai and Steve Mustard, PE

The production of design and engineering documents for automation projects is expensive and time consuming, and the output quality can vary considerably, because often the processes are mostly manual. However, many tools are available that can reduce time and cost, while increasing documentation quality. Engineering, procurement, and construction (EPC) contractors, instrumentation engineers, consultants, and others use these tools in projects, and educational institutions use them to train the next generation of users.

An automated, standards-based documentation process saves time and cost while increasing quality.

The centralization and automation of document production saves time and money and removes many manual, error-prone steps. Combining these tools with international standards makes the output more consistent across end user, EPC, sector, and country. Many instrumentation engineers are accustomed to manual methods for creating the complex engineering and design documents and drawings required for typical process industry projects. These manual methods are inefficient, expensive, and subject to human error.

A typical small process industry project with 1,000 input/output (I/O) tags may spend more than six months producing required documentation, incurring costs of around $150,000, assuming no errors. Medium and large projects will see proportional increases in these costs and timescales. Problems identified and corrected later in the project may significantly contribute to project cost overruns.

Changes are common to any automation project, whether to correct errors or to address new functional requirements. Change management is a major challenge to project cost and timescale. Managing changes through manual processes is prone to error and consumes a major portion of project implementation time.

Project documentation requirements

At a minimum, a typical process industry instrumentation project needs the following engineering and design documents:

- *Instrument index*: A database for all devices documented in process flow diagrams (PFDs) and piping and instrumentation diagrams (P&IDs) (figure 1).
- *Junction box schedules*: Information about specifications and quantity of junction boxes, the number of terminals of different sizes, the dimension of the junction box, along with construction, glands, and ingress protection of cables used in the project.
- *Cable schedule*: Details regarding types of cables used, number of cores, size, and length of various cable types.
- *Wiring diagrams*: Indication of how to wire instruments into junction boxes, marshalling racks, control panels, and I/O channels of the programmable logic controllers (PLCs) or distributed control systems (DCSs).
- *Terminal diagrams*: Details of the connection of wires to terminal numbers inside the junction box, marshalling rack, and control panel.
- *Device specification forms*: Specification of details of all devices used in the project, such as project, client information, general parameters, process conditions and parameters, construction, standards, process connections, communications, and purchase details.
- *PLC/DCS I/O listing*: A list in tabular form of inputs and outputs required for the PLC and DCS.
- *Loop diagrams*: Engineers and technicians use these diagrams to ensure all the equipment wiring is in accordance with the design documents (cable schedule, wiring diagrams, and terminal diagrams).
- *Hookup drawings*: Details of the mounting and connection of field devices to the process.

Currently, instrument engineers use several tools to produce project documentation, with Microsoft Excel and AutoCAD being the most widely used. Excel is well-suited to produce information lists, and there are many functions, such as filtering and searching, that can aid users when accessing the information. Excel works well for projects with small I/O counts and can potentially produce many of the list documents described above, such as instrument index, schedules, and I/O listings.

Excel has limited drawing capabilities. Tools such as AutoCAD are more suitable for producing loop diagrams, hookup drawings, PFDs, and P&IDs. AutoCAD is a computer-aided design (CAD) tool used across multiple sectors to produce engineering drawings. Table 1 lists the limitations of current tools related to scalability, lack of centralization, and required skills.

Standards are fundamental

ISA is a standards development organization (SDO) accredited by the American National Standards Institute (ANSI) (https://ansi.org). ISA produces standards for the automation profession, including standards governing symbols and nomenclature, safety, and communications. ISA has been creating standards for more than 75 years and has produced several publications to ensure automation professionals have the technical resources they need to be successful. Engineering and automation professionals use ISA standards in their day-to-day work designing PFDs, P&IDs (figure 3), instrument indexes, specification forms/data sheets, logic diagrams, and loop diagrams.

Instrumentation documentation must follow all applicable company, sector, and country standards. The use of ISA standards ensures a consistent approach across company, sector, and country. The ISA website has a complete list of all ISA standards (www.isa.org/standards-and-publications/isa-standards), and ISA members have read-only access to all ISA standards. Some standards that ISA produces relating to instrumentation documentation include:

- ISA-5.1-2009, *Instrumentation Symbols and Identification*: Establishes a uniform means of depicting and identifying instruments or devices and their inherent functions, instrumentation systems and functions, and application software functions used for measurement, monitoring, and control, by presenting a designation system that includes identification schemes and graphic symbols.
- ISA-5.4-1991, *Instrument Loop Diagrams*: Establishes minimum required information and identifies additional optional information for a loop diagram for an individual instrumentation loop. This loop is typically part of a process depicted on the class of engineering drawings referred to as piping and instrument drawings. This standard gives guidelines for

Scalability	Lack of centralization	Skill requirements
There are limits in many commercial tools. There is a limit of 65,536 rows in older versions of Excel. Newer versions support 220 rows, but at this size, the performance of the application is unacceptable on most desktop computers.	It is often necessary to use multiple tools because one alone cannot produce all the documents required. Using multiple tools can create discrepancies in output from the different tools.	AutoCAD requires substantial user experience to produce the typical project drawings described. Creating the project documents needed in Excel requires user knowledge of macros, Visual Basic, and other Microsoft automation tools.

Table 1. Limitations of current tools

Project Title	Captive Power Plant - Hyder Power Co.	INSTRUMENT INDEX	plantworx SOFT brains
Subtitle	30 MW Mixed Fzuel		
Projct Reference	CPP/30MM-MxF-Advantis-01/2022		

P&ID Ref	Loop No	Line No	Proces Area	Location	Service	Tag ID	Device	Rng Max	Rng Min	Set Pt.	UoM	UDF-01	UDF-02	Prot. Cls	Hazard Cls	Rev no	Rev Dtd
PID-0001A	0001	3"-1207-A11A-H30	WaterIntake	Storage	Inlet Pmp	0001LT001	Lvl.Xmittr	500	80	350	Cms	NA	NA	IP66	NA	0	12/04/2021
PID-0001A	0002	3"-1207-A11A-H31	WaterIntake	Storage	Inlet Pmp	0001TT002	Tmp Xmittr	60	5	50	°C	NA	NA	IP66	NA	0	12/04/2021

Client / OEM	Avantis Power Generation	Designed By		ShtNo	21	30
Consultant	ABC Power Consultants Pvt Ltd	Approved By				
End User	Hyder Power Generation Co. Hyderabad	Status				

Figure 1. Instrument index generated from an automated solution

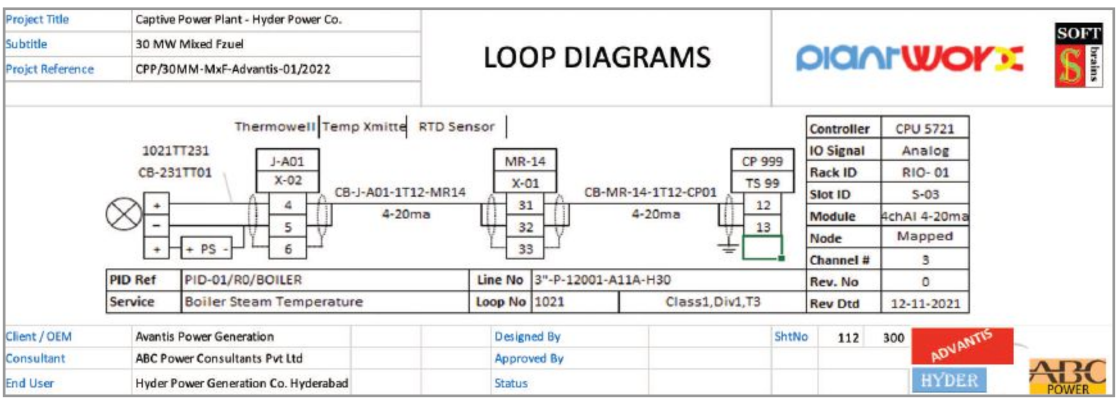

Figure 2. Loop diagram generated from an automated solution

the preparation and use of instrument loop diagrams in the design, construction, startup, operation, maintenance, and modification of instrumentation systems.

- ISA-20-1981, *Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves*: Provides forms (checklist) to promote uniformity in instrument specification—both in content and form—by listing and providing space for principal descriptive options. These forms facilitate quoting, purchasing, receiving, accounting, and ordering procedures.

With standards-driven processes and workflows comes the assurance of following the best industry practices during the definition, design, development, integration, documentation, and support of automation projects. This ensures the execution of projects with precision and standardization. Benefits to a project include:

- assisting in preparation of a complete specification by listing all principal descriptive options
- promoting uniform terminology
- facilitating procedures for quoting, purchasing, receiving, accounting, and ordering by uniform display of information
- improving efficiency from the initial concept to the final installation.

Commercially available tools

- Intergraph SPI-Intools by Hexagon PPM: www.hexagonppm.com
- Aveva Instrumentation: www.aveva.com/en/products/electrical-instrumentation
- Plantworx by Softbrains: www.softbrains.net/products

Automating the documentation process

Considering the limitations of existing methods, an automated solution should:

- be scalable to allow the documentation of the largest process industry projects
- centralize all data, so there is less scope for the introduction of discrepancies
- be sufficiently intuitive and reduce the dependency on specialist knowledge
- embed key standards to help users produce compliant documentation more easily.

Figure 2 shows an example of an output from such an automated solution. The data in the diagram comes from a central database, and its placement is automatic. The user specifies certain basic parameters and can also change these parameters and obtain updated documents immediately.

Considering the example cited above of a small project with about 1,000 I/O, below is a comparison of the approximate time taken to produce design and engineering documents by an automated tool instead of methods using Excel, AutoCAD, and other conventional tools. With the automated

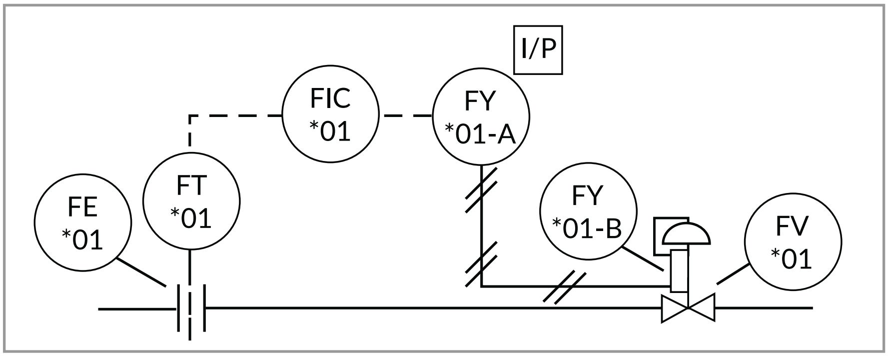

Figure 3. A P&ID drawn using ISA standards (FE: flow element, FT: flow transmitter, FIC: flow indicating controller, FY: flow computational device, FV: flow valve)

solution, there is an upfront investment to define the project properties and parameters, specify the tag formats, create user roles and permissions, and create detailed records for all devices in the project.

In a well-designed automated solution, this is a one-time activity. Thereafter, generating any of the required project documents is instantaneous. Because of the centralization of data, there is far less work validating information across documents produced from the same centralized source of information.

In comparison, users applying conventional methods spend significant amounts of time generating and regenerating project documents as changes arise, as well as validating the information across these documents.

A well-designed automation solution can execute a project with 1,000 I/O with 60 percent less effort compared to using conventional methods. This saving grows as the I/O scope increases due to efficiencies in the automated process. Considering the potential to save time and cost while increasing quality, there is a strong case for using a standards-based automated solution to generate documentation in automation projects. ■

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Vilas Desai (d.vilas@softbrains.net) is a member of ISA and has recently been invited to join the ISA20 committee that promotes uniformity in instrument specifications. Desai is the inventor of the software tool Plantworx for Instrumentation Engineers and the CEO of SoftBrains, an engineering services company for process automation based in Bangalore, India.

Steve Mustard, PE (steve.mustard@au2mation.com), is past president of ISA and the CEO of National Automation, Inc., in Houston.

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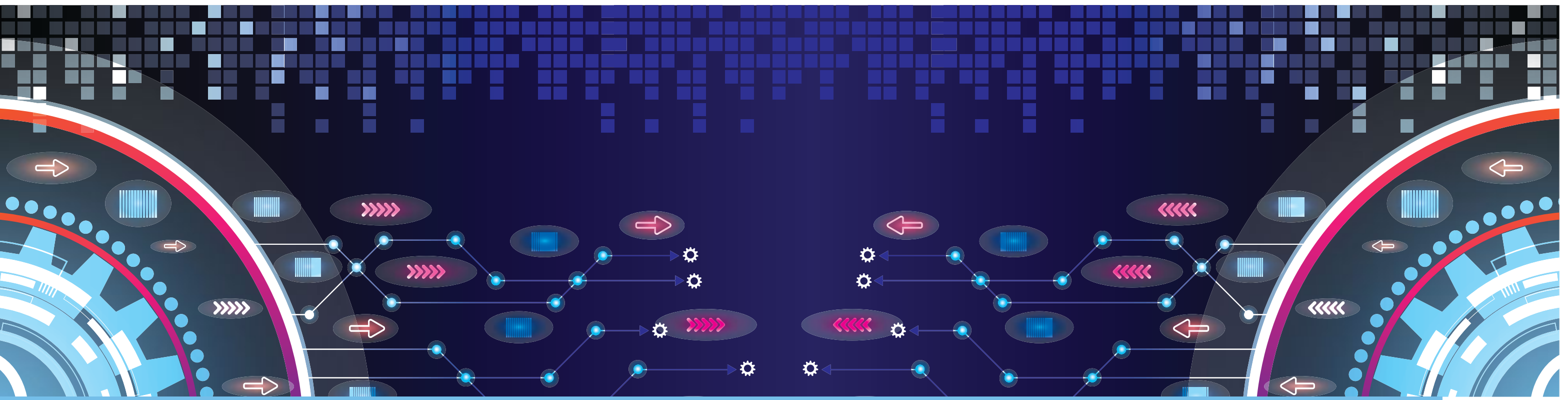
Experience Centers Teach Cybersecurity Best Practices



By learning about and building cyber-physical protection systems into modern ICS deployments, organizations can better defend their control systems from internal and external threats.

By Luis Narvaez

The adoption of Industry 4.0 technologies is increasing efficiency and profitability across industrial control system (ICS) environments, making data available from myriad sources, and employing advanced software tools to analyze information. This gives plant staff insights for facility and machine optimization at a rate never before experienced in industry.

This increase in data is attributed to Industrial Internet of Things (IIoT) sensors and data processing engines everywhere—inside and around machines within the shop, in remote field locations, at the edge of factory control networks, and in the cloud. The interconnectedness of these components helps generate accurate and beneficial insights.

Though the benefits are numerous, connecting an enterprise of ICS devices while maintaining security is no easy task. Where interconnected components exist—especially involving the cloud—so do opportunities for downtime, data theft, and other kinds of malicious cyberattacks. But through careful planning and implementation, and using modern cyber-physical protection systems, users can leverage the benefits of the IIoT while defending their networks, devices, and data from intrusion.

Modern ICS challenges

IIoT devices generate data throughout the enterprise, which helps users make better-informed operational decisions. But many are hesitant to connect every facet of their plant and implement Industry 4.0 trends because of the risks of exposing previously isolated devices.

A 2018 application and network security study by Radware revealed the average cost of a penetrating cyberattack is a staggering $1.1 million. In addition to being a major financial and business continuity disruption, a cyberattack can erode confidence and public trust, critical factors in today's business landscape.

Users are left with a conundrum: If they do not connect their plants, they miss out on cloud services, remote connectivity, and increased contextual access to data on the factory floor—and therefore on more benefits for operational efficiency and simplicity. But they are rightfully concerned that to reap these benefits and improve productivity, they risk exposing their facilities to cyberattacks.

Fortunately, there are tools to achieve these benefits while mounting a strong defense against cyberattacks. Implementing network monitoring and artificial intelligence–driven threat detection systems is a positive start to cyberattack reduction and mitigation, but these do not go far enough to address modern-day cyberthreats to operational technology (OT) systems. These software systems are adept at detecting and alerting administrators about suspicious network activity, and in some cases blocking it, but remediation capabilities are debilitatingly limited.

When a cyberattack gets through, there is not much—if anything—these systems can do to kill the threat and control damage to the OT environment. They typically rely on human intervention to shut off hackers' connections to the network and to reclaim machine and process control.

By integrating cyberthreat detection tools with programmable logic controller (PLC) code to act during an attack, programmers build in the protection and assurances needed to safely connect a plant. This type of cyber-physical incident response solution responds to threat detection by intelligently maintaining uptime of noninfected production cells when possible. Meanwhile, it places infected components into a safe physical state and quarantines them from the rest of the network, shutting down bad actors' access into the system.

Experience centers educate visitors

Although cyber-physical protection systems can provide robust protection and mitigate risk, deploying them properly requires a thorough understanding of ICS cybersecurity best practices. To help users develop these skills, visitors of hands-on manufacturing experience centers are taught methods for connecting devices securely, showcasing the benefits of integrating cyber-physical protection systems into real-world production lines.

Demonstration systems, on a most basic level, flash warning lights and sound alarms when a simulated intrusion takes place. Using human-machine interface displays, visitors witness more advanced actions, such as dynamic firewall rules isolating infected zones, while PLCs place physical equipment into safe states. These systems also demonstrate access control via radio frequency identification and password login, with some users limited to accessing certain areas of the plant, and other users limited to different areas.

Manufacturing industries are recognizing that threats do not only come from outside an organization, but they can also come from within it. They are consequently moving to a "zero-trust" stance (figure 1). They must watch and secure traffic on the local network, in addition to monitoring traffic coming in and leaving the network, and every user and device with network access must be authenticated.

Defense-in-depth

To reliably protect a network, it is necessary to implement defense-in-depth (DiD). This strategy focuses on creating multiple layers of security, so in case one fails, others remain to protect a facility and its assets.

As a physical example, DiD can be related to the types of security found in most homes and offices. The front door locking mechanism acts as the outer layer of security. To access the next layer in, residents and visitors must authenticate via key, Bluetooth, fob, or another means of entry. Once inside, there are likely multiple rooms, each containing separate assets and topics of information. These rooms can be locked, restricting entry again only to those with the appropriate clearance. This protects most of the structure if one or more rooms become compromised.

Analogously to rooms in a home or office, factories are made up of individual cells, each performing a specific task for producing finished goods. Each cell shares information with units inside the cell and with a limited number of

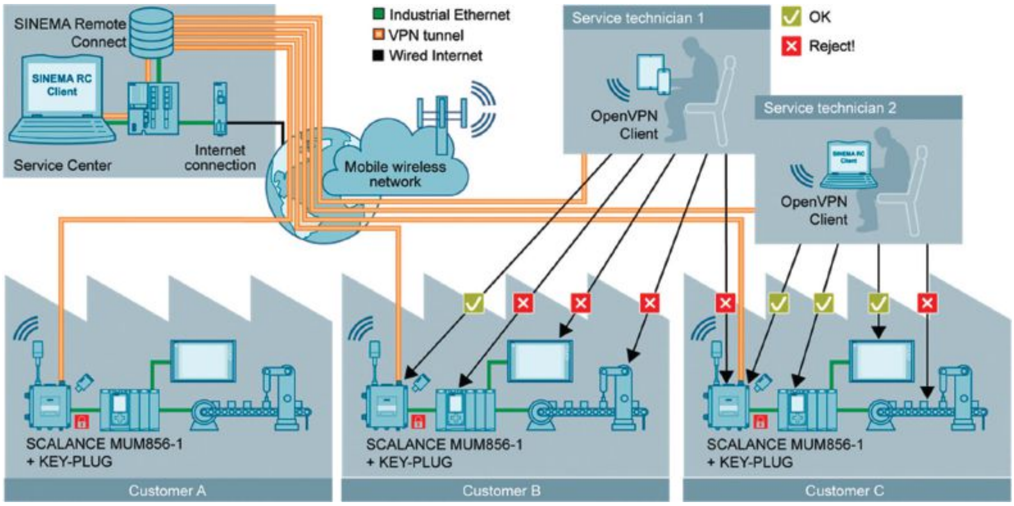


Figure 1. Zero-trust stance. Recent events show cyberattacks can come from external or internal threats, prompting designers to adopt a zero-trust stance for ICS environments, where every network device and user must authenticate.

carefully monitored data exchanges across cells. Intercell data sharing requires authentication, helping to protect information and machine control from falling into the wrong hands.

There are three pillars of DiD:

1. *Plant security:* maintaining control at a facility's cyber- and physical boundaries, determining who and what are allowed in and out. This refers to personnel, devices, and information.
2. *Network security:* limiting network and port access to verified and trusted devices that are supposed to transmit data through these mediums. Cyber-physical protection systems ensure network security is maintained, and they sound an alarm and even act in the event of intrusion.
3. *System integrity:* protecting individual devices from compromise. Integrated security features in control devices help provide protection against unauthorized configuration changes and can further resist the ability of bad actors to navigate a plant network.

Layered security through DiD is the linchpin of implementing industrial cybersecurity safeguards. Integrated enterprises and facilities must maintain strong firewall rules, only allowing necessary traffic between information technology (IT) and OT networks, and among cell areas on the plant floor. Requiring certificates and authentication to access networks and devices adds another layer of security that hackers must overcome to gain control.

Additional safeguards

Deploying network segmentation by location and cell area helps isolate security breaches if they do arise, limiting the spread of malware infection or equipment control compromise. By contrast, flat and nonsegmented networks allow infection to spread much more quickly and with much less visibility to facility personnel.

In addition, many modern PLCs and intelligent IIoT devices have onboard encryption capabilities. Facility staff should ensure these functions are enabled and used, though individual device protection is no substitute for safeguarding network infrastructure. For secure remote connection to machines and plants, it is recommended to use and manage secure virtual private network tunnel connections.

With these and other safeguards in place, users strongly increase their defenses against cyberattacks from within and without plant boundaries. But the threat is always present no matter how well prepared an organization is.

Cyber-physical protection systems help reduce the frequency and severity of cyberattacks in sensitive ICS environments by using threat-detection software platforms of user choice, and programming response actions directly into PLC logic. In a security event, firewalls and switches within the architecture self-adjust access rules to shut down the bad actor's connectivity, while PLCs act directly on process equipment to place potentially affected cell areas into a predetermined safe state, which is often but not necessarily always "off."

Further factory integration

Designing and programming effective cyber-physical protection systems takes time, collaboration, and a strong understanding of system requirements—especially when passing data between IT and OT networks and using the cloud for remote access and data analytics.

Hands-on experience centers showcase cloud-edge integration in a standard factory floor automation portfolio, giving visitors practical examples of the defense-in-depth concept deployed on a production line. Visitors can observe the steps a cyber-physical incident response system takes while responding to a cyberthreat, with the same PLCs driving robots and other machines used to execute safety logic sequences.

These interactive facilities are technology and brand agnostic, so visitors witness tech from different vendors, which is what most factories look like. The cyber-physical response demonstrations and other core ICS security considerations are applicable to all vertical industries throughout discrete and process automation.

In conjunction with a local manufacturing research group, Siemens recently equipped and is opening a hands-on digital enterprise experience (DEX) center showcasing the DiD approach, along with simulated threat detection and response. At this DEX center, Siemens conducts hands-on workshops across a multitude of Industry 4.0 technology topics, driven by user interest. The demonstrated production line focuses on educating DEX center visitors on the importance of access control and a segmented network architecture to protect individual cell areas from other potentially compromised cells during an attack (figure 2).

Considering methodologies for plant, network, and device cyber-protection, users should be emboldened to install IIoT technologies throughout their enterprises. By building out cybersecurity defense-in-depth, plant managers are preparing their facilities for a host of digital operation and production enhancements.

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Luis Narvaez is the U.S. product marketing manager for SIMATIC PLCs and industrial security at Siemens Industry Inc. He has a BS in electrical engineering from the University of Central Florida to complement more than 10 years of automation experience in a variety of markets including construction, entertainment/theme park, discrete, and process industries.

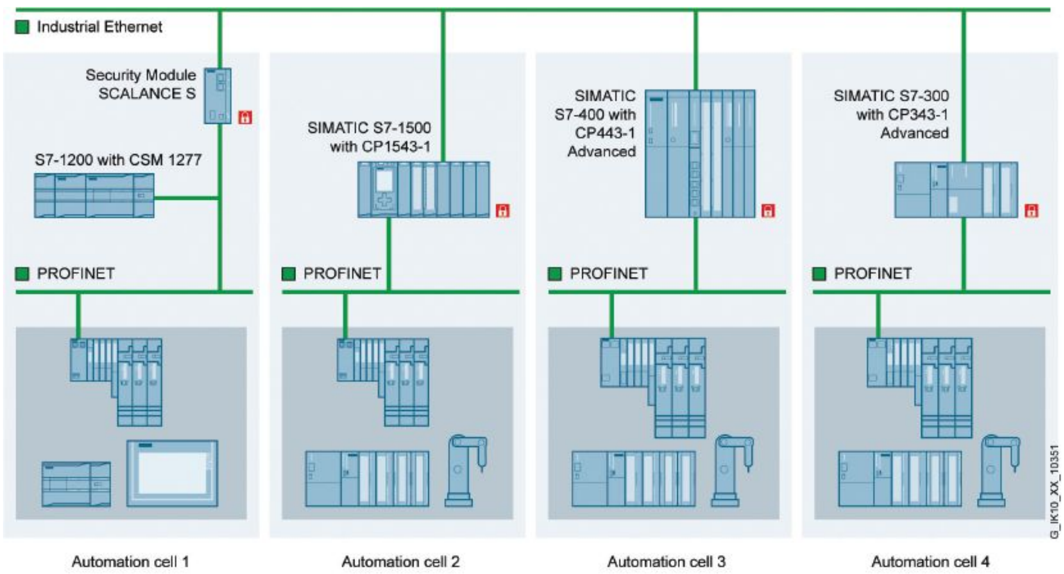
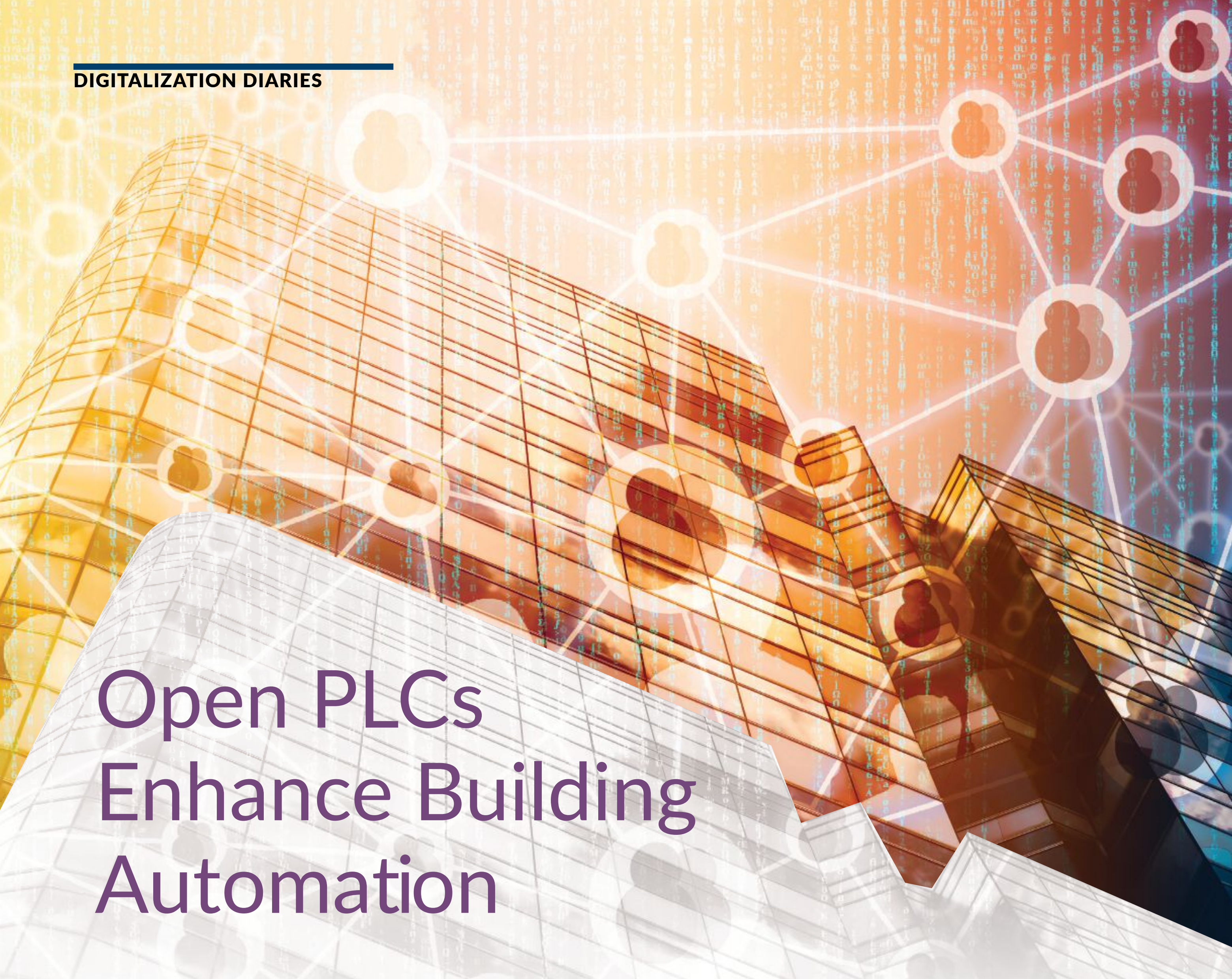


Figure 2. Segmenting a network. By segmenting a network and limiting traffic among various cell areas—a concept demonstrated for visitors at Siemens' hands-on DEX center—users mitigate the risk of cyberattacks.

Regardless of skill level, tapping outside help and attending hands-on sessions in an ICS environment can help equip users with the skillsets they need to efficiently safeguard their facilities from intrusion. This also brings operational peace of mind, knowing automated responses are configured and ready to act. Careful design and deployment let companies gain the benefits of IIoT data and analysis reliably and securely. ■

All figures courtesy of Siemens Industry Inc.



Open PLCs Enhance Building Automation

An HVAC company in search of modern machine-control advantages finds an Arduino-compatible open PLC controller is the solution.

By Frank Bicknell

Like many modern-day makers and hobbyists, I have always been inspired by the possibilities of high-tech computing and automation. Although my work history has kept me rooted in the practical needs of commercial and industrial control systems, I have been on the lookout for how to merge more capable and open devices into industrial applications.

My love of hands-on field service led me to start Bicknell Heating & Cooling in the Cincinnati area. We support all types of clients with heating, ventilation, and air conditioning (HVAC) needs using mostly traditional products. This article describes how we used modern industrialized Arduino microcontrollers to operate air handlers, chillers, hot water systems, and more.

A multitude of microcontrollers

There are many types of dedicated microcontrollers used to operate equipment, and there are also a variety of programmable logic controllers (PLCs). These all work well, but they lack the openness of today's general-purpose controllers. When it comes to these "open" controllers, there are many options for consumer- and hobbyist-grade microcontrollers, and some are even mildly "industrialized."

I tried several types of microcontrollers on various personal projects, such as modernizing the controls on my boat. The flexibility was good, and I could use modern programming languages and methods such as C++ and “sketches,” and the material costs were minimal.

Especially important for today’s applications is the ability to connect mobile devices or a browser to microcontrollers to access data for visualization and analysis. One option is to host web pages right on the controller. Another is to use external software running on a PC or mobile device to access the microcontroller data, and then display and act on it as needed. I experienced good success using the Xojo cross-platform rapid application development environment to do this.

However, even considering the many benefits of microcontrollers, I knew their durability was suspect, and it could be problematic to connect them to the typical voltage and current signal levels used with standard industrial instruments. Nothing I had found convinced me these types of controllers would be suitable for industrial applications.

Finding a tough open controller

After more research, my team and I discovered an industrial automation vendor had developed an Arduino-compatible controller, and packaged it in a form factor compatible with its line of PLC I/O, communication, and other modules (figure 1). Open-source Arduino Software makes it easy to write code and upload it to a compatible computer board.

With this solution from AutomationDirect, users like me can take advantage of modern programming methods and use a specialized graphical programming language included with the controller. We can connect physical sensors and controlled devices using typical industrial signals and proven modules, and even make the most of many types of specialized Arduino “shield” modules for other purposes.

Creating an open building automation system

Our team was already very familiar with using commercially available, proprietary HVAC control platforms, which are reliable but can be expensive and somewhat overspecialized. We also had a good amount of experience with traditional PLCs, which can certainly be used for HVAC control applications. However, after investigating the capabilities of AutomationDirect’s targeted open PLC controller product line, we were confident this Arduino-compatible platform would have the open flexibility we wanted combined with the robust characteristics of established PLC systems.

Our first project was re-automating the HVAC system of a nearby school. HVAC projects need to monitor many types of sensors for temperature, humidity, pressure, airflow, and more. They also need to control devices like solenoids and valves. In some locations, variable speed drives were needed for fan and pump control (figure 2). A variety of control panels were needed, and the team could source all types of necessary devices from one supplier, speeding up design, procurement, and fabrication efforts.

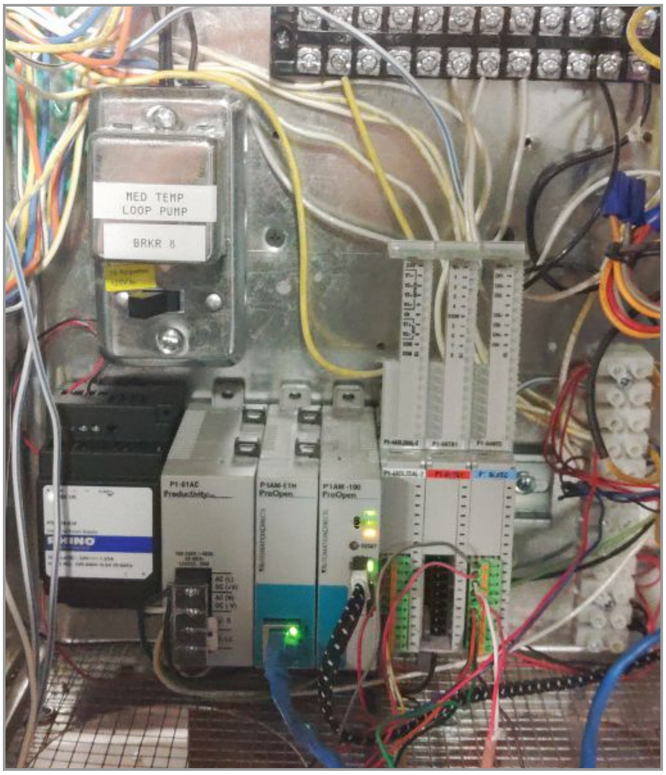


Figure 1. An industrialized open-source and Arduino-compatible CPU interoperates with PLC I/O modules and various Arduino “shields.” (Shown: AutomationDirect ProductivityOpen P1AM-100)

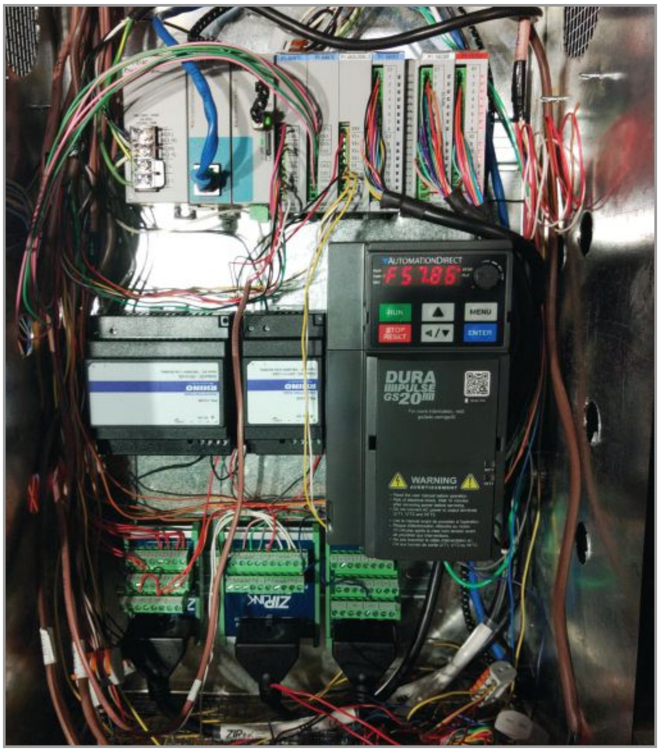


Figure 2. HVAC projects need to monitor temperature, humidity, pressure, and airflow sensors, and control solenoids and valves. In some locations, variable speed drives were needed for fan and pump control.

For this project, we automated the following equipment and packaged systems (figure 3):

- 15 air handlers (which are supply fans with heating and/or cooling coils)
- one chiller
- two steam boilers
- four hot water boilers
- several water-supply pumps.

All logic was developed to run within the selected open PLC controllers. The controller logic was well suited for us to create our own temperature control algorithms, including a weather reset functionality that allows the system to adapt to the exterior climate. In many ways, the control results were better than what we had experienced with other common but dedicated off-the-shelf microcontrollers.

A PC running Visual Basic–like Xojo provided a supervisory front end so operators could visualize system function and adjust set points.

The system was commissioned rapidly, and because the site was an operating school, it was necessary to perform the final cut-ins largely during off hours. We found that I/O checkouts were straightforward, just as they would have been for a PLC.

The control system has functioned reliably; there is plenty of capacity to expand; and the school personnel have found the system easy to use. We are now using the system for on-site visualization and control. In the future, we can add more controlled systems and even expand operating capabilities. Currently, remote access is accomplished using Google Desktop. This works extremely well, but adding remote access directly to the control platform would have been easy too. Any remote access efforts require careful consideration of cybersecurity.

Modern flexibility, traditional robustness

Sometimes, the best automation engineering answer involves products and solutions that are relatively dedicated,

Figure 3. Typical HVAC systems use many types of equipment and packaged systems, which must be directly controlled or supervised to deliver the proper environmental control and utilities.

sometimes known as "fit for purpose," but these solutions are often expensive and inflexible. To address these and other issues, today's users prefer more modern and open designs that can connect with a variety of other systems, are exceptionally flexible, and have plenty of room to grow.

For the types of HVAC systems that our company regularly automates, we have found this Arduino-compatible open PLC controller platform to be capable and an excellent value. We can use modern programming languages and methods to deliver advanced control, while connecting to all sorts of field devices using proven I/O modules and signaling.

Although our experience with this platform to date has been only with HVAC systems, we are confident its advantages will also be significant for other types of commercial and industrial applications. ■

All figures courtesy of AutomationDirect and the author

ABOUT THE AUTHOR

Frank Bicknell is the proprietor of Bicknell Heating & Cooling, a small HVAC contractor in the Cincinnati, Ohio area. He started in the HVAC industry cleaning coal furnaces for the family business while in junior high school in the 1970s and then moved on to installing and servicing equipment. Subsequently, Bicknell obtained a stationary steam engineer license and became chief engineer of a large office tower, then earned his electrical engineering degree and worked for companies like General Signal in fields including semiconductor backend machine manufacturing, medical lab equipment setup, servicing missile defense component manufacturing, and precision-controlled environment automation using many control system brands.

RESOURCES

"CPAPs RE-INVENTed into Emergency Ventilators Using PLCs and HMIs"
www.automation.com/en-US/Articles/June-2020/CPAPs-RE-INVENTed-into-Emergency-Ventilators-Using

"Embedded IEC 61131 is Enabling Industry 4.0 & Industrial Internet of Things"
www.automation.com/en-US/Articles/2016-2/embedded-iec-61131-is-enabling-industry-40-industr

"Experts Discuss Open Process Automation Issues"
www.automation.com/en-US/Articles/January-2022/Experts-Discuss-Open-Process-Automation-Issues

Update on ISA108, Intelligent Device Management Standards

ISA108 has been working collaboratively with International Electrotechnical Commission (IEC) SC65E WG10 for several years to develop a series of standards and technical reports of the best practices and work processes for effective implementation, management, and use of diagnostics and other information provided by intelligent field devices. The intent is to gain the inherent increases in reliability that such devices bring through intelligent device management (IDM)—a multidisciplinary approach for managing intelligent devices through the facility, supplier, and technology lifecycles, independent of particular asset management tools or sets of those tools.

The initial document describing the concepts and terminology of IDM was developed solely by ISA108 and published in 2015 as ISA-TR108.1. That ISA technical report was then further developed in the joint ISA-IEC work, with updated and equivalent versions of the technical report published in 2020 as ISA-TR63082-1 and IEC TR 63082-1, respectively. The ongoing ISA108-IEC series is being developed in three main levels or parts:

- Concepts and terminology as set forth in part 1 form the basis for the subsequent documents by explaining the intent and benefits of the series (the "why").
- Part 2 will be a normative document describing the "what, when, and who" necessary to implement an IDM program.
- Part 3 will address the "how," providing guidance on implementations in different industries or for specific types of equipment.

The part 3 documents will be started as a series of technical reports once part 1 and part 2 are fully aligned as international ISA/IEC documents presently under development.

Despite setbacks caused by the pandemic, the joint committee has been meeting regularly to develop part 2, a standard setting forth normative requirements and recommendations. A draft of the standard was distributed in February to both IEC SC65E and ISA108 committee members for their respective reviews and balloting processes.

With the part 2 standard nearing a stage of technical completeness, the ISA108/IEC joint team is beginning an update of the part 1 technical report to make it an ISA/IEC international standard in complete alignment with the forthcoming part 2 standard.

The current ISA-TR63082-1-2020 technical report is available at www.isa.org/findstandards. Experts from any country who are interested in participating in this joint project are asked to contact standards@isa.org. ■

This update was provided by Ian Verhappen, CAP, a senior solution architect at Willowglen Systems in Calgary AB. He is an ISA Fellow and a member and former vice president of the ISA Standards & Practices Board, for which he serves as managing director of several ISA standards committees including ISA108, as well as co-chair of ISA112, SCADA Systems. He represents Canada as an expert in several IEC standards committees, most notably as international chair of IEC SC65C, Industrial Networks, which is responsible for fieldbus protocols. In 2018, he received ISA's highest award for leadership in standards development, the ISA Standards Excellence Award.

Revision of Annunciator Sequences and Specifications Standard

The ISA18 committee, Instrument Signals and Alarms, has reactivated a working group to revise ISA–18.1, *Annunciator Sequences and Specifications*, which was first published as an American National Standard in 1979 and then reaffirmed without change in 2004. The working group has started by working through comments from a prior revision draft from several years ago, from which it will determine if new content is needed—such as, perhaps, around the use of software annunciators.

At one time, the most important alarms were found in annunciators, but the advent of computer monitor–based control systems in the 1980s and 1990s saw a major shift of most alarm window displays onto computer screens. This led to a downturn in sales of conventional alarm annunciator systems, with some supplier companies being sold off or going out of business. However, new annunciator panels have continued to be included in designs for a variety of reasons. In recent years, in fact, alarm annunciators have seen a resurgence in popularity—especially for use in IEC 61508 SIL 1 and safety, health, and environmental alarm-monitoring applications.

The ISA-18.1 working group plans to release an updated version for review within the ISA18 committee in the coming months, with the intent to complete the revised standard by the end of 2022. Individuals interested in participating are welcome and are asked to contact Bridget.Fitzpatrick@woodplc.com. For more information on ISA18, visit www.isa.org/isa18. ■

This update was provided by Bridget Fitzpatrick of Wood, who, with Cristobal Ruiz of Dow, is co-chairing the annunciator working group for ISA18. Fitzpatrick is a member of the ISA Standards & Practices Board, for which she serves as managing director of the ISA18 committee.

LETTERS

In Memoriam: Greg Shinskey

You wrote so well about Greg Shinskey in the December issue [https://www.isa.org/intech-home/2021/december-2021/columns/greg-shinskey-honoring-a-man-by-building-on-his-le]. Thank you for telling his story so well.

Rod Love, senior engineer, Process & Equipment Development

Nicely Put Together

Regarding the October 2021 issue: Nicely put together! A thought-provoking editorial ("The Essential Skill of Mastering Virtual Worlds") [https://www.isa.org/intech-home/2021/october-2021/columns/the-essential-skill-of-mastering-virtual-worlds]. I wasn't as inconvenienced as many were. I haven't had to go to an office or client meeting since I retired in 2017. I have committed myself to never getting on another airplane.

Two of the articles were of special interest to me: "LoRaWAN: A Clipboard Killer for Condition Monitoring," [https://www.isa.org/intech-home/2021/october-2021/features/lorawan-a-clipboard-killer-for-condition-monitorin] and "FDI Certification Enables Smoother Digital Transformation" [https://www.isa.org/intech-home/2021/october-2021/features/fdi-certification-enables-smoother-digital-transfo]. For the last number of years before retiring in 2017, my main focus was promoting and supporting Neles' asset management and condition monitoring offering.

Jon Monsen, www.Control-Valve-Application-Tools.com

ASSOCIATION NEWS

CERTIFICATION

New CAPs and CCSTs

The following individuals have recently passed either ISA's Certified Automation Professional (CAP) exam, or one of the three levels of Certified Control Systems Technician (CCST) exam. For more information about either program, visit www.isa.org/training-and-certification/isa-certification.

Certified Control System Technicians

Level 1

Chad M. Arnoldus, U.S.
James Andrew Atkinson, U.S.
Samer Battikha, U.S.
Ryan Blair, Shermco System Integration, U.S.
Kayle Bollin, U.S.
Andrew Boone, U.S.
Alexander Brimacombe, Canada
Daniel M. Chandler, U.S.
Eliazar D. Cruz, U.S.
Duane Dickey, U.S.
Lon Fitch, Cobb County Water System, U.S.
Daylen Grewe, U.S.
William Brian Gubbins, Akorn Pharmaceuticals, U.S.
Luis Miguel Hernandez, U.S.
Laurence JH Kaufman, U.S.
Sean Keane, MillerCoors, U.S.
David Leal, U.S.

Level 2

Aaron J. Conley, U.S.
Danny Cooper, MillerCoors, U.S.
Walter Duckworth, Total Petrochemicals USA, U.S.
Adam Eishen, Prime Controls LP, U.S.
John Gowder, MillerCoors, U.S.
Joseph Mark Grubb, U.S.
David Halter, MillerCoors, U.S.

Level 3

Benjamin G. Cade, U.S.
James A Frederick, Engineering Institute of Technology, U.S.
Jacob R. Irvin, Cobb County Water System, U.S.
Daniel Ray Richter, U.S.
Edward J. Tomaszewski, Xcel Energy, U.S.

Certified Automation Professionals

Mohamed Abdelrahman, Yokogawa Saudi Arabia, Saudi Arabia
Devesh Agrawal, Yanbu Aramco Sinopec Refining Company (YASREF) Ltd., Saudi Arabia
Mohamed Amin Ahmed Salama, Egypt
Ali Hussain Al Majed, Saudi Arabia
Mohannad Al-Shahrani, Saudi Arabia
Ali Alhaddad, SNC-Lavalin Fayez Engineering, Saudi Arabia
Ali Almatar, Saudi Arabia
Abdulaziz Balghonaim, Saudi Arabia
Nate Bisantz, ASC Process Systems, U.S.
Mohamed Amer Mansur Eljabo, Canada
Miguel J. Borges Filho, Petrobras – CENPES, Brazil
Asim Iqbal, Worley Parsons Engineering Consultancies Company, Saudi Arabia
Mohamed Ismail Khalid Mohamed, FM Approvals, Saudi Arabia
Christopher Michael Marik, U.S.

Continuous Improvement Is Not Digital Transformation

By Bill Lydon

To be competitive in your industry, it is important to understand the difference between continuous improvements that leverage new technology and manufacturing digital transformation.

Right now, the industry is at a tipping point for manufacturing digital transformation. Many things are enabling true transformation, including the large influx of new and powerful low-cost technologies, cloud and edge computing advances, embedded computing innovations, labor shortages driven by demographics, and make-to-order manufacturing demands. These elements empower countries around the world to create highly competitive manufacturing and production operations. These operations are motivated to transform.

Transformational change happens infrequently at intervals, which leads companies to believe that maintaining the status quo is the best strategy forever. For perspective, years ago there were huge arguments about analog (pneumatic and electronic) versus digital PID control, leading some to wait too long to convert to digital. Making refinements on existing assets when industry is at a tipping point can be a sunk cost trap, with existing production lines becoming noncompetitive.

Henry Ford's design and production methods are one of the milestones, prior to Industry 4.0, of industrial transformation. With his revolutionary holistic approach to new product design, materials, and production processes, Ford empowered the company to dominate the world automotive market with production of the Model T. Toyota repeated this pattern in the 1990s, leveraging technologies and methods that caused other automobile companies to lose significant market share and jobs.

Many companies, when reporting that they are making a digital transformation, describe applications that are valuable incremental improvements but are not transformational. Incremental continuous improvements can be valuable investments that are evolutionary and organizationally comfortable, because they enhance existing processes. But these should not be confused with transformational investments. In times of significant technological change, when your competitors are transforming to gain a significant competitive advantage, these investments may have only marginal impact on improving your existing operations.

Not transforming production is betting on the incompetence of competitors. This can be extremely dangerous for the future of a company, leading to loss of business and jobs.

Due to their knowledge and interaction with a wide range of groups, automation professionals are in a unique position in a company to facilitate digital manufacturing transformation. Automation professionals have the knowledge and know-how to be change agents—informing and educating management about the advantages of applying advanced manufacturing techniques and incorporating technological innovations to transform production to be competitive.

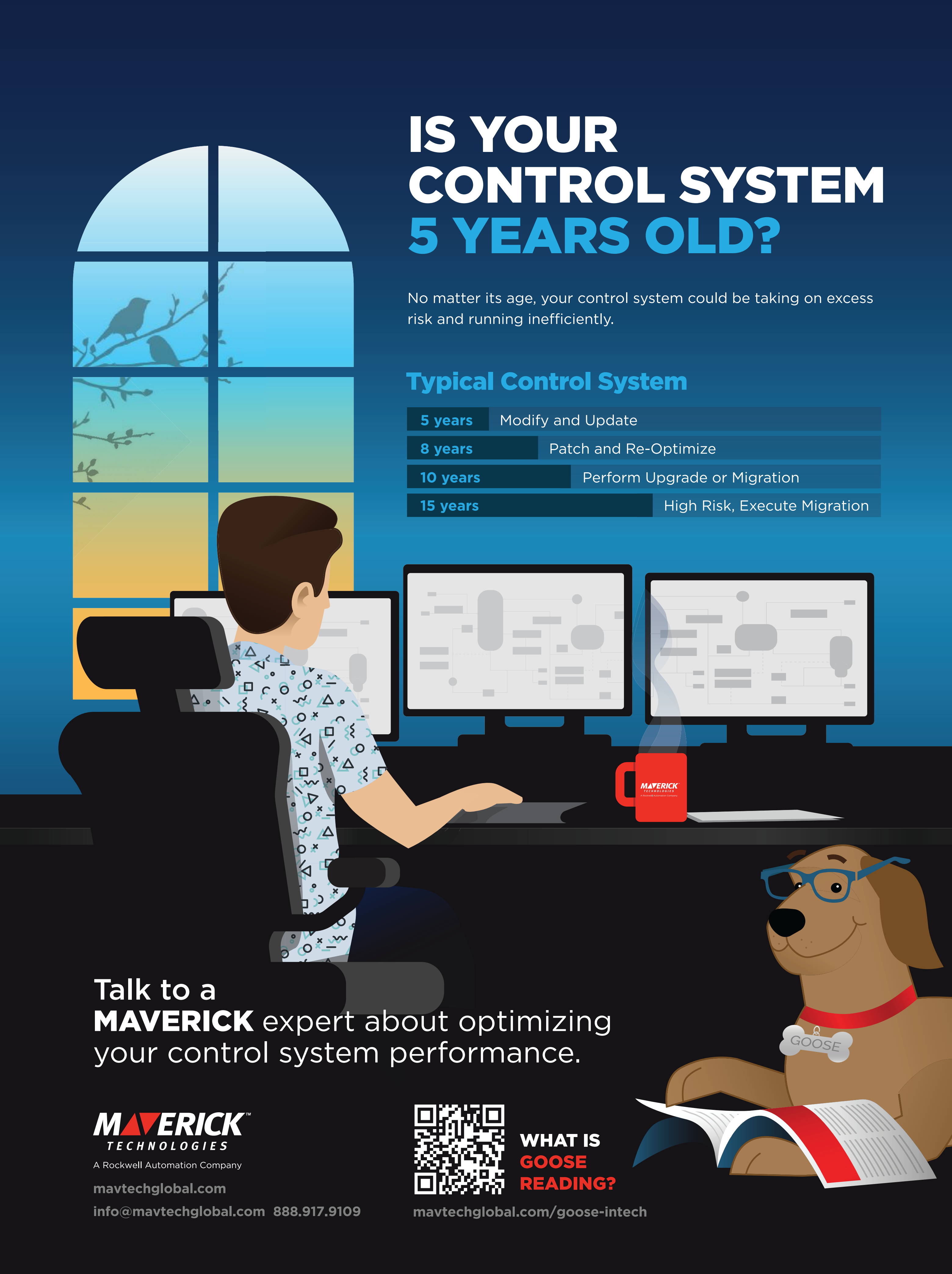
Automation professionals can positively impact their companies—by helping an organization understand the possibilities, showing how to make them a reality, gaining organizational support, and convincing management to invest in true digital transformation.

"The remains of the old must be decently laid away; the path of the new prepared. That is the difference between Revolution and Progress."
—Henry Ford

Automation professionals can make major contributions to their companies by taking the initiative to collaborate with manufacturing groups, creating transformative manufacturing processes and applying technologies such as collaborative robots, machine learning, artificial intelligence, and virtual/augmented reality to transform fundamental production processes.

Manufacturing digital transformation requires rethinking fundamental processes. This can lead to radical change that brings significant, environmentally responsible improvements that achieve competitiveness and sustainability. ■

ABOUT THE AUTHOR
Bill Lydon (blydon@isa.org) is an *InTech* contributing editor with more than 25 years of industry experience. He regularly provides news reports, observations, and insights here and on Automation.com.



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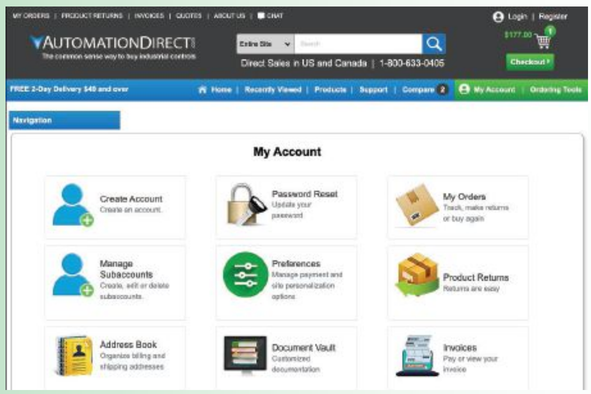

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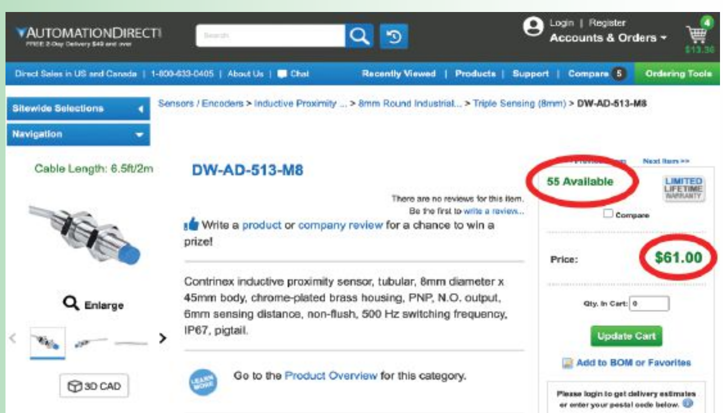

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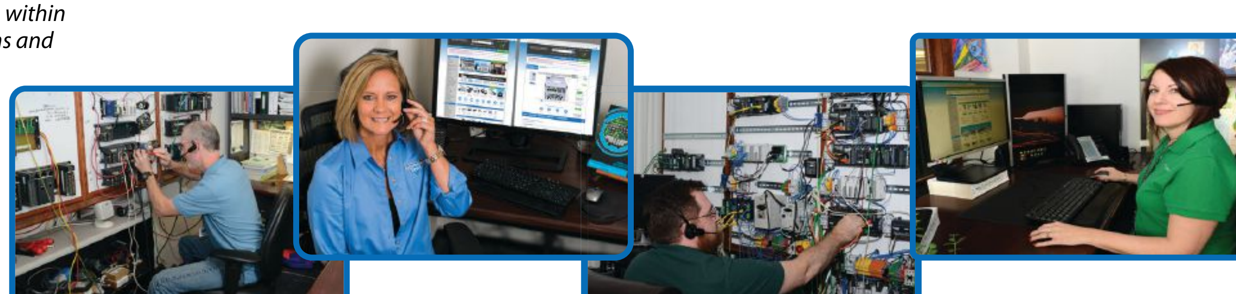

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