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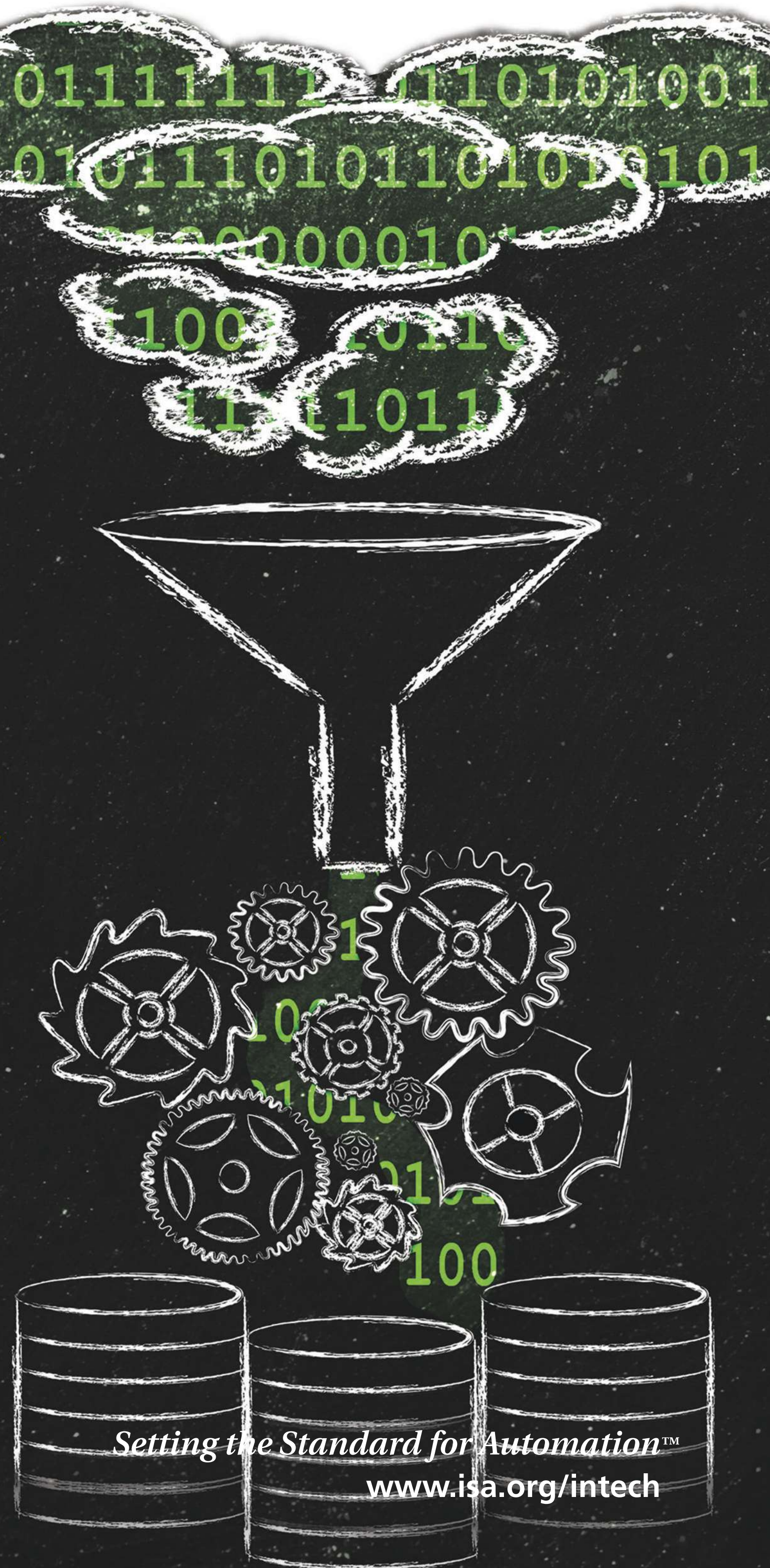

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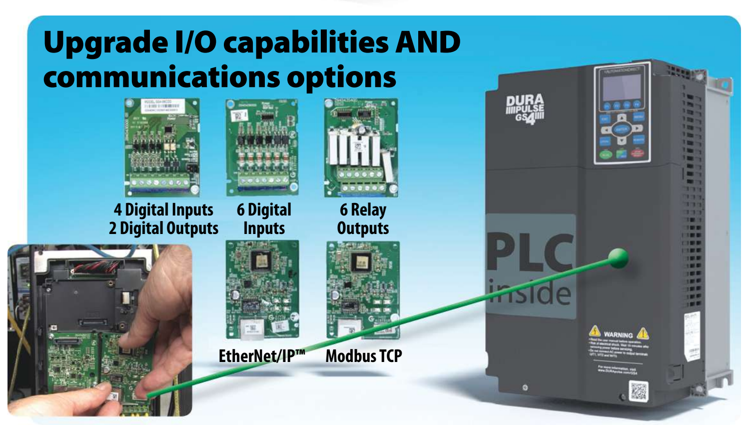

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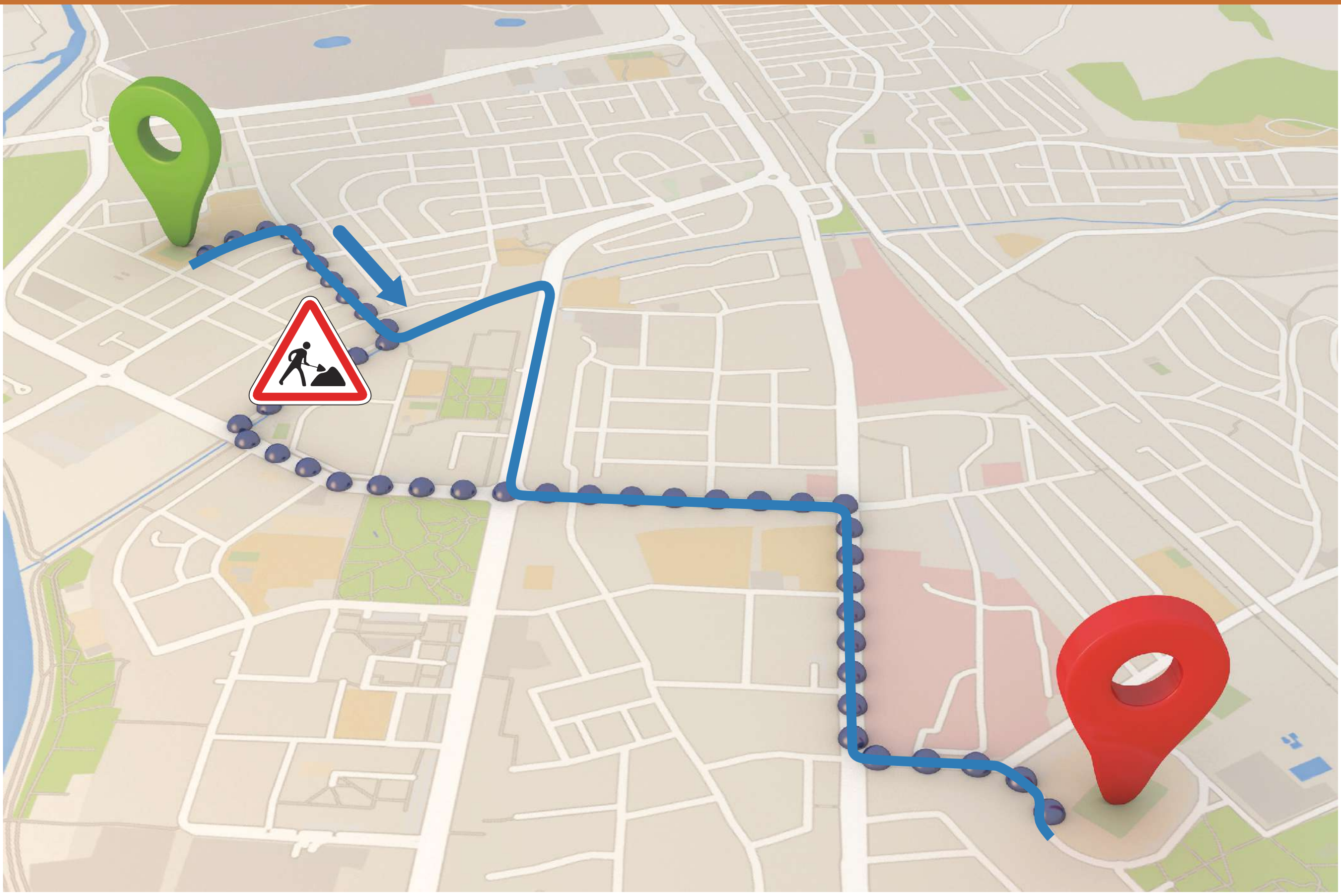

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Manufacturing automation—a vital competitive weapon

By Bill Lydon, *InTech*, Chief Editor

Regardless of your industry, automation is being used throughout the world to be more competitive and transform industry. These are exciting times for automation professionals, who can be vital contributors to the success and future of their companies. The influx of technology creates challenges, and automation professionals are subject-matter experts who have an important role informing and guiding company management to make the best automation investments.

Understanding

Understanding what new technology and solutions are available and those appropriate to apply in your company to improve efficiency and quality—and simultaneously lower production costs—is an important responsibility. Sorting out the new technologies and solutions that can be applied effectively in your operations takes effort. With the influx of new technology and rapid change, it is wise to look beyond the offerings of your existing vendors to learn about new technology and solutions. With the swift adoption of new technology for manufacturing in parts of the world not tethered by existing systems, it is important to learn about a range of new options.

Management

Industry 4.0, Industrial Internet of Things, analytics, artificial intelligence, and other developments are leading the top management of many companies to look for new solutions. Management is being bombarded with information from business consulting firms, information technology suppliers, and existing and new automation vendors advocating for the application of new technologies throughout the business to remain competitive and profitable. This frenzy can result in poorly informed automation investments with a poor return on investment. Worse, over time it can make the company less competitive than others using superior automation solutions that may be nontraditional.

"I have been saying for many years that we are using the word 'guru' only because 'charlatan' is too long to fit into a headline."—Peter Drucker, American management consultant

System integrators, consultants, and vendors can be valuable resources, but they do not have the working knowledge of your company's production. The fact of the matter is automation professionals within a company understand the company's production dynamics better than any automation resource outside the company.

An important task for automation professionals is to earn the respect of management by informing and educating them to make proper automation investment decisions. This requires concise communications without burying management in technical details. It takes concerted thought and effort to convey the benefits, functional description, and investment reasoning.

Challenge

The challenge for the automation professional is to understand new technologies and how they can be productively applied to production. In times of major change, it takes effort to learn and look beyond traditional solutions. Poor decisions are amplified over time, since most company investment life cycles are long. ISA information sources, including *InTech* magazine, *InTech Plus,* Automation.com, and ISA symposiums, can be used to learn. I also advocate attending major nonvendor-sponsored trade shows to learn about new solutions, products, and methods.

"The basic economic resource—the means of production—is no longer capital, nor natural resources, nor labor. It is and will be knowledge."—Drucker

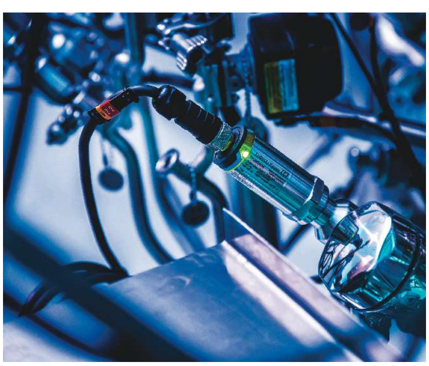
Look beyond existing solutions to learn what is possible and analyze what is new to improve production. ■

Endress+Hauser earns 2018 Hermes Award

The winner of this year's Hermes Award is Endress+Hauser Messtechnik GmbH + Co. KG. The award was presented by Germany's Federal Minister of Education and Research, Anja Karliczek, at the official opening ceremony for HANNOVER MESSE on 22 April 2018.

Endress+Hauser received the award for a hygienic compact thermometer. It has a self-calibrating sensor for process temperature measurements that meet stringent safety and quality specifications, as required in the food and pharmaceutical industries. The temperature of the sensor is calibrated automatically using a physical fixed point based on the Curie temperature (which is material-specific and has long-term stability) of an internal reference sensor integrated in the sensor. The fully automated inline calibration of the temperature sensor is audit proof and facilitates regular recalibration without additional processes or system downtime.

Along with the winner Endress+Hauser (based in Weil am Rhein, Germany), the following companies were also nominated for the award: Alpha Laser (Puchheim, Germany), GBS German Bionic Systems GmbH (Augsburg, Germany), TH Ingolstadt/Continental AG (Ingolstadt/Hannover, Germany) and Upskill (Washington, D.C.). ■



OPC Foundation and ZVE partner

The OPC Foundation and ZVEI (German Electrical and Electronic Manufacturers' Association) have signed a memorandum of understanding for combined activities relating to Industry 4.0. The first focus is an OPC UA–based mapping of the Industry 4.0 Asset Administration Shell (I4AAS).

Under the moderation of the OPC Foundation, the concept of the I4AAS, defined in a technology-independent manner so far, will be mapped into the technology of OPC UA. The conceptual input of the I4AAS is a result of the Platform Industry 4.0 Working Group 1 "Norms, Standards and Reference Architecture," the ZVEI Mirror Group "SG Standards and Models," and the ZVEI subworking group "Administration shell in detail." To ensure the interoperability of the I4AAS with the OPC UA companion specifications (developed with the VDMA), the VDMA is included in addition (beside the ZVEI) and part of the upcoming OPC joint working group. ■

Peter Martin inducted into MCAA Hall of Fame

Peter G. Martin, PhD, vice president, innovation and marketing, for Schneider Electric's process automation business, was inducted into the Measurement, Control, & Automation (MCAA) Hall of Fame. The MCAA Hall of Fame recognizes individuals whose work has contributed to the instrumentation and control industry in a significant and memorable way, either through technical achievements or business accomplishments and industry leadership. Martin is only the seventh person to attain this distinguished achievement.

Martin, an ISA Life Achievement Award winner, is a recognized innovator in the field of automation and control. He has authored three books (including *The Value of Automation* [www.isa.org/value] and *Bottom-line Automation* [www.isa.org/bottomline]), coauthored two (including *Automation Made Easy* [www.isa.org/automadeeasy], and been a contributing author for three more. He has also published dozens of articles and papers in the field of automation and control. Martin holds or has pending multiple patents related to real-time business measurement and control. He was recognized by *Fortune* as a "Hero of U.S. Manufacturing," by *InTech* as one of the "fifty most influential innovators in control," and by *Control* as a member of the Automation Hall of Fame. ■

Cybersecurity controls lacking

Indegy announced that nearly 60 percent of executives at critical infrastructure organizations polled in a recent survey said they lack appropriate controls to protect their environments from security threats. As expected, nearly half of all respondents indicated their organizations plan to increase spending for industrial control system (ICS) security measures in the next 12–24 months.

Although organizations have made significant investments to secure their information technology (IT) infrastructures, they have not fully addressed threats to operational technology (OT) environments. The recent poll of nearly 100 executives from various critical infrastructure organizations underscores the lack of preparedness in important sectors, including energy, utilities, and manufacturing. Among the findings:

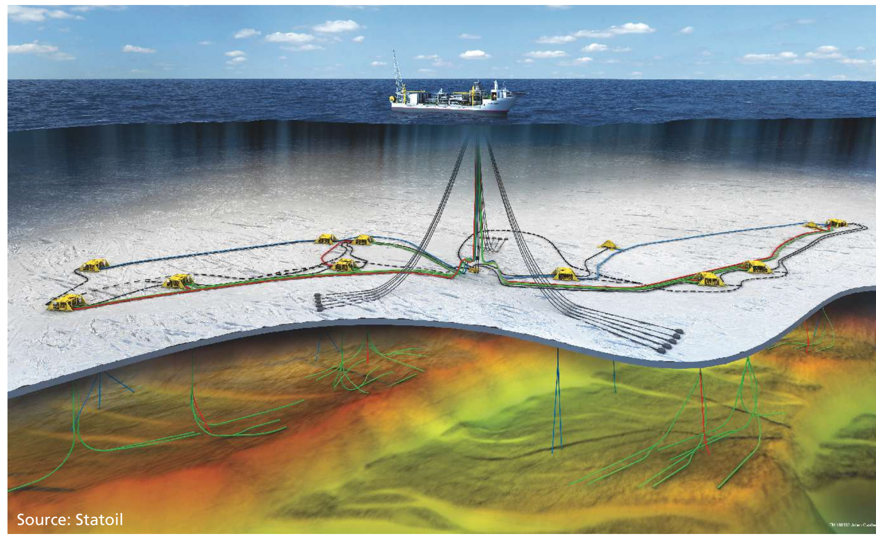
- Of respondents, 35 percent said they have little visibility into the current state of security within their environment, while 23 percent reported they have no visibility.
- Insider threats and misconfigurations are the biggest security risks faced by 63 percent of respondents.
- Fifty seven percent said they are not confident that their organization, and other infrastructure companies, are in control of OT security.
- Meanwhile, 44 percent of respondents indicated an increase in ICS spending was planned in the next 12 to 24 months, with 29 percent reporting they were not sure. ■

Automation by the Numbers

400 and 600 million

ABB will provide integrated automation, safety, and communication systems to Statoil's Johan Castberg oil field development project in Norway. Located in the Barents Sea, north of the Arctic Circle, the field will be developed with a floating production, storage, and offloading (FPSO) production vessel and subsea installation with 30 wells. The field has volumes estimated at between **400 and 600 million** barrels of oil.

ABB will provide ABB Ability System 800xA automation and safety systems, including simulation and related services to ensure safe operation of the offshore FPSO. The order is valued at about $25 million. ■



Source: Statoil

210,000

Under the motto of "Integrated Industry – Connect & Collaborate," a total of **210,000** visitors attended HANNOVER MESSE, with 5,800 exhibitors. Topics like machine learning, artificial intelligence, industrial IT platforms, the expansion of power grids for eMobility, the use of robots and autonomous systems in production and intralogistics, and the role of workers in the integrated factory were the subject of intense debate at the stands of exhibitors at the event. As the official partner country, Mexico presented itself as an innovative business partner and industrial location.

More than 70,000 of the visitors came from abroad, for an international share of 30 percent. China headed the foreign visitor statistics with a total of 6,500, followed by the Netherlands (5,300), Poland (2,700), and the U.S. (1,700). A total of 1,400 visitors attended from featured partner country Mexico.

Central trends highlighted at Hannover this year included the ongoing convergence between information technology (IT) and mechanical engineering, industrial IT platforms, and other new business models, and the imminent impact of artificial intelligence on the factory environment. The exhibitors in the automation halls profiled drive technology and fluid power as a key driver of digitized and integrated manufacturing. ■

34 GW

Kansai Electric Power (KEPCO) and OSIsoft LLC will help power producers improve the efficiency and operation of their thermal power plants with data. KEPCO will collaborate with its customers at every stage, from planning a new thermal plant to running the facility. The Kansai-value creation service, or K-VaCS, has services and technology to detect system abnormalities for utilities and others in the electric power supply chain. One of the key elements of the service is OSIsoft's PI System, a software infrastructure that brings insights about operational performance and equipment health across an enterprise. Engineers and operators can make critical decisions and track the results of implemented strategies.

The remote monitoring service has already started to help an early customer, the Bluewaters Power Station in Australia. Kansai Electric Power has also used the PI System in its own operations.

Based in Osaka, Japan, Kansai Electric Power is one of Japan's largest utilities. It operates more than 150 power plants with about **34 GW** of authorized capacity. ■

33,000

According to Global Market Insights, Inc., SCARA (selective compliance assembly robot arm) robots used in the automobile industry will exceed **33,000** units by 2024. This can be credited to increasing usage in applications like high-speed assembly and handling operations. Rising demand for reduced bottlenecks and optimized productivity will boost the product penetration.

Parallel robots will have a compound annual growth rate greater than 4 percent by 2024. Micromanufacturing automation will fuel the product demand over the forecast period. High speed, stiffness, and flexible fixturing support the product demand.

Growth in the automobile industry is leading to the implementation of advanced products to meet customer demand. Vendors focusing on automation solutions to eliminate risk factors arising from labor will spur the demand for automotive robotics. Additionally, extensive usage of robotics will reduce labor costs and thereby increase original equipment manufacturers profitability.

The need for better productivity and proper functioning of assembly lines in vehicle production has enhanced industry growth. Increasing technological advancements in raw materials used to make robots will escalate the product demand. In addition, increased demand from applications, such as welding, robotic processing, painting and dispense, and handling operations, will augment the industry growth rate. ■

What's next for big data in process manufacturing

Big data stored in process historians for decades has often been underutilized—new advanced analytics simplify access to solutions by accelerating time to insight

By Michael Risse

FAST FORWARD

- Advances in technology enable more effective use of big data, which has been around for decades in the process industries.
- Many process industry firms use old tools, usually spreadsheets, to derive insights from their big data, with unsatisfactory results.
- Advanced analytics solutions address spreadsheet shortcomings in four areas: context, self-service, deployment, and ease of use.

According to the big data analytics cover story in the November/December 2015 issue of *InTech* (www.isa.org/intech/20151201), "Manufacturing firms have the benefit and curse of technology refresh rates typically measured in decades, and technology selection processes typically measured in months or years. This is a benefit, because the technology we buy is built to last and provides a return on investment well beyond that of other industries. It is also a curse. Since we do not get new technology very often, when we get the chance we often bite off more than we can chew, are paralyzed by fear of the unknown, or seek out the new shiny toy."

Big data is no longer new, but as the quote points out, it takes more than availability for new technologies to improve process manufacturing organizations. Implementing new technologies requires innovative products, opportunity for adoption, and applied use by skilled personnel.

As a result, while big data may be entrenched and accepted in less constrained environments, it is only now leaving its introductory stage for most process manufacturing organizations. Early adopters have deployments and have achieved success, and many companies are evaluating or including new analytics projects on their road maps, but the single most popular term in articles on big data and the manufacturing industry is "opportunity." As in, the opportunity is out there, but there is still too much:

- data (mostly stored in process historians) and too little insight
- hard work instead of easy access to innovation
- unplanned downtime
- time spent cleansing and modeling data before analytics can even begin

Ask process engineers what their most commonly used analytics tool is, and for most the answer is a 30-year-old, single-user, heavyweight-client piece of software called a spreadsheet. Ask managers about their data environments, and they will answer in terms of process historians, asset management systems, and other silos.

So big data, for many companies, is still out there as a promise, waiting for the intersection of innovation and opportunity to bring new insights and improved production outcomes to plants and organizations. And no industry has more need to create value from big data. Manufacturing plants generate twice as much data as any other vertical market, according to McKinsey and Company research from the seminal report that launched big data awareness—and hype—back in 2011 (figure 1). With this much data comes a corresponding opportunity for

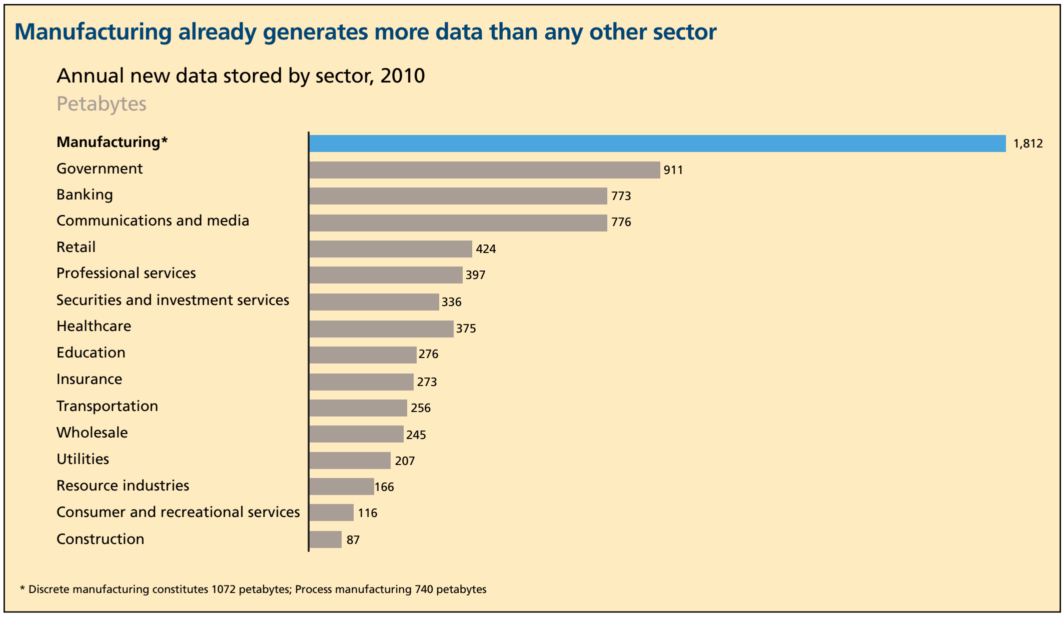


Figure 1. No industry produces more big data than manufacturing, creating a huge opportunity for improvement through advanced analytics.

Source: McKinsey

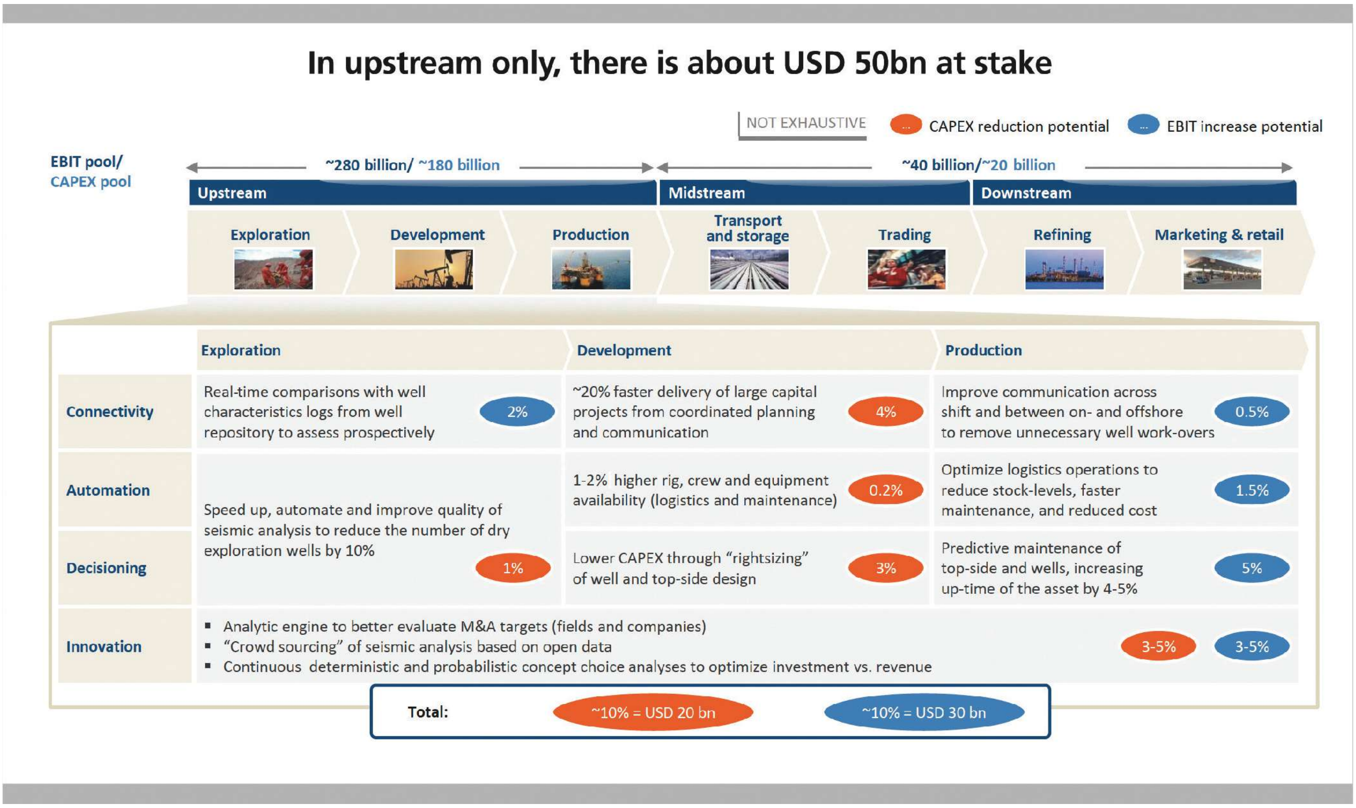


Figure 2. Better use of big data presents a $50 billion opportunity in upstream oil and gas facilities, with hundreds of billions of dollars in opportunity across other process industries.
Source: McKinsey

improvement, to the tune of $50 billion in the upstream oil and gas industry alone (figure 2).

Help is on the way as big data offerings and expectations have changed to better fit process manufacturing requirements. The market has moved from a Model T, "any color so long as it is black" product to a variety of sizes and shapes to meet customers' needs. The interface or user experience with many big data applications, for example, is no longer an erector-set experience.

In fact, a new set of themes around big data is emerging just as more companies are open to and interested in new advanced analytics experiences. If plant evolution is measured in decades, and big data awareness and innovation is approaching a decade of investment, the time should be ripe for implementing new technologies.

This article will discuss four of the expectations associated with a modern big data experience in process manufacturing firms. Fulfilling these expectations will result in a more polished and higher-level experience by taking advantage of the data management, storage, and analytics capabilities now available to improve production and business outcomes.

Context across data sources

The three "Vs" of big data—velocity, variety, and volume—are well known and have been part of the big data definition for longer than the term big data. But of the three, one of them is far more of an issue in process manufacturing than the other two.

The issue is not volume, because process historians and other sources have plenty of data stored and available for analysis. Similarly, velocity has a number of solutions with high capacity networks and faster ingest rates for historians. Variety, however, presents the biggest challenge to advanced analytics, and new big data solutions are working to address it.

The challenge with variety is that most existing plant sensors support only a limited data set of time, value, and perhaps state. Therefore, the most typical data type in manufacturing, time-series signals, is by definition separated from other data sources, which store the related context. So, before any investigation can take place, an engineer has to deal with the variety issue—in particular the integration of continuous analog signals with the relational or discrete data sets stored in other databases.

This integration, usually done by hand, is one of the biggest drivers of spreadsheet use within organizations. Even organizations with information models in enterprise manufacturing intelligence (EMI) solutions have to rely on spreadsheets for ad hoc analytics, because if a data set is not integrated and modeled in the EMI, and it rarely is, then it is back to square one and interpolation, alignment, and time matching by hand.

There are many terms for the alignment and integration of unlike data types in the industry. Data blending, data harmonization, and data fusion are three examples—but for process manufacturing firms, the term typically used is *contextualization*, which is adding context or information about the data as attributes of a time range.

This could be data stored in another source, for example, the periods of time defined by a batch stage or asset state in a manufacturing execution system (MES) or computerized maintenance management system. The context could be within the time series data itself, defined by when a reading is above or below a certain threshold. Or it could simply be time periods of interest, for example, when a signal "looks like this," with context created to define when a shape or pattern is present in a signal.

In each of these cases, context is added to identify the time periods of interest. Once identified, these time periods can be combined to create a new set of time periods describing an exact, multidimensional data set for analysis (figure 3). With new big data capabilities, there need not be any bounds to the depth or number of "stacked" layers required, up to 15 or more sequential layers of criteria in some cases. With most analytics efforts requiring integration of data from five to seven different sources, this is a critical advantage over current approaches.

With unlike data types, in particular time series and relational data sources, advanced analytics can get off to a slow start by requiring extensive manual mapping of data types, not to mention data cleansing and other aspects of data preparation. But with recent innovations, underlying big data technologies provide this type of data connectivity, alignment, and mapping to accelerate the definition and modeling of complex operations. What was once the month-long job of programmers and application programming interfaces (APIs) can now be features any process engineer can implement in minutes.

Figure 3. Using Seeq capsules, engineers can combine time periods to create a new set of time periods describing an exact, multidimensional data set for analysis.

Delivering self service

In the early stages, big data meant programmers writing code to *map* the analytics of a large data set to a cluster of compute nodes, and then to *reduce* the output from the nodes into a consolidated summary. The MapReduce algorithm, which defined this programming model, was open sourced by Google in 2004 and became the basis for Hadoop, which was later commercialized by vendors such as Hortonworks.

At the same time, Google did not expose the MapReduce API to users as the interface to their search engine. Instead, they presented the algorithm's functionality in a simple web page where any customer could simply search for whatever they wanted by just typing in data in plain English.

This approach to wrapping complex functionality in easy-to-use interfaces is a common experience in our lives as consumers, and these same approaches are now being adopted by analytics offerings for engineers in process manufacturing.

For example, the ability to "search like Google" across all the tags in a historian or other big data storage system is now available in some advanced analytics software. Other capabilities that make big data innovations more easily accessible are similarly delivered. This enables (never allows) engineers to work at an application level with productivity, empowerment, interaction, and ease-of-use benefits.

The ability to transform complex data science programming to features easily used by engineers is a critical capability of the advanced analytics offerings. Although there has been much excitement about data scientists and their role in improving production outcomes, such as the *Harvard Business Review's* "Sexiest Job of the Century" article back in 2012, more recent articles and anecdotes from end users tell a different story.

The issue is that while data scientists know their algorithms, they do not know plant processes and context. There has been a more recent spate of articles on the need for data translators or data liaisons between data science and engineering teams. But all of this can be avoided if vendors simply close the gap and bring data science innovation to engineers by creating features that enable self-service, advanced analytics for engineers and other subject-matter experts (figure 4).

The strategy cannot end with engineers, however, because self-service is what engineers have been doing for 30 years with spreadsheets. Therefore, the new generation of advanced analytics for big data must empower teams and networks of employees that rely on production and operations insights within the organization. If that sounds like fancy language for dashboards and reports, there is a critical difference.

The key change is maintaining a connection between the analysis that is created and the underlying data set, so users can click through and get to the underlying data. These advanced analytics offerings can be used to produce not just pictures of data in visualizations but can also provide access to the analytics and sources that generated the outputs. Engineers, teams, managers, and organizations can therefore

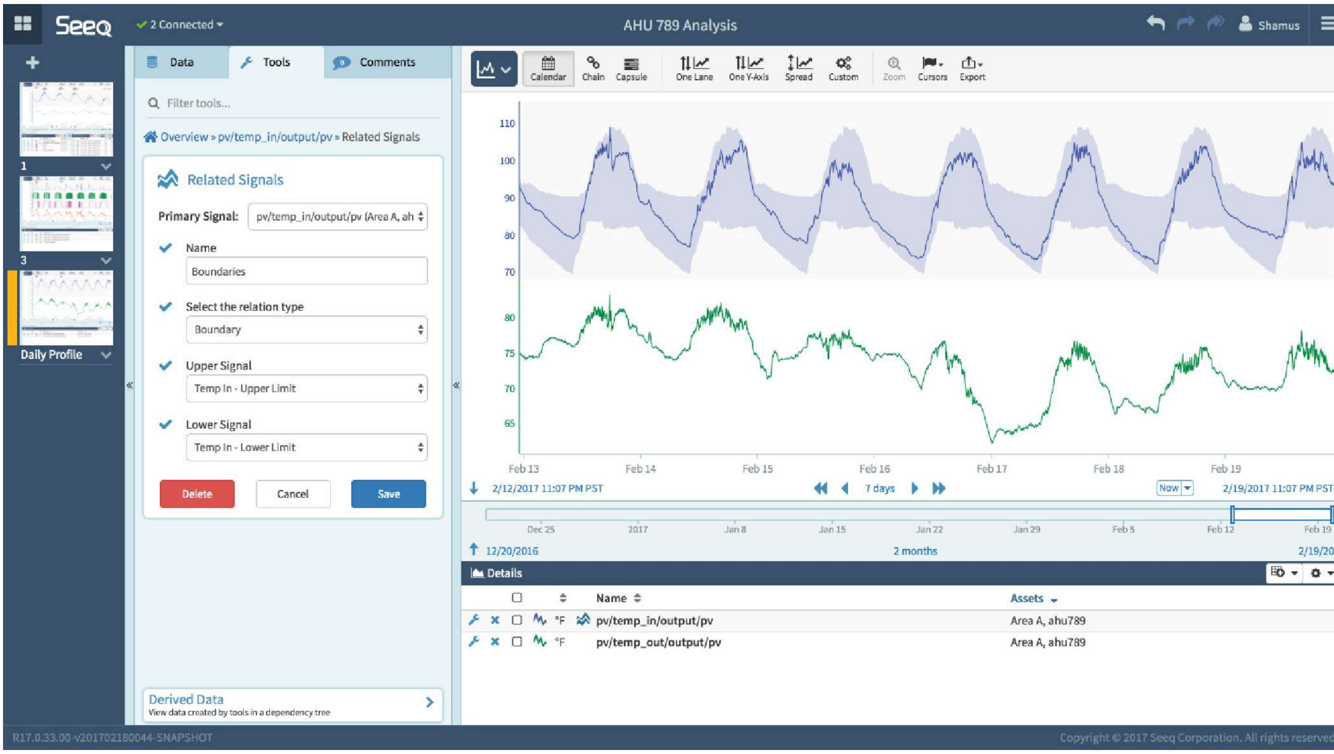


Figure 4. Advanced analytics software provides self-service capabilities for engineers to create various views of data.

use these new capabilities to enable the distribution of benefits throughout a plant and a company.

Revolution in deployment

"We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run," observed Roy Amara, past president of The Institute for the Future. If big data is not new, then certainly the cloud is not either. Some popular picks for the start of cloud computing include the introduction of the first big "SaaS" application (Salesforce) in 1999; the introduction of AWS by Amazon in 2002, and then S3 and EC2 in 2006; and when cloud computing competition got interesting with Microsoft's and Google's cloud platform introductions in 2008. So conservatively, like big data, there is a decade of history and innovation to leverage for advanced analytics.

To be clear, the cloud is not a requirement for big data implementations. If someone says a cloud deployment is required for advanced analytics with big data, he or she is likely a cloud salesperson seeking quota fulfillment. In our experience, the data is just fine, wherever it is; it is the analytics that needs attention.

That said, there are many good reasons to leverage cloud computing, and it certainly has momentum in its favor, although it is impossible to generalize proposed benefits versus specific costs for every organization. Costs can include security, data governance, time to gain approval, and actual cost of deployment. If one couples the cloud, or not, with innovations in both open source data management and Industrial Internet of Things (IIoT) cloud platform investments, the result is a host of tempting elements for deployment of big data solutions. Consider that in just 90 days in late 2017 and early 2018, eight companies received more than $250 million in investment capital for open source data storage, IIoT cloud platform, and IIoT analytics—and one gets a sense of the interest in advanced analytics.

What this means is that the current model for big data storage in process manufacturing—which is on-premise, historian-based, and proprietary—is undergoing a transition, enabling new alternatives for how and where advanced analytics are run. The new model might be a data lake for data aggregation, on-premise or in the cloud, or a comprehensive IIoT solution—like a next-generation data storage platform. At a minimum, current process historian vendors need to introduce road maps with safe passage for data from on-premise offerings to the cloud.

As a vendor of advanced analytics solutions, here are examples of what this means to the end users we work with daily. Three years ago, we had customer requests for sales engineers to visit them on site to work with their on-premise and air-locked data sets. Today, in contrast, we have customers sharing five-year road maps that integrate cloud-based offerings, and specifically asking for context on some of the open source offerings, such as Hortonworks and InfluxData. The assumption that data can never, or will never, move to the cloud is increasingly uncommon, and has changed quite quickly in process manufacturing over the past few years.

Not only will the services and deployment models change, but new vendors will enter the market for data management and analytics. In particular, Microsoft, Google, and Amazon all have cloud platforms and time-series data storage services—Cosmos DB, Bigtable, and Dynamo, respectively. All three have acquired IIoT platform companies (Solair, Xively, and 2lemetry, respectively) to build out their manufacturing solutions.

GE with Predix, Siemens with MindSphere, and PTC and ThingWorx may have more industrial domain knowledge, and OSIsoft starts out with the best customer base and richest on-premise offering, but the deployment revolution offers flexibility in deployment and service levels for how companies license and run advanced analytics solutions.

calculation offerings that have been used for years to accelerate insights for end users. As McKinsey and Company defines advanced analytics solutions: "These [advanced analytics solutions]—which provide easier access to data from multiple data sources, along with advanced modeling algorithms and easy-to-use visualization approaches—could finally give manufacturers new ways to control and optimize all processes throughout their entire operations."

What has happened is that vendors have recognized there is too much data from too many sensors, and potentially of too many types, for one person to simply solve problems manually with a spreadsheet. Therefore, through the introduction of machine learning or other analytics techniques, an engineer's efforts must be accelerated when seeking correlations, clustering, or any needle within the haystack of process data. With these features built on multidimensional models and enabled by assembling data from different sources, engineers gain an order of magnitude in analytics capabilities, akin to moving from pen and paper to the spreadsheet.

These advanced analytics innovations are not a black box replacement for the expertise of the engineers, but a complement and accelerator to their expertise, with transparency to the underlying algorithms to support a first principles approach to investigations. In this way, it is a natural next step in the history of statistical and control processes, rather than a data science approach to investigations. At the same time, advanced analytics recognizes the path to quicker insights must leverage innovations in adjacent areas to address the scope of data available for investigation.

Analytics is now so over used that the word has lost specific meaning in a 30-year history of spreadsheets and in a 20-year role with the term marketed for "actionable insights."

Advancing analytics

The manufacturing industry would be well serviced by a marketing dictionary to define the large number of buzzwords, technology eras, and "marketectures" (marketing architectures that run on PowerPoint). In this dictionary of terms, big data would of course be included under "B," but it would be preceded by "analytics." Analytics: descriptive, predictive, diagnostic, interactive, prescriptive, basic, real-time, historical, root cause, and so forth. Analytics is now so over used that the word has lost specific meaning in a 30-year history of spreadsheets and in a 20-year role with the term marketed for "actionable insights."

But now, the role of analytics has to change to address the volume, challenges, and opportunity associated with massive data volumes, variety, etc. To the rescue comes a new entry to the dictionary, "advanced analytics." Just as adding "smart" to a noun denotes a thing with sensors for telemetry and remote monitoring services (e.g., smart refrigerator, smart parking lot), adding "advanced" to "analytics" brings analytics into a modern framework for today's challenges.

Specifically, advanced analytics speaks to the inclusion of cognitive computing technologies into the visualization and

Same last mile

As process manufacturers find an opportunity when their plant transitions or capital investments enable the introduction of new advanced analytics capabilities, they will find a new set of features and experiences, far removed from the early days of the big data era. Applying these advanced analytics solutions to big data will improve the user experience by accelerating the path to implementation.

Contextualization, self-service for organizations, new platforms options, and advanced analytics capabilities benefit from years of vendor investment and early adopter feedback. The one thing they do not guarantee, however, is success in the last mile of any analytics project, big or small, which is the landing or adoption of new insights into a conservative and questioning culture. That, always, is the largest obstacle for any analytics project, which no amount of technology innovation can paper over.

But by embracing an analytics culture and the innovation now available, organizations can seize the opportunities to create value from their big data, allowing them to remain competitive. ■

ABOUT THE AUTHOR

Michael Risse (michael.risse@seeq.com) is vice president and CMO at Seeq Corporation, a company building advanced analytics applications for engineers and analysts to accelerate insights from process manufacturing data. He was formerly a consultant in big data applications and platforms, and prior to that worked with the Microsoft Corporation for 20 years. Risse is a graduate of the University of Wisconsin at Madison.

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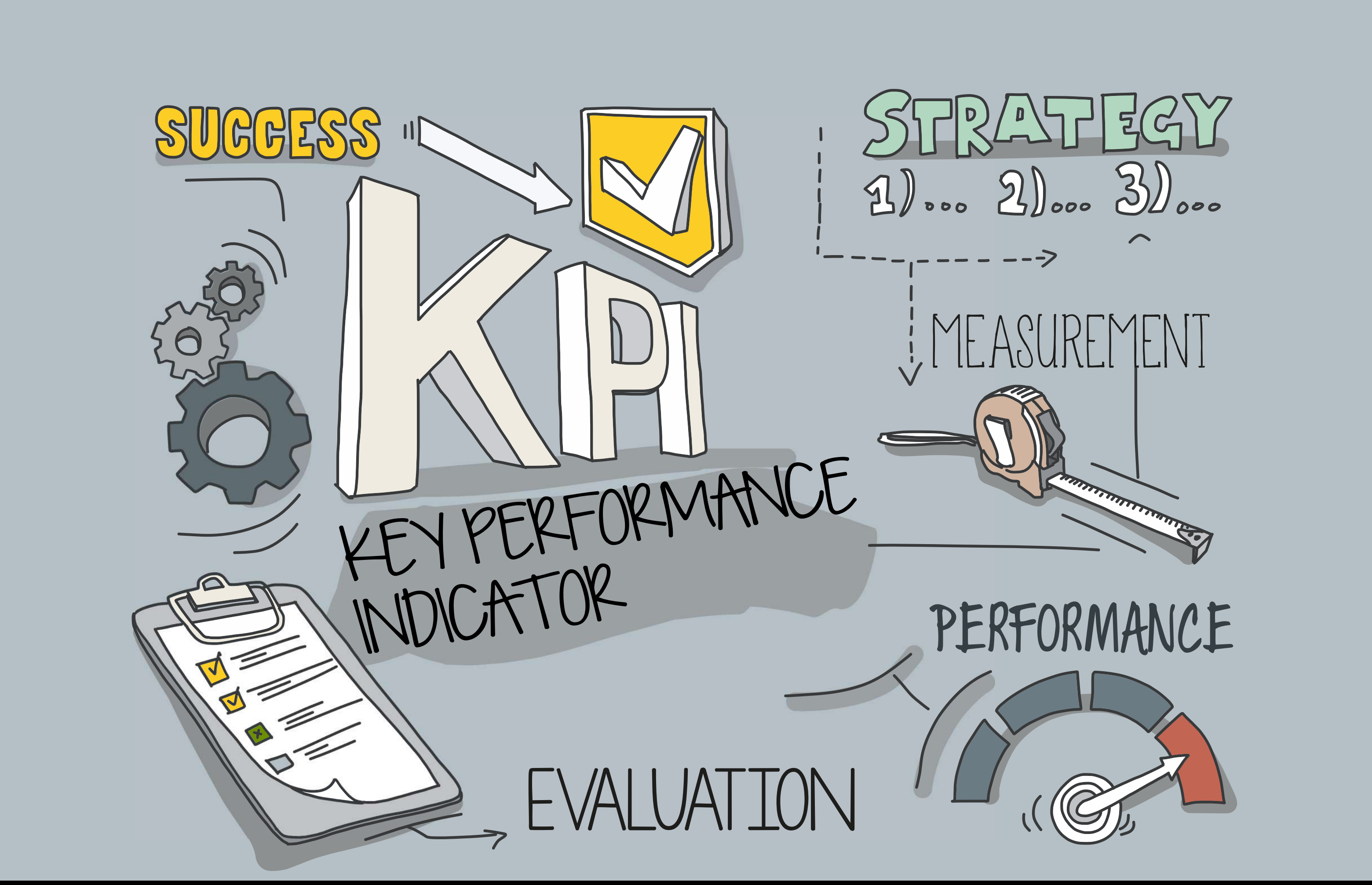


Optimizing related process variables to improve profitability

By Yasunori Kobayashi

Profitable and reliable operation depends on optimizing related process variables, which can be achieved by control room operators leveraging DCS domain knowledge and big data

In today's competitive environment, process industry companies are focused on two key objectives: profitability and delivering value to customers. However, these objectives are often disparate goals not aligned across departments, plants, or enterprise boundaries.

Disconnected, outdated methods of reporting and inconsistent metrics make it nearly impossible to get a holistic view of performance drivers. Information is often available only after the fact and lacks contextual knowledge, which leads to poor decision making.

To address these and other issues, many companies use C-level key performance indicators (KPIs), such as costs, margins, and incidents. Unfortunately, the KPIs used by C-level executives (CEOs, CFOs, etc.) frequently do not match up with those used by engineering and operations personnel. They typically have their own set of KPIs, often generated independently to maintain safe and stable plant operations.

Additionally, factors like integrity operating windows, plant constraints, and economic conditions can affect KPI prioritization and operations. Adding to these challenges, experience and competency are declining due to retirement of key personnel, especially control room operators. This situation can be addressed and rectified to some extent by using the big data stored in distributed control systems (DCSs) and plant historians to create better KPIs, but this requires careful analysis to produce the desired results.

What if KPIs could be structured systematically across an organization from management through engineering to operations to unify all the employees' capabilities, motivate them to do better, and cultivate the knowledge that is in the DNA of the organization? This can be done, but it requires alignment of KPIs among all plant personnel, starting with optimization of related process variables in operations.

Creating systematic SPIs

Domain knowledge and the big data found in the plant DCS can help process industry companies select, monitor, and optimize key process variables and set points for operations, such as fuel gas consumption, furnace efficiency, and main fractionator pressure. Given the right information, control room operators can accomplish these tasks by interacting with the DCS. Successful implementation will not only result in safe and stable operation, but also improve profitability, energy conservation, and asset reliability.

Process variables are optimized by setting an optimal range for each critical set point, which can be used to systematically structure a plant's KPIs and create an improved set of metrics, henceforth referred to as synaptic performance indicators (SPIs).

Process historians are electronic databases, typically used to store and display data. In a process plant, common data points include temperatures, flow rates, pressures, levels, and other types of analog data. Increasingly common is the "historization" of digital data, such as the output or feedback states associated with valves, pumps, and other discrete control devices.

Analysis of historical data by process engineers and experts with extensive domain knowledge can determine the correct range for each set point, a complex task because many control loops interact with each other. Further complexity is added by also considering the effects of set points on the supply chain. All this data can be combined to provide deep insight into the behavior of a process at any point in time. These insights can be used to optimize set points for improved operations.

SPIs for each area can be defined by using domain knowledge and historian information. SPIs help operators set an ideal range for each variable with an alerting function. They provide expert guidance in the form of messages when a variable goes outside of the ideal range. Other functions in a DCS can guide operators to optimize related process variables for more profitable and reliable production.

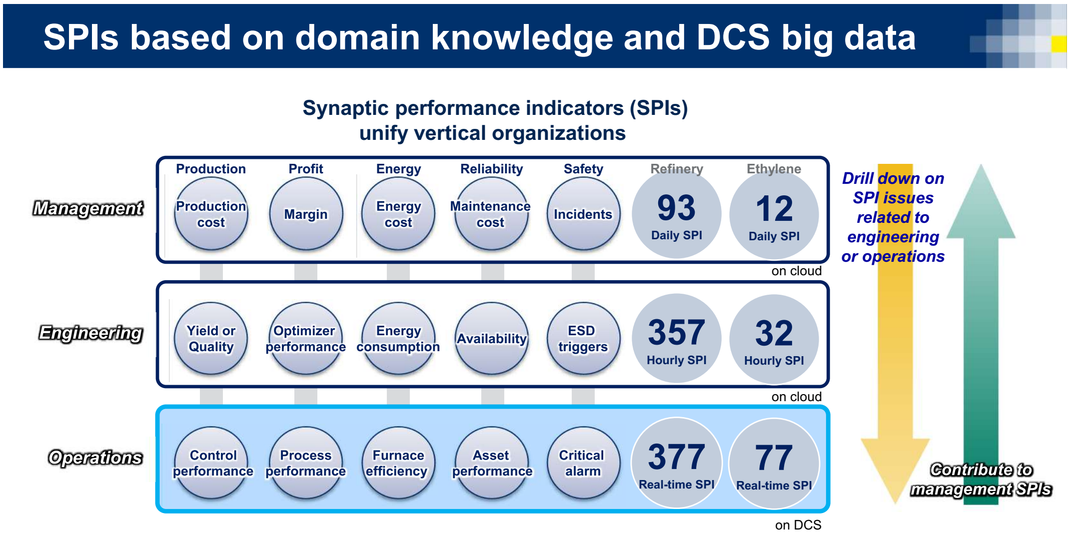
These key process variables are systematically connected to engineering and C-level KPIs, so C-level personnel can drill down on KPI issues related to engineering or operations. Operations can also contribute to C-level KPIs.

SPIs in action

At the operations level, a typical midsized refinery has about 377 SPIs, and a typical ethylene plant has about 77 SPIs. Approximately 60 percent of SPIs indirectly correspond to control variables, and 40 percent directly correspond to

FAST FORWARD

- KPIs are often not aligned, producing suboptimal process plant performance.
- Advanced process control metrics referred to as synaptic performance indicators can be used to align KPIs.
- The result is improved performance, primarily driven by control room operators supplied with SPI information and suggested actions.



Source: Yokogawa

Figure 1. The term synaptic performance indicator (SPI) identifies an improved set of key performance indicators that can be used to optimize plant operations.

control variables. Our midsized refinery will have about 93 high-level SPIs for daily viewing and use by management, 357 SPIs for hourly viewing and use by engineering personnel, and 377 SPIs for real-time viewing and use by shift operators (figure 1).

Some of the management and engineering SPIs use manufacturing execution system data as well as DCS data (e.g., production plan data, crude assay data, laboratory data), along with data from external sources, such as utility and feedstock pricing. Managers and engineers often prefer to check SPIs using a laptop, mobile phone, or tablet from anywhere in the world.

Therefore, management and engineering SPIs are often provided via a digital twin in the cloud (figure 2). The digital twin in the cloud gathers data from the plant's distributed control systems, historians, and labs—as well as from other sources, such as feedstock and energy pricing. It uses this data to calculate relevant management and engineering SPIs, and securely distributes this information to users worldwide.

On the other hand, operations SPIs, the main topic of this article, can be determined using DCS data. Each of the 377 operation SPIs has up to five subcategories in the areas of control performance, process performance, energy efficiency, asset performance, and critical alarms. For SPIs not measured due to a lack of sensors or analyzers, process simulation can be implemented within the DCS to calculate soft sensors for estimating unmeasured process variables from measured variables using rigorous process models.

Improve operations

Once the SPIs are created, they provide measurable goals for control room operators, typically tied to optimization strategies and production plans. Most of these goals are achieved not through the efforts of a single operator, but by the effort of all operators working in the facility, so tracking operator performance is difficult, but can be done by using karaoke-type dashboards.

In Japan, there is a mechanism for scoring karaoke singers based on categories, such as pitch, technique, passion, stability, and rhythm. These dashboards help singers analyze their singing and motivate them to improve.

In process plants, karaoke-type dashboards use a similar scoring mechanism, but focus on operational priorities, such as production, profit, energy, reliability, and safety (figure 3). These dashboards help control room operators analyze operational priorities and find areas for improvement, motivating them to achieve improved operation.

The karaoke-type dashboard tracks the performance of each control room operator during his or her shift by checking the uptime of an SPI (time during which the SPI is in the ideal range or without alarm). Operators can check their performance with respect to profit, production, safety, reliability, and energy use. Improvements can be visualized by improved performance of the operator during a shift.

Karaoke-type dashboards can be linked to relevant SPI dashboards that display each SPI with its ideal range(s). If a certain SPI is outside the ideal range, an alert is automatically activated, and expert advice is displayed so the control room operator can take agile action to optimize the SPI. By optimizing SPIs, operator actions mimic those of a multivariable controller, which is one of the categories of advanced process control, resulting in optimal control of related process variables.

Improve process plant engineering

SPIs, alert information, and operators' scores are stored in the DCS, and plant engineering and third-party personnel can use them for benchmarking, root-cause analysis, or expert consulting for continuous improvement. SPIs and related dashboards can thus help engineers and operators transform their work from event driven to profit driven.

Even with profit-driven operation, it is easy to fall into the trap of functional silos of information, with each person optimizing his or her area of responsibility to meet objectives—but with overall effectiveness of the organization, operation, or value stream suboptimal. This happens when the engineering team and management personnel use a set of SPIs that are different from and nonaligned with the control room operators' SPIs. This problem can be addressed by having aligned targets for engineering, operations, and management.

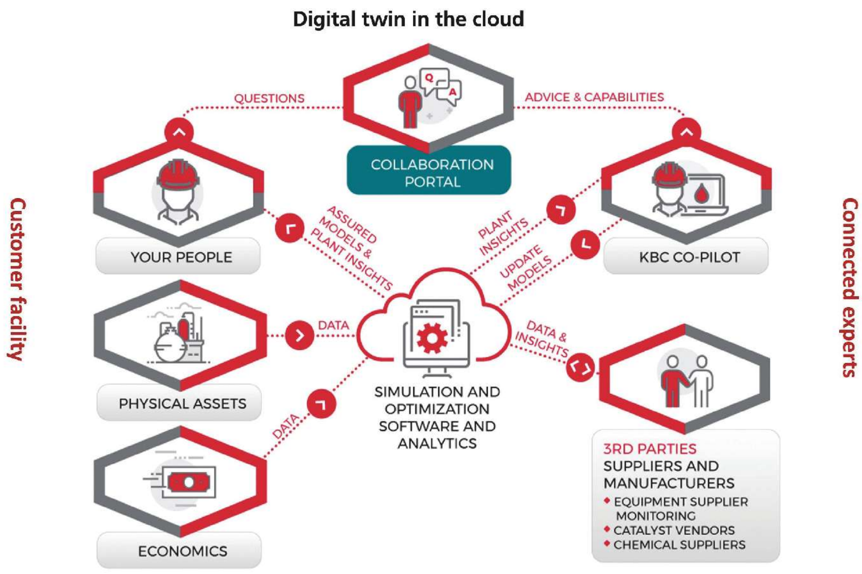
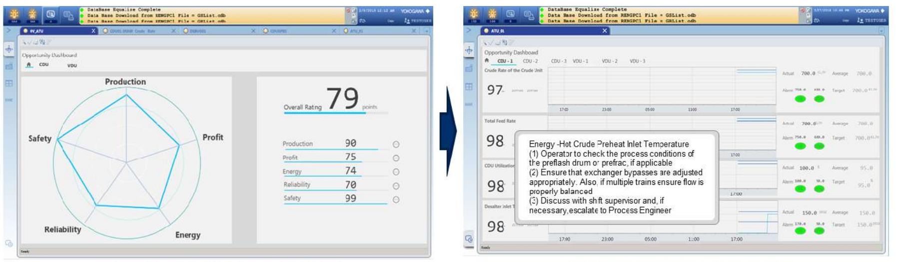


Figure 2. Digitally replicating live plant operating data and economic data in the cloud allows KBC, a division of Yokogawa, to distribute SPIs to management and engineering personnel worldwide.



Shift-basis karaoke-type dashboard

- Operators understand the pattern of own operation
- Operators can be motivated to better operation
- Operators drill down on reasons of low score
- Managers analyze the balance of different objectives
- Managers identify improvement opportunities

SPI dashboard with expert advice

- Senior operators can take agile action based on alert and expert advice
- Managers can avail benefits of benchmarking, root-cause analysis and expert consulting for continuous SPI improvement

Figure 3. Control room operators can use karaoke-type dashboards to improve plant production, profits, energy use, reliability, and safety (left side of diagram). Plant engineers and experts create SPI dashboards to guide operator actions and optimize SPIs (right side of diagram).

The control room operator SPIs are utilized to alarm the engineering team of possible improvement opportunities, and this creates aligned targets for the operations and engineering teams. The engineering team can use structured SPIs and stored data for analysis of plant performance, for improvement opportunities, and for analysis of other issues related to production.

Improve plant management and performance

SPIs for management give a clear picture of high-level performance metrics, such as facility operations, the difference between planned and actual production, and energy use. The balanced performance metrics associated with carefully crafted SPIs lead to improvements in quality and efficiency, reduce inventory, ensure compliance, and increase flexibility—ultimately leading to greater profitability.

SPIs are systematically and seamlessly connected from the management level to engineering personnel and then to control room operators, and vice versa. They help management to drill down to issues related to operations. Improvements in control room operator SPIs also ultimately contribute to better management SPIs.

Synaptic performance indicators aligned from operations to engineering to management provide a common mission for all plant personnel, leading to improved performance of the plant or facility. ■

ABOUT THE AUTHOR

Yasunori Kobayashi (yasunori.kobayashi@jp.yokogawa.com) is the general manager and executive consultant at Yokogawa. He has 30 years of consulting experience in process automation, and over 10 years of management experience in R&D, marketing, sales, operations, and services. He has led projects developing new solutions, including procedural automation using AI (Exapilot), software sensors using Neural Networks (Exaneuro), real-time alarm browsers in DCS (CAMS), automation benchmarking (CEA), knowledge-based graphics using ergonomics (AOG), and remote monitoring and consulting using cloud technology (KBC Co-Pilot Program).

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Simplified remote access

Remote monitoring and control systems using modern data collection techniques deliver improved performance and security, along with simpler implementation and lower costs

By Benson Hougland

Data collection from industrial facilities and plants provides a number of benefits to end users, system integrators, and machine and process skid builders. End users can monitor their facilities and plants worldwide from any location with cellular network or Internet access, and system integrators can do the same for their projects. Original equipment manufacturer (OEM) machine and process skid builders can monitor their products and systems wherever they are installed, even at remote customer sites.

Data collection by OEMs can be especially useful for both the OEM and the customer. Data can be acquired for analysis and remote monitoring, and data can be sent to machines and process skids for remote control. This two-way remote access provides:

- remote monitoring to quickly alarm and alert personnel
- predictive capabilities to anticipate problems before they occur
- remote control to respond to issues and problems
- improved overall equipment effectiveness: better uptime, throughput, and quality
- cost savings by eliminating most trips to the field

In addition, OEMs can:

- log usage data for billing or maintenance
- gain insight into customer needs
- analyze data to improve future product or process designs

Although most OEMs need remote access to provide the quality of service their customers want, the barriers are high and include security issues, technical difficulties, and costs.

Cybersecurity is a major concern for both OEMs and their customers. Busy information technology (IT) departments may not have the time, resources, or technical skills to set up remote access to automation systems and equipment.

As a result, older methods like opening ports through firewalls and creating virtual private network (VPN) tunnels are falling out of favor. Newer methods of remote access, particularly those using the Message Queuing Telemetry Transport (MQTT) protocol in publish/subscribe communication models, can be a major improvement, providing the data and access OEMs need without burdening their customers (sidebar).

Industrial hardened edge programmable industrial controllers (EPICs) address these and other remote access requirements with local computing, multiple programming options, local control, and sensor input and output interfaces.

Edge processing

Edge processing encompasses at least three functions. The first is to collect, process, view, and exchange data where it is produced—at the edge

of a network. This function requires a powerful processor and an open operating system, such as Linux. The processor filters out anomalies, sorts relevant data, and creates exception-only reporting.

The second function is securely storing and sharing data among databases, cloud platforms, Web services, and programmable logic controllers (PLCs) using modern communication methods. Sharing data with this wide range of hardware and software requires support for multiple communication options at both the hardware and software level.

At the hardware level, multiple communication ports are a must. Minimum requirements for modern systems include multiple gigabit Ethernet, USB, and serial ports. At the software or protocol level, many protocols should be supported, including different variants of Ethernet, Modbus RTU and Modbus/TCP, and MQTT.

Many industry offerings now include embedded support for multiple connectivity methods in their EPICs, including Ethernet and Modbus protocols, plus OPC UA drivers and MQTT/Sparkplug. These methods give support now, and also provide for the future, as vendors are constantly updating their protocol support options.

The third function of an edge processor is to bring data visibility to authorized personnel in several ways: on an integral touchscreen, on a local human-machine interface (HMI), and from any device capable of hosting a Web browser (figure 1). Many OEMs will find an integral touchscreen, and an HDMI port for optional connection to

Figure 1. Local monitoring, control, and adjustments are greatly facilitated by providing built-in HMI on the edge controller.

FAST FORWARD

- Many remote access solutions require extensive IT assistance and support.
- Newer solutions rely on open systems to simplify remote access, allowing it to be implemented by operations personnel.
- These new solutions provide fast and secure remote access, along with simple implementation, which is particularly important for OEMs and their customers.

an external display, a significant benefit.

If the touchscreen is sufficient, then the OEM can save the expense of purchasing and installing an external HMI. If the vendor includes an HMI development tool as part of the EPIC software package, a low-cost graphics monitor can simply be connected to the HDMI port to provide an external HMI. In that case, there is no need for an external PC-based HMI, which is very expensive due to the high costs of industrial PCs and PC-based HMI software.

Programming options

Multiple programming options are required for any modern EPIC. Some of the more popular languages are flowcharting with scripting options for sequential machine and process skid control, and the suite of IEC 61131 languages. These two options will be sufficient to support most real-time control needs, but some OEMs may require or prefer more flexible and powerful programming languages, such as C/C++, Python, and Java. These and other languages can be most easily used if the EPIC provides secure shell access, a common feature when a Linux operating system is used. And all of these languages can be used together, with data passing among them internally within the EPIC as required.

For many remote access applications, real-time control is of secondary importance, with data exchange among various controller, HMI, and other platforms the primary goal. For these types of tasks, the browser-based, open-source, flow programming tool Node-RED (https://nodered.org) is becoming more widely used by EPIC vendors, and by many other companies in both the commercial and industrial sectors (figure 2).

Using this open-source visual language, developers can cut and paste prebuilt function blocks or nodes to configure various communication paths. Because Node-RED is specifically designed for these types of tasks, it is much easier to use for data handling than languages designed for real-time control, such as flowcharts, or general-purpose languages, such as C/C++, Python, or Java.

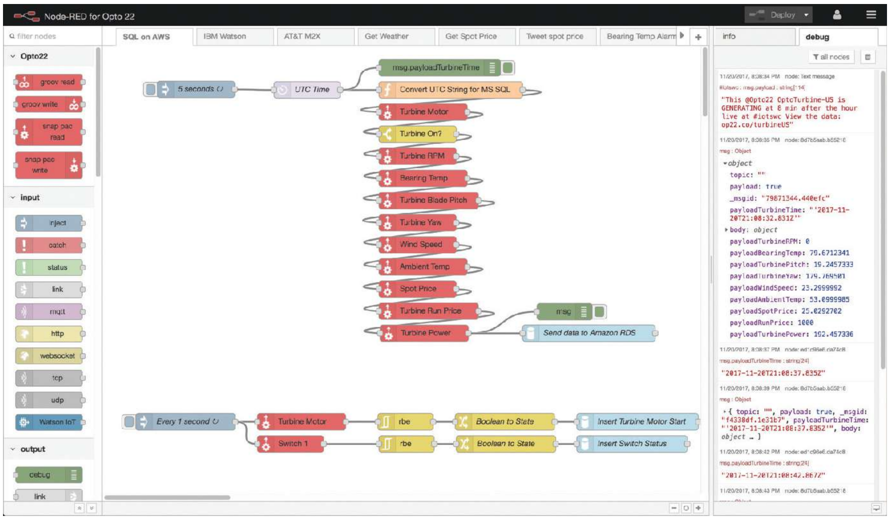

Figure 2. The open-source Node-RED programming tool embedded in edge controllers enables users to easily wire together hardware devices, APIs, and online services.

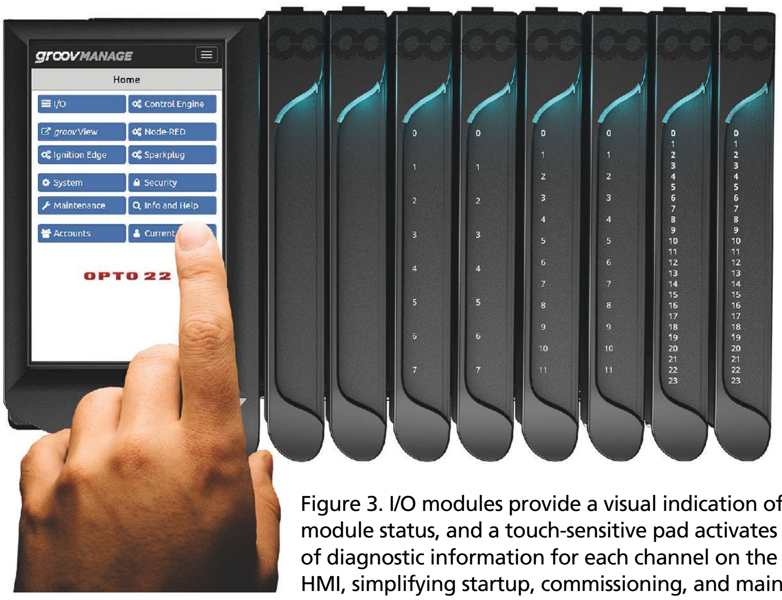

Figure 3. I/O modules provide a visual indication of the overall module status, and a touch-sensitive pad activates the display of diagnostic information for each channel on the embedded HMI, simplifying startup, commissioning, and maintenance.

Industrially hardened

Many of the capabilities mentioned above are in commercial data collection products, specifically PCs with plug-in data acquisition cards. But using these products in an industrial environment presents a number of problems.

First is the difficulty of mounting and protecting commercial components, such as a desktop PC, in an industrial enclosure. Second is the high likelihood of failure after installation due to temperature extremes, shock and vibration, electrical noise, and other conditions common in industrial environments. Third is the lack of certification for use in hazardous locations.

To avoid these and other issues, any EPIC intended for an industrial remote access application should meet minimum requirements, including:

- DIN-rail mounting
- operation from about –20°C to 70°C
- industrial microprocessor
- solid-state drive
- certification for use in hazardous locations

One of the most basic functions for any remote access system is connecting inputs to I/O terminals in an efficient manner.

Control and I/O

Connecting control outputs and inputs should be as simple and foolproof as possible, particularly with the larger point counts to support Industry 4.0 and Industrial Internet of Things. Ideally following industry norms, I/O terminations are made to removable and hot-swappable terminal blocks incorporating a quick connect to the edge controllers that have a captive hold-down (i.e., screw). Terminations made to the block should support up to 14 AWG using accepted industry methods, including spring clamps and screws. Supporting the high point counts for Industry 4.0 and Industrial Internet of Things high-density I/O modules should strongly be considered (i.e., 24 channels per module). Multiple discrete and analog input types and at least 20-bit resolution for analog inputs to support the wide range of control and big data applications should be included. Local LEDs indicating the status of each channel enable local users to verify operation at a glance (figure 3).

In addition, I/O configuration should be simple, with individual I/O modules reporting their identities to the EPIC. Ideally, a local touchscreen will have I/O specifications, wiring diagrams, and channel status to facilitate commissioning and troubleshooting.

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"A new way to envision your remote process"
www.isa.org/a-new-way-to-envision-your-remote-process

Simplifying edge automation

Remote access used to be a complex undertaking for machine builder and process skid OEMs, with numerous issues related to performance, cybersecurity, and IT details. New automation components and open standards, such as MQTT and Sparkplug, are addressing this issue, making it far easier and less expensive to deploy and support highly secure remote access systems. ■

ABOUT THE AUTHOR

Benson Hougland (bensonh@opto22.com), vice president, marketing and product strategy, drives strategy for Opto 22 products, connecting the real world to computer networks. He has 30 years of experience in IT and industrial automation and speaks at trade shows and conferences, including IBM Think, ARC Forum, and ISA. Hougland's 2014 TEDx Talk introduces nontechnical people to the IoT.

View the online version at www.isa.org/intech/20180603.

Request-response versus publish-subscribe

There are two main methods for implementing network communication in a data collection or remote access application: request-response and publish-subscribe.

In the request-response model, a client computer or software requests data or services, and a server computer or software responds to the request by providing the data or service. In industrial remote access applications, the client is typically a laptop, PC, tablet, or smartphone. The client requests data from the server, usually a controller, such as an EPIC, PLC, or PAC.

A different way, which is often preferred for remote access applications, is for devices to communicate on a network called publish-subscribe, or pub-sub. In a pub-sub architecture, a central source called a *broker* (also sometimes called a server) receives and distributes all data. Pub-sub clients can publish data to the broker, subscribe to get data from it, or both.

Clients publishing data send it only when the data changes, often referred to as *report by exception*. Clients subscribing to data automatically receive it from the broker/server—but again, only when it changes. The broker does not store data; it simply moves it from publishers to subscribers. When data comes in from a publisher, the broker promptly sends it off to any client subscribed to that data.

MQTT is a popular and open transport protocol used with the pub-sub architecture. MQTT is extremely lightweight. It takes up almost no space in a device, so that even small devices with very little computing power can use it. But MQTT does not define how the data is packed or unpacked, so another standard is useful, such as Sparkplug that encodes the data payload and defines how the data is packed before it is sent by the publisher and how it is unpacked at the subscriber.

Data sent over MQTT with Sparkplug is compressed and efficient. MQTT messages packed with the Sparkplug definition must also be unpacked with Sparkplug, so both publishers and subscribers must use it in order to get the data delivered. MQTT with Sparkplug also has an efficient way to track the state of clients to make sure clients on a tenuous connection can still deliver and receive data.

In systems with multiple servers and clients, typical in many remote access applications, the volume of traffic in a request-response model can quickly become a problem. This is because each client is individually connected to each server it needs to request data from, and each connection may be opened, queried, answered, and closed—over and over.

In contrast, a pub-sub architecture simplifies communications (sidebar figure). Direct connections and repetitive requests for data are not needed. The web of links is replaced by a single link from each device to the broker/server.

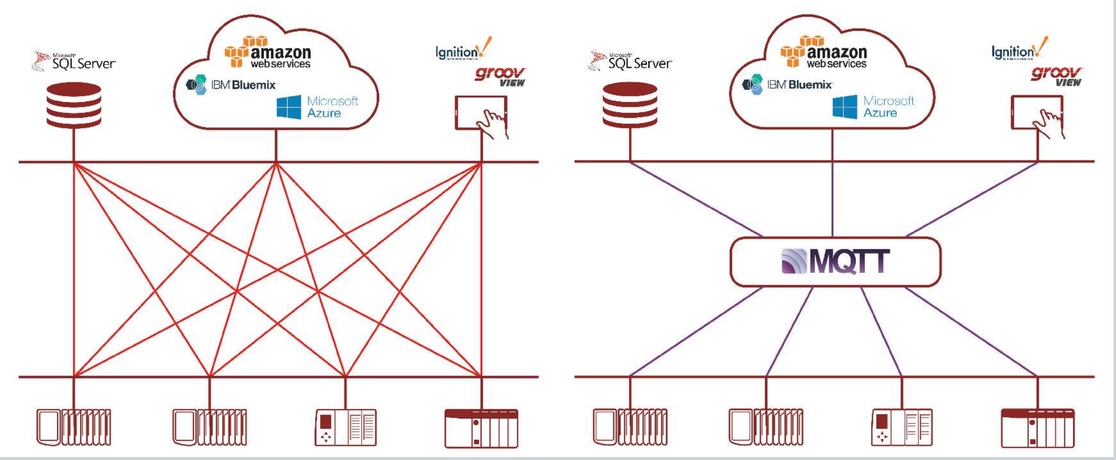
The connection between client and broker is kept open and is lightweight. Only two things travel over this connection: changed data and a tiny heartbeat to let the broker know that the client is still there.

A pub-sub model, therefore, works well for systems with many servers and many clients that need to share data and services, which is typical in remote access applications implemented by OEMs. In these applications, a controller in a machine or process skid serves information to clients. An OEM may have hundreds of machines or process skids installed worldwide, so there are many servers. Multiple OEM and OEM customer personnel may require remote access, and each device used is a client.

Because the broker is the central clearinghouse for data, individual servers do not have to strain to serve multiple clients, and clients do not have to connect to multiple servers. In addition, network traffic is reduced overall, because data is published and sent on a report-by-exception basis—that is, only when the data changes—rather than at regular intervals.

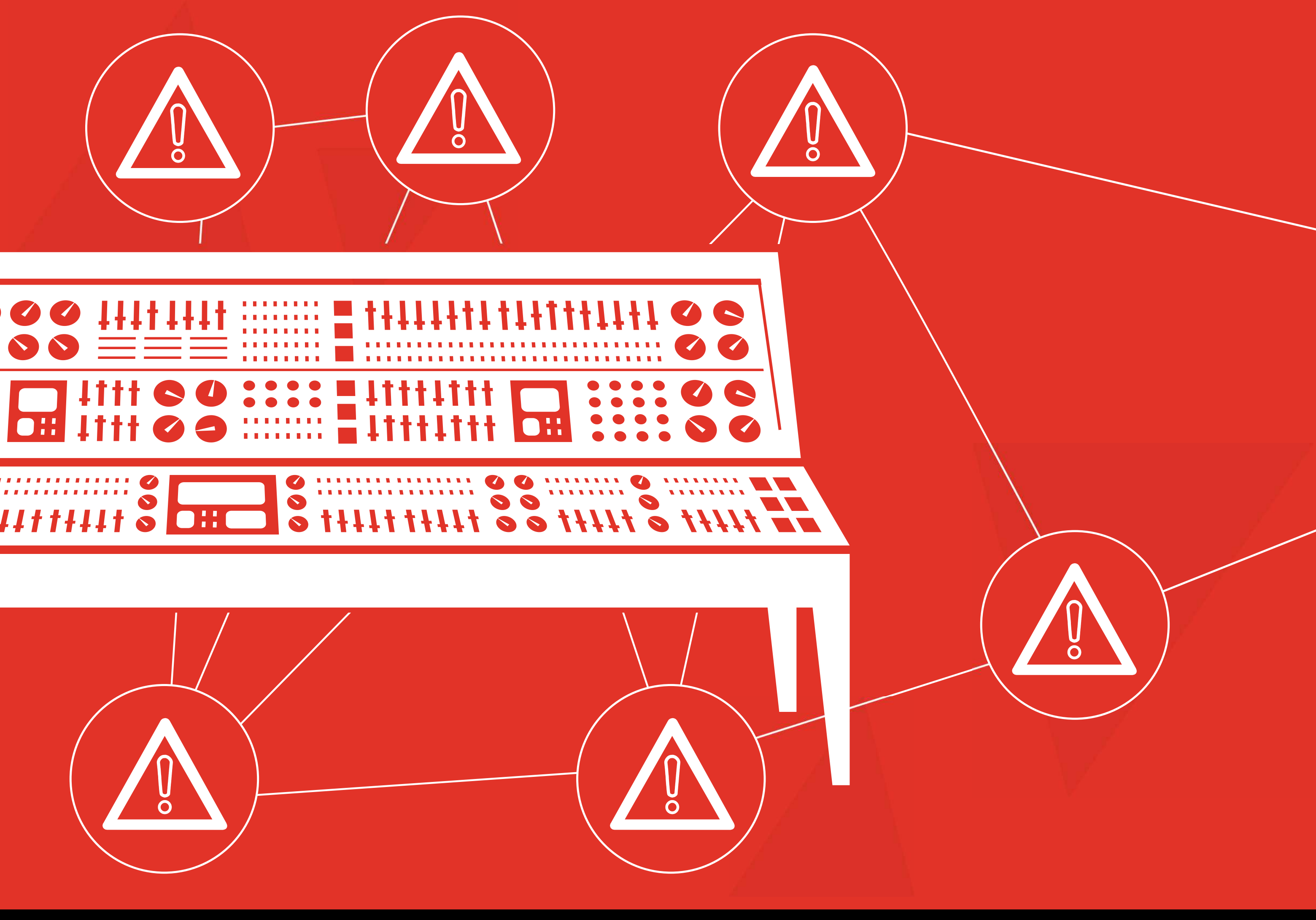
Pub-sub can also make sense when it is difficult to set up a direct connection between a client and a server, or when the network is low bandwidth, expensive, or unreliable—for example, when monitoring equipment in remote locations, common to many OEM and remote access applications.

Most importantly from a security standpoint, all MQTT/Sparkplug communications are outbound connections from the client to the broker. Because firewalls typically allow outbound connections, that means IT does not need to open ports in the firewall or create VPNs to move data securely. For OEMs with machines or process skids at customer locations, the ability to access data remotely without having to involve customer IT departments is a major plus.



As shown on the left diagram, communications among many clients and servers is complex with request-response methods, but greatly simplified with pub-sub and MQTT, on right.

WORRIED ABOUT A DCS MIGRATION?



Why automation projects are tough to manage

And how to execute them better

By Lee Swindler

Reflecting on my 30-year career as a project manager, I have come to realize process automation projects have unique challenges, which make them more difficult to execute than other types of projects. Why is that? Based on my experience and many discussions with peers, here are some key reasons:

Complexity

The process automation industry is highly fragmented with numerous global suppliers each controlling a small portion of the market. With the typical automation project containing literally thousands of individual components, every automation system ends up as a mixture of parts from multiple suppliers. Because these suppliers have limited expertise outside of their immediate product family, the project team is left to integrate all these parts. Considerable engineering and coordination is required to ensure this plethora of equipment comes together to form an integrated, high-performing control system. The resulting designs are highly engineered and customized for each application.

Adding to the challenge is that automation components are based on rapidly changing computer, software, and electronics technology. Unlike other disciplines, automation knowledge becomes outdated every few years as the underlying technology advances. Not only is it difficult for manufacturing facilities to keep their installed systems current, project teams need to be proficient in implementing the latest technology. Ongoing effort is required to keep technical resources updated to ensure sound decisions are being made, and the team members can effectively execute the work needed.

Third-party interfaces to various subsystems often require special skills and knowledge, as standardization for data communication and

formatting has been lacking among suppliers. Third-party interface data is not only difficult to transmit through various specialized protocols but also is usually the last thing the supplier delivers—delaying configuration development and testing until the subsystems arrive at the job site.

The inherent complexity of automation requires extensive documentation to define the requirements and maintain the resulting assets. The documentation is also very interdependent. A simple change can affect multiple documents. Something as simple as changing an instrument tag affects the piping and instrumentation drawing, I/O list, instrument specification sheet, distributed control system (DCS) database, field junction box drawing, marshalling cabinet drawing, and loop sheet. As a result, documentation is difficult to keep current and accurate throughout the project.

Scope evolution

Unlike most other types of projects, automation scope evolves throughout the life cycle of the project—even through commissioning and startup. Expecting to completely define the scope up front with little or no change is an exercise in frustration. This is where project organizations focused primarily on civil- and mechanical-type projects often stumble, because they fail to make allowances for this characteristic.

Design inputs for automation scope come in piecemeal throughout the project as the various project stakeholders perform their detailed engineering. Key information regarding the automation details for various packaged equipment modules (skid packages) are not known until deep into project execution after those suppliers are selected and perform their engineering work. Some operations requirements are only revealed when the operators have a chance to put their hands on the system during testing and commissioning.

There is often a significant gap between the process control requirements as set by process engineering and the definition needed to create the actual system configuration. This is because the process engineers do not speak the configuration engineers' language. Translating the process engineer's control requirements into the format of the configuration functional specification is required. In addition to requiring an understanding of the underlying process, this translation is a highly specialized task requiring resources with deep configuration expertise on the control platforms. A similar translation is required of mechanical, civil, and electrical disciplines as well. Any errors or omissions in the resulting functional specifications cause changes down the line.

FAST FORWARD

- **Specialized project team knowledge and skills are required for integrating automation system components and technology.**
- **Automation scope evolves as the design develops and other requirements materialize through the project's life cycle.**
- **In addition to disciplined project management, there are many good practices that can help ensure successful execution.**

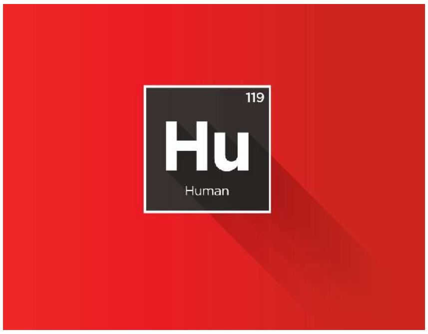
Schedule constraints

The automation scope has numerous dependencies on other disciplines involved in the project. These other disciplines are not able to finalize and communicate the automation requirements until they perform their own engineering tasks. For example, before instrumentation and control valves can be specified, process engineering needs to define the process conditions and control requirements, and mechanical engineering needs to define line sizes, materials of construction, and any physical installation constraints.

These dependencies often cause late changes and schedule compression of the automation engineering effort. Having to absorb all the changes while being expected to hold to the original timeline and budget is frustrating and can lead to skipping steps for the sake of meeting expectations. The discipline to properly execute the required engineering while meeting the project schedule and budget requirements is a delicate balance.

Automation is always on the critical path for completion. No matter how large the overall project, there is always a task near the end to test and commission the automation system before startup. This can only be done after all construction is completed to keep from violating the integrity of the tested system. When the overall project is late, there is additional pressure to minimize or shortcut commissioning activities, which can have negative consequences if not properly executed.

The situation can be even worse in the case of brownfield projects. Most manufacturing facilities are under pressure to minimize unit downtime to lessen the impact on production. Without widespread recognition for the importance of thorough automation system testing and commissioning, it is difficult and stressful to maintain proper checkout discipline when everyone else is pushing to achieve an earlier startup.



The human element

The automation system is the primary interface between the collection of equipment that makes up a plant and the operator who is trying to run it. To achieve successful operation, it is critical for operators to get an accurate and complete view of how the process is behaving and how the equipment is working. If the automation system is contributing to process upsets or not clearly communicating an accurate picture of unit operation, the ongoing lost opportunity costs can be massive.

To achieve successful operation, it is critical for operators to get an accurate and complete view of how the process is behaving and how the equipment is working.

Although there has been excellent human-factors science applied to this human-machine interface (HMI) in recent years, there is still a large amount of personal preference that must be accounted for. Because the automation system is such a tangible element with a look and feel that anyone can understand, it seems everyone has an opinion about how it should work. Operators have inherent perspectives and biases based on past experience with other automation systems, but they may not all be applicable in the current scenario. These personal preferences are difficult to completely define but need to be accommodated or corrected to make the interface fully effective and achieve operator buy-in.

Changing an automation system is easy—simply a matter of programming. However, this ease of change makes it difficult to manage, because it encourages ongoing tinkering with the configuration. Robust change management procedures are needed, including an approval process to ensure each change is justified.

There is also a creative element to contend with. Modern automation systems allow significant flexibility in how various functions are programmed in both controller configuration and the HMI. Although this flexibility enables the automation system to be customized to optimally control the process, it also makes requirements difficult to completely define and enforce.

The road to success

How can you mitigate these numerous challenges inherent in automation projects? Respecting what makes them unique is a good start. Engaging an automation service provider with experience and expertise to handle the challenges is essential. Beyond these basics, here are some additional suggestions:

- Early engagement of automation engineering in the front-end loading (FEL)/front-end engineering design (FEED) stages results in clearer definition of the project scope and decreases the risk of rework in detailed design.
- Reduce customization of the design by using standard configuration, graphic, and documentation templates to decrease the amount of work required to execute the automation scope.
- Apply robust project management discipline, like you should on any large, complex project. A detailed project execution plan, schedule, and quality plan are all important for effective execution. A well-developed roles-and-responsibilities matrix helps to define exactly what information is expected from each stakeholder. A risk register can identify potential problems and associated mitigation plans before issues surface.
- Technologies and processes can minimize the impact of late delivery of design inputs. For example, autogenerating documentation based on the I/O database can quickly create and update key deliverables.
- A vigorous quality assurance program can help mitigate the subjective nature of automation requirements.
- Flexible system architectures, like configurable I/O modules, can help to minimize the impact of late changes on testing and documentation.
- Appointing an interface manager to the project team can reduce the risk resulting from multiple dependencies on other stakeholders. This is a position dedicated to facilitating information flow from the various disciplines and equipment suppliers.
- Disciplined testing and commissioning procedures executed by qualified resources are critical for safe and efficient startup. Shortcuts here inevitably lead to ongoing operational problems, costing many times the minimal savings from reduced commissioning time.

Process automation projects are difficult to manage. The inherent complexity, evolving scope, schedule constraints, and human interaction all contribute unique challenges. Utilizing a project manager and a team with experience managing these characteristics and the ability to maintain proper execution discipline are critical to achieving success. ■

ABOUT THE AUTHOR

Lee Swindler (lee.swindler@mavtechglobal.com) is a program manager at MAVERICK Technologies. He has 30 years of automation industry experience, including 21 years in manufacturing and nine years on the engineering services side. He has a Project Management Professional (PMP) certification and is a TÜV Certified Functional Safety Engineer (FSEng). Swindler has a BSEE from the South Dakota School of Mines and Technology.

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Cybersecurity at the edge

Purdue Reference Model Level 0,1 field devices cybersecurity risks

By Bill Lydon

I had a discussion with Joe Weiss, PE, voting member and managing director of the ISA99, Industrial Automation and Control Systems Security committee, who is bringing into focus major cybersecurity and safety issues. He is committed to standards and practices to achieve secure systems. Weiss is an ISA Fellow, a Certified Information Security Manager (CISM), and is Certified in Risk and Information Systems Control (CRISC). Cybersecurity is a big issue that can have serious consequences. We discussed cybersecurity and safety issues, and my questions and his responses follow:

What are the most serious issues that are gaps in cybersecurity thinking today?

The first issue is the use of the word "edge." To the information technology community, an "edge" device is a router, switch, hub, cell phone, tablet, laptop, etc. To a control system engineer, an "edge" device is a sensor, actuator, or drive, that is, a Purdue Reference Model Level 0,1 device.

The lack of cybersecurity in Level 0,1 devices, as described in the Purdue Model and ISA95, stands out as a major area of vulnerability that is not being adequately addressed. Attacks at this level can directly impact the reliability and safety of processes, manufacturing, material handling, and overall production. Level 0,1 devices are the fundamental elements that manipulate physical processes and production. Devices include process sensors, analyzers, actuators, motor controls, and related instrumentation. These are the fundamental "things" that make process control and manufacturing automation possible, reliable, safe, and effective.

There has been a significant emphasis on computer systems and networks, which are important, but essentially no strategy for Level 0,1 devices. The lack of cybersecurity focus on Level 0,1 devices provides a serious cybersecurity exposure. The lack of cybersecurity and authentication in Level 0,1 devices has not been a consideration for almost all users and vendors. There seems to be an assumption that these devices are within the operations, so they are inherently either protected or unable to be affected. This is the same line of logic that opened the door for cybersecurity attacks that "walked in" on USB sticks.

For those who don't think it is possible to hack process sensors, consider simply using the hand-held HART/Foundation Fieldbus field communicator to change the process sensor ID. This can be either a malicious cyberattack or an unintentional error, often with little chance to tell the difference. Regardless of why,

FAST FORWARD

- Cybersecurity is not adequately addressed in Level 0,1 devices as described in the Purdue model and ISA95.
- Not having cybersecurity protection or forensics for Level 0,1 devices invites unintended or malicious damage to production and people.
- The ISA99, Industrial Automation and Control Systems Security, committee has established a new task group for Level 0,1 security issues.

with the ID changed, the sensor will no longer be able to communicate with the programmable logic controller or distributed control system. There may be an alert, but it may be too late to prevent a catastrophic failure. This is not just loss of view and loss of control, but a loss of safety.

Because the cybersecurity of Level 0,1 devices is not being addressed elsewhere, the ISA99, Industrial Automation and Control Systems Security committee has established a new task group to identify if Level 0,1 devices are adequately addressed in the existing IEC 62443 series of standards, particularly IEC 62443-4-2, *Technical Security Requirements for IACS Components*. After review of the document, it is clear that the existing IEC 62443 standards, and also Institute of Electrical and Electronics Engineers (IEEE) power industry standards, do not address the unique issues associated with Level 0,1 devices. Additionally, the definition of Level 0,1 needs to be reassessed in light of modern communication and instrumentation technologies.

Do Level 0,1 cybersecurity considerations affect other ISA standards in addition to ISA99?

Yes, the considerations affect ISA18, Instrument Signals and Alarms; ISA50, Signal Compatibility of Electrical Instruments; ISA67, Nuclear Power Plant Standards; ISA77, Fossil Power Plant Standards; ISA75, Control Valve Standards; ISA84, Process Safety Standards; ISA-88, Batch Control; ISA95, Enterprise-Control Integration; ISA100, Wireless; ISA108, Intelligent Device Management; and ISA112, SCADA Systems.

Do Level 0,1 cybersecurity considerations affect other standards organizations?

Yes, including standards from the IEEE, the International Electrotechnical Commission (IEC), the American Society of Mechanical Engineers (ASME), and the American Institute of Chemical Engineers (AIChE), to name a few.

Is there coordination and cooperation between ISA and these other organizations?

To date, informal at best, though there is outreach.

Can Level 0,1 devices be compromised?

Yes. As there are currently no cyber-forensics at this level, it is generally not possible to determine if a problem is a sensor or actuator mechanical/electrical problem, a process anomaly, or a cyberattack. And, there have been many sensor-related cybersecurity catastrophic failures to date. ■

About Joe Weiss

Joe Weiss, PE (joe.weiss@realtimeacs.com), is a voting member and managing director of the ISA99, Industrial Automation and Control Systems Security committee and managing partner at Applied Control Solutions, LLC (www.realtimeacs.com), which provides thought leadership to industry and government in control system cybersecurity and optimized control system performance. He has more than 40 years of industrial instrumentation controls and automation experience, coupled with over 18 years in industrial control systems cybersecurity. He has provided support to domestic and international utilities and other industrial companies, prepared white papers on actual control system cyberincidents supporting NIST SP 800-53, and supported the NRC on the regulatory guide for nuclear plant cybersecurity. Weiss co-authored a chapter on cybersecurity for *Electric Power Substations Engineering* (first and second editions) and a chapter in *Securing Water and Wastewater Systems*. He wrote the book, *Protecting Industrial Control Systems from Electronic Threats* and was featured in Richard Clarke and R.P. Eddy's book, *Warnings – Finding Cassandras to Prevent Catastrophes*. He has prepared two modules for the IEEE Education Society and is a U.S. expert to IEC TC65 WG10 and IEC TC45A. ■

ABOUT THE AUTHOR

Bill Lydon (blydon@isa.org) is chief editor of *InTech*. Lydon has been active in manufacturing automation for more than 25 years. He started his career as a designer of computer-based machine tool controls; in other positions, he applied programmable logic controllers and process control technology. In addition to experience at various large companies, he cofounded and was president of a venture-capital-funded industrial automation software company.

View the online version at www.isa.org/intech/20180605.

RESOURCES

ISA99 committee

The ISA99 standards development committee brings together industrial cybersecurity experts from across the globe to develop ISA standards on industrial automation and control systems security. This original and ongoing ISA99 work is being used by the International Electrotechnical Commission in producing the multistandard IEC 62443 series.

www.isa.org/isa99

ISA Security Compliance Institute (ISCI)

ISCI is an operational group within ISA's Automation Standards Compliance Institute. ASCI bylaws share the open constructs of ISA, while accounting for compliance organization requirements. Operating the ISA Security Compliance Institute within ASCI allows the organization to efficiently leverage the organizational infrastructure of ASCI. ISA provides professional management services to ASCI.

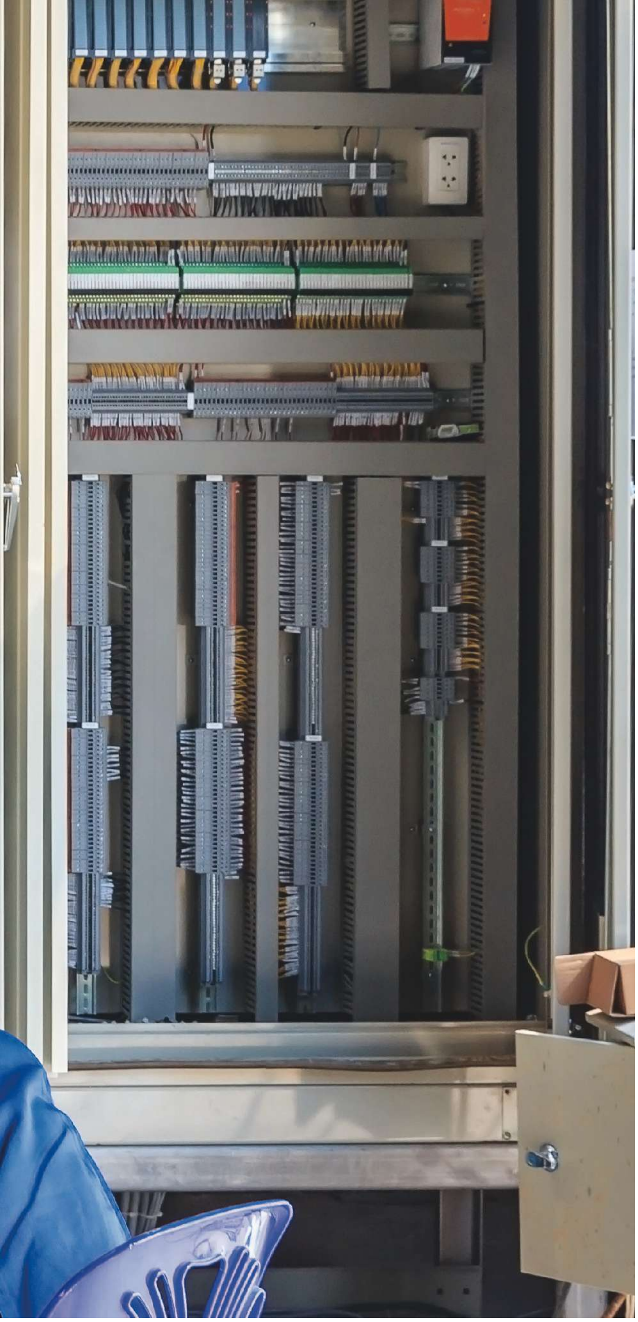
www.isasecure.org/en-US

Troubleshooting

Valuable skill

By Bill Lydon

Troubleshooting control and automation systems is a fundamental skill that is valuable throughout your career, and the techniques and experience are transferable to all types of problems in other areas. The most obvious benefit is finding the problem and fixing it to get production running again when something goes wrong. The experience gained in troubleshooting and fixing problems also provides a wealth of knowledge for designing control and automation applications.



FAST FORWARD

- Troubleshooting control and automation systems is a fundamental skill that is valuable throughout your career.
- Troubleshooting is ideally an orderly process, but be prepared for unusual and abnormal situations.
- Successfully troubleshooting and solving a problem can be immensely rewarding.

I know this firsthand, because in the beginning of my career I did a great deal of controls and automation system troubleshooting and gained invaluable knowledge and experience. Working with systems that have problems means you observe unusual patterns of data and operation that need to be considered when designing control and automation applications. For example, an engineer can understand the impact of a critical sensor failure and use that information to design an application to set the process into a safe operating mode when the censored value reflects a failure.

Troubleshooting

Ideally, troubleshooting is an orderly process of understanding the problem, identifying the cause or causes of the problem, and implementing solutions to return operations to normal. The problem to be addressed is determined by the difference between proper operation and how it is working abnormally. Once the cause is identified, the appropriate actions can be taken to either correct the issue or mitigate the effects. The latter is sometimes referred to as a "workaround."

The alternative to an orderly and systematic troubleshooting approach is often referred to as "shot gunning," that is, making a big mental leap without verifying the source of the problem and then taking an action like replacing a part. For example, a car will not start, and the troubleshooter assumes the cause is a worn-out battery and immediately replaces it—which does not fix the problem. The problem might be a faulty starter motor, starter switch, broken power cable, or something else.

There is a difference between "shot gunning" and an "educated guess." Without experience, replacing parts without diagnosis is like playing roulette in a casino; the house is against you. Troubleshooters with a great deal of experience learn patterns and symptoms they have seen before and may at times replace a part without further diagnosis. Experienced troubleshooters typically only use a strategy, and they believe there is a high probability it will fix the problem.

General method

Controls and automation systems with problems are acting abnormally, not functioning as they were originally designed. Examples of things that can create problems include sensors with erroneous readings, loose electrical connections, network communication errors, electrical interference from newly installed equipment, overheated control cabinets, power supply problems, and powerful fluctuations.

Software-based systems have created some new dimensions that also have to be included in troubleshooting. When you consider all local lines of software code, there is a much higher level of complexity compared to hardware systems. In my experience, there are two major categories of software-related issues:

- Problem after a software update. For example, after an update the software does not recognize an unusual control program configuration that was not considered in the software update.

- Condition never considered in the software design. These kinds of problems typically occur when you make a change or addition to the system, creating a condition that was never accounted for in the original software design.

It is important to review the history of software updates when troubleshooting and search the update notes online for reported issues.

There are different troubleshooting philosophies, but these are common elements and a sequence to start the process:

Observe and gather information

As much as possible, observe and gather information, avoiding preconceived notions. The goal is to understand the current reality about what is happening. These are some typical questions:

- What are the symptoms?
- When did the problem first start?
- What else that is related to this control or automation has unusual data or behavior?

Ask people working in the area what they observed. What is different now compared to when things were working properly?

Software and firmware issues in systems have increased the complexity and potential problems created by system updates that can change the behavior of applications and controllers. In many systems, the information-gathering process should include the history of software and firmware updates.

Record the chronology of the problem and changes made to the system, including operating parameters, alarms, and alerts. Chronology is the science of arranging events in their order of occurrence. It helps provide an understanding of the problem in the context of the environment. As you proceed with troubleshooting a problem, record the chronology of steps and information gathered in a notebook or electronically with a tablet computer or smartphone. Review the chronology for clues about the problem.

Based on my experience, I cannot stress enough the value of making a chronological and data record as you proceed through troubleshooting. Early in my career I was taught by an experienced troubleshooter to carry 3x5 cards and record each step and data as I was troubleshooting automation systems. That was one of the most valuable lessons for troubleshooting.

The most valuable discipline when troubleshooting systems is not making assumptions.

Identify root causes

Following a logical path of reasoning based on symptoms can solve many problems, but there are other problems that are more difficult. Sometimes after observing symptoms, the root causes are obvious. With more complex control and automation, however, it takes more effort to identify root causes. There may be more than one component (i.e., sensor, actuator, relay power supply, or network communications) that is contributing to the problem. Today this is complicated with software, firmware, network configuration, and potential cybersecurity problems.

Identifying root causes may follow a logical path of reasoning based on the observable symptoms. In my experience many problems fall in this category, but with greater system complexity there are increasingly bigger troubleshooting challenges.

Finding the source of the problem is the detective work of troubleshooting. In complex systems where there can be multiple things contributing to a problem, it is advisable to change one thing at a time and check if that solves the problem. Steps taken should be added to your chronology notes.

Open mind

It pays to keep an open mind and think outside the box. There may be ways to find the problem that are not obvious.

Working with machine tool–based controls early in my career, there was a perplexing problem with integrated circuits that overheated on control boards. When I opened the cabinet, the problem would go away. I wrestled with this for quite a while. Then I talked to a very experienced troubleshooter I worked with, and he reached into his bag of tools and pulled out a hairdryer! I created cardboard baffles we used to partition off parts of this large circuit board and first heated one half of the board, then the other, to find the area failing under heat. We simply divided the problem area in half and did the procedure again, continually narrowing the focus. Neat method!

I had a similar problem a couple of years later with the minicomputer, and I used my troubleshooting hairdryer to isolate the problem and fix it. Always keep in mind that troubleshooting is finding an abnormal operating condition that can be caused by a wide range of things.

The most valuable discipline when troubleshooting systems is not making assumptions.

In another example years later, I was involved in one of the early industrial network installations of DeviceNet on a liquid crystal display production line. Our company provided the control software that was running the production line. After the line was commissioned and running, there was an intermittent problem with the automation that occurred periodically around midnight.

Because this was an important new installation, every vendor involved was on site trying to troubleshoot the problem, bringing in sophisticated network analyzers and other equipment. There was not an absolute root cause established, but suppliers made changes based on hunches to fix the problem. The problem persisted.

One night I went in with the plant operations person to watch the operation of the system. When the cleaning person was working in the area, default occurred. We quickly found the root cause. The network was implemented with cables interconnected using round screw-type quick connectors. We noticed the cleaning person bumped cable connectors when using a broom to sweep underneath the assembly line. We found a cable connector that was not tightly screwed together, and this solved the problem!

We all made the faulty assumption in the beginning that since this was a new high-tech production line, the problem had to be complex. Everyone had a complex theory about the problem they worked to find with sophisticated test equipment.

Workarounds

Based on the urgency of the problem, it might be necessary to implement a temporary workaround solution to restore operations to some level. A workaround is typically used when there is a special circumstance, such as a lack of parts to fix the problem immediately and properly. Generally, the controller or automation will not perform up to normal specifications using the workaround. Workarounds on complex systems have to be done considering the implications so you do not create unstable or unsafe operations. For example, bypassing a faulty safety switch to keep the process running would not be an appropriate workaround.

Process troubleshooting

Joseph Alford, consultant, Automation Consulting Services, has more than 35 years of experience and is a highly active ISA member. He shared his thoughts on process troubleshooting:

"One of the most important traits that a process operator can have is the ability to quickly and accurately diagnose process upsets and respond accordingly. Chances are that, for new processes/plants, various process abnormal situation analysis techniques were used by engineers and scientists in developing the process. These may have included FMEA [failure modes and effects analysis] or perhaps "rationalization" exercises as part of specifying alarm parameters, and may have resulted in the creation of graphics, such as fault trees or fishbone "cause-effect" diagrams (also known as Ishikawa diagrams) and content in an alarm management database. Regardless, some thought and documentation regarding process failure modes was undoubtedly pursued in developing a manufacturing process.

"There are several challenges in the pursuit of effective process troubleshooting. One challenge is that there are usually several possible causes to a given process upset (e.g., an abnormal tank pressure reading may be due to a pressure sensor failure, seal or gasket failure, relief or control valve failure, or out-of-control exothermic reaction). Many of the possible causes will not be immediately detectable with relevant sensors, so cannot be automatically reduced to a single probable cause. So, to help operators with manual troubleshooting, what is useful is an online callable list of the possible causes and some indication of the probability of their occurrence and/or priority in checking them out, that is, what root cause should the operator check first?

"A second challenge is the need to make process troubleshooting information as quickly and easily available to operators as possible (i.e., time is money, and time delays in troubleshooting and responding to process upsets will often result in an escalation in the severity of the process upset). So, things like fault trees, fishbone diagrams, or alarm rationalization databases should not remain as items in hard documents but should be distilled into useful information for operators and made available online as part of the human-machine interface in systems they routinely use (e.g., process control computers)."

Assumptions

Withhold judgment until you have gathered information without jumping to conclusions. Cables with barrel connectors screwed together made up the network.

Successfully troubleshooting and solving a problem can be immensely rewarding. One phrase that I found helpful when troubleshooting was from my AC/DC fundamentals professor in college. He started every class by stating, "Where does the reasoning begin?" ■

ABOUT THE AUTHOR

Bill Lydon (blydon@isa.org) is chief editor for *InTech*. He has more than 25 years of industry experience in building, industrial, and process automation.

View the online version at www.isa.org/intech/20180606.

RESOURCES

Troubleshooting: A Technician's Guide
www.isa.org/troubleshoot

***A Guide to the Automation Body of Knowledge* (Chapter 31 on troubleshooting)**
www.isa.org/autobok

The time is right to embrace digitalization

By Kevin Lewis, PE

ABOUT THE AUTHOR

Kevin Lewis, PE, vice president, digital factory, factory automation, at Siemens, leads a team committed to implementing digital factory automation initiatives. Lewis has a background as an engineering and operations leader. He has a BSME from the University of Illinois and an MBA from Northwestern. To contact Lewis, email Karen.kasik@siemens.com.

Digitalization is everywhere. Industrial software designed for specific industries, artificial intelligence, and self-learning machines, as well as the rise of connected devices, sensors, actuators, and cyber-physical systems, are all driving companies toward a digital enterprise. For example, aerospace and rail are using additive and digital manufacturing to produce repair parts that do not meet minimum batch production thresholds to reduce inventories and be more responsive to customers.

Digital factory

Digital factory vision, concepts, and implementations are happening with digital technologies that encompass all phases of product life-cycle manufacturing, including product design, process planning, production engineering, production execution, and utilization services. Seamless integration between the various technologies enables all phases of product life-cycle manufacturing, which results in a comprehensive approach and positions companies to be efficient and profitable world-class competitors.

Digital twin

Virtual design, modeling, simulation, validation, commissioning, and ongoing continuous improvement are accomplished with a digital twin. First, design engineers focus on customer requirements using integrated design and analysis tools that capture and manage all information, including computer-aided design, engineering, and manufacturing. Virtual modeling, simulation, validation, and commissioning help ensure working conditions for humans, robots, production lines, and even entire plants will be effective before any physical equipment is installed.

Powerful new integrated design environment software platforms are used to implement the real-world solution. They use a common engineering framework to implement production processes with programmable logic controllers (PLCs), HMIs, motors, and other devices. PLC code can automatically be generated from virtual machine and plant design models.

The large volume of data generated as products are manufactured and put into use can now be analyzed to continually refine and improve operations. This results in greater efficiencies and profits. Cloud-based applications are used to aggregate, analyze, and transform data into actionable information, creating a closed-loop feedback to continuously optimize product development and production planning.

Device and systems interoperability

Realizing the potential of digitalization requires open connectivity, so different assets, devices, and systems can be seamlessly connected regardless of origin or age. There are two ways to achieve this. The first way is specifying the standards and requirements that a manufacturer's ecosystem of system integrators and original equipment manufacturers must comply with for seamless interoperability. The second method requires systems to communicate with each other by connecting data from machines and the operating environment to a common industrial cloud platform. A cloud-hosted infrastructure with open connectivity, APIs, and development tools empowers all users to access, build, and integrate software applications and services to achieve unique industry goals. This is where the breakthroughs come in terms of connecting industrial hardware and automation. A reliable, transparent flow of information across all levels creates tremendous value, provides insights, and enables deeper collaboration, higher efficiency, and new revenue streams.

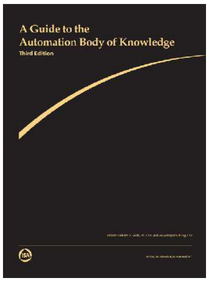
Value chain

It is now possible to have a digital twin of your entire value chain, so companies can perform simulation, test, and optimization in a completely virtual world. Understanding the interaction of elements along the value chain, including bottlenecks, waste, and nonvalue-adding activities, lets companies resolve these problems and optimize their enterprise in the virtual world before committing any resources in the real world, creating a digital thread.

Digitalization plan and strategy

A strategy and action plan for digitalization that is communicated to and understood by the entire organization yields great benefits. Users are creating digitalization road maps that define the most important key performance indicators, including speed, flexibility, efficiency, quality, and security, in consultation with technology vendors. Effective digitalization road maps include a step-wise implementation approach for the overall journey for a successful digital enterprise strategy. Making a digital twin of your product, your process, and your equipment is not a far-off vision, it is a reality today. Manufacturers can achieve dramatic results when all of these elements, including product design, manufacturing execution systems, automation, and data analytics, are linked. ■

ISA publishes third edition of *A Guide to the Automation Body of Knowledge*



ISA has released the third edition of *A Guide to the Automation Body of Knowledge* (www.isa.org/autobok), an overview of the essential concepts and processes in industrial automation and the skills required to master them.

This release has been updated to reflect the continuing evolution of digital technologies and their impact on automation processes and automation standards in such areas as alarm management, human-machine interface design, and operational technology cybersecurity.

The book's co-editors—Nicholas P. Sands, PE, CAP, senior manufacturing technology fellow at DuPont, and Ian Verhappen, PE, CAP, senior project manager at CIMA+—are ISA Fellows who have decades of collective expertise and experience in automation standards development, automation competency, safety instrumented systems, alarm management, process safety, and industrial communications networks.

Sands says the book is particularly valuable to automation professionals early in their careers, as well as to practitioners needing a "refresher" on certain topics. The guide is also consistent with the Automation Competency Model—which defines the core skills and knowledge needed to succeed as an automation professional—and is a study guide for those seeking to earn ISA Certified Automation Professional (CAP) certification. ■

Stratus Technologies newest ISA partner

Stratus Technologies, a global provider of continuous availability solutions for mission-critical applications, is now an ISA promotional partner. For more than 35 years, Stratus, based in Maynard, Mass., has been providing technology platforms that keep business-critical applications running. The company's hardware and software prevent unplanned downtime and maintain data integrity, both in the data center and at the edge.

The company develops industrial automation solutions for the Industrial Internet of Things, life sciences, manufacturing, the power industries, and the oil and gas, water/wastewater, and food and beverage sectors.

Under the partnership agreement, Stratus will work with ISA to codevelop a range of informational and promotional resources, including ad inserts within *InTech* magazine and a diverse range of online and e-newsletter ads, video alerts, and eBook sponsorships delivered on and through Automation.com, ISA's online publisher of automation-related content.

The ISA Corporate Partnerships Program gives companies a customized approach to sponsorship within the organization. Partnership packages include year-round promotion, prominent association-wide access and recognition, and turnkey service from a dedicated team of professionals. ■

In memoriam

John Rennie of Norwood and Falmouth, Mass., passed away on 20 March 2018 at the age of 82. Rennie was a graduate of Northeastern University and earned a bachelor's degree in electrical engineering. He was a retired engineer for Factory Mutual, working there for many years, and was a Korean War veteran (U.S. Marine Corps).

Rennie was a longtime ISA Life Member (since 1974) and a member of the Boston Section. He was a member of the Education Division and the Safety and Security Division, but was especially active in standards work (mainly ISA-12, *Electrical Equipment for Hazardous Locations*, and IEC TC31, *Electrical Apparatus for Explosive Atmospheres*, where he took an active role in the development of the IECEx system).

He received an ANSI Elihu Thomson Electrotechnology Medal for exceptional contributions to the field of electrotechnology standardization, conformity assessment, and related activities in October 2009. He had a major leadership role in the U.S. National Committee of the International Electrotechnical Commission (IEC) and its predecessor organization, helping create its current organizational structure. Rennie was also on the USNC Technical Advisory Committee and was the technical advisor to IEC Technical Committee 31. ■

New CAPs and CCSTs

Qualifying for and passing one of ISA's certification exams is a noteworthy accomplishment. The exams are rigorous and require a solid command of various disciplines in automation and control. Below is a list of individuals who have recently passed either our Certified Automation Professional (CAP) or one of the three levels of our Certified Control System Technician (CCST) exam. Congratulations to our new certification holders! For more information about the ISA CAP and CCST certification programs, please visit www.isa.org/training-and-certifications/isa-certification.

Certified Control System Technicians

Name	Company	Location
Level 1		
Roberto Ramirez	Prime Controls	U.S.
Brennan M. Lane	None	U.S.
Justin R. Rickman	None	U.S.
Allen Russ Gartman	RMS Electronics	U.S.
Diego Contreras	None	U.S.
Robert A. Coon	City of Ann Arbor Water Plant	U.S.
John M. Barden	None	U.S.
Jeremiah K. Jones	Dominion Energy	U.S.
Eric Gutierrez	None	U.S.
Bryan T. Bellar	None	U.S.
Willis Daniel Howard	Alyeska Pipeline Service	U.S.
Zachary J. Schlott	Alyeska Pipeline Service	U.S.
Cory S. Landry	Nucor Steel Arkansas	U.S.
Regan A. Vatzlavick	None	U.S.
Trevor W. Thacker	Prince William County Service Authority	U.S.
Sean F. McRunnel	Prince William County Service Authority	U.S.
Aaron L. Weatherspoon	Prince William County Service Authority	U.S.
Rasel Ahmed	Prince William County Service Authority	U.S.
Danny Dookhoo	None	U.S.
Roger A. Gable	Climax Molybdenum	U.S.
Michael K. Ayoub	BDC	U.S.
Ahmed Kaleem Alattar	YLNG	New Zealand
Daniel C. Margotta	None	U.S.
Wilmer Huertas	None	Peru
Jason A. Hall	Alyeska Pipeline Service	U.S.
David S. Jaenike	None	U.S.
Jason A. Dockins	Koch Nitrogen Co. LLC	U.S.
Matthew C. Johnson	None	U.S.
Christin Ray	None	U.S.
Malcolm Bradley Coulston	None	U.S.

Certified Control System Technicians

Name	Company	Location
Level 2		
Logan Gene Willmert	None	U.S.
Christopher R. Andrews	Goodrich Aircraft Wheels & Brakes	U.S.
Zac Q. Opong	None	U.S.
Ronald W. Johnson	None	U.S.
Robert E. Bepple	City of Kennewick	U.S.

Certified Automation Professionals

Name	Company	Location
Hesham A. Manea	None	Yemen
Dongarmal Rathore	None	Germany
Danaca Jordan	Eastman Chemical Co.	U.S.
Chris J. Child	None	U.S.
Ibrahim Samir Al-Ramadhan	Saudi Aramco	Saudi Arabia
Hoe Saw	None	Australia
Brian C. Kan	None	U.S.
Kendry D. Pacheco	Saudi Aramco	Saudi Arabia
Nicholas L. Bazzell	None	U.S.
Ali Shakir Fadhil Al-Najjar	URUK Engineering & Contracting Co. LLC	U.S.
Richard D. Hogan	Linde	U.S.
Islam Zaki Ibrahim	None	Egypt
Michael L. Roberson	Bridgestone Americas Inc.	U.S.
Scott M. Thomas	Rockwell Automation	U.S.

ISA Certified Automation Professional (CAP) program

CAP question

Identify three levels within the manufacturing computer systems hierarchy.

A. operating system, machine interface, Internet

B. planning, execution, device control

C. MRP II, planning, enterprise requirements

D. inventory, movement, planning

CAP answer

The correct answer is *B*, "planning, execution, device control." The manufacturing computer systems hierarchy is defined in ISA-88 and ISA-95 by Level 0 through Level 4. Level 4 encompasses the business planning and logistics activities, such as the basic plant operations schedule, inventory, and shipping requirements.

Activities at Level 3 are concerned with manufacturing operations management. These are the activities related to the *execution* of recipes and production workflow and creating operations records.

Levels 1 and 2 are focused on *device control*, whether it is batch, continuous, or discrete control.

Answer A only lists hardware and software used at each level where computers are used. Answers B and C are all activities found at Level 3 of the hierarchy.

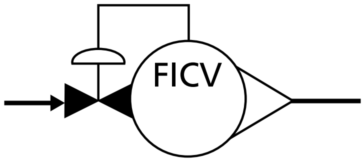
Reference: Trevathan, Vernon L., *A Guide to the Automation Body of Knowledge, Second Edition*, ISA, 2006.

Certified Automation Professionals (CAPs) are responsible for the direction, design, and deployment of systems and equipment for manufacturing and control systems.

ISA Certified Control Systems Technician (CCST) program

CCST question

According to ISA-5.1, the following P&ID symbol represents which kind of device?



A. Pitot tube

B. magnetic flowmeter

C. damper valve

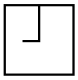
D. constant flow regulator

CCST answer

The correct answer is *D*, "constant flow regulator." The symbol for the constant flow regulator is a compound symbol made from the symbol for a variable area flowmeter (FICV) with an integral manual adjusting valve adjacent to a control valve symbol. The line above the two symbols indicates that the valve uses the flow signal to adjust the valve position, and hence, maintain a constant flow rate.

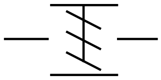
The symbols for the other three items are:

Pitot tube:



Magnetic flowmeter:

Damper valve:



Certified Control System Technicians (CCSTs) calibrate, document, troubleshoot, and repair/replace instrumentation for systems that measure and control level, temperature, pressure, flow, and other process variables.

Reference: Goettsche, L. D. (Editor), *Maintenance of Instruments and Systems, Second Edition*, ISA, 2005.

Explaining AC drives

By Bryan Sisler

When powering AC motors, the electrical supply can be at full power to run at full speed or at variable power to run at variable speed. Applications with varying loads benefit from the variable speed provided by an AC drive, because less power is used at lower loads and speeds. This article explains how an AC drive accomplishes this.

Simply put, an AC drive, also referred to as a variable frequency drive (VFD), is a power supply control and conditioning device for AC motors (figure 1). Because AC motors require frequency to spin, the drive must provide the required energy waveform with enough voltage to deliver the needed current to produce magnetic flux within the motor. The motor revolutions per minute (rpm) can be defined as:

Motor rpm = Frequency (in Hz) • 120 (a constant) / # motor poles
i.e., 60 Hz • 120/4 poles = 1800 rpm (minus slip = 1750 rpm for a four-pole motor)

To produce this desired frequency waveform, an AC drive is provided with an AC voltage supply and rectifies it to DC voltage, normally through a diode bridge, or if it is a regenerative four-quadrant drive, then through insulated-gate bipolar transistors. This rectified power is stored in a capacitor bank as part of a DC bus. This is known as the converting section of the drive.

The DC power stored in the capacitor bank is then supplied to switching devices to create the required frequency. This AC power is supplied to the motor and enables it to spin at a desired speed, normally measured in revolutions per minute.

Figure 1. AC inverters, also called AC drives or variable frequency drives, provide the frequency and voltage needed to drive an AC motor.

The drive produces a set of pulse-width modulated signals that are positively or negatively oriented to create the desired waveform. The height of the pulse, typically 162.5 or 325 VDC, is a result of the stored energy level, with 230 VAC rectified to approximately 325 VDC or ±162.5 VDC, and a 460 VAC supply rectified to 650 VDC or ±325 VDC. The width of the pulse, the modulation, is regulated by the length of time the switch is on, and the deadtime is the time between pulses.

This switching of the power devices enables control of the amount or level of voltage that passes through the switches, as well as the frequency at which the waveform is created, providing the required energy to control motor speed.

The AC drive enables control of the operating characteristics of an AC motor, which can reduce energy used by the motor. This energy savings comes through adjusting or limiting the applied voltage and current during controlled acceleration/deceleration and during normal operation.

AC drive application basics

Pumps, fans, and conveyor applications alone can generate hundreds of applications. Even the terms within applications can be synonymous. Bulk conveying can be carried out with pumps, fans, or conveyors, for instance. Application examples include tons of flour blown through pipes for a bagging operation, pumps handling tens of thousands of gallons of soda through a bottling line, conveyors moving coal or rock over miles of a quarry, or a conveyor carrying thousands of cookies through a baking oven.

Figure 2. Unless specifically rated for field mounting, AC drives, such as these AutomationDirect GS2 drive units, should be installed in a control cabinet to protect them from the environment, with proper spacing for cooling.

From the simple air fan in the warehouse to the complexity of energy storage systems, water supply, or wastewater management systems—AC motors running at variable speeds play a key role. Because AC motors consume much of the electricity generated worldwide, using AC drives to limit energy use can produce significant savings.

Best practices for AC drive integration

Best practices for AC drives include a thorough review of the application. A properly selected motor type, with the right-sized motor and drive, is the starting point for any application, and this requires a detailed review of the load characteristics. Also consider the nature of the energy supply to the drive and the environment in which the system will operate. In some instances, an AC transformer or supply reactor may be needed to provide a clean source of power.

The need for dynamic braking units, by energy injection or by removal of energy with choppers, and braking resistors should be defined. Regenerative energy-handling requirements should also be defined. Stopping a variable load, especially quickly and often, will stress the drive and motor and should be considered.

An installation review, including protection required from other energy consumers on the AC drive supply side, is necessary in many cases, and proper grounding systems are also needed. Finally, there must be adequate room for the AC drive and its protective devices. For example, the enclosure type and size must be sufficient to provide cooling and protection from the environment (figure 2).

Create a plan for programming the AC drive to provide the connected motor with the best operational methodology and energy savings possible. Fortunately, many of the required capabilities are built into AC drives for this purpose. Some common capabilities include:

- preprogrammed control for V/Hz applications
- quick-start menus
- safe torque off for the protection of operators and users
- autotuning for motors when in sensorless vector mode
- efficient handling of acceleration and deceleration ramps
- current, frequency, and voltage limits
- methods for handling excess system energy
- options for controlling emergency stops

All of these capabilities and more can be used to optimize operation of an AC drive/motor system and to ensure safe operation over the life of the system. ■

ABOUT THE AUTHOR

Bryan Sisler (bsisler@automationdirect.com) is the product manager for drives and motors at AutomationDirect. Sisler has been involved in the automation and the electrical/electronic field for 35 years and in the automation industry for the past 27 years, mostly specializing in drives, motors, and communications technologies at a variety of large industrial manufacturers and distributors.

RESOURCES

More in-depth information on this topic can be found in ISA books and training courses.

Variable Speed Drives: Principles and Applications for Energy Cost Savings, Third Edition
www.isa.org/vsd

Motors & Drives: A Practical Technology Guide
www.isa.org/motorsanddrives

Motors & Drives: A Practical Technology Guide – Instructional Supplement
www.isa.org/manddguide

SP15 – Applying Motor Controls and Drives Training Class
22–25 October 2018, Newhall, Calif.
3–5 December 2018, Research Triangle Park, N.C.

Beauty is in the eye of the beholder—How saleable is your business?

By Cathy Durham

Today, 70 percent of all businesses in the U.S. are owned by baby boomers, who are turning 65 at a rate of 10,000 per day, and only 10–15 percent of these owners have a plan for ownership transition. When it is time to sell your business, you do not want to get stuck in a bad situation where your expectations do not align with reality. Not sure where to begin? It all starts with business valuation.

As the classic saying goes, "beauty is in the eye of the beholder." Although some businesses appear to be successful, they may not be saleable for more than liquidation—the value of the assets less the company's liabilities.

You may have built what you consider to be a successful system integration business, but the real question is "would an educated buyer be willing to pay more than liquidation value for your business?" How do you know if *your* business would sell for a price that includes value above liquidation (i.e., goodwill)?

While there are many factors to consider, the questions below can help you uncover generally if a business would garner more than liquidation value, or if it would be more accurately classified as a successful career:

- *Is your business too dependent on you?* If you become seriously sick, injured, or die, would the business's operations survive long term? A test: Could you leave the office for a month without interacting with others at the business?
- *Do the business's profits provide you, the owner, with a return on investment?* Is your business profitable? Is it profitable even after adjusting the financial statement for market levels of compensation for you and other owners? *Market compensation* means your salary if you went to work for a competitor.

If the business can continue if you are not able to work *and* is profitable after adjusting for market compensation, the business is most likely saleable, or would garner a value greater than liquidation value. This is good news! Now you can focus on increasing the value of your business.

If you answered *yes* to the first question, or *no* to the second question, unfortunately your business will not likely be considered as saleable or transferable. It is possible to become a transferable business, though, and here are some ways to get started.

You may have built what you consider to be a successful system integration business, but the real question is "would an educated buyer be willing to pay more than liquidation value for your business?"

Decreasing dependency

Let's use a fictitious system integrator, A+ SI, as an example. A+ SI is owned by Mike, and Mike is the sole customer contact for the business, because he wants to control the customer experience and likes working with customers. Mike also oversees the accounting and payroll for the business, because he does not want to share financial results or salaries with anyone else in the business. When Mike goes on vacation for a week he does not really "unplug." He is the only one who understands how the company's processes and techniques work together to deliver customer solutions.

Unfortunately, Mike is setting himself up for trouble, because the business cannot survive long term without his personal day-to-day involvement. So, when it comes time for Mike to exit the business, his only option is to liquidate the business's assets.

If Mike's goal is to eventually sell A+ SI for more than just the value of the tangible assets, here are a few ideas he could work on to create a transferable business:

- Document processes and systems in a central place that others can access.
- Build an experienced employee workforce. Train, cross train, educate, and motivate key people to stay in the business.
- Regularly include one or more team members in client meetings and communications.
- Delegate, delegate, delegate.

Other dependency issues include customer concentration or employee dependency. One customer should not represent more than 10 percent of your total revenue. Similarly, no segment of the business should be too dependent on one employee.

Improving profitability

If the issue is that your business is not profitable and not generating sufficient cash flows for you to earn a return on your investment, reach out to your accountant or business advisor to identify ways to increase business profitability. Questions to consider:

- Is a customer, or group of customers, high need with low profitability?
- Are you pricing your services or products too low?
- Benchmarking: How do your margins compare with others in your industry?
- Do you need to structure your employees' compensation differently?

These are just a few examples of how to make your business more transferable, but there are numerous ways based on your specific business situation. With time and investment, you can increase the value of your business beyond what you see on your financial statements. ■

ABOUT THE AUTHOR

Cathy Durham (cdurham@capvalgroup.com), MBA, ASA, is the president of Capital Valuation Group, Inc., headquartered in Madison, Wisc., and a member of Control System Integrators Association (CSIA) (www.controlsys.org). The company helps business owners across the country understand and increase the value of their businesses through keynote speaking, valuation analysis, determining damages, and expert witness testimony.

Alarm Philosophy Technical Report supports ISA-18 standard

ANSI/ISA-18.2, *Management of Alarm Systems for the Process Industries*, has found wide and growing global use across the process industry sectors in improving the development, design, installation, and management of alarm systems. To aid in understanding and applying the standard, the ISA18 standards development committee has developed a comprehensive series of ISA technical reports over the past several years.

The latest technical report in that series, ISA-TR18.2.1, *Alarm Philosophy*, provides guidance on how to implement the recommendations and requirements described in the alarm philosophy clause of the standard. It outlines potential approaches and has specific examples that can be included in an alarm philosophy in order to properly manage the identification, rationalization, detailed design, implementation, operations, maintenance, monitoring and assessment, management of change, and audit life-cycle steps. Like the standard itself, the new technical report is intended for those who (a) manufacture or implement embedded alarm systems, (b) manufacture or implement third-party alarm system software, (c) design or install alarm systems, (d) operate or maintain alarm systems; or (e) audit or assess alarm system performance.

An IEC version of the ISA-18.2 standard, IEC 62682, was completed in 2014 under the leadership ISA18 co-chairs Donald Dunn of Allied Reliability Group as the IEC convenor and Nicholas Sands of DuPont as the IEC secretary/editor. The ISA18 committee then used the IEC version as a starting point for preparing the current 2016 ANSI/ISA version of the standard. Dunn and Sands are once more preparing to lead the IEC team in updating IEC 62682 based on the ANSI/ISA 2016 revision.

In addition, ISA18 confirmed at a face-face meeting in early May that it will begin the process of updating its series of supporting technical reports, which in addition to the new alarm philosophy document include:

- ISA-TR18.2.2, *Alarm Identification and Rationalization*, which addresses alarm identification and rationalization for facilities in the process industries for such purposes as improving safety, environmental protection, product quality, equipment protection, and plant productivity. The methods described are applicable to batch and discrete processes as well as continuous processes. Identification and rationalization cover the processes to determine the possible need for or a change to an alarm, to systematically compare alarms to the alarm philosophy, and to determine the alarm set point, consequence, operator action, priority, and class.
- ISA–TR18.2.3, *Basic Alarm Design*, which provides guidance on implementing the practices set forth in ISA-18.2. Following the life-cycle model of ISA-18.2, the document assumes that alarms to be addressed in the basic alarm design have completed rationalization where attributes such as alarm set point and priority have been defined.
- ISA-TR18.2.4, *Enhanced and Advanced Alarm Methods*, which helps users evaluate when to use enhanced and advanced alarming methods, what benefits they can achieve, and what challenges and costs to expect. Per ISA-18.2, enhanced and advanced alarm methods typically go beyond the basic methods and techniques that are usually, or at least initially, applied. Although significant improvement in alarm system function and performance can usually be made by following the basic alarming methods and principles, in some cases they may not be sufficient to achieve the goals for performance and operator guidance stated in the alarm philosophy.
- ISA-TR18.2.5, *Alarm System Monitoring, Assessment, and Auditing*, which gives guidance on the use of alarm system analysis for both ongoing monitoring and periodic performance assessment. Monitoring, assessment, and audit are essential to achieving and maintaining the performance objectives of the alarm system. These activities can identify improvement opportunities in the other life-cycle stages, such as philosophy, rationalization, detailed design, implementation, operation, maintenance, and management of change.
- ISA-TR18.2.6, *Alarm Systems for Batch and Discrete Processes*, which covers the application of alarm management principles in ISA-18.2 to batch and discrete processes. The general principles and techniques described are intended for use in the life-cycle management of an alarm system based on programmable electronic controller and computer-based human machine interface technology.
- ISA-TR18.2.7, *Alarm Management When Utilizing Packaged Systems*, which provides guidance on how to integrate packaged systems into a basic process control system–based centralized alarm system. The scope includes discussing various issues that can arise when ISA-18.2 work processes are applied to facilities where packaged systems are used and providing guidance on how to successfully apply ISA-18.2 in these situations.

For information on viewing or obtaining ANSI/ISA-18.2-2016, ISA-TR18.2.1-2018, and the additional technical reports, visit www.isa.org/findstandards. For information on ISA18, contact Charley Robinson, crobinson@isa.org. ■

Variable speed drives

The Altivar family of variable speed drives now includes the Altivar Machine ATV340, which addresses the challenges of the smart-machine era by combining application control and automation capabilities. The variable speed drive is suited to a variety of industrial sectors as well as applications, such as packaging, material handling and working, and hoisting.

The ATV340 is built for applications requiring rapid dynamic control. It has the flexibility to handle practically all motor types in open or closed loop. Built-in multiprotocol Ethernet, an embedded encoder, integrated application functions, and compatibility with multiple motor types bring design flexibility. One-button autotuning for motor identification allows project replication, while a library of tested, validated, and documented architectures boosts the speed of design.

The ATV340 range has Achilles Level 2 cybersecurity certification and is compliant with EN ISO 1384901 and EN 62061. It is suitable for environments with high levels of dust and vibration and operating temperatures up to 60°C. Remote monitoring enables predictive maintenance, and fast device-replacement services ensure prompt machine recovery.

Schneider Electric, www.schneider-electric.com

Frequency converter portfolio

The company has extended its Sinamics frequency converter portfolio for standard applications. The Sinamics V20 includes a new frame size, the FSAC, in the voltage range 1 AC 200 V to 240 V, 1.1 kW to 1.5 kW. FSAC is replacing the previous FSB frame (1 AC 200 V). It is 40 percent more compact than its predecessor, and the frame size offers more space-saving application possibilities. The Sinamics V20 is a basic converter available in nine frame sizes.

In the Sinamics V90 servo drive portfolio, the smallest frame size FSA is now also available as a Profinet version for 0.1 kW and 0.2 kW, which are covered by frame size FSB at the moment. These changes have enabled the footprint to be reduced by 10 millimeters, making the V90 FSA frame 18 percent smaller. It is now also possible to transmit process and diagnostic data over the Profinet interface in real time using a single cable. Within the V90 servo drive system, the Simotics S-1FL6 (SH45, SH 65, and SH90) motor series has also been released, with the connections now angular on the motor side, but straight on the cable side. The Sinamics V90 servo drive system is suited for dynamic applications.

Siemens, www.siemens.com

Ethernet-connected VFDs

There are now Ethernet-connected versions of the FR-A800 and FR-F800 series variable frequency drives (VFDs). The FR-A800-E and FR-F800-E VFDs have Ethernet connectivity as a standard feature, allowing the drives to be connected directly to automation equipment and plant information management systems.

These VFDs are designed for factory automation in the automotive and food processing sectors, as well as wastewater treatment plants. They can be used in process control applications, multiple pump control systems, and in networks that require continuous monitoring, such as the measurement of energy consumption.

The FR-A800-E and FR-F800-E inverters can be connected to a manufacturing execution system network and exchange data in either direction. They can act as an interconnected VFD "team," without referring to a separate controller, by entering programmable logic controller programming directly into the drives. They operate simultaneously within an Ethernet environment and virtually any other automation network, forming a gateway between a plant's other automation equipment.

Mitsubishi Electric Automation, www.mitsubishielectric.com

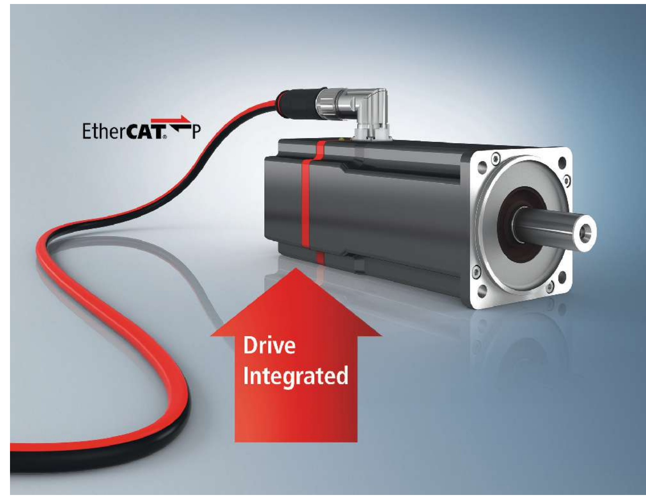
Distributed servo drive

The AMP8000 distributed servo drive system integrates a servo drive directly into a servomotor. By relocating the power electronics directly into the machine, a control cabinet can house a single coupling module and supply power to multiple servo drives with a single cable via the distribution module.

With the AMP8000, space requirements for drive technology inside electrical cabinets are reduced to a single coupling module. Via EtherCAT P technology, which provides EtherCAT signals and power over one cable, a coupling module can control up to five distributed AMP8000 servo drives via an IP 67–protected AMP8805 distribution module. Because the entire AMP8000 system can be cascaded, companies can implement complex motion systems.

The power module is located at the back end of the motor shaft, so the attachment dimensions of the distributed servo drives are identical to those of standard AM8000 series servomotors. The only dimensional change is to the overall servomotor length, which is extended by approximately 7 cm.

The AMP8000 distributed servo drive system is available in flange sizes F4 and F5. Various models are available with power ratings from 0.61 kW to 1.23 kW and standstill torque ratings from 2.00 Nm to 4.8 Nm (F4) or power ratings from 1.02 kW to 1.78 kW and standstill torque ratings from 4.10 Nm to 9.7 Nm (F5). STO and SS1 safety functions are integrated into the AMP8000 series by default, and a range of additional safe motion functions are in preparation.



Beckhoff Automation, https://beckhoff.com

Stepper drives

The family of STR stepper drives has two new AC-powered units for use in industrial applications. Offering the benefits of low noise, smooth motion, and high torque over wide speed ranges, the STRAC stepper drives bring motion control to basic step and direction applications. Units are suitable for larger motors and applications requiring maximum power.

Like their DC-powered counterparts, the stepper drives have microstepping performance and current control with antiresonance that improves motor smoothness and torque over a wide speed range. Units operate on AC supply voltages of 90 VAC to 240 VAC and wire directly to 120 VAC or 220 VAC line voltages to eliminate DC power supply requirements. The drives internally convert AC line voltages to high DC bus voltages to drive large step motors at maximum power.

Available in two models, the STRAC2 provides up to 2.2 A per phase, while the STRAC8 provides up to 8.0 A per phase. Every stepper drive in the STR series operates in step and direction or pulse/pulse control mode. Select between the two modes by moving a jumper located under the drive cover or via a dip switch on the front panel. Each drive microsteps to 25,000 steps/rev with a 1.8° step motor (1/125 step) even when command pulses are low resolution—thanks to the proprietary step smoothing filter. Users can set up drive parameters—including motor selection, current, and step resolution—using dip or rotary switches. No software is required.

Applied Motion Products, www.applied-motion.com

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Sample of Jobs Available at Jobs.isa.org

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Senior coordinator, maintenance

CF Industries: This position in Terre Haute, Ind., provides technical skill, knowledge, and guidance to execute instrument and electrical (I&E) maintenance and new project construction throughout distribution facilities. Major responsibilities include designing, documenting, and troubleshooting I&E equipment; supervising outside contractors doing major work; assisting engineering personnel as needed; training operations personnel in troubleshooting; and shop testing I&E equipment. The position requires the equivalent of five to 10 years of experience in a plant I&E department and a deep background in instrumentation and controls. An undergraduate degree in engineering is helpful . . . see more at Jobs.isa.org.

Process controls engineer

Toshiba International Corporation: The process controls engineer must have proven skills in requirements gathering, design, configuration, integration, and implementation of process control solutions for projects, including programmable logic controllers and distributed control systems, HMI packages, SCADA systems, and industrial PC networking technology. The engineer, based in Houston with some domestic and international travel, implements solutions and supports team objectives for control system projects implemented on behalf of the company's customers. A minimum of 10 years of process controls engineering experience is required. A bachelor's degree in electrical or chemical engineering is preferred. Experience in the process industries is a plus . . . see more at Jobs.isa.org.

Senior associate, manufacturing

Neon Therapeutics: The company, based in Cambridge, Mass., seeks a motivated individual with chemistry and cGMP manufacturing experience to join the technical operations group. The associate will interact directly with the company's contract manufacturing and testing organizations to coordinate activities, review records, and manage issues. The associate will be responsible for the technical review of manufacturing records and monitoring the performance of manufacturing processes. A bachelor's degree in chemistry, engineering, or a physical sciences discipline, cGMP pharmaceutical or biotechnology manufacturing experience, and an understanding of organic synthesis and small molecule manufacture is required . . . see more at Jobs.isa.org.

Network engineer

Salesforce: The engineer will provide technical leadership and guidance during deployment activities in facility power, cooling, rack layout, and cable management and will recommend strategic and tactical changes to existing physical infrastructure. Positions are available in San Francisco, Houston, and Herndon, Va., with 10 to 30 percent travel required. A minimum of three years of IP networking or TCP/IP networking, architecture experience, or enterprise network infrastructure is required. Competence in configuring and troubleshooting IP routing/switching technologies and protocols, including TCP/IP, BGP, OSPF, and ISIS in a dual-stack IPv4/6 environment; a solid understanding of data center design and operational best practices; and a strong familiarity with Unix or Linux OS/networking is also desired . . . see more at Jobs.isa.org.

New software for next-gen automation

By Harry Forbes

ABOUT THE AUTHOR
Harry Forbes (hforbes@arcweb.com) is ARC's lead analyst for the distributed control system market. ARC leverages Forbes' utility expertise in its open process automation initiatives and the electric power vertical industry. Forbes has 30 years of experience in industrial automation, with a BSEE from Tufts University and an MBA from the University of Michigan.

The rage right now in the world of enterprise IT are "containers" and "microservices." Container software technology enables applications to be packaged with only the needed software components that are then deployed ("pushed") to a set of target systems where they execute. Microservices refers to breaking large applications into many small parts and deploying these parts on cloud computing platforms by the hundreds or even thousands. In microservices, the application code for individual apps is much simpler, but monitoring and managing them ("orchestration") is much more difficult. However, these orchestration tasks are done by mature open-source software with a multiyear track record running applications for a familiar company—Google.

In the world of process automation systems, the focus of the Open Process Automation Forum (OPAF) is on standardizing ISA-95 Level 1 and 2 functions; these are basic I/O from field devices and regulatory control loop execution. Today these functions are performed in proprietary DCS and PLC process controllers, sized to support roughly 100 to 1000 function blocks each. ExxonMobil and other end users envision automation systems with many more, but much smaller, process controller hardware. These devices would control as few as one or two loops each.

What changes are required to deploy and manage the functions of an industrial control system using open-source enterprise software technologies? What advantages do end users gain to justify the change?

Common software run-time environment

Industrial controllers have never benefited from a common software run-time environment. Instead, each automation supplier developed and delivered its own software environment, which is normally invisible to the end user. End users interacted with the controllers only via the vendor's controller configuration software toolset. If you bought a controller from a different vendor, you had to learn a different software toolset. Thus, in the marketplace the controller software toolset represents a vendor differentiator and lock-in.

In higher-level industrial software applications (such as data historians), the Windows software environments leveled the playing field. But at the level of process controllers, the software environment has been a real-time operating system (RTOS), and the end user, by design, has been shielded from it.

This will not be the case in the next generation of process automation systems. One or (more likely) several software run-time environments will become commonplace in process automation. End users would be foolish and unrealistically demanding to expect one single and universal solution. Recall that this never happens for the most common "standards" (e.g., 50 Hz versus 60 Hz, drive on right versus left). Probably one environment will be an operating system, one a hypervisor, and one a container run-time engine. Some important features of these software environments will determine the extent of their use in industrial process automation. Criteria that suppliers (and standardization bodies) should use to evaluate any candidate as a standard software run time are:

Longevity and support: Only a software system that is likely to be long lived with a solid open-source support community is realistic.

Cybersecurity: Security is a major priority, which favors solutions that present a small attack surface and that can be quickly and easily patched.

Compactness and simplicity: An RTOS is usually simpler and more compact than "rich" operating systems (OS). By the march of Moore's Law, the footprint of a full OS (Linux at least) is less of a barrier. Simplicity remains a virtue for many reasons, though, which bodes against a full-featured OS serving widely in this role.

Ecosystem: The platforms need more than just a support community. They need an active software ecosystem that provides other features and services.

The fundamental question is why move away from a software model that has been in service for decades? What advantages drive this transition? Here are a several:

Greater vendor independence: Today, the degree of vendor lock-in is equivalent to the minicomputer market in the 1970s, when each supplier supported its own application software. End users do not benefit.

Enterprise-wide visibility: Management and analytics of automation systems now take place at a process unit level (if they take place at all). Critically important analytic applications are almost impossible to implement across a set of proprietary automation software environments, yet end users badly need to extend these apps across all their operations.

Better skill sets: The high degree of vendor-specific knowledge required today greatly limits the ability to develop and use human resources. This becomes a problem for end users and automation suppliers alike, and neither can afford the current situation any longer.

Fundamental change is finally coming to automation software. ■


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