April 2021

InTech

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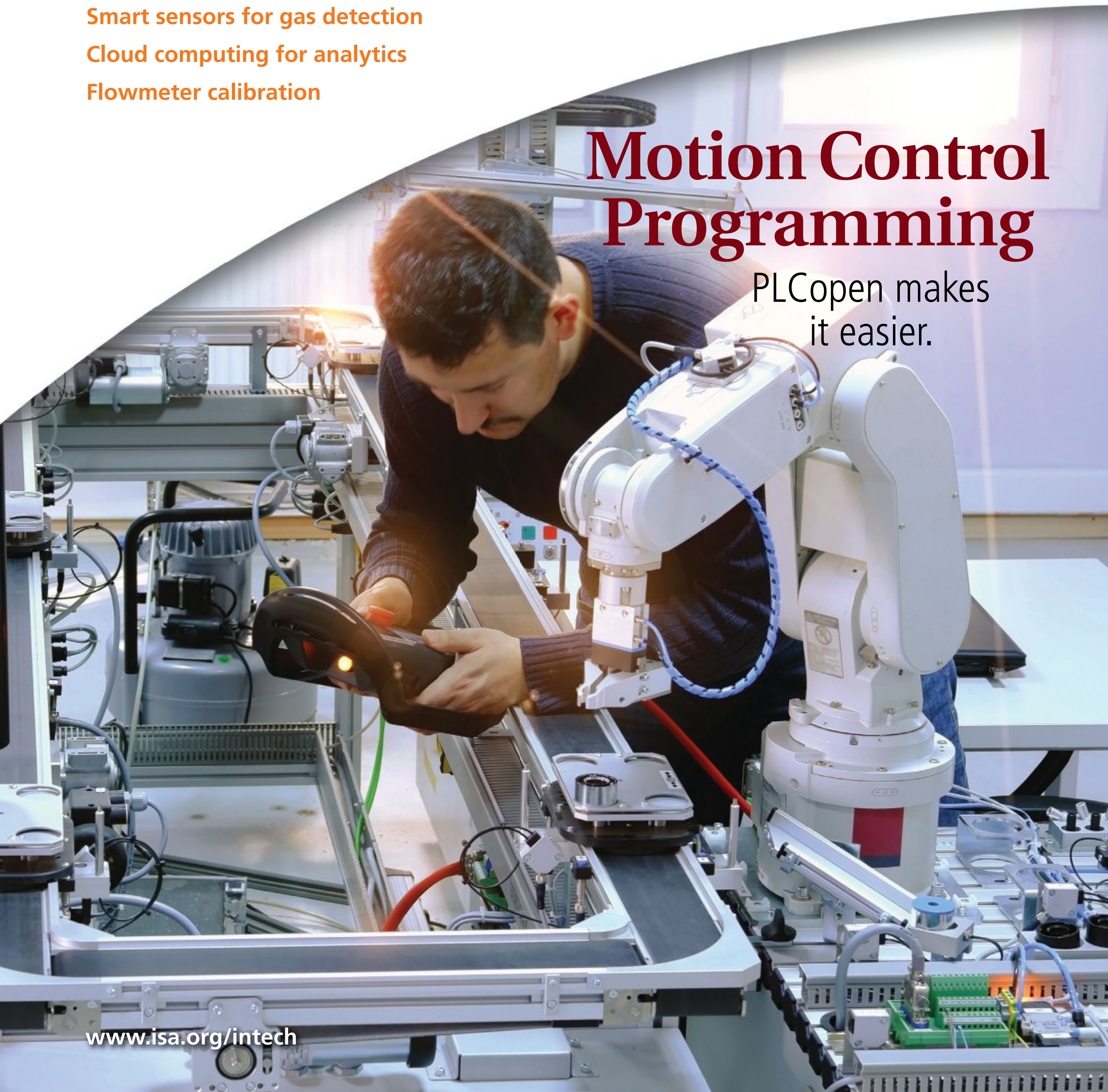
Petrochemical asset management

Smart sensors for gas detection

Cloud computing for analytics

Flowmeter calibration



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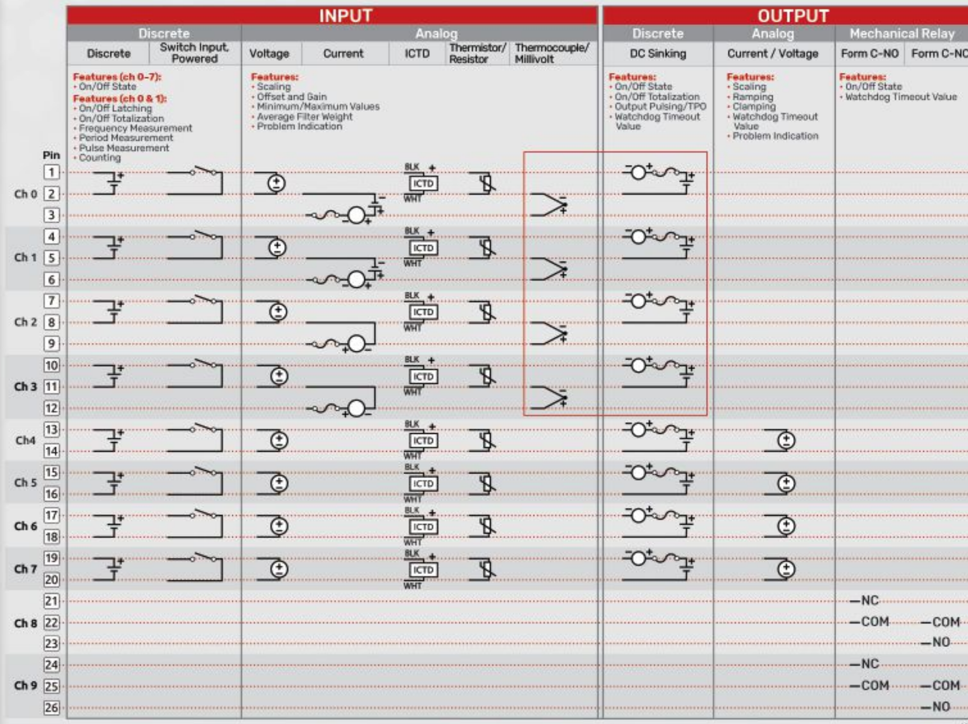

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By Bill Lydon

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By Fawaz A. AlSahan, Ghulam Farooq, and Saleh M. AlGhamdi

Gas detection systems warn workers in oil and gas plants of toxic or combustible gas leaks, and smart sensors for gas detection with analytical capabilities are evolving and bringing more benefits. Capitalizing on the fourth industrial revolution, Saudi Aramco took a holistic approach to improve the performance of thousands of gas detection sensors.

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By Megan Buntain

Process manufacturers require new levels of agility to satisfy extreme fluctuations in global demand, and the COVID-19 pandemic has increased this requirement. Cloud computing is being rapidly adopted to support improved production agility and more distributed work teams. Previous barriers to cloud computing, including security, network connectivity, and data protection, have been overcome with hybrid and pure cloud approaches.

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Most petrochemical and other process manufacturing plants are highly automated, but many types of operational and maintenance disruptions still persist. What is the solution?

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InTech provides the most thought-provoking and authoritative coverage of automation technologies, applications, and strategies to enhance automation professionals' on-the-job success. Published by the industry's leading organization, ISA, *InTech* addresses the most critical issues facing the rapidly changing automation industry.

Optimizing investments in people and systems

By Renee Bassett, *InTech* Chief Editor

New is not always better, but issues ignored or avoided will almost certainly get worse.

As Sean Sims says in this month's Executive Corner column (p. 12), "it is exciting to think about the potential of IIoT, digital transformation, and autonomous operations, but what is often overlooked is that many organizations are operating below capacity, producing off-spec product, and dealing with unplanned production upsets. All of these and other issues can be addressed by optimizing the process control system in place today."

Even a small plant or process unit has useful data available from thousands of devices, according to "Asset Management Transformed" (p. 28), but it is typically locked in historians or other isolated databases. "Most companies do not extract most data and get it to the people who could use it," says Hiroshi Yokoi. "The overall picture should be clear: Data is available, and it can help reduce risk, prevent incidents, and guide maintenance."

Measurements from process control instrumentation are increasingly being recognized as key components for industrial asset health management specifically and digital transformation overall. Determining why production unexpectedly stops mid-operation, or preemptively avoiding such stoppages, requires diagnostic data that can only come from the machines themselves.

Gathering data has been a mainstay of industrial operations for a long time. Viewing, analyzing, and applying the lessons of that data—whether to provide maintenance, improve real-time operations or invest in significant business transformation—is the ongoing challenge. Experienced personnel who understand measurement instrumentation and control systems—their potential as well as their limits—can and should be asked to help.

Instrument engineers at Saudi Aramco describe their work to improve the gas detection system performance coming from the thousands of existing gas detection sensors at their facilities in "Smart Sensors for Gas Detection" (p. 18). The currently installed gas detectors were reevaluated, the existing maintenance practices were reviewed to identify improvement opportunities, a benchmarking study was conducted, and latest smart sensors technologies for toxic and combustible gas detection were evaluated and field tested. The article describes the implemented improvements, including the identified smart technologies and their field-tested results.

Gathering data has been a mainstay of industrial operations for a long time. Viewing, analyzing, and applying the lessons of that data is the ongoing challenge.

By considering how the control system functions as the core of a successful digital strategy—and soliciting input from the engineers and technicians at every level who know the processes best—organizations can achieve performance gains from existing automation investments.

Then they can see how future gains can best be achieved by applying the exciting new technologies you'll also find discussed in the pages of *InTech*.

Talk to me. Let me know what you've read about in *InTech* or elsewhere that your facility has adopted, or avoided, to measurable success. ■

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ARC 2021: Industry Leaders Share Digital Transformation Journeys

The Annual ARC Industry Forum celebrated its 25th year and for the first time hosted the forum online. "Accelerating Digital Transformation in a Post-COVID World" was held in February 2021. "We have held this forum in Orlando, Florida, for the past 24 years. We are excited to bring this one right to you wherever you are," said Andy Chatha, president of ARC Advisory Group. ARC plans to host all future forums in hybrid form, he says.

The forum boasted 2,500 attendees, 400 companies, 200 speakers and panelists, and 75 corporate and media sponsors. Many of ARC Forum's impressive lineup of speakers championed the phrase "IT-OT fusion" as they described the ongoing process of uniting information technology and operational technology into a single force operating for the good of the business. Individual speakers shared how they are using new technologies and processes to transform their business and manufacturing operations in the digitalization age, which has been accelerated by the pandemic.

ExxonMobil: Value of digital tech

"While our digital transformation started long before 2020, the challenges of last year had a few significant impacts on that journey," said Nick Clausi, vice president of engineering for ExxonMobil Research and Engineering Company. "It accelerated the rate at which we were deploying digital technology, and it revealed value in digital tech that we didn't recognize."

Clausi noted that ahead of the pandemic, ExxonMobil had begun testing some tools for remote support but was hesitant because it believed remote support may not be as effective. However, the pandemic showed employees that they could do a lot more work remotely than they had previously thought, and the time efficiency allowed them to better leverage technical resources.

Like most organizations, ExxonMobil limited the number of people at its sites during the pandemic, necessitating the increased application of robotic inspection techniques that were under development. "Our Baton Rouge facility is home to the world's largest IPA unit, which is a key ingredient in hand sanitizers," Clausi said. "We were able to leverage our remote connectivity tools with our advanced dynamic matrix control capability to rapidly and remotely update control applications. We did that in sync with physical modifications we were making to the unit. We rapidly expanded the production capability of that IPA unit."

Clausi also recognized potential opportunities in autonomous operations moving forward.

Operators are tasked with running fairly complex processes safely and efficiently around the clock. They need to synthesize large quantities of data and manipulate potentially hundreds of variables to optimize an outcome, making this a rich area to use digital technology. ExxonMobil is working on intelligent self-optimizing plants. "The goal here is to take advantage of cognitive learning and adaptive capabilities based on AI [artificial intelligence] and machine learning to automate, reduce human error, and make better decisions," Clausi said.

"We tend to simultaneously overestimate the risk and underestimate the value of our digital technologies and transformation," Clausi said. "And that's a really important lesson for all of us to keep in mind as we pursue some of the more challenging digital technologies and applications."

ADNOC CTO Alan Nelson said, "Digital and AI are not about replacing people, but about enhancing what people can deliver."

ADNOC: Enhancing what people do

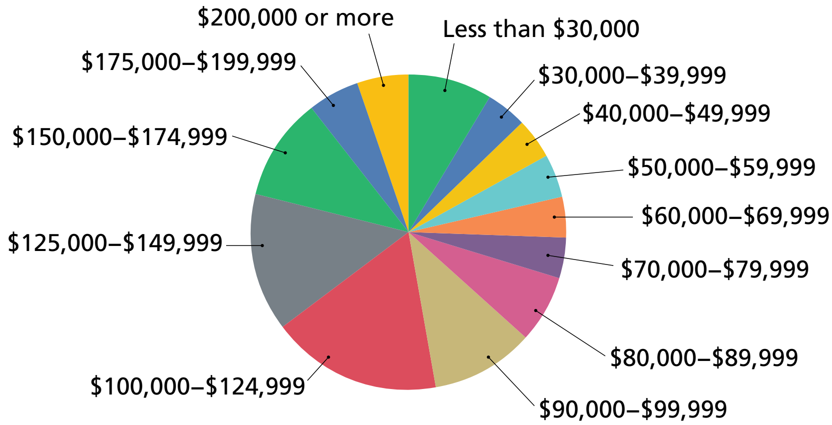
Alan Nelson, chief technology officer of Abu Dabi National Oil Company (ADNOC), spoke about how ADNOC is applying technology to frame the opportunity and challenge of the pandemic and the call for increased digitalization. Nelson emphasized that "digital and AI are not about replacing people but about enhancing what people can deliver."

"There are multiple opportunities to harness the power of digital and AI across the entire oil and gas value chain," Nelson said. He listed nine active projects and introduced Panorama, which he called "the gateway to ADNOC's digital transformation. It represents the single source of accurate and timely information across our value chain," he said. "It visualizes and streamlines our entire operations and our critical business information on a single 50-meter video wall in one secure facility. It puts big data at the fingertips of our sharpest minds."

ADNOC has made advances in predictive maintenance with centralized predictive analytics and diagnostics, which applies AI algorithms to predict critical equipment anomalies ahead of time, as well as with a smart expert system to deliver automated predictive maintenance advisories. The company also applied Panorama as part of its COVID-19 response. Its predictive AI models could predict, track, and model COVID-19 infections and recovery progress and simulate scenarios to practice health and safety measures. ■

—*By Melissa Landon*

Automation Salaries in a Global Pandemic: A Snapshot



Worldwide 2020 gross salary for automation professionals.
Source: Automation.com Annual Salary Survey

Are you paying your automation employees enough? How did your salary change during the past year of economic turmoil from a global pandemic? Answers to those questions are reflected in the 28-page Automation.com *2020 Industrial Automation Salary Survey* of engineering, business, and technical professionals in manufacturing and industry.

Overall, the survey indicates a slight increase in global salaries over 2019 levels. A survey emailed to our global audience in November resulted in almost 2,000 responses, with 60 percent of respondents from the U.S. Nearly 64 percent of respondents indicated they received or expected to receive an increase in total compensation in 2020 over 2019. However, nearly half (47 percent) of those expecting an increase anticipated it to be less than 4 percent.

About 22 percent of all respondents made $59,999 or less; 25 percent made $60,000 to $99,999; and 41 percent of respondents made between $100,000 and $174,999. Just over 10 percent of respondents reported making $175,000 or more in 2019.

By many measures, 2020 was a year of disruption, uncertainty, and change. The effects of the COVID-19 pandemic on individuals, local and national economies, individual businesses, and global supply chains continue even now. So this year's survey asked a few open-ended questions about automation professionals' experiences during this pandemic.

Reports are that most industrial companies are weathering the pandemic storm well. Plenty of answers to our survey indicated either a lack of change in workplace situation or just a positive regard for companies' efforts to maintain normalcy for employees. For example, one respondent noted, "I believe my company has handled the pandemic about as well as we could." Others report seeing negative effects of the pandemic; one respondent simply said, "The pandemic has made in-person work very difficult."

Whatever your personal experience of working through the pandemic, it seems other automation professionals experienced similar things. For some, working remotely was a necessity in 2020; for others, it was just more of the same. Nearly half (48 percent) of respondents indicated they had the ability to do their job remotely, while 25 percent said they did not. More than one-quarter (26.8 percent) said they were working remotely at the time they took the survey.

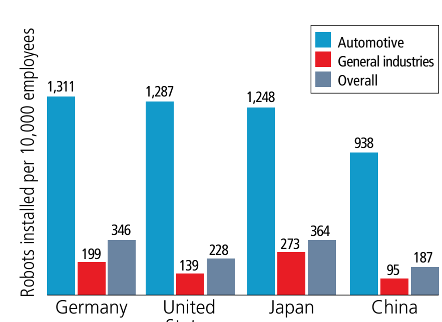
The full 28-page salary survey results report includes figures that break out salary data by factors that influence salary, such as job function or years of experience. It also reports salary trends both globally and only for U.S. respondents. ■
—By Melissa Landon

Automotive Plants Lead in Robot Density

According to the latest stats from the *World Robotics* report from the International Federation of Robotics (IFR), robot density—the number of installed units per 10,000 employees—worldwide in general industry is still relatively low, at only 139 units. The robot density in U.S. automotive plants, however, hit a new record of 1,287 installed units per 10,000 employees. The U.S. auto industry ranks seventh worldwide, with a density similar to Germany (1,311 units) and Japan (1,248 units). China is in 12th place with 938 units.

In all surveyed countries, the potential for robot installations overall is high as digital transformations take place, and some are investing. In the U.S., yearly orders of robots from nonautomotive sectors surpassed automotive robot orders for the first time in 2019. Food and consumer goods plants ordered 60 percent more robots, for example, while plastics and rubber plants saw a 62 percent increase. Year-over-year orders for robots by U.S. life sciences companies increased by 72 percent.

"Automation is the key not only to post-pandemic recovery, but to post-pandemic growth and progress," says Milton Guerry, president of IFR. After the 2008 financial crisis, companies like General Motors, Ford, Fiat-Chrysler, and Tesla invested extensively in robotics and automation, he says. As a result, thousands of new jobs were created in the automotive industry. Now is the time for other industries to learn from that lesson, he says. ■



Robot density in the automotive vs. general industries 2019
Source: International Federation of Robotics

Seizing Industry 4.0 by Tapping 5G, Edge Computing, and Hybrid Cloud

By Joe Berti

ABOUT THE AUTHOR

Joe Berti, vice president, AI applications, IBM, works with clients to accelerate their digital transformation using intelligent insights. His team leads the overall product strategy for a portfolio of business applications that includes the IBM Maximo Application Suite, a platform providing intelligent enterprise asset management, monitoring, predictive maintenance and reliability.

Like many buzzwords, there isn't necessarily a strict, widely agreed-upon definition for Industry 4.0, or the fourth industrial revolution. Within industrial and manufacturing settings, it usually encompasses a broad array of technologies and automation techniques that promise to help optimize processes.

Industry 4.0 can refer to models that decide which fulfillment center will ship materials so they arrive at factories sooner, or product suites like IBM Maximo, which use advanced analytics and artificial intelligence (AI) to guide asset management and decide which repairs should be made next. It can also refer to robots that help us do the heavy lifting, or visual inspection technologies that help organizations identify flaws on the assembly line or make rapid changes to their operations.

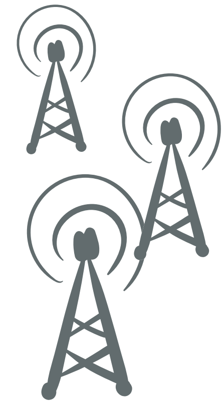
Like the steam engine or the assembly line, Industry 4.0 offers a steep improvement to productivity and production by automating work that humans find tedious, or, on the other hand, by augmenting human ability with tools that help people do their jobs significantly better. However, to make any of these functions work at scale, a large array of enabling technologies is needed, from sensors and Internet of Things devices that gather data, to edge computing, hybrid cloud, and 5G, which allow models and operations to run wherever organizations need them.

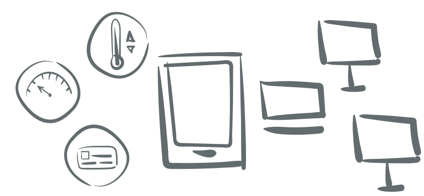
The technical infrastructure beneath Industry 4.0

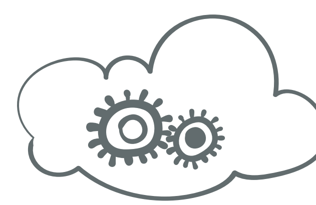
In the 21st century, meaningful changes to the way we work require deliberate investment and a sophisticated digital infrastructure with a footprint all the way from the edge to your data center to your cloud. A hybrid cloud architecture achieves this, giving you a common container-based platform across all your infrastructure locations, the ability to auto-scale based on your workloads, and the flexibility to run your platform in any cloud—public, private, or edge and across all of them.

Edge computing and next-generation mobility networks like 5G also make it possible to gather insights and process data in motion.

When computing can be done at the edge, organizations can interpret vastly larger amounts of data without degrading network performance. With edge computing, you can also run certain







workloads such as some AI models on site, allowing AI to do much of the work of determining which data and insights are valuable enough to merit analysis in a central hub.

Advancing automation

With a hybrid cloud architecture and other key infrastructure in place, a great deal of the automation implied by Industry 4.0 becomes possible. You can gravitate away from human interventions toward digital ones. Cameras and beacons can detect when equipment is running hot or indicate some sort of mechanical flaw. AI models can assign holistic health scores to different assets, and predictive maintenance models can take a fixed budget and determine the optimal repairs under different criteria. In the very near future, and in situations where the problem is being caused by a software and not a mechanical issue, AI models will likely even be able to carry out interventions of their own, identifying the problem and then determining and running the software patch needed to fix it. This has ramifications not only for company savings and efficiency, but employee safety: Why send an inspector into a cell tower or some other potentially dangerous situation if you don't have to? ■

Digital Transformation Depends on the Core Process Control System

By Sean Sims

ABOUT THE AUTHOR

Sean Sims is the vice president of the Emerson DeltaV platform. Before his current role, Sims was vice president for both the Measurement and Analytical business for the Asia Pacific region, and for Lifecycle and Performance services. He has a BSc Engineering degree (metallurgy and materials science) from the University of the Witwatersrand (Johannesburg, South Africa).

In the past few years, discussion around the Industrial Internet of Things (IIoT), Industry 4.0, cloud, edge, and enterprise connectivity has been pervasive. It is exciting to think about the potential of IIoT, digital transformation, and autonomous operations, but what is often overlooked is that many organizations are operating below capacity, producing off-spec product, and dealing with unplanned production upsets. All of these and other issues can be addressed by optimizing the process control system in place today.

By considering how the control system functions as the core of a successful digital strategy—whether the vision revolves around IIoT, digital transformation, or autonomous operations—organizations can achieve performance gains from their existing automation investments.

Maintaining a robust, well-configured control system is a key element of any digital transformation strategy. Applying new solutions without first leveraging existing automation within the control system means opportunities are missed to increase the value of an organization's entire digital infrastructure.

Two of the most common areas where organizations underutilize the control system, and as a result leave value on the table, are optimizing control loop performance and implementing state-based control. A predictive modeling infrastructure can help improve production performance, quality, and repeatability. However, if that infrastructure is built on a suboptimal automation foundation and operators do not have the best decision support tools available, existing operational inefficiencies can prevent production and profitability gains when a new production plan is pushed down to the plant.

Control loop performance improvements ensure optimal control capabilities per control loop, which aggregate to significant gains, while state-based control manages normal and abnormal process situations and gives operators the bandwidth to drive peak performance. These proven programs, which are the basis for autonomous operations, have reduced operator interventions by more than 80 percent and increased annual capacity by 1.5 percent, which equates to a fast and long-standing return on investment (ROI). The underlying architecture to support both is likely already part of the plant's control system and readily available for deployment.

Capturing unrealized value in the control system must also include empowering personnel. An effective alarm management strategy—which in Emerson implementations has achieved as much as a 90 percent reduction in alarms—makes it easier for operators to focus on proactively avoiding abnormal production situations and increasing their span of enhanced control. Many modern control systems also have the ability to configure in-place analytics that provide situational awareness and decision support for operators at a glance, creating the right environment for operators to perform at their best.

It is exciting to think about the potential of IIoT, digital transformation, and autonomous operations, but many organizations are operating below capacity, and dealing with unplanned production upsets.

One critical strategy for building a strong automation foundation is to optimize control systems immediately after they are deployed, and to make a commitment for continued optimization across the life cycle of the equipment. Organizations that prioritize this strategy early unlock the highest long-term ROI from their systems. It does not take long for a new operation to become the status quo. By making continual optimization part of that status quo, plants maintain a far higher baseline of performance.

At the same time, many plants are staffed to run, not optimize. Increasingly, companies are looking to automation partners for expertise to help them stay on top of the updates, upgrades, adjustments, tools, and process changes that can help keep control infrastructure operating at its best. These providers' automation expertise and institutional knowledge about their customers' operations helps optimize the operational foundation today, while preparing them to take the next step toward digital transformation initiatives that deliver the highest value. ■

Increased Motion Control Programming Efficiency

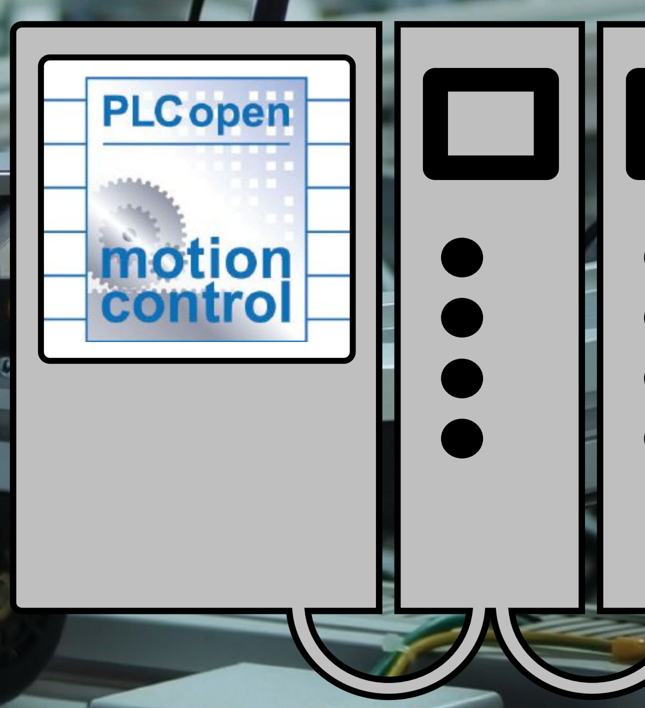
PLCopen standards simplify motion applications' development and quality.

By Bill Lydon

Motion control has become a fundamental part of industrial, off-road equipment and other automation applications from simple to mechatronic, and programming motion control has been simplified with the PLCopen motion control specifications and standards. Using standard function blocks, engineers build applications without programming.

Motion control applications are increasing and becoming more complex to meet demands for greater system throughput, improved quality, and operational flexibility. The PLCopen motion control function blocks support the user by providing vendor- and platform-independence and reducing overall development time. PLCopen function blocks make it easy for application engineers to apply mechatronic concepts using multiple coordinated drives rather than cumbersome mechanical gearing methods. The standards enable engineers to build applications with higher speeds, faster changeovers for flexibility, and improved reliability.

A great example is machine builders in the packaging industry. A packaging plant may include machines for bagging, wrapping, bottling, labeling, weighing, inspecting, and palletizing, just to name a few. In this industry, manufacturers must quickly react to consumer needs, so they require flexible machines. A food and beverage company may need to quickly change a package concept to meet marketing demands, requiring changes to packaging materials and dispensing systems. In a strictly mechanical system, this requires a shutdown of the production line and many hours, or even days, of changeover. There is a high risk of



human errors creating problems. In contrast, a mechatronic solution with a flexible software interface can easily be simulated before deployment and virtually commissioned before the physical changeover is quickly and confidently accomplished. This translates into lower downtime, higher production utilization, quicker marketing response, decreased costs, and increased profits.

FAST FORWARD

- PLCopen motion control specifications and standards have made programming motion control simpler.
- The PLCopen motion control function blocks support the user by providing vendor- and platform-independence and reducing the overall development time.
- Before the introduction of PLCopen and the IEC 61131 standard, the motion control industry was very fragmented.

Reusable application

Because of application requirements and project specifications, engineers must use a wide range of motion control hardware. In the past this required creating unique software for each application even if the functions were the same. The PLCopen motion standard provides a way to reuse applications on multiple hardware platforms. This lowers development, maintenance, and support costs and reduces confusion. In addition, engineering becomes more efficient, and training costs decrease.

Standardization is accomplished by defining libraries of reusable software components. This makes the programming less hardware dependent, increases the reusability of the application software, reduces the costs related to training and support, and makes the application scalable across different control solutions. Due to data hiding and encapsulation, software components are reusable on different automation architectures, ranging from centralized to distributed or integrated to networked control. The PLCopen motion function blocks are building blocks to serve as a basis for creating many applications. Therefore, the applications created with reusable software components can be deployed on existing and future systems.

Why standardize?

Before the introduction of PLCopen and the IEC 61131 standard, the motion control industry was very fragmented. There were a variety of systems available, each with its proprietary technology, languages, communication, and development tools. Machine builders often delivered multiple versions of a machine, including a low-cost version, a medium-level machine, and a high-performance solution. In addition to that, machine builders often had to release different brands of controllers for different regions.

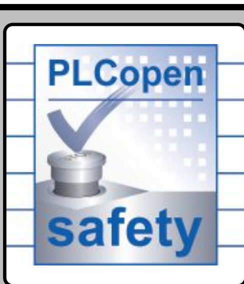
The PLCopen Motion Task Force set out to create a library of function blocks to act as a standard motion interface regardless of the architecture. This standard interface can be used across many different systems. This means applications can be developed independently of the platform, so the engineer can easily change architectures or support multiple platforms. Automation designers can wait until after the application design stage of a project to finalize their choice of hardware. Maintenance and training costs are also greatly reduced.

The PLCopen motion control function blocks satisfy a long demand for a standardized programming method to control positioning tasks quickly, easily, and efficiently. These function blocks can be programmed in the IEC 61131 languages such as Ladder Diagram and Structured Text. Because these function blocks are hardware independent, they can be used to program many different types of motors, drives, feedback systems, and even different topologies, such as centralized or decentralized solutions. This hardware independence and programming flexibility also allows users to select hardware based on the requirements of the application instead of limiting their decision simply because of previous experience or level of training. The optimal hardware solution can be configured for the application at hand.

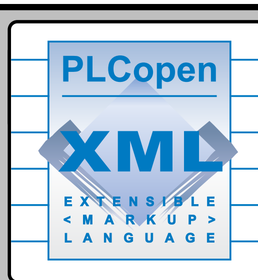
Standardizing on a motion interface also makes education much easier and more efficient. It is a great benefit to be able to train future programmers without having to directly refer to specific hardware or programming tools. Once trained, engineers can apply their knowledge to a broader range of motion control products.

Software value

Increasing software programming efficiency is important. “Three decades ago machinery required almost no software, whereas now software development accounts for about half



The PLCopen Safety Overview is available online at https://plcopen.org/technical-activities/safety, and the full specifications are available at https://plcopen.org/downloads?field_technical_activity_target_id=64.



In 2014 PLCopen handed over its intellectual property rights on the schema, specification, and documentation to the IEC; this has become IEC 61131-10:2019 *Programmable controllers – Part 10: PLC open XML exchange format* (https://webstore.iec.ch/publication/33034).

of the total cost of a production line," according to Eelco van der Wal, managing director of PLCopen. "Flexible motion control technology paired with an open, standard industrial software interface can greatly reduce the complexity of all types of industrial machinery and automation applications."

Motion control software standardization, along with IEC 61131 standard software languages, has many advantages, including:

- greater reusability of software
- less dependence on hardware
- faster time to market
- decreased installation time and cost
- decreased maintenance time and cost
- wider acceptance across the industry
- reduced training time and costs.

Architecture independence

Machine developers can leverage the platform-independence of PLCopen. For example, many developers are moving away from a centralized motion control approach because of the advantages of a decentralized solution. Centralized designs require an expensive motion controller to handle the hefty processing load of multi-axis systems. Even then, large axis counts may not be possible because of limitations of the controller and communication network.

Decentralized control platforms with intelligent drives remove much of the load from the main motion controller and reduce the network limitations by closing their own positioning loops. This eliminates the need for a large, expensive motion controller. Larger numbers of synchronized axes are possible on a single network that has a high-speed, scalable motion solution. Motion control performance is not dependent on the processor performance or the number of axes being run on a network. Standardized motion control interfaces across multiple platforms and minimizes development time and cost.

The intention of PLCopen is to allow developers to move from one platform to another as technology becomes available. The PLCopen function blocks operate independently of the underlying architecture. Machine builders can continue to develop their machines without fear of obsolescence or extraneous engineering costs.

Standards development

Standardization is accomplished through the efforts of the PLCopen organization. PLCopen was established in 1992 to harmonize the industrial control market across different platforms during development, installation, and maintenance in accordance with the IEC 61131 programming environment. Current initiatives include motion control, safety functionality, XML data exchange, and benchmarking standards. PLCopen also continues to promote the use and training of this standard around the world. The PLCopen website (https://plcopen.org/voting-members) lists vendors that have certification to the organization's standards.

To produce a standard motion control specification, a set of reusable, hardware-independent control components has been defined based on the IEC 61131 function blocks. With this standard, application software can be reused. This is possible even across multiple platforms. Training and support costs are reduced as well. New developments can be implemented much more easily with shorter time to market.

These goals were achieved for motion control with definition and standardization on a basic set of function blocks, which allow both single-axis motion and synchronized multiple-axis motion. A state machine describes the behavior of an axis during a machine's sequence.

Currently the suite of PLCopen motion control specifications consists of the following parts:

- Part 1&2 – Basics and extensions combined in one
- Part 3 – User guidelines and examples
- Part 4 – Coordinated motion
- Part 5 – Homing procedures
- Part 6 – Extensions for fluid power

Every specification contains three sections:

1. Definition of the state machine
2. Definition of a basic set of FBs for single axis and multi-axes motion control
3. Compliance rules and statement procedure.

The complete specifications are available online (https://plcopen.org/downloads?field_technical_activity_target_id=63).

Definitions

The axis is always in one of eight defined states:

- synchronized motion
- discrete motion
- continuous motion
- stopping
- error stop
- homing
- standstill
- disabled.

Any motion command is a transition that changes the state of the axis and, as a consequence, modifies the way the current motion is computed.

The state diagram normatively defines the behavior of the axis at a high level. This diagram is useful to build a more complicated profile or to treat exceptions within a program. (Real implementations may define additional states at a lower level).

A normal procedure starts in the disabled state. In this state the power can be switched on per axis (via the command MC_Power), which transfers the relevant axis to the state of standstill. From there one can access the homing state (by issuing the command Home per axis), which after normal completion returns to standstill. From here one can transfer an axis to either discrete motion or continuous motion.

The programming of an axis of motion is very logical. The axis needs to be powered, homed, and moved. In three steps, an axis is moving or even synchronized with another axis. The code behind function blocks is hidden from the user and is the responsibility of the control software supplier. This code is dependent on the hardware and architecture of the system. The interface, which includes the inputs and outputs of these blocks, stays consistent over any platform. This differentiation of software levels is key to PLCopen's functionality. The motion of an application can be programmed in the same manor regardless of the hardware because the lower-level code is hidden from the user. The user does not have to have detailed knowledge of a drive or network architecture.

Expandability of PLCopen

After the task force outlined a basic set of function blocks to cover single- and multiple-axis control, it became clear that additional functionality was needed to reach a broader range of motion control systems. As a result, the PLCopen Motion Control Extensions were developed. Beyond this, machine builders and control suppliers can create advanced function blocks as a supplement to the standard function blocks. These reusable libraries take the PLCopen standard even further. The PLCopen User Guideline provides details and examples of how these user-specific libraries can be created based on standard PLCopen function blocks and according to the same specifications. Machine builders can then apply and reuse the function blocks they have created for their area of competence. This task force is also working to expand programming further with interpolation of coordinated multi-axis motion in three-dimensional space and extensions to the existing homing routines.

Integrated safety

Another development area that goes hand in hand with motion control is safety. In parallel with its motion control definitions, PLCopen developed standardized safety functionality that can be integrated into logic and motion applications. The ability to incorporate these safety standards achieves the same benefits as the motion control function blocks: greater reusability and portability, reduced engineering and training time, lower development and maintenance costs.

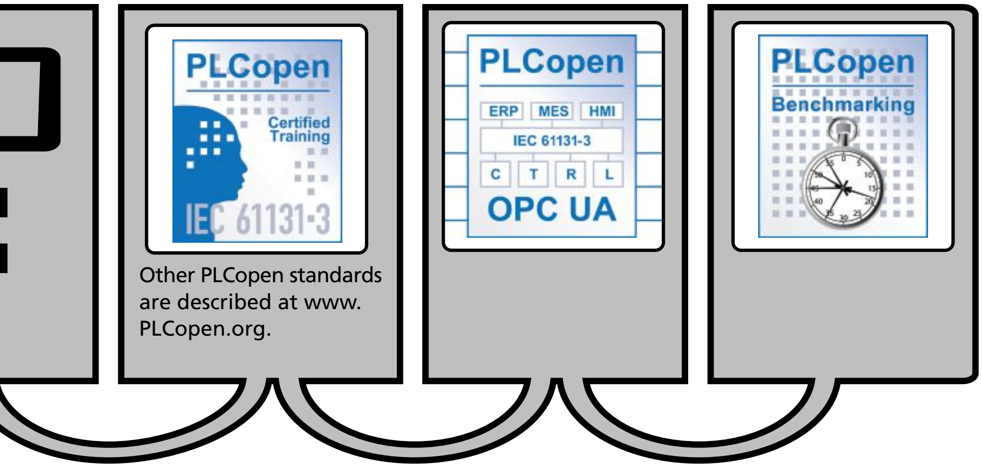
The PLCopen safety standards also reduce certification time and costs. To accomplish this, PLCopen has defined programming guidelines, safety-related data types, error handling and diagnostic concepts, representation of the software architecture, and certification guidelines. This combination of standardized motion and safety features gives users a more complete solution from a single programming environment that is portable across multiple platforms.

Software's role in industrial automation is increasing more and more, which increases the cost of software, even to the point that it is the largest part of the total system. To control these costs, one needs more efficient application development, while increasing software quality and decreasing maintenance and update costs.

PLCopen XML

Users want to be able to exchange their application programs, libraries, and projects between development environments, and to accomplish this the PLCopen XML interchange standard was developed. The PLCopen work group named TC6 for XML (eXtensible Markup Language) defined an open interface that can be used by different kinds of software tools to transfer the information that is on the screen to other platforms. In 2014 PLCopen handed over its intellectual property rights on the schema, specification, and documentation to the International Electrotechnical Commission (IEC). At that point, PLCopen XML became IEC 61131-10:2019 *Programmable controllers – Part 10: PLC open XML exchange format*.

PLCopen is a product-independent vendor and a worldwide association for topics related to industrial control programming. PLCopen is a platform of cooperation for our members, coming from all fields of the industry, and works to consistently improve efficiency. Because of the cooperation of members, the entire automation community benefits from knowledge and support. ■



Other PLCopen standards are described at www.PLCopen.org.

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Bill Lydon, *InTech* contributing editor, brings more than 10 years of writing and editing expertise, plus more than 25 years of experience designing and applying technology in the automation and controls industry.

Smart Sensors for Gas Detection

Protect workers and equipment at oil and gas plants.

By Fawaz A. AlSahan, Ghulam Farooq, and Saleh M. AlGhamdi

Gas detection systems are meant to protect workers in oil and gas plants by warning them if there is a toxic or combustible gas leak. Smart sensors for gas detection with analytical capabilities have been evolving, and they are bringing more benefits to the oil and gas industry.

Poor gas detection performance and ineffective management of gas detection systems in oil and gas facilities are unacceptable. These two scenarios impose risks to workers' lives, the environment, and plant assets in addition to dramatically increasing the operating cost to ensure the functionality of these detectors.

Capitalizing on the fourth industrial revolution, Saudi Aramco took a holistic approach to improving the gas detection system performance in its operating facilities, where thousands of gas detection sensors are running. It reevaluated the currently installed gas detectors, reviewed the existing maintenance practices to identify improvement opportunities, conducted a benchmarking study, and evaluated and field tested the latest smart sensor technologies for toxic and combustible gas detection.

This article presents the assessment findings, the implemented improvements, the identified smart technologies, and the field-testing results. The article also emphasizes the benefits of the smart sensors in terms of safety enhancement, performance improvement, and optimization of operating costs.

Gas detection system common challenges

When addressing the design requirements, and similar to other instruments, ambient conditions (including temperature, humidity, sandstorms, and rain) affect the performance of gas detectors. The sensors must have the required ingress protection (IP) and approval for proper area classification. It is particularly important to understand the sensors' limitations on storage and operating time and proper installation at vibration-free locations, with a sunshade and proper accessories (like a dust guard and splash guard). Being aware

FAST FORWARD

- Smart sensors for gas detection with analytical capabilities are evolving and bringing more benefits to the oil and gas industry.
- This article presents assessment findings, implemented improvements, identified smart technologies, and their field-testing results.
- Smart sensors provide safety enhancement, performance improvement, and operating cost optimization.

of poisonous gas and preventing sensors' exposure to liquids (such as water, oil, and paint) are also important considerations that prolong sensor life. Conducting the required testing and calibration per the manufacturer recommendations in addition to using the right gas cylinders can ensure a reliable gas detector operation.

Gas detectors performance evaluation

Evaluating new technologies for gas detection needs to be rigorous to cover all important aspects, including environment, performance, and end user experience in the oil and gas industry. These steps are normally followed in evaluating the performance of new technologies for gas detection:

- Type testing, which covers unpowered storage, measurement of deviations, mechanical tests, environmental tests, performance tests, electrical tests, stability, fault signal tests, software-controlled equipment, and protection against water.
- Ingress protection and hazardous area approval. This is to ensure consistent and safe performance for indoor and outdoor installations in oil and gas facilities.
- Offshore compliance, which covers compliance with temperature (–25 to 70°C), humidity (up to 100 percent), vibration (up to 4 g), electromagnetic compatibility (radio frequency, electrostatic discharge), and enclosure (up to IP68).
- Benchmarking to probe the market and other end users.
- Field piloting that demonstrates the actual performance of gas detectors.

Evaluation and results: Electrochemical smart sensors

An electrochemical H_2S smart sensor is a disruptive smart plant technology for H_2S gas detection. It works similarly to batteries. When the target gas is present, a

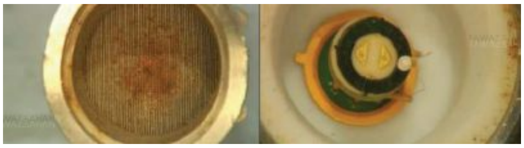

Figure 1. Failure of H_2S sensors caused by hose down

small electrical charge is generated chemically between two electrodes and displayed in the measuring head. The signal strength is proportional to the concentration of the gas. The sensor has a fast and linear response within the range 0–100 ppm, compared to a metal oxide semiconductor (MOS). Also, the electrochemical H_2S smart sensor is not affected by humidity, because it contains aqueous electrolytes.

The electrochemical smart sensor was selected after conducting a comprehensive study on H_2S sensing technologies suitable for the oil and gas industry. Seventeen industry standards covering gas detection were reviewed, and a benchmark study was also conducted. About 23 potential products were reviewed. Multiple onshore and offshore field tests were conducted in collaboration with many Saudi Aramco facilities. A collaborative, solid conclusion was then made that the electrochemical H_2S smart sensor was the best available option for H_2S gas detection in the company. The new technology has been widely deployed in the company with more than 8,000 installations so far.

Electrochemical H_2S smart sensor technology has many benefits compared to conventional MOS technology. The table in figure 4 summarizes the main advantages.

Evaluation and results: Autonomous smart sensors

The autonomous H_2S smart sensor is an advanced version of the electrochemical (EC) smart sensor and the latest technology for gas detection. It has two parts: one consists of the generator, sensor, and pump, and the other of the electronics. The hardware, software, and sensor of the autonomous H_2S smart sensor comply with safety integrity level (SIL) 2 requirements.

The technology has an automatic self-generation and self-testing mechanism, where it generates H_2S (5–10 ppm) and tests itself every 24 hours. An automatic self-test with gas is performed at programmable intervals—normally every 24 hours. Also, a manual self-test can be initiated, after calibration or actual exposure to H_2S.

During self-testing, 2 mA is measured, and a distributed control system (DCS) alarm can be configured to indicate "self-testing." When a failure takes place, 0 mA is measured, and a "failure alarm" can be generated at the DCS.

The H_2S generator is an electrochemical generator. It contains solid sulphur salt and conductive electrolyte. If current is applied to such a system, electrolysis starts, and in this case, H_2S is generated. The amount of H_2S generated is proportional to the electrical charge applied.

The criterion for the sensor test is the response time to this gas puff. The concentration of the gas generated depends on the sensor module applied. The relevant parameters driving the generator are stored in its RAM. In order to maintain adherence to the SIL 2 standard, the proof test or calibration interval must be

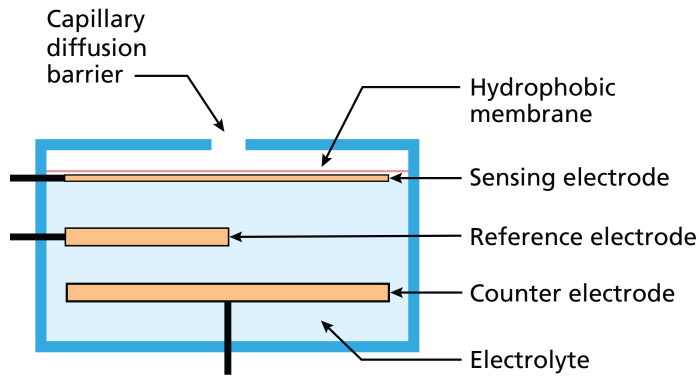

Figure 2. Electrochemical H_2S smart sensor

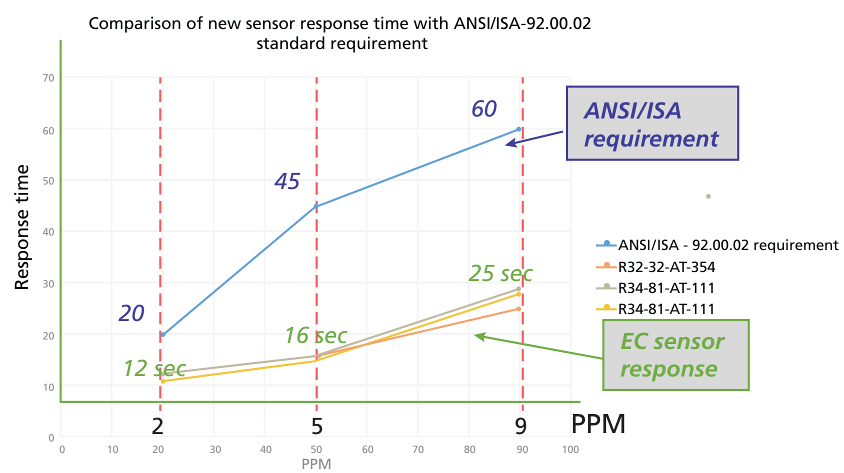

Figure 3. Field testing results – Electrochemical H_2S smart sensor response time

Characteristics	Electrochemical smart sensor	Metal oxide semiconductor
Response time	**≤25 seconds**	30 to 120 seconds
Testing	**2 times a year**	12 times a year
Calibration	**1 time a year**	4 times a year
Self-test diagnostic (Analytics)	**Yes**	No
Fail safe	**Yes**	No
Sleeping effect	**No effect**	Yes

Figure 4. Advantages of electrochemical H_2S smart sensor

no longer than one year.

Figure 5 illustrates the main advantages of the autonomous H_2S smart sensor compared to the electrochemical smart sensor, for gas detection.

The autonomous H_2S smart sensor was field tested at Saudi Aramco. Two sensors were installed at Saudi Aramco Riyadh Refinery. The following is the test success criteria, developed and used by the team to evaluate the new technology:

Characteristics	Autonomous H_2S smart sensor	Electrochemical smart sensor
Bump testing and calibration frequency	One time calibration/year	Three time testing and calibration/year
Sensor life in operation	Two to five years (vendor specific)	Two to five years
H_2S generation and self-test	Yes	No
SIL 2 rated w/o testing	Yes	No

Figure 5. Autonomous H_2S smart sensor benefits

- The response time of the sensors during pump testing satisfies T20 and T50 and exceeds the requirements in the ANSI/ISA-92.00.01 standard.
- The sensor does not fall asleep if not exposed to H_2S gas.
- The sensor does not die or fail for whatever reason within the trial period.
- The transmitter does not show any signs of fluctuations (i.e., it gives a steady 4-mA signal for H_2S gas-free atmosphere).
- The transmitter does not generate a false alarm.
- The sensor does not drift outside the detector's specification, allowing for the accuracy of the gas cylinder.
- Self-testing is generated every 24 hours and reflected at the DCS.
- Failure mode is tested, and a failure alarm is confirmed at the DCS.

The field testing of the autonomous H_2S smart sensor technology demonstrated exceptional performance over both traditional MOS technology and electrochemical technology. The performance of autonomous H_2S smart sensors, like other electrochemical smart sensors, exceeds the industry requirements (such as ANSI/ISA-92.00.01).

Evaluation and results: Open path gas sensors

An industrial gas detection system has always been considered a base for the safety of people, the plant, and the environment in the petrochemical and oil and gas industries. Basically, it consists of gas-sensing technologies with point configuration (metal oxide semiconductor, catalytic bead, electrochemical cells, and point infrared) and open-path configuration (infrared and laser). Some Saudi Aramco facilities are using open-path infrared detectors along with the point gas detectors. Vibration and misalignment have always been main concerns for these open-path infrared gas detectors.

To overcome these issues, Saudi Aramco evaluated a new laser-based technology, enhanced laser diode spectroscopy (ELDS), which was piloted at the RRD diesel hydrotreating and ISOM areas (figure 6).

ELDS-based technology can detect either methane (CH_4) or H_2S, or both gases simultaneously. Some of the advantages of this technology are no routine maintenance or calibration, dual-gas detection capability, inherent fail-safe design, and the ability to operate in extreme weather conditions.

Single- and multi-gas detection capability models are available in industry. Single-gas detection capability models are used to detect either CH_4 or H_2S gas leaks. Multi-gas detection capability models can detect both CH_4 and H_2S gas leaks simultaneously, so this model is also called the dual-gas detection model.

Figure 6. Open path laser gas detector (ELDS) transmitter (left) and receiver (right)

A dual-gas detection model uses the same apparatus (one transmitter and one receiver) to detect methane and H_2S gas leaks simultaneously. In this case, one laser beam is used to detect methane and a second laser beam to detect the H_2S gas leaks. A dual-gas detection model should only be selected if both methane and H_2S gases are present in the process stream. If there is no methane present, then the model will only work if at least 750 ppm meter of H_2S concentration is present. So if only H_2S is present in the process, then a single-gas detection model specifically for H_2S detection should be used.

Enhanced laser diode spectroscopy significantly increases the sensitivity and reliability of laser-diode-based gas detection and measurement, even in extreme environments. ELDS uses harmonic fingerprinting to achieve the earliest possible detection of gas leaks while reducing the negative repercussions of false alarms.

Using a separate transmitter/receiver configuration, ELDS systems detect and measure gas concentrations at specific target gas absorption wavelengths over distances of up to 200 meters. The detector measures absorbance changes along the line-of-sight path when a combustible or toxic gas passes through the beam. ELDS uses highly reliable, solid-state laser diode sources similar to those used in demanding telecommunications applications. Signal processing methods significantly increase sensitivity, enabling reliable detection down to fractions of a percent LEL.meter for combustible gases, and low ppm. meter levels for toxic gases.

ELDS addresses problems experienced by traditional laser diode systems including laser relative intensity noise (RIN), absorption by atmospheric gases, and coherence/fringe effects. ELDS uses a combination of techniques, which significantly enhance the ability of an open path gas detector (OPGD) to detect small fractional absorbance with an extremely low false alarm rate. ELDS techniques allow companies to finally meet stringent regulatory and safety integrity requirements with a false-alarm free system for low-level combustible and toxic gas detection.

The gassing cell is used to perform the functional testing of these ELDS OPGDs, in field-service conditions. The compact gassing cell only allows gas response checking to be performed with relatively high concentration test gases. Gases that can be satisfactorily used inside the gassing cell include methane, propane, butane, hydrogen sulfide, and carbon dioxide. For functional testing, the relevant gassing cell compatible with the excessive target gas shall be used. These detectors (OPGD) are calibrated for life by the manufacturer.

Transforming Saudi Aramco standards and procedures

Transforming the governing engineering standards and procedures for gas detection is another milestone, which was achieved. Saudi Aramco engineering standards governing gas detection systems (SAES-J-505 and 34-SAMSS-514) were enhanced to mandate the new technologies. The company also developed a new company procedure, SAEP-1029, to enhance gas detectors testing and calibration. The new procedure also covers the requirements for personnel qualification, verification of gas cylinders, frequency of testing and calibration, and life-cycle management of gas detectors.

Maintenance 4.0 for gas detection system

The new smart sensors for gas detection enable industrial mobility and wireless connectivity. For example, Bluetooth wireless connectivity is a new option for conducting maintenance for gas detectors.

An internal risk assessment on gas detectors using Bluetooth wireless technology was conducted. The risk assessment study objective was to allow Bluetooth wireless technology to gauge cybersecurity measures, and also to govern the use of mobile devices in hazardous and classified areas.

The assessment resulted in accepting Bluetooth wireless technology after implementing the right cybersecurity measures in each facility. The measures are basically implementing the capability to restrict, manage, and monitor the use of hazardous area–classified mobile devices, properly managing the mobile devices used to connect to gas detectors, developing a process to approve and track mobile device assignments to personnel, and finally implementing the local passcode feature on all Bluetooth-enabled gas detectors.

Ending remarks

Digital transformation is inevitable. Saudi Aramco is continuously exploring and deploying smart plant solutions, including wireless sensors, autonomous smart sensors, and maintenance 4.0 solutions.

Healthy gas detectors are essential elements for HSE. Using smart sensors for gas detection will not only improve safety in the company facilities but will also improve performance and optimize the life-cycle costs. Gas detectors' good performance is supported by type testing, benchmarking, compliance to industry standards, and field piloting.

The company is currently taking full advantage of the latest smart sensors for gas detection to enhance safety and improve reliability. Other smart technologies are still attractive options to further improve performance and optimize cost, like a single detector with two sensors, a flanged gas detector for installation inside an oil-water sump and a heater firebox, remote calibration capabilities, and a compact gas detection system with a detector, horn, and beacon all in one device. ■

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Process Manufacturers Leverage Cloud Computing for Advanced Analytics

COVID-19 is accelerating IT cloud investments to deliver the innovations required to cope with the pandemic and other market disruptions.

By Megan Buntain

FAST FORWARD

- Cloud computing is being rapidly adopted to support improved production agility and more distributed work teams.
- Previous barriers to cloud computing are being overcome with hybrid and pure cloud approaches.
- Microsoft and AWS are increasing the breadth of industry-specific services and learning quickly which are viable.

Process manufacturing encompasses critical industries supplying the world's consumers and businesses with energy, food, water, and other crucial and life-supporting goods. With the spread of COVID-19, industry faced a tidal wave of challenges to manage production in this volatile environment.

New levels of agility were needed to meet extreme fluctuations in global demand for products and services, and the pandemic also exposed risks in vulnerable supply chains. As a result, many manufacturers accelerated investments in information technology (IT), specifically in cloud computing, advanced analytics, and digital factory initiatives. The theory was that without access to real-time insights for improved decision making, manufacturers would be left flat footed when trying to respond to rapidly changing market conditions.

Some of these investments in agile models and digital factories were already starting to take shape before the pandemic. In May 2019, McKinsey reported that "many leaders in asset-heavy companies hear about agility through their internal digital teams . . . Companies often establish special units—digital factories, garages, accelerators, incubators, studios, labs—to execute at speed . . . then scale up."

Later in 2019, IDC forecast that half of manufacturing companies worldwide would invest in supply chain resiliency and artificial intelligence (AI) before the end of 2021 to achieve productivity improvements of up to 15 percent. To cope with the COVID-19 pandemic, factories began accelerating the pace of these investments to:

- achieve improved production scheduling.
- empower employees to collaborate productively while working from home.
- gain predictive insights from advanced analytics to ensure process improvements could be implemented proactively.

The results of a February 2021 survey titled "Fast Forward to Future Factories" by the U.S.-based Manufacturing Leadership Council (MLC) backs this up. "When the MLC first surveyed its membership to understand more about the pandemic's potential impact on [Manufacturing 4.0] adoption during the height of the first COVID wave in April and May of last year, just over 50 percent of respondents indicated that it had prompted them to accelerate their adoption of M4.0 technologies across their organizations and factory floors . . . The MLC's latest research, however, clearly indicates that this acceleration surge was far from a temporary fix. Over 40 percent of respondents in our latest survey now confirm that they will continue to accelerate their rate of M4.0 adoption for the foreseeable future. For two in five manufacturers, this marks an inflection point in M4.0 adoption that is set to drive digital transformation faster than ever before." These predictions and surveys illuminate a problem faced by many manufacturers: getting more value from existing data.

Cloud computing drives insights from data

Access to operational data and the analytics tools needed to find the proverbial needle in the haystack, or more accurately the thousands of needles in the millions on haystacks, are imperative to achieve agile and efficient operations. More data from automation, human-machine interfaces, and supervisory control and data acquisition (SCADA) systems is coming online daily. To cope with this deluge of data, industrial companies are turning to cloud computing for its near-limitless

storage capacity and computing capability, along with ease of access for remote users worldwide.

For example, in many operational analytics programs, teams begin with a goal of achieving widespread access to plant-level data, and eventually to enterprise-wide reporting on key performance indicators. With global reporting in place, the next wave of innovation in the program typically aims to harness the transformational potential of machine learning–driven analyses, which can be provided by cloud-based deployment (figure 1).

For example, consider the potential of a standardized method of predicting downtime events for hundreds to thousands of assets—such as pumps, compressors, or heat exchangers. What is the prospective return for productivity improvement in your plants that can be achieved through downtime avoidance, or by extending

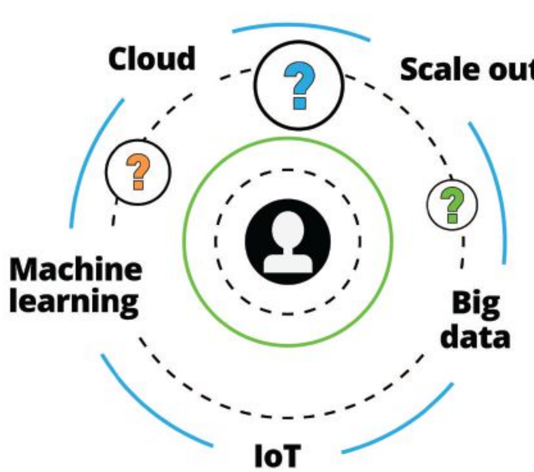


Figure 1. The cloud can serve as a nexus for implementation of various types of analysis at scale.

Figure 2. Manufacturers are overcoming the hurdles to cloud computing.

the life cycle of expensive-to-replace assets by months or years? Next, consider the impact on agile manufacturing initiatives when those analyses are retrained and redeployed on the fly and at scale as production needs or operating conditions change. These and other improvements are possible, and cloud computing often provides a quicker path to implementation.

Hurdling cloud barriers

To achieve the goal of optimized operations, the barriers to adopting cloud technologies must be carefully evaluated and overcome. The common challenges cited by operational leaders involve three areas of concern: cybersecurity and data protection, network connectivity and latency, and the change management required to foster more IT and operational technology (OT) collaboration. There are numerous resources available from industry, analyst, and vendor publications outlining the best practices for addressing each of these issues.

What is common across most approaches is a hybrid world for many years to come, where some operational data remains stored within the corporate network, while other data migrates to the cloud.

Data on the corporate network can still be securely accessed from analytics applications running in the cloud, with other data sets loaded or streamed directly to the cloud, while using the best models for cybersecurity threat prevention. For network connectivity, capabilities such as edge computing and smart caching of data in the cloud bring high-speed analytic results for many use cases.

Finally, the cloud is the place where OT and IT teams will inevitably come together. When a manufacturer decides to transform its end-to-end operations, both OT and IT will need access to data and the ability to create automated business processes and workflows across supply chain, operations, financial, and customer management systems.

This end-to-end view is best achieved by intelligent use of the cloud. This requires a partnership with IT supporting the underlying technology infrastructure, while OT ensures the most critical data and applications—those driving production—are not left out of the digital transformation effort (figure 2).

The following examples show how three different process manufacturers are dealing with this issue by implementing cloud-based solutions for advanced analytics.

Driving agility with the cloud

A global consumer packaged goods manufacturer is halfway through a three-year program to implement digital factories and a program called "futures engineering." Engineers and subject-matter experts in over 300 factories are empowered with self-service industrial analytics applications for improved decision making. The first phase of the initiative involves replicating critical OT data to the cloud data platform. From there, engineers will be empowered with near-real time analytics tools to find time periods of interest; cleanse, contextualize, and trend the data; and operationalize prediction models. These actions will continuously improve quality and yield outcomes, each of which can be easily shared with and rolled out globally to peers. This manufacturer chose to drive its agile and digital programs from its employees' needs, and then work backward to design the underlying cloud computing infrastructure.

Another example is OT and IT leaders at a multinational chemical manufacturer coming together to launch a common vision for OT and IT convergence, designed to improve agility in production scheduling. This manufacturer deployed a hybrid approach building on its global on-premises OT data infrastructure by adding cloud-based analytics tools. This enabled its engineers to easily connect to the data and find insights to achieve plant and companywide reliability, productivity, and sustainability goals with maximum flexibility. This manufacturer also put its people at the center of its strategy, and then rallied the team to align OT and IT goals, with joint execution plans in support of employees.

A final example is an energy company that took the leap over the past two years to implement a pure cloud model. The company transformed operations by moving from multiple SCADA systems, including over 25 historian servers managed by business operations and IT teams at a local level, to an enterprise-wide SCADA system in the cloud. The goal was to simplify the data strategy

Figure 3. Analytics tools can be deployed using a software-as-a-service model, with secure connections made to on-premises process data.

and access by standardizing SCADA and historian data systems in a single cloud platform, enabling Industrial Internet of Things (IIoT) and machine-learning initiatives.

As these examples show, process manufacturers are rapidly transitioning at least some of their data storage to the cloud. AWS, Microsoft, and other software giants are joining the party by offering complementary offerings (see sidebar: Cloud Providers Launch Data Services for Industrial Analytics).

RESOURCES

"The quest for the most magical algorithm"
www.isa.org/intech/202004exe

"Analytics for predictive, preventative maintenance"
www.isa.org/templates/news-detail.aspx?id=160151

"Analytics next: Beyond spreadsheets"
www.isa.org/intech-home/2019/july-august/features/analytics-next-beyond-spreadsheets

Gaining insights

Whether an organization's approach to cloud computing is all in or the more common hybrid approach, the cloud is quickly becoming a foundational part of agile manufacturing and a critical enabler for quickly achieving returns. My company works with hundreds of process manufacturers to accelerate the impact they are having with advanced analytics, giving us a front row seat to best practices. The most important thing we have learned is that manufacturers can achieve gains from analytics as they move to the cloud.

The good news is that it is not necessary to move or aggregate all operational data in the cloud or a data lake to get started. Instead, analytics tools can be deployed in minutes or hours using a software-as-a-service model, with secure connections made to on-premises process data (figure 3).

From that quick starting place, engineers and subject-matter experts can create high-value insights on the existing data, wherever it resides. As requirements evolve and the need to leverage more cloud capabilities emerges, process and contextual data can be stored in the cloud, with analyses continuing at greater scale and with increased impact. ■

All figures courtesy of Seeq.

ABOUT THE AUTHOR

Megan Buntain is the director of cloud partnerships at Seeq Corporation, a company building advanced analytics applications for engineers and analysts that accelerate insights into industrial process data. She was formerly a consultant with analytics, IoT, and blockchain software and services companies, and prior to that worked at Microsoft for 15 years.

Cloud Providers Launch Data Services for Industrial Analytics

To meet the urgent demands from the process industry, cloud providers—specifically Microsoft and Amazon—are investing in manufacturing as a priority market. Both companies are launching new cloud services in the industrial platforms and analytics category.

Kevin Prouty, group VP of energy and manufacturing insights at IDC, describes the evolution of both companies' approaches in a December 2020 report, "The Battle of the Operations Hyper-Platforms." "Since the mid-eighties, Microsoft has been the dominant player in the operational software space. Microsoft has been the foundation for OPC and the majority of operational software used to run industrial operations. But after AWS's re:Invent 2020, plus the in-the-trenches ecosystem building that AWS has been doing over the last few years, Microsoft now has a real rival in the operations platform space. AWS has always had an innovation bent to its approach to OT. AWS has taken all of the individual products like AWS gateway appliances, IoT products, vision systems, and AWS AI/ML products into a single industrial framework."

Cloud hyperscalers are providing services tailored to the needs of industry for data storage and analytics.

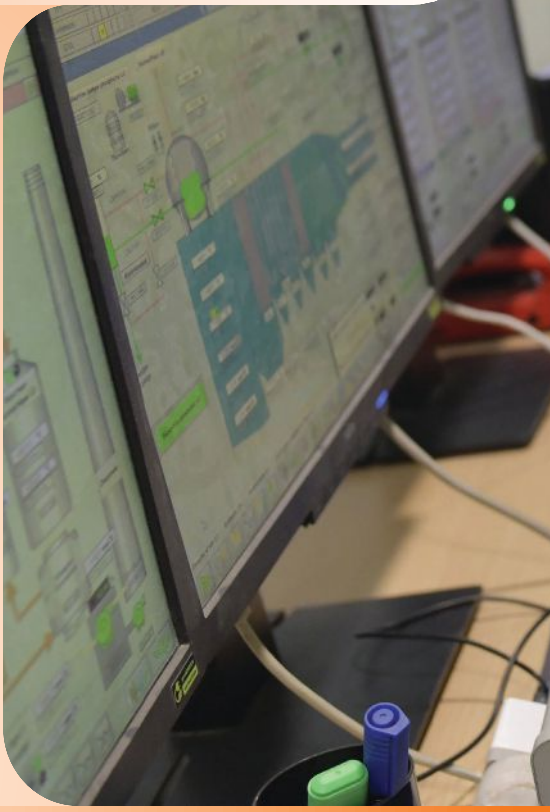
Cloud providers have heavily leveraged their expertise in IoT to develop services for process manufacturers. This IoT-centric approach, very much tuned to greenfield IoT scenarios, includes services for IoT data ingestion, edge computing and applications, optimized data queries for business intelligence applications for enterprise reporting, ML services for anomaly detection, computer vision, and others.

Microsoft Azure Time Series Insights Gen2 and Amazon Timestream are optimized for IoT data, which must be aggregated or preprocessed for optimal query performance. This is not yet an optimal approach for industrial analytics, because important context and meaning can be lost unless one builds analyses using raw, high-fidelity data. These services are rapidly evolving as both Microsoft and Amazon get direct customer feedback; the investment in these purpose-built services will continue to grow.

As an advanced analytics software provider, our company sees a significant near-term opportunity for gaining immediate value from industrial data in brownfield deployments, specifically by adding analytics-driven value to the existing OT data infrastructure.

IDC forecasts that factories with more than 500 employees are generating 1 TB/day of data on average. Most manufacturers are already creating, storing, historizing, and processing large volumes of data, yet these companies are challenged to achieve insights at enterprise scale, the classic data rich and information poor conundrum.

Asset Management Transformed



Digitalization helps petrochemical companies create a plant environment where everything just works. Why don't more companies practice it?

By Hiroshi Yokoi

"A well-managed factory is boring. Nothing exciting happens in it because the crises have been anticipated and have been converted into routine," says Peter Drucker. And if we expand the scope of that observation we can say, "A well-managed petrochemical plant is peaceful."

While we would like it to be so, "peaceful" is not always the nature of process plants and units, where a variety of disruptive events are still part of the routine. These include:

- process upsets
- equipment failures
- feedstock variability
- energy waste
- corrosion damage
- safety incidents
- substandard out-of-spec product
- unscheduled interruptions.

The list could go on. The common denominator of all these is that they cause reduced profitability from lost revenue and increased operating costs. How bad is the problem?

"The impact of unplanned downtime in the process industries has been vastly underestimated. ARC estimates that unplanned downtime is costing the process industries about $1 trillion per year in lost production and revenues," per the ARC Advisory Group *Process Industry Downtime and Key Performance Metrics*, 2017.

That $1 trillion figure is hard to grasp, since it is aggregated across the entire process industry sector. To put it in more specific industrial terms, any given plant typically loses 3 percent to 7 percent of its annual production due to these types of problems. Adding several percentage points to most plants' productivity has a major positive impact on profitability.

How is this situation possible? Haven't process automation companies been providing digital transformation (DX) technologies for years that are able to prevent these kinds of things? The answer is yes, yet a group of long-standing problems never seems to go away in many plants. Some companies and departments have challenges and a perceived excessive level of risk

when adopting available tools and techniques. This leaves the efforts uncoordinated and any tools that are adopted remain unintegrated, resulting in minimal improvement. Managers simply shrug, accept the status quo, and live with the poor overall performance. Some of those companies have undoubtedly been shaken out, casualties of pandemic-related market stresses.

On the other hand, many companies have made serious efforts to adopt new DX tools and techniques, only to find a few stubborn problems refuse to go away. It is clear that there are fewer problems now than would have been the case years ago, but more remain than are tolerable. What is the cause of this situation, and what is the answer?

FAST FORWARD

- **Process manufacturers lose too much production and profitability to operational problems and excessive maintenance spending.**
- **Digital transformation technologies can help, but they can bog down when they require new work practices.**
- **Outside help is often needed to implement transformational asset management.**

Understanding situational awareness

One of the root causes of many problems under consideration is situational awareness. Do operators, reliability teams, and maintenance departments have enough information available to them to understand the true situation? Is this information timely and accurate? The answer may be yes, or at least could be yes, because the supporting data is available; however many of those individuals may not fully realize what they are seeing. They are unaware of what the data is telling them, so they do not fully grasp the larger situation.

It is a common struggle. "While human error remains a primary reason for unplanned downtime, problems in the process or problems with the equipment controlling the process are more likely to blame. If that information is not effectively communicated to the operator in a timely and contextual fashion, your chances of an incident will go up significantly," per the ARC Advisory Group *Process Industry Downtime and Key Performance Metrics*, 2017.

We can extend that to include the equipment supporting the process. The reliability and maintenance teams do their best, but often they unnecessarily touch something before there is a need, while something else runs to unscheduled failure. With the right approach, plants can stop wasting money and introducing risks by working on equipment that requires no maintenance.

The diagnostic data is probably available, but locked up in individual device database silos, where the right people might not see or understand it in time.

Progressing toward a peaceful plant

Let's look at the picture in more positive terms. Every plant or unit has some period when it performs just like it is supposed to. Feedstocks are ideal, good operators are at the board, all the equipment is running perfectly, product is in spec, and output is at maximum. The people, the process, and the technology are all in peaceful harmony. There might be very minor disruptions here and there, but everything is manageable, and everyone is happy. How does this become an everyday experience?

It starts with data. Whether companies realize it or not, the equipment in their plants is already generating an enormous amount of diagnostic data capable of indicating the condition of equipment and warning of developing problems. However, most companies do not extract most data and get it to the people who could use it in a way that tells them something useful.

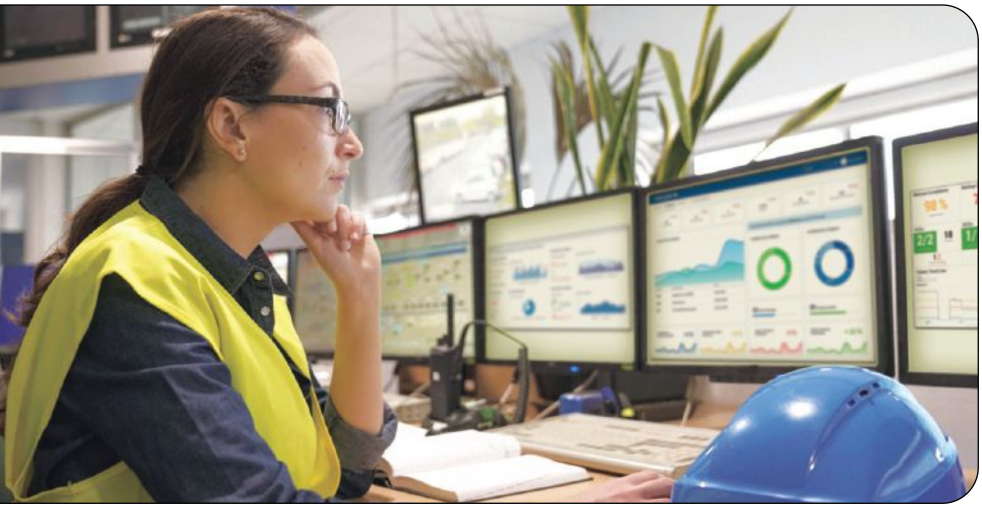


Figure 1. Data may be available, but it must be presented effectively to operators to realize the full benefit.

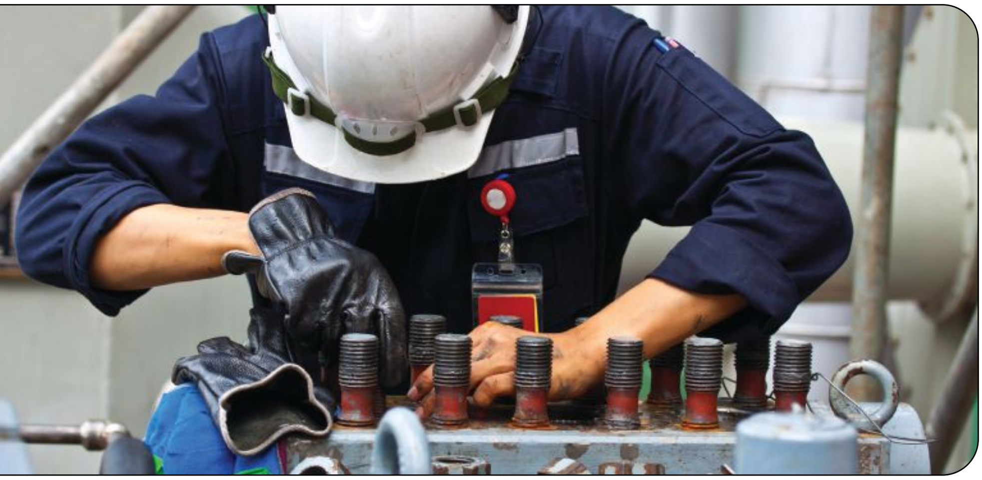


Figure 2. When does equipment get repaired? Ideally, it would be when diagnostic data says it needs attention.

The data needs one overarching interface that can bring it all together as clear, action-oriented information, so the system can make the necessary links between different areas and sets. Where the performance and condition of one asset affects another and the larger whole, these links must be identified. The data, interconnections, and information must be available to the plant's human operators and technicians in all areas, operations, maintenance, reliability, and management, via relevant dashboards able to support timely decisions, scheduling, and actions.

Why doesn't this happen in all plants? Well, it is easier said than done. The technology side of things is the first step, collecting at least some of the diagnostic data from smart devices, and many companies have gone this far. This alone makes some positive impact, but usually not enough. The next step is where the effort bogs down: changing people and procedures. DX is not only about technology; it also requires organizational transformation to integrate people, processes, and technology.

Changing thinking

Here is a case in point per the ARC Advisory Group *Improve Asset Uptime with Industrial IoT and Analytics*, 2015: "Preventive maintenance assumes the probability of equipment failure in-

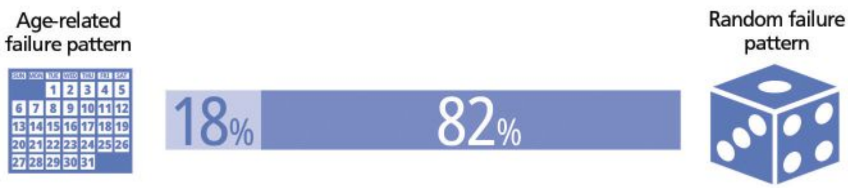


Figure 3. Failure patterns are more difficult to predict than many maintenance departments believe.

creases with use, and schedules maintenance based on calendar time, run time, or cycle count. However, data on failure patterns from four different studies show that (on average) only 18 percent of assets have an age-related failure pattern; 82 percent exhibit a random pattern. These data show that preventive maintenance provides a benefit for just 18 percent of assets" (figure 3).

This illustrates a common but incorrect assumption that equipment wears out in a predictable way over time. Most maintenance efforts reflect this belief, so many companies waste resources by fixing things that do not need to be fixed while allowing others to run to failure. ARC's observation points out a critical disconnect between what data shows and underlying assumptions. Identifying when an asset is developing problems must be determined from quality diagnostic data, captured and presented to operators so they can see what is happening in a timely manner.

Even a small plant or process unit has diagnostic data available from at least 1,000 devices, but typically this is isolated in multiple databases, with little or no cross communication. All this data must come together into a single knowledge base so analysis tools can operate effectively and present findings to operators.

To reinforce the point, how many situations have there been where something major went wrong in a plant or unit that resulted in an incident? When investigators try to determine what happened, what do they do? They go back to process and diagnostic data looking for the root cause, but they look at it after the fact. The same data was available before the incident happened and could have warned what was coming, but was anybody looking at it then?

Closing the loop

The overall picture should be clear: data is available, and it can help reduce risk, prevent incidents, and guide maintenance. However, efforts to realize such practical improvements often run out of momentum because the company or plant cannot integrate the technology with its people and procedures. Old work practices remain in place, posing a major obstacle to condition-based proactive maintenance. The implementation loop never fully closes.

To make matters worse, implementation requires cooperation between the information technology (IT) and operational technology (OT) sides of the company, which cannot always be taken for granted. Also, creating the framework for the overarching data engine can expand the surface for potential cyberattacks, which causes some companies to hesitate.

Internal efforts vs. outside help

Carrying out a full implementation as discussed calls for a variety of resources and competencies, which many companies may not be in a position to assign on such a scale. Some aspects of this type of DX can be implemented incrementally, but this kind of undertaking calls for a more concentrated effort. This point alone is a likely reason why so many companies never complete the effort.

Most companies need help to follow through to a full completion because of the scale of the problem. This can be handled via a managed service designed for exactly this kind of project, with the provider delivering maintenance and development services to build optimized operations over the entire plant life cycle. This includes a plantwide maintenance and asset management platform that shows data on asset per-

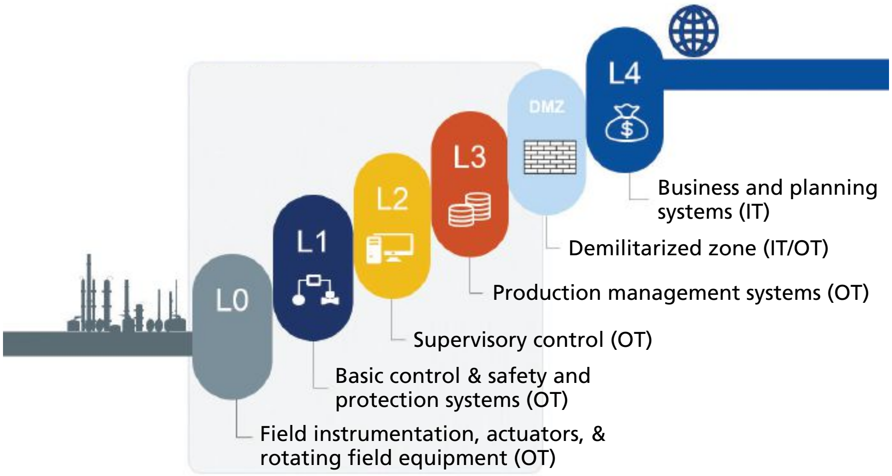


Figure 4. Managed services, such as Yokogawa's OpreX, help implement asset management programs spanning all levels of a plant, from field instruments to business systems.

formance, reliability, and security concerns in a single window.

This has to happen at every layer of the operation (figure 4), including:

- L0 – Field instrumentation, actuators, and rotating equipment
- L1 – Basic process control and safety instrumented systems
- L2 – Supervisory control
- L3 – Production management systems
- L4 – Business planning systems

These overlap and touch on both IT and OT systems, so appropriate cybersecurity measures must be included at strategic points. All the elements can be integrated under an overarching managed service suite (figure 5) that works with the plant's existing IT and OT networks.

This approach brings a long list of services beyond the reach of most companies' internal capabilities:

- connections to all sources of plant data, even currently unused sources
- the application of sophisticated analysis tools to turn data into valuable information using effective dashboards
- maintenance and development services designed for optimized operations using proactive maintenance techniques
- an integrated digital services platform providing managed services that bring together process, people, and technology.

Fully integrated dashboards identify which processes are not compliant or trending in the correct direction, and simultaneously show which maintenance actions should be performed. The ultimate objective is to eliminate 100 percent of the risk, but there will invariably be trade-offs calling for a balance between maximizing production and effective maintenance. The system's analytical tools help optimize these choices.

The benefits of a comprehensive program to digitalize asset and maintenance management are easy to visualize, but for most companies, implementing something on this scale using internal resources alone simply is not possible. For those who want to build toward these types of operations, managed services can fill the gap. ■

All images courtesy of Yokogawa.

ABOUT THE AUTHOR

Hiroshi Yokoi is the head of the Lifecycle Service Business Division in the IA System and Service Business HQ of Yokogawa Electric Corporation. He joined Yokogawa in 1989 as a DCS engineer, advancing to his current position in 2020. He has extensive experience in batch process DCS engineering for the chemical and pharmaceutical industries; execution of system integration, security, upgrade, and migration projects for the Global Engineering Division; and leadership of technical strategy and solution development, business incubation, and marketing for the Global Service Division.

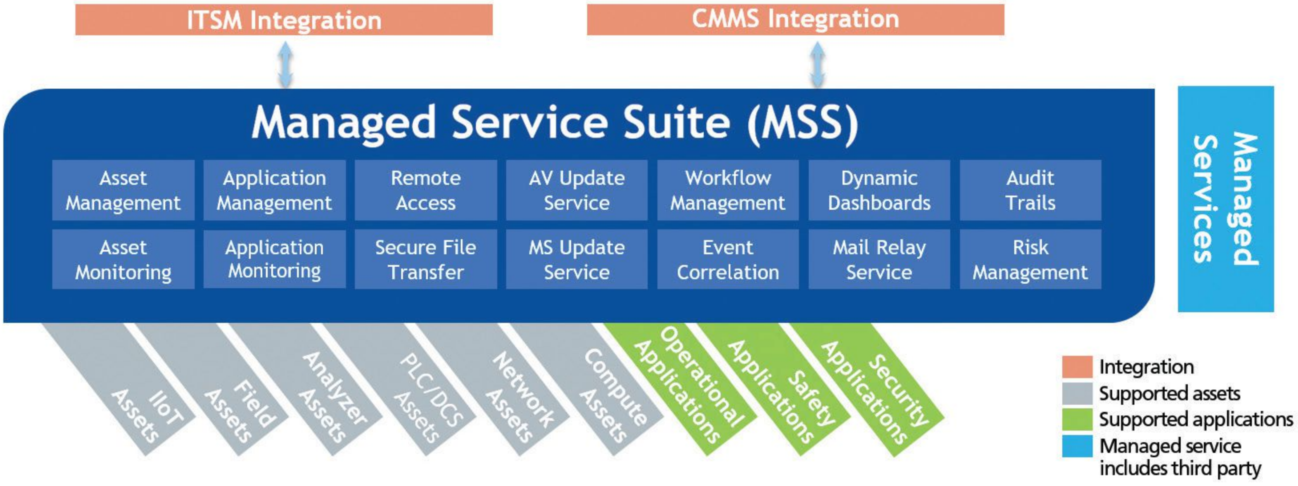
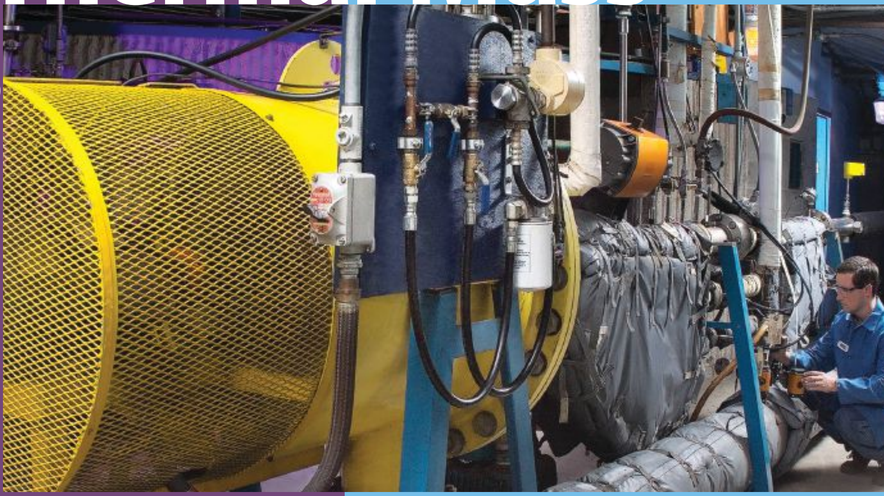


Figure 5. Managed services integrate all plant and company areas into one overarching platform.

Calibrating Thermal Mass Flowmeters



Proper calibration ensures new and old instruments deliver reliable results.

By Michael Bess

Instrument calibration should never be taken for granted, and thermal mass flowmeters are no exception. Flowmeters can be built with the highest safety ratings, features, and functions and the most industrially robust sensor technology, and still deliver unsatisfactory performance. This happens if the calibration is inaccurate or subject to uncertainty due to an equivalency-based calibration or simulation methods rather than an "actual" fluid calibration.

Poor calibration practices can result in possible safety exposures and process inefficiencies that might go undetected until the process is running and something goes wrong. Inefficient processes also frequently result in poor product quality and excessive costs, which negatively impact the bottom line and competitiveness.

All thermal mass flowmeters work by measuring the cooling effect of a moving gas along a cylinder. The cooling effects are mostly a function of the properties of the gas, including its thermal conductivity, specific heat, density, and viscosity (figure 1). This is true for all thermal mass flowmeters, regardless of their measuring technique. Additional variations come from the sensors themselves and how each sensor is affected across its full flow range.

Heat transfer path variability

All thermal flowmeter manufacturers need to understand not only the heat input equation and the surface area, but all the heat transfer paths. The variability in the sum of these heat transfer paths will be unique to the flowmeter and may differ in the same way fingerprints differ on someone's hands. Although the right index and left index fingers of your hands appear similar, they are actually different in their details. Similarly, the sensors of thermal mass flowmeters, even with tight manufacturing tolerance controls, precision methods of sensor fabrication, and the automation of sensor assembly, are subject to variations. These variations, even if subtle, make a formulary, standardizing gas correction factor inadequate and much more complex than a mere single variable correction factor.

Calibration laboratory

The capital investment and infrastructure needed to develop and maintain traceable, actual gas flow stands is substantial, particularly for gases that are hazardous or flammable. Additionally, flowing the specific gas itself, plus the energy required to flow it at specific temperature and pressure conditions, comes at a higher recurring cost. Many thermal mass flowmeter manufacturers simply sidestep this investment and evade the higher cost of an actual gas calibration by performing a simulated or "equivalency" quasi-calibration.

Not all "equivalencies" equal

Manufacturers performing equivalency calibrations use a reference or surrogate fluid, typically air, at ambient conditions. They apply empirically based calibration parameters that use a theoretical, formula-based calculation to the air flow readings to set their instrument's gas calibration. At best, this procedure simply infers the fluid's cooling effects on the gas properties such as viscosity, density, specific heat, thermal conductivity, and Reynolds number ranges.

Unlike an actual gas calibration, this inferred equivalency method does not accurately replicate the true thermal heat dissipation of the actual gas. Corrections required for process conditions, such as variations of pressure and temperature extremes, create an even greater uncertainty. As stated and confirmed by ISO Standard

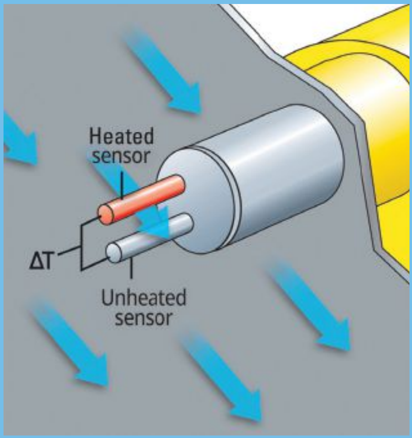


Figure 1. Thermal dispersion principle of operation. Thermal mass flow sensors comprise two platinum resistance temperature detectors (RTDs) that are protected within thermowells. One RTD is heated while the other provides a reference by measuring the process temperature. This temperature differential is directly proportional to the mass flow measurement.

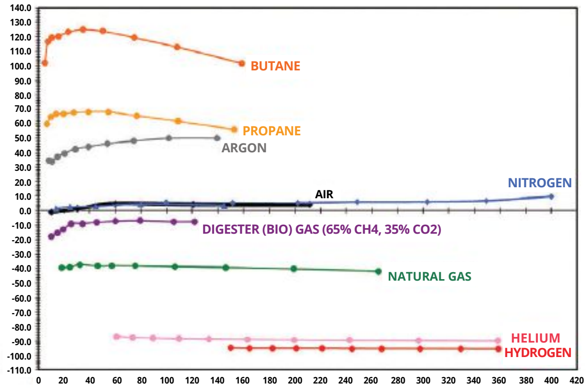


Figure 2. Brand X thermal mass flowmeter accuracy performance using selectable gas menu, equivalency (4-inch line size, 4–20 mA output signal converted to SFPS at 70°F [21°C]). Calibrated range of unit is 10-692,8 SFPS in air.

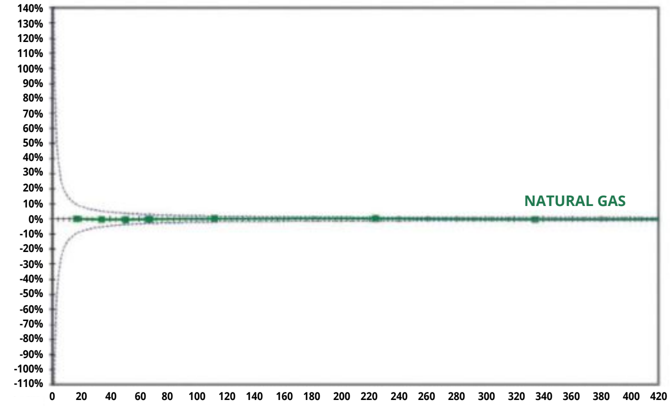


Figure 3. FCI Model ST100 thermal mass flowmeter accuracy performance in natural gas using actual calibration (4-inch line size, 4–20 mA output signal converted to SFPS, at 70°F [21°C])

14511, Section 8, "... the best practice for calibrating thermal mass flowmeters is to perform an actual gas calibration, and at actual process conditions, when feasible."

For any critical application where stoichiometric calculations are critical or when measured gas flow rates are essential for safety or efficiency, no simulated calibration method should be considered for thermal flowmeters when an actual, "true" fluid calibration is available.

Furthermore, an air equivalency, simulated calibration is not recommended where process conditions are moderately unstable, where flow velocity profiles are potentially in the transitional range, or where there is a potential nonlinear relationship between the calibration fluid and the actual service fluid. Therefore, theoretical or equivalency calibrations represent a very limited range of applications. Many flow ranges with turndowns greater than 10:1 extend well beyond a simple linear correction range, and a single factor correction as applied by many manufacturers is ineffective due to the nonlinear relationships between the fluids. This is particularly true with thermal mass flowmeters that rely on thermal conductivity and cooling effects as the essential measurement.

Problem with simulated calibrations

To illustrate graphically the measurement uncertainty of simulated calibrations, consider the accuracy performance curves in figure 2. These curves were obtained from a thermal flowmeter produced by a global, multitechnology flowmeter manufacturer, whose meter embedded a user-selectable menu of gases. It is alarming to see the extent of the errors. Clearly, this instrument is not calibrated directly in each of these basic gas compositions but instead applies an inaccurate equivalency algorithm correction factor.

The large errors seem to indicate a simple, single order correction, and the manufacturer does not even attempt to use a polynomial correction for purposes of correcting nonlinearities. Through most of the flow range you can see that these corrections, while extremely large in scale, have a certain linearity. As expected, the air and nitrogen curves are relatively close to zero offset, because the base calibration is performed in air as the calibration fluid. However, when the instrument has one of the other gases selected, then the additional measurement error after the theoretical correction factor is applied can be as high as ±100 percent!

Also detectable is the inability of the algorithm to correct nonlinearity for some gases flowing at slightly elevated temperatures. This nonlinearity range can vary as much as 30 percent, which means a correction factor approach, even if accurate, would not apply across the full fluid flow range.

Ask about procedures

To demonstrate the significant performance improvement obtained by using an actual gas calibration, refer to figure 3, which shows an FCI Model ST100 using an actual gas calibration for natural gas. Compare this result with the natural gas plot line in figure 2, which used an equivalency calibration. The resulting improvement is exceptional.

If you are responsible for flowmeter performance in critical processes, or for plant safety or environmental compliance, then you have a right to ask manufacturers about their calibration procedures. They should be able to explain and demonstrate how your company's new meters are to be calibrated, on what types of traceable equipment, under what methods and what conditions, and to which specific mechanical, electrical, and safety standards.

You should ask to tour the calibration laboratory where the work will be performed and to meet with the engineers and technicians responsible for the work. In addition, a flowmeter factory representative should be made available to you when necessary to review the application requirements and inspect the actual meter location to ensure a successful installation. ■

ABOUT THE AUTHOR

Michael Bess is calibration lab and test engineering manager for Fluid Components International (FCI), www.FluidComponents.com. FCI has invested in and maintains more than 20 calibration rigs on three continents. These flow stands, in various pipe diameters, can flow air, pure inert gases, hydrocarbon gases, and precision mixed-gas compositions with up to 20 actual gas constituents. All of these stands can flow the fluids and calibrate in actual temperatures up to 454°C (850°F) and in actual pressure ranges from ambient to 34 bar (500 psi).

This article originally appeared in FCI's *Air/Gas Flow Measurement Solutions Handbook* (https://www.automation.com/en-us/products/forms/air-gas-flow-measurement-solutions-handbook).

NATO Energy Security Centre and ISA99 Sign Cooperation Agreement

The NATO Energy Security Centre for Excellence and the ISA99 standards committee, *Industrial Automation and Control Systems Security*, have signed a letter of intent for cooperation in the exchange of information and possible collaboration on learning resources and activities.

The NATO Centre became interested in applying the ISA/IEC 62443 standards during the course of a cyberrisk study of the industrial control systems used in the NATO Central Europe pipeline system, pointed out Vytautas Butrimas, who led the agreement for NATO and now represents the NATO Center on ISA99. "With this agreement," he stated, "we look forward to exploring new ways of collaboration with ISA to improve the safety, reliability, and performance of the backbone technologies that support economic activity, national security, and well-being of our societies."

The ISA/IEC 62443 standards are developed primarily by the ISA99 committee with simultaneous review and adoption by the Geneva-based International Electrotechnical Commission (IEC). ISA99 draws on the input of cybersecurity experts across the globe in developing consensus standards that are applicable to all industry sectors and critical infrastructure, providing a flexible and comprehensive framework to address and mitigate current and future security vulnerabilities in industrial automation and control systems.

The agreement with NATO is the latest in a string of notable milestones in the ongoing development and growing global application of the ISA/IEC 62443 series. This included a prior decision by the United Nations Economic Commission for Europe to integrate the standards into its Common Regulatory Framework on Cybersecurity, which serves as an official UN policy position statement for Europe. It also included completion of several key standards in the series:

- ISA/IEC 62443-3-2, *Security Risk Assessment for System Design,* defines a comprehensive set of engineering measures to guide organizations through the essential process of assessing the risk of a particular industrial automation and control system (IACS) and identifying and applying security countermeasures to reduce that risk to tolerable levels.
- ISA/IEC 62443-4-1, *Product Security Development Life-Cycle Requirements,* which specifies process requirements for the secure development of products used in an IACS and defines a secure development life cycle for developing and maintaining secure products.
- ISA/IEC 62443-4-2, *Technical Security Requirements for IACS Components*, which provides the cybersecurity technical requirements for components that make up an IACS, specifically the embedded devices, network components, host components, and software applications.

Other standards in the ISA/IEC 62443 series cover terminology, concepts, and models; establishing an IACS security program; patch management; and system security requirements and security levels. All may be accessed at www.isa.org/findstandards.

The ISA99 committee, like all ISA standards committees, is open to participation to all who are interested. For more information on ISA99 and the ISA/IEC 62443 series of standards, contact Eliana Brazda, ISA Standards, ebrazda@isa.org. ■

Smart Manufacturing Standards News

ISA's long-standing focus in its consensus industry standards on end-user performance, safety, and security is evident in several widely used series of International Electrotechnical Commission standards that are based on original ISA standards. These include standards in the key areas of control systems security, enterprise-control systems integration, functional safety, and wireless systems for automation. These ISA original standards and others are important elements as organizations, including ISA and IEC, work to develop the new standards needed as smart manufacturing and Industrial Internet of Things (IIoT) technology advances.

Beyond ISA's existing standards work, the ISA Standards & Practices (S&P) Board has established an ISA Automation & Operations Lifecycle Advisory Group to research and support the understanding of smart manufacturing concepts across ISA Standards. Former ISA S&P vice president Chris Monchinski is leading the group.

The group intends to work closely with ISA's Smart Manufacturing & IIoT division, the newest of ISA's 17 technical divisions. Visit www.isa.org/membership/participate-in-a-technical-division for information. Among its activities, the new division is involved in supporting ISA's Smart Manufacturing & IIoT Conference, which will be held virtually this year on 11 May. Visit IIoT & Smart Manufacturing Virtual Conference (https://programs.isa.org/isa-iiot-smart-manufacturing-virtual-conference) for information.

ISA is also involved in an IEC systems committee on smart manufacturing. A systems committee is intended to set high-level interfaces and functional requirements that span multiple work areas across the IEC and its partner, the International Organization of Standardization (ISO), to achieve a coordinated standards development plan. ISA's participation in the systems group is facilitated through an IEC organizational liaison by which ISA standards and technical reports, both published and in development, can be circulated and reviewed within the systems committee as appropriate.

For information on ISA standards or related activities, contact Charley Robinson, ISA Standards, crobinson@isa.org. ■

Meet 2020 ISA Fellow David Rahn

David Rahn, who is part of the U.S. Nuclear Regulatory Commission in Rockville, Md., first became an ISA member in the late 1970s. "I believe it was 1977, after I had been designing nuclear power plants for about three years," Rahn said. After receiving his BS in electrical engineering, Rahn decided on nuclear power plant control systems as a career because it seemed a necessary and important role and not many engineers were working in the field.

Rahn is a member of the ISA Nuclear Standards Committee and has contributed to ISA Nuclear Standards for many years. He has also attended or presented at many ISA/POWID conferences and served as a conference session developer. As a newly appointed ISA Fellow, Rahn is receiving recognition for developing and implementing a new methodology and acceptance criteria to ensure the reliability of critical safety equipment of nuclear power plants.

"I am most proud to have been able to use my knowledge and skills in the implementation of automation in the area of nuclear power plant design, construction, startup, operations, maintenance, and regulatory licensing and compliance over the past 46 years," Rahn said.

"Participating in ISA standards committees is fulfilling because it lets you hear from participants from outside your own engineering organization." *—David Rahn*

"I believe that my generation has successfully preserved the safe operation of our existing light water reactor fleet and improved upon the work of early nuclear power plant pioneers. We also broke new ground by putting into service newer automation technologies that the early engineers did not have available to them," Rahn added.

Most recently, Rahn participated on the ISA Nuclear Standards committee that developed the latest version of the ANSI/ISA 67.04.01-2018 standard regarding criteria for establishing setpoints for nuclear safety–related instrument channels. He also contributes to ISA Nuclear Standards regarding instrument sensing lines, transducer and transmitter installation, performance monitoring, and other areas pertinent to the use of automation in the nuclear power industry.

"I also participate in other international professional society activities, as well as in the development of international standards and guidance, such as International Atomic Energy Agency documents," Rahn added.

Rahn said participating in ISA standards committees is fulfilling because "it provides an opportunity to hear from participants from outside your own engineering organization, who may have different viewpoints from yours. Committee meetings provide a chance to exchange ideas and identify the best practices from all over your industry, which can result in a better industry standards product," he noted.

Now, Rahn and his committee colleagues are updating the ISA Recommended Practice document ISA RP67.04.02, a companion implementing guide to the ANSI/ISA 67.04.01-2018 standard. "When I retire from my current position in a year or two, I plan to work on enabling and advancing the use of new nuclear technologies in America's energy portfolio—either in the government policy or commercial nuclear industry advocation arenas," Rahn said.

Rahn offers plenty of advice for young engineers just beginning their careers. "Always keep your professional aspiration options open, and don't be afraid to explore and venture into new areas while you are still working in one particular area," he said. Rahn also recommends keeping in mind the "big picture" aspects of what is happening in the world and how one's role fits in.

"Events can change the way your role is considered within the big picture, so the more skills you have, and the more topical areas in which you have gained additional knowledge and skills, the easier it will be to find your place in a new area, if that becomes necessary," he said. ■ *—By Melissa Landon*

In 2020, ISA elevated four members to the esteemed member grade of Fellow, which is one of the highest honors ISA bestows. A senior member must have "outstanding and acknowledged engineering or scientific attainments [and] must receive peer evaluations leading to recommendation for election by the Society Admissions Committee" and must receive a majority vote from the Society's executive board to become an ISA Fellow. In ISA's 75-year history, 495 distinguished individuals have made the list. See them all at www.isa.org/members-corner/isa-honors-and-awards/fellow-member.

Former ISA President Howard P. Zinschlag

Former ISA President and student section advocate Howard Zinschlag died on 12 March 2021 in St. Louis. He was 83. Zinschlag had a long association with ISA that started in 1974. For the Society's 75th anniversary in 2020, he said his early activities included writing an ISA paper that predicted the use of microprocessors to do process control, the founding of the Society's Computer Technology Division (called COMPUTEC), and the development of a Bulletin Board System (BBS) for executive board communications.

"I also developed student section involvement in ISA and encouraged us to technically compete with each other—in live competitions," said Zinschlag. "I coordinated with universities in Illinois and Kentucky to support ISA and to form ISA sections, from which we received recognition from state governments." After he became president in 1993, Zinschlag visited ISA student sections to get them involved with ISA, and also travelled globally to bring the ISA message directly to members around the world.

Zinschlag was a 1959 electrical engineering graduate of the University of Illinois Urbana-Champaign, and later received his master's degree from the University of Santa Clara, Calif. Most of his career was spent in the semiconductor industry.

Born 27 August 1937, Zinschlag was a beloved husband, father, grandfather, and friend. He is survived by his wife Mary Jane, whom he married in 1959, and leaves daughters Lora Latrell, Debbie Brown (Bob), Rebekah Parish (Andy), and seven grandchildren (Nathan, Nicholas, Rachel, Lindsey, Adam, Garrett, and Benjamin), a sister Dorothy O'Connell (Larry), and many nieces and nephews. He called St. Louis his home for 46 years. ■ —*By Renee Bassett*

Data Analytics in Oil and Gas: A Lot of Digital, Too Little Transformation

"The reality is, while we have become data rich in many places, in many cases we are still information poor. It isn't about how cool an algorithm is or having the latest piece of technology . . . it's about how we are using it." So said Jim Crompton, professor of practice in the Petroleum Engineering Department at the Colorado School of Mines, during his keynote at the ISA Data Analytics in Upstream Oil and Gas Virtual Conference in February. He discussed the current state of digital transformation in the upstream oil and gas industry, including business drivers, pilots and investments, tech companies' marketing efforts, and the challenges ahead.

Crompton's words kicked off a day of insight and fresh perspectives from a range of experts discussing how upstream oil and gas professionals could harness what is now an unprecedented influx of data. Speakers included users from Shell Permian Basin and technology experts from Canvass AI and Seeq.

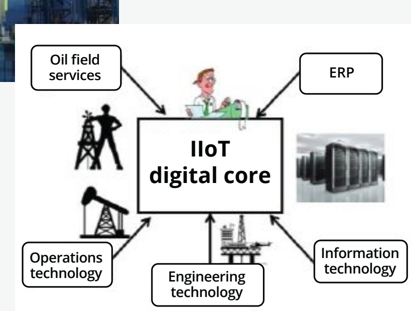
Crompton noted that Rystad Energy recently published a report that indicated automation and digitalization could save 100 billion dollars per year in the oil and gas industry, and currently C-suite executives in every company are working on some kind of digital transformation program. However, he said, there is too much "digital" and not enough "transformation" going on.

"Particularly because of low oil prices, getting oil and natural gas out of the rock isn't the problem anymore," Crompton said. "It's making money while we're getting oil and natural gas out of the rocks. And we hope to do that not with more people and more rigs but with more data and insight into that data."

Crompton highlighted the importance of applying data not just within one function of the industry but over multidepartmental, multifunctional, multi-life-cycle stages within an oil and gas well. However, combining data from, for example, oil field services, enterprise resource planning, operations technology, engineering technology, and information technology to form useful information can be challenging. "We need a data platform that allows us to have access to good data from all over the company, solving the classic silo problem," Crompton said.

Find other webinars and conferences presented by ISA online at https://isaautomation.isa.org/virtual-events-program. ■

—*By Melissa Landon*



From Jim Crompton's keynote address at the ISA Data Analytics in Upstream Oil and Gas Virtual Conference

The Connected Worker is Key to Productivity in 2021

By Louis Columbus

ABOUT THE AUTHOR

Louis Columbus, enterprise software strategist, is currently principal of DELMIAWORKS and a member of the Enterprise Irregulars. Columbus has an MBA from Pepperdine University and completed the Strategic Marketing Management and Digital Marketing Programs at the Stanford University Graduate School of Business. You can reach him on Twitter at @LouisColumbus.

Imagine having to reinvent your manufacturing business in real time as customers in one market put a hold on purchases while those in another are placing record-size orders that need to be delivered in days. This is the reality many manufacturers have faced over the past year—pivoting from markets that have slowed, such as automotive aftermarket parts, to areas with huge spikes in demand, notably personal protective equipment (PPE) and COVID-19 testing kits.

The trend is continuing in 2021 with the recent enactment of the Defense Production Act to accelerate COVID-19 vaccine and supplies production. Moreover, the global supply chain issues over the past year have more retailers, healthcare providers, original equipment manufacturers, and others looking closer to home for manufacturers that can produce a range of products and components. The market shifts are bringing both new opportunities and greater pressure on manufacturers to respond quickly and with the highest quality products they can produce.

Capitalizing on these opportunities—while ensuring product quality goals—depends on a manufacturer's ability to pivot the entire operation. That means everything from getting new suppliers onboard to creating and distributing work instructions across the shop floor. It includes scheduling production, defining quality and compliance specs, and managing logistics, including labeling and delivery. And all of it needs to be done in days.

Clearly, adding more machinery or expanding shop floors alone will not cut it. Instead, manufacturers need to transform their teams into connected workers by providing them with the technologies, tools, and training they need to excel. Let's look at four key ways that manufacturers are connecting their workers to successfully adapt and pivot to fast-changing conditions.

1. Guided production on the shop floor

Informed workers are key to switching rapidly from one production run to the next. For long-term employees, the process may be second nature. However, manufacturers often rely on newer employees or temp workers who will require on-the-job guidance or training.

Digital workflows presented via touchscreen-based shop floor interfaces at work centers help workers get up and running quickly. These workflows guide team members through the set of tasks they are responsible for and only present the information they need. This focused guidance effectively provides intuitive, on-the-job training that improves accuracy, helps users adapt to exception-based workflows for product customizations, and prevents the most common human errors.

2. Companywide communications

The goal of any connected worker strategy is to break down the silos between workers by enabling them to communicate digitally. Manufacturers are achieving this by giving employees access to information residing on systems whether employees are working in the office, remotely, or on the shop floor. Systems, such as enterprise resource planning, manufacturing execution systems, quality management, customer service, and customer relationship management software, are a lifeline for workers, giving them the context they need to excel in their roles.

Employees may access such systems from their remote offices or via tablets or other mobile devices to stay informed of what is going on during the day. Monitors displaying data on the shop floor also provide visibility. Even more powerful is the ability to dive into the details as needed right from the work center.

Regardless of the mechanism, by enabling employees to access data anywhere they need it, manufacturers can vastly improve employee decision making and create greater competency levels across the entire production team. Equally important is having shared information to guide workers toward common goals. As the founder and CEO of one manufacturing company noted, "It's imperative everyone owns product quality, so if we're producing piping one day and PPE the next, everyone knows the quality goals."

3. Real-time production and process monitoring

Connecting workers starts with recognizing that data needs to be as up to the moment as possible. Real-time production and process monitoring give teams the insights they need to collaborate and continuously improve. Real-time production monitoring helps workers follow jobs as they move from production scheduling through production to fulfillment. It also provides instantaneous feedback on critical parameters, such as total parts created, production time, downtime, rejects and parts remaining to be produced, and any cavitation changes.

Real-time process monitoring is used for monitoring, analyzing, and communicating key parameters of devices, including pressures, temperatures, dimensions, weight, and fill rate. Manufacturers use real-time process monitoring to create statistical process control charts and graphs to identify any potential anomalies in the production process and ensure product quality remains high.

4. Certified robotics maintenance

The acute labor shortage in manufacturing has been exacerbated by the higher hourly wages that Amazon, Target, Walmart, and other large-scale e-commerce providers are paying employees in their distribution centers. To mitigate recurring labor shortages, more manufacturers are investing in robotics for diverse, repetitive tasks on the shop floor. These range from end-of-arm assembly to labeling, pick and place, packaging, stacking, and palletizing.

At the same time, forward-thinking manufacturers are investing in employees who want to become certified on maintaining their robotics, whether through bonuses or reimbursement for courses passed. By relying on new technologies to open up new learning opportunities, manufacturers can attract employees seeking a career path. Additionally, as one manufacturing CEO noted, having an internal robotics services team will save significant costs down the line.

Connected workers are more about how technology can be selectively used to ensure each team member excels and less about smart manufacturing for its own sake. By enabling connected workers, manufacturers can create an ideal environment to excel despite the rapid changes and unpredictability facing the market today. By using real-time production and process monitoring and sharing data in real time anywhere employees need it, manufacturers are breaking down barriers between departments and creating a more adaptive workforce. ■

Sample of Jobs Available at Jobs.isa.org

See more at Jobs.isa.org, where you can search for available jobs or advertise positions available within your company. ISA Members post resumes at no charge.

Senior control engineer

Colonial Pipeline Company: The senior engineer of controls in Alpharetta, Ga., is responsible for performing and leading engineering design and support activities for various controls systems. He or she performs project-related work to keep projects with budget and on schedule; helps manage integrators and vendors by participating in developing bid packages and reviewing proposals and statements of work; defines test plans and methodologies to ensure the control system functions as intended; and leads troubleshooting and issue resolution of control system problems. The position requires a BS in electrical, controls, computer, mechanical, or chemical engineering, a valid driver's license and the ability to travel 50 percent of the time, experience with various Allen-Bradley programmable logic controller platforms, and an advanced understanding of PLC products, programming principles, and architectures . . . see more at Jobs.isa.org.

NetOps engineer

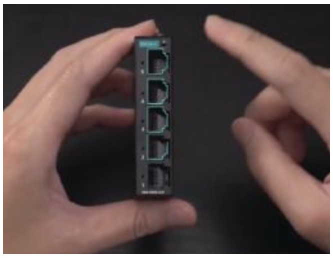
Central Peninsula Hospital: The NetOps (network) engineer in Soldotna, Ala., manages high-end routers, switches, load balancers, and firewalls and is responsible for the architectural design, planning, and operational implementation of networking solutions. The engineer will perform complex and nonroutine specialized network infrastructure administration support and troubleshooting, analysis, debugging, and problem solving focused on securing the highest network uptime in a 24/7 clinical environment. The position requires some on-call responsibilities and four or more years of network, server, or storage experience . . . see more at Jobs.isa.org.

Senior cybersecurity project manager

Danaher: The manager is a member of the Chicago-based information security team, working with the senior director of the security management office. Responsibilities include leading diverse project teams comprising other project managers and leaders, IT resources, security team personnel, and external vendor partners; coordinating and ensuring decentralized project execution and accountability; designing standard work processes; clearly communicating security initiatives in simple-to-understand terms; and developing and tracking detailed project plans, schedules, timelines, and achievements. Qualifications include seven or more years of experience in large enterprise environments leading large-scale cybersecurity projects, a BS in a technical field, the ability to navigate through ambiguity to anticipate and overcome challenges, and the desire to learn new concepts . . . see more at Jobs.isa.org.

Tiny, mighty unmanaged Ethernet switches

Designed with space constraints in mind when used in existing cabinets or machines, the EDS-2000-EL series of unmanaged Ethernet switches come in five- and eight-port Ethernet options, with the five-port model measuring 18 × 81 × 65 mm. The switches meet demands for flexibility, reliability, and continuity. Specifications include SC/ST fiber models available for the EDS-2008 series, support for 12/24/48 VDC input, microsecond-level latency, high EMC resistance, and QoS and BSP*** DIP switch configuration.



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AMD processors in embedded PCs

The CX20x3 embedded PCs include processors made for 32-bit and 64-bit systems, such as TwinCAT 2 and TwinCAT 3 automation software. The CX2033 is a fanless device without rotating parts using an AMD Ryzen V1202B CPU (2.3-GHz clock frequency, two cores). The CX2043 is a high-performance device with a ball-bearing-mounted and speed-controlled fan equipped with an AMD Ryzen V1807B CPU (3.35-GHz clock frequency, four cores).

The processors' Zen architecture combines high computing power with a high clock frequency. Graphics are integrated separately from the CPU cache, enabling "excellent" real-time characteristics. Users can select the Microsoft Windows 10 IoT Enterprise 2019 LTSC or the new TwinCAT/BSD operating system.
Beckhoff Automation
www.beckhoff.com/en-us/products/ipc/embedded-pcs/cx20x3-amd-ryzen

Sunlight-readable industrial tablets

The Rocktab Ultra U200 series of industrial tablets have Intel processors, up to 16 GB RAM, a screen brightness of up to 1000 cd/m2, and a viewing angle of 89° from all sides. The touchscreen can be operated with fingers, work gloves, or the supplied touch pen. Operation in the rain or with a dirty touchscreen is also possible. The Rocktab U212 has an 11.6-inch display, and the Rocktab U214 has a 13.3-inch display. The U212 is 22 mm deep—one of the slimmest tablets in its class. Both are fully IP65 certified and, with MIL-STD-810G military certification, can withstand accidental drops from a height of 1.20 m. They also have large, user-replaceable batteries, with the battery of the U212 being hot-swappable. A built-in 2x2 MU-MIMO WLAN adapter supports 802.11ax, is Wi-Fi 6 certified, and enables data rates of up to 2.4 Gbps. The integrated Intel My Wi-Fi technology lets the tablets act as their own access points when needed.
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To download a PDF copy of the whitepaper, visit https://gca.isa.org/isagca-quick-start-guide-62443-standards. To talk about how your company or organization can join ISA GCA, contact Rick Zabel at rzabel@isa.org.

Tomorrow Has Not Been Canceled!

By Bill Lydon

ABOUT THE AUTHOR

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

Tomorrow has not been canceled! This is a powerful thought that has been echoing in my mind during the pandemic. I heard this statement from Mark Taft, ABB Group vice president, in his opening keynote at the 2009 ABB Automation & Power World event when everyone was recovering from the 2007–2008 financial crisis. Taft emphasized, ". . . it is important for us to remember that tomorrow has not been canceled." We each benefit by making the best of tomorrow—and every day—with a positive attitude, willingness to accept challenges, and creativity in moving forward.

The United States Marine Corps motto echoed in my mind as well: "Adapt, Improvise, and Overcome." In discussions and virtual meetings throughout the pandemic there are great examples of automation professionals taking on challenges created by the pandemic, overcoming obstacles, and creating innovative solutions.

Throughout the world, we have all been facing the effects of the pandemic at the same time, punctuating the interlinking of the world and our common problems.

Virtual events

There is great camaraderie in the automation community with a spirit of good friendship at industry events and conferences. People benefit from discussing problems, sharing solutions, gaining insights, and learning together. Today we are doing this with virtual meetings and conferences. I do miss face-to-face meetings with people at physical events, but in some ways virtual events have brought the world closer together. Virtual events have allowed more people to participate, because the cost and time of travel is not a barrier.

Participation

The most valuable virtual event sessions I have attended have been the ones where the audience actively participates with questions and answers. Audience members also add valuable information to the discussion, generally through a chat window. I encourage you to actively participate if you are attending these events.

Connection

At physical events most of us have found the presentations valuable and the ad hoc discussions at breakfast, lunch, dinner, and evening social events at least as valuable. Attendees share problems and solutions, and generate new ideas. Realizing the value of those interactions, I have been communicating more often

We each benefit by making the best of tomorrow—and every day—with a positive attitude, willingness to accept challenges, and creativity in moving forward.

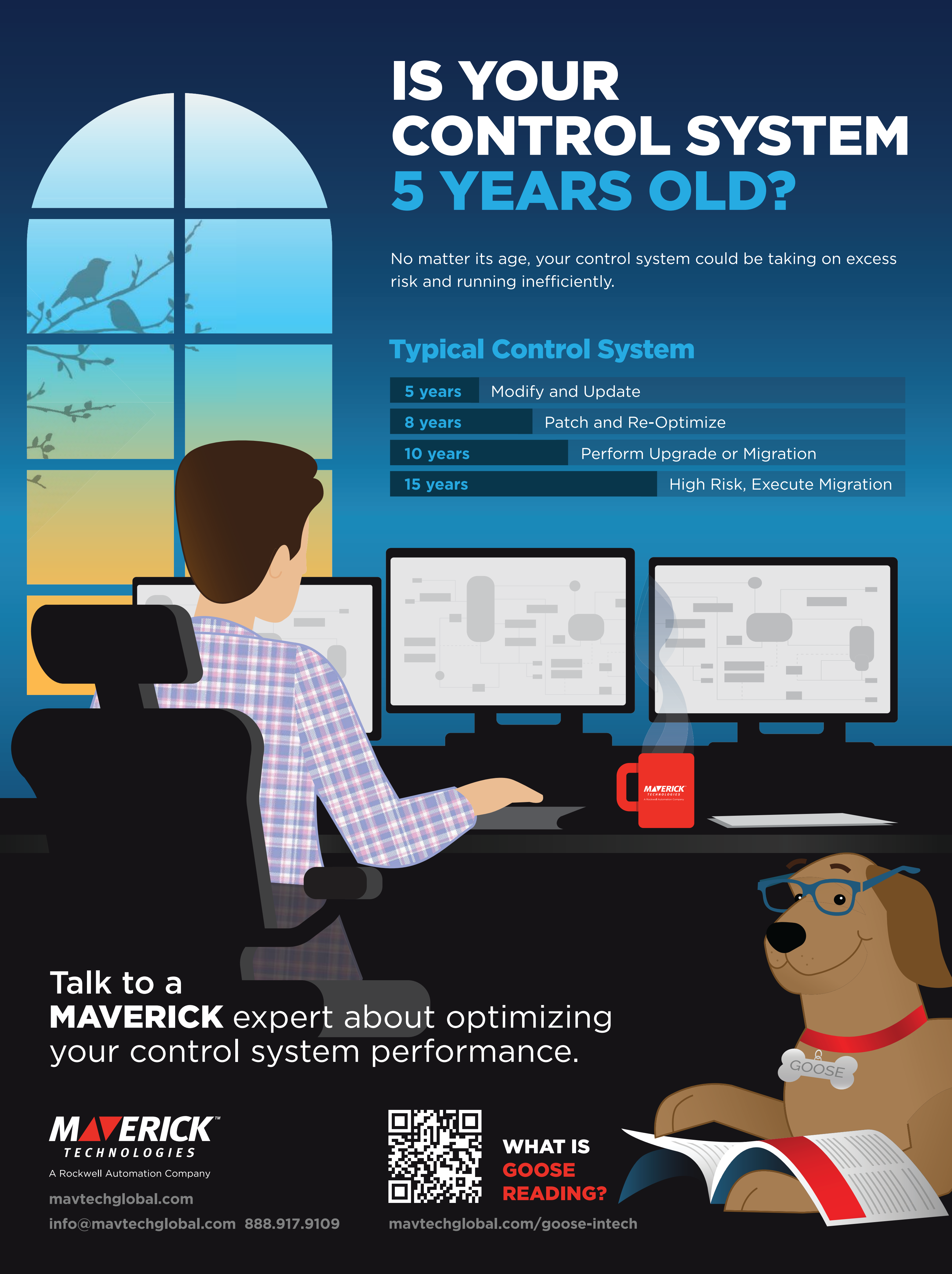
with many people I would normally see at events using email, occasional phone calls, private Zoom meetings, and LinkedIn. I recommend doing this sensibly.

Digitalization

There is an old proverb, "necessity is the mother of invention," and this is certainly accurate in the pandemic. Industry has been accelerating digitalization out of necessity during the pandemic. In a virtual keynote at the 25th Annual ARC Industry Forum, Nick Clausi, vice president of engineering for ExxonMobil Research and Engineering, discussed what happened when his company was compelled to deploy more digitalization during the pandemic: They realized that, in the past, the risk of using new digital products was overestimated and the value to the organization was underestimated.

Pandemic epilogue

In a couple years what do you think your pandemic epilogue will be? What did you learn and apply that improved things? ■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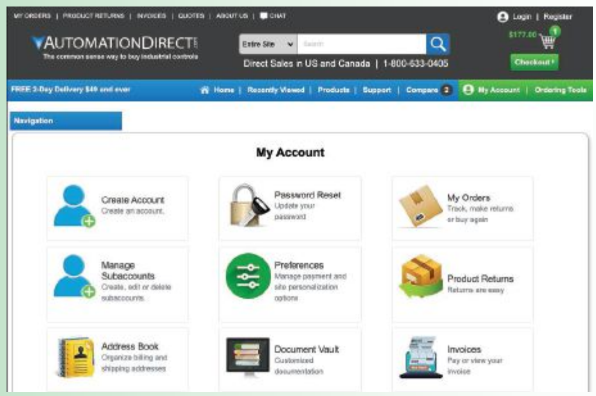

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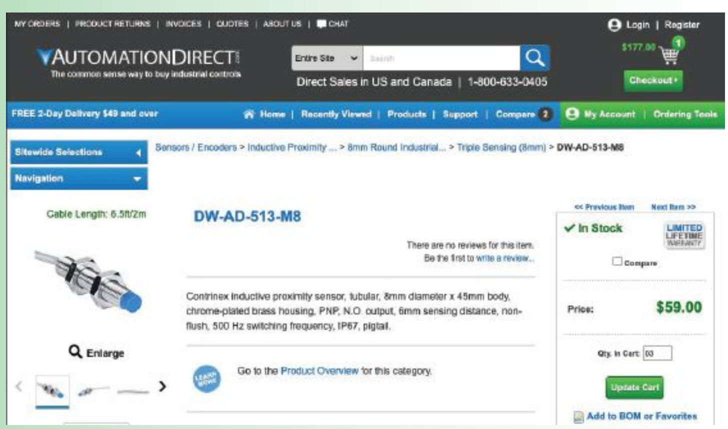

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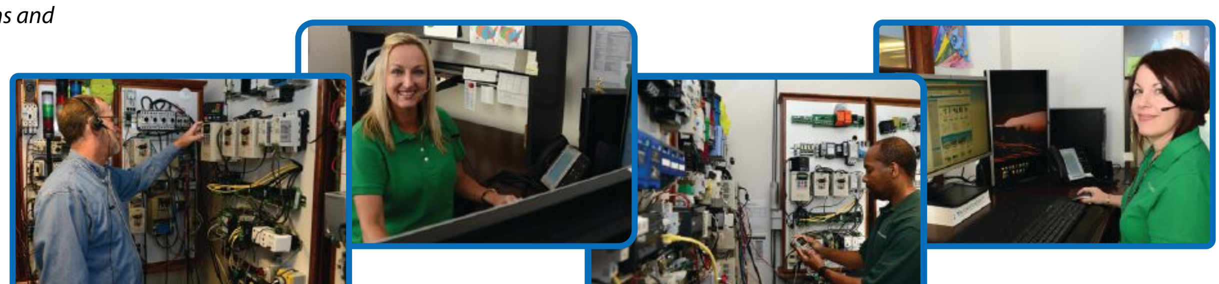

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