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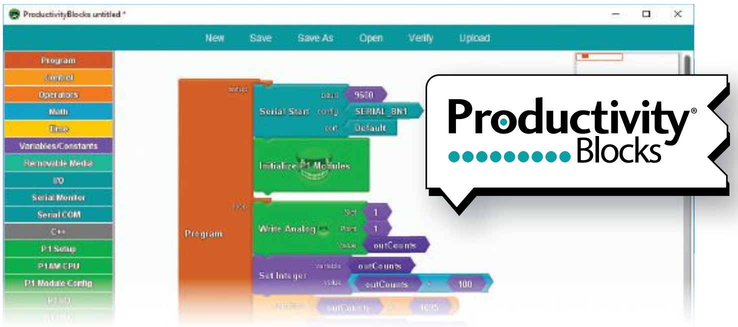

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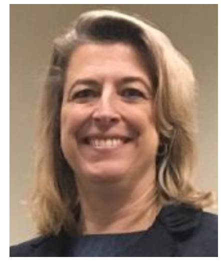
By Renee Bassett, *InTech* Chief Editor



A print magazine has been helping ISA to Set the Standard for Automation™ for almost all of this association's more than 75 years in existence. During that time, the name has changed—from *ISA Journal* to *Instrumentation Technology* to *InTech*—but the magazine's mission has always reflected and supported ISA's vision, mission, and values. We do that by regularly creating and delivering industry-leading, unbiased content in a variety of formats that advances the technical competence of our diverse global membership. And we keep evolving, in more than just name.

You see today a streamlined and re-designed *InTech* magazine—a magazine that reflects the realities of rising costs for paper and postage as well as the desires of members for a better digital experience. When our more than 14,000 member subscribers indicate their preferred format, 62 percent want to feel the paper in their hands while 93 percent want pixels on a screen. The majority, as indicated by the overlap, prefer both print and digital content consumption.

InTech magazine articles are now more compact; extraneous departments have been removed; and author bios and links to additional resources have been expanded. The Digital Edition of *InTech*, which is a reproduction of the printed pages that is viewable as either a "flip book" or a sequence of single-page PDFs, retains all the figures, photos, and design elements of the printed page while enabling easy sharing and links to additional information.

Revamped processes also mean more contributors can find a home outside the physical limits that printing and postage impose, because high-quality articles that do not fit in *InTech* magazine can be more easily published in *InTech FOCUS* ebooks or *InTech Plus* newsletters.

In 2021, we shared the work of 46 authors through the pages of *InTech* and *InTech FOCUS*. We gave their articles additional reach through *InTech Plus* newsletters and social media channels. If you are an author, a blogger, or an automation professional looking to get published for the first time, I hope you will send your well-researched reports, application notes, and thought-leader essays to be considered for the *InTech* family of publications. Reach out to me or to any ISA Pubs Committee member shown in the box on the right with completed articles or topics you want to write on. You can also reach out to *InTech* contributing editors. Our newest, Jack Smith, joins Bill Lydon, Charley Robinson, and me as staff who are here to help ISA members get published. ■

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Automating the Final Manual Frontier: Plant Asset Management

By Ben Myers

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Ben Myers is the product marketing manager for solutions and service at Endress+Hauser. Previously he was a process automation engineer on Endress+Hauser's Solution Engineering Team where he was heavily involved with field engineering and execution of various solutions projects. Myers has a BS in manufacturing engineering technology from Purdue University and an MBA from Anderson University.

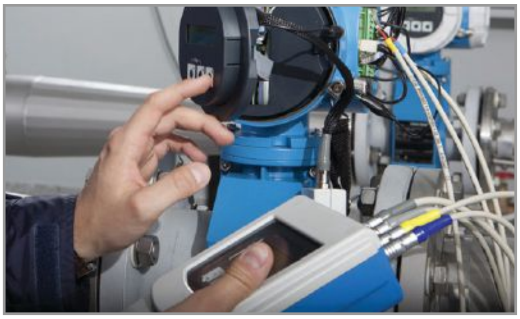
In the aftermath of a failed military campaign or attempt to stop an enemy attack, critics may blame intelligence services, saying they did not "connect the dots" and understand the true picture of an incident. A process manufacturing plant trying to determine why production suddenly and unexpectedly ground to a halt may go through a similar discussion. The process shut down in mid-operation because of an equipment failure that should have been anticipated and fixed before a complete breakdown, but nobody could connect the dots and recognize the indications of the developing problem.

Solving situations like this requires a field device management system, one that can recognize which assets need attention. This type of system can collect and analyze large amounts of data from a population of smart field devices, including process analyzers and instruments, along with other control devices such as valve actuators and positioners. The system can connect the dots automatically to ensure effective operation without interruptions, supplemented by more effective use of maintenance resources.

Manual versus automated monitoring

Well-trained and experienced technicians equipped with appropriate field communicators can do a lot to diagnose the condition of a flowmeter or a pressure transmitter (figure). This involves connecting to the individual instrument and scrolling through perhaps dozens of variables and configuration settings. If the person happens to catch a developing problem by recognizing something drifting out of its normal range or by viewing an alert message, it might prompt timely remedial action.

Imagine posing questions to the production manager of a typical petrochemical plant unit. "Why do you have all this automated, computer-driven control system equipment working with all those electronic field devices? Wouldn't it be better to operate the plant manually?"



An individual technician can evaluate instruments one by one, but this manual approach cannot keep up with a large population of field devices.

The question would be considered nonsensical. Responses would undoubtedly include points like the huge number of people who would be required to perform repetitive and tedious manual tasks, contrasted with the efficiency and effectiveness of a well-designed distributed control system (DCS). A follow-up question might be harder to answer: "Why is so much of your asset health monitoring still manual? Shouldn't it be automated as well?"

Capabilities of asset health monitoring solutions

Today's sophisticated field devices can provide enormous amounts of data. Estimates suggest the basic primary variable represents barely 3 percent of the data originating from an instrument or analyzer. What does the other 97 percent represent? It varies based on the type of instrument—a differential pressure transmitter produces different information than a Coriolis flowmeter or smart valve actuator. But in general, it includes:

- *Diagnostics*: Discrete and continuous indicators for internal problem states and random failures of the sensor and electronic components.
- *Monitoring*: Continuous asset and process indicators such as process noise, which can indicate changes outside an instrument's primary function.
- *Soft sensing:* Secondary, tertiary, and even additional variables. These can work individually or in conjunction with other instruments to approximate process measurements not directly measurable. ■

This article was adapted from the March 2021 InTech Focus: Temperature and Pressure *(www.automation.com/en-US/Articles/April-2021/Automating-Final-Manual-Frontier-Plant-Asset#authorInfo).*

Top Industrial Companies Find Pathways to Transform

Figure 1. ARC Industrial Digital Transformation Top 25

By Marianne D'Aquila, Greg Gorbach, Michael Guilfoyle, and Mark Sen Gupta

Digital transformation provides the pathway to success for industrial and infrastructure organizations. Yet, success is uneven across many industries, and mistakes, false starts, and dead-end investments are common. Companies continue to push forward, however, driven by market disruption, digital economies, and customer demand, with the pandemic accelerating the adoption of new technologies and work models. Leaders are emerging, supported by business cultures that embrace change as a competitive advantage. Who are the real leaders in digital transformation and why?

It is not straightforward to identify leaders in such a complex space, but ARC Advisory Group developed a rigorous process based on financial performance, a community intelligence–based ranking system, and software and sustainability data. Publicly available financial information, ARC primary and secondary research, data from ARC's market database, and the opinions of members of ARC's community of end users were factored into the determination of the *Top 25 Industrial Companies in Digital Transformation*. The result is an analysis and listing of the top 25 companies together with their scores in various categories, profiles of each of the leading companies, details about the research methodology, and more. The industrial companies on this year's list are shown in figure 1.

The prevailing philosophy behind digital transformation has been that this transformation naturally translates to success. Although the notion shows some truth on the surface, a closer look reveals much more complexity. For

The ARC Industrial Digital Transformation Top 25 report identifies global industrial digital transformation leaders and what others can learn from them.

this research, digital transformation is defined as: "The integration of digital technology into all areas of business, fundamentally changing the way companies operate and deliver value to customers. The organization is typically charged to innovate and improve across multiple dimensions such as: digital/disruptive technologies, culture and leadership, operational agility, workforce engagement, customer experience, environmental, social and governance, and competitive performance."

Software as a strategy. One important indicator of success is the accelerating adoption of software by industrial companies. This metric is captured within ARC's digital transformation index score. While it is true that these companies have been purchasing software for many years, their objectives for doing so (as well as what they purchase) continues to evolve. Leaders see software-as-a-strategy as a pathway to attain competitive advantage, with digital technologies allowing new levels of innovation, speed, and accuracy. From a shareholder perspective, that analysis holds true, as an increasing amount of evidence directly links the relationship between software purchases and industrial company valuation.

Market signals and competitive excellence. For most companies—and this includes innovators when they started—determining an effective starting point is overwhelming. Without better ideas about how to develop strong digital competencies, what ARC refers to as "digital wisdom," companies often experience the collapse of their pilots and projects, leading to the internal perception of wasted investment. So, what do leaders seem to be doing differently?

The common thread is *clarity* around a starting point. Effective digital transformation does not occur unless the organization connects the change to some external market or customer signals. That starting point is crucial. Innovation leaders focus externally on the market signals shaping their industries, whether specific to customers, competitors, or some new disruption. As a result, it leads them to ask different questions about what motivates the organization to change. Digital transformation occurs when it supports competitive differentiation relative to those signals.

Culture change enabled by machines and data. Regardless of how compelling a market signal is, innovators also understand that nothing changes unless company culture is reinvented. The most forward-thinking transformation leaders clearly understand both the importance and challenges of reshaping their cultures, which avoid both risk and change.

The most forward-thinking transformation leaders clearly understand both the importance and challenges of reshaping their cultures, which avoid both risk and change.

Because of these deeply ingrained challenges, these companies emphasize culture change at the executive level, establishing a digital champion leadership empowered to identify and implement change. This change is almost always considered drastic at first, and then it becomes commonly accepted as a standard and the best way of securing the company's ability to compete in digital economies.

As mentioned, these digital transformation leaders begin by identifying critical market signals that compel them to change. They use those signals as a basis for identifying what must change within the organization, how it will change, and what incentives exist for doing so. These include:

- *Emphasis on business outcomes that differentiate:* The company defines ideal outcomes that emphasize the speed and accuracy of how the company recognizes and reacts to these external market signals. This provides vision for what needs to change.
- *Transparency of objectives:* Armed with an externally based vision for change, leaders are transparent by communicating what transformation will look like and how it will affect people.
- *Aligned incentives:* By realigning incentives with the vision, transformation leaders can reward transformative behavior. This becomes the lynchpin step for realigning the work culture.

Using this step-by-step process, the people, processes, and data involved become evident. This process also clarifies what digital transformation technologies can best be applied to support change.

Learning from others. Engaging in anything transformational requires learning new things and experimentation. Those

ARC Industrial Digital Transformation Top 25

For the complete list and profiles of the top 25 companies, download the full report: https://www.arcweb.com/arc-industrial-digital-transformation-top-25-report.

ARC Advisory Group
Industrial Digital Transformation Top 25

requirements present overwhelming challenges for industrial companies that are hardwired by controlled and stable operations and transactions. Leaders in transformation understand that inherent contradiction, and they look outward for better ideas. As a result, another consistent characteristic of digital transformation is the presence of strong digital peer groups outside their traditional industrial ecosystems.

At almost all the companies ARC interviewed, employees noted that when they began their journeys, they quickly recognized they did not have all the answers, either within their own walls or in their market footprints. In fact, their digital champions began by aggressively expanding their sources of wisdom beyond their historic and current resources.

These expanded peer groups always brought return value. For example, one company was able to make extraordinary leaps in data management and security. In return, it provided a wealth of leading-edge knowledge on transformational ways of managing highly distributed infrastructure.

Establishing new competencies. Despite considerable progress, a dose of reality is helpful, particularly for those companies still trying to find a foothold. Apart from businesses that began with transformation as part of the mission statement, no comprehensively transformed company exists.

For most industrial companies, transforming to an organization where constant change and adjustment define normal operations is still very conceptual. Considering that, leaders focus on identifying and growing those initial digital transformation core competencies that will clearly support clear competitive excellence.

As a result, these companies typically have established some specific competencies that are well ahead of their peers. At the same time, they still struggle in many areas of the business and operations. In fact, they might still have certain aspects of their operations that look relatively primitive when compared to others. That is the nature of digital transformation now, where pockets of innovation occur with new digital competencies that will aggregate to establish fully transformed organizations. Even the leaders will be on this journey for some time.

A look at the top five

The top companies stand out for showing substantial progress in transforming their cultures, adopting technologies, and embracing digital transformation to enable business outcomes. There is no universal recipe for success, and no single company has everything figured out. These companies, while not perfect, are pushing full steam ahead. The top five companies are Tesla, Intel, BMW, Johnson & Johnson, and 3M (figure 2). This partial list and a profile of the top company, Tesla, show how all these companies exemplify characteristics of leaders in digital transformation.

The scoring comprises three main components: financial indicators, transformation indicators, and collective intelligence. The financial indicators come from publicly available data, and their significance is as follows: Profitability and growth are positive business outcomes of some companies that are well down the digital transformation path. Year-over-year revenue growth and profitability were chosen as metrics because they are widely seen as strong indicators of digital transformation outcomes. Most of the successful companies have stated their revenue growth and profitability would suffer in the future if they did not digitally transform quickly enough. Ultimately industrial companies must extract value from assets, so this metric was selected. A major purpose of digital transformation is to create value by enabling employees to work more efficiently. Profit per employee was selected as a metric because it measures the efficiency in which a company is using its workforce.

The transformation indicators correlate as follows: Environmental, social, and governance (ESG) factors are a strong

Company	Rank	Profitability as % of Revenue	YoY Revenue Growth	Return on Assets	Profit per Employee ($USD)	Community View	ARC Analysts View	ESG Score	Digital Transformation Index	Score
Tesla	1	2.2%	28.3%	3.8%	9,752	1,231	485	57	44	689
Intel	2	26.8%	8.2%	15.5%	188,960	822	487	90	37	676
BMW	3	4.1%	–6.7%	2.5%	36,577	1,051	573	85	44	656
Johnson & Johnson	4	17.8%	0.6%	9.5%	109,398	829	289	91	59	594
3M	5	16.7%	0.1%	15.3%	56,681	924	261	92	30	578

Figure 2. Sample from the ARC Industrial Digital Transformation Top 25 table

indicator for digital transformation. There is an increasing push across global industries to incorporate ethics and sustainability into business practices. Environmental, social, and corporate governance is a business outcome resulting from a successful transformative process. The ESG scores reflect an ARC assessment based on available company data and multiple publicly available ESG indexes.

For industrial companies, there is a correlation between investment in software and other transformational technologies and a company's valuation. Appropriate software and technology research study data—including historical and forecast data for areas such as manufacturing execution systems, enterprise resource planning, cloud platforms, and analytics—were used to generate a digital transformation index derived from ARC's proprietary research database.

The results also rely on the collective intelligence of ARC's community. The collective intelligence component scores reflect the progress companies are making as demonstrated by the level of awareness and visibility in the knowledgeable industrial community and among ARC analysts.

An example: Tesla hits the mark on many fronts. Some may argue that Tesla started out as a transformative company and is not one that has recently transformed, given that its intent was to disrupt the automotive industry. The company's growth has been fueled by several bold digital strategies. Founded in 2003, the company's message from day one was not that an electric car could be good but that it could be better.

Tesla's fundamental philosophy, internally and externally, is to move perception. Before Tesla, the market perception of an electric vehicle was a slow, ugly, juiced-up car with little range. Tesla shifted this perception to a sleek, high-performance, and faster-accelerating mode of transportation. This same strategy is used inside the organization to gain buy-in for digital initiatives and processes. For example, when Tesla sets out to automate its internal processes, it tries to build better from the start rather than start a clunky project and hope to get better on revision four or five. This orientation is fundamental in determining what key performance indicators the company values, as many of them are far different from metrics managed by manufacturers relying on traditional views of success.

By showing value from the start and having internal stakeholders support initiatives, internal employee resistance is minimized. As ARC sees it, this is an example of a company that is comfortable with digital transformation and adapts to business challenges with greater ease quickly. Tesla's digital connectivity has allowed the company to deliver more value to consumers. Its business model is built on the tenet that the vehicles are more like interactive computers with wheels. This led the company to create an intelligent data platform and connected ecosystem, enabling Tesla to learn from and serve its customers.

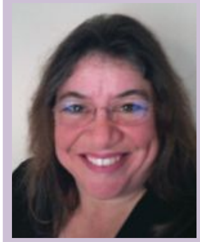
In the third quarter of 2021, Tesla publicly stated it plans to grow manufacturing capacity as quickly as possible. Over a multiyear horizon, Tesla expects 50 percent average annual growth in vehicle deliveries. This rate of growth will depend on Tesla's equipment capacity, operational efficiency, and the capacity and stability of the supply chain.

Digital transformation in every industry

Digital transformation leaders across many different industries share common traits and visions, helping them overcome complex challenges to innovate and stay agile. Some industries experience a greater resistance to change centered around their manufacturing processes, which can make transformation slower, more difficult, or less obvious. Regardless, ARC has witnessed digital transformation occurring in these industries as well. The final digital transformation top 25 list comprises companies from a varied set of industries. Industrial innovation continues to accelerate, and leading companies have their transformation initiatives well underway. For those who succeed, the result is a competitive advantage, even during the most difficult global times. ■

ABOUT THE AUTHORS

This article is the result of research by the ARC Advisory Group.



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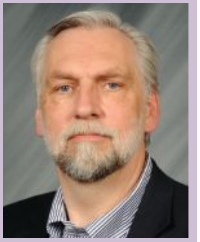

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Digitalization Drives Sustainability

By Lindsey Wilcox

The production of greenhouse gases, inefficient water and energy usage, and significant harmful emissions have given the manufacturing sector a negative reputation for its impact on the environment. For example, the oil and gas industry alone is responsible for 42 percent of the world's greenhouse gas emissions.

As a result, manufacturing sector organizations have a moral, social, and economic obligation to address sustainability as a top corporate objective, and to make the necessary investments to ensure sustainable operation. Over recent years, sustainability has become a popular buzzword in many companies' annual reports, and organizations often invest in personnel with a sole focus on sustainability.

Digitalization in the form of advanced analytics provides the insights required to increase efficiency and improve sustainability.

Yet with all this focus, along with clear recognition of sustainability as an important topic, organizations struggle with exactly what to do or how to achieve their objectives. The result is often well-intentioned goals that fall short of objectives, with no measurable outcome or improvements.

Digitalization can be used to improve efficiency and thus sustainability, specifically by creating more value from data through the use of advanced analytics applications.

Implementation impediments

Although sustainability is clearly recognized as an area of significant importance in the process industries, companies are typically challenged to identify places to invest time and resources. Sustainability in the process industries is often synonymous with cutting-edge or newer technologies, such as carbon capture, alternative energy, and power storage. While these initiatives can be effective, they are expensive to implement and maintain. Companies interested in sustainable operation may lack the capital to invest, as it is difficult to quantify the return on investment.

These large capital projects are not only costly, but the benefits of sustainability are also not immediately realized. For example, wind energy is recognized as a green energy source, but there is a carbon footprint associated with the production of each wind turbine, which must be paid back through operation. When factoring in the time required to design, build, and implement a wind farm, the period to realize the sustainability benefits is much longer.

The same concept applies to many other technologies. And while innovations such as these are part of the solution, focusing solely on these new, niche technologies often makes companies overlook what they can do right now to optimize their environmental performance, with little to no capital investment required.

Frequently, companies do not have an accurate or easy method for presenting and tracking their current environmental performance. Without this insight into current operation, it becomes difficult, if not impossible, to make improvements and optimize. So, why aren't companies doing more to track their environmental performance by optimizing use of their existing assets? Simply put, they do not have the right tools in their digitalization arsenal.

Without the right tools, designed specifically for analyzing time-series manufacturing data, performing any sort of metric calculations is difficult and time consuming. This often causes valuable engineering resources, typically subject-matter experts (SMEs), to invest significant amounts of time in menial data management activities. Without the right tools to give a company and its employees insight into their environmental key performance indicators (KPIs), there is little that can be done to drive improvements.

Advancing with analytics

Process manufacturers can use advanced analytics applications, a key component of digitalization, to gain more insight into their environmental process data. With the right tools, process manufacturers can leverage the expertise of their SMEs to define sustainability KPIs and track performance. Knowing the score enables the organization to identify areas for improvement, so it can optimize the environmental performance of existing assets.

Without the right tools and KPIs, organizations are at best reactive to their environmental performance, responding to events after the fact when they are identified in monthly or quarterly reports. Advanced analytics applications empower process manufacturers to move from this reactive approach to a proactive, or even a predictive, model.

For example, advanced analytics applications enable SMEs to identify relationships among environmental KPIs and process parameters. With these relationships understood, entire processes can be continuously monitored to identify and mitigate environmental excursions. This continuous monitoring ensures quick reaction to events, while facilitating root cause analysis by SMEs. Excursions are identified and acted upon quicker, and root causes and leading events can be quickly identified.

Advanced analytics applications not only provide monitoring and root cause investigation, but they also can be used to build models of a process to better understand how changes to the process or events will affect environmental performance. These models allow SMEs to perform "what if" analyses to gain a comprehensive understanding of any impacts to environmental KPIs. These models can further be applied to predict environmental performance, which can be used to prevent excursions entirely.

With the right advanced analytics application, insights can easily be shared and communicated with colleagues and the broader organization. SMEs can collaborate with their colleagues in real time, alleviating the siloed and error-prone analyses that exist when organizations are not equipped with the right tools and depend on spreadsheet applications. Analytics can quickly and easily be scaled to many assets across the entire fleet, with results communicated through auto-updating dashboards or reports.

Analytics in action

Improving environmental performance can mean many different things and often varies by company, industry, and objectives. Many oil and gas companies are focused primarily on decreasing emissions, while other companies may be more interested in minimizing water and energy consumption, while others work on progress toward the circular economy. Whatever the focus, advanced analytics can play a role in achieving an organization's objectives for more sustainable operation.

Reducing emissions. With the world's current focus on climate change, emissions are a huge area of concern for oil and gas companies, and other heavy industries as well. Yet, when typical process engineers at a refinery think about emissions, they are likely focused on compliance. When SMEs are not armed with the right tools, a typical workflow requires downloading historical operating data to a spreadsheet application, and then spending days each month cleansing, aggregating, and contextualizing the data to identify excursions.

And while compliance is important, companies need to do more than just comply to go net zero. Focusing solely on compliance results in reacting to environmental excursions after the fact. To shift from this approach, organizations need to empower their SMEs with advanced analytics applications so they can contextualize data, and then provide key insights, or perform root cause analysis in real time.

At one super-major oil and gas company, SMEs used an advanced analytics application to automate their regulatory compliance reporting. The application pulls data from the process historian and applies calculations defined by process engineers to report emissions levels accurately and efficiently, ensuring regulatory compliance.

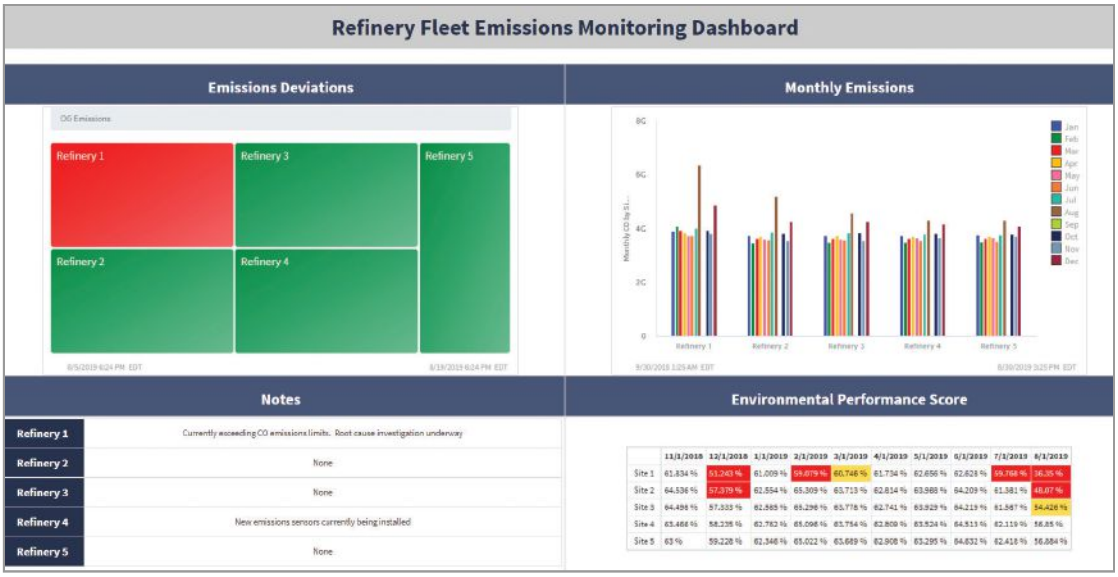

Figure 1. Organizations can use advanced analytics applications to monitor emissions KPIs across an entire fleet of refineries.

As new data becomes available in the data historian, the calculations and reports are automatically updated with the latest information (figure 1). By using an advanced analytics application, the company has saved a significant amount of time in generating these reports.

But more importantly, having emissions performance information readily available with the latest data empowers the company to shift from a reactive to a proactive approach to identify issues quicker, instead of just reporting after the fact.

In another example, a super-major oil and gas company leveraged an advanced analytics application and its flexible architecture to operationalize the work of a centralized data science team, which built a proprietary neural network algorithm to estimate NOx emissions based on the current operation of the site. This algorithm was then deployed as a custom add-on tool in the advanced analytics application, providing wider availability to the site teams, along with seamless integration to their application.

The team of engineers at the site now uses this custom tool to gain near-real-time insight and monitoring into their environmental performance, enabling them to make proactive decisions and adjustments to reduce greenhouse gas emissions.

Cutting energy and water consumption. At a specialty chemical manufacturer, SMEs used an advanced analytics application to build a multivariate model of the chemical manufacturer's process energy consumption. This model was used to compare expected (modeled) and actual energy consumption (figure 2).

These comparisons and subsequent investigations have identified process issues, such as a nonfunctioning valve or

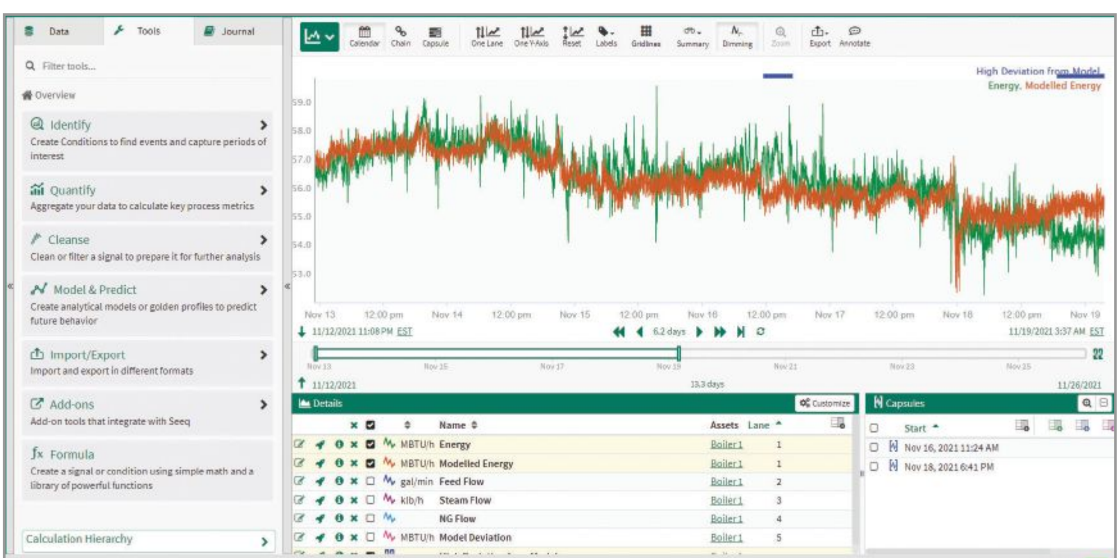

Figure 2. Using an advanced analytics application, SMEs working for a chemical manufacturer compare modeled to actual energy consumption. If a high deviation from the model is identified, SMEs perform a root cause analysis.

a poorly tuned controller, causing significant energy waste. Identifying the root cause of these deviations enabled the engineers to perform corrective actions and mitigate energy waste. Before developing these energy models, such issues typically went undetected.

Progress to a more circular economy. Advanced analytic applications can be applied to help process manufacturers as they continue to promote the circular economy. Manufacturers are being pushed, now more than ever, to produce the required goods using methods that ensure efficient use of raw materials, less waste, and more recycling. As with other sustainability focus areas, these objectives can be achieved with the help of advanced analytics.

With the right advanced analytic application, SMEs can monitor their plant, process, or equipment mass balance in near real time. While organizations may already have methods for performing mass balance calculations, these traditional methods are often difficult to maintain and update as new data becomes available.

However, with an advanced analytic application, SMEs can run their mass balance calculations continuously to track changes over time and efficiently identify deviations. In this case, deviations may indicate a loss or waste of material, and identifying these issues in near real time allows proactive mitigation.

Final thoughts

Process manufacturers have a moral obligation to be world leaders in sustainability efforts, but they are faced with the daunting task of determining the best approach to address concerns. They should not overlook the optimization opportunities already available at their fingertips to use existing assets and resources more efficiently, with low to no capital investment.

As part of a larger digitalization effort, using advanced analytic applications to reach sustainability goals ensures an organization is fully leveraging its workforce's expertise. Additionally, any changes or process optimizations implemented as a result of insights typically result in immediate performance improvements.

Sustainable manufacturing is a significant topic, and many people are passionate about the issue. By arming personnel with the right advanced analytics applications to provide more insight into environmental performance, companies can engage their employees at all levels to directly and positively impact the organization's environmental footprint. ■

All figures courtesy of Seeq Corporation

ABOUT THE AUTHOR

Lindsey Wilcox is a customer success manager at Seeq Corporation, where she helps end users discover new ways to interact with their process data to drive continuous improvement using advanced analytics software. Before her role at Seeq, she served in engineering positions at the Westinghouse Electric Company and Control Station, a software company focused on process control optimization. She has a B.S. in chemical engineering from the University of Connecticut.

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OPC UA Makes IIoT Implementations Possible

By Isao Hirooka

The kind of communication necessary to support the "fourth industrial revolution" demands a protocol able to tie everything together. It's here today.

For some years now, people involved in manufacturing industries have stopped referring to the industrial revolution as a singular event. There have been four phases, each reflecting major advances in technology:

- Phase 1: Water and steam power facilitates mechanized production.
- Phase 2: Electric power enables mass production.
- Phase 3: Electronics, computers, and information technology (IT) automate production.
- Phase 4: Digital integration fuses physical, digital, and biological spheres.

The fourth phase, or the "fourth industrial revolution," is discussed in an article, "The Fourth Industrial Revolution: what it means, how to respond," by Klaus Schwab, the founder and executive chairman of the World Economic Forum. As the title suggests, Schwab describes this revolution, along with challenges and opportunities, and its impact on business.

The expectation is that connecting millions of things to the Internet, often referred to as the Industrial Internet of Things (IIoT), will be a key driver in this fourth industrial revolution. The IIoT comprises huge numbers of industrial sensors, each creating data about manufacturing processes. The "big data" gathered from these connected sensors can be analyzed by machine learning (ML) and artificial intelligence (AI) to predict equipment malfunctions and abnormalities, while improving overall plant operations.

As promising as it is, implementing IIoT solutions using fourth industrial revolution concepts is easier said than done. However, many companies are trying to leverage the technologies and data to improve operational decision making. As sensors become more miniaturized and cheaper, companies can deploy them throughout a plant to do the kind of data collection required for IIoT implementations.

This demands a high degree of connectivity with mechanisms to easily send, receive, and use the data. In addition to the data from small sensors, there are many more complex devices that generate large volumes of data. Effectively handling this mix of high- and low-volume data requires bundling and abstracting on a device-by-device basis. What is the best way to facilitate this?

Overview of OPC UA

OPC UA has emerged as a key technology for smooth data exchange. It predates the IIoT, because it was released as a standard in 2008, built on the success of OPC Classic (DA, A&E, and HDA). Companies implementing IIoT programs are turning to it because it has four critical characteristics necessary to send and receive data securely and efficiently:

- The OPC UA governing body, the OPC Foundation, certifies equipment to ensure interoperability when devices from different vendors are interconnected.
- OPC UA uses an information model to easily send and receive data for many kinds of devices.
- Its communication method effectively connects devices using a range of data requirements for a variety of applications.
- It applies different proven cybersecurity tools taken from information technology and operational technology environments to ensure a high level of security.

Testing and certification program

End user companies will not adopt OPC UA without assurances that they will not be driven to any specific vendors or be forced to create workarounds to overcome incompatibilities. Supported and certified devices, regardless of vendor, must interoperate out of the box.

To avoid interoperability issues, the OPC Foundation has a certification and conformity program for its more than 800 members to provide proof that a device conforms to OPC specifications, and that it also has sufficient quality to perform reliably in actual operation. It guarantees that certified devices meet the compliance requirements listed below, thus minimizing problems for the user when integrating them, and enabling smooth connections. Testing for certification must be performed in an OPC test laboratory, and devices must meet the following conditions:

- compliance with OPC specifications
- problem-free interoperability with other vendors' OPC products
- robustness and reliability—enough to recover from common communication abnormalities
- general functionality in accordance with widely accepted best practices
- effective and efficient resource management (e.g., CPU, memory, free disk space).

When a device passes the series of tests, its manufacturer can certify it for use in OPC UA networks.

Information models

A critical element to support multivendor interoperability is OPC UA's use of information models (figure 1). Because information for a particular device can be handled in meaningful chunks following a prescribed format, it is possible to monitor operation among devices from multiple vendors without complex engineering. For example, it is impossible to handle data from a robot or centrifugal pump without programming to identify each piece of data.

In the past, engineers made data meaningful by manually configuring and assigning engineering units. However, when trying to handle the enormous amount of data generated by

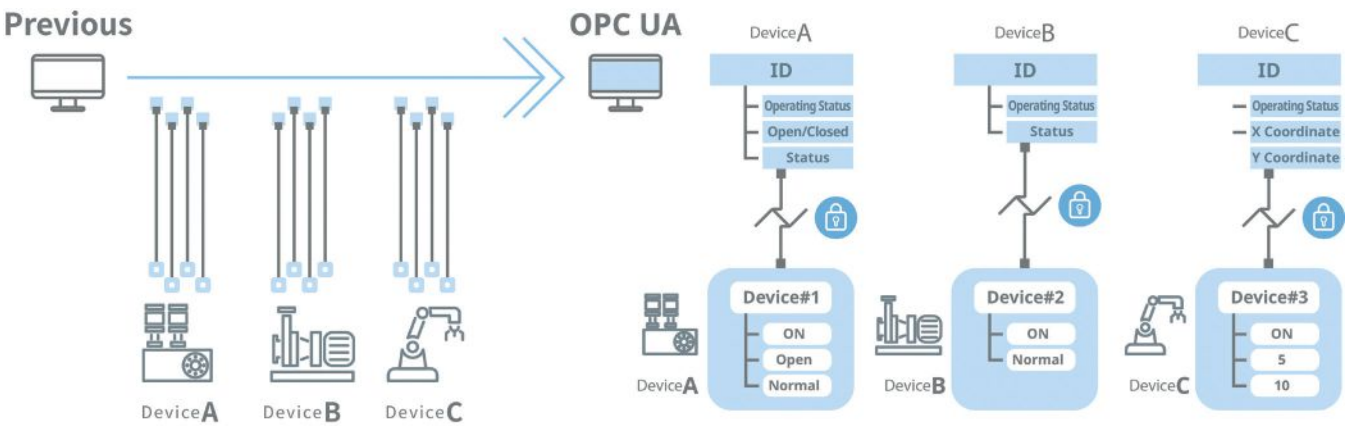

Figure 1. OPC UA information models make the presentation of data from a variety of devices more consistent, easing communications.

the growing number of devices in an entire plant, this becomes impractical. Engineering costs and the risk of configuration errors for all these manual operations is too high.

The information model enables the system to discover and interpret data from each device, helping the host understand its meaning automatically. This significantly reduces engineering costs and eliminates setup errors. Also, the information model supports object-oriented programming methods that can be executed to perform a series of processes.

Companion information models

The OPC Foundation has a mechanism for building information models tailored to specific industries and processes, called companion information models. The OPC Foundation describes these thusly:

"New Information Models can be created based on the OPC UA Data Model and eventually derived from OPC UA Base Information Models. The specifications of such information models ("industry standard models" because they typically address a dedicated industry problem) are called Companion Specifications. The synergy of the OPC UA infrastructure to exchange such industry information models enables interoperability at the semantic level."

For example, there are information models for master control station and distributed control system interface standardization (MDIS), which supports subsea oilfields. There is also IEC 61850, which supports the integration of an automation host system with power control.

Communication formats

OPC UA supports two communication methods: the original client-server approach, and the more recent publish-subscribe (PubSub) approach. The client-server method has been used since the first versions of OPC Classic. Here, data can be exchanged after two devices establish communication. If there is a communication problem, it is possible to minimize the impact by resending the transmission or issuing an alarm. Accordingly, process data, alarms, and other information can be saved without loss, making this information suitable for subsequent analysis.

In contrast, PubSub is a one-to-many communication method. A publisher device broadcasts its data to an unspecified number of subscribers on the network, and target subscribers acquire only relevant portions of the data. Publishers only send and subscribers only receive, so if communication fails, no resending or other actions are required. Subscribers always work with the latest data they have received.

PubSub fully integrates into existing OPC UA technology, enabling further adoption of OPC UA at the shop-floor device level where controllers, sensors, and embedded devices typically require optimized, low-power, and low-latency communications via local networks. OPC UA does not rank either client-server or PubSub above the other, but supports both depending on the application.

Cybersecurity

OPC UA incorporates proven IT security technologies for both IT- and control device–related communication. The OPC UA specification defines its security concepts for communication between equipment:

- confidentiality: encryption
- integrity: signatures
- availability: denial-of-service measures
- authentication: electronic signatures
- authorization: access rights
- accounting: audit trail history.

OPC UA covers a wide area from control equipment to information and core systems, and it uses multiple methods, because the security requirements for each objective are

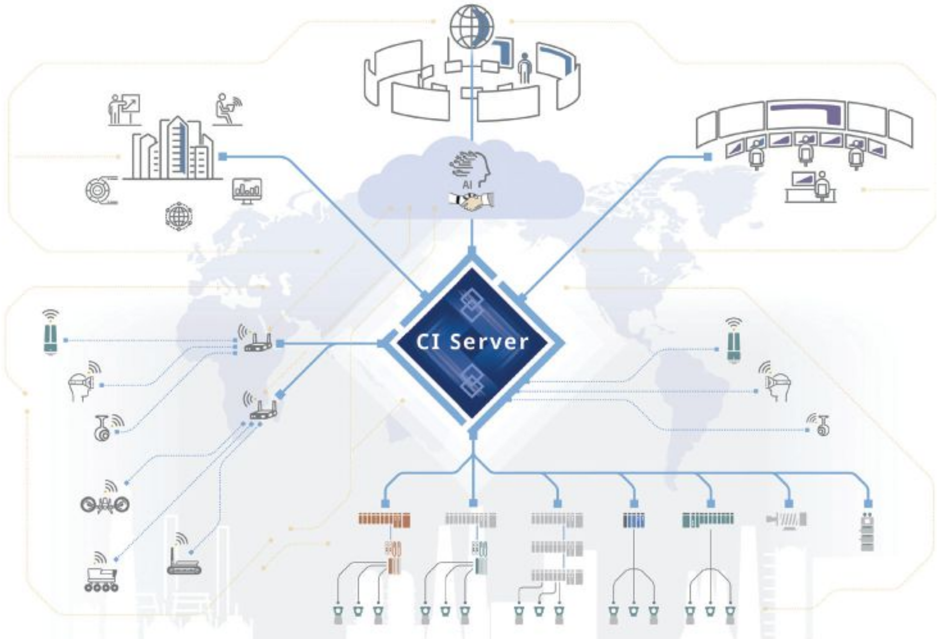

Figure 2. A CI server must communicate with a huge variety of platforms and networks to be effective. OPC UA makes this possible.

different. This way, OPC UA can respond flexibly by adhering to whichever requirement is necessary.

Collaborative information server

So far, we have concentrated on OPC UA itself, but now we will look at how it can be implemented on a plant- or company-wide basis using a collaborative information server (CI server). A CI server is designed to support an environment where information and data obtained from various equipment, systems, and devices across multiple sites and plants can be easily integrated (figure 2). OPC UA is one of the CI server's major communication protocols, and it supports both client-server and PubSub communication methods. It also provides a way to construct information models.

Conventional process control and monitoring systems target process data (temperature, pressure, and flow) acquired from distributed control systems (DCSs), safety instrumented system (SISs), and other systems. However, these methods do not break through the "programmable logic controller (PLC) barrier," meaning they do not reach directly to small controllers and field devices. This is changing, because OPC UA can exchange data with a variety of communication protocols. By providing many kinds of PLC drivers, it is possible to acquire data directly from the devices and systems used to monitor and control a variety of equipment and installations. This allows companies to manage the data in a plant at all levels from a central location, rather than through other systems (figure 3).

For example, by using PubSub, OPC UA can send temperature and vibration information from a large number of small IIoT-enabled sensors to the CI server directly. It can then combine this information with various types of process data and alarms from the DCS, turning this into big data, which can be analyzed using ML and AI. The CI server also provides graphics for operators, displaying the results of data analysis in real time. Ultimately, this information supports decision making and can be used to improve plant operations.

There are two main ways a CI server uses OPC UA. The first involves the clients or the subscribers on the data acquisition side. By using the information model of the devices, plant personnel can access information easily, efficiently, and securely.

The second involves using the server as the data publisher. All data related to plant instrumentation, such as control systems, safety systems, power control systems, equipment, and devices, can be integrated, abstracted as an information model, and used in secure communication.

Future developments

OPC UA is an important technology for implementing the fourth industrial revolution and realizing its full potential. It has become successful in this regard because it incorporates many methods to facilitate and secure data communication among devices and controllers in different applications and from different vendors. ■

All figures courtesy of Yokogawa

ABOUT THE AUTHOR

Isao Hirooka is a planning department manager for Yokogawa Electric Corporation. He joined Yokogawa in 1991 as a software engineer for control system, and he has more than 30 years of experience in planning and development of integrated control systems.

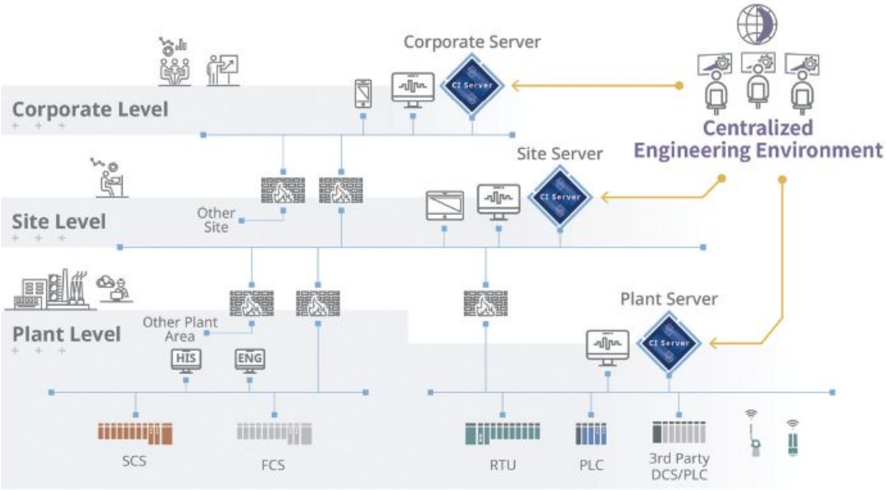

Figure 3. CI servers are the interface to bring all levels together.

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Machinery Health Moves Toward an Integrated Future

By Drew Mackley and Shane Moser

A focus on integrating data helps build a foundation for improved performance across both the plant and enterprise.

The process industries rely on high-performing equipment to meet ever-increasing goals in support of their organizations. Unaddressed equipment issues can lead to costly repairs or replacements and create safety issues.

As experienced maintenance personnel retire in droves, creating a skilled worker shortage, few plants can continue to rely on manual maintenance checks to ensure equipment runs at its best. To close the gap, plants will continue the move to automated asset management.

However, asset management technologies implemented without a plan have the potential to generate problems that complicate maintenance in new ways. To avoid these problems, organizations striving for the best performance must carefully plan system implementation based on a foundation of integration—among technologies and key stakeholders, and with business enterprise systems.

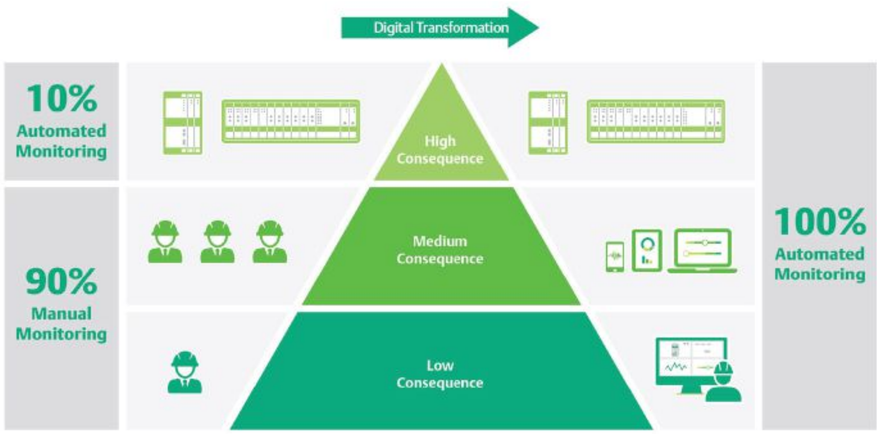

Figure 1. As digital sensing technologies become more affordable, process plants are moving to fully automated monitoring using technologies to collate data and identify reliability issues.

The rise of data

Rapid decreases in the cost of sensing technologies have made it fast and easy to instrument nearly everything in the plant. Maintenance teams are quickly shifting critical, and even balance-of-plant equipment, from the list of assets needing routine in-person monitoring to a more automated monitoring strategy (figure 1).

However, the multitude of devices monitoring plant equipment are controlled by a wide range of software and protocols—often proprietary—to deliver the critical data plant personnel rely on for better decision making, creating potential issues. As plants add additional disparate monitoring systems to their maintenance arsenals (figure 2), the risk of stranded data and barriers to collaboration rapidly increases.

To address these and other issues, forward-thinking organizations are engineering their asset management solutions around software that aggregates and analyzes data from multiple monitoring technologies, while providing tools to share and enhance data locally and in the cloud for enterprise-wide collaboration.

Teaching technologies to communicate

Today's asset management is about more than identifying a spike in vibration or temperature on a piece of equipment. Plant personnel also must focus on asset interaction and how those interactions affect production. For example, what if a vibration increase only occurs when another piece of equipment upstream is in a certain state? Or, what if a temperature spike only happens on Thursdays at 4:00 p.m.?

To investigate these multivariate issues, personnel must be aware of all relevant variables, and even the most skilled technicians cannot be in two places at once. Instead of waiting for a new generation of technicians to come up to speed and manually cover every asset, tomorrow's maintenance teams will rely on integration among all the devices monitoring plant assets, so their results can be viewed, compared, and trended in one place.

When different devices operate using different protocols, guidelines, and software packages, operators and technicians are left running between pieces of equipment or switching between many different systems, some in different areas of the plant. This style of work slows responses and significantly limits return on investment (ROI) for asset management technologies. The solution lies in integrating data from a wide variety of devices using a shared technology architecture. Doing so requires open technology standards for asset monitoring. Many of these standards are currently in their infancy, but even these early open technologies are already significantly impacting the way organizations design automated monitoring systems.

To speed ROI, plants are turning to machinery health software packages that can collect data from many types of devices, perform local analysis, and export critical values

Figure 2. Small wireless sensors, like the Emerson AMS Wireless Vibration Monitors shown here, are simple to install, making it easy to monitor plant assets.

Figure 3. Machinery health tools, such as Emerson's AMS Machine Works, collect data from equipment across the plant or enterprise, and present it in a single location to help personnel more easily assess holistic plant health.

(lead photo). These software packages analyze aggregated data from multiple monitoring technologies to make an early diagnosis of developing issues and to help users identify root causes and isolate problems before they become severe.

As more plants embrace the integrated data foundation, industry will share machinery health data exported via OPC UA in data repositories, such as data lakes, where it can be combined with metadata, process data, historian data, and more. Such systems can quickly turn raw data into the highly contextualized information plant personnel need to improve performance, efficiency, and safety.

An interconnected workforce

Collaboration is key to plant health. Whether maintenance personnel are standing next to each other at an asset or relaying important workflow steps from a corporate headquarters miles away, success is directly related to the ease with which they can share data, advice, and awareness. As staffing shortages escalate and plants are forced to accomplish more with fewer people, industry will continue to build comprehensive collaboration platforms to extend the reach of expert personnel without the delay, cost, and hassle of travel.

To empower smaller workforces, organizations will leverage persona-based machinery health software to help mobile workers more easily identify problems. With persona-based platforms, users receive only the data relevant to their roles, so they do not miss critical issues buried under alerts and alarms more relevant to other personnel.

Highly performing plants will use those same collaboration software packages to make sharing information easy. To help personnel, industry will rely on platforms with robust machine journal tools to comprehensively log work recommendations and the history of previous actions. Technicians will attach photos, videos, notes, annotations, and more to create a living document of all the different problems a site or piece of equipment has experienced throughout its lifecycle.

The move toward a persona-based framework for such tools will enable better visibility through intuitive collaboration among users across a plant or enterprise. Collaboration can include tagging other personnel, so they receive real-time notifications of updates, work in progress, and any requests for expert support—or to identify issues in need of attention and to assign the proper person.

These platforms will feed into new digital transformation technologies used across the enterprise to centralize maintenance and help smaller crews serve a wider area without delay. Vendor-neutral connectivity to data lakes will make it easy for the content of a plant's live journal to be viewed, tracked, and trended from anywhere. Experienced technicians in a centralized maintenance center, or performing critical work at other plants, will be able to view comprehensive histories of all the plants in the enterprise, empowering them to monitor and assist less-experienced personnel working in those facilities.

When less-experienced technicians need more involved assistance, they can use holistic data management platforms for instant support. Advanced data management platforms will provide established workflows and instant access to manuals, video walkthroughs, knowledge bases, and more to rapidly upskill new and experienced personnel. The same tools will also use global positioning system (GPS) technology to help guide personnel to the right assets, and personnel can use geofencing software to avoid hazardous or off-limits areas.

When a plant requires a technician with more experience than the staff available on site, data management platforms connect personnel with more experienced technicians—internal or external to the organization—from anywhere in the world. Using augmented reality tools, these technicians can see exactly what an operator or technician is seeing in real time and assist using annotations directly overlaid on the user's screen.

Improving the view from above

Key performance analytics start at the plant level—where the processes, equipment, and systems reside and interact. But even plant-level analytics are driven by corporate initiatives. As these plant-level initiatives show ROI, many organizations will begin to expand their reach, performing analytics across plants on similar assets to gain visibility of higher-level trends.

In the past, getting plant data to enterprise systems required infrastructure—hardware, software, and a reliable backbone of network equipment—all of which needed a skilled information technology (IT) staff to manage. But today, many of the tools plants rely on to aggregate and contextualize machinery health data are either cloud ready or entirely cloud based.

Machinery health platforms will play a key role in the transition to cloud platforms, acting as translation packages to help make device data cloud ready. As industry continues to embrace the cloud for macro-level analytics, it will rely heavily on machinery health applications. These platforms will collect crucial data from sensors and export it via application programming interfaces and open protocols, such as OPC UA, to data repositories where it can be accessed by cloud systems.

Industry trends toward sending data straight to cloud applications—directly from the plant floor via an edge gateway or 4G router, for example—will enable plant teams to import critical data into analytics and support tools without the need for IT experts to support hardware and connectivity. The same cloud tools will also help connect to even the most remote assets, ensuring no equipment data is ever stranded.

Without having to invest in hardware and technology support, it is easy to start small with a pilot application of analytics because initial investments of both time and money are dramatically reduced. And when those pilot programs show success through fast ROI, they can easily be scaled up without having to change hardware. Moving to more robust, wide-ranging, and comprehensive analytics is as simple as changing the terms of the hosting agreement.

An integrated technology foundation

At every level of industry, personnel need high-quality, contextualized, mobile data to generate information and provide insight into the safety, performance, and health of operations and equipment (figure 3). As plants move toward fully automated and predictive maintenance, they need to generate information quickly and easily, and to deliver it to relevant personnel.

Successful long-term maintenance strategy depends on selecting technologies that are designed from the ground up for easy integration. These technologies deliver the richest data to the relevant personnel at the right time, while providing tools for users to work together efficiently and effectively. As those tools generate ROI, often quickly, they will be better positioned to scale with the plant and the enterprise, protecting the organization's investment over the lifecycle of its equipment. ■

All figures courtesy of Emerson

ABOUT THE AUTHORS

Drew Mackley has more than 25 years of experience in the predictive maintenance industry. He has worked with customers to establish and grow machinery health management programs in a variety of industries and locations around the world. He is currently working with customers and other industry professionals on incorporating best practices and modern technologies in their asset monitoring digital transformation journeys for efficiency, safety, and performance improvements. Mackley has a BS in electrical engineering from the University of Tennessee.

Shane Moser is a mechanical engineer from the University of Florida and has an MBA in marketing and business analytics from the Georgia Institute of Technology. He has been with Emerson for roughly four years and is currently the product manager for machinery health management software. Moser is driving innovation to align AMS Machine Works with Emerson's overall digital transformation direction.

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What You May Not Know About SoftPLCs

There are misconceptions about what SoftPLCs can and can't do.

By Steve Mustard, PE, Eur Ing, CAP, and Pascal Girerd

A SoftPLC is a software-based version of a programmable logic controller (PLC). The term SoftPLC has been used for many years, and like many technical terms, it means different things to different people.

IEC 61131-3 standard

For many years, the control systems market saw the proliferation of a variety of programming languages and development environments—different for each manufacturer. IEC 61131, the international standard for programmable controllers, was first published in 1992 (as IEC 1131). IEC 61131 standardizes programmable controller technology and covers equipment requirements, programming languages, user guidelines, communications, and functional safety.

The third part of IEC 61131 (IEC 61131-3) deals with the programming languages used in programmable controllers. The standard originally defined five programming languages:

- Ladder Diagram, based on the most common form of PLC programming language.
- Structured Text, similar to high-level information technology (IT) programming languages such as C or Pascal.
- Function Block Diagram, a graphical language where users connect blocks of functionality together to create a program.
- Sequential Function Diagram, another graphical language that allows finite state machine execution.
- Instruction List, another text-based language similar in style to assembly language. This is now deprecated in the standard.

The IEC 61131-3 standard defines a series of functions and data types that must be supported by all compliant programmable controllers. The functions are the basic building blocks of all programs and include arithmetic operations, Boolean logic, and programming structures such as loops, comparisons, and decisions.

SoftPLCs in Action

The growth of software's role in automation has increased the spread of SoftPLC solutions, according to a Seneca Automation Interfaces blog post (https://blog.seneca.it/en/the-softplc-concept). These software emulations of typical PLC functionality, which are based on PC-type architectures, are equipped with real-time operating systems, like Windows CE, RTAI, RTLinux, and QNX, and implement the IEC 61131-3 standard. The Sequential Function Chart (SFC) language is used as a tool for the design and description of control logic and the four other standard programming languages: Ladder Diagram (LD), Function Block Diagram (FBD), Structured Text (ST), and Instruction List (IL).

Associations such as PLCopen (www.plcopen.org) promote standards related to SoftPLC technology, their reuse, and interoperability with other systems—not only IEC 61131-3, but also libraries for motion control, remote control, integration with safety features, and interface management. Although the IEC 61131 standard is common to SoftPLC and PLCs, manufacturers of "traditional" PLCs still tend to interpret hardware constraints and programming environments according to "proprietary" visions. The portability of applications between different PLCs or SoftPLCs never has zero cost: Accurate I/O reconfiguration and machine cycle verification activities are required, according to the Seneca post.

Conversely, SoftPLC systems are characterized by a compact architecture with decentralized I/O, a high level of connectivity and interoperability, an ability to manage and store large amounts of data, an ability to operate in noncritical operating conditions, distributed architecture based on open hardware and common to other applications such as supervisory control and data acquisition and cloud, and easy software application transfer between different PCs (figure).

In an Automation.com article titled "RelaxC Controller Improves and Maintains Process Control," author John Masse, founder of APPEDGE, writes about a new type of controller, "The industrial controller RelaxC is an innovative and unique method of stochastic gradient descent on time evolving systems."

According to Masse, the "controller has been successfully tested on complex industrial plants. By its performance, RelaxC is a great alternative to advanced or classical control methods, such as predictive functional control, model predictive control, internal model control, LQG, LQR, and proportional-integral-derivative, which struggle or fail in the control of complex systems of the following types: nonlinear, with delay, with nonminimal phase, and with control constraints.

"With its small memory footprint, RelaxC can be easily encapsulated in engineering software, run times, and SoftPLC to the IEC 61131-3 standard with languages (ST, FBD, SFC, LD, and IL)." *—By Jack Smith*

Feature	Standard PLC	SoftPLC
CPU	Proprietary	Standard/dedicated/multicore
I/O	Centralized/distributed	Distributed on fieldbus
Data memory	MB	GB
Operating system	Proprietary	Standard/HRTOS: Unix, POSIX, VxWorks, Linux, QNX, RTXDOS, VRTX, Windows Embedded, .NET
Programming language	IEC 61131 (SFC, LD, FBD, ST, IL), C, C++	IEC 61131 (SFC, LD, FBD, ST, IL), C, C++, C#, VB, Java Text Editor, JSON-RPC, Node-Red
LAN protocols	Proprietary, TCP/IP	TCP/IP, OPC, CoAP, MQTT, Rest
Sensors/actuators protocols	Proprietary, fieldbus	Fieldbus, Ethernet, OPC

One view of how hardware-based PLCs and SoftPLCs compare

Courtesy of Seneca Automation Interfaces

Putting IEC 61131-3 into Perspective

Industry forums and presentations focused on digitalization usually mention that companies need to look at new business models. This is also the case for traditional industrial automation vendors. With open multivendor interoperable standards, automation companies still need to be able to compete on traditional dimensions including quality, reliability, customer service, and value.

Bill Lydon, *InTech* and Automation.com contributing editor and director, North America, for the PLCopen organization, moderated an insightful roundtable discussion on "Automation Industry Expert Insights: CODESYS Tech Talk Fall 2021" (www.automation.com/en-US/Articles/October-2021/Automation-Industry-Expert-Insights-CODESYS-2021). It covered industrial automation future trends and challenges with industry leaders and innovators. Roundtable participant Don Bartusiak, president of Collaborative Systems Integration, said, "A challenge for end users is to be bold enough to go after step change improvements in productivity and step change reductions in total cost of ownership of systems by pursuing open architecture system concepts and open process automation ideas." Bartusiak is a champion of open automation systems, instrumental in the development of the Open Process Automation System standards.

On Automation.com, Lydon also wrote "The Missing 'Industry 4.0/Digitalization' Link—Open Programming Standard Conformance & Certification" (www.automation.com/en-US/Articles/May-2020/Missing-Digitalization-Link-Open-Program-Standards). The fundamentals of IEC 61131-3 have been adopted by many kinds of automation vendors throughout the world. IEC 61131-3 is supported by the PLCopen organization that extends the standard with special interest groups, standards, and certifications. These standards and certifications include motion control, safety, OPC UA, XML interchange, and reusability. Due to the task structure of a full IEC 61131 implementation, both event-driven and cyclical approaches can be accomplished. There have been significant enhancements to IEC 61131 by the PLCopen organization, including OPC UA for enterprise communications, remote procedure calls, and controller-to-controller standardized data communication models.

Compliance and conformance are essential

Regardless of the programming standard, according to Lydon, there must be strong vendor compliance and certification of products to effectively ensure program portability and multivendor interoperability. This has been an ongoing issue in the industrial and process automation industry. The lack of vendor full conformance and certification to open programming standards creates tremendous inefficiencies and architectural challenges that lead to isolated "islands" of control. Integrating these islands into an entire plant architecture requires a great deal of application engineering, extra hardware, and more software to build a coordinated plant automation and control system. The added layers of interfaces cause lower reliability, increased production downtime, and potentially higher costs. *—By Jack Smith*

One of the outcomes of IEC 61131 adoption was the recognition that the software and hardware elements of programmable controllers could be considered separately. This in turn created the SoftPLC concept.

SoftPLC characteristics

A SoftPLC combines the functions of conventional PLCs with those of data loggers, communications gateways, and other elements such as human-machine interfaces (HMIs) and web servers. In the early days of SoftPLCs, it was common to use industrial PC hardware as the platform. This approach is one reason there are many misconceptions about what SoftPLCs can and cannot do, including:

- *Nondeterministic operation:* Early industrial PC hardware tended to run the Microsoft Windows operating systems. Because these are nondeterministic, many people decided a SoftPLC could never be used in place of a conventional PLC.
- *Reliability and ruggedness:* The experience of Windows operating system reliability, combined with the potential lesser environmental specification of the PC hardware, led many to discount this solution for industrial applications.
- *Security:* Once industrial control system security became an issue, the maintenance of obsolete operating systems, such as Windows NT on SoftPLC hardware, was a potentially limiting factor.

However, there are many flavors of PC hardware and operating systems that can be a SoftPLC platform. Real-time operating systems such as RTLinux, QNX, RTAI, Intime, FreeRTOS, and VXWorks provide the fault-tolerant, deterministic behavior expected in a conventional PLC.

Many PLCs that users believe to be conventional are in fact built on SoftPLC technology. The principal business model for SoftPLCs is based on original equipment manufacturers (OEMs) porting the SoftPLC run time to their platforms and seamlessly integrating it into their wider configuration and monitoring ecosystems.

Reasons to use SoftPLCs

Although there are some misconceptions, there are many more potential benefits of SoftPLC technology—some that relate to the OEM and some to the end user:

- *Time to market:* OEMs can develop their applications and select or design their hardware systems in parallel, and finally port the SoftPLC run time quickly and easily.
- *Versatility:* The same SoftPLC application can be ported to different hardware and operating system combinations. This means users can potentially develop and maintain a common application (or at least a library of common functions) that can run in different environments if needed.
- *Upgradability:* The abstraction of software and hardware makes it easier for the OEM to update the hardware and operating system while maintaining backward compatibility on software and applications.
- *Standardization:* Following IEC 61131-3 simplifies user training and supports greater consistency in application development, which in turn helps reduce ongoing maintenance costs. Even if a user changes a SoftPLC solution, using IEC 61131-3–compliant application code can greatly reduce the cost of migration. This also applies to communications protocols (such as IEC 61850, DNP3), which are often integrated into SoftPLC solutions.
- *Product differentiation:* Many SoftPLC solutions have functionality besides the IEC 61131-3 standard. Examples include support for industrial protocols, built-in redundancy, and distributed operation capabilities.

Security and safety concerns

Security and safety will always be major concerns with any automation system component. It is possible to develop a resilient, secure, and safe solution using SoftPLC technology, and many OEMs have done just that. When the OEM has all the source code, everything is under its control.

An advantage of SoftPLC solutions is hardware and operating system choices can be made independently, based on security and safety requirements.

Some SoftPLC solutions have even developed run times that OEMs can integrate into systems targeted for IEC 61508 certification. They do this by reducing the feature set, removing functions that can create safety hazards, and developing the run time itself using approved methods.

Final thoughts

Much has changed in the 30 years since the inception of IEC 61131-3, and many popular "conventional" PLCs are running on SoftPLC technology. As with any solution choice, the requirements should drive the answer, but SoftPLC-based approaches should be included in any consideration. ■

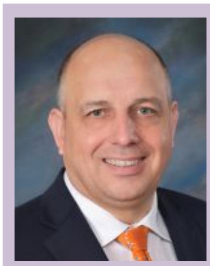
SCADA Needs Open Standards Too

Standards are not meant to eliminate thinking and stifle creativity. If used properly, standards create a common language and a systematic approach to solving problems using industry-wide best practices. They encourage communication and foster creativity in solving engineering problems.

A supervisory control and data acquisition (SCADA) system should be based on open standards, which promote interoperability and make integration, scalability, and collaboration much easier, writes Don Pearson, chief strategy officer at Inductive Automation, in an Automation.com ebook article titled "Must-Have SCADA Features for the Modern Era." Open standards are vendor neutral by definition, offering an alternative to a single vendor's proprietary technology, which often prohibits mixing and matching pieces of software or hardware.

Open standards poise a system for moving into the future by allowing organizations to choose best-of-breed technologies instead of being locked into a specific vendor's ecosystem, according to Pearson. *—By Jack Smith*

ABOUT THE AUTHORS



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Pascal Girerd is business developer at Straton Automation, which provides a software-based PLC with many benefits to industries like utilities and embedded automation.

RESOURCES

"Manure Spreading Goes High-Tech with IIoT"
www.automation.com/en-US/Articles/August-2021/Manure-Spreading-Goes-High-Tech-IIoT

"PLCopen and OPC Foundation release new edition of PLCopen OPC UA Client for IEC 61131-3"
www.automation.com/en-us/articles/2016-2/plcopen-and-opc-foundation-release-new-edition-of

"Tension in Industrial Automation: Open Systems and the User's Dilemma"
www.automation.com/en-US/Articles/2019/tension-in-industrial-automation-open-systems-and

ISA Process Industry Virtual Conference Highlights Open Process Automation

"In the past few years, open process automation and industry initiatives have focused on open modular, interoperable, and portable solutions," said Bridget Fitzpatrick, process automation authority for Wood Applied Intelligence, during her keynote speech at the ISA Process Industry Virtual Conference (PIC) held 2 November 2021. The level and pace of competition in the process industries highlights the need for better solutions, she added.

Fitzpatrick, who has more than 30 years of experience in process engineering, is an ISA Fellow who has been active in the association since the 1990s. In her keynote called "Future Ready Now: Developing, Adopting, and Managing New Technology," she discussed how process automation has developed over the years.

"I'm suggesting we set our redesign sights back on the drawing board and create engineering solutions that best support the underlying functional requirements," Fitzpatrick explained. "The companies that embrace the possibilities of these new platforms will be future-ready and potentially the most successful."

Fitzpatrick said becoming future-ready involves different opportunities for each segment of the industry:

- For vendors, embrace the opportunity to refine and use intellectual property to help better manage commercial and custom client technology.
- For operating companies, it is an opportunity to step back and redesign systems to leverage technology rather than perpetuate the existing controls.
- If open source hardware is used, when you next need new hardware, you can port your IP to the new platform and not have to rebuild.
- There will be some control design evolution, but it will be driven by performance improvement rather than by obsolescence.

In summary, Fitzpatrick highlighted four major focuses of future-ready now initiatives: leverage technology, including open systems; customize when you need to; standardize where it makes sense and figure out the best method for common unit operations; and enable the operator to agilely respond to opportunities.

The virtual PIC event (https://virtualpic.vfairs.com) also included sessions on the best practices for automation project management, digitalization of functional safety, and a variety of technology demonstrations. ■ *–By Melissa Landon*

In Memoriam: Thomas Leigh Phinney

Thomas Leigh Phinney—instrumental in the formation of the ISA100.11a wireless standard, IEC 62734, and the local area network standards IEEE 802.11 and IEEE 802.4—passed away 2 December 2021. In addition to his contributions to industrial process control systems and network system standards, including the first one for Wi-Fi, much of Phinney's work before and after retirement centered on cybersecurity for wireless automation networks, including communications encryption for utilities, iris recognition for airports, and federally funded projects concerning U.S. security issues, especially after 9/11.

Phinney graduated from the University of Notre Dame with a BS in mathematics and worked for GE/GE Process on automation system architecture and software design. He also worked at Honeywell Process Solutions, where he was the company's first Senior Principal Engineering Fellow.

He founded Concord Data Systems, which developed early modems, and Concord Communications. He sold the business in 1989, using the proceeds to purchase a much-enjoyed summer home on the Oregon coast. He then reconnected with Honeywell, this time with Honeywell-Europe's Brussels office, working with Shell International at The Hague and with the European MAP Users Group. Additional Honeywell assignments followed in the U.S., with projects that included working on ISA's SP50 fieldbus standards committee.

"His knowledge, integrity, and professionalism set a great example for me," says Penny Chen, senior principal technology strategist, Yokogawa U.S. Technology Center. "Tom was a true inspiration, not just for work but for his life. He was learning ballet and Chinese after retirement. He was a very open-minded person and willing to try different things."

Phinney was an avid patron of, and contributor to, the performing arts scene. He enjoyed classical music, performed ballet in Arizona productions, and was on the board of various related organizations. He has said he was "a significant supporter of early music programs and education at Arizona State University, for which [he] commissioned and contributed two clavichords to early music pedagogy and performance." He also endowed the Oregon Bach Festival keyboard chair—he and his family enjoyed the event every summer. ■ *–By Lynn DeRocco*

Meet 2021 ISA Fellow Jagan Mohan Reddy Yeturu

Jagan Mohan Reddy Yeturu, CAP, has 25 years of experience in architecture and system engineering, instrumentation, and control systems technology development. He developed a system that uses machine learning and artificial intelligence at edge devices to predict failures of high-pressure gas skids. The system uses vibration, pressure, and position to learn a failure model. The model is then deployed across multiple sites and employs course correction based on the predictions versus the actual results. The system reduces the cost of downtime and repairs for natural gas suppliers.

Yeturu also conceptualized, designed, and implemented the integrated control and safety system for a Qatar-based gas processing greenfield project with more than 60 OPC integrations to the distributed control system. This was a unique experiment to replace traditional systems with OPC DA, AE, and HDA.

Other projects included conceptualizing and designing docker technology for control systems, in which control execution is performed as a container in the hardware to make the software agnostic to the underlying software. Further, he designed, developed, and implemented a first-of-its-kind Foundation Fieldbus–based control system for biomass-based power plant applications. As a member of the Fieldbus Foundation Committee, he has trained hundreds of project and support engineers in these technologies.

Yeturu became a Certified Automation Professional early on and was one of the few initial members from India to pass the exam. "I renewed thrice, which is a measure of my continuity toward its usefulness, and became a mentor to others taking this exam, to get certified to improve their prospects in employment in the profession," he says.

For more than 10 years, he has served ISA District 14 in various capacities and contributed to the growth of the Society by enrolling people and conducting events. He has also been a member of the ISA100 group from its inception, actively implementing and incubating WCI scripts to test device compliance for proper operation and interoperability.

Yeturu coauthored *Foundation Fieldbus* with other ISA Fellows and implemented Foundation Fieldbus (FF) at Reliance Jamnagar, the largest FF implementation in India for the oil and gas domain. He is a member of the board of studies of more than five colleges and on the senate of three universities to encourage more students to adopt instrumentation, control, and automation as a profession. He implemented an integrated control systems lab for industrial and building systems using digital protocols, such as Foundation Fieldbus and BACnet, at the International Institute of Information Technology in Bangalore, India, to enable thousands of students to train and become industry-ready professionals.

Additionally, Yeturu wrote a book on instrumentation and control for Indian students. It is used as a textbook in more than 100 colleges in India. He also coauthored the reference book *Industrial Process Automation and Design*. He has numerous patents and has been published in scores of peer-reviewed, internationally renowned journals.

Yeturu is currently a senior engineering manager of Honeywell Technology Solutions Labs, and his current projects include research on vision- and voice-based soft sensors with artificial intelligence.

Find out about other ISA Fellows and other 2021 award winners at www.isa.org/members-corner/isa-honors-and-awards.

■ *–By Lynn DeRocco*

ISA President Mandolesi Discusses "Key Results" Goals for 2022

In his first blog post as ISA president (https://blog.isa.org/the-future-of-isa-is-now), Carlos Mandolesi urged ISA members to "remember the components of our strategy that includes our vision, mission, and values. We need to live our strategy, and all of our members and volunteers, from the sections and divisions to our staff, need to take them into consideration in all that we do."

ISA's vision is to create a better world through automation. ISA's mission is to advance technical competence by connecting the automation community to achieve operational excellence.

During the last month of 2021, Mandolesi said the executive board reviewed ISA's strategy, defined its objectives, and "introduced the concept of key results that will allow us to measure our progress." The key results all members should be focused on during 2022 are: grow our professional membership by 2 percent, increase ISA's audience in specific target segments by 5 percent, increase ISA's non-U.S. audience in specific target segments by 10 percent, increase total training attendees by 5 percent, increase non-U.S. training participation by 2 percent, increase certificates and certifications by 5 percent, improve Leader Satisfaction Score by 2 percent.

Connect with Carlos Mandolesi on ISAConnect, LinkedIn (https://www.linkedin.com/in/mandolesi), or via email (president@isa.org). ■

ISA Safety Committees Advance into New Year with New Initiatives

ISA's primary safety standards committees, ISA18 and ISA84, are launching several new projects this year in addition to wrapping up some key ongoing projects. Here is brief rundown of these efforts.

ISA18, Instrument Signals and Alarms

An ISA18 working group led by Bridget Fitzpatrick of Wood has begun work on an update of ISA-18.1, *Annunciator Sequences and Specifications*. The purpose of the standard is to establish uniform annunciator terminology, sequence designations, and sequence presentation—and to assist in the preparation of annunciator specifications and documentation. The standard is intended to improve communications among those that specify, distribute, manufacture, or use annunciators. Primary usage is intended for electrical annunciators that use individual illuminated visual displays and audible devices to call attention to abnormal process conditions. Annunciators covered range from a single annunciator cabinet to complex annunciator systems with many lamp cabinets and remote logic cabinets.

Beyond the update of ISA-18.1, much of the work of ISA18 pertains to support and education for applying ANSI/ISA-18.2, *Management of Alarm Systems for the Process Industries*. The standard has found wide use and success in improving the development, design, installation, and management of alarm systems across the global process industry sectors. The ISA18 committee plans to begin working on a new revision of ISA-18.2 later this year.

At the same time, a new technical report, being developed under the leadership of Dale Reed of Rockwell Automation, focuses on alerts, events, prompts, and other notifications. The intent is to help users manage the notifications between control systems and operators that are not alarms, and other notifications not intended for operators. The technical report is expected to be completed in late 2022.

Among other activities, ISA18 is planning to establish a new working group on the digitalization of alarm management activities. The scope of the work, still being developed, may include topics ranging from digital design to artificial intelligence for improved alarm system performance.

ISA84, Instrumented Systems to Achieve Functional Safety in the Process Industries

ISA84 is also in the process of setting up a working group on digitalization, with plans to develop a technical report with the tentative title *Guidance on the Use of Digital Information Management Needed to Effectively Manage Functional Safety*. The technical report is expected to address how digital technologies can be applied during each phase of the functional safety lifecycle, with a focus on the associated benefits. It will identify how digital technologies can be used to facilitate timely collection, analysis, and visualization of functional safety information.

The main focus of ISA84 continues to be its ongoing work in developing and updating a comprehensive set of technical reports that give guidance and practical examples for applying the widely used ISA/IEC 61511-2018 standards, *Functional Safety – Safety Instrumented Systems for the Process Industry Sector, Parts* 1–3. These ISA/IEC standards, the first version of which was completed by ISA84 in 1996, set forth requirements for the specification, design, installation, operation, and maintenance of a safety instrumented system so that it can be entrusted to achieve or maintain a safe state of a process. Among these activities:

- Work continues on updating ISA-TR84.00.05, *Guidance on the Identification of Safety Instrumented Functions (SIF) in Burner Management Systems (BMS)*. Focus is on providing BMS-specific guidance/clarity to all phases of the safety lifecycle, updating unit operation examples based upon the latest governing standards/practice, and incorporating end-user feedback as appropriate.
- An update is underway of ISA-TR84.00.07-2018, *Guidance on the Evaluation of Fire, Combustible Gas and Toxic Gas System Effectiveness*, which addresses detection and mitigation of fire, combustible gas, and toxic gas hazards in process areas.
- Work continues on updating ISA-TR84.00.09-2017, *Cybersecurity Related to the Functional Safety Lifecycle*, which provides guidance on integrating the cybersecurity lifecycle with the safety lifecycle as they relate to safety controls, alarms, and interlocks, inclusive of safety instrumented systems.
- A revision of ISA-TR84.00.02, *Safety Integrity Level (SIL) Verification of Safety Instrumented Functions*, is complete and expected to be published in February 2022. Angela Summers of SIS-Tech led the work on this document, which is a tutorial on the fundamentals of data selection and the reliability calculations.

ISA standards participation is open to all interested parties, and experts from any country are welcome to join any ISA standards committee. For more information, contact Charley Robinson, ISA Standards, crobinson@isa.org.

All ISA standards and technical reports, including those developed by the ISA18 and ISA84 committees, may be accessed at www.isa.org/findstandards. ■

Sample of Jobs Available at Jobs.isa.org

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

Data engineer

Expedia: The engineer, located in Seattle, will apply knowledge of software design principles, data structures, and computer science fundamentals to write code that is clean, maintainable, optimized, and modular. He or she will also develop expertise in the performance marketing domain and associated data structures; use a whole systems approach to analyzing issues by identifying and accounting for all components; and recommend advancements, innovations, and changes in technologies (specifically relating to data engineering, cloud data platforms, data models, business intelligence, and data science). The position requires five to seven years of experience in data engineering with two or more years mentoring team members, a master's degree in a technical field, and very strong Python, Spark or PySpark, and SQL skills . . . see more at Jobs.isa.org.

Control systems lead

CBRE: The successful candidate for this position in Lewisberry, Pa., will lead a team of service technicians to maintain, troubleshoot, and modify material handling controls systems equipment to ensure optimal operational performance. Responsibilities include promoting a safe working environment, troubleshooting and modifying software programs for material handling control systems, and acting as first-level escalation support for the control system technician teams. Basics qualifications include an associate's degree with a focus on electronic technology and five or more years of experience with motor controls, human-machine interface components, programmable logic controllers, and robotics system components. Preferred qualifications include a BS in electrical engineering and four or more years of experience in the electrical fields or control systems development, troubleshooting, and programming . . . see more at Jobs.isa.org.

Process control engineer

Darling Ingredients: The engineer is responsible for installing electrical hardware or software, assisting in the layout design, troubleshooting electrical components, programming and installing programmable logic controllers, and helping develop a program to keep electrical schematics updated. Note that the job location for this position is flexible due to the amount of travel. Minimum requirements include at least five years of experience in the controls and automation field and demonstrable experience in industrial environments. Preferred qualifications include a BS in engineering, experience with Rockwell Automation PLC/SCADA, and leadership ability . . . see more at Jobs.isa.org.

Senior mechanical engineer

Fly Pig Designs: The company in Broomfield, Colo., seeks a self-motivated engineer who has excellent oral and written communication skills and can develop user-centric, clean, and efficient designs with minimal supervision. The position requires a BSc in mechanical engineering and seven or more years of relevant experience. . . see more at Jobs.isa.org.

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Control Remains Fundamental

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.

While new digitalization tools, including cloud computing, big data, and analytics, provide great value, fundamental control application engineering remains the bedrock of industrial and process manufacturing. Sound control has always been the workhorse of production, with application engineers applying appropriate methods as new technologies become available, progressing from the early days of mechanical and pneumatic methods to the electronic and digital methods emerging today. The latest technologies are expanding control and automation implementation options at an incredibly fast rate, so it is important to understand how these new tools can be a benefit in achieving goals.

Automation professionals need to take the lead in guiding management to adopt new technology, or the organization will become noncompetitive. A challenge is balancing your time between addressing today's problems with evaluating new methods and technology to improve production. As the rate of change continues to increase, taking advantage of ISA offerings is a wonderful way to continually increase knowledge and know-how. Key resources include:

ISAConnect. A continuing stream of information from online communities and resources within communities for each section, student section, division, and Society committee.

Certification Programs. ISA certification programs include Certified Automation Professional (CAP) and Certified Control Systems Technician (CCST). Earning ISA certifications demonstrates your mastery of working with a standardized body of automation knowledge; it showcases your automation proficiency to employers and helps you stand out among your peers.

Certificate Programs. ISA certificate programs increase knowledge and skills across a broad range of topics, including cybersecurity, safety instrumented systems, and automation project management. Certificate programs are based on industry-developed, job-performance criteria and IEC-adopted standards:

- Automation Project Management Specialist
- Cybersecurity
- Safety
- CAP Associate
- CST Associate.

Control Systems Engineer (CSE) License Program Support. ISA supports the CSE license, a specialized Professional Engineering (PE) license recognized in the U.S. for engineers working in automation and control. ISA offers training courses and review materials to help engineers prepare for state boards' exams held each October.

Events. ISA offers virtual events, including webinars, virtual conferences, and ISAConnect Live across a variety of topics. Virtual conferences give attendees insight into key operational and business topics through online sessions, panels with live Q&A, and virtual exhibits, as well as providing networking and chat opportunities.

Smart Manufacturing and IIoT Division

Sixteen topic-focused divisions within ISA enable members to connect on the topics they are most interested in and to grow professionally and technically. The Smart Manufacturing and IIoT Division (also known as SMIIoT) is the newest and fastest growing ISA division. ISA's understanding and focus on smart manufacturing, Industry 4.0, and Industrial Internet of Things (IIoT) is continually evolving to adapt to the high level of activity and interest being shown in the worldwide industrial automation community. Constant developments of new technologies, new applications, and new concepts from most of the major hardware manufacturers, solution providers, businesses, research institutions, and even governmental agencies are pushing these topics ahead at a rapid pace. ISA and SMIIoT are a forum for networking and collaboration on these topics as automation professionals seek clarity around the newest digitalization tools and better ways to solve critical control problems.

Explore the possibilities at www.isa.org. ■

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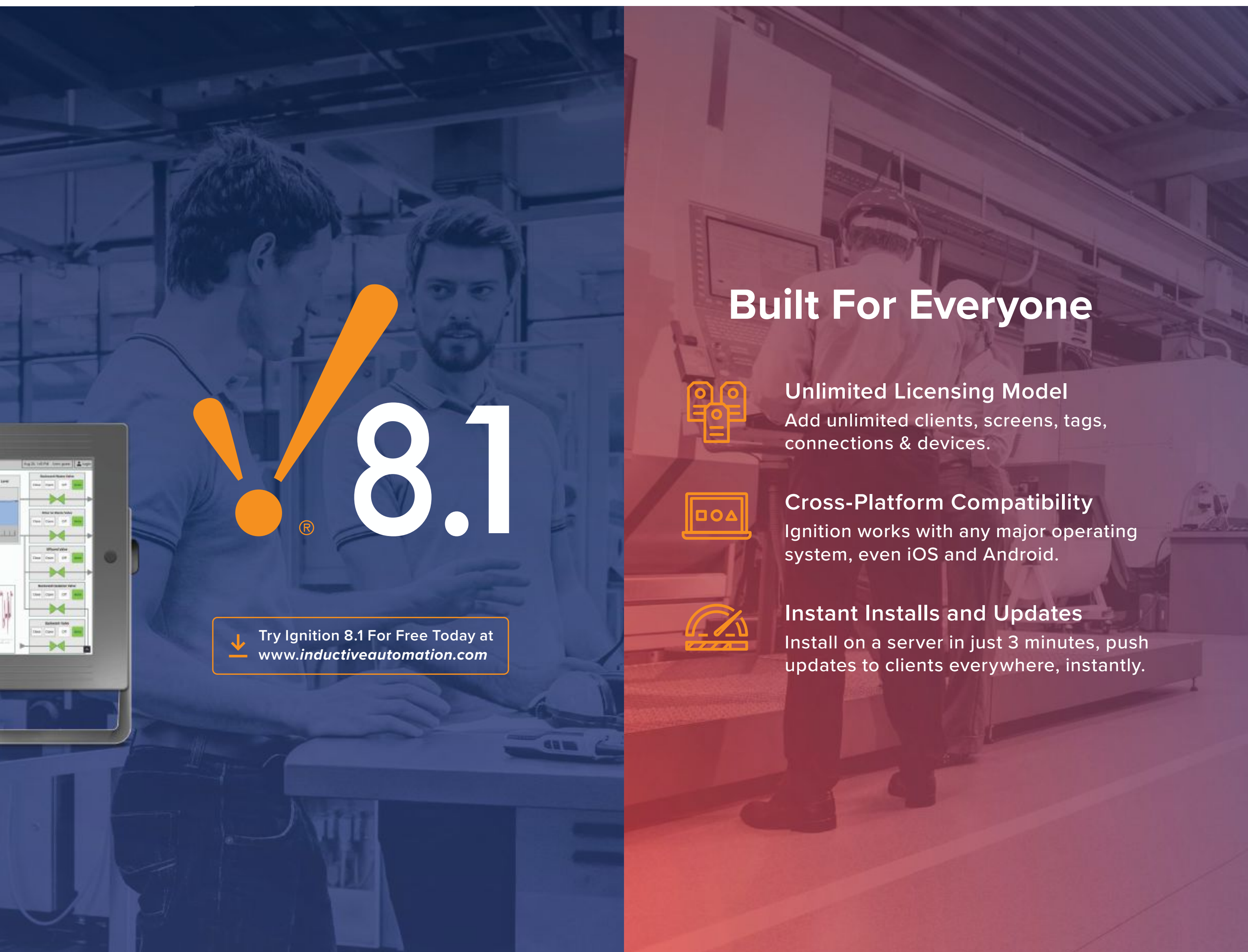
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