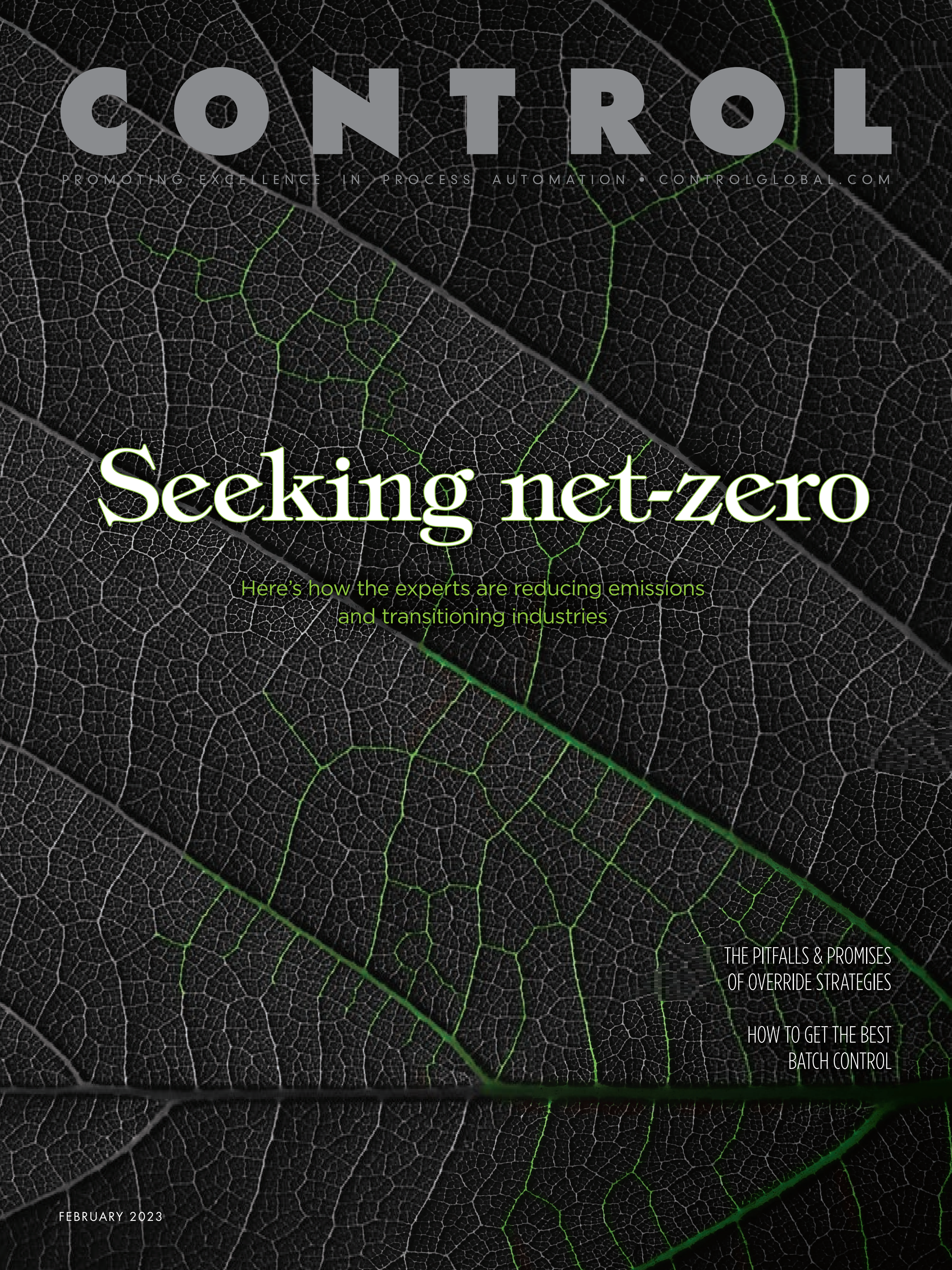

CONTROL

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Seeking net-zero

Here's how the experts are reducing emissions and transitioning industries

THE PITFALLS & PROMISES OF OVERRIDE STRATEGIES

HOW TO GET THE BEST BATCH CONTROL

FEBRUARY 2023


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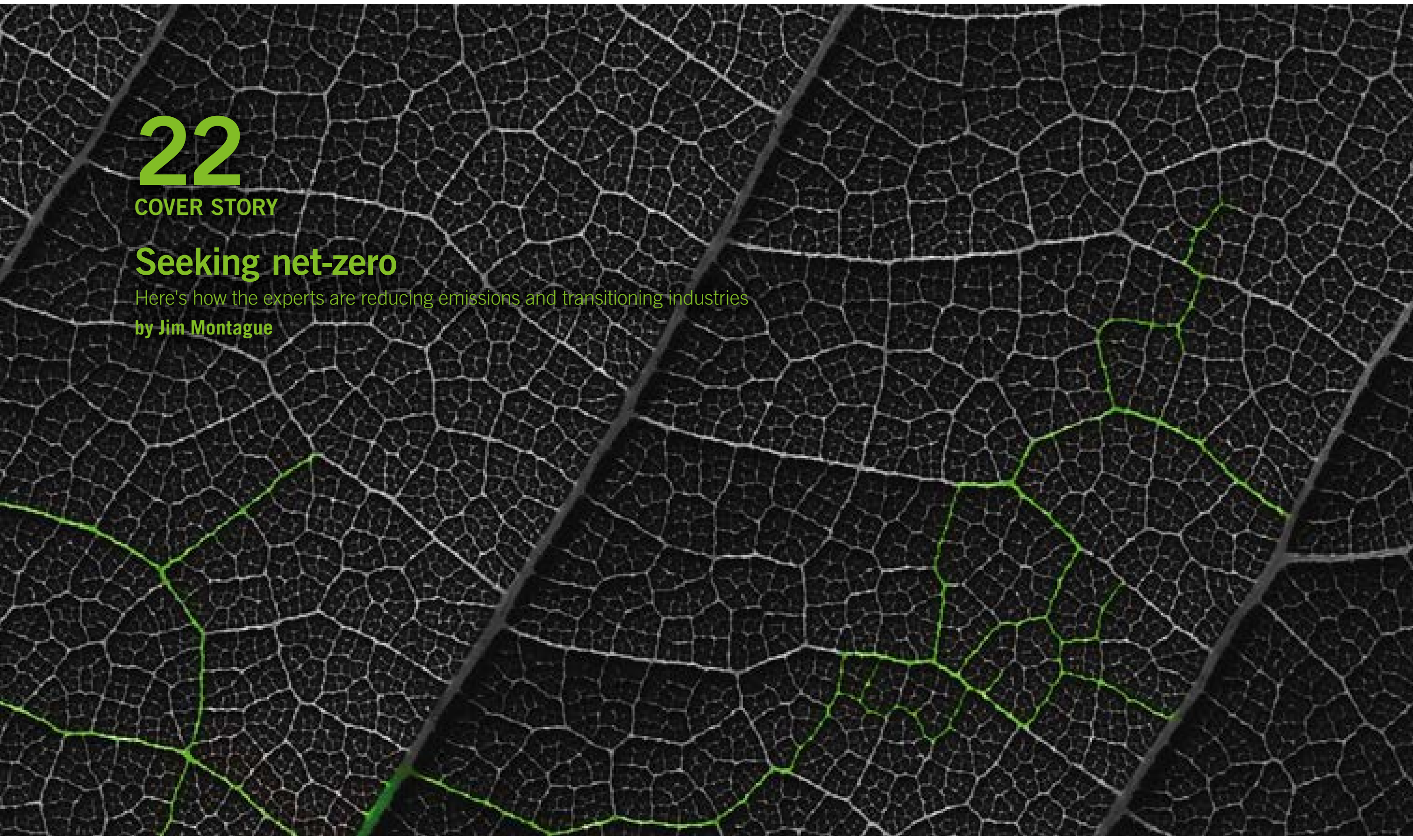
CONTROL



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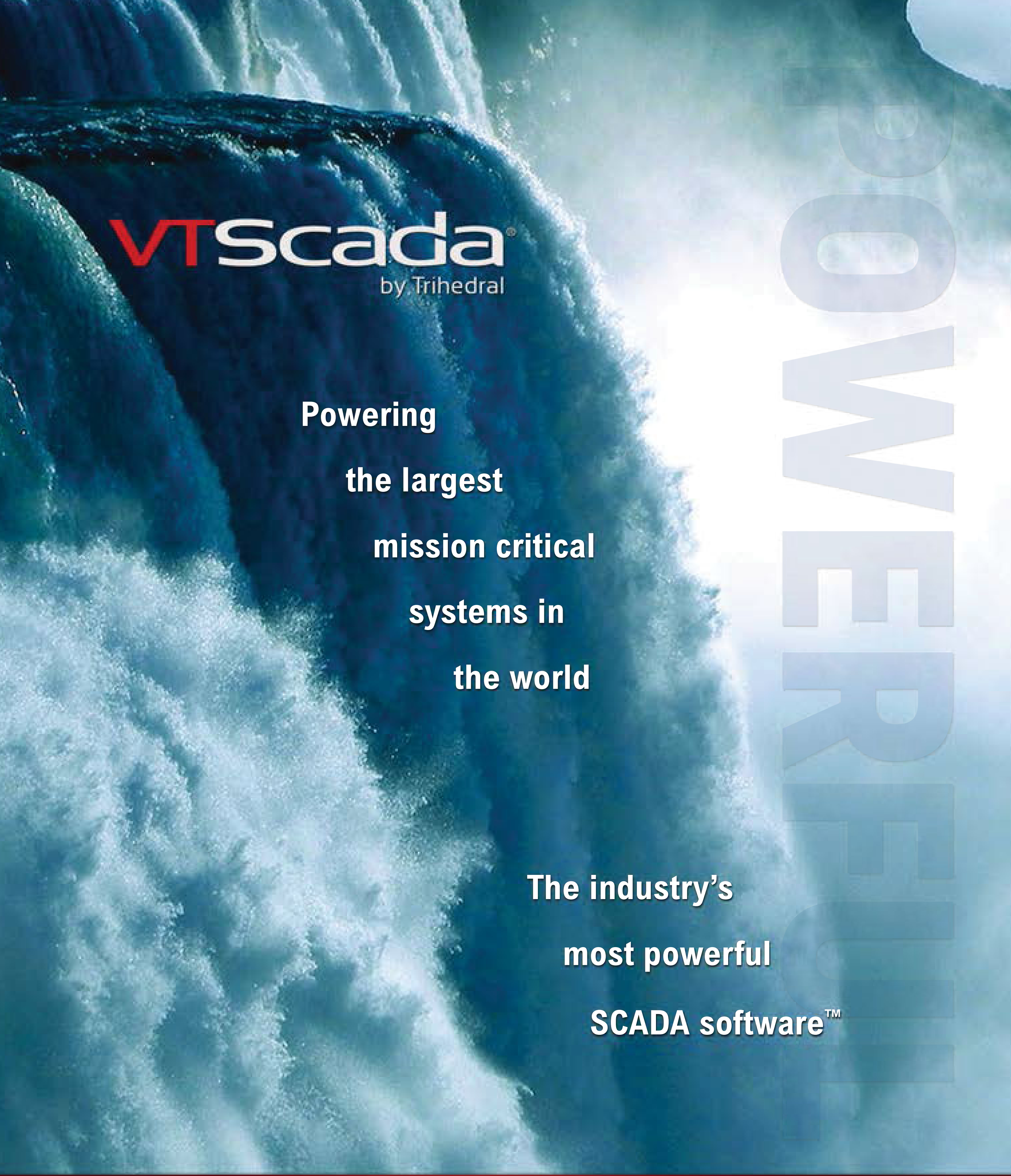
CONTENTS

Departments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No mystery here

Why industry's technology evolution should have no end in sight.

LEN VERMILLION
Editor-in-Chief
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"Manufacturers' necessity is two-fold: Productivity, for one, and safety, for another."

THERE'S nothing mysterious about the continual need for innovation. Inventions of many types have made life simpler, safer, and sometimes just more fun for people throughout the ages. But where do the seeds of these life-changing ideas begin? The old-adage, "Necessity is the mother of invention" says it all, right?

Many great minds have driven that point home with their own takes on necessity and invention. Aristotle, Twain, Einstein, each had their colloquial ways of verifying it. And speaking of mysteries, author Agatha Christie even weighed in, offering up a slightly different motive. "Invention, in my opinion, arises directly from idleness, possibly also from laziness—to save oneself trouble," she wrote.

Modern manufacturers are certainly not lazy, but they wouldn't mind saving themselves some trouble. Their necessity is two-fold: productivity, for one, and safety, for another. And there's no mystery as to how those two needs will be satisfied—technology. Specifically, automation technology will continue to evolve to help ease the pains of plant processes and factory floors. It will also continue to help improve worker safety by removing much of the danger manual laborers face. It will have a "greater focus on flexibility, scalability, and process adaptability, becoming a tool to optimize efficiency through manufacturers' ability to adapt to demands," says Alan Duncan, senior industry strategy director at Blue Yonder, a supply chain management company.

Duncan's thoughts on the need for continued technology innovation, as well as those from Stewart Beer, site manager at enclosures and cable management manufacturer Electrix International, can be found in the article, "Why manufacturing's technology evolution must never end," which can be found at https://bit.ly/3WUgvxV.

The article points out that the Association for Advancing Automation revealed data that showed 1Q22 saw 11,595 robots sold. This provided a huge increase in percentage sold compared to both the previous quarter and the quarter with the best figures. Meanwhile, manufacturing output grew in the same timeframe, and industrial leaders are examining the data to analyze any correlation.

Emphasis on using automation to eliminate higher risks has been made within the industry, the article points out. "Some processes are naturally more dangerous, either due to the machinery or work involved, but if this can be reduced, it can help save lives," points out Beer, the article's author.

One mystery solved: industry will always need new technology innovation to keep up with productivity and safety demands. ∞

Operations managers: net-zero secret weapons

IF an industrial company is serious about executing its climate pledges, it must put the ball in the hands of its operations managers, according to a survey of 300 operations managers in industrial sectors across the U.K., U.S. and Germany by ESG software, data and consulting firm Sphera (sphera.com).

Many respondents to the survey, which is part of a report titled, "Operational landscape: the inside view of industrial decarbonization from operations managers," argue that responsibility for net zero is too heavily concentrated at the top of their organization. In fact, 95% report that accountability for net zero lies solely with C-suite executives and the board of directors. Meanwhile, 42% of operations managers receive little or no encouragement to contribute suggestions on improving the environmental sustainability of business operations.

However, the report finds a growing desire among mid-level employees to share responsibility for climate change goals, with 40% of operations managers calling for carbon targets to be included in their performance reviews.

"With high levels of personal and professional commitment to sustainability, operations managers have emerged as the secret weapon for businesses in the fight for more sustainable operations. Yet, many companies are experiencing a gap between carbon pledges and operational practices because of limited involvement by operations managers," says Paul Marushka, Sphera's CEO and president. "Our report finds that operations managers have the influence and desire to help drive decarbonization efforts across business operations, as well as supplier and partner networks. Now, what they need are the data, software and best practices to do so."

While companies may need to better empower their operations managers, many are still trying to establish climate goals. The survey also found that 40% of industrial companies now have a public, net-zero strategy, while 43% have allotted more than 20% of their extra budgets to sustainability and net-zero initiatives, indicating an increasingly widespread commitment to climate action at the board level.

But, they're having trouble executing on their promises. The report found that 85% of companies now have net-zero strategies, but the majority are failing to incorporate them into daily business operations. Only 41% of operations managers have seen sustainability strategies produce significant changes in daily practices, and 32% say their firms don't align with science-based emissions targets.

Marushka points out that transparent tracking of decarbonization results is the missing link between business net-zero pledges and practices that lead to progress, with operations managers consistently calling for more frequent measurement of progress towards decarbonization at every level.

"Throughout the report, transparent results emerge as essential to building the trust and confidence of employees and customers in corporate climate change pledges,' he says.

Respondents to the survey indicated the key to net-zero success is to treat emissions reduction targets like financial targets, which are included in everything from quarterly reviews to employee KPIs. "Existing technologies and content, such as data analytics and AI, already enable companies to rapidly record and reduce their carbon footprint," adds Marushka.

The report also discovered that 73% of companies are already actively exploring or addressing the challenge of Scope 3 emissions, while 43% percent of operations managers are already discussing sustainability issues with their suppliers and partners.

Meanwhile, 22% of operations managers say regulations are still the main driver of business attention to sustainability initiatives. However, only 40% of operations managers rate employee engagement with their organization's sustainability strategy very highly. ∞

Why instrumentation purchases should require FDI device packages

It's crucial to ensure multi-vendor interoperability between controllers and instruments

COMPANIES are experiencing genuine advances in the boardroom, control room and the field derived from successfully deployed digitalization strategies. To help implementers achieve success, it's crucial to ensure multi-vendor interoperability between controllers and instruments, and also across control systems.

FieldComm Group doesn't sell anything to end users, but instead operates as a non-profit standards organization that owns and manages the development of digital technology standards, including Ethernet-APL, HART, HART-IP, WirelessHART, Foundation Fieldbus, FDI and PA-DIM. FieldComm Group maintains a vested interest in keeping end users aware of these technologies and the benefits they enable, when incorporated into products developed by our worldwide member companies, numbering more than 400.

Since 2002, FieldComm Group has annually designated an end-user facility as "Plant of the Year," illustrating effective digitalization efforts. This award is given to a site making excellent use of FieldComm technology. For example, Wanhau Chemical Group in Yantai, China—the 2022 winner and first ever recipient in that nation—boasts an impressive 180,000 HART, Foundation Fieldbus, and WirelessHART instruments deployed facility wide, and almost all are monitored via an asset management system. To manage these instruments, the company implemented remote configuration, commissioning, device health monitoring, and condition-based maintenance, saving tens of millions of dollars and avoiding over 40 potential shutdowns since 2017.

Promoting the FDI standard

HART and Foundation Fieldbus demonstrably provide tremendous operational efficiency improvements for process facilities when deployed with continuous, digital data transmission among instruments, asset management systems, and Industrial Internet of Things (IIoT) platforms. But this article will focus on the importance of the Field Device Integration (FDI) standard.

This standard defines a common set of software components for incorporation into systems and instruments, which improve the tasks of configuring, commissioning, operating, monitoring and maintaining field devices throughout multi-vendor installations. Finalized in 2015, many host systems and instruments from FieldComm Group-member companies now support the FDI standard.

Emerson's AMS Device Manager, V14.5, was the first FDI-registered host, while ABB's Ability Field Information Manager, Siemens Simatic PDM, Honeywell's Field Device Manager (FDM) and, most recently, PACTware 6.1 also support FDI.

On the instrumentation side, major suppliers, including ABB, Emerson, Endress+Hauser, Honeywell, Schneider Electric, Siemens, Yokogawa and many others, all offer FDI Device Packages for many of their instruments. A complete list of instruments with registered FDI Device Packages can be found at go.fieldcommgroup.org/fdi-packages.

Stated directly: if you're an end user, a systems integrator (SI) or an engineering, procurement and construction (EPC) firm, you need to urge instrument suppliers to provide FDI Device Packages with their instruments. There are few reasons to prioritize this push, but first a bit of not-too-technical background.

FDI advantages

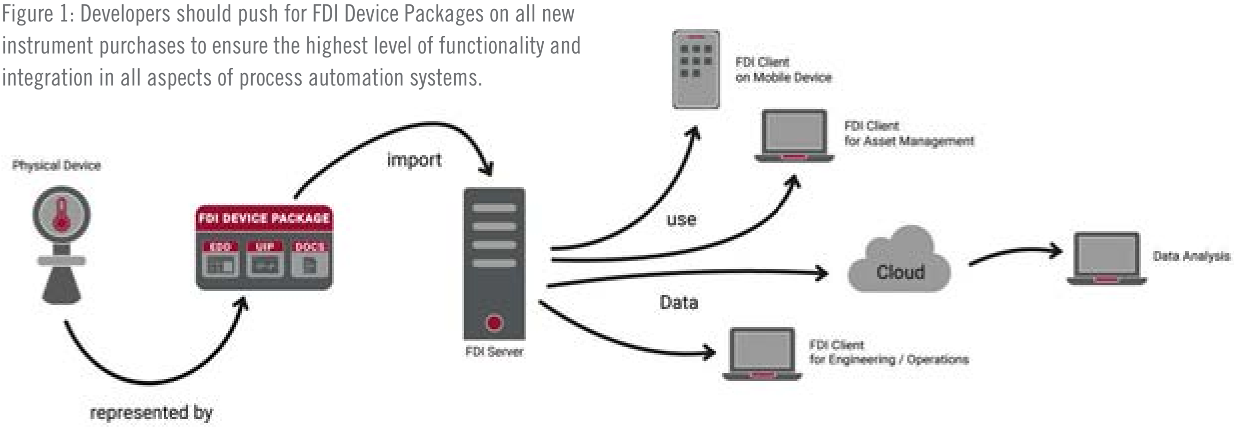
For nearly two decades, process automation host systems and instruments have relied on device description (DD) software driver files to define what an instrument can do and how it operates within the host. Users most likely associate these files by their extensions such as .fm6, .fm7, .ff0 and others.

The FDI standard also uses DDs, but now the DD is encapsulated in a software package, similar to a ZIP file, which can include specialized user interface plugins and documentation. The file extension associated with an FDI Device Package is .fdix. Of particular importance for instruments that support an FDI Device Package, the DD includes the following new features by specification, many of which users have requested for years (Figure 1):

PAUL SEREIKO
Director of Marketing,
FieldComm Group

"Finalized in 2015, many host systems and instruments from FieldComm Group member companies now support the FDI standard."

Figure 1: Developers should push for FDI Device Packages on all new instrument purchases to ensure the highest level of functionality and integration in all aspects of process automation systems.



- **Device health:** Advanced, device-health diagnostics must be supported per the NAMUR NE 107 recommendation. This specification defines five device-health categories for an instrument—good, check function, maintenance required, out of specification and failure—along with a set of visual indicators to easily assess status. Endress+Hauser has an excellent blog post on NE 107 that can be found at netilion.endress.com/blog/namur-ne-107. Monitoring device health in a process helps identify, mitigate and manage issues before they become failures or downtime events.
- **IIoT readiness:** A standard information model is necessary to increase asset management and IIoT connectivity to instrument data across the OT/IT chasm, which, up to this point, has been a major challenge in the process automation industry. Users in the space are hearing much more about advanced process control optimization, machine learning, artificial intelligence and overall equipment effectiveness (OEE) optimization than they were five years ago. Effectively taking advantage of the promises inherent in these ideas requires tremendously easier access to data from the operations side than has historically been available. To address these and other challenges, FieldComm Group, along with many other standards and user organizations, developed a standard for Process Automation Device Information Models (PA-DIM) using OPC UA technology. This standard enables protocol-agnostic communication of common process automation instrument parameters, including semantic IDs as defined by IEC 61987. The elimination of automation protocol dependencies simplifies the integration of IT and OT systems, and the inclusion of semantic device information enables unambiguous, machine-to-machine (M2M) communications. HART or Fieldbus-specific implementations are converted into the address space of PA-DIM's information model.
- **Offline Configuration:** Configuring instruments and systems prior to installation—or offline—and then downloading the configuration to the physical instrument in the field when it's ready, is required for faster commissioning and reduced downtime during turnarounds. In the process automation industry, commissioning tends to be systematic, comprehensive and well-planned, ensuring that all instruments, controllers and asset management systems are configured per the operational requirements for a specific application. Offline configuration helps further improve the efficiency of this task.
- **Modern user interfaces:** FDI Device Packages may come with an improved user interface plug-in (UIP) supporting .NET or HTML5 technology. All registered host systems that support FDI must support UIPs. Prior to FDI, user interfaces for system-integrated instrument configuration tools were limited to text and simple graphics, or reliant upon vendor or OS-specific custom applications. The FDI standard defines a new user interface that can be included with FDI device packages, complete with real-time configuration and visualization capabilities that reduce the chance of entry errors.
- **FDI Device Package Security:** The FDI Device Package ensures security because suppliers must "sign" the package using a recognized certificate authority during the FieldComm Group conformance and registration process. FieldComm Group provides an additional signature indicating conformance.

Propelling digital transformation

FDI Device Packages are designed to support numerous features essential for modern process automation and management applications. FieldComm Group provides software development tools for its members, aiding suppliers in the development of FDI-enabled products, and ultimately in the conformance testing and registration of these products.

Equipping instrumentation with FDI Device Packages enables enhanced device health information, IIoT data, offline configuration, modern user interfaces, improved security and other features, such as standardized bulk configuration tools. Because host systems that support FDI also support older DD technology, it's essential for users, SIs and EPCs to continue encouraging suppliers to deliver FDI Device Packages with instrumentation to best support digital transformation. ∞

To synch or not to synch?

Messages sent on industrial networks can be synchronous or asynchronous

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THAT is the question, as I tried to persuade my very annoyed spouse. “Why can’t people just answer their phones!” was her complaint. “They just texted me,” she exclaimed. Therefore, they should be available, one might conclude.

“I would just text them back” was my best suggestion, which was no comfort whatsoever. “I hate texting,” was her reply. I’m confident that her incompatibility with texting isn’t going to be cured by me, but it did cause me to reflect.

Those of us old enough to be annoyed with texting probably recall a day when analog phones were the primary communication tool of business. On-wrist video chat was a prescient fiction dreamed up by Chester Gould for "Dick Tracy" (the comicstrip printed in daily newspapers). Most folks in business had an “administrative assistant,” who would pick up missed phone calls and deliver small pink slips with the name and number of callers seeking to contact us.

If you were an individual whose duties required a timelier response, you might have a pager. Even in the current age of 5G cellular service, some occupations still use pagers for the service’s more far-reaching and reliable network.

Voice messaging and the fax machine represented some progress, but the technology I found most liberating was email. Once all your goods and services providers had it, you could blast a single message out to all of them simultaneously. It saved me five phone calls when I changed the scope of a project for which I was soliciting proposals, or when I changed the due date for a bid. Everyone received precisely the same message.

Texting, I suggested to my wife, was liberating like email; it frees the sender from the trouble of connecting by voice. And now that all her contacts had multi-featured computers in their bags (that includes voice service) she need not interrupt them from what they might be doing at the moment—driving, for example. When I was frustrated by the lack of response from emails, even my less-than-uber-techie-boss suggested “try texting”—which worked.

Messages sent on industrial networks like fieldbus also can be synchronous (to a degree) or asynchronous. Just as phone calls request recipients to interrupt whatever they’re doing, synchronous communication via fieldbus requires a receiver/consumer cease what it’s “doing” and process the message. The message might be an alarm, for example, that benefits from a precise timestamp and prompt display on the HMI. They resemble the network-connected pocket computers most of us possess, as our facilities have been filling up with digital devices for over three decades. Once digitally integrated, concerns about the timeliness or “determinism” of messages should be considered.

In an instance where a PID controller receives a measurement, the PID controller, in addition to features like HMI and alarming, is essentially “just doing math” on the measurement it receives. Without customization, the math algorithm has no special accommodation for the timeliness of the message. It adjusts an output—potentially very swiftly these days—which then becomes a “message” to a final control element such as a valve. The loop works only to the degree that said move happens in a timely fashion and impacts the process, which impact is then measured by a sensor and transmitted back to the controller. If the messages become stale or have random latency, some closed-loop controllers may fail to function.

Random latencies were a worry back when present-day Foundation Fieldbus was invented. That’s one reason why its creators valued control in field devices (PID solved in a device) and a “macrocycle” to ensure that the control cycle didn’t have random or unknown latency, at least owing to the network and function execution.

While the Zeitgeist favors asynchronous messages, the practice of “answering the phone when it rings” can be crucial for the performance of critical control loops. End users should ensure that their choice of digital infrastructure accommodates their loops where deterministic execution is crucial.∞

"End users should ensure that their choice of digital infrastructure accommodates their loops where deterministic execution is crucial."


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Managing industrial assets wirelessly

Asset tracking is one of the most widely deployed Internet of Things applications

WIRELESS technology is a key enabler of asset management. In many cases, it works quietly in the background, such as when an operator or maintenance person is making their rounds, and it's used to upload the resulting report over the plant Wi-Fi network to the central maintenance software.

Being able to track something is the first step in managing it. Keeping the asset working and able to perform its assigned role is a logical goal of asset management. Combining these capabilities provides the following key asset management elements:

- Automate inventory control—knowing what assets you have at any point in time;
- Physical asset monitoring—knowing where assets are at any point in time;
- Precise maintenance management—understanding the condition of assets; and
- Loss prevention—prevent loss of the asset itself or a negative impact on system reliability.

Because assets have value, asset tracking is one of the most widely deployed first-generation Internet of Things (IoT) applications. As IoT technology expands, the asset maintenance component of asset management is the next logical area of growth.

To support the above asset management elements, IoT-based sensor asset tracking solutions can provide broader visibility into three types of use cases:

- Asset identification—high-volume tracking of assets using very low-cost, reusable or disposables tags.
- Asset track and trace—includes tracking the location of stationary or slow-moving, non-powered assets using battery-powered sensing devices. Smart-sensor solutions can also cover where an asset's geolocation is traced, including the ubiquitous access cards used for offices or to enter a facility.
- Asset condition monitoring—IoT applications that allow remote monitoring of the condition, status or health of assets in the field.

The two most widely used wireless systems to collect asset information are radio frequency identification (RFID) and Bluetooth low energy (BLE). Passive RFID has the advantage of not requiring an energy storage device, but can only respond to a read request from an active RFID reader. Passive RFID is often used in conjunction with QR-codes for device identification. It's also used as a "stepping off" point to more detailed information access, for example, using alternate technologies with higher bandwidth with IEC 61406. This implementation can be used to create an intelligent device nameplate for the industrial automation sector.

Passive RFID tags have a read range from near contact to 25 m, while active RFID tags containing a power source can boost their broadcast ability to 100 m.

Passive RFID is often used in situations where items are likely not to be returned. This is due to the low cost of the tags, typically a few cents.

BLE systems, on the other hand, usually establish their own wireless networks with a combination of beacon and hub devices. Many BLE solutions can incorporate mobile, Bluetooth-enabled devices, such as smartphones as a roaming hub, which helps simplify implementation and provides a convenient interface.

The ability to use consumer mobile devices as roaming hubs makes BLE a particularly common technology for location and tracking applications. It is one reason why several manufacturers include a BLE configuration interface in their devices.

Unfortunately, for the industrial environment, BLE solutions don't function particularly well around metal or reflective surfaces. In addition, as we all know from personal experience, BLE devices also require pairing to connect.

Not all asset management information will be collected wirelessly, but wireless connectivity reduces the barrier to entry of collecting data. Analyzing and interpreting the meaning of the data is where the value is found. ∞

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"The two most widely used wireless systems to collect asset information are radio frequency identification (RIFD) and Bluetooth low energy (BLE)."

Emerson plans to buy National Instruments

NI board reportedly rejects $7.6 billion cash offer

EMERSON (www.emerson.com) announced Jan. 17 that it's offered to buy National Instruments (www.ni.com) for $7.6 billion in cash, based on a 32% premium over NI's $53 per share closing price on Jan. 12. However, NI's board has allegedly been rejecting Emerson's proposals for about nine months. NI bought back more than 2 million of its shares for an average weighted $40.24, took two months to announce a strategic review after forming a working group to evaluate options, and implemented a poison pill strategy, according to Emerson.

Emerson reports its proposal isn't subject to any financing conditions, and was submitted to NI on Nov. 3, and improves on its initial $48 per share offer submitted on May 25. Emerson adds that it's tried engage with NI since May 16, 2022. Details are at www.MaximizingValueAtNI.com.

"Although Emerson would've preferred to reach an agreement privately, given NI's announcement that it's undertaking a strategic review, and after refusing to work with us toward a premium cash transaction over the past eight months, we're making our interest public for the benefit of all NI shareholders," says Lal Karsanbhai, president and CEO of Emerson. "Acquiring NI is another step forward in Emerson's journey to develop a cohesive, higher-growth and higher-margin portfolio, and build on its global automation focus. As Emerson outlined at our recent investor conference, we're transforming our portfolio toward higher-growth automation markets aligned with secular macro trends, which will deliver significant growth and profitability for years to come."

Karsanbhai adds that Emerson has long admired NI, and believes combining its electronic test and measurement and software products with Emerson's automation technology and software would enhance its ability to bring comprehensive solutions to a diverse set of end markets, accelerate growth and position Emerson to create shareholder value. "We stand ready to work immediately with NI's board and management team to reach an agreement that would provide a compelling premium and certain cash value today for all NI shareholders," he says.

Yokogawa acquires Fluence Analytics

Yokogawa Electric Corp. (www.yokogawa.com) reported Feb. 2 that it's acquired Fluence Analytics Inc. (www.fluenceanalytics.com), a U.S.-based startup that provides real-time analytics solutions to polymer and biopharmaceutical companies worldwide. Since signing investment and collaboration agreements in August 2021, the two companies have been exploring potential business opportunities. Following the acquisition, Fluence will integrate its operations with Yokogawa, and operate as Yokogawa Fluence Analytics.

As a leader in polymerization reaction monitoring and control, Fluence reports its automatic, continuous, online monitoring of polymerizations (ACOMP) product is the only commercially available system that can measure and analyze multiple polymer properties in real time. ACOMP's data streams provide insights into material properties that let users optimize and control polymerization processes, improve quality, increase yields, use less energy, and reduce waste. Based on the average size of a polymer reactor, the ACOMP system is estimated to deliver $1.5 million in value per year.

Fluence is presently developing its next ACOMP product, which will become part of Yokogawa's OpreX offering. The two companies are exploring how to integrate ACOMP with Yokogawa's advanced control solutions and the digital technologies of KBC, another Yokogawa company. Its global network will perform engineering and system integration tasks and provide after-sales field services for the ACOMP system.

"Polymers are used in nearly every aspect of modern society in the form of plastics, rubber, paint and so on. Combining ACOMP and other technology with our know-how will let us work with our customers to digitalize and automate polymerization processes that are currently monitored and adjusted manually," says Kenji Hasegawa, VP and head of Yokogawa's products headquarters. "This will assist customers to improve worker safety, profitability and environmental performance. We also plan to apply this technology to polymer reuse."

Jay Manouchehri, CEO of Yokogawa Fluence Analytics, adds that, "Joining forces with Yokogawa lets us capture the full value of our unique datasets, and we can't wait to deliver this added value to our customers. Together, we'll enable autonomous operations and digital transformation in the polymer and biopharma industries."

Phoenix Contact buys iS5 Communications

The Phoenix Contact Group (www.phoenixcontact.com) announced Jan. 19 that it's acquired iS5 Communications Inc. (www.is5com.com) in Mississauga, Ontario. The company provides industrial network products, and specializes in services and solutions for critical infrastructure networks.

"iS5's expertise enables Phoenix Contact to take a leading position in the market for critical infrastructure networks and further expand the business together," says Martin Müller, VP of Phoenix Contact. "Cybersecurity and data analysis play a strategically vital role in this field."

iS5 was established in 2012 and employs more than 40 people, who bring IIoT and IT together and have engineering expertise. Phoenix Contact invested in the company in 2018 through its venture capital company, Phoenix Contact Innovation Ventures. Building on this, product development and joint sales activities have already been initiated through the participation of Phoenix Contact USA.

"We're pleased that we have a strong global player to further expand our business with Phoenix Contact on our side," says Pino Porciello, CEO at iS5. "Our existing cooperation in product and technology development will continue to grow as a result of the acquisition."

ABB opens Mexico tech hub

ABB Process Automation (go.abb/processautomation) opened its new North American regional operations center on Jan. 18 in Merida, Yucatan. The new, $1 million, Mexico Technology and Engineering Center (MXTEC) will bring technology expertise closer to customers, build on similar global resources, and let ABB increase its project delivery capacity.

Located in Merida's modern SkyWork building, alongside a community of other technology and cybersecurity companies, MXTEC will serve as a resource for ABB's engineers, covering automation, electrical and software engineering. It's also expected to increase ABB's engineering capacity by 25%, with some projects involving commissioning of ABB Ability System 800xA DCSs at user sites. In addition, further competencies for supply chain, project management and sales support may be added in the future.

ABB adds that opening MXTEC comes at a time when industrial companies are addressing their supply chains, and either near-shoring or near-sourcing to ensure secure and reliable operations. It reports that Mexico is establishing itself as an emerging center of excellence for communications, engineering, IT and manufacturing across industries, including automotive, process industries and energy.

SIGNALS AND INDICATORS

- **Emerson** (emerson.com) reported Jan. 24 that it will provide automation, software and analytics for an ethane cracker with a capacity of 2.1 million tonnes per year at the Ras Laffan Petrochemical Complex in Qatar as part of a consortium with **Viasat Energy Services** (www.viasat.com). The $6 billion polymers project, a joint venture between **QatarEnergy** (www.qatarenergy.qa) and **Chevron Phillips Chemical** (www.cpchem.com) is under construction and scheduled to go online in late 2026.
- **Galco Industrial Electronics Inc.** (Galco.com) announced Jan. 27 that it's acquired **Zesco Inc.** (zescoinc.com), a regional automation solutions provider in Brecksville, Ohio. Zesco specializes in drives, motion control, and automation, and serves customers in Ohio, Pennsylvania and West Virginia.
- **Panduit Corp.** (panduit.com) announced Jan. 11 that it's acquired the subsea cable and pipe protection product portfolio of marine manufacturer **DongWon EN-Tec Co., Ltd.** (DWE, dwentec.en.ec21.com), in Ulsan, South Korea. The product portfolio includes UraProtect, a polyurethane submarine cable and pipe protector solution, bend stiffeners and restrictors, and J-Tube seals for wind-turbine applications. Terms were not disclosed.
- **AW-Lake** (aw-lake.com) reported Jan. 31 that it's supplying flow monitors to the **National Oceanographic and Atmospheric Administration** (NOAA.gov) for use on its research vessels to measure the temperature and salt content of the world's oceans.
- **Helukabel Group** (www.helukabel.de), a global cable system solutions provider, announced Jan. 23 that it will build a new facility in Haan, Germany, that will collectively house its robotic-dress-pack and drag-chain system subsidiaries. The new building will also serve as headquarters of Helukabel's Rhine-Ruhr sales branch, and is planned to be completed by 2025.
- **Sealevel Systems** (sealevel.com), a supplier of industrial I/O and embedded computing solutions, announced Jan. 19 that it's expanding into international markets in Germany, Italy and Spain. As part of its growth strategy, Sealevel has grown its internal team, and is bolstering its network of distributor partners.

For ABB, it's well-placed for growth and will link ongoing operations in North and South America. The new center will initially serve as ABB's orders pipeline from process industries including mining, pulp and paper, battery manufacturing and metals.

In addition, MXTEC is recruiting and employing 30 engineers, mainly from local talent pools, while ABB also establishes connections with Mexican universities. The center's newest employees were trained at ABB's Czech Operations Center in Ostrava, and are presently onboarding using a customized development program.

"Our aims for the MXTEC are to grow our engineering competencies and capacity to deliver projects with local resources in the same time zones as Mexico, U.S. and Canada, but also become part of a technology-focused community in Merida, where people can stay for a long time and grow their careers," says Michel Blondeau, hub operations manager for North America at ABB. "Its success relies on talents and efforts of our new local team, and we're pleased to see them successfully onboarded and ready to complement our operations centers in Europe and India." ∞

Tender, loving asset management

Control's monthly resources guide

SEVEN CASE STUDIES

This online library, "Asset performance management" from Valmet, includes specific examples from Oulu Energy's biopower plant, Metsä Group's bioproduct pulp mill, Hervanta's heating plant, Anhui Shanying's roll maintenance, and Bohui Zibo and Burgo's paper mills. They're at www.valmet.com/automation/asset-performance-management

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10 STEPS FOR CMMS

This article, "10 principles for CMMS implementation and utilization success" by George Williams, advises knowing each application's needs, set data requirements, provide adequate training, listen to users, don't skimp on system administration, use work orders, and track all costs. It's at www.plantservices.com/cmms/article/11291185/10-principles-for-cmms-implementation-and-utilization-success

PLANT SERVICES
www.plantservices.com

BASICS, ECOSYSTEM AND TOOLS

This online article, "Asset performance management," covers the basic goals, overall ecosystem, digital tools and practices of APM, and shows how it can be done proactively with IIoT and analytics, and how to compare maintenance strategies and approaches. It's accompanied by an eight-minute video interview with Ralph Rio, ARC's research director. It's at www.arcweb.com/technologies/asset-performance-management

ARC ADVISORY GROUP
www.arcweb.com

KEEP TABS ON PROFIT

This 62-minute video, "Sustaining advanced process control (APC) performance and benefits," shows how to use Honeywell's Profit Performance Monitor software, which is a cloud-based APC-monitoring solution that lets users understand what's limiting process from achieving peak performance. It's at www.youtube.com/watch?v=6igr1Yk7pss

HONEYWELL PROCESS SOLUTIONS
https://process.honeywell.com

PREDICTIVE WITH EXAMPLES

This online article, "Six steps to predictive maintenance" features end-user case studies that illustrate its recommendations. It details the costs of adopting the wrong strategy, gaining data visibility, remediating gaps with more sensors, analyzing and understanding trends, using them to predict faults, adjusting operations, and establishing a reliability culture. Its at new.abb.com/process-automation/genix/six-steps-to-predictive-maintenance

ABB
www.abb.com

PUT THE ENTERRISE INTO EAM

This multi-section online article, "What is EAM?" from IBM, shows how enterprise asset management combines software, systems and services to maintain, control and optimize the quality of operational assets throughout their lifecycles. It covers key definitions and features, as well as related participation by computerized maintenance management systems (CMMS) and software as a service (SaaS), and has links to several end-user case studies. It's at www.ibm.com/case-studies/cheniere-energy-inc

IBM
www.ibm.com

MONITOR AND MAINTAIN

This 32-minute video, "Introduction to asset monitoring and condition-based maintenance with the PI system" by Gopal Gopalkrishnan and Keith Pierce, both of OSIsoft, shows how to use PI System to kick off an asset-monitoring or condition-based maintenance initiative. It's at www.youtube.com/watch?v=yds9csEBRUw

AVEVA
www.aveva.com

MANAGEMENT ARCHIVE

This web-based "Asset management" archive includes a dozen articles on debunking misconceptions, best practices for condition monitoring, streamlining proof testing, improving reliability, monitoring remote valves, and making the most of reliability personnel. It's at www.emersonautomationexperts.com/asset-management

EMERSON
www.emerson.com

AUTOMATING MAINTENANCE

This online article, "How maintenance managers can maximize asset performance with automation and control system tools" by Bryan Christiansen, shows how asset monitoring principles can apply infrastructures and utilities. It's at blog.isa.org/maintenance-managers-maximize-asset-performance-automation-control-system-tools

ISA
www.isa.org

WHAT'S MY CONDITION IN?

This online article, "How to make condition-based maintenance (CBM) more effective" by Mark Cousineau, has chapters on CBM's benefits, when it's used, different types, and how to use it more effectively. It's at www.fiixsoftware.com/blog/effective-condition-based-maintenance

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www.fiixsoftware.com

Coriolis technology is making hydrogen dispensing safer and more efficient

GENNY FULTZ
Global Product Manager,
Emerson

HYDROGEN is a sustainable fuel solution that is quickly gaining traction in the global marketplace. Hydrogen dispensing requires the utmost safety parameters to ensure risks are mitigated. That is especially true for one of hydrogen's primary potential uses, which is serving as a fuel source for vehicles.

Emerson is on the forefront of measuring hydrogen dispensing efficiently thanks to one of its newest products, the Micro Motion High-Pressure HPC020 Coriolis Flow Meter, which is set to debut in March.

Genny Fultz, global product manager for Emerson, talked with *Control* about the new unit, the increasing market interest in hydrogen, the challenges facing hydrogen dispensing, and the safety and benefits of the HPC020 Meter.

Q: There appears to be an increasing demand for loading and unloading high-pressure hydrogen into vehicles such as trucks and tank cars. Does the HPC020 perform better than previous models in those applications or even than competition?

A: We have found that there is a market for filling larger commercial and passenger vehicles at a faster rate to keep up with the diesel truck industry. But in addition to dispensing those applications, we've also found that there's a need for loading tube trailers. The loading and offloading point within the hydrogen transportation value chain is something that we've been looking into quite recently. With that in mind, the design of these HPC sensors, specifically the HPC020, reflects those changes in the market by utilizing sensor components that are slightly different than the HPC015 and that allow for a higher flow rate while keeping the batch accuracy at 0.5%.

Q: There are also some challenges in metering hydrogen, especially with regards to temperature, pressure and accuracy. Can you speak to that?

A: Hydrogen offers a pretty great opportunity to fuel vehicles of all different types and sizes. Like other gaseous fuels, it can be compressed and kept at high pressures to be used in that single fueling. The flowmeter uses the batch fueling process, and it needs to remain accurate over that fill. A wide variety and dynamic range of conditions, including pressures exceeding 10,000 psi, is crucial so that it is able to perform at -40 C all the way up to 60 C, and these are ambient temperatures. It's something to keep in mind with a flow meter. Coriolis technology offers the best solution for those types of metering needs.

Q: Hydrogen leaks can be a very serious safety hazard. How does the HPC020 protect the safety aspects of the dispensing operation?

> Coriolis sensors are designed to be installed and left alone to work. They do not require regular maintenance and do not require yearly replacement components like some other technologies do.

A: One thing to note about the Coriolis sensors is that they're well suited for these types of applications because of their completely welded assembly. The Micro Motion sensor is a fully welded assembly, meaning that the only connections are the inflow and outflow of the meter. The HPC015 and HPC020, use hydrogen embrittlement-resistant materials. Those materials are XM-19, which is an austenitic stainless steel commonly used in aviation and nuclear industries when working with hydrogen-related fuels. It has nearly twice the strength of 316 L, and it's a pretty good choice when working with the higher pressures necessary when refueling hydrogen cars or large trucks.

Another benefit to using a Coriolis sensor is that they're extremely reliable. We have this phrase that you install it, you set it, and forget it. Once the sensor's been installed in the field, the likelihood of that meter ever needing any kind of maintenance is very low. That eliminates the need for anyone to open the dispenser to check the flow meter, and reducing those touchpoints is another way of improving safety in the field.

Q: Can we assume the fact that these meters are low maintenance also helps with reducing costs?

A: Yes, in addition to not requiring regular maintenance, they don't require any yearly replacement components like some other technologies do. The sensors are designed to be installed and left alone to work. We also offer Smart Meter Verification, Emerson's proprietary diagnostic software that uses onboard diagnostics with the flow transmitter. It continuously monitors those key performance indicators that maintain measurement and accuracy and meter integrity. Over long-term, this reduces costs through early detection of any issues that you could possibly have in your dispensing process.

Micro Motion High-Pressure HPC020 Coriolis Flow Meter

Q: Can you tell us about the flow rate and pressure capabilities of the HPC020?

A: There are two available models with different flow rates and pressure capabilities. The HPC020M sensor is designed for a 700-bar system that flows at a little bit higher rate, at 9 kilograms per minute nominal flow rate. The HPC020N sensor is designed for a 700-bar system that has an additional safety pressure requirement. That pushes that pressure rating higher than the M model, while flowing at a reduced nominal flow rate at 7.7 kilograms per minute. They both have the same face-to-face dimensions on the exterior of the sensor, like the case and connection points are all the exact same dimensions, but the difference comes down to the material components within the sensor that allows for those pressure rating and nominal flow rate differences.

With the addition of the new HPC020, Emerson now has a full hydrogen dispensing portfolio that will help any customer in their hydrogen dispensing operations, whether they want to fill a semi or a passenger car.

To learn more about the new Micro Motion High-Pressure HPC020 Coriolis Flow Meter visit emerson.com/micromotionHPC

Seeking net-zero

BY JIM MONTAGUE

Here's how the experts are reducing emissions and transitioning industries

REAL or phony? Acting and making a real difference, or just talking and looking busy? When it comes to climate change and global warming, the only yardstick is reducing carbon dioxide (CO_2) and other greenhouse gases (GHG), and striving for net-zero emissions is the goal.

So, if we're just getting more efficient at extracting and burning fossil fuels, we can technically and justifiably claim we're acting more sustainably. However, a drop in the bucket and nod to sustainability—or even outright "greenwashing"—while we keep doing what we've always done isn't nearly enough. Big pivots and shifting to alternative energy sources such as hydrogen, solar and wind are crucial and unavoidable—and everyone knows it.

For instance, Compañía Española de Petróleos, S.A.U. (cepsa.com) recently started coprocessing bio-feedstocks at its Energy Park CEPSA La Rábida refinery in Huelva, Spain. It also adopted five-year decarbonization plan in 2021, and is one of more than 50 worldwide oil companies that endorsed the World Bank's Zero Routine Flaring by 2030 program. Operating since 1967, La Rábida was expanded in 2010 from 100,000 barrels per day (BPD) to 220,000 BPD.

The refinery operates a hydrogen network that is integrated with an adjacent petrochemicals complex. The network has three hydrogen producers, including a platformer, aromax catalytic reformer and a steam reformer. The network's main consumers are a hydrocracker and multiple hydrotreaters and petrochemical units that convert toluene to benzene and benzene to cyclohexane. Each consumer requires different hydrogen purity level.

To reduce its CO_2 emissions and environmental impact, CEPSA recently optimized its hydrogen network to:

- Maximize utilization of hydrocarbon and petrochemical units, depending on economics;
- Minimize hydrogen losses to flare or fuel gas and reduce CO_2 emissions from hydrogen production;
- Increase hydrogen feed to hydrocracker and other hydrogen-consuming units;
- Handle increased hydrogen required by bio-feedstock coprocessing; and
- Enable panel operators focus on value-added activities.

Because of the hydrogen network's complexity, CEPSA undertook a two-phase project to balance it. It implemented Generic Dynamic Optimization Technology (GDOT) software from Aspen Technology Inc. (aspentech.com), which addresses the longstanding challenge of margin leakage in refineries and olefins plants by coordinating and optimizing multiple, closed-loop process units covering broad process envelopes.

Phasing in less flaring

The first phase was a steam methane reforming (SMR) application that was upgraded in 2011 to minimize flaring. It's focused on the high-purity hydrogen section to reduce flaring by balancing the hydrogen header, and modulating the steam reformer (producer) with the hydrocracker and petrochemical units (consumers). Unit capacities were adjusted based on the hydrogen mix. With GDOT in place, average valve-open percent value in the hydrogen network decreased significantly, reducing hydrogen loss to flare by more than 70% or 250 normal cubic meters (Nm^3) per hour, saving approximately 200,000 euros per year, and achieving a service factor of better than 97%. This equates to a reduction of approximately 1,400 tons of CO_2 per year, which is 0.5% of the SMR's CO_2 emissions.

The second phase was done in 2018, when GDOT was commissioned on the rest of the hydrogen network. Its goal was reducing hydrogen loss to fuel gas. This includes a pressure swing adsorption (PSA) section for hydrogen purification, which recovers hydrogen from the lowpurity header, and recycles it to the PSA, instead of sending it to the fuel gas header. After GDOT was deployed, hydrogen loss to fuel gas was reduced by 500 Nm^3 per hour for a reduction of up to 80%, which saved about 250,000 euros per year. This equates to a reduction of approximately 2,800 tons of CO_2 per year, if hydrogen production wasn't limited.

In addition, GDOT accounted for each of La Rábida's major hydrogen producers, consumers and recovery units that experience constantly evolving operational situations. GDOT also delivered value to CEPSA's bio-feedstock coprocessing efforts by providing a clearer understanding about its hydrogen use and highlighting any restrictions. This helped CEPSA prioritize what it needed to maximize, such as hydrogen for bio-feedstock coprocessing feeds or other hydrogen consumer feeds, etc. Likewise, GDOT increased the cyclohexane unit feed by almost 10% or an equivalent of 1% increase in feed to the hydrocracker, when the system was limited by available hydrogen. In general, CEPSA reports that GDOT helps it quickly respond to volatile market conditions, such as elevated pricing for hydrogen and CO_2 emissions credits.

Guidance and directives

A growing awareness of climate change and global warning—followed by increasing demands for action by customers, employees, job candidates and the public—are pushing many process industry businesses to pledge to meet net-zero GHG emissions targets, and adopt more sustainable practices.

Of course, these efforts can be greatly aided by common concepts, definitions and language, which can help keep all parties on the same page and maximize what they accomplish.

One of the most comprehensive tools is the three scopes for emissions defined in the greenhouse gas (GHG, ghgprotocol.org) protocol developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). It classifies a company's GHG emissions as:

- Scope 1—direct emissions from its owned or controlled sources;
- Scope 2—indirect emissions from the generation of purchased energy; and
- Scope 3—indirect emissions, not included in Scope, that occur in the value chain of the reporting company, including both upstream and downstream emissions (Figure 1).

The three scopes and other definitions, such as the U.N.'s 17 Sustainable Development Goals are being distributed by several organizations, including the Carbon Trust (www.carbontrust.com) and the U.S. Environmental Protection Agency (www.epa.gov/climateleadership). As a result, they're being adopted by numerous companies and other organizations striving to achieve net-zero emissions and committed to fulfilling other sustainability pledges.

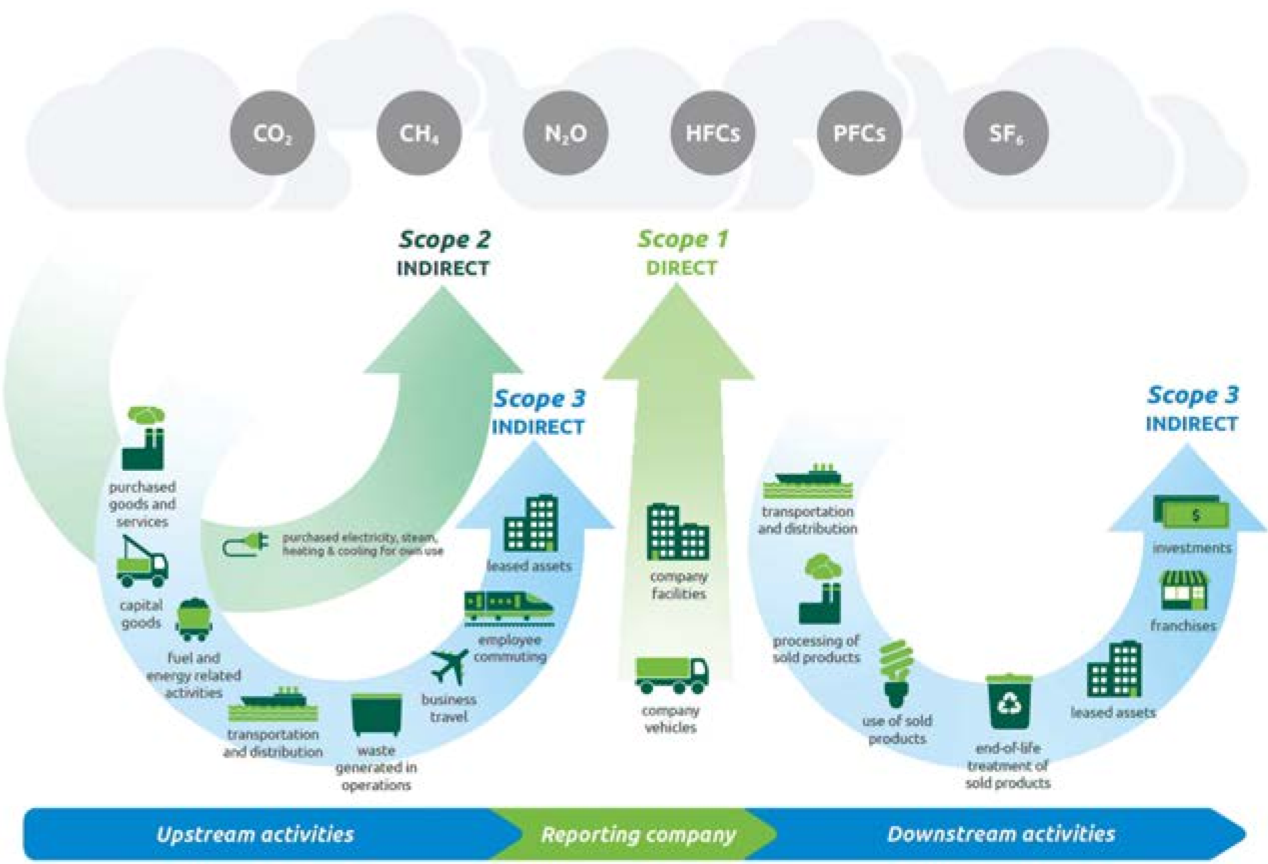

Figure 1: The Greenhouse Gas (GHG) Protocol classifies a company's GHG emissions as: Scope 1—direct emissions from its owned or controlled sources; Scope 2—indirect emissions from generation of purchased energy; and Scope 3—indirect emissions, not included in Scopes 1 and 3, which occur in the value chain of the reporting firm, including both upstream and downstream emissions. Source: The Greenhouse Gas Protocol (ghgprotocol.org) and the U.S. Environmental Protection Agency (www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance)

First steps

However, as with any huge topic that's hard to contemplate, it's important to break it up into approachable pieces, tackle the well-known low-hanging fruit of simpler projects that can deliver with the most returns, score some quick wins, use early successes to secure buy-in and funding for more difficult sustainability tasks, and convince others to do the same.

One of the best ways to get some sustainability experience is to take on a roll-your-own, do-it-yourself project that teach about unfamiliar processes and solutions. It can also give some much-needed solidity to less-tangible promises and plans.

For instance, Phoenix Contact (www.phoenixcontact.com) installed a 960-kilowatt photovoltaic (PV) array in 2021 with more than 2,600 panels on the roof of its logistics center at its U.S. headquarters near Harrisburg, Pa. It cost about $1 million, but received grants that were key to securing corporate buy-in.

Similar to any large distributed energy resources (DER), the array requires continuous, segment-level monitoring and control to maintain day-to-day efficiency and plan predictive maintenance. Its I/O points gather information on the PV system's inverters, cameras, string currents and voltage, PV module soiling, temperature and weather (Figure 2). The array is integrated with the company's building management system (BMS).

To monitor and control its PV array, provide alerts, and collect and analyze data, Phoenix Contact's facilities management team looked in-house to its own engineering services department. Phoenix Contact also has more than 20 years of solar power experience, so its PV array also highlights its related products and services. For example, PV functions are managed by its PLCnext controller, which aggregate data from its I/O modules and EMpro meters, and transmit it to a cloud-computing service for analysis by the company or third-parties. Meanwhile, an industrial PC runs SCADA software that gathers data for history and long-term trending, and its Solarworx software manages solar power data and supports communications.

The array is networked by Phoenix Contact's Radioline wireless modules that communicate with PV module temperature and soiling sensors via RS-485, while its Power over Ethernet (PoE) devices transmit data and power at the same time. Managed and unmanaged switches integrate and protect the network, while FL mGuard security devices provide firewall security and user management.

Specifically, the PV array's monitoring system checks:

- Operational status and faults for 12 inverters, as well as array performance metrics, including DC input power, AC output power, and active and reactive power.
- Current and voltage from the six strings at each inverter.
- Meteorological data, including wind speed and direction, air temperature and pressure and relative humidity.
- Solar irradiance that's measured by two pyranometers—one horizontal and one at a 10° angle similar to the panels.
- Soiling sensor for measuring light loss resulting from the soiling of the panels.
- Panel temperatures by multiple sensors.
- Feed-in control for overall power grids stability. PGS controllers record voltage and reactive power present at grid connection points and determine corresponding control values for the inverters. (This capability isn't used at present due to local restrictions, but its data is available if and when it's needed.)

"While our overall energy demand presently exceeds our maximum solar output, when you combine it with our 1 MW of microturbine generation, there are times during the year when we can provide electricity back to the utility via net metering, and be compensated for this generation," explains Doug Ferguson, senior VP of Americas operations services at Phoenix Contact. Though the PV array is expected to meet 30% of the facility's needs, the company also runs five, natural gas-powered microturbines to match loads it can't handle.

Phoenix Contact plans for the Harrisburg campus to be carbon-neutral by 2030, and data from its PV monitoring system

Figure 2: Phoenix Contact installed a 960-kilowatt photovoltaic (PV) array in 2021 with more than 2,600 panels at its U.S. headquarters near Harrisburg, Pa. Its monitoring system and I/O modules gather information about inverters, cameras, string currents and voltage, PV module soiling, temperature and weather, while its PLCnext controller and SCADA software aggregate, display, and transmit data to a cloud-computing service for analysis. Source: Phoenix Contact

will help chart its progress. Likewise, information from its U.S. operations will be shared with its headquarters in Germany to contribute to reaching its global sustainability targets.

Beyond do more with less

One of the first items on any sustainability to-do list is adding some new goals to the traditional mission of simply making more product and accelerating throughput.

"We're seeing changes in project goals due to sustainability. Traditionally, clients just wanted to make more product and make it less expensively, but projects lately are addressing concerns and requirements outside of increased production and efficiency," says Ian Burns, president of Applied Control Engineering (www.ace-net.com), a system integrator in Newark, Del., and a member of the Control System Integrators Association (CSIA, www.controlsys.org). "Clients are refocusing their activities on longer-term benefits or requirements from other bodies. They're seeking to limit resource utilization, reusing more scrap, and shifting to alternative energy sources—often because their customers are demanding it."

Burns reports that one of ACE's chemical manufacturing clients used to buy ethylene oxide produced from a petrochemical process, but recently switched to making it themselves from ethanol. "They licensed this technology five years ago, and we designed and programmed their control system, which includes multiple reactions, distillation and other unit operations," says Burns. "We deployed Rockwell Automation's PlantPAx DCS and AADvance safety system, and integrated third-party skids."

Because ACE's client could source raw biomass material for its new process it could produce ethylene oxide more sustainably, and gain other efficiencies and advantages. "Ethylene oxide is flammable and explosive, so it's costly to transport, but now our client can make it as needed, which was more efficient and less expensive," adds Burns. "Plus, sustainable production lets their customers, who use the surfactants produced, market their products as more sustainable, too."

To make the big shift to meaningful sustainability, Burns adds that process engineers, end users, system integrators, suppliers and their partners can still use the control, efficiency and optimization know-how they've employed for decades.

"The needs are different—we may be recycling instead of simply processing and consuming raw materials—but many of the tools required for sustainability are the same," says Burns. "For instance, one startup client in Connecticut is taking food scraps that usually go to the landfill, and removing protein to make animal feed. We did some of the data recording and metering for their process last year. They needed to measure protein during the input process, so we installed and integrated a new sensor with their PLC and historian."

The electricity environment

Some of the lowest-hanging fruit on the sustainability tree is doing what should have already been done, namely increasing efficiency and reduce energy power consumption. Luckily, many of these efforts were underway even before sustainability became more of a priority. In recent years, energy went from being an accounting function to being a process variable that could be monitored and optimized at increasingly granular levels in many facilities, processes and devices.

"Our space is primarily energy and controlling it, so our role in sustainability is reducing energy costs. We're presently working on multiple projects to add more meters to monitor electricity, natural gas, steam and water flows," says Doug Medley, technical project manager at Matrix Technologies Inc. (matrixti.com) in Maumee, Ohio, also a certified CSIA member. "Clients want to know why one plant's production costs are lower than another, so they're doing more overall equipment effectiveness (OEE) studies, and realizing they can add energy to those calculations."

Medley reports that improvement for Matrix's clients always starts with understanding their processes. This typically means adding metrology and data collection systems to monitor how the process is running, as well as energy and raw material consumption. He adds that no process can be controlled unit all the variables are known. In a process controls environment, this means collecting data from as many sources as possible, historizing and trending data, looking for patterns and find opportunities for improvement.

"Five years ago, we did a job for a pre-packaged, lunch food manufacturer in Cleveland that wanted to improve boiler efficiency. The boiler was only used to heat water for sparging steam for a clean-out-of-place (CoP) vessel that they used to sanitize equipment overnight. We initially suggested that a water heater would be more efficient, but if the mechanical action of the sparging was removed, then more hand-scrubbing

Figure 3: Long Ridge Energy recently converted its 485-MW, natural gas-fired power plant in Hannibal, Ohio, into what it reports is the world's first combined-cycle hydrogen power plant, which injects hydrogen into the natural gas it burns to produce electricity. To make this process efficient and safe, LRE adopted a Coriolis flowmeter at the injection point to set the injection rate within an error band of 0.25% without needing restrictive piping, Raman analyzer to measure and validate hydrogen blending, and a main-line flowmeter downstream of the hydrogen injection point to monitor main-line gas flow. Source: LRE and Endress+Hauser

Figure 4: Indoor, vertical, eco-friendly farming company 80 Acres and its proprietary Loop production platform are using Siemens' power distribution, security, building management and industrial automation technologies, as well as its HMIs and edge devices, to foster sustainable, healthy, traceable and more productive farming practices. Siemens is also developing a digital twin that simulates the farm, plant growth and production process to predict growth under diverse conditions. Source: 80 Acres and Siemens

and labor would have been needed. The CoP vessel, with sparging, is like a dishwasher, and required much less labor, so when all factors were considered, the better overall choice was keeping the boiler."

To help users weigh the aspects and options in their process operations—and add sustainability to the mix—Medley advises using a simple mathematical model to visualize all their contributing parts. Simply stated, his Industrial Sustainability equation is: Raw material + Energy + Labor – Scrap = Finished goods.

"By controlling the process variables in this equation, anyone can achieve a more sustainable process. Any part of this equation can accomplish a sustainability goal—and you can drill down into each variable—but it must balance with the others," explains Medley. "It's also important to keep in mind that sustainability means different things to different people. It can be defined as: reducing energy consumption or raw materials, and environmental stewardship, but also providing jobs, wages and benefits for employees and their families and communities. Sustainability is a complex topic, but if dealt with one task at a time, it's a great and achievable goal."

Medley adds that Matrix is presently working with a food-grade vegetable oil manufacturer that wants to monitor the energy used by its boilers, steam system and other components, so it's adding meters along with upgrading its controls. This refinery area is handled by 1,500 to 2,500 tags and associated I/O, and controlled by a Plant PAx control system from Rockwell Automation. It's being joined by Aveva's OSI PI Historian software, which is being implemented by another system integrator that's developing a dashboard with trends and analyses to enable efficiency and sustainability. This area has 11 power feeds, and is adding new power meters to its medium-voltages devices.

"We did the field work and PLCs for the vegetable oil manufacturer, but even though no performance results have been released yet, the client is already talking about doing the same upgrades at more sites," adds Medley. "Sustainability has gained a lot of momentum over the past five to seven years due to overall societal pressures. All big projects have a sustainability component now."

Holistic for hydrogen

Even though wind and solar have been making gains for years, the sustainability flavor of the decade so far is hydrogen. This is because it promises to be one of the best ways to store power generated by the other two sources, and can also be blended with natural gas to improve its sustainability.

To explore and develop hydrogen's potential, Long Ridge Energy (LRE, longridgeenergy.com) in Hannibal, Ohio, recently developed what it reports is the world's first, purpose-built, utility-scale, combined-cycle hydrogen power plant. The 485-megawatt (MW) plant began operations on natural gas, but transitioned by early 2022 to begin blending hydrogen into the natural gas fuel it burns to produce electricity, and prove the viability of using carbon-free, renewable hydrogen as a feedstock for cleaner power generation (Figure 3).

However, blending hydrogen with natural gas increases the potential risk of fire, explosion and environmental impact, so LRE had to mitigate those risks. It also needed to reduce waste, increase efficiency, and make its product eco-friendly. These goals required strict cofiring requirements, such as implementing an accurate hydrogen-injection system with blend validation, scaling operations easily and efficiently, smart measurement technology, and safety assurances.

Consequently, LRE completed four tests of injecting and controlling 5% blends of hydrogen. It obtained the gas from a local chemical manufacturer's byproduct and consulted with Endress+Hauser (www.us.endress.com) about providing measurement instrumentation that could safely control the sensitive hydrogen/natural gas blend. The plant was fitted with a Coriolis flowmeter, Raman analyzer to measure and validate hydrogen blending, and a main-line flowmeter downstream of the hydrogen injection point.

The Proline Promass Q Coriolis flowmeter is used at the injection point to allow blending into the fuel system, and enable setting the injection rate within an error band of 0.25% without needing restrictive, straight-run piping upstream or downstream. Downstream of the injection point, a Proline Promass F Coriolis flowmeter was installed to monitor main-line gas flow. Flowrates are used to determine the correct hydrogen injection rate into the natural gas system, but monitoring the blend's percentage concentration helps validate its safety and performance optimization. Both Endress+Hauser flowmeters at LRE are employed in accordance with EPA fuel-flow standards for calculating emissions, including adjusted emissions after introducing hydrogen.

In addition, LRE added Endress+Hauser's Raman Rxn5 spectroscopy-based analyzer to perform blend validation to mitigate the consequences of an off-balance gas blend, especially one with a high hydrogen content. The analyzer performs real-time composition analysis of rapidly changing gas turbine fuels blended with hydrogen. This analyzer was also paired with a Raman Rxn-30 probe that only needs 15 seconds to conduct an accurate measurement directly in the gas stream. Together, the two analyzers provide calculations of the Wobbe index, which is a reference that compares the energy output of different gas blends, and is critical when using alternative fuel sources like hydrogen that has fewer BTUs per volume than natural gas.

"Unlike gas chromatography (GC) that takes samples and requires users to wait for six to 10 minutes, Raman can measure compositions in just a few seconds, which allows users to respond and improve their process in ways they couldn't do before," says Cesar Martinez, marketing manager for natural gas, carbon capture, blue hydrogen and LNG industry at

Endress+Hauser. "In this case, sustainability comes from greener energy sources and what they can add to the value chain. The U.S. has many upstream power sources, so its goal is exporting natural gas, lithium and other commodities."

Powered by partnerships

Because moving toward true sustainability is such a heavy lift, it's essential to have partners who can shoulder some of the burden.

For example, 80 Acres Farms (80acresfarms.com) in Hamilton, Ohio, operates five indoor, vertical, eco-friendly farms in southwestern Ohio, and is fostering sustainable, healthy, traceable and more productive farming practices aided by automation, control and optimization hardware and software from Siemens, including its intelligent facility and energy management systems, and industrial automation technology. Working with the company's technology subsidiary, Infinite Acres, Siemens supports the industrialization and scaling of the company's proprietary Loop platform that encompasses crop management software and algorithms, environmental controls, robotics, and automation (Figure 4).

"Infinite Acres built the Loop platform through collaboration with best-in-class technology partners such as Priva, Ocado, and Signify," says Tisha Livingston, co-founder of 80 Acres Farms and CEO of Infinite Acres. "Likewise, our new partnership with Siemens takes our collaboration and technology platform to a new level with the 360° approach across software and connected hardware solutions, and from digital twins to advanced controls."

Siemens' Smart Infrastructure division is providing power distribution equipment, while its energy and building management technologies in the farms monitor fire and life safety, security and power distribution systems on one interface. Siemens' Digital Industries division will install industrial automation technologies and edge devices to automate the production line, while edge devices and HMIs monitor and update the farms' control systems. Taking a deeper look into the growth processes, Siemens Digital Industries is developing a digital twin that simulates the farm, plant growth and production process to predict plant growth under diverse conditions as well as optimize future farms for growth and shipping. ∞

Industrial digital transformation: Taking control, making an impact

MICHAEL MARTINEZ
Global Distributed Control
Systems Leader
Schneider Electric

HEAVY process industries are on a digital transformation journey. In fact, 60% of companies see this as having a major impact in their business over the next couple of years. So, how can companies manage an impact that will span processes, products, and people, while still supporting their bottom line of profitability and sustainability?

To find out, Control caught up with Michael Martinez, global distributed control systems leader for Schneider Electric's Process Automation business.

Q: What do you hear most often from clients about the status of their control and automation systems?

A: There are really two types of end users that we talk to today, those who are building new facilities, which are referred to as greenfield, who are interested in the latest most advanced technologies and then those who have been in operations for some time, which are referred to as brownfield, who are interested in sustaining their operations and getting the most out of their facilities. There is a subset of those brownfield end users who are expanding their facilities and one of their primary concerns is making sure that the new systems are compatible and/or interoperable with the existing automation infrastructure.

Of all these end users, the largest percentage are brownfield and from them, what we hear is that the automation systems that they currently have implemented are either aging, insufficient or unsupportable. In fact, in a digital transformation report recently released by Omdia (https://bit.ly/3HqXHCh), over 60% of those surveyed suggested that their current automation systems were either incapable or only partially capable of achieving the business outcomes that their companies were after. That's not to say that their systems are not capable of operating the facility today but that new initiatives like sustainability, energy management, ESG, asset management, AI/ML and other programs are putting new requirements on the automation systems. Now, not all customers are at the same stage in their digital transformation journey and not all of them are implementing the same initiatives, but with over 60% concerned about their current capabilities, it's time we take a look at their current systems and reimagine automation in a way that meets these new requirements.

Q: You've said that customers are at different stages of a digital transformation journey – what is holding them back from change?

A: I'll start by noting that 94% of the respondents in the Omdia report perceive digital transformation as having an impact on their business in the next two to three years. This means that regardless of where they are starting, they believe that changes in technology are coming soon, and those changes will be influential. So, what's holding these changes back? Not surprisingly, at the top of the list is implementation cost and supplier selections.

Implementation cost is not only the cost of new technology, but the opportunity cost of outages, start up and training required to get the benefits out of the investment; and supplier selection is critical based on today's paradigm of proprietary systems. Selecting a supplier has consequences for decades and the challenge of picking an automation platform and potentially dealing with change often leaves end users in a difficult decision cycle that doesn't get resolved until the existing system is obsolete, unsupportable or, worst case--just stops working. There are other concerns, like cybersecurity and the people aspects of change, but cost and deciding who to partner with on this automation journey are still the biggest challenges.

Q: So, I have to ask, why do anything? By addressing customers' immediate needs and fixing

what's broken, why encourage them to do more and disrupt their current business models?

A: There are a significant and growing number of trends that are driving us to reconsider and reimagine automation. Workforce skills and availability, technology obsolescence, supply tensions, performance and quality demands, increasing regulation, and more are pushing existing systems and the current proprietary model to and beyond its capacity. For those end users who expect to grow their businesses, it's critical to examine their automation systems today and understand if these systems are limiting their ability to achieve the business outcomes they are after or if they enable the flexibility, adaptability and capability to leverage innovative new technologies in a timely way that meets not only today's requirements, but those of the future as well. Groups like OPAF and NAMUR have been envisioning a future of open automation systems for a while now, but today organizations like Universal-Automation.org and technologies like EcoStruxure™ Automation Expert are making this vision a reality.

By decoupling hardware and software, today's open systems, like those being developed by Schneider Electric, are capable of providing a software-centric automation experience that eliminates the need to replace a system simply because of obsolescence. Because it's software-centric this gives us an entirely new way of thinking about architectures and incorporating the right hardware, in the right location for the specific application. Everything from running control at the edge in a similar architecture as today, to running in local micro data centers or even the cloud; and when hardware needs to be replaced, simply replace it with something as good or better than, redeploy the software and continue running. Back to the previous question, the reason cost to change can be high is because often it is necessary to spend a significant amount to simply replace an existing system with a new system that does exactly the same thing because of all of the cost to recreate the existing process application in the new configuration tools. Additionally, the reason supplier selection can be so difficult is because making that decision locks you into a proprietary system and puts the end user at the mercy of the selected supplier's technology roadmap and supply chain. The open systems, being developed and released today, address both of these concerns with the added benefits of empowering end users to deal with the trends that are driving the need to change in the first place.

Q: With the launchpad that digitalization is setting for the industry today, are there any examples you can share that demonstrate this future of automation?

A: There are several. Just last June 2022 at the ARC Forum, ExxonMobil hosted a presentation called "Open Process Automation-Reimagining Industrial Control Systems" where they described their OPAF testbed and plans for field trials leveraging the UniversalAutomation.org and Schneider Electric software-centric solutions. Another ARC Forum presentation by Gr3n, highlighted their use of the same technologies to share their vision for "distributed automation through IEC61499 in plastics chemical recycling industry" in a demo plant where they have identified several opportunities to leverage these technologies for modularity and market scale-up. We have other energy end users who are currently completing Factory Acceptance Testing (FAT) and are ready to deploy an EcoStruxure Automation Expert based solution in their facilities. We are in discussions with pulp and paper end users who are reimaging automation and architectures in a way that allow them to accelerate and leverage the convergence of IT and OT both from a technology and resource perspective. We are also working with desalination end users to develop innovative solutions, using EcoStuxure Automation Expert, to address some of their top challenges. It really is an exciting time in automation. Ironically, it's taking advancements in technology to enable us to move from a technology first discussion to a process first discussion, allowing us to partner with end users to be the best at what they do, support the achievement of their business ambitions and reduces the need for them to be constrained by that same technology. ∞

The pitfalls & promise of **override strategies**

The strategy is simple in principal, but mastery of the practice is necessary for success

by Peter Morgan & Greg McMillan

AN override control strategy employs two or more controllers in a configuration that allows one controller to act to maintain or regulate one process variable (the main controller), while another controller monitors a different process variable (the constraint variable) to intervene through a high or low signal selector if the constraint is exceeded. While the strategy is a simple one in principle, without adding or configuring features that prevent integral wind-up and avoid latency in override action, the strategy won't perform well.

When a conventional PID algorithm is used to implement the strategy, integral tracking (or its equivalent) is employed to ensure there's no integral windup in the non-selected controller and that it can intervene without latency when the constraint is approached or exceeded. An alternative implementation of the override strategy, made possible when filtered positive feedback is adopted to provide integral action at the controller, simplifies implementation, and without added provisions, provides preemptive action. This article discusses the importance of adding a first-order filter in the integral tracking signal when conventional PID is used in an override strategy. It also shows the benefit of using PID algorithms employing positive feedback for integral action.

Conventional PID with integral tracking

Figure 1 illustrates an override strategy using conventional PID algorithms. For the controller that's not selected, the PID integral term follows the track value. The controller output is the track value plus (typically) the controller gain times error. Unless the control error is zero, the PID output is the track value with the error dependent offset applied.

When integral tracking is implemented without a filter added to the tracking signal, the controller actuating error on both controllers is a sign to drive the output away from the limit, for example, for a low signal selector when both controllers are acting to reduce valve position. In many applications, this condition may not commonly occur. However, the possibility of it occurring can't be discounted, and a filter should always be added for this reason. In the following discussions, the example used is a flow controller acting to modulate the speed of a pump drawing a commodity from a supply tank with an override controller acting on low tank level. In this application, it would be a common occurrence for the flow to be higher than setpoint; at least transiently, while the tank level is low, both conditions demand a reduction in pump speed. While the conditions may be momentary, when they occur, without a filter in the tracking signal, the speed demand can be driven to zero in just several controller scans with potentially adverse consequences to plant operations.

Figure 2 illustrates the behavior of the controllers in an override strategy without a filter in the tracking signal, when sustained errors on both controllers are acting to reduce demand. For clarity, the output of the low select is omitted. In this case, the controller execution interval is one second.

As illustrated in Figure 2, the output of each controller reduces in alternate scans by the amount Kc*error. This results in the output reaching the low limit in just five scans (five seconds in this case). With higher scan rates, as might be the case in a PLC implementation, the same change in output could occur in less than a second.

In Figure 3 at instant “a,” controller output “A” is less than that for controller “B” and is selected as the output at the low signal selector. In the next scan (instant “b”), controller “A” is registered as selected, since the low selector output and status is that from the previous scan, and controller “B” is switched to tracking mode. The output of controller “B” is calculated as the last output of the low select minus 10%, and output for controller “A” is calculated as its last output plus the incremental change (negative) due to integral action. At instant “b,” controller output “B” is less than that for controller “A,” and is selected as the output at the low signal selector.

In the next scan (instant “c”), controller “B” is registered as being selected, since the low selector output and status is that from the previous scan, and controller “A” is switched to the tracking mode. The output of controller “A” is calculated as the last output of the low select minus 10%, and output for controller “B” calculated as its last output plus the incremental change (negative) due to integral action. Note that, since the IAT for controller “B” is longer than that for controller “A,” the incremental change at the output of controller “B” due to integral action is smaller than that for controller “A” in the previous scan. At instant “c,” controller output “A” is less than that for controller “B” and is selected as the output at the low signal selector.

The cycle repeats while the controller actuating errors remain unchanged until the output reaches the low limit (in this case).

When a filter is applied to the tracking signal, conventional PID with integral tracking performs well in an override strategy. However, there are some subtleties in behavior to consider when the actuating error on both controllers drive the outputs in the same direction to lower the output, such as in the case of a low select or to raise the output in the case of a high select.

At instant “a” for one scan, the output of controller “A” is just less than that for controller “B,” and until the next scan, is selected as the output of the low select. In the next scan, the low selector status indicates that controller “A” is selected and controller “B” output is calculated as the filter output minus 10%. Note that, at this instant, the filter output is 2% higher than the output of controller “A,” so there's an 8% step in the low select output.

Between instants “a” and “b,” controller “B” output gradually reduces at the rate determined by the controller’s IAT and magnitude Kc*error (-10% in this case). Over the same interval, the output of controller “A” (in tracking mode) follows the filter output minus 2% (Kc*error for controller “A”). Note that, since the filter time constant is less than the IAT for controller “B,” the controller outputs are converging.

At instant “b” for one scan, the output of controller “A” is just less than that for controller “B,” which results in the cycle repeating.

The behavior described applies when the error is sustained. In practice, when the controllers are acting to reduce error, the discontinuity in action wouldn't be so repetitive or so great. In the following closed-loop example, the possibility of discontinuous action can't be discounted. Discontinuous action is when both controllers act to reduce output for a low-select implementation or increase output for a high-select implementation.

Figure 4 shows the closed-loop response for the override strategy, when there's an initial imbalance between tank inflow and outflow, and a subsequent disturbance in tank outflow causes the flow controller and level (override) controller to momentarily to reduce pump speed. Figure 5 shows the results of the same simulation but for the range of 140 to 160 seconds. These conditions may seem contrived, but they can occur in practice nonetheless, and serve to show the closed-loop behaviour of a conventional override strategy in this situation. Note that the recommended filter is included in the integral track signal.

In this example, tank inlet flow is 50% and the setpoint for outlet flow is 60%. As a consequence, the tank level (not shown) continuously falls until it reaches the low-level override setpoint (50%) at approximately 120 seconds. At this point, the level controller output is selected, and reduces the VFD demand and tank outflow. At 140 seconds, a positive disturbance in pump flow is introduced, in this case, reducing the offset between the non selected flow controller and level controller. In Figure 5, at approximately 146 seconds, flow controller output is less than the level controller output, and is selected by the low select. This situation lasts no longer than one scan because, in the next scan, the level controller matches the flow controller with a negative offset applied, so the level controller output is reselected at the low select. This results in a step in the VFD speed demand, which may not be that consequential unless there' s derivative action on error, but is still undesirable. Note that, with the filter in the tracking signal, there are no successive step changes in the VFD demand.

In an override strategy, integral tracking is implemented without a filter. And, for the conditions in the previous case, the successive handing off from

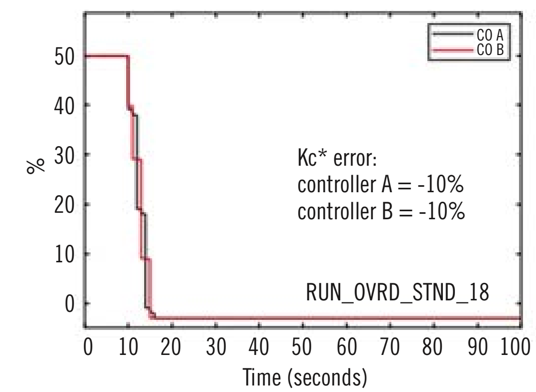

Figure 1: Override strategy implementing integral tracking

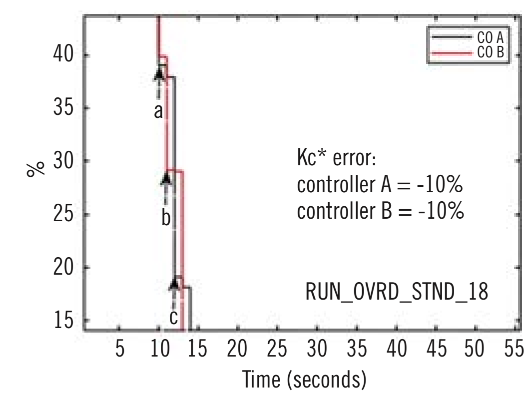

Figure 2: Low select override strategy with integral tracking without filter

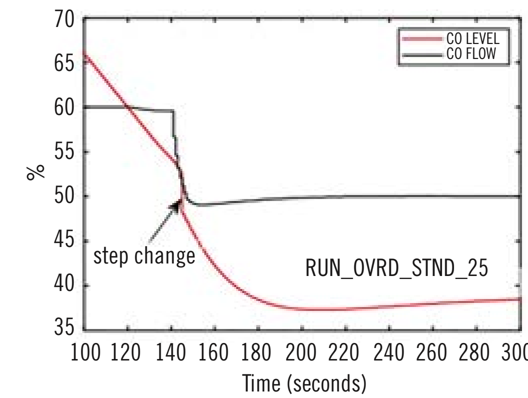

Figure 3: Low select override strategy with integral tracking without filter (detail)

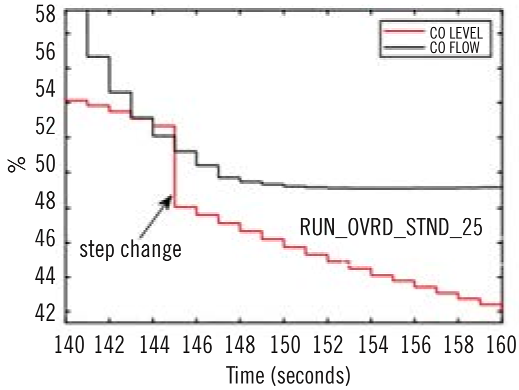

Figure 4: Closed loop response for override strategy with integral tracking with filter

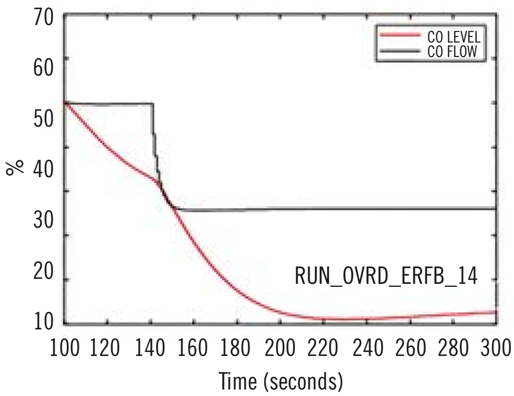

Figure 5: Closer look at closed loop response for override strategy with integral tracking with filter

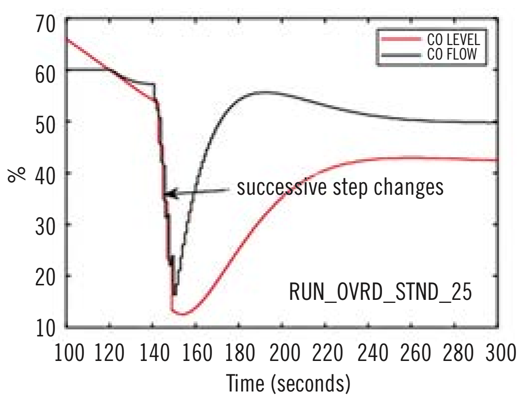

Figure 6: Closed loop response for override strategy with integral tracking without filter

one controller to the other results in a series of steps in the output of the low select, until the level output is consistently lower than the output of the flow controller when the flow controller offset is positive (Figure 6).

PID with filtered positive feedback for integral action

A technique applied out of necessity in pneumatic controllers to obtain integral action is equivalent to using positive feedback through a first-order filter. F.G. Shinskey (internationally known as Greg Shinskey) recognized there were benefits in applying this method of obtaining integral action in closed-loop control. Among the benefits (too many to cover in this article), this method provides the opportunity to implement external-reset feedback (ERF) that can be advantageous in an override strategy. Note that this method of obtaining integral action and the application of ERF isn't universally supported by the vendors of contemporary systems, but it still merits wide support.

When an override strategy is implemented with controllers employing filtered positive feedback for integral action, the implementation is simpler from a user point of view and doesn't suffer from the aforementioned discontinuity in action when both controllers are acting to reduce demand (for a low select) or both acting to increase demand for a high select. It's beyond the scope of this article to describe the implementation of PID using filtered positive feedback, and readers are encouraged to explore the references provided at the end of this article for further information on the subject.

When an override strategy is implemented using conventional controllers with integral tracking, the discontinuity on transferring from the output of one controller to the other when both controllers are acting to reduce demand (for a low select) is due to the gain*error at the non-selected controller being less in magnitude than that at the selected controller before the transition occurs. When an override strategy is implemented using controllers employing filtered positive feedback configured to use the output of the signal selector as the feedback signal (external reset feedback), in all circumstances, when a controller output is newly selected, there's no change in the output of the non-selected controller other than that determined by the incremental change in the feedback filter output or controller error. As a result, in all circumstances, the transition from one controller to the other occurs smoothly.

Figure 7 illustrates the closed loop response for the override strategy using external reset feedback. Absent in Figure 7 is the discontinuity evident in Figure 4, which illustrates the closed-loop response when the override strategy is implemented using conventional PID controllers with integral tracking. Note that the conditions modelled in Figure 7 and Figure 4 are the same except for a slight increase in the flow disturbance in the case of the external reset feedback implementation, which is made to ensure that the flow and level controllers momentarily act in the same direction to confirm there's no discontinuity in action during this condition.

Figure 8 illustrates the closed-loop response for a change in flow setpoint occurring at 10 seconds but without the subsequent disturbance in flow introduced in the previously discussed cases. It's evident in this case that, for an implementation employing ERFB, the level controller acts in advance of that for an implementation employing conventional PID controllers with integral tracking, and that undershoot of the level is less with ERFB. For the implementation employing conventional PID con-

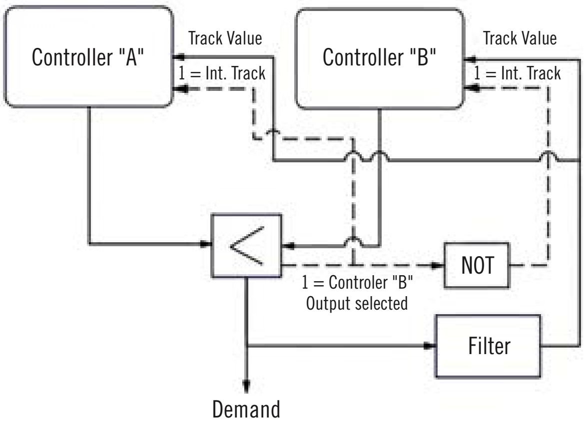

Figure 7: Override strategy implemented with PID controllers employing external reset feedback for integral action

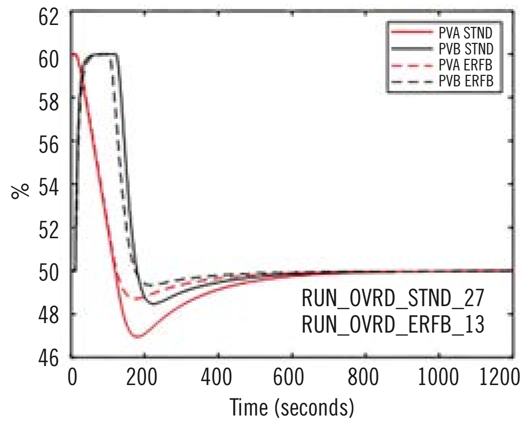

Figure 8: Closed loop response for override strategy implementing external reset feedback for integral action

trollers with integral tracking, filter time constant is set (by conventional wisdom) to match the integral action time of the fastest loop in the override strategy, in this case, the flow controller.

As a result, while the demand is determined by the flow controller, the filter output closely follows the output of the low select until the level controller PV is close to or slightly lower than the override setpoint. When the override strategy adopts PID controllers with ERFB, the filter time constant on the level controller is the integral action time for the level controller, and is longer than that for the flow controller. In this case, as the demand is initially increasing under the action of the flow controller, the output of the feedback filter is further behind and lower than the output of the level controller, so the level controller output matches the flow controller output at a higher tank level than in the case of an implementation employing conventional PID controllers with integral tracking. ERFB in this application can be viewed as providing advance action for rapid changes in load to result in better constraint control.

The response for conventional PID can be modified to match that of PID controller employing ERFB, but only by increasing the complexity. For the strategy implementing conventional PID, using the state of the signal selector, when the flow controller output is selected, the filter time constant can be set to match the integral action time of the level controller (controller A). And, when the level controller output is selected, the filter time constant can be set to match the integral action time of the flow controller. Note that, to accommodate this, the implementation platform has to allow the filter time constant to be written to by configured logic without disturbance. If this is not the case, the filter would have to be built with the basic function blocks provided.

Future constraint control possibilities

One of the advantages of model predictive control (MPC) in constraint control is the future prediction of a constraint violation enabling proactive action. This capability could be achieved to some degree by using of a future value prediction for a constraint PV of an override controller. The calculation is used in batch profile control and endpoint prediction besides a full-throttle setpoint response. The calculation is rather simple and easily adjusted. A dead time block is used to create an old value of the PV that, when subtracted from the new PV and divided by the dead time, is the rate of change of the PV. The dead time is chosen to be large enough to provide a good signal-to-noise ratio. This simple method introduces no dead time into the calculation seen in more traditional methods. The rate of change multiplied by a time interval to give a predicted change in PV is then added to the new PV to create a future value PV of an override controller to enable a fast proactive reaction to prevent constraint violation. The override controller tuning would be based on the dynamics of the new PV response to the manipulated variable.

While override strategies can be implemented with conventional PID algorithms utilizing integral tracking to prevent integral windup on the non-selected controller(s), without a filter in the tracking signal, unexpected and potentially damaging upsets can occur when more than one controller is called on to reduce demand (for a low select) or increase demand in the case of a high select. When a filter is applied to the integral tracking signal, conventional implementations of PID serve well in override strategies, but there remains the potential for a discontinuity in action when more than one controller is asserting influence. Implementing an override strategy using PID algorithms employing filtered positive feedback reduces preemptive action with no added logic. ∞

Peter Morgan has 40 years experience designing and commissioning control systems for the power and process industries. He's an ISA senior member and contributing member of the ISA 5.9 PID committee. Greg McMillan is *Control*'s Control Talk columnist.

Controlling undersea energy transportation

It is necessary to understand the capabilities of measurement and control to meet this challenge

This column is moderated by Béla Lipták, who is also the editor of the *Instrument Engineers' Handbook (5th Edition: https://www.isa.org/products/instrument-and-automation-engineers-handbook-proce)*. If you have a question concerning measurement, control, optimization or automation, please send it to: liptakbela@aol.com. When you send a question, please include full name, affiliation and title.

Q: I'd like to know what methods are used to find the locations of damage on undersea power cables transporting large quantities of green electricity (500-1,000 MW) over long distances (more than 1,000 km) or identify damage on similar capacity hydrogen (liquid or gas) pipelines? To your knowledge, are such under-ocean transportation systems in operation? Do they transport green energy? Are their costs published? I read that such systems are being built in Europe, but would like to learn more. If you or your expert colleagues could point me to some cost or operating reports, I'd be grateful.

Z. FRIEDMANN

A1: This is the type of question I like, not only because it relates to an evolving new technology, but also because it requires understanding the capabilities of measurement and control to meet this challenge.

Your question is logical because the conversion to a green-energy economy will require long-distance energy transportation. That's because much of the green energy will probably be collected in unpopulated areas—where there's plenty of insolation and/or wind—and will have to be transported to the users from such offshore wind farms or distant solar plants either by undersea (submarine) power cables or hydrogen pipelines.

The total yearly electricity consumption of humankind is about 150 quad (Q). One Q is short for one quadrillion (10^{15}) BTU. In high energy concentration areas on land or sea, the solar or wind energy concentration is about 200 GWh/year/mi^2. Therefore, meeting our global electricity needs would require about 225,000 mi^2 (roughly the area of a square with 500-mile sides). This is an immense area. If the solar farms were on land, they'd take up 7% of the Sahara Desert. Naturally, less space will be needed because much of the green energy will be collected elsewhere. Still, some long-distance, subsea transportation will be required.

Submarine power cables: The design of these cables (Figure 1) differ from those used on land. They're stronger, heavier (40 to 80 kg/m) with diameters ranging from 70 to 210 mm. Today, they mostly carry only "gray or red" electricity produced by fossil fuel-burning (gray) or nuclear (red) power plants. The transportation of green electricity by subsea power cables mostly started with building offshore wind farms and ocean-energy collecting plants.

Up to a distance of about 80 km, these power cables usually carry AC power. For longer distances, high-voltage DC current is used. One example of such an installation is the 450-km and 1.6 billion euro North Sea Link (NSL) that's connecting the U.K. with Norway, and will eventually have a total capacity of 1,400 MW (larger than a nuclear reactor). It's a link between Norway's hydropower and the U.K.'s wind energy resources. When Britain's wind production is high and demand for electricity is low, the cable exports energy to Norway, where it's stored in hydropower facilities. When demand in Britain is high and the wind generation is low, hydropower is imported back from Norway. Even longer "green" cables are planned between the U.K. and Iceland (1,200 km), and between the solar farms in Azerbaijan and Hungary, where a 1,100-km cable runs along the bottom of the Black Sea.

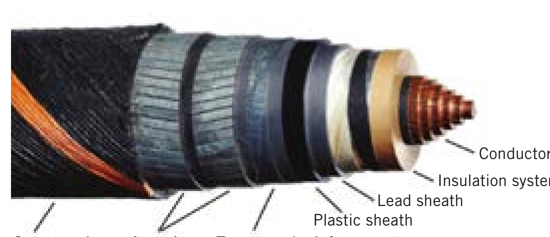

Figure 1: Submarine power cables can weigh 40 kg or more per meter

Process control contribution: Today, some 5,000 submarine cables are bringing the power generated by offshore wind turbine systems to shore. A major component of their operating costs is maintenence. Submarine cables are laid on the bottom of the ocean (Figure 2) or are buried a couple of feet below. If damaged by a ship anchor, fishing equipment or other causes, they require a major effort to repair. Just about every cable fails at least once in its lifetime, and on average, repairing a break in longer cables take about 100 days. Therefore, speeding up locating of points of damage is critical.

Time-domain reflectometers (TDR) are most often used to roughly identify a fault location (their accuracy is about 1% of cable length). In the case of the 1,000-km cable, this is ±10 km, and this precision in insufficient. One method of improving this accuracy is to place reference points at known locations in the cable, but that's also imprecise.

Fault location sensors can also be mounted at either end of the cable. This is expensive, but still pays for itself after locating the first fault. Light can also be sent over fiber-optic cables of different lengths, which find fault locations by the length of the fiber on which the transmission was lost. In the acoustic fault location method (Figure 3), high-voltage surge pulses are sent down the cable, which generates an audible signal that can be detected by microphones. Once the fault is located, the damaged cable must be brought to the surface in two separate pieces because there isn't enough slack to simply rejoin the cable.

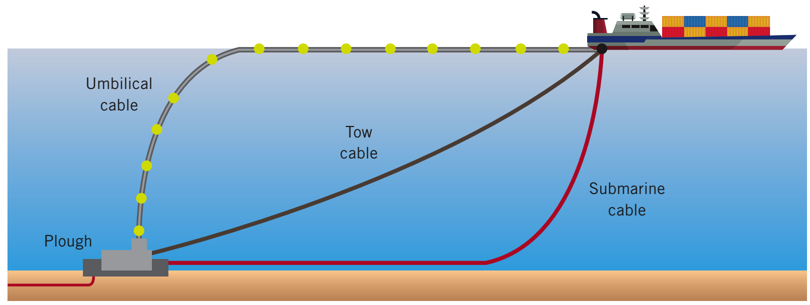

Figure 2: Burial of submarine cables are often done by using ploughs

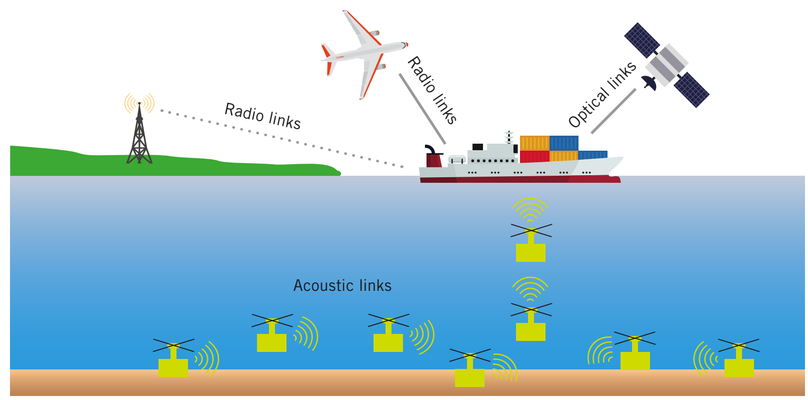

Figure 3: Fault detection by acoustic links

Submarine hydrogen pipelines: Nearly 2,000 miles of "gray" hydrogen pipelines have been safely operating in the U.S. for decades. Some natural gas supplies are blended with up to 15% H_2 to reduce its CO_2 and NOx emissions, which exacerbates or causes asthma, acid rain and ozone depletion. This blending is a temporary step. In the long term, the electric grid itself will move underground and an H_2 distribution piping network will expand into a parallel grid, so fueling stations can serve both battery and fuel cell-powered cars, and regular homes can be connected to either or both.

Long, submarine, hydrogen pipeline systems don't exist yet, and are only beginning to be built. These systems have four components: the electrolyzer/compressor that converts green energy into pressurized hydrogen gas, the pipeline itself, the facility to store excess H_2 generated during periods of low electric demand and the fuel cells (if needed) to convert the H_2 back into electric power. One of the first such systems, a 455-km long submarine pipeline, is under construction between Barcelona and Marseille. At times of green hydrogen shortage, it will also transport "red" H_2 from France back to Spain. The pipe is sized for a capacity of 2 million tons of H_2 per year. It's expected to cost $2.6 billion and is planned to be expanded to become an EU hub by the end of the decade.

According to one estimate, the cost of a 36-in. submarine pipeline, transporting 10 GW of green H_2 over a distance of 1,000 miles a year, is estimated to be 12% less than transmitting that same energy by a high-voltage submarine power cable. The study estimates that such transmission of H_2 by submarine pipes costs $1,226 MWa/mi. The same transmission by electric cable would cost $1,400 MWa/mi.

All energy transmission involve loses, which are a function of length, capacity, etc. Over a 1,000-km transmission length, they amount to about 5% of the power carried. In case of H_2 transmission, most losses are caused by leaks and embrittlement. H_2 system costs are expected to be reduced by reducing pipe weights plus reducing the costs of electrolyzers and reliability of compression technology. One very promising effort involves using fiber-reinforced polymer (FRP) pipelines for hydrogen distribution. These pipes are less expensive and are available in sections that are much longer than steel, minimizing requirements for welding.

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New Vue static or height-adjustable workstations are easily configurable for all process control environments. They offer different widths and connecting cabinets for accommodating multi-operator solutions. New Vue's horizontal- and vertical-adjustable monitor mounts offer ergonomic viewing. They come in five colors and four work-surface options, and have an open architectural design, but are also available in a closed-base version with doors in the lower section.

WINSTED
952-944-9050; www.winsted.com

CERTIFIED PURGE AND PRESSURIZATION

Bebco EPS 7500 Series purge and pressurization system continuously monitors enclosure conditions, provides automatic pressure adjustments, and offers an output alarm for reliable protection. It comes with NEC, CEC, ATEX and IECEx third-party certifications for use in Class I and II, Div. 2 and Zone 2/22 applications. Bebco EPS-7500's large, multi-feature, touch display enables convenient setup and gives users access to key parameters. Status LEDs, a pressure bar graph, and preset programs simplify operation.

PEPPERL+FUCHS
www.pepperl-fuchs.com

STEEL BOXES PREVENT INTRUSION

EJ Series junction boxes from Hammond Manufacturing protect electrical and electronic equipment against harsh industrial environments. Formed from 16-gauge steel with welded seams and a formed lip to prevent intrusion by flowing liquids and contaminants, these boxes perform best as instrument enclosures; electrical, hydraulic, or pneumatic control housings; electrical junction boxes; or terminal wiring enclosures. They comply with NEMA Type 3R, 4, 12, and 13 and IEC 60529, IP66.

GALCO
www.galco.com

EQUIPMENT & MATERIALS

FIVE SIZES, RATED FOR HYGIENE

Hygienic Design (HD) pushbutton enclosures and accessories optimize hygienic practices in the high-hygiene zone. Available in five sizes for maximum versatility, these enclosures feature 304 brushed-grain, stainless-steel construction and 3° slope on all sides to prevent pooling. IP 66 and 69 and UL Type 4X ratings offer protection and security, while FDA-compliant gaskets prevent ingress of contaminants and bacteria.

RITTAL NORTH AMERICA
800-477-4000; http://www.rittal.us/hygienicdesign

PROTECTION FOR PCS AND THIN CLIENTS

Enclosures for thin clients and small PCs provide sealed, clean, cool spaces, even in washdown settings. They let users create a full, standalone workstation by adding a universal mount monitor, industrial keyboard and pedestal mount. Each is made of heavy-gauge stainless or black powder-coated steel, and sealed to NEMA 4/4X, IP65/IP66 specifications, while a drip gutter diverts water around the door. They feature DC power, a removable pre-drilled mounting plate, internal cable routing, and fan-based cooling.

HOPE INDUSTRIAL SYSTEMS
www.hopeindustrial.com

INTERIOR MOUNTING PANELS AND SHELVES

Side panels and weight-distribution shelves provide interior mounting flexibility and support for installing heavy equipment in non-metallic, polycarbonate Stahlin enclosures. The panels allow components to be mounted on enclosure walls (either on the long or short side), and provide added mounting. They're easy to install with common tools, and are available in nine SKUs for enclosures from 6 x 6 in. to 24 x 24 in. The aluminum shelves are available in seven SKUs for enclosures sizes from 10 x 10 in. to 24 x 24 in.

STAHLIN
https://stahlin.com

AD INDEX

How to get the best batch control

What to do and what not to do to achieve robust batch control

GREG MCMILLAN

Gregory K. McMillan captures the wisdom of talented leaders in process control, and adds his perspective based on more than 50 years of experience, cartoons by Ted Williams, and (web-only) Top 10 lists. Find more of Greg's conceptual and principle-based knowledge in his Control Talk blog. Greg welcomes comments and column suggestions at ControlTalk@endeavorb2b.com

BATCH control sequences are used to automatically meet the many other challenges of batch operations, especially to meet unexpected changes in feed and equipment conditions without causing an interruption or efficiency loss. The last thing you want is the operator to have to decide how to recover and resume an operation. We're fortunate to have Michael Taube of S&D Consulting to discuss what to do (and what not to do) to achieve robust batch control applications, and elevate the operator's role into one of observation and offering future improvements.

GREG: How do you get started on the best path?

MICHAEL: The first step is understanding the "why" for process control, particularly for batch processes. The definition I use is that a batch sequence program monitors and controls a non-continuous (event- or state-based) process to produce predictable, robust products. That sounds simple enough, but the "devil is in the details and so is salvation" to quote Admiral Hyman George Rickover, the "father" of the Nuclear Navy. To be "robust," a sequence program must:

- Be tolerant of perturbations or abnormal conditions (AC);
- Generate predictable and repeatable behavior even (and especially) when encountering errors and/or AC; and
- Require no manual intervention (with "engineering access") to reset or restart the program after encountering an error.

GREG: Why do you describe "robust" like that?

MICHAEL: In many control systems, when a sequence program encounters an "error" (i.e., a system tag is in the wrong mode or state), the sequence program simply stops or halts, and requires manual (human) intervention to rest or restart it. So, to be "robust," a program must be designed to check and compensates for potential "error conditions."

GREG: Is there anything else that should be considered to make a sequence program robust?

MICHAEL: "Initialization" is widely recognized in continuous control, but sometimes overlooked with sequence programs. A robust sequence program is designed to recognize the state of the process, and jump to the portion of the sequence program monitoring and controlling that state. This is how a sequence program initializes, but this behavior is often overlooked by sequence designers. They often assume the sequence program will always run the process, so there's no need to assess the process state. This assumption often leads to trouble when a program unexpectedly halts—getting it back in synch with the process depends on how the program is structured.

GREG: Is this different from continuous control?

MICHAEL: Yes. When continuous control functions encounter an error during execution, they get processed again from the beginning during the next execution cycle. In other words, they get another chance to execute to completion, whereas sequence programs don't. They just halt. That's why having an externally generated source of the process state is so important.

GREG: How does this translate to the design and implementation of batch sequences?

MICHAEL: There are interlocking, mutually required factors process engineers (or sequence designers) must consider when designing the program, some following object-oriented programming (OOP) principles:

1. The program scope should include only one piece (or a limited set) of equipment or unit operation. This is part of the OOP design principle of encapsulation. It often means there could be multiple programs covering an entire "process."
2. A second OOP principle related to encapsulation is there should be control system tags

external to the program, which indicate and/or command the equipment's state (e.g., standby, off, run, regen, heat, cool, etc.) This means the program doesn't have to adjust multiple instruments (valves, motors, controllers, etc.) to achieve a particular process state. The external tags "command" the specific state, and the external logic handles the details.

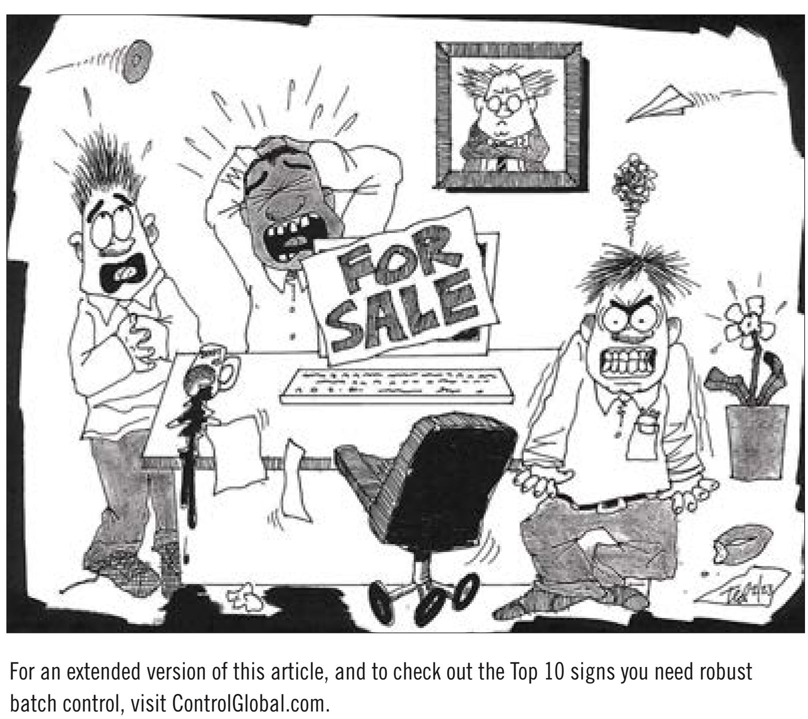
3. Sequence designers should avoid iterative loops and parallel branches in the sequence program. That is, the program should have a simple "once-through" execution path because most control systems use a function block (FB) programming "language" for sequence programs. While this supposedly makes the program easier to understand, it hides that, during execution, one can't predict, a priori, which part of the program is executing. Also, while parallel branches of FB appear to execute in parallel, the reality is they're processed serially—one after the other, and not necessarily in the expected order. This may cause unexpected behavior during runtime. Thus, if some parallel processing is required, then the parallel logic should be "broken out" into separate sequence programs or system tags, which are processed or executed at the appropriate time in the overall sequence. This also requires that any "handshaking" or coordination between programs be very robust and predictable, though doing so is easier when the designer has explicit control over the parallel programs.
4. Complex and/or iterative calculations should be configured in external control system tags or blocks. The reason for this was explained earlier when describing robust behavior.
5. The program should behave like an attentive and conscientious operator. That is, it should only perform actions that a human operator would do, such as advancing the sequence (e.g., move to the next step or equipment state). It should also do nothing more than a human operator would do. So, if a human operator is to "press a button" on the control system to perform an action (e.g., advance to the next sequence step), then the sequence program should do the exact same thing.
6. A consequence of four and five is that the program and external control functions should be designed so the human operator can operate the process (using the same control function tags as the sequence program) without using the sequence program. In other words, if the sequence program is required to operate the process, then the program and control functions haven't been properly designed.
7. A consequence of six is that the sequence program can be started (and stopped) even while the process is already running without altering the process' state. This is where "initialization" (described previously) and the caveat from six comes into play.

GREG: Is there anything else the designer needs to consider?

MICHAEL: The "easy part" of sequence design is defining the sequence steps when everything works properly. The real challenge is identifying and defining the proper response(s) to abnormal conditions. The sequence program must know when equipment doesn't function as required (i.e., a valve fails to move to the commanded position, a motor fails to start or stop, etc.) and respond appropriately. In many, perhaps most, situations the human operator must perform some action to correct the AC and return control to the sequence program. In the most severe cases, the operator must take full control of the process or equipment, even to the point of shutting it down, so repairs can be performed. Thus, the abnormal condition handler—the sequence code that traps and responds to AC—is the most vital part of the program that produces robust and reliable operation of the process.

GREG: Any parting words of wisdom?

MICHAEL: Modern control systems are very capable and have lots of underutilized function blocks. Robust sequence controls require that the sequence designer and programmer learn and use them. ∞



For an extended version of this article, and to check out the Top 10 signs you need robust batch control, visit ControlGlobal.com.

Green wishing

I hope sustainability succeeds, but I wouldn't bet on it.

JIM MONTAGUE
Executive Editor
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"We'd better get cracking because the ice is probably going to slide off Greenland in about 20 minutes, and then the U.S. Midwest will finally get some respect when we shelter the refugees from the coasts."

YOUNG, would-be storytellers are often told to "write what you know." I can confirm this is good advice, even though my job is conveying what other people know.

The snag in gathering stories from others is that I can begin to tell when we're on unfamiliar ground because specifics get rare and generalities get common. You've likely seen the often-Xeroxed quote, "If you can't dazzle them with your intellect, baffle them with you B.S." This is an occupational hazard for many technical topics because we're usually covering innovations, such as new networking protocols, cloud-based data analytics or artificial intelligence (AI). They're much discussed, but still mostly speculative because they aren't widely applied yet, so users don't have many experiences to share.

Sustainability is one of these topics because it's huge and gets into so many different process control areas and disciplines. Plus, many aspects of "going green" are unfamiliar to many sources, so they default to what they know. This is why nine of 10 discussions for this month's cover article, "Seeking net-zero (p. 22), quickly snapped back to efficiency. Carbon-capture and mixing hydrogen with natural gas seemed to be especially popular because, I think, they allow many end users to stay on the same course they've always been on, even if it leads to a dead end.

So, we settle for a gambling on few exciting, short-term pennies, rather than investing in consistent, boring, long-term dollars. Anything to release those dormant fight-of-flight hormones. I guess we're all driven by gut bacteria.

This is why inflexibility appears to be reflexively preferred by many of us, and keep us from daring to go 90° off course, and really committing to alternative energy. As usual, "the devil we know better than the one we don't." The other symptom triggered by the unfamiliar and unknown is willful ignorance and an almost gleeful resistance, which puts a brave, "you're not the boss of me" face on deep insecurity, despair and disbelief that constructive change is possible. Parents of toddlers know the bottom-line quote here is, "I don't wanna and you can't make me."

But kids and everyone else has to grow up sometime, and adapt to changing conditions and environments. Just as AI, cloud-computing, Internet everywhere and digitalization are today's shifts, many experts have reminded me that fieldbuses, PLCs, relays, pneumatics and sharpened sticks were all dubious and unproven technologies at some point, and potential users were suspicious and resisted using them, too.

Now it's sustainability's turn, and we have to adopt wind, solar and whatever else will achieve net-zero CO_2 emissions, even though the positive effects aren't likely to be realized for dozens or hundreds of years. This is permanent lifestyle change instead of dieting. This is like the move to digital photography that Kodak ignored and attempted too late. I believe it's closer to the epic shift U.S. automakers made during World War II when many shifted to building airplanes.

We yearn to be a great generation like those of the past. Well, this challenge is bigger than any of them faced, including Europe's cathedrals, China's Great Wall, Egypt's pyramids and all the other pre-industrial projects that took generations to build. I think we're talking about revising much of the foundation that was built from the Industrial Revolution to now. No wonder it's hard to contemplate, but hopefully it can be broken into approachable tasks like any big job.

All we need is the will, though I'd only put my $2 on that horse for sentimental reasons.

And we'd better get cracking because the ice is probably going to slide off Greenland in about 20 minutes, and then the U.S. Midwest will finally get some respect when we shelter the refugees from the coasts. This may be hyperbole that will never happen, but we must act just in case because the stakes are so high. We must act no matter if the developed world burned more in the past or the developing world is likely to burn more in the future. And we must act even if it's too late because it might not be. ∞


The Plant Floor in Your Pocket
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