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Supply chain issues hit home

How a Finnish paper mill strike impacted this issue of *Control*

KEITH LARSON
Editor in Chief
klarson@putman.net

AS an information resource for process automation professionals, we at *Control* focus our attention on how new automation technologies as well as societal developments like the pandemic, a shortage of qualified workers and supply-chain glitches affect operations across the process industries. From where I sit, it's all too easy to throw stones at how the resilience of supply chains had been sacrificed in pursuit of a just-in-time, single-sourced economic optimum. That is, until a series of unfortunate events came around to remind me just how vulnerable we are as well.

You see, here at *Control* and across our parent company's other industrial brands, the focus is on developing great content for our engineering and operations readers. Increasingly, we distribute that content digitally—through websites, e-newsletters, podcasts and blogs. But printed magazines are still the preferred communication medium of thousands of *Control* readers (actually, more than 42,000 by last count) and that's where things almost went sideways.

You see, the printer we partner with to convert our digital creations into the physical magazine you now hold in your hands (assuming you're not catching this online) informed us in mid-February that because of a paper mill strike in Finland that started on the first of the year, they only had half of the paper needed to print our March issues—and couldn't get their hands on any more. This, despite being contractually obligate to always maintain a 90-day supply at minimum.

Up to this point, I'd escaped the pandemic fallout relatively unscathed, enduring only a few relatively inconsequential inconveniences. Indeed, my closest brush of late was nabbing for my daughter the very last Gersby bookcase stocked at my local IKEA. But now, a supply-chain hiccup complicated by a worker shortage across an ocean was poised to hit where it hurt.

After some tense negotiations, we were able to locate some alternate paper and, by squeezing our folio a bit, were able to meet our March issue commitments. Last I heard, the strike had been extended to April 2—even without shipping, far too late to meet our April issue magazine commitments. So, the search for alternate solutions—and alternate printers—continues.

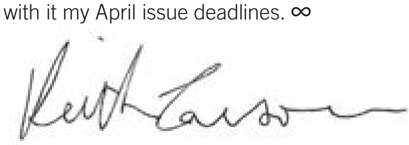
We're not alone. According to Adrian Lloyd, CEO of Interact Analysis, supply chains are by far the biggest issue facing manufacturers today. "The just-in-time model was always fragile, and COVID-19 broke it," he says. "I think we always knew just-in-time had the potential to be weak, but the pandemic highlighted massive problems, and it's going to be difficult for them to be overcome."

Shipping problems will persist

Shipping remains a notable weakness, with capacity problems that will take a long time to resolve, Lloyd adds. "In early 2020, shipping firms did the predictable thing. They laid off workers, cancelled over 1,000 voyages in March through July 2020, decommissioned containers, and cut back on orders for new kit. What they didn't anticipate was the boom in e-commerce as locked down workers disposed of spare cash online. We saw the emergence of a phenomenon known as 'coiled demand,' where, as money in the pockets of consumers grew, demand for goods sprang ahead, even as uncertainty in the economy persisted."

Container prices are through the roof, at eight to nine times the pre-2020 rate. "And it's interesting to note that the global shipping industry is quite consolidated, with 75% of the market dominated by seven companies," Lloyd adds. "The resulting lack of competition has led to the archaic scenario where purchasing a spot on a ship doesn't guarantee a spot on that ship. Instead, you get bidding wars between freight agents. It's an anachronism in an otherwise finely-tuned global supply chain."

Thanks for listening and think positive thoughts on our behalf. Spring's just around the corner, and with it my April issue deadlines. ∞



"Up to this point, I'd escaped the pandemic fallout relatively unscathed, enduring only a few inconveniences. But now, a supply-chain hiccup complicated by a worker shortage across an ocean was poised to hit where it hurt."

NEWS & BLOGS

The OT network community cares about data; the engineering community cares about deaths
Dale Peterson has written and published podcasts discussing the lack of importance of Level 0,1 devices. In this blog post, Joe Weiss outlines Peterson's stance, and offers his own response, arguing that ignoring sensor-level security could be, literally, a fatal oversight.
www.controlglobal.com/blogs/unfettered/the-ot-network-community-cares-about-data-the-engineering-community-cares-about-deaths

Lack of applicability of NIST Special Publication 1800-32 to process sensors
As there's still confusion about cybersecurity of process sensors and other Purdue Reference Model, Level 0,1 field devices, Joe Weiss was asked to review NIST Special Publication (SP) 1800-32, "Securing distributed energy resources: an example of Industrial Internet of Things Cybersecurity" for applicability to legacy process sensors (e.g., pressure, level, flow, temperature, voltage, current, etc). In this blog post, he provides an overview of the SP, along with his analysis and recommendations.
www.controlglobal.com/blogs/unfettered/lack-of-applicability-of-nist-special-publication-1800-32-to-process-sensors

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Video reveals basics of level instrumentation specification

Measuring the level of material in a tank, reactor, or other vessel is more complicated than it seems. Every container and material comes with its own set of special challenges. Watch this insightful video that dives into the various applications and challenges to consider when selecting the right level instrumentation. Topics covered in this video include: the necessary evils of level measurement, application issues, questions to consider, how to make an informed decision, and the eight common types of level instrumentation.
info.controlglobal.com/video-ebook-2022-process-control-basics-level-measurement_proc

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The cloud: a tutorial guide

This new, 17-page tutorial guide from the editors of *Control* offers a path to achieving cloud success in your facility. In the pages of this downloadable eBook, you'll learn how to increase your chances of cloud success, how to seamlessly and securely connect your plant floor to the cloud, how to simplify and streamline wireless applications, learn whether your industrial network has what it takes to create a smart factory, and get the straight talk on cybersecurity.
info.controlglobal.com/ebook-2022-wago-the-cloud-a-tutorial-guide_ios

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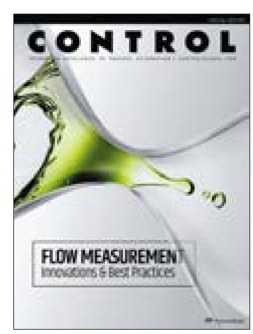
Flow measurement innovations and best practices



This anthology of recent coverage in *Control* magazine and at ControlGlobal.com discusses recent developments in flow measurement. This new State of Technology Report includes the latest information about flow measurement innovations and best practices, including new devices. This eBook will also teach you how to best apply multiple-hole orifice plates, explore a study of use cases for Ethernet-APL, and give you a better understanding of a power-law approach to orifice flowmeter calibration.
https://info.controlglobal.com/state-of-technology-2022-flow-measurement_proc

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Digitalization: why not just put it in the DCS?

Many considering a "digital transformation" may ask the question, "Why can't I do that with my current control system?" With all the buzz, many may have forgotten the potential of the systems they own, as well as the limitations of those systems. In this webinar, Dr. Jake Tuttle of Griffin Open Systems will explain the role of the DCS and PLC in digitization; Adivarent Control and the benefits of synergizing with the DCS; and robustness, efficiency and advantages of modular solutions.
https://info.controlglobal.com/webinars-2022-digitalization-why-not-just-put-it-in-the-dcs_ce_dm

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Please Recycle This Magazine

Pandemic winners and losers

WITH the COVID-19 pandemic approaching endemicity in many regions of the developed world, we caught up with Adrian Lloyd, CEO of Interact Analysis (interactanalysis.com) for his take on the pandemic, its implications for manufacturers, and other aspects of the roller-coaster ride we've all been on these past two years.

***Q:** Adrian, what's the most interesting thing you've seen in your current manufacturing research?*

A: It's the shape of the recovery, which I can only describe as elongated and lumpy. There were winners and losers during the pandemic, and it all looks a bit random. It's not random in reality, of course; there's a reason for everything. But in this downturn the outcomes were highly unpredictable.

Normally, a downturn has a negative effect across the whole economy. But with the pandemic, that wasn't the case. Some industries saw soaring growth, such as consumer electronics, and some went into meltdown. Some, like automotive, initially collapsed in a way one might expect given lockdowns, but then bounced back almost immediately in a most unexpected fashion. Others, such as aerospace, will take much longer to recover. Without specialist insight, the global manufacturing sector during COVID-19 looks like a child playing with a mixing deck—randomly pushing some dials up and some down.

Also, recovery at a regional level has been dependent on government responses to the pandemic. Again, it's been a bit unexpected. Countries that stayed open in the name of putting the economy first, such as Brazil, have recovered slowly. Countries that immediately shut down their economies, such as China, are now booming.

It's fascinating, and a challenge, to model these dynamics.

***Q:** What can you tell us about reshoring?*

A: There's been a lot of talk about reshoring being the solution to the supply chain crisis we face right now. It isn't. The supply chain crisis needs short term solutions. Reshoring is a long-term thing, but that doesn't mean it isn't a real trend in some sectors.

One aspect driving reshoring is political pressure and the green agenda. With more food, for example, being produced and consumed locally, new techs such as vertical farming may well facilitate it. In other industries, there may be some targeted reshoring. I'm talking about 'strategic' industries, such as semiconductors, where the West has hitherto been pretty much totally reliant on supplies from Asia. The E.U. recently committed $43 billion to boost semiconductor manufacturing in the region, following the U.S.'s lead.

***Q:** What should companies in the manufacturing value chain be looking out for now?*

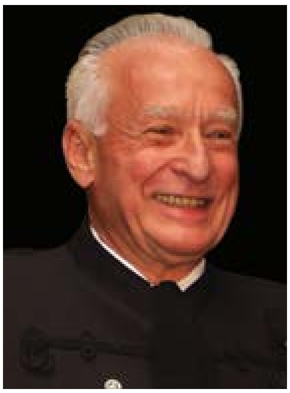
A: My advice to people in manufacturing, particularly equipment providers or component vendors, is to be mindful that fears about shortages will result in overordering. Companies are playing it safe. They're placing multiple orders and then cancelling them. It's artificial demand, and it can quickly go from a boom to a bust cycle. Stockpiling can also be an issue. All this distorts demand cycles and ultimately causes slumps down the line.

***Q:** How is 2022 looking so far?*

A: 2022 is going to be a growth year because of the elongated recovery. When it comes specifically to machinery, I call it a 'square root recovery." We've seen a huge dip in machinery sales, and now we'll see a slow, protracted return to growth. Our partners at ITR Economics are predicting a slowdown in the U.S. economy in the 2nd half of 2023, but not a massive shock. ∞

Batteries or fuel cells?

Ease of distribution, energy density and material requirements will make the difference



BÉLA LIPTÁK
liptakbela@aol.com

"The public perception that switching to battery-electric vehicles will lower carbon emissions is mistaken because batteries are most often recharged with 'grey' electricity, generated in carbon-emitting power plants or by other carbon-emitting processes. Today, only about 4% use green electricity."

ENERGY storage is the key to a green energy economy. Intermittently available energy supplies have to be converted into continuously available ones that can be stored and transported. The global energy storage market—if we include electric vehicle batteries—could see a five-fold increase in the next eight years, from 800 gigawatt-hours today to as much as 4,000 gigawatt-hours by 2030, according to the U.S. National Renewable Energy Laboratory.

For most of us, electricity storage means batteries, but in a decade or two, this might change. Why? Because one kilogram of a lithium battery can store only 0.15-0.25 kWh of electricity, while one kilogram of hydrogen contains 39.6 kWh, and battery technology won't be catching up any time soon.

In addition, while batteries can serve stationary and relatively small users (such as storing solar energy for private homes or in cars), they aren't suited for transporting large quantities of electrical energy. In the case of larger green energy sources like solar farms, transportation as hydrogen is better because the existing grids in the area are likely to be undersized, the losses through the grid are large and—even if the grid is updated—its installation and maintenance cost are higher.

By contrast, hydrogen can be stored and transported in any quantity to any user, in a similar manner to natural gas today. One possibility for rapidly expanding the hydrogen delivery infrastructure is to adapt part of the natural gas distribution system to carry a blend of natural gas and hydrogen (up to about 15% hydrogen), which requires only modest modifications. Converting to deliver pure hydrogen may require more substantial modifications. Current research and analyses are examining both approaches (1).

In addition, hydrogen can also be stored in natural or artificial salt caverns (2). The Teeside salt cavern in the U.K. stores 25 GWh of hydrogen at 45 bar pressure in three separate cavities, while the Clemens Dome salt cavern in Texas has a capacity of 92 GWh and pressure in the range of 70–135 bar. Two larger salt caverns (Moss Bluff and Spindletop), also in Texas, have capacities of 120 GWh (3). As for distribution, in addition to trucks, ships and trains, there are currently only about 3,000 km of commercial hydrogen pipelines worldwide (of which 1,300 km are in the U.S.), but eventually the millions of miles of natural gas pipelines can also be adapted for that purpose (4).

EV status report

The public perception that switching to battery-electric vehicles (BEV) will lower carbon emissions is mistaken because batteries are most often recharged with "grey" electricity, generated in carbon-emitting power plants or by other carbon-emitting processes. Today, only about 4% of BEVs use green electricity. A similarly low percentage of fuel-cell-operated electric vehicles (FCEV) use green hydrogen, though these percentages are slowly rising as more solar-roof-generated electricity is being used to recharge the families' electric cars. (In California, for example, there are 1.3 million solar homes and storage is compulsory.)

Ten years ago, only about 25,000 BEVs were on the roads. Today, they number 5.6 million, and by 2030, their number is projected to rise to about 200 million (10% of the total). Today, the global number of FCEVs (including buses and trucks) is roughly 100,000—small, but still larger than the number of BEVs a decade ago. The rate of increase of BEVs is limited by infrastructure availability. For example, there are now 125,000 regular gas stations in the U.S., while the global number of BEV charging stations in 2019 was only 25,000 and the number of hydrogen-fueling stations was about 500.

BEVs are superior to FCEVs in terms of costs and infrastructure availability. In Europe, prior to the Ukraine events, drivers paid around nine to 12 euros to drive 100 kilometers in an FCEV, while a BEV cost only two to seven euros per

100 kilometers (depending on electricity prices and subsidies in individual countries). The advantages of FCEVs include a free and unlimited fuel source, they emit only water, and driving range is higher, while their weight, refueling time and noise levels are all lower than that of BEVs.

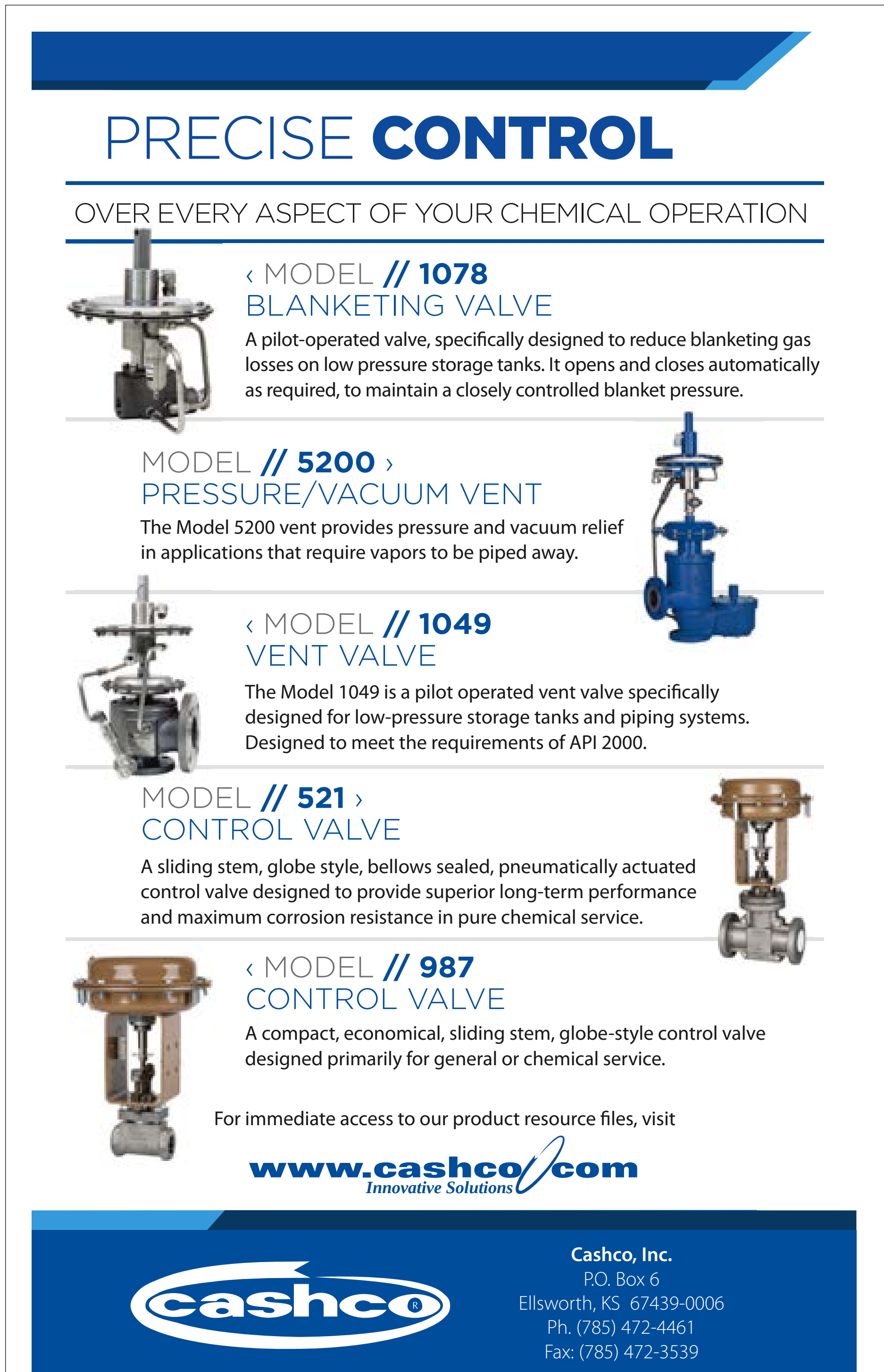
Battery limitations

Today, lithium-ion batteries are the dominant design. They contain lithium (Li), cobalt (Co), and nickel (Ni) in the cathode, graphite in the anode, as well as aluminum and copper in other cell and pack components. The electric storage capacity of a BEV averages about 60 kWh for regular and 12 kWh for plug-in hybrid EVs (PHEVs), respectively. Between 2020 and 2050, it's estimated the demand for lithium and cobalt will increase 20-fold and nickel will increase 30-fold.

If the number of electric vehicles on the roads increases to 200 million by 2030, keeping up with this demand will drastically increase battery costs, require battery recycling, and make FCEVs more competitive. Today's demand for EVs is the largest in China, Japan and South Korea.

Compared to the weight of fuel cells, batteries are at least 12 times heavier, with the weight of BEV battery packs ranging from 250 to 700 kg (550 to 1,500 pounds). The mass-based energy density of batteries is in the range of 0.1 to 0.27 kWh/kg. In comparison, gasoline is 13 kWh/kg and hydrogen gas at 700 bars pressure has an energy density of 39.6 kWh/kg. Batteries consume 0.24 kWh to 0.87 kWh of electricity per mile (an average of about 0.33 kWh per mile). For normal passenger cars, the capacity of battery packs ranges from 30 kWh to 100 kWh.

In an average BEV, the weight of the battery packs equals the weight of five or more passengers, and the volume of the batteries also limits the remaining free space. The low energy density of BEV batteries is also the reason for their relatively frequent recharging requirement. Their charging time is a function of the "Level" of charger used. In an hour, Level 1 chargers will supply enough electricity for 3-5 miles of driving; Level 2 chargers will provide 20-80 miles; Level 3 chargers will provide up to 200 miles; while "superchargers" will load enough electricity for 300 miles of driving in 15 minutes.



From grey to green hydrogen

Electrolyzers have long been used in industrial processes, but their use for dedicated hydrogen production hasn't-been widely adopted yet. When hydrogen is produced by carbon-emitting processes, it's called "grey," and when it's made by splitting water with electricity from renewable sources, it's called "green." Today, the production cost of green hydrogen is high compared to the cost of grey, and closing this gap is a key goal of the U.N. and the U.S.

In 2019, the global demand for hydrogen was about 70 million metric tons, of which half was used to make ammonia and fertilizers, and half was used in petrochemical refineries. Approximately 48% of hydrogen was produced from natural gas, 30% as a byproduct of petroleum refining and 20% from coal gasification (mostly in China). Compared to these numbers, the production and consumption of green hydrogen was negligible, but the Hydrogen Council expects green hydrogen production to reach 550 million metric tons by 2050—a significant jump from the roughly 0.36 million metric tons produced in 2019.

Today, the number of FCEVs on the roads is only about 1% of all EVs, but their numbers could rise, as did the number of BEVs during the last decade. What we do know is that Toyota and Hyundai have already developed fuel cells that are ready for mass production. And in Japan, Panasonic is already producing very small fuel cells for homes using hydrogen instead of battery-based electricity storage.

Also, FCEVs are already favored for use in buses, trucks and trains, and hydrogen airplanes are even under development and projected to be in mass production by 2035. ∞

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2. https://www.polytechnique.edu/en/content/salt-caverns-store-hydrogen
3. https://www.sciencedirect.com/topics/engineering/hydrogen-underground-storage
4. In my new book, *Controlling the Future*, to be published by ISA this spring, I cover the satellite, drone and ground sensor instrumentation that must be used to eliminate natural gas leakage. The 2% of all natural gas that leaks uncombusted from infrastructure today makes the greenhouse impact of natural gas as bad as coal.

When AI is, er, artificial

All 'smart' algorithms rely on organic creators to ensure their utility

INTELLIGENCE that's "anything but artificial" boast the ads for luxury, battery-powered cars. AI engines may be a boon to consumer marketers, who are getting better at mapping the robotic habits and appetites of their organic end users. But should we be tempering our expectations at all as we contemplate how such algorithms are applied to industrial processes?

A decade ago, our chief console operator, Chaz, witnessed the newly deployed model predictive control (MPC) application making moves in anticipation of changing measured variables and measured disturbances. He liked to call it "Spock's Brain," which fans of *Star Trek* TOS ("the original series," for the uninitiated) will recall featured a fetching alien intruder, who removes the science officer's brain to replace a worn-out brain controlling a subterranean HVAC. The newly lobotomized Spock accompanies the usual crew, who eventually discover his new role, ensuring his captors could remain cozy and comfortable in their 1960s go-go boots.

The creator and writers of science fiction have imagined AI like the conversant ship's computer on the Enterprise and *Knight Rider*'s KITT for decades. We're experiencing it firsthand now as we interact with Siri, Hey Google and Alexa, seeking navigation guidance, movie trivia, sports updates and even tuning suggestions for pH loops.

Just as the MPC controls were just doing math, there's no personality churning through the algorithms to answer questions on behalf of the Google or IOS user. These services are astonishing in their abilities to index and retrieve seemingly the sum of all human knowledge in seconds. However, they're balanced by the times they get it entirely wrong—no, I don't want to call the mayor of Tunis, I want to know if Meijer supermarket has tuna.

So, when a Bayesian optimization engine recently prompted the operators to drive the unit into perilous territory, Chaz likened it to another *Star Trek* TOS episode, "The Ultimate Computer," in which the brilliant scientist Dr. Richard Daystrom's M-5 computer was determined to wipe out all the humans in pursuit of self-preservation. The moral was that even the most thoughtfully crafted logic could lead to unintended consequences. It's incumbent on AI creators to imagine every if-then-else that might befall their programming. The engineers of self-driving cars, for example, must consider the torments their machine will encounter from humans determined to befuddle it. *Star Trek* enthusiasts will recall how Captain Kirk foiled the M-5 with its own logic. How prescient were the sci-fi writers and producers of the mid-20th century?

To boldly go

Data-lake mariners are also boldly going where no one has before—and have justifiable enthusiasm for the prospect of finding a new world of golden treasures in the murky depths. But, like the artificial lake made by the U.S. Army Corps of Engineers in the next county, no one bothered to clear all the stumps. Even though the lake may be vast and polluted by trash, one can hypothesize with some confidence that there are valuable insights to be found. Many providers promise their algorithms can dredge through the deposits of sediment, revealing correlations and forecasting trajectories.

Whatever you call your algorithm, George Box's maxim still applies: "All models are wrong, but some are useful." They exist almost exclusively in cyberspace, while their real-world counterparts are often haunted by all manner of curious, unmeasured disturbances and dynamics. Twinning something as simple as a waste heat incinerator and boiler can still run across relationships that defy "useful" modeling. It's not uncommon for carbon monoxide in the stack to react faster than the temperature sensors. Just try correlating that.

The process industries are no strangers to predictive controls and optimizers. Contemporary AI engines and methods have new promise as we channel more pervasive sensing and other flotsam into the data lake. But let's keep in mind that robots excel at being robotic, and fantasies like *Knight Rider*'s KITT or the Enterprise's guidance computer require organic intelligence to ensure their utility. ∞

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"Whatever you call your algorithm, George Box's maxim still applies: 'All models are wrong, but some are useful.' "

Reinventing the process historian

Analysis of non-process data streams is reshaping expectations

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"Perhaps NOA intends for the parallel communications to be a software-defined network (SDN) to the controller, rather than a completely new infrastructure."

THE role of the process historian is changing and expanding. Today, beyond its traditional, on-prem instantiation, it's likely to be part of (or input to) a corporate data lake, and store far more information than just process data from the control system. The first expansion of this incremental data collection is the asset management data associated with the field devices monitoring and controlling the process itself.

One model developed to increase access to this incremental data and integrate it with business systems is the NAMUR Open Architecture (NOA) concept. The underlying premise of NOA is to introduce an open interface between the existing core process control domain and a newly defined monitoring and optimization (M+O) domain, which is based on IT systems and extends up through existing Level 3 maintenance tools that run in parallel to the process control domain.

NOA does a wonderful job of developing the concepts, and as the authors indicate, future reports will provide additional details. However, all models in the NE 175 NOA report indicate a parallel connection to either the sensor itself or from the input/output (I/O) card. We've seen this concept before, as with the introduction of WirelessHART, where one of the use cases installed a parallel wireless network infrastructure with wireless "thumbs" to collect diagnostic information. This approach to gathering asset management information obviated the need to upgrade to I/O cards that supported HART.

Though the parallel system is one option, it circumvents all the constraints built up over the years to prevent changes to the control system that would affect security, safety and reliability—all under the management of change and reliability umbrella. Perhaps, if we could instead simplify the process of adding a new device (the approach being proposed by the FieldComm Group's PA-DIM information model), we might achieve the same result with less complexity.

With the increased adoption of Ethernet at the field level, bandwidth is no longer the challenge it once was, and perhaps NOA intends for the parallel communications to be a software-defined service like a software defined network (SDN) to the controller, rather than a completely new infrastructure. NOA is really all about getting the additional information available across the organization into an accessible context, where it can be used and useful. The document incorporates several interesting techniques to address cybersecurity, and importantly recognizes this need.

Data collection only the start

Collection of data is only one piece of the puzzle. Mining the data to convert it to information and knowledge is where the true value resides. Unfortunately, many organizations are simply building the lake—like the reservoir behind a dam—with the intent and hope that someday it will be useful. The artificial intelligence (AI) models to come will require historical information, so that part is correct. Of course, someone needs to train the AI models, which means setting the parameters for which pieces of data to use as the basis for the model, and cleaning up or at least flagging the periods when data is to be ignored. The historian will continue to be an important part of any control system, and its data management role is almost certain to expand to diagnostics, such as those demonstrated by fieldbus technology, which uses status verification to ensure only reliable data is used for closed-loop control.

The vast amounts of data now available also illustrate the importance of not only international standards to harmonize how data is shared and used, but also the importance that data science will play in our future.

Setting noble goals is all well and good, but if only step one is completed, the goal is never achieved, the effort becomes a money pit, and discouragement follows. However, this is where we in the automation profession shine. Making magic from masses of data is what we've done for years, if only to optimize our processes using the process data in our historians. ∞

E+H details process analysis plans

Endress+Hauser reveals strategies for process analytics and accompanying product releases

IN an extraordinarily detailed series of presentations, Endress+Hauser's (www.endress.com) leadership laid out their latest technical and organizational strategies in an online press conference on Feb. 8 that covered process analytics, corporate acquisitions, digitalization and other advances for meeting the needs of its customers worldwide.

For instance, laser-based analysis technologies accounted for about a quarter of Endress+Hauser's sales in 2021, and culminated in it's forming a new company, Endress+Hauser Optical Analysis, at the start of this year. This will reportedly make it possible for traditional flow and level technologies to also be used for measuring material properties such as density and viscosity.

Manfred Jagiella, member of Endress+Hauser's Executive Board

"Creating Endress+Hauser Optical Analysis moved ahead our analysis strategy. Raman spectroscopy and tunable diode laser absorption spectroscopy (TDLAS) fit perfectly as advanced technologies in our analysis portfolio, and create new opportunities for our customers through added-value innovations," says Manfred Jagiella, member of Endress+Hauser's Executive Board. "Raman spectroscopy is an ideal method for users in the life sciences industry, for example in vaccine production. TDLAS opens up further opportunities for us in the global market for gas analysis. Merging SpectraSensors and Kaiser Optical Systems puts us in an even better position to solve customers' challenges by bundling our expertise in laser spectroscopy. Together with Endress+Hauser Liquid Analysis and Analytik Jena, we have an extremely strong analysis portfolio for customers worldwide."

In fact, Endress+Hauser Liquid Analysis and Analytik Jena are already developing a common platform for data management between lab and process applications. This Netilion IIoT ecosystem will serve as a data link to give users valuable information, and will also be the basis for future digital services.

To bring advanced analysis processes to its users, Endress+Hauser Optical Analysis added existing structures, personnel and know-how to its center of competence for process analyzers in Lyon, France, which has 21 staffers, and supports 40 sales and service engineers across Europe. It also added new structures to support its customers, and plans to expand this model in North America and Asia. The center is certified in accordance with ISO 9001, ATEX and IECEX requirements.

Jagiella reported that Endress+Hauser is likewise concentrating on its core product portfolio for analyzing gas, liquids and solids. "We'll expand our successful platforms for liquid analysis, such as Liquiline and Memosens, with new sophisticated functions and several added parameters, such as oil in water," added Jagiella. "We'll also bundle our core expertise and our know-how across lab and process analytics even more extensively. Our innovative CA80 family of analyzers is growing by adding parameters. We sold more than 2,000 analyzers in 2021, mainly for applications in the wastewater and power plant sectors. Likewise, Endress+Hauser Optical Analysis is offering its new J22 gas analyzer, which is the first product in our new TDLAS instrument platform. Plus, we're also investing in further development of the Raman spectroscopy technology for new applications."

Products featured in the presentations included:

- J22 TDLAS gas analyzer, which includes Endress+Hauser's Heartbeat diagnostic, monitoring and verification, comprehensive process monitoring, alarms for critical measurement values, web server for data access, robust enclosure, improved isolation and enclosure heating, and easy-to-remove gas sample cells.
- CKI50 process spectrometer from Endress+Hauser's Memosens Wave family detects colors by employing VIS spectroscopy. It scans the 380 nm to 830 nm wavelength range of the electromagnetic spectrum and outputs the color in the form of CIE L*a*b* values, a three-dimensional color space model in which every color location is defined by the coordinates L*, a* and b*. Mathematical analysis models for analyzing spectroscopic results are stored in the instrument.
- Proline Promass Q Coriolis flowmeter has a density specification of 0.1 kg/m3, and provides dedicated application software packages for specific industries from food to oil refineries, and a web server. It will soon be available with a nominal diameter range of DN 25 with the premium-density option, which is usually deployed in bypass as a pure density monitor.
- Solitrend continuous, process-based moisture sensors are based on TDR technology to precisely determine the water content of bulk solids based on the runtime of a radar impulse across a ceramic measurement cell, using the physical effect of the increasing dielectric constant as it relates to increased water content. These moisture sensors are installed directly in the bulk solid stream with the help of a bracket to ensure fast and reliable measurements.
- CA79 total organic carbon (TOC) analyzer operates with a proven UV-oxidation process and differential conductivity measurements. With a response time (t90) of 50 seconds, it constantly delivers reliable, precise measurement values, so users can immediately recognize if the quality of ultrapure water has deteriorated and react immediately to prevent contamination.

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VEGA launches multi-application radar level sensor

VEGA Americas Inc. (www.vega.com) reported on several milestones during its online Feb. 24 press conference, including its June 1 opening of a new headquarters in Mason, Ohio, near Cincinnati, and the recent sale of its one-millionth radar-level device worldwide. However, these items were eclipsed by its unveiling of a game-changing radar level sensor that's both simpler and can measure in every application and setting.

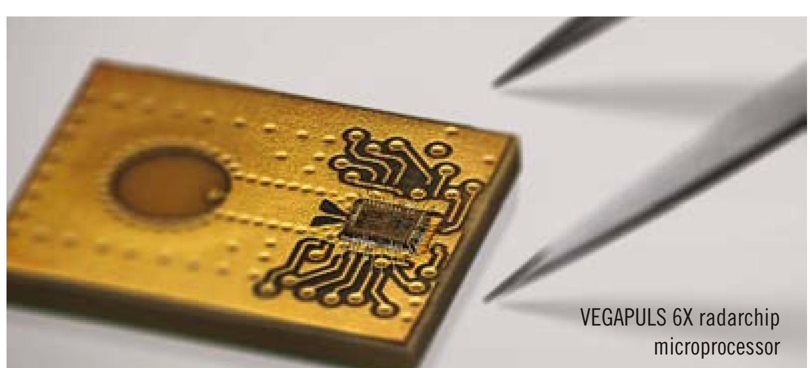
"We gained a lot of experience selling 1 million devices, which let users interpret future signals and limits, and also help them create safe environments that limit risk," said John Groom, co-CEO at VEGA Americas. "For example, our compact radar sensors have increased in food, pharmaceutical and water/wastewater applications as they expanded during the pandemic, while we also sold 85,000 Proline components for more complex processes last year. We know what to use where, but all these frequencies, measurement ranges, medium properties and other options can be confusing for users trying to secure the best measurement for their situation."

VEGA experts already answer these questions for users worldwide, but now it's offering a device that can make their choices even simpler. Scheduled to ship in early May, VEGAPULS 6X radar sensor can employ several frequencies, and measure in all types of applications and mediums from liquids to bulk solids. It also simplifies configuration with software that lets users adjust for six key parameters, such as vessel height, distance, and measurement, application and medium types.

VEGAPULS 6X's versatility is accomplished by VEGA's new "radarchip" microprocessor, which it developed in-house, and provides expanded application possibilities and simpler operation, and a self-diagnosis system that immediately detects damage or interference and ensures significantly higher availability and safety. The radarchip's improved dynamic range and sensitivity gives VEGAPULS 6X at least a 120-meter measurement range with ±1 mm accuracy, while its improved bandwidth and resolution lets the sensor measure solids down to just 12 inches from the top of vessels.

"VEGAPULS 6X makes the process of configuring your sensor simple," said Scott Rollman, sales director at VEGA. "Our customers can now choose the very best sensor possible as dictated by the application that they have great knowledge about. The days of having to know many confusing model numbers and frequency ranges are over."

VEGAPULS 6X is the company's first 80-GHz sensor with SIL certification. It also complies with the IEC 62443-4-2 cybersecurity standard. "SIL certification means safety from inside the device, while IEC 62433 compliance means safety from external threats," added Greg Tischler, product manager at VEGA. ∞



VEGAPULS 6X radarchip microprocessor

SIGNALS AND INDICATORS

- **HITA** (www.hita.be), a deep geothermal energy company in Belgium, reported Feb. 22 that it's selected **Emerson** (www.emerson.com/skua-gocad) to help it discover and develop geothermal energy sources in northern Belgium. Emerson's SKUA-GOCAD geological and reservoir modeling software will reduce risk in selecting drilling locations by creating highly realistic models designed for easy interpretation.

- **Honeywell** (process.honeywell.com) reported Feb.1 that it's working with **Walvax Biotechnology Co., Ltd.** (en.walvax.com) to provide automation control solutions to achieve intelligent and digitized vaccine production for China's first mRNA COVID-19 vaccine production plant. Honeywell will deploy batch process control, building management solutions (BMS) and energy management systems (EMS) at Walvax to optimize production.

- **Motion Industries Inc.** (www.Motion.com) launched Feb. 2 its Motion Automation Intelligence (ai.motion.com) automation business brand. MotionAi consists of its value-added engineering divisions, including AMMC, Axis, Braas, F&L, Integro, Kaman Automation and Numatic Engineering.

- **GE Digital** (www.ge.com/digital) reported Feb. 11 that Dr. Colin Parris, CTO and a GE officer, has been elected as a member of the **National Academy of Engineering** (www.nae.edu) for leadership, advancing industrial operational technologies, and innovation based on digital data analytics and IoT. He is joined by Dr. Manoj Shah, an engineer at GE and GE Research, and professor of electrical, computer and systems engineering at Rensselaer Polytechnic Institute, who was elected for contributions to design, analysis and electric machine performance enhancements. The third GE honoree is John McDonald, smart grid business development leader at GE Grid Solutions, who was elected for leadership in smart grid development and for advancing the professional growth of power system engineers.

- **Wind River** (www.windriver.com) reported Feb. 24 that it's supporting **Intel**'s (www.intel.com) Xeon D processors. This support is part of a multiyear effort to optimize Wind River Studio for Intel IoT system-on-chip (SoC) offerings. Their combined technologies will address the challenges of enabling greater computing power and capabilities in space- and power-constrained rugged environments of verticals to meet the demands of edge applications.

- **Siemens Digital Industries Software** (www.sw.siemens.com) reported Feb. 23 that it's collaborating with **NVIDIA** (www.nvidia.com) on simulating computational fluid dynamics (CFD). Part of the Xcelerator portfolio of software and services, Simcenter Star-CCM+ 2022.1 software, is integrating CUDA-enabled GPU acceleration to deliver faster turnaround times at lower hardware investment costs to CFD simulation within design and engineering organizations.

- **Schneider Electric** (www.se.com) reported Feb. 21 that its EcoStruxure Foxboro DCS has been certified as compliant with ISASecure System Security Assurance 4.0.0 Level 1 ISA/IEC 62443-3-3 cybersecurity standard. This endorsement complements its existing ISA/IEC 62443-4-2 ISASecure Component Security Assurance (CSA) 1.0.0 and ISA/IEC 62443-4-1 ISASecure Security Development Lifecycle Assurance (SDLA) 2.0.0 certifications, and its IEC 62443-2-4 System Integrator Security for Industrial automation and control systems certifications achieved in 2019-21.

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Coriolis technology fueling chemical industry transformation

MICHAEL MACHUCA
Marketing Director,
Chemical Measurement Solutions,
Emerson

BACK when Micro Motion debuted the first Coriolis meter some 45 years ago, the chemical industry was really the first to recognize the inherent advantages of direct mass flow measurement. At first, it was all about the ability to precisely control the molecular ratios of reagents, which after all is what chemical reactions are all about. But over the intervening years, Coriolis technology—along with a range of complementary Emerson instrumentation technologies—have proven their worth along with many other dimensions as well. To further explore the transformative aspects of Coriolis technology and associated instrumentation for chemical industry operations, *Control* caught up with Michael Machuca, director of chemical industry marketing, Emerson.

Q: What do you see as the key challenges demanding the attention of the chemical industry?

A: Traditionally, three things have been of foremost concern for chemical makers. First, safety remains the highest level of focus. The second focus area is maintaining consistent levels of product quality, which has become especially challenging when you consider the increasingly diverse formulations demanded in the specialty chemicals space. The third has to do with supply chains—the ability to meet customer demands by delivering the right product at the right time. Two additional concerns that have moved to the forefront more recently are increased sustainability—which it seems every customer and government agency is clamoring for—and dealing with the recent effects of inflation. Increasing material and energy costs are having a significant impact on the operating margins of chemical manufacturers.

Q: In the past several years, digital transformation has emerged as a key initiative for manufacturers of all stripes. From an instrumentation perspective, how is Emerson helping to advance digital transformation in the chemical industry?

A: In this context, digital transformation is all about using the ancillary data that instruments generate to offer advanced diagnostics about instrument performance as well as process conditions. Smart Meter Verification, which Emerson debuted back in 2010, was ahead of the broader digital transformation movement and was a real breakthrough. By ensuring that a Coriolis meter's unique vibration signature had remained unchanged, it provided an extremely high assurance that the meter continued to operate as it did when installed or last calibrated. This allows users unparalleled confidence in our Micro Motion Coriolis meters and obviates the need to pull them from service for calibration as often as other flowmeter technologies.

Q: Coriolis seems to be expanding its footprint more broadly across the application landscape. What's changed?

A: Users are moving to Coriolis meters over other flow metering devices for their critical attributes, including direct mass measurement, multivariable output and no moving parts. Micro Motion 4200 two-wire transmitters have made the shift to Coriolis technology easier with existing 4-20 mA infrastructure. Meanwhile, we expanded the range of meter sizes available, and adapted them to higher pressures and temperatures.

Q: Batch applications are a particularly good fit for Coriolis meters relative to other flow measurement technologies. Can you explain why this is so?

A: Batching brings a different set of complexities than continuous processes, and when you look at specialty chemicals that are produced primarily in batches, Coriolis meters have proven to significantly reduce batch cycle time, increase batch predictability and even reduce waste and energy use. Many specialty chemical makers use multiple recipes and multiple feedlines that converge on a single flowmeter to be dispensed into a batch reactor. Traditionally, they used volumetric measurements and no density check to track product changeovers, resulting in inconsistencies from one batch to the next, and even the wrong product being erroneously batched in, resulting in loss of the entire batch. We've seen users, who changed over to Coriolis, use density to verify that the correct ingredient is added. Between reduced scrap, reduced cycle times and savings in energy, we've seen the switch to Coriolis meters pay for itself in as little as two months of operation.

Q: Speaking of batch applications, Emerson has broadened its portfolio of related instrumentation to include insertion meters for density and viscosity measurement as well as Coriolis meters. Can you give some examples of how these instruments are being used to precisely define, for example, reaction endpoints more precisely than other methods?

A: Both density and viscosity are qualitative measurements and can confirm that a desired degree of reaction or endpoint has been reached. For example, we worked with an acrylic manufacturer that had a 20-second window in which to stop a polymerization reaction—and if they failed to quench the batch in time, it was wasted. Adding a simple fork viscometer to the reaction vessel increased visibility of reaction completion, and dramatically reduced wasted batches.

Q: It seems that sustainability, specifically in the context of reducing greenhouse gas emissions, has displaced predictive diagnostics as the "killer app" for industry's digital transformation initiatives. Emerson's instrumentation technologies certainly play a role in providing greater visibility and accountability when it comes to greenhouse gas emissions, but they're also being used in more active roles to advance sustainability. How are Emerson instrumentation technologies making a difference, and how do they fit into Emerson's larger sustainability commitments?

A: Emerson has a three-pronged focus on sustainability, which includes "greening of" our own operations, "greening by" which is what we help do for our customers' operations, and "greening with" in which as we invest in university and other programs to innovate and advance new technologies in the sustainability arena.

End users in the chemical industry are moving to Coriolis meters over other flow metering devices for their critical attributes, including direct mass measurement, multivariable output and no moving parts.

One key area we're working on with partners is carbon capture using amine-based absorption processes. Density, it turns out, is a critical control parameter that correlates directly to the concentration of absorbed carbon dioxide. The custody transfer of high-pressure carbon dioxide and hydrogen is also an ideal application for Coriolis. The production of lithium batteries used for electrical energy storage involves very corrosive processes, where flow measurement and pH analysis are needed. Plastics recycling, too, is pushing toward catalyzed pyrolysis to convert plastic wastes back into reusable monomers or polymers, and our instrumentation technologies are helping to make these processes a practical reality.

These are just a few of the broad range of customers and organizations across the chemical industry that Emerson is engaging with to better understand how they can improve and optimize their processes, all with an eye on more sustainable operations. Across our company, Emerson is highly relevant to a more sustainable future with expertise, technologies, solutions and a global perspective that can help the world find a path forward. ∞

BY JIM MONTAGUE

RUBBER MEETS ROAD

OPAF/O-PAS efforts gaining global traction

THE green light may not be fully lit yet, but the starter's flag is certainly on its way down. But, because even the best-laid plans can go astray, the members of the Open Process Automation Forum (www.opengroup.org/opaf) can be forgiven if they seem a little obsessed with getting the Open Process Automation Standard (O-PAS) ready for interoperability testing, conformance certification and eventually widespread implementation. Several OPAF leaders presented a Feb. 16 update on its activities over the past 12 months. The previous year's highlights included:

- Publication last May of O-PAS Version 2.1 Preliminary (V2.1, publications.opengroup.org/standards/opa) and the debut of Part 6.5 covering IEC 61499;
- Interoperability workshop in January, where a dozen suppliers explored how well their devices meet O-PAS requirements;
- Announced a "first wave" for the second half of 2022 of formal conformance testing and certification of compliance with O-PAS rules for cybersecurity, network interoperability, systems management, and initial phases of distributed control node (DCN) physical platform profiles; and
- Publication this past December of the O-PAS Business Guide, Version 2.0 (publications.opengroup.org/g182), which shows the value proposition of the standard and how potential participants can make a business case for it. OPAF's Business Working Group is also drafting a reference implementation guide to help users adopt O-PAS.

"We have 110 organization members, including 22 operating companies, six of the major DCS suppliers, and a host of other suppliers and system integrators," says Don Bartusiak, co-chair of OPAF and president of Collaborative Systems Integration (CSI-automation.com). "We also held an end-user caucus last June that was attended by 179 people, which radically exceeded our expectations and was really gratifying. The current theme for OPAF and O-PAS is 'making theory work in practice.' "

Bartusiak reports O-PAS is already running in several real-world prototype projects, which are producing vital know-how from which all participants can benefit, especially when they seek to scale up interoperable systems and process applications in the future. These projects include:

- Open Process Automation (OPA) Test Lab operated by ExxonMobil Research and Engineering (corporate.exxonmobil.com) near Houston, with system integration and administration support from Yokogawa (www.yokogawa.com/us). ExxonMobil is also investing in a related O-PAS field trial with more than 2,000 I/O that's scheduled for commissioning in 2023.

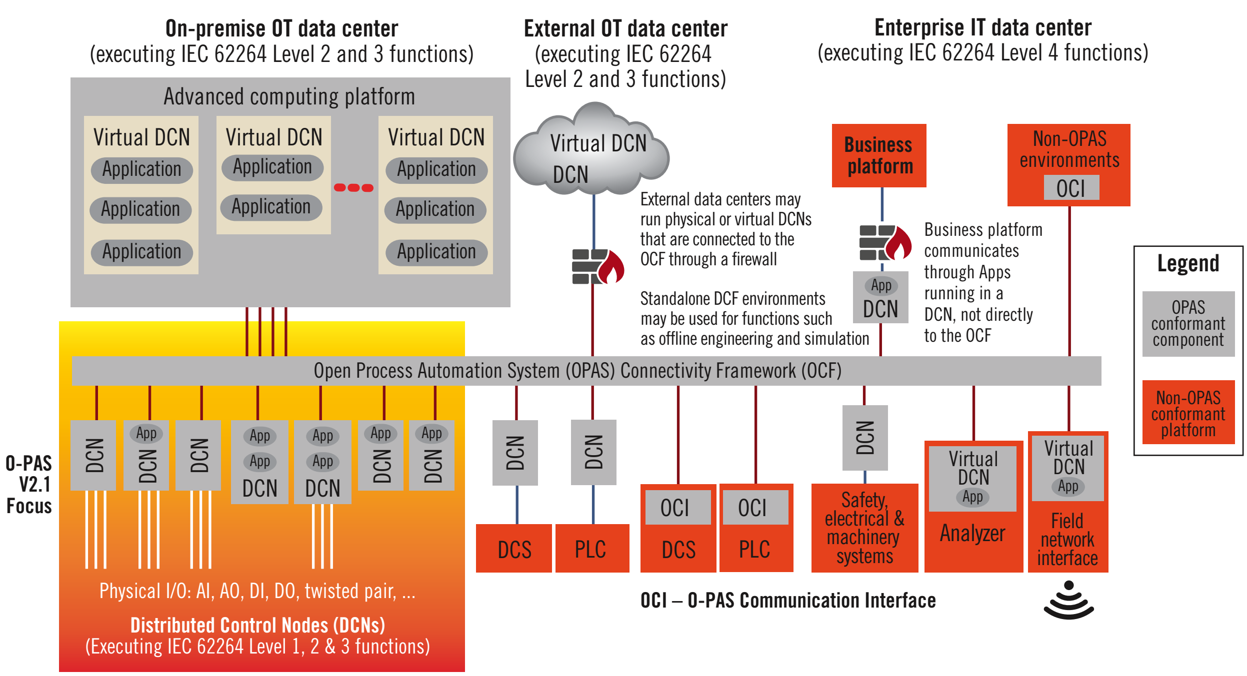
- O-PAS demonstration board by Georgia Pacific (www.gp.com) for improving data access and achieving savings at its 150 manufacturing sites.
- BASF's (www.basf.com) OPA demonstrator for the chemicals industry with four water tanks and managed control loops, which uses Module Type Package (MTP) technology based on the NAMUR Open Architecture (NOA) program.
- Middle East OPA Testbed by Saudi Aramco (www.aramco.com) and Schneider Electric (www.se.com) that hosts the test lab at its Innovation and Research Center in Daharan.
- Dow Chemical's (www.dow.com) MxD open architecture testbed is reportedly exploring OPA along with digital twin concepts.

To help other potential players explore O-PAS and develop their own experiments, proof of concepts and prototypes, several OPAF-member suppliers and system integrators recently organized the Coalition for Open Process Automation (COPA). They include CSI, CPlane.ai, Codesys, Phoenix Contact, Smar and ERDi i4.0 TestLab at the University of Western Australia and in Perth. COPA has developed and is offering its QuickStart training program on using O-PAS for control system interoperability. (A video of its demonstration is at explore.copacontrol.org)

Greater than parts

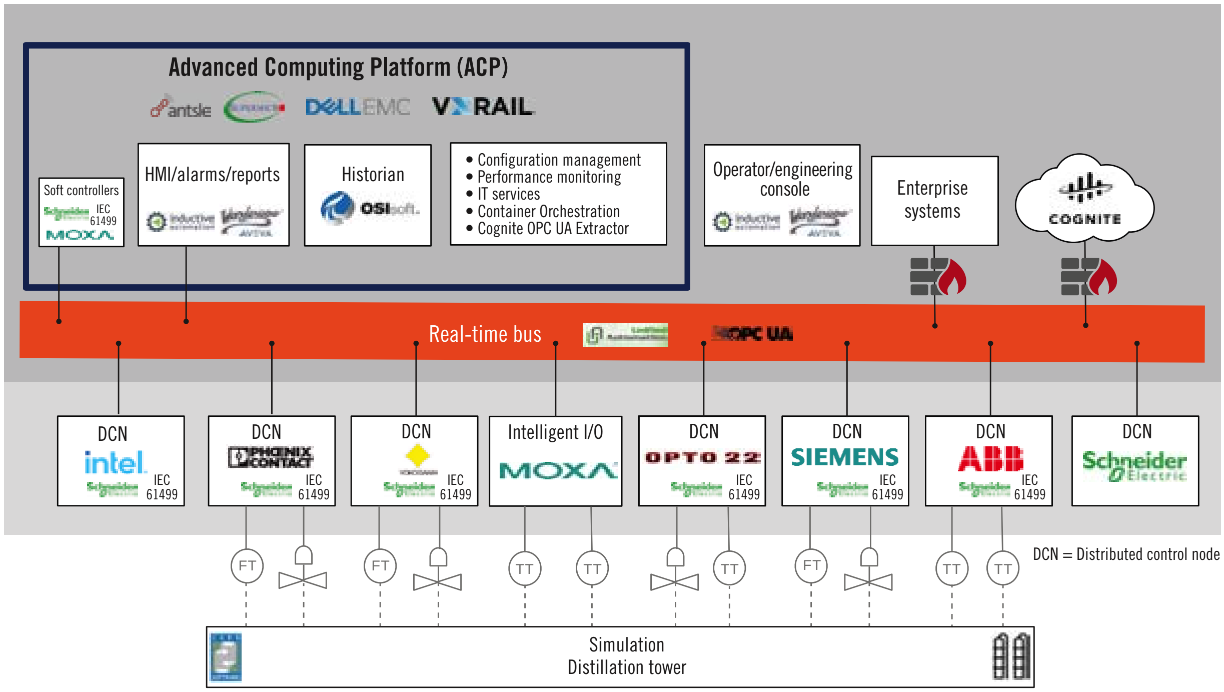
Because OPAF wants to create a "standard of standards" that saves time and labor on the way to interoperable process control, it includes pieces from many standards, protocols and technologies. However, this makes it crucial to keep track of all those pieces. Dave Emerson, co-chair of OPAF's Enterprise Architecture Working Group (EAWG) and VP of the U.S. Technology Center at Yokogawa, provided an update at the Feb. 16 meeting.

The recent publication of Part 3 and introduction of Part 6.5 followed the March 2021 general release of V2.1, which covers many of the DCNs that connect to the OCF in the overall O-PAS technical architecture (Figure 1). V2.1 consists of:



READY, SET, TEST

Figure 1: Open Process Automation Standard (O-PAS), Version 2.1 Preliminary (V2.1) covers distributed control nodes (DCN) that connect to the O-PAS connectivity framework (OCF) and O-PAS communication interface (OCI) in the overall O-PAS technical architecture. The Open Process Automation Forum (OPAF) is quickly developing functional profiles for DCNs, OCF, OCIs and other functions, which it can use to create conformance tests for products, so they can be certified as O-PAS compliant. Preliminary interoperability workshops are allowing suppliers to check their devices before testing likely begins in the second half of 2022. Source: OPAF



GOING TO (FIELD) TRIALS

Figure 2: The Open Process Automation (OPA) Test Lab operated by ExxonMobil with support from Yokogawa operates four process environments controlled by an open-process system architecture with DCNs communicating via an OCF network. After running for about two years, it's apparently generated enough positive results that ExxonMobil is investing in a related O-PAS field trial with more than 2,000 I/O that's scheduled for commissioning in 2023. Source: ExxonMobil

- Part 1 on technical architecture is based on IEC 62264 (ISA-95) as a reference standard and provides an overview.
- Part 2 for built-in security is based on IEC 62443 (ISA-99). OPAF's subcommittees created checklists about which parts of IEC 62443 apply to which parts of O-PAS.
- Part 3 on profiles for conformance and certification. It collects features and functions, and breaks products down to functional levels that can be conformance tested and certified.
- Part 4 on connectivity is based on IEC 62541 (OPC UA).
- Part 5 on interoperable system management uses DMTF's (dmtf.org) Redfish standard and the REST protocol to specify information reporting by platforms such as DCNs. This allows different profiles and software to be certified, and requires each supplier to report their information in a consistent way.
- Part 6 with Part 6.1 on information and exchange models using OPC UA; Part 6.2 on basic configuration using OPC UA's information model; Part 6.3 on alarms based on IEC 62682 (ISA-18.2), Part 6.4 on reference function blocks; Part 6.5 on IEC 61499 event-based programming, and Part 6.6 on IEC 61131-3, which both determine how function blocks should be opened.
- Part 7 on physical platform with a reference standard to be determined.

"Because Part 5 on system management requires consistent reporting, it provides the overall 'systemness' that O-PAS is seeking, and allows users to count on the information that's displayed," says Emerson. "Likewise, for cybersecurity in Part 2, if all components comply with IEC 62443, then when a system is put together, it's also easier for the system integrator to be responsible for system-level testing and certification."

In the same way, Emerson reports that O-PAS, V2.1, Part 6.2 on configuration adds vocabulary that tightly defines and controls system data, while Part 6.3 on alarms requires uniform reporting, so each supplier has to provide a common way to do it. "Each supplier used to publish alarms and event conditions in different formats, so users had to waste time with different types of messages," explains Emerson. "Consistent reporting means they can save time. In addition, Part 6.4 is trying to give users a set of reference function blocks, so they can have consistent tests, and be able to compare apples to apples."

Finally, Emerson adds that Part 6 and O-PAS also strive for consistent functions, which can be scaled down to the smallest control systems or scaled up to the largest systems, and be applied in all types of process industries, instead being restricted to one industry or a small group of end users. "We're not solving one industry's problems anymore. We're trying to solve the problems of many applications and industries at the same time," adds Emerson. "For instance, scalable O-PAS can go into each windmill at a wind farm, and bring them all together. In the future, we believe Version 3 (V3) will allow application portability between different systems, which will allow more workloads, smoother performance, and greater reliability and resilience. Users will also be able to pull and replace standard, O-PAS hardware without impacting the larger system."

Testing takes off

To deliver the consistent functions it requires to achieve interoperability between devices, O-PAS requires thorough conformance testing and certification. The first wave of submitting and testing products for compliance with O-PAS is expected to begin at authorized labs and facilities in the second half of this year.

"There are many components that will be tested and certified based on O-PAS profiles set by OPAF's technical and business working groups," says Ed Agis, co-chair of OPAF's certification working group (CWG) and senior director of compliance and certification at Intel (www.intel.com). "Once they develop conformance tests for profiles like OPC UA, suppliers will work with third-party verification labs to get their products tested. Test results will be validated and verified, and OPAF will get the results."

Just as they already contributed to O-PAS, organizations responsible for particular standards within it are also likely to facilitate the testing process. These include the OPC Foundation, ISA Security Compliance Institute (ISCI), DMTF and others. They and OPAF have already held interoperability events or "plug fests" to examine products and gauge their readiness for eventual testing. The latest was the January workshop attended by a dozen suppliers, and another will be held in July or August if enough products and suppliers are available.

"The beauty of these events is they let participants run test scenarios for their devices using functions based on O-PAS specifications, and see how well they work together," says Agis. "We tested software function blocks, execution engines and other capabilities in January, and now we're distilling the results. For example, O-PAS developers can see if its specification are working, while suppliers can learn whether they understand O-PAS and can work with other suppliers, and both can show end users where O-PAS is at and how well it's working. After a workshop, suppliers also get time to adjust their products in preparation for eventual testing. Most of what's needed for the first wave of testing is in place. Future O-PAS profiles will be introduced and tested for in subsequent waves."

Bartusiak adds that OPAF's recent interoperability workshops are similar to events that the OPC Foundation and other organizations use to advance their protocols. "We're just testing aspects of O-PAS and its interoperability," says Bartusiak. "So, we'll focus on data bundling into signals, and whether devices can do it. In the latest session, we tested O-PAS global discovery service

(GDS). Suppliers got hardware and software to do the 'blocking and tackling' needed for system management, and many succeeded in making progress. However, we need to continue clarifying about function block layouts and the lines between them that signify data exchanges, and keep on raising everyone's collective understanding about collecting and communicating data."

Finally–field trials

As usual, the most extensive implementation of O-PAS-related devices, software and networking is the OPA Test Lab operated by ExxonMobil with support from Yokogawa at its Woodlands facility near Houston. The lab's testbed consists of four process environments responsible for development, testing and validation, acceptance testing of user applications, and production with continuous operation and demonstration functions. It's controlled by an open-process system architecture with DCNs communicating via an OCF network that also works with an advanced computing platform (ACP) (Figure 2).

After running for about two years and generating a trove of interoperability know-how, the testbed has apparently generated enough positive results that ExxonMobil is investing in a O-PAS field trial at a brownfield manufacturing facility on the U.S. Gulf Coast. Presently at the front-end engineering and design (FEED) stage, the field trial is expected to have more than 2,000 I/O and 90-100 control loops. It will be enabled by components from a host of as-yet unspecified suppliers, and Yokogawa will act as system integrator and contractor. The field trial is scheduled to be commissioned in 2023.

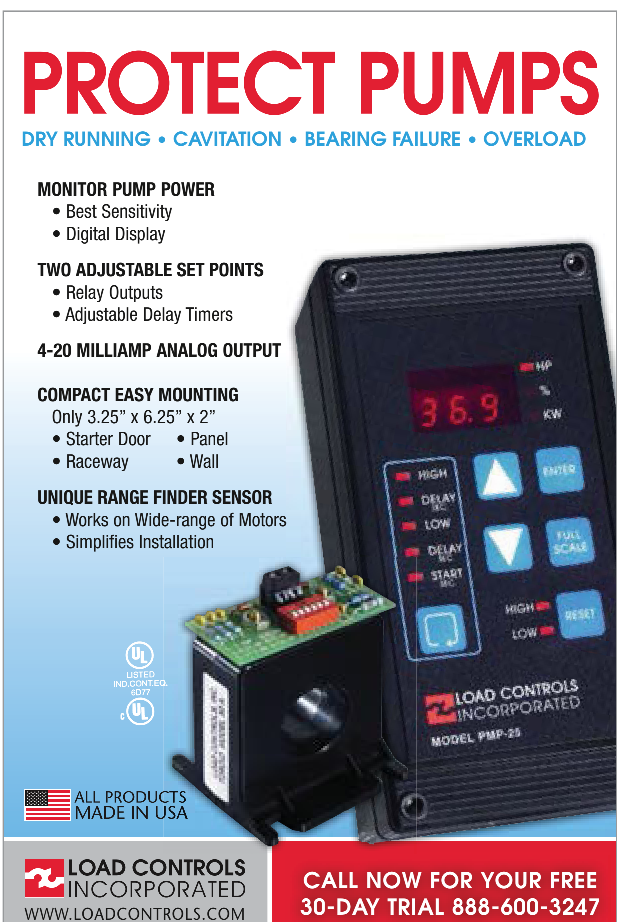
"The OPA Test Lab showed we could take existing products and implement a cohesive, successful system that's consistent with O-PAS," says Ryan Smeltzer, OPA program manager at ExxonMobil Research and Engineering. "We used the testbed to derisk open process automation, and convince ourselves that it could add value and generate a successful return on investment (ROI). The test bed was also our way to qualify products against ExxonMobil's requirements and match O-PAS, too."

Smeltzer reports the testbed also let ExxonMobil assess that it met the functional requirements, which would allow its O-PAS deployment to meet most of the performance needs it would have to deliver in the field. Its developers also devised paths to closure for the remaining functions, so they could be achieved later. This enabled ExxonMobil's management to approve investing in the new field trial project last October.

"The manufacturing facility is a single-console operation, and the field trial will implement O-PAS, V2.1, employ OPC UA communications, and use the IEC 61499 control run-time standard, which is a reference architecture for executing regulatory and supervisory control," explains Smeltzer. "These interoperable controls will provide the industrial control functionality typically provided by a DCS and PLCs. We expect the ROI from the field trial will come from applying advanced applications enabled by O-PAS, and interoperability will deliver the improved capabilities and benefits that process users have been seeking for a long time. O-PAS will allow end users to employ best-in-class components from the full range of products that fulfill its requirements. The standard is still at the 'wet paint' stage, but many suppliers are recognizing that O-PAS is what users want, so they're developing or adjusting products to meet it."

Beyond O-PAS-enabled I/O, DCNs and OCF networking, Smeltzer adds that ExxonMobil is also exploring how ACP could perform control tasks in a hyper-converged architecture, which could also be part of the field trial.

"For some process functions, there are limited products that meet our needs, so we're also investigating how ACP can help us do low-latency, high-availability control that would be decoupled from and independent of the usual control hardware," adds Smeltzer. "We're excited that ExxonMobil can be a catalyst for the O-PAS ecosystem in the process industry, and that we can use our field trial to hopefully encourage other users to develop and implement their own field trials. These are especially critical for O-PAS to succeed industry-wide, so we're also sharing what we're learning in our testbed and field trial, so others can use O-PAS for control and automation, too." ∞



Edge solution conquers connectivity challenges

Remote vision, inspection and detection solution is powered by advanced edge computing

by Kaylor Greenstreet, Twin Eagle Solutions

MANY industries—such as upstream oil and gas, water/wastewater, renewable energy and power distribution utilities—operate large numbers of remote sites. Modern sensors, automation systems and connectivity are vital for monitoring and controlling these widely dispersed assets. But many of these operations also demand onsite inspections by personnel, in some cases at every site, every day.

It's tempting to think that the proliferation of consumer-grade cameras could be leveraged to help these companies keep an eye on their assets, but the reality is there are many technical reasons why only industrial-grade solutions will work in the long run. Connectivity to remote locations is expensive, limited in bandwidth and often intermittent, so a degree of intelligence must be built into any such solution to process and store data.

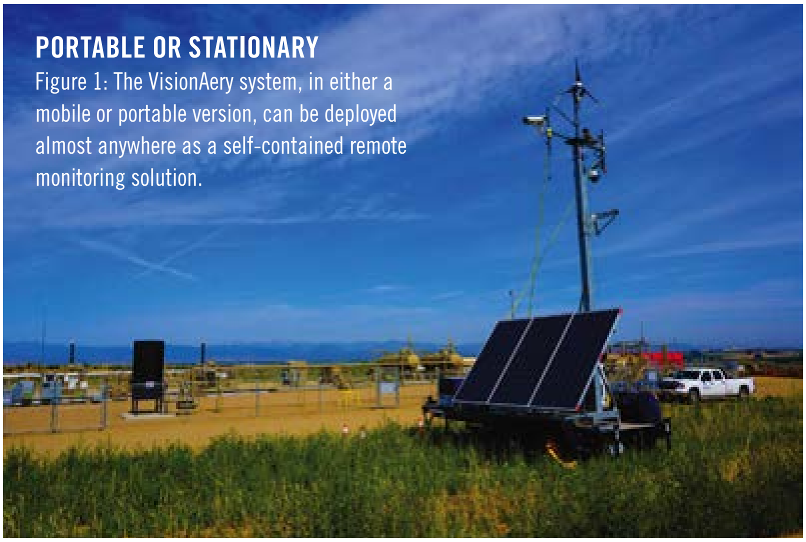
Twin Eagle Solutions (www.twineagle-solutions.com) was founded more than 20 years ago as an industrial wireless consulting company, and it has extensive experience in that field, along with enterprise-networking and edge-computing expertise. Understanding the need for always-on solutions that can excel in the harshest conditions with limited bandwidth, it combines advanced edge and Industrial IoT (IIoT) technologies to push data and imaging information cost-effectively from the edge to the office, without straining the network infrastructure.

Long distance dilemmas

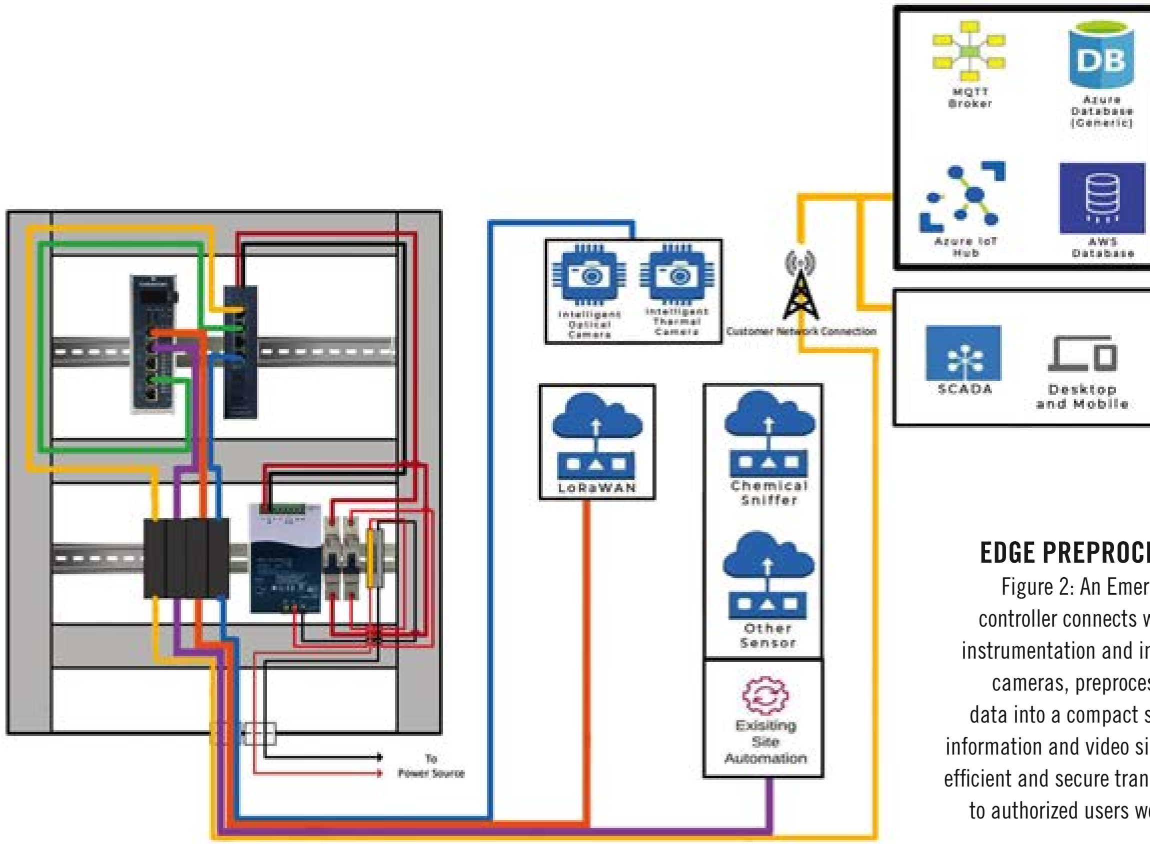
Automated production and operation sites in remote areas usually require attention beyond what can be provided by traditional instrumentation, programmable logic controllers (PLCs), human-machine interfaces (HMIs), and supervisory control and data acquisition (SCADA) systems. This often takes the form of in-person visits by operations, maintenance or engineering personnel. However, it's very expensive to deploy personnel to remote sites in terms of worker hours and travel expenses, and it increases risk of exposure to hazardous materials.

Even if a worker detects a problem, such as a leak, there may not be any indication of how long it's persisted. The leak could have started one minute before it was spotted or one minute after the last worker visit. End users everywhere are familiar with cameras used to monitor commercial and residential locations, so it seems natural to apply similar technology to industrial sites. Modern video and still cameras have the potential to take the place of some site visits, saving money and improving employee safety. If a picture is worth a 1,000 words, a video or enhanced video is worth much more.

Unfortunately, remote sites typically don't have fast, inexpensive or reliable upstream networking connections, so bandwidth usage must be carefully controlled. This means that local (edge) pre-



PORTABLE OR STATIONARY
Figure 1: The VisionAery system, in either a mobile or portable version, can be deployed almost anywhere as a self-contained remote monitoring solution.



EDGE PREPROCESSING

Figure 2: An Emerson edge controller connects with local instrumentation and intelligent cameras, preprocessing the data into a compact stream of information and video signals for efficient and secure transmission to authorized users worldwide.

processing is needed to evaluate video signals in near-real-time, and condense the data transferred upstream. Some industrial cameras with a certain level of intelligence are available, but another common need is to coordinate video information with other inputs from field sensors or smart devices such as analyzers. This provides a complete monitoring solution.

One other point to consider is how the Internet and cloud computing are used for a given implementation. Solutions that rely heavily or exclusively on these technologies may not be suitable for remote industrial applications. From a business standpoint, even if a remote monitoring solution uses some aspect of cloud computing or connectivity, many companies want to own and manage their own data, rather than leasing it as a service.

A better vantage point

Recognizing these and other issues, the Twin Eagle Solutions team applied years of field-networking experience to develop its VisionAery solutions. They became practical, in part, because of the availability and performance of Emerson's (www.emerson.com) edge controllers and industrial PCs (IPCs), both designed and rated for use in challenging environments.

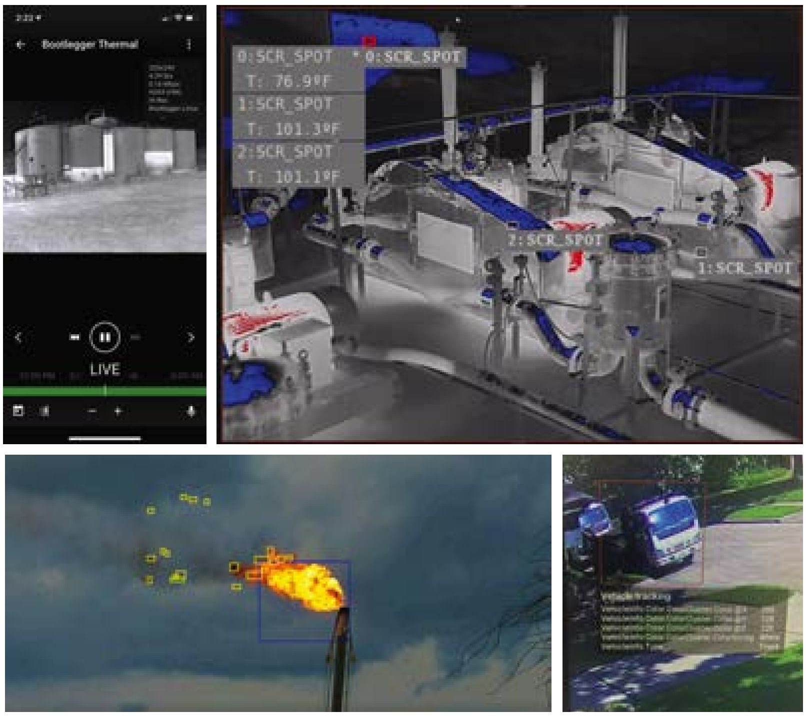
An edge controller combines the functionality of a traditional deterministic PLC with general-purpose Linux-based computing, like a PC, in one consolidated and industrialized form factor. The deterministic side can interact with many types of field I/O signals, and can perform control and logic functions. The general-purpose side can communicate securely via a variety of communication protocols with intelligent field devices and higher-level systems, and it can interact with the deterministic side in a secure and carefully controlled manner using OPC UA.

An IPC is an even more capable general-purpose computing platform, and can run visualization, communication, analytical applications and more right at the edge. They can also interact with many PLCs or other field devices. Emerson offers both edge controllers and IPCs preloaded with industry-specific software to support edge and IIoT applications. Called PACEdge, the software enables scalable and open connectivity, visualization and analytics at the edge.

Edge computing is crucial for connectivity with intelligent field devices, and for performing the local edge computing necessary to consolidate edge data into useful information that can be sent offsite with minimal bandwidth required. Edge computing ensures that site/SCADA networks are not overloaded, and upstream communications costs (via cell, satellite or Internet) are minimized, providing users with the best view of their assets.

Achieving clarity

When Twin Eagle set out to develop the VisionAery concept, the original target was to support remote oil and gas production



VIDEO & THERMAL INTELLIGENCE

Figure 3: The VisonAery platform uses Emerson edge technology to combine signals from intelligent video and thermal cameras with other site instrumentation, providing consolidated information such as (clockwise from top left) tank levels and leaks, equipment thermal profiles and operational parameters, vehicle tracking and flare status.

sites. However, the designs are suitable for any type of remote location. The team developed a mobile trailer-mount version (Figure 1) and a skid-mounted, portable version that can be hoisted or moved by forklift. To date, VisionAery systems have been deployed at more than 100 field sites.

All data is processed onboard the VisionAery system using an Emerson edge controller and/or IPC depending on the scale and extent of the application (Figure 2). Because data is preprocessed, the resulting information stream is greatly reduced, making the solution viable for sites with limited connectivity.

The standard Remote Vision version of VisionAery supports remote sites by providing:

- Remote site inspection via video zones;
- Automated gauge readings;
- Alerting on abnormalities;
- Automated site surveys;
- Automated recording on triggered events (such as trucks entering the site);
- Simple true/false analytics; and
- Event counting.

The more advanced Thermal Vision and Intelligent Vision versions provide added benefits (Figure 3), including:

- Detecting liquid levels and leaks;
- Monitoring flares (on, off or smoke);
- Supporting predictive maintenance for equipment;
- Monitoring to see if onsite personnel are wearing personal protective equipment (PPE);
- Identification of abnormalities;
- Tracking vehicle arrival/departure and operations, including license plate reading; and
- Integration with advanced analyzers such as methane leak detectors and audio analytics to listen for abnormal sounds.

Oil well site companies are subject to various operational environmental regulations, so it's vital to determine exactly when anomalous events like a smoking flare or leak started and how long they continued. Or, some sites must be periodically serviced by pump trucks, so detailed video information for vehicle tracking can ensure that service billing is correct.

All video and operational data is collected and stored locally, but local edge computing ensures that only essential results are transmitted to higher-level systems, so users obtain the best clarity regarding the situation in the field. Data can be converted at the edge into whatever protocol or coding language the end user needs, such as MQTT, JSON, Python scripts and more. Deployment is rapid, and Twin Eagle offers superior field support to adapt installations as needed for all types of field sites and enterprise computing host systems.

A new vision

In addition to the technical merits, an edge computing solution is affordable, requires no monthly subscription fees, is suitable for all types of edge environments and applications, and is expandable/scalable for the future. There are minimal annual renewal costs for the video management software, but most clients realize a return on investment within 12 months or less. Emerson edge controllers and IPCs enable Twin Eagle's VisionAery to excel today, with the ability to meet any future needs, such as adding LoRaWAN communications or connectivity to other advanced field devices. ∞

Behind the byline

Kaylor Greenstreet is a board member and vice president of business development at Twin Eagle Solutions, and is is one of the creators of the VisionAery platform. He holds a business marketing degree from the University of Phoenix.

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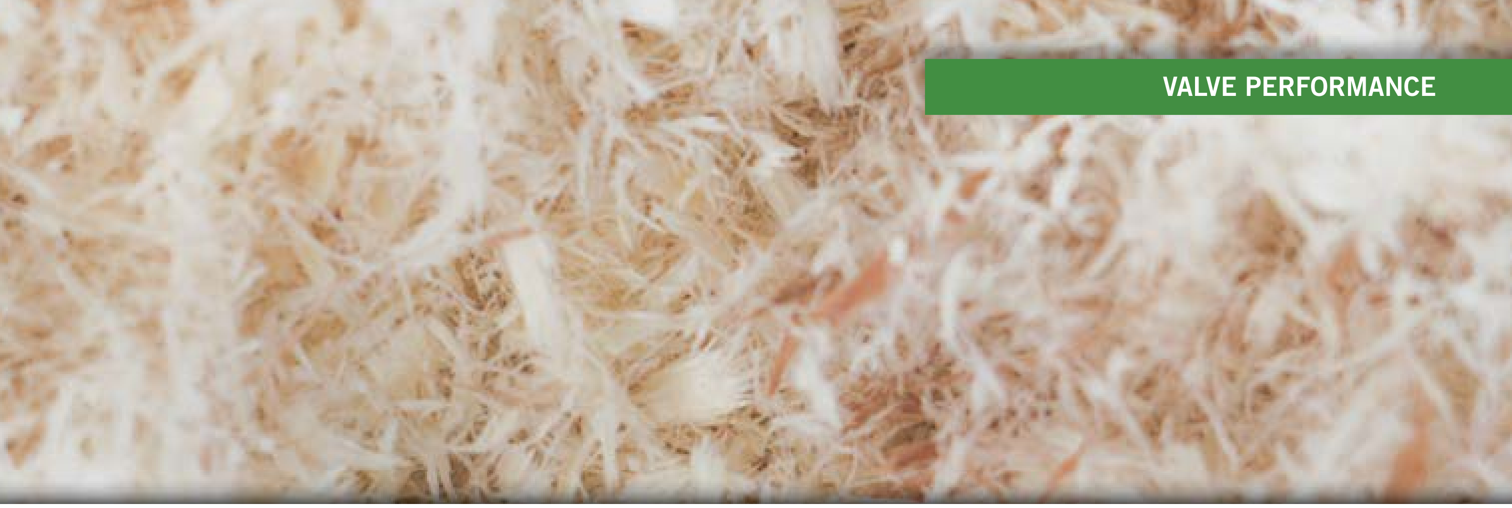


Stability boosts sustainability to a pulp

Klabin's Puma wood pulp plant in Brazil optimizes production with Neles' valves, positioners and Expertune Plant-Triage software

by Jim Montague

IT'S no surprise that efficiency hogs the stage in most sustainability discussions because it's already a familiar way to save resources, and easily tack on the popular motivation of reducing some environmental impacts. Most importantly, many end users are already doing it to some degree, so they can simply do more of what they're already doing, and get some added credit for going green.

However, efficiency must be continuous and consistent to maintain its initial gains, and that's where stability comes in. It may play second fiddle to efficiency, but stability is just as well-known to process operators and engineers, and may be even more important to gaining sustainability over the long term.

"The mainstream components of sustainability are people, planet and profit, including socially responsible investing

PULP AT PUMA

Figure 1: Klabin's Puma pulp plant in Paraná, Ortigueira, Brazil produces 1.1 million tonnes per year of bleached hardwood pulp and 400,000 tonnes/year of bleached softwood and fluff pulp, and uses renewable fuels such as wood, tree bark and lignin to generate 270 megawatts (MW) of electricity. It's automatically monitored online by 600 control loops, and controlled by 15,000 I/O and 38 DCSs networked via Profibus. Its present phase operates 2,000 automatic valves and 2,700 instruments for measuring temperature, pressure, flow and level. Source: Klabin and Neles

that's also included in most environmental, social and governance (ESG) guidelines," says George Buckbee, who just retired from the Performance Solutions division at Neles Corp. (neles.com). "A higher-level, top-down view is taken by everyone from investors to young people. Sustainability is a huge consideration for them, and they're asking more questions, which are rolling down through organizations and becoming endemic concerns for them."

Cristian Moraes, head of Performance Solutions at Neles, reports that Expertune PlantTriage recently added new assessments and calculations for energy savings, which can provide its analysis and controls software and services to more types of equipment and processes. "These capabilities can decrease variability and save revenue, but they can also target each user's approach to sustainability. Some want to reduce energy consumption or carbon emissions, while others want to reduce chemical consumption. These days, you can't just save money—you have to also reduce waste and improve safety at the same time."

Moraes adds that Neles' clients always have specific goals based on the individual characteristics of their applications and facilities, but their sustainability tasks don't end there. "End users are also saddled with the fact that today's sustainability efforts are more visible," adds Moraes. "Many companies have publicly stated sustainability goals, so there's more awareness and they need to show greater transparency."

Pulp process performance

To better optimize wood pulp and power production, Klabin's (klabin.com.br) five-year-old Puma pulp plant in Paraná, Ortigueira, Brazil, spent two years refining its application by expanding its partnership with Neles, adding more of its valves and other devices, and adopting its ExperTune PlantTriage software.

The facility makes short-fiber pulp from eucalyptus, long-fiber pulp from pine, and fluff pulp for diapers and other absorbent products. The plant simultaneously produces a total of 1.1 million tonnes per year of bleached hardwood pulp and 400,000 tonnes/year of bleached softwood and fluff pulp, but it's also designed to use renewable fuels such as wood, tree bark and lignin to generate 270 megawatts (MW) of electricity, consuming 120 MW internally and exporting up to 150 MW to Brazil's national grid. Klabin's 18 mills are reported to be similarly self-sufficient in power generation (Figure 1).

The Puma plant's pulp and power production is managed by 38 DCSs, 15,000 I/O and about 2,900 other devices networked via Profibus. Its present phase operates 2,000 automatic valves and 2,700 instruments for measuring temperature, pressure, flow and level. To coordinate these devices, manage all their data, and maintain stable pulp production, Puma automatically monitors 600 control loops online according to Klabin's established KPIs.

Moraes reports PlantTriage lets operators and managers analyze the plant's data, and use it s a predictive tools for making real-time adjustments, such as adjusting the weight of its standardized cellulose bales. "The lack of tuning between the moisture and the steam control loops was a challenge, and adjustments were being made manually," explains Moraes. "With PlantTriage, the plant solved the problem, and now every bale is consistently produced.”.

Value added by valves

On the hardware side, Klabin further enabled operations at the Puma plant by installing a customized Neles globe valve on its boiler. An earlier engineering study simulated that valve's operating conditions, and compared it to actual data that indicated how the device would need to be customized. This included incorporating particular alloys for the valve body, and selecting suitable internal materials. The new valve also has an intelligent positioner, which enables remote diagnostics and anticipates failures (Figure 2).

POSITIONER PLAYERS

Figure 2: Before adding a customized Neles globe valve and intelligent positioner to its boiler, Klabin previously installed ND9000 positioners from Neles on 120 valves at the Puma plant, and added 12-inch Neles ball valves at the outlets of its mass tanks. The company delivered a total of 1,800 valves, each equipped with ND9000 smart control valve positioners or on-off valve monitors. Source: Klabin and Neles

“The valve development wasn't limited to standard technical specifications. It considered the variations of pressure, flow and the high mechanical stress that the piece undergoes in the field,” says Pablo Cadaval Santos, Klabin's industrial manager at the Puma plant. "This equipment operates under severe conditions, and is subject to high pressure, in some cases up to 100 bar. The new

"In less than a year, we reduced average absolute error from the variable average of 25-30% to a level of 15%. Two years after starting, we reached the current average of 1.5%.”

valve gives stability to the operation and doesn't present premature degradation due to the correct application."

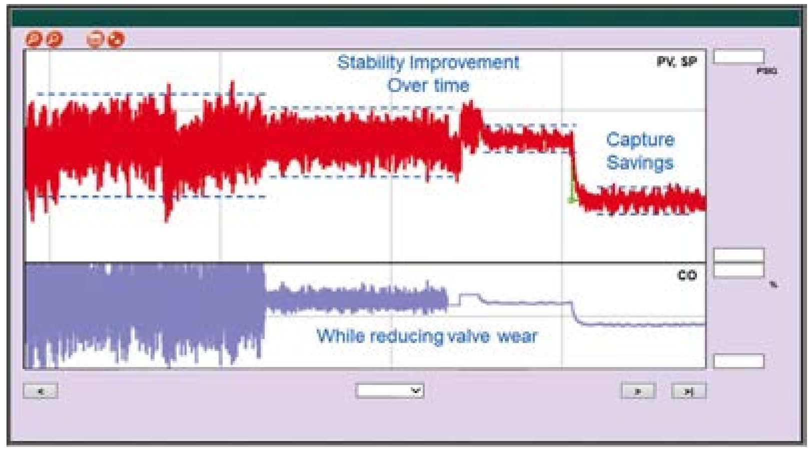
During its initial Puma I construction phase, Klabin previously installed ND9000 positioners from Neles on 120 valves, and added 12-inch Neles ball valves at the outlets of its mass tanks . These valves replaced knife gate-type devices originally planned for the project. When the plant was expanded during its Puma II project, Neles became its leading valve and positioner supplier, and delivered 1,800 valves, each equipped with ND9000 smart control valve positioners or on-off valve monitors.

Less variability, more stability

To manage the 600 loops controlling its process devices, Klabin also installed PlantTriage during the Puma II phase.

"Tuning control loops is essential for stabilizing processes and reducing control errors. When the plant started up, we had room for adjustments, and we made them," says Santos. "In less than a year, we reduced average absolute error from the variable average of 25-30% to a level of 15%. Two years after starting, we reached the current average of 1.5%."

For instance, Santos and his team dramatically reduced variability on the Puma plant's fiber line, so that it presently runs with only a minor error rate (Figure 3). Fewer errors and less variability stabilizes the fiber line and other processes at the plant, which enables them to maintain quality standards, produce better pulp products, and better control variable costs throughout the year. Likewise, if process parameters only vary within specified control error limits, then only a small amount of chemical additives need to be consumed. These fine-tuned control loops also make it easier to track who's operating and maintaining the plant. Finally, reduced variability and increased stability also reduced alarm rates, lightened workloads of Puma's operators, and let them focus more on value-added process optimization.



STABILITY REWARDS

Figure 3: Operators at Klabin's Puma plant tuned their 600 control loops, reduced variability and stabilized their fiber line and other pulp-related processes with help from ExperTune PlantTriage software. In less than a year, its staff reduced average absolute error from the variable average of 25-30% to a level of 15%, and two years after starting, it reached the current average of 1.5%. This stability lets operators maintain quality standards, produce better pulp products, and better control variable costs. Source: Klabin and Neles

Savings and sustainability

Whatever combination of optimization and/or sustainability objectives users desire for their processes, they can likely be achieved by upgrading to modernized analytics software and support devices. However, Buckbee and Moraes add some common-sense preparations are also needed for these projects to succeed.

"Users need to be clear about what they want, so they need to survey their plant landscape and find opportunities to save and optimize. Unfortunately, if they haven't tracked performance over time, they often don't know where those opportunities are," explains Moraes. "If it's hard to figure out where to start, they can begin with the largest likely energy users such as distillation units or reactors. Other areas that are often overlooked are utilities. If users have been controlling these processes manually, they aren't getting the benefits they could be, but they won't know without the fundamental data showing it."

Similarly, Buckbee adds that one of the biggest potential contributors to sustainability is establishing daily and weekly data workflows, which support operations by allowing users to take more targeted action to improve daily performance. "One of our most important services is sitting down with the staff at a plant, going over existing workflows, and determining who is the right person to get certain information, and who is the right person to act on it," says Buckbee. "For example, if a boiler tripped last night, the questions are why, how was it set up, did instruments freeze, and how was the process upset? A lot of data usually floods in when an event like occurs, but much of it's often unused. I think Gartner reports that less than 0.5% of collected process data is ever used, even after it's been analyzed.

"However, achieving greater sustainability is going to require making better use of data in daily workflows, not just what's already on spreadsheets, and integrating sustainability back into those workflows. Operators and engineers must track sustainability efforts, show they have value, get their managers to buy in, and get their organization's whole food chain involved, as well as their suppliers and customers." ∞

What orifice flow error should I expect?

Errors are usually caused by generating inaccurate DPs—not when measuring them

This column is moderated by Béla Lipták (http://belaliptakpe.com/), automation and safety consultant and editor of the Instrument and Automation Engineers' Handbook (IAEH). If you have an automation-related question for this column, write to liptakbela@aol.com.

DEAR SIR: I am Miten Thakkar from GSFC in India. I have a query regarding orifice-plate volumetric flow measurement. What can be the accuracy of a volumetric flow measurement when we measure differential pressure (DP) using a smart transmitter such as a Rosemount 3051 or Yokogawa EJA110E device?

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A1: The table shown in Figure 1 will give you the likely rangeability and accuracy of flow control loops when based on perfectly sized, accurately calibrated, correctly installed, clean and well-maintained orifice elements. But in my experience, this is never the case and, depending on the noted factors, the errors can be drastically greater. People often believe that using high accuracy and rangeability transmitters will make large improvements in the overall error, which is seldom the case because the errors are usually caused by generating inaccurate differential pressures, and not from the accuracy of reading them. If you read the comments of my colleagues below, you'll see how many potential error sources exist in orifice-based flow control.

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A2: Often the accuracy of the transmitter is less of an issue than the accuracy of the meter calculation and compensation for deviation from design conditions. The DCS reading is the engineering unit high value / 10 * SQRT (% DP). This number is often off by 5 to 10%.

When the meter calculation is performed at the design stage, an orifice bore is calculated based on the desired orifice DP at the maximum flow. Before the meter is installed, the actual orifice diameter should be measured, and the existence noted of a weep hole and size, orifice plate material, and actual pipe size.

The meter calculation can then be run with correction factors for meter area thermal expansion; weep hole; actual flowing pressure vs. design pressure; actual temperature vs. design temperature; actual gas gravity vs. design gravity; gas super-compressibility (normally not needed except at very high pressure); and gas expansion factors. The resulting meter calculation at maximum DP gives a number that should be close to the engineering unit high value entered into the DCS.

Meter calculations also assume that the piping and orifice are clean and flow is homogenous across the orifice. I worked in a plant restart recently where meter readings were highly suspect. Many meters had rust buildup and scale partially blocking the orifice plate. These meters ran as much as 50% high.

Mass balances across sections of the plant helped determine which orifices needed to be removed, flushed, recalibrated and reinstalled.

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A3: Although manufacturers might report the ability of their devices to have a 2% flow rate error, in my experience, best practicable is about 5%, and the error may be greater due to many reasons. Orifice flow rate devices are less expensive than other types of flow rate measurements, so they're often an economic preference. However, the user needs to balance cost with performance. I think the general rule is that if flow rate measurement is critical (such as in custody transfer), then use one of the more accurate devices. And if flow control is used for in-line composition, use composition measurement feedback to adjust the flow rate setpoint to correct the orifice measurement.

There are many issues to consider with accuracy and precision of orifice meters, and many are unrelated to the measurement device itself. Here's a list of issues that immediately come to my mind:

1. The classic assumption of the square-root rela-

Type of hardware	Rangeability	Orifice plate error	Transmitter error	Loop error at 10% flow	Loop error at 25% flow	Loop error at 35% flow	Loop error at 50% flow	Loop error at 100% flow
Pneumatic								
Standard transmitter	3:1	<1% AR	0.5% FS	NG	NG	~3%	2%	1.5%
Two plates or transmitters	6:1	<1% AR	0.5%FS	NG	~3%	~3%	2%	1.5%
Electronic								
Standard transmitter	4:1	<1% AR	0.2% FS	NG	2%	~2%	~1.5%	1.2%
Smart transmitter	15:1	<1% AR	0.1%FS	2%	1.5%	~1.5%	1.2%	~1%

ORIFICE RANGEABILITY AND INACCURACY

Figure 1: The nominal accuracy of an orifice-plate flowmeter, as reported above, depends largely on a perfectly sized, accurately calibrated, correctly installed, clean and well-maintained orifice element. In practice, the pressure measurement itself is an unlikely contributor to error. (AR = actual reading; FS = full scale; NG = no good.)

tion of volumetric flow rate to pressure drop is based on the ideal Bernoulli relation for non-viscous, linear, streamline flow. Installation geometry factors are critical, and even if they're closely followed, the square-root relation is not exactly true, and the orifice flowrate can be off by several percent.

2. Orifice plates can be installed backward, and can erode or corrode over time. In any case, even if it was perfectly installed and calibrated, the calibration changes over time.
3. Pressure taps can accumulate non-condensable gases, heavy liquids or particles, all of which will change the differential pressure, leading to a calculated flow rate error.
4. If the liquid or gas density isn't well known, or is different from the calibration fluid, that will cause error. The size of the flow rate error is proportional to the ratio of density error to the fluid density. Therefore, if this ratio is 1%, then the calculated flow rate will have a 1% error.
5. The DP sensor needs to be calibrated, and the calibration error may change over time, perhaps due to ambient temperature. This error is proportional to the DP error divided by the square root of DP. This can become very important at low rates.
6. If the orifice plate is improperly sized (likely some ideal relation was used to size it), or even if once properly sized but the flow rate significantly changes, this could lead to out-of-range, high DP values or extreme low DP values in the very sensitive portion of the square-root functionality.
7. The relationship between orifice flow rate and pressure drop is valid only for fully-turbulent flow.
8. Error is caused if the measurement is noisy or fluctuates rapidly in time due to flow turbulence. In such cases, measurement averaging is needed to dampen the noise. If the noise is 5% of the signal (each sampling has a ±5% perturbation, which seems reasonable from my experience), then using the statistics central limit theorem to reduce the error on the signal to just 1% requires an averaging of 25 samples. If the sampling is 10 Hz, and a first-order filter is used, this means introducing a measurement lag of 2.5 seconds. Averaging reduces, but doesn't eliminate the measurement error due to process noise.
9. There are two sorts of error. Bias (or systematic error) is the true average error due to installation and calibration imperfections. Random error is due to noise, with independent perturbations on each sampling. The reported measurement combines both.
10. Because of noise filtering (or any sort of averaging, whether it's on the device or in any part of the communication and display system), the filtered value will lag the true value during a transient. So, if you're interested in tracking a transient, the error due to the lag might even be larger than the combined bias and random errors.
11. Using the ideal square-root relation and propagating uncertainty, the error is proportional to the inverse of the square root of the DP. This means that, at low flow rates, the measurement error is much larger than at high flow rates.
12. Likely, there are several digital processing steps in the DP device. If a device has a 10-bit processor, it can only have 2^10 = 1,024 values. If the middle 60% are used for the signal (such as 5-20 mA in a 25 mA range, or 3-15 psi in a 20 psi range), then counts between about 205 and 820 would be used for the signal. With only 820 - 205 = 615 values, the resolution due to digital discrimination is 100/615 = 0.16% of full scale. This means that, even if the DP sensor and equation to convert DP to flow rate were perfect, there would be a 0.16% error. Depending on where the digital process is happening, this resolution error may be invisible at high flow rates, and progressively dominant at lower flow rates.

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Integrated models redefining PAT

DeltaV Spectral PAT streamlines, simplifies process analytical technology

THE life sciences industry has long sought to close the loop on analytical techniques used to verify the quality of its therapies, both to automate real-time product release and optimize production throughput. But until recently, moving the necessary multivariate spectral analyses from the laboratory to the plant floor meant a massive commitment of time, resources and targeted expertise. Moreover, even after organizations committed those resources, they typically ended up with complex, fragile process analytical technology (PAT) systems requiring significant upkeep over their lifecycles.

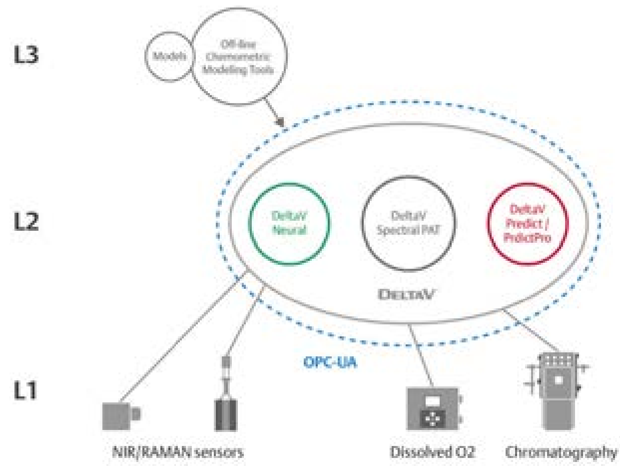
Today, manufacturers have at their disposal a new, streamlined approach to implementing PAT by embedding the necessary chemometric models into their control systems. "Emerson's DeltaV Spectral PAT runs the models directly in the DeltaV control system, which allows real-time prediction of critical quality attributes," explains Molly Firkins, DeltaV product marketing manager at Emerson. "And that means our customers can more readily monitor and perform closed-loop control on these really hard to measure but essential quality values."

Historically, turning the 3,000 or 4,000 pieces of spectral data produced by a Raman or near infrared (NIR) probe into a univariate value usable by the control system required a layered approach. First, an engineer developed a model offline to be validated as part of the process. The model was then run on servers at Level 3 of the Purdue model to translate analyzer data into a value useful for control. Finally, that value was passed back to the controllers to adjust the process in near real-time.

Integration reduces complexity

While the layered model of traditional PAT enables closed-loop control, the connections among systems are typically quite fragile. To support such a model, operators require three or four disparate systems to communicate seamlessly. The analyzer must talk to the third-party system performing the conversion, which in turn communicates with a PAT application comparing the model and values, which itself must share data with the control system.

This configuration creates a complex web for IT and OT to implement and maintain. It also creates a wide surface area for compatibility problems. Moreover, validating all these systems is complex and time-consuming. But, with Emerson's new DeltaV Spectral PAT, operations teams can bring spectral signals directly into the control system, where the raw spectral data is analyzed and quality assessed, and control decisions are made—all in one dramatically simplified process.



DELTAV SPECTRAL PAT

Figure 1: Emerson's DeltaV Spectral PAT represents a dramatic simplification of process analytical technology implementations.

To make this all possible, an industry-leading chemometric model engine is implemented in a standard DeltaV function block running on the DeltaV Application Station. This new PAT function block is easily configured using DeltaV Control Studio, and can be easily incorporated into control strategies.

This new approach improves product quality by reducing variability—online measurements and quality calculations provide continuous data for tighter process and quality control. DeltaV Spectral PAT also increases reliability and robustness by eliminating layered solutions, multiple servers and communications dependencies of traditional approaches. Finally, it lowers the costs and effort required to implement, maintain and validate PAT solutions. "Embedded DeltaV PAT leverages the DeltaV configuration, database and support infrastructure used by other control applications," explains Firkins. "And process validation is simplified because applications are all part of an integrated DeltaV platform."

Life sciences manufacturers can find themselves sitting on millions of dollars of work-in-process (WIP) inventory, while waiting on quality test results. Emerson's DeltaV Spectral PAT technology is among the new technologies poised to unlock fully automated manufacturing and eliminate WIP altogether. The shift is happening fast, and looking toward a fully automated future will help organizations secure speed-to-market and competitive advantage in the years and decades to come. ∞

Controllers add digital bells and whistles

PLCs, PACs and PCs rope in communications, IIoT, IEC 61131, safety ratings, I/O and function modules

EDGE FOR IIoT APPLICATIONS

PACSystems Edge solutions are licensed and optimized combinations of RXi edge computers, controllers, HMI, IIoT analytics and supervisory software. This portfolio simplifies selection and deployment, and reduces time spent integrating, developing and validating digital transformation projects. PACSystems Edge Solutions leverage Movicon, NExT, WebHMI, Connext OPC UA server and PACEdge software. The portfolio also provides connectivity and computing for plantwide analytics and supervision.

EMERSON
www.emerson.com/PACSystems-Edge

SMART PLC/PAC/RTU UPGRADE KNOWS FLOW

OSA Remote +Flow industrial control system is a compact, cyber-secure PLC/PAC/RTU option with integrated process control and flow computing. It includes Flowcal algorithms, factor linearization and meter proving. OSA Remote +Flow can handle up to 20 software programmable I/O with standard protocols. A sealed all-metal housing, temperature rated from -40 °C to +80 °C (176 °F), secures a multi-core ARM Cortex processor with 512 MB program RAM and 64 GB secure Flash memory.

BEDROCK AUTOMATION
https://bedrockautomation.com

MODULAR HMI/PC UP TO ZONE 2/22, DIV. 2

VisuNet FLX are flexible operator workstations and monitoring systems for ATEX/IECEx Zone 2/22, Division 2, and non-hazardous areas. Thanks to its fully modular design, VisuNet FLX's HMI solutions can be configured to maximize functionality for quick and easy customizing in the field. Three basic configurations—mostly based on thin client technology—are available and are supplemented by a continuously expanding range of peripheral devices, including HMI system, panel PC and box PC.

PEPPERL+FUCHS INC.
330-486-0002; us.pepperl-fuchs.com

TWO SLOTS, MULTIPLE OPTIONS

Click Plus PLCs combine the simplicity of the original Click PLC with advanced features, including Wi-Fi, MQTT, data logging and mobile access. Click Plus two-slot CPU offers an added, built-in option module slot for even more PLC I/O customization. More than 400 option slot I/O module combinations are possible for one standalone PLC. For systems with higher I/O needs, the two-slot CPU can be expanded with up to eight added, stackable I/O modules for up to 156 discrete I/O or 60 analog I/O points.

AUTOMATIONDIRECT
www.automationdirect.com/click-plus-plc

OPEN WITH LINUX, RELIABLE WITH IEC 61131

PLCNext open-control platform combines PLC reliability and smart-device openness, and also combines the advantages of traditional IEC 61131 programming with the flexibility of open-source languages like Linux. Users can directly access PLCNext's core via Linux, letting them leverage the open-source community or develop their own Linux-based applications on a hardened control platform. It also enhances IEC 61131 PLC programming and makes it possible to program controllers using high-level languages.

PHOENIX CONTACT
www.phoenixcontact.com/open

PERFORMANCE IN A SMALL FOOTPRINT

CP2E Series PLCs from Omron provide performance in a compact footprint. They're designed for small- to medium-sized machines, and provide features previously only available in higher-end controllers, including enhanced communication to enable M2M data transfer and facilitate IIoT applications. With fast instruction and scan times coupled with better environmental ratings, expansion options and up to four axes of motion, CP2E enhances the performance and value of any machine design.

DIGI-KEY ELECTRONICS
www.digikey.com

EDGE COMPUTE, EDGE CONTROL

Edge Controller and Edge Computer for edge-of-network computing achieve low-latency control and simplify connections with cloud services. Edge Controller (752-8303/800-002) lets users run high-speed and complex applications with its quad-core processor as well as applications through Docker containers with its Linux-based real time operating system. Edge Computer (752-9400/752-9401) comes with a Debian Linux operating system, quad-core Atom processor, 64 GB flash memory and 4 GB or 8 GB of RAM.

WAGO
www.wago.us

ADD I/O FOR POWER MONITORING

groov EPIC edge-programmable controller has added two I/O modules for large-scale power monitoring and signal integration. They are GRV-IVAPM-3 for Category III three-phase AC power monitoring up to 600 VAC and GRV-MM1001-10 for universal I/O sensing and control. Once acquired, data from GRV-IVAPM-3 and GRV-MM1001-10 is immediately available to backend applications via *groo*v EPIC's embedded MQTT clients, Ignition Edge from Inductive Automation, REST API and regular protocols.

OPTO 22
800-321-OPTO (6786); www.opto22.com

EXPANSION MODULE OFFERS OPTIONS

PLCs from Mitsubishi fit any industrial automation engineering need. With a wide variety of local and expansion module options running on AC or DC power, they provide multiple digital and analog I/O inputs, RS-485 SD connections, and memory card slots. In addition, each PLC also hosts its own IP address that, when coupled with the built-in Ethernet port, allows it to easily be connected and programmed into any established network.

MISUMI
misumi.info/PLC

ULTRA-COMPACT, IP65/67 INDUSTRIAL PC

C7015 ultra-compact, robust, industrial PC with IP65/67 protected housing is Microsoft Azure certified and AWS qualified, and is ideal for decentralized installation. C7015 measures 85 x 167 x 43 mm, runs Intel Atom multi-core processors with up to four cores, and can serve as a field-based machine controller. C7015's EtherCAT P connection also creates options for efficient sensor/actuator connection via its IP67-protected EPP modules.

BECKHOFF AUTOMATION
www.beckhoff.com/en-us/products/ipc/pcs/c70xx-ultra-compact-industrial-pcs-in-ip65-67/c7015.html

PAC WITH A-B RIO/DH+ PORT

NeoPAC is an open-architecture PAC with virtually unlimited memory and multiple, configurable ports. It supports up to two Allen-Bradley "bluehose" ports to interface to Data Highway Plus (DH+) or A-B Remote I/O (RIO) networks. NeoPAC can be connected to Ethernet or serial I/O from many vendors, while also connecting to new and old Rockwell Automation controllers as a peer. This lets users of A-B PLCs upgrade obsolete devices without changing the A-B controller or buying costly interfaces. NeoPAC can even replace an A-B PLC.

SOFTPLC CORP.
800-SoftPLC, 512-264-8390; http://softplc.com

SPEED SOLVES CHALLENGES

FA-M3V series PLCs seek higher speeds to solve manufacturing challenges. Its Vitesse series has reportedly set industry speed records, while maintaining stable control, extensibility and reliability. It executes in 3.75 ns for basic instructions, 7.5 ns for application instructions and 37.5 ns for floating-point add instructions. This pursuit of speed also produced Yokogawa's Instruction, Processing, Response, and Scan (IPRS) design, which features parallel and independent processing.

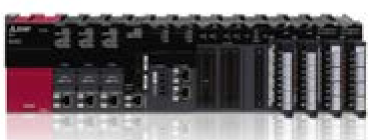
YOKOGAWA
https://t.ly/cSWF

PLC SUPPORTS IIoT EFFORTS

ControlEdge PLC combines with the Experion platform to reduce integration costs, minimize downtime, embed cybersecurity, and lower TCO with an extended lifecycle. This controller connects through all levels of process and business operations, and is one of the first supporting Honeywell's IIoT-ready initiative. ControlEdge also uses the OPC UA, and works with Universal I/O to enable remote configuration and late design change flexibility as part of the LEAP project execution methodology.

HONEYWELL
process.honeywell.com

PID AND GENERAL CONTROL IN ONE MODULE



Melsec iQ-R Series automation controller enhances process control systems with its wide range of CPU modules, which integrate advanced PID and general control into one module. This provides system scalability (from small to large) for a best-fit solution. When paired with a redundant function module, it creates a redundant control system that's ideal for applications that require highly reliable control. Various network modules with redundant functionality embedded are also available.

MITSUBISHI ELECTRIC
www.mitsubishielectric.com

COMBINE PLC, MOTION, IIoT TASKS

ctrlX Core is a modular control system for PLC, motion and IoT applications. It's built on a 64-bit, multi-core CPU and uses EtherCAT automation bus to control servo drives, I/O and other devices. Its Linux Ubuntu Core embedded OS with real-time extensions let users tailor their requirements with apps from the ctrlX Store. These include ctrlX PLC and Motion apps, which are scalable to provide basic to advanced functionality. ctrlX Works software tool provides the PLC's programming environment, using IEC 61131 languages.

BOSCH REXROTH CORP.
https://apps.boschrexroth.com/microsites/ctrlx-automation/en

EQUIPMENT & MATERIALS

AD INDEX

Realizing ratio control

Proactively keep units in balance without waiting for feedback correction

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@putman.net

GREG: If you look at a process flow diagram (PFD), you see there are flows given for each process and hopefully each utility stream. The goal of a control system is to maintain these ratios for the given set of operating conditions and correct them as necessary to account for unknowns and disturbances particularly in terms of concentrations. When units are started up (e.g., distillation columns), the units may be brought to operating conditions based on ratio control before being switched to temperature or composition control.

A change in feed to one unit operation has a widespread ripple effect on downstream unit operations. Ratio control can keep all the units in balance with the total production requirement without waiting on feedback controllers to see and correct an error from the unbalances. Not only does an appreciable error have to develop for feedback correction, but the settling time (time for the process variable to stay close to setpoint) can be quite long—especially if there is any interaction between the loops. For day-to-night optimization, the production unit may be in a constant state of disruption.

If feed flows can be moved in concert quickly throughout the process, production rates can match changes in market demands without requiring as much product in storage tanks. Reducing product inventory is important for reducing bottom-line costs. Changes in product grade also require changes in existing feed rates and addition and deletion of feeds. Transition time and off-spec product can be minimized by using ratio control throughout the units.

To help us realize the benefits of ratio control we get the inside perspective of Michel Ruel, ISA Fellow and co-chair of the ISA 5.9 Technical Report on PID Algorithms and Performance, and interviewee in the recent, insightful Control Talk columns “Want to be a hero” (bit.ly/2203RC1) and “Keys to optimization project success” (bit.ly/CT2203RC2).

Michel, how do we decide whether to use ratio control or flow-feedforward?

MICHEL: Ratio control is preferred over flow-feedforward control, so the flow controller can correct for valve nonlinearities and pressure disturbances, and the operators and process engineers can be more involved in seeing and understanding how control system is working in concert with the PFDs. The ratios are typically mass flow ratios. Using Coriolis mass flowmeters provides correction for density and potentially composition changes in the streams, besides offering great accuracy and rangeability. If volumetric flowmeters are used, they may need to be corrected for density. This is commonly done for gas flow measurements by temperature and pressure compensation assuming a constant composition.

However, in some applications, flow controller response is erratic or too slow, and feedforward control is consequently used instead of ratio control to directly manipulate a control valve or variable speed drive based on feedforward and an installed flow characteristic. This is typically the case for steam-header systems, where the installed flow characteristic of the upper header letdown valve is used as a flow-feedforward for the lower header along with the net result of users and suppliers for the lower header. The half decoupling and preemptive correction for changes in supply and demand has been shown to greatly improve the control of headers, eliminating unnecessary venting.

GREG: What are some examples?

MICHEL: There are many examples of unit operations where flow, speed or power is ratioed:

- Blend composition control – additive/feed (flow/flow) ratio
- Column temperature control – distillate/feed, reflux/distillate, reflux/feed, steam/feed, and bottoms/feed (flow/flow) ratio
- Combustion temperature control – air/fuel (flow/flow) ratio
- Drum level control – feedwater/steam (flow/flow) ratio

- Extruder quality control – extruder/mixer (power/power) ratio
- Heat exchanger temperature control – coolant/feed (flow/flow) ratio
- Neutralizer pH control – reagent/feed (flow/flow) ratio
- Reactor reaction rate control – catalyst/reactant (speed/flow) ratio
- Reactor composition control – reactant/reactant (flow/flow) ratio
- Sheet, web and film line machine direction (MD) gage control – roller/pump (speed/speed) ratio
- Slaker conductivity control – lime/liquor (speed/flow) ratio
- Spin-line fiber diameter gage control – winder/pump (speed/speed) ratio
- Header pressure control – letdown/user (flow/flow) ratio
- Density control – slurry/water, pulp/water (flow/flow) ratio
- Formation on a paper machine – fibers/machine (speed/speed) ratio, where pressure in head box converted to kinetic energy provides inferential measurement of speed of fibers

GREG: What is the architecture for flow ratio control?

MICHEL: The main flow is the wild flow (not controlled) or leader flow (set by production rate); secondary and tertiary flows need to follow at a certain ratio to the wild or leader flow. If the flows go to plug-flow volume, a process feedback controller corrects the ratio, which is equivalent to a feedforward multiplier. However, if the volume has significant back mixing, the process time constant being inversely proportional to flow cancels out the process gain nonlinearity. In this case, the correction of the ratio-control ratio creates a residual nonlinearity that adversely affects PID tuning, and it is preferable to have the PID correct the ratio-control bias, which is equivalent to a feedforward summer.

GREG: The correction of the bias is also particularly good at dealing with the more common and larger zero error or offset instead of span error in flow measurements. Adaption of the ratio can be done automatically by something like a valve position controller that's a mostly "integral only" to slowly correct the ratio and minimize the process controller feedback correction. Procedure automation and state-based control can also proactively improve the ratio for startup and transitions besides abnormal conditions.

What are some common problems and fixes?

MICHEL: The PID controller uses feedback error to reduce the feedforward error, hence we have transitory responses. And, even if the process variable (PV) will return to setpoint (SP), errors are unavoidable. During transient responses, actual ratio will vary. For example, if the leader flow changes brutally, other flows will seriously fall behind. If possible, the leader flow should change slowly (usually larger valves move more slowly) and use an architecture where all streams are controlled with a ratio. With proper tuning and PID structure, such as two degrees of freedom, each loop may have close to the same setpoint response time.

Many flowmeters have poor rangeability and large sensor errors at low flow. For example, a flowmeter may not realistically be able to measure below a certain flow (e.g., 15% for a vortex meter and 25% for an orifice flowmeter). Suggested solutions are first to use a magnetic flowmeter or, even better, a Coriolis meter that's properly sized with an error in percent of reading that's relatively constant and small. If this isn't feasible, consider more than one flowmeter (e.g., 0-30% of flow using differential-pressure (DP) transmitter 1, and 30-100% of flow using DP transmitter 2, possibly with different technologies). Also, at low flow, a soft sensor may be added based on pressure and valve opening, taking into account the installed flow characteristic.

GREG: For much more detail, see the ISA Mentor Program WebEx presentation "Feedforward and Ratio Control" (bit.ly/2203TALK1) and the follow-up "Feedforward Control Q&A Addendum" (bit.ly/2203TALK2). ∞

Seek out the online version of this article on ControlGlobal.com for the Top 10 reasons for using ratio control. (Not the least of which is compensating your favorite sports coaches' salaries based on their win-loss records.)

Help wanted

Useful change needs participation to overcome inertia

JIM MONTAGUE
Executive Editor
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"The real value of the truth is it gets everyone on the same page, and generates the best ideas and options about what to do next."

WHILE cleaning up my bloated email inbox, I was reminded recently of the hundreds and likely thousands of people, who generously help me cover *Control*'s major topics from flow to fieldbuses. They patiently explain their basic workings, how they evolve, and most importantly, how to help our readers understand and hopefully benefit from using them. I know it's not easy to get these concepts and principles across to me, so I can relay them to others. I'm grateful to every source who is willing to try, and I hereby offer another sincere thank you to all of them.

However, I've learned this willingness to participate and explain has a value far beyond simply informing readers and keeping me employed. Similar to voting, jury duty, public/military service—or a family just talking about their days over dinner—I believe that willingness and participation binds together groups, organizations and communities of all sizes. Older veterans get to share their hard-won lessons learned and even regrets, and younger rookies get to share the inspiration of everything that's new and full of life—and hopefully each listens long enough to benefit from the others.

Whether professionally or geographically defined, I know many groups and communities are elevated by the exchanges between their members. The real value of the truth is it gets everyone on the same page, and generates the best ideas and options about what to do next.

At the same time, I've covered other groups that are unwilling or unable to participate or even communicate. Some are stuck behind short-sighted communications policies or corporate hierarchies. Others are closed off behind physical, self-imposed gates. I think most are unaware of the vitality they're missing, and don't think interacting with their communities is important because they don't realize what's possible. Ignorance isn't really bliss after all.

This is why every upgrade, migration, adoption or integration project starts with recruiting one or more internal champions, who can drive these efforts and convince their colleagues, management and organizations to buy in and support them. When each fieldbus, Ethernet, batch, wireless, cybersecurity or IIoT protocol and standards effort emerged, they all needed evangelists to advocate for them, almost as much as they required the developers who created them. In this issue's "Rubber meets road" cover article (p. 22), the Open Process Automation Forum (OPAF) is again urgently seeking participation in and support for the Open Process Automation Standard (O-PAS). Even though it's already made significant progress, OPAF knows that O-PAS must maintain its momentum to achieve its goal of interoperable process controls.

Whatever the endeavor, securing the greatest possible participation is essential. This is just as true for local bake sales, kids sports programs, school and municipal boards as it is for international process standards and all sorts of multinational coalitions, which have been tackling COVID-19 and supply chain snags, and now Russia's invasion of Ukraine.

However, even though seeking participation in good causes is commendable, I should mention that I've noticed it comes with at least a couple of occupational hazards. First, just as stiction is hard to overcome and valves don't like coming unstuck, inertia-bound individuals and organizations usually don't appreciate being rousted to action or even asked nicely to wake up. Consequently, opening communications and inviting participation is often a thankless task.

Second, organizers and participants in every effort to make useful changes or adopt something new typically have to deal with endless undermining along the way, whether they're pushing for O-PAS or local ordinances. Plus, they usually have to accept partial victories, many setbacks, and compromise on achieving far less than they originally planned.

As usual, slow chipping away is the only way. Keep forging ahead for what's right. Just be ready for plenty of backbiting. ∞


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Accelerate Your Automation Deployment with MTP

One of the first automation vendors to support NAMUR's standard, Emerson introduces Module Type Package (MTP) solutions to enable seamless integration of our DeltaV™ DCS, PACSystems™ PLCs, and our AMS Asset Monitor. By integrating distributed processes, reliability assets and equipment, system integrators and manufacturers simplify fulfillment of customer requirements, improve scalability, and accelerate time to market.

To see how Emerson MTP solutions can save you weeks in project time and thousands in engineering costs compared to traditional integration, go to Emerson.com/MTP

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