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OK, smarty plants

Suppliers are increasingly up to the task to helping forge more sustainable and efficient operations.

LET’S face it, we live and work in a world that’s uber-focused on sustainability and digitalization. Increasingly, that focus centers on how those two goals are intertwined in the name of efficiency (and profitability, of course.) At this point, one wonders if it’s even possible to have sustainable industrial operations without going through a digital transformation? The smart answer is “no.”

Don’t get me wrong, true sustainability would back us up to before industrialization even happened, but none of us have the stomach to live a never-ending episode of “Survivor” or “Naked and Afraid.” I shudder at the thought.

A few weeks ago, I took a trip to Charlotte, N.C., to join a host of other global journalists at Honeywell’s new-ish, “smart” tower in the heart of the city. While I focus on processing plants for a living, there was a plethora of information to be gained from hearing and seeing how the company works with partners to forge sustainable buildings and cityscapes that are sustainable and efficient. Incidentally, my colleague, Jim Montague, joined Honeywell in the Chicago area around the same time, and you can read his report on the plants he toured on page 24 of this issue.

Whether an office building or an industrial plant, the cost of downtime and inefficient safety controls is increasing. One hour of downtime for any mid-sized or large company can cost about $1 million or more, according to Manish Sharma, chief product officer of Honeywell’s connected buildings unit. Meanwhile, there are constantly changing and increasing cyber-threats that the FBI says have cost Americans $10 billion or more. That’s why smart buildings, plants and factories are increasingly embracing digitalization, automation and electrification efforts. It just makes sense.

Becoming a “smart” plant is an intricate dance between OT and IT. It’s a refrain I’ve heard time and again from those I talk to in the process industries. In addition, sustainability goals, particularly as regulations and change from industry to industry, add to the formidable task. So where do you begin?

Instrumentation and software suppliers are increasingly up to the task, and updating their technology with digital transformation and sustainability in mind. Meanwhile, they also realize the need for expert help in setting up smart facilities. These days, the vendor experience goes beyond supplying products. It requires becoming a partner in transforming industrial operations and plants.”

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Dow's bold, carbon-reduction strategy

Nuclear energy will take center stage in Seadrift, Tex., by the end of the decade

by Jonathan Katz

DOW is setting its sights on nuclear energy as a key player in its carbon-reduction plans, with a goal to have an operational nuclear plant supplying power to its Seadrift, Tex., location by the end of the decade, says Kreshka Young, the company’s North America business director for energy and climate.

Young discussed the company’s partnership with nuclear reactor developer X-energy during the opening keynote session on Sept. 12 at the World Chemical Forum in Houston. The companies announced a partnership in March to develop the first, grid-scale, advanced nuclear reactor for an industrial site in North America.

Nuclear energy shows more promise than renewable energy for powering chemical plants because it can provide a 24/7 supply of both steam and electricity, said Young during the event hosted by Chemical Market Analytics.

“The two options that we see as frontrunners right now are hydrogen combustion, which is linked with carbon capture, transportation and sequestration,” Young says. “But the other one is advancing nuclear power. That’s because, in the chemical industry, as I’m sure you’re all well aware, we have a need, not only for a lot of reliable electricity, but also for incredibly reliable steam.”

The project is currently in the engineering stage, with a budget of $50 million. Half of this funding is provided by Dow, while the remaining half comes from the U.S. Dept. of Energy’s Advanced Reactor Demonstration Program. The partners expect to submit documents for the construction permit in the first quarter of 2024, Young says. This will be followed by another investment request from Dow to create a detailed facility design. Dow expects to receive the construction permit in 2026, Young says.

The planned facility will use X-energy’s Gen-4, a high-temperature, gas-cooled reactor. The modular configuration is smaller than traditional nuclear facilities, occupying just under 30 acres, says Marcy Sanderson, VP at X-energy. The UCC Seadrift Operations spans 4,700 acres, and produces plastics for wire and cable, glycols and oxide derivatives for health and beauty products. The plant will include “four-pack reactors,” each capable of producing the equivalent of 80 MW of electricity, Young says.

A safer alternative?
The technology is safer than the standard nuclear plants that most people are familiar with, says Sanderson. X-energy’s technology is called a “pebble-bed reactor” that the company says can’t melt down.

She likens the technology to a big gumball machine with 220,000 fuel pebbles that get loaded in the reactor. The National Energy Institute (NEI) describes the pebbles as small uranium kernels coated in concentric layers of heat-resistant materials, including graphite and wrapped together in polished spheres. The pebbles can be loaded and withdrawn while the reactor is operating, so there’s no need to shut down for refueling. Standard reactors must shut down every 18 months to two years for refueling, according to NEI.

One of the challenges Dow and X-energy must address going forward is the availability of uranium, Young says, adding that they’re working with the DoE to secure domestic fuel. Most uranium has traditionally been sourced from Russia, but a U.S. House committee passed a bill in May to ban uranium imports from Russia.

Nuclear will play a role along with renewables, including blue hydrogen, in Dow’s efforts to reach its net-zero goals by 2050, says Young.

“I’ll say that it’s not our goal to be sort of one and done with nuclear,” she says. ∞

Jonathan Katz is executive editor of Control’s sister publication, Chemical Processing, which is also part of of Endeavor Business Media.
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EVALUATING SCADA SOFTWARE
- A DECISION MAKERS GUIDE -

On paper, critical SCADA components can look the same from one platform to another. Asking the following questions can help you compare apples to apples when deciding the future of your industrial process.

### WHEN EVALUATING PLATFORM RESILIENCY

**How does it handle automatic failover for application servers, Historians, comm networks, PLCs, remote client connections, and alarm notifications?**

[Adding one or more redundant servers is one of the simplest ways to improve resilience. For critical systems, ensure the software you choose supports native redundancy for each of the components above.]

**How many redundant servers can the platform support?**

[Events serious enough to take out one server can easily take out two, especially if they’re in the same office. Look for platforms that support two or more levels of redundancy across multiple locations.]

**When offline servers are restored, how do they synchronise missing data?**

[Look for a product that automatically backfills process history, alarm/event data, configuration history, and user accounts. Each redundant server should be an up-to-the-minute backup of your whole application.]

**How quick is the vendor to patch security issues when they are identified?**

[Many vendors take years to respond when vulnerabilities are discovered. Look for a track record of responding to evolving threats in a timely fashion. Ask if their development process has received cybersecurity certifications like IEC 62443.]

### WHEN EVALUATING PLATFORM SCALABILITY

**How much coding is required to assemble basic SCADA functionality?**

[Many platforms are made of third-party and native components held together with custom code. These systems are difficult to expand or debug and are prone to age rapidly. Look for a built-in suite of pre-integrated features out of the box.]

**How long will third-party components remain compatible?**

[Updates to non-native components can make them increasingly incompatible, assuming they’re not discontinued. Built-in features like alarm notifications, version control, and Historians ensure your system works seamlessly after every software update.]

**When does the vendor plan to deprecate the proposed software version?**

[Some vendors periodically retire versions, often due to dependencies on third-party components, forcing users to start over. Look for a forward migration path that does not abandon the time and money you already invested in your system.]

**How flexible is the system to changing application and network architectures?**

[Look for systems that let you easily unlock larger tag bands, deploy additional redundant servers (without custom code), and distribute the applications across local and remote sites.]}

### WHEN EVALUATING PLATFORM COST

**How much will support/renewal costs increase over the next decade?**

[Beware of unpleasant surprises. Look for companies that let you see what you will pay twenty or thirty years from now.]

**Why do we need to pay for “unlimited” I/O points?**

[How many I/O will your system need? Unless you are planning massive growth for the next decade, unlimited pricing simply means you will pay for more than you need. Look for a platform that lets you easily add tags and features as required.]

**How much will we pay for the drivers that communicate with I/O devices?**

[Direct comm drivers are the most efficient way to import process data from PLCs and RTUs but they are often a significant recurring cost. Look for platforms that include a library of industry standard drivers as part of the base software license.]

**When new features are added, will we need to purchase them?**

[In addition to major versions with significant new features, SCADA providers should be releasing product improvements and security updates every few weeks. Make sure your support contract entitles you to these changes.]
Quantifying lost manufacturing time

In part one of this two-part series, agrochemicals producer Syngenta shows how it used Seeq software to identify production losses, and increase efficiency and profitability

by Dr. Stephen Pearson and John W. Cox

UNDERSTANDING

Asset utilization is key to maximizing productivity in any industrial process. In manufacturing, production can be held up by several sources, including mechanical breakdowns, material shortages, external delays, operator errors and equipment degradation.

To evaluate operational performance, manufacturing productivity is quantified by measuring these key loss categories:

• Quality—quantified by off-specification product;
• Availability—quantified by equipment failures and material shortages; and
• Performance—quantified by slow cycles and small stops.

Data analysis plays a crucial role in automatically calculating and monitoring lost productivity because it can inform manufacturing personnel of their leading loss sources, which can be addressed as part of a continuous improvement program.

In part one of this two-part series, we’ll demonstrate how Seeq’s analytics software was deployed by Syngenta, a global producer of agrochemicals, to establish phase-duration benchmarking analytics based on historized batch data, and separated by phase start and end times. Using a basic set of assumptions, Seeq can be used to classify and generate insights into lost productivity without requiring operator- or equipment-provided reason codes.

Process background

This case study is derived from a chemical manufacturing process at Syngenta, in which two mixtures are combined and then held at temperature for a fixed time until they react. At the end of the reaction phase, a sample is taken to ensure the level of an unwanted byproduct is below the upper limit, so remedial treatment in a downstream unit won’t be required.

Following the reaction phase, any unreacted volatile reagent is recovered for reuse by altering the pressure. In the resulting two-phase mixture, the bottom layer (containing the desired product) is removed via the bottom run-off valve, while separation is monitored by conductivity. Data is available for lines 1 and 2 that perform the same process over a three-week period. It consists of labeled, batch-phase start and end times, and other properties, such as batch number and batch quality results.

How cycle times are distributed

When manufacturing processes are under recipe control, the process moves to the next phase in a recipe when certain conditions are met. This is based on a timer, sensor reading, equipment or material availability, or another trigger. This typically produces a right-skewed distribution, where most of the data is close to the lower limit because small overruns are more common (Figure 1). As a result, the 25th and 50th percentiles are typically close together.

Extreme delays are usually due to mechanical breakdowns, lack of raw materials or unavailable downstream equipment. So, investigations focused on individual occurrences of abnormally long phases, or overall unit performance degradation, typically yield the greatest value.

Using an automated approach, standard durations can be applied across all units. These

Figure 1: Typical right-skewed distribution for a phase duration caused by a mixture of availability, quality and performance losses
durations are calculated for each batch phase over a reference time, and then applied to future results as lost-time benchmarks (Figure 2).

The 25th percentile is used for the standard duration because most data are close to this value, but it’s less sensitive to extreme delays caused by equipment availability or equipment failure than the 50th percentile.

The 85th percentile identifies the worst delays for investigation. Also, there’s a second stipulation for classifying availability loss, occurring when phase duration is more than double the standard time, which keeps longer performance losses from being incorrectly labeled.

More complex logic could be used for assigning losses, such as classifying phases based on dependencies, but this would require more time to implement. For smaller operations and lower-value products, this wouldn’t provide a worthwhile return on the extra time invested.

**Setting up the analysis**

Beginning with start and end times for each batch phase, plus overall batch quality results, Syngenta deployed Seeq to create its lost-time monitoring solution using the following approach:

1. Create an asset group to structure data for production lines 1 and 2. This produces one set of calculations to maintain, and provides asset-scaling to rapidly generate trends, comparative tables and reports for each asset of interest.

2. Calculate the actual duration of each batch phase.
   a. Over a historical basis period, calculate the 25th and 85th percentile durations by phase.
   b. Create 25th and 85th percentile benchmark signals that change with phase. This requires a key data analytics feature, in which batch-phase, contextualized percentiles are spliced into one signal across time.
   c. Join process batches to quality batches reported later, moving the quality result to the process operating period. This helps identify batch capsules, where the end-of-reaction test failed specification. The advanced analytics solution does this by linking time periods with matching batch ID, while retaining associated capsule properties.

3. Using one formula function, calculate a continuous signal for the accumulated time duration of each batch phase.
   a. Search the signal for time periods when the duration goes above the 25th percentile benchmark. Create another search for time periods when the duration goes above the 85th percentile benchmark (and is also greater than twice the 25th percentile).

4. Using Seeq Value Search, Composite Condition and time period manipulation functions, and capture and quantify the lost-time events.
   a. Quality losses per batch = total batch duration for batches with a bad quality result.
   b. For batches with good quality:
      i. Availability losses per batch = sum (actual phase durations — 25th percentile benchmark) for phases with duration > 85th percentile and duration > 2 x 25th percentile
      ii. Performance losses per batch = sum (actual phase durations, 25th percentile benchmark) for phases with duration > 25th percentile (and not an availability loss)
5. Calculate total productive time = total batch durations – availability losses – performance losses - quality losses

After creating each calculation step, Syngenta visually confirmed the result on the process trends (Figure 3) using Seeq Conditions with Capsule properties, and calculated metrics and signal values. Loss-category calculations were then combined with asset swapping and visualization option, such as histograms and tables, to analyze operational performance and find optimization opportunities.

The approach outlined above can be scaled to hundreds of assets with Seeq Data Lab, a Python Jupyter Notebook environment, to automate benchmark signal calculations, and create asset trees and subsequent lost-time classifiers.

**Lost time monitoring and productivity insights**

Lost-time monitoring results for a three-week period were analyzed in multiple ways. Reviewing time lost by phase or loss type (Figure 4), the following insights were clear:

- Phase operation improvement efforts should first focus on the “charge” phases because they have the highest time losses on lines 1 and 2;
- The “react” phase is significantly worse on line 1 than 2, so investigation should look for differences in the “react” phase for both lines; and
- The largest loss category is availability, so the biggest improvements can be obtained by reducing the wait time to start successive batches.

While not shown, the phases can be further classified by the criteria used to step forward. Visualizing it this way, time lost to availability can be further divided into material shortages, awaiting user input, awaiting the phase step trigger, and equipment failure.

Examining the lost time splits in tabular form—and scaling the results across both lines (Table 1)—it’s apparent that line 2 is optimized compared to line 1, though both lines lose significant time each week. Line 2 usually produces more batches per week than line 1.

**Increase productivity with systematic analysis**

In summary, modern data analytics were applied to batch manufacturing data at Syngenta to automatically classify lost productivity. By identifying delays, capable of scaling across a diverse range of production processes, the company took early steps toward increasing asset utilization.

After making process changes, lost productivity can be continuously monitored moving forward, demonstrating whether resultant changes achieve desired gains. Targeted and high-value improvement efforts are based on quantitative operations assessments.

In part two, we’ll explore how phase classifications in Seeq can identify actionable root causes from process sensor data analysis. This requires considering correlations between multiple sensors, not just individual profiles. ☢️

Dr. Stephen Pearson is a principal data scientist at Syngenta. He helps worldwide manufacturing sites improve data management and analyses. John W. Cox is a principal analytics engineer at Seeq, where he works on advanced analytics use cases.
Whither fieldbus?

Navigating the challenges of industrial process control upgrades

IN temperate latitudes, tree-dwelling rodents labor to hide their stash to sustain them through the coming season of scarcity. They carefully choose stealthy spots that won’t be raided by their neighbors. One wonders what investments will bridge their enterprise to the next period of prosperity. Some of these remarkably clever tree dwellers will perish during the cold months; perhaps their buried stash will grow into trees for their progeny. Likewise, many manufacturing plants tried and failed to endure tough economies, which many of us witnessed in the Rust Belt decay of the midwestern U.S.

I got a curious piece of advice at one of our supplier’s offices. I was expressing some concerns about the degree to which their software “upgrades” were becoming sketchy in their support for fieldbus. Features we’d used for a couple decades didn’t function in the updated versions, which themselves were represented as minor or so-called “point” upgrades.

Their advice was to upgrade. “Upgrade to what?” I asked. I can’t think of anyone offering a proven advanced physical layer (APL) solution. Their recommendation was HART 4-20 mA. It was a little bewildering.

“Fieldbus isn’t on the roadmap,” they said. So, for my next instrument purchase, should I start buying only HART 4-20 mA transmitters and valve positioners? How exactly should I wire them up? Maybe I should stay “on the bus,” risking a potentially rough ride to the dreary dustbin of decaying support?

Let’s imagine what such an upgrade would entail. Fieldbus can be replaced with a highly scalable remote I/O, some of which neatly integrates with my DCS. Since “field” infrastructure consists mainly of copper, twisted-pair cables and terminals, I’d need to invest in field-based DC power supplies in every junction box and specialized I/O hardware. To match the redundant UPS power supplied over the FF or PA twisted pair, I’d need to invest in redundant power supplies from diverse AC feeds. Hopefully my twisted pair “trunk” will function as a home run. Otherwise, I must run new Cat 5, Cat 6, or fiber-optics out to every field junction box. New hardware for integrating the remote I/O into the DCS is also required in the house.

Meanwhile, I need to buy all the field devices on a given segment. If you average 12 devices, that’s $20 million to $30 million or more, depending on the sophistication of the devices. There’s the cost of installation, cutover and loop checking, and the revision and checkout of all the DCS loops that used the device-resident fieldbus blocks. The HART signal is digital, but its low-amplitude, sing-song signal is noise prone, so 4-20 mA must be used for control. Do the units match what was configured in the fieldbus device? Is a square root required? Now imagine doing this for 1,000 fieldbus devices on 100 fieldbus segments. There’s an entire DCS upgrade to execute.

After this substantial and intimidating investment, will this upgrade sustain me through lean times? Gone are the fieldbus devices, which once relentlessly sent their measured value, on a deterministic schedule, regardless of the configured “full scale” of its analog input block. HART devices will saturate at 20-something millamps, and yield no useful data beyond it. Precision is also eroded, as digital-to-analog and analog-to-digital must be performed at both transmitter and receiver. The unknown and potentially variable latency from remote I/O can impact loop tuning and performance.

While fieldbus devices would reveal wiring issues through communication drops and errors, 4-20 signals might drain off to ground, and deliver an unrevealed, biased result. Aside from my supplier diverting talent and resources from supporting fieldbus, I don’t see much advantage for the end-user. Vendors can also profit substantially from supplying an expensive, inferior system they’ve trapped me into purchasing. When will the support for that solution expire?

Our premier suppliers often proclaim they provide solutions. When they’ve created the problem, it will embitter their end-users if we bear the burden of deploying it. There’s no reason today’s fieldbus can’t last another 20 to 30 years, but we need our best suppliers to be on board with the end-users.

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ON THE BUS

John Rezabek
Contributing Editor
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“After this substantial and intimidating investment, will this upgrade sustain me through lean times?”
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SCADA evolution: Changing to meet new challenges

Fifth-generation systems are the largest SCADA transition yet

SCADA systems have progressed along the same evolutionary path as any computer-based system. Every generation has been defined by the new challenges it must address.

First-generation, monolithic SCADA systems were characterized by radio modems and local data aggregation. Second-generation, distributed SCADA systems used telecommunications networks and PC-based systems. Third-generation SCADA systems were defined by window-based HMI, along with standard network protocols. Fourth-generation systems are Internet-based networks with browser-based HMI and COTS infrastructure, and are typical of today’s systems.

Perennial innovation drivers common across all generations of SCADA include:

- Maximizing system reliability (no unscheduled downtime);
- Minimizing operational costs;
- Minimizing capital expenditures;
- Minimizing risk, including protecting workers and intellectual property;
- Providing more data, more reliable and longer distance coverage and faster analysis; and
- Competitive pressures to reduce costs and cycle time while improving quality.

These same perennial drivers are the impetus for fifth-generation SCADA systems, which include:

- Expanding IIoT devices inside and outside the traditional OT environment;
- Real-time integration of OT systems with non-OT systems including the cloud; and
- Cybersecurity for critical infrastructure.

Scott Greig, senior product manager at Willowglen Systems, and I recently presented on SCADA at the AIMST 2023 Conference (aimanufacturing-conference.com) in Dallas, and discussed how these perennial drivers are driving the need for adaptable SCADA, including:

- Emerging cybersecurity threats;
- Environmental, safety and security legislation;
- Availability of ML-based efficiency tools; and
- Availability of IIoT devices; and

- Amalgamation of companies and service providers due to mergers and acquisitions.

These situational changes are driving the requirements for the fifth-generation adaptable SCADA platform, which needs to be capable of supporting these emerging needs:

- Frequent patches to support legislative requirements for installing software updates on a more frequent update cycle. Facilities normally having full outages are driving a need to support live updates without reboot;
- Managing new security threat vectors and understanding how the security threat can affect operations incrementally rather than a full operational shutdown;
- Obtaining safety and security certification from independent third parties to verify compliance with international standards and regulations;
- Managing operator overload with AI-based and ML-based efficiency tools to guide operators through increasingly complex operations that they may not have observed before;
- Exponential growth/incremental expansion of systems through integration of IIoT devices to drive more accurate models and understanding of facility’s operations;
- New paradigm for maintaining system reliability including, not only integration of multiple different suppliers into a single supervisory SCADA environment, but also how to upgrade legacy systems with new systems that can support situational requirements, while satisfying the perennial needs of every SCADA installation; and
- Pressure to adopt new technologies to realize cost efficiencies and manage risk through better understanding of and integration of real-time data into business planning processes.

The increasing complexity and expectations of fifth-generation SCADA systems mean, other than the aggregating and presenting data function from previous generations capabilities, it’s no longer a “pure SCADA” play. SCADA is becoming a data orchestrator connecting information across all layers of the enterprise—from sensors to the cloud.
SCADA projects highlight ICC 2023

Inductive Automation hosts most visitors ever at community conference in California

NOT bad for a 20-year-old. Inductive Automation drew almost 1,000 visitors to its 12th annual ICC community conference (icc.inductiveautomation.com) on Sept. 26-28 at its usual venue in the Harris Center at Folsom Lake College near Sacramento. The event’s record-breaking onsite attendance was supplemented by many more participants, who attended ICC’s sessions via livestream for the first time.

The event featured close to 40 presentations, including keynotes, three tracks of technical sessions, workshops, demos and other presentations. The conference culminated with ICC’s traditional Build-a-Thon contest, in which participants design and construct a SCADA application using Inductive’s web-based Ignition software, which is gaining applications as users transition to greater digitalization, while try to keep efforts simple.

“We’ve been talking about these technologies for years, but digital transformation has been giving them a new level of urgency lately,” says Colby Clegg, CEO at Inductive, which also celebrated two decades in business earlier this year. “If you’re at ICC, you’re likely already among the forward-thinking, but we believe Inductive can help everyone get on the proactive side of that urgency, help with their digitization journeys, and make real and lasting change, which we believe comes from the bottom up.”

This assistance began with Ignition software’s unlimited licensing, continued with Ignition Edge unified gateways and Inductive’s partnership with Cirrus-Link (cirrus-link.com) and its MQTT publish-subscribe protocol, and was demonstrated most recently by the launch of Ignition Cloud Edition, which lets users achieve value from the edge to the cloud, and is now available via AWS Marketplace and Microsoft Azure.

For instance, a wall of input from members of the Ignition Community and their #WhatTheHeckIsIgnition social media posts detail all ways they’ve employed and advanced the web-based SCADA software. “We’ve often talked about how Ignition is ‘the new SCADA,’ but it’s so much more,” says Travis Cox, chief technology evangelist at Inductive. “Ignition is what its community makes of it because it can harness the collaboration of all kind of all kinds of work groups.”

Firebrand winners shine again
As usual, ICC’s Discovery Gallery (icc.inductiveautomation.com/discover-gallery) featured another crop of projects by end users and system integrators, including 10 finalists and six who won the 2023 Firebrand Awards. The winners included:

• 2GI Technologie (www.2giotechnologie.com) helped Saint-Gobain PAM modernize its 150-year-old, waterpipe manufacturing plant by employing Ignition as a paperless enterprise platform, which enables a six-person team to manage the facility’s transformation, and implement SCADA, MES, ERP, track and trace, quality control, and other functions.

• ESM Automation Systems (esm.com.au) used Ignition to help Creature Technology Co. develop its C-Tech 2 system, which provides simple visual tools for theatrical technicians to modify or create interactions and motion by complex animatronic dinosaur figures without needing to access or be experts in PLC, motion or SCADA programming.

• Grantek (grantek.com) built an alarm management system for Merck & Co.’s biopharmaceutical manufacturing plant in Wet Point, Pa. The system integrator employed Ignition Perspecti

Inductive's chief technology evangelist, Travis Cox, presents a wall of input from members of the Ignition Community and their #WhatTheHeckIsIgnition social media posts that detail how they use the software that started out as “the new SCADA.”

Keith Gamble from Barry-Wehmiller Design Group show how his team used Inductive Automation’s Ignition web-based HMI software and Opto 22’s groovEPIC controller to build an application in two days that could track golf balls on a Galter board, gather and display their data, and win the Build-a-Thon contest at ICC 2023.
Unlocking the carbon-capture value chain

Emerson’s Brandon Bromberek offers expert insights on technologies enabling the up-and-coming climate solution

**CARBON-CAPTURE** utilization and storage (CCUS) is one of the most discussed techniques for curbing carbon emissions in the Earth’s atmosphere. Many oil and gas operators have looked at investing in carbon-capture solutions, particularly recently as calls for viable solutions to climate change grow louder. In a recent episode of the Control Amplified podcast, Brandon Bromberek, VP of oil and gas for Emerson’s measurement solutions business, told Control’s editor-in-chief, Len Vermillion, how carbon capture can help usher in the energy transition and the value chain that coincides with its rise.

**Q:** Why is there a lot of talk about carbon capture?

**A:** Carbon capture is a critical component for tackling climate change. If we want to reach a net-zero emissions case by 2050, removing carbon dioxide (CO₂) from the atmosphere must be on the agenda. Reducing emissions alone isn’t going to get us there and that’s where carbon capture comes in.

It’s really the process of removing CO₂ in two general areas: from industrial sources before release to the atmosphere occurs, or through pulling CO₂ which has previously been released, out of the atmosphere (a.k.a. direct air capture). We then take those captured emissions and permanently sequestered them at depth, usually in a depleted oil and gas reservoir or in a saline aquifer far below the subsurface.

**Q:** The carbon capture value chain has many parts to it. Can you walk us through it?

**A:** The way I break it down is into five key parts. The first part is the source of those CO₂ emissions, whether high-purity emissions, low-purity emissions, or capturing super low-purity or maybe dispersing emissions from the atmosphere through direct capture. High-purity would be CO₂ that’s released as part of, perhaps, hydrogen generation through the steam methane reforming from a process such as ethanol production. Low-purity would be something coming off a cement plant or from a coal-fired or natural gas-fired power plant. Direct air capture is pulling CO₂ out of the atmosphere.

The second part is the systems and technologies to remove or separate the CO₂. We have point-source capture methodologies such as absorption or adsorption, or membrane technologies that might be mounted right on the back end of an industrial process. In the third part, we usually have some type of treatment that happens, and that’s primarily dehydration to get residual water out of that stream, and compression to get ready to move the captured CO₂. The fourth part is the transportation part of the value chain, which can be a pipeline or a ship or marine vessel in the case of cross-continent transport. There might also be truck or rail cars where we load and move the CO₂, which currently are infeasible if we want to scale this thing up.

The fifth part is what we do with it at the end point. It can be broken down into two different paths. The first is injection into the subsurface. That’s going to be probably 95% of the case, where it’s simply sequestered for good. About 5% of the case is utilization of CO₂, which can go into things such as specialty chemicals or even in the food and beverage industry where you might think of something like a carbonated beverage.

**Q:** Are there companies trying to tackle all this from end to end?

**A:** It’s a very complex process. Certainly, there’s a lot of different links in the chain from the source through to the eventual storage or utilization point. There are cases where individual entities look at owning the process from end to end, and this scenario becomes feasible when we have single-source, single sink arrangements. To make the economics work, you need the proper
subsurface characteristics nearby to the emissions source, for one. On top of that, you’ve got to be able to secure a permit for such a well, and then be able to carry out all the well construction activities necessary to build that site.

Because of this, what we see is more of a hub or a cluster concept rather than single entities trying to carry out all the steps in the process.

The idea is that on the source side, you might have multiple companies located in a small geographical area where we can get some efficiency by bringing together multiple point sources, and utilize shared infrastructure for transportation to a separate location offsite for sequestration. The storage site can be optimized for different things like subsurface geology or its location potentially away from metro areas.

Q: How do we keep track of the CO$_2$ molecules?

A: Just like any other commodity or waste stream, when there’s a changing of hands or custody transfer, there must be some measurement that takes place to ensure that the parties agree to that trade. In the hub concept, one can understand why that becomes quite important. Furthermore, you can consider that while CO$_2$ is emitted as a gas, it’s likely to be compressed to higher pressures and moved to a different state, potentially liquefied, before it’s moved. As such, there’s a lot of complexity to ensuring the fact that all those measurement points match up across different phases. As we move toward globalized trade of CO$_2$, accuracy in terms of that fiscal impact becomes critically important. Ensuring that we see overall mass balance across that chain, and that we’re truly sequestering and getting rid of the CO$_2$ that we’ve captured, relies on accurate measurement along the way.

Q: What are some of Emerson’s technologies used in carbon capture?

A: Where we come in with Emerson’s automation portfolio is that we truly span across that value chain from process optimization on the front end, to ensuring carbon streams are captured as efficiently as possible, to optimizing the transport network, to building the systems that are used for custody transfer of carbon streams. We even help with modeling the subsurface for storage capacity and integrity.

On the measurement instrumentation side of the business where I sit, we’re involved in everything from process measurement of things such as pressure and temperature to gas analysis, where we help understand CO$_2$ stream purity, contamination and water content, to metering the flow of those fluid streams.

We’ve been involved in the instrumentation of carbon streams for decades, and as a whole, that’s something we’d consider ourselves highly experienced in with expertise and technology that can really be applied today.

Q: Any final thoughts?

A: We’re encouraged by the speed at which some of these projects are hitting the ground running. It’s exciting to see the openness and the collaboration that’s taking place in a relatively new domain. It’s uncharted territory for many who are starting their journey into carbon capture, and we’re happy to partner with them on their energy transition goals.

Hear More
You can hear more details about carbon capture and the technologies behind this emerging process for the energy transition on the Control Amplified podcast, available at ControlGlobal.com/podcasts

The Micro Motion CMF300 Coriolis Meter has many uses as part of the carbon capture value chain. (Source: Emerson)
to provide alarm monitoring, historization and a management interface for more than 10,000 points, while also delivering ad hoc and scheduled reporting tools to assist rationalization of up to 30,000 alarm events per day.

• **Room in the Inn** (RII, www.roomintheinn.org) housing, health, education and employment provider in Nashville, Tenn., worked with system integrator Vertech (vertch.com) to reconcile RII’s Client Track, Volgistics, JotForm and Razor’s Edge software packages, Excel spreadsheets and email system it employs to run its 13 homeless shelters, 111 congregations, and thousands of homeless participants and volunteers. Vertech used Ignition to develop RII’s Discovery homeless management information system (HMIS).

• **Skellig Automation** (skellig.com) helped Center for Breakthrough Medicine (CBM) develop an automation infrastructure and data management system (DMS) for what it reports is the world’s largest cell and gene therapy program. The DMS combines open-source technologies, including Opto 22’s groovEPIC controllers, Ignition’s web-based SCADA software and Canary’s Historian, which all use MQTT publish-subscribe protocol.

• **Vantage Data Centers** (vantage-dc.com) designed and deployed a hub-and-spoke Ignition Perspective system to monitor and control multiple data centers across the Europe, Middle East and Africa (EMEA) region; support continuous improvement with SCADA synchronization; and reduced development and deployment cycle for new projects from a few months to a few weeks.

Similarly, just as the Ignition Exchange program provides a one-stop resources shop of resources for Ignition users, Inductive also launched its Sparkplug Data Dash program that publishes edge performance data from 50 companies via Cirrus Link’s bridge to Snowflake’s Data Cloud, so other participants can benefit from their input and digital transformation experiences. For example, the World Economic Forum’s Lighthouse program recently recognized Ignition users for modernizing and improving efficiency by 15% at CEAT’s tire manufacturing plants in India, which reduced their carbon footprint and water use.

*For more coverage of the sessions and projects presented at ICC 2023, visit icc.induicamateautomation.com.*
**SIGNS AND INDICATORS**

- **Brooks Instrument** (www.BrooksInstrument.com) reported Sept. 28 that it’s opened a new manufacturing facility in Penang, Malaysia, increasing its operational footprint in Asia-Pacific for producing mass flow controllers (MFC). The new 57,000-square-foot plant follows the company’s recent manufacturing expansion in Korea and is its fourth global production area. The other locations are in the U.S. and Hungary.

- **Siemens** (www.siemens.com/private-5g-networks) reported Sept. 28 that it’s launching a private infrastructure developed in house for the 5G mobile communications standard. This solution enables industrial companies to build their own local 5G networks that will provide optimal support for automation applications. The solution is already in use at Siemens plants and pilot customers like Salzgitter AG.

- **Amphenol Industrial Operations** (www.amphenol-industrial.com) announced Sept. 14 that it’s expanding its operations with a 58,000-sq-ft factory in 4Q23 in Mesa, Ariz. This new factory will create up to 50 specialized jobs, and will produce solar junction boxes, connectors, and other interconnect assemblies.

- **ABB** (www.abb.com) reported Sept. 19 that it’s agreed with SalMar (www.salmar.no) to operate digital services at its remote-controlled Arctic Offshore Farming (AOF) facility located at sea off northern Norway. The partnership also requires ABB to deploy its Ability EdgelInsight software to collect real-time and historical operational data from individual fish farms and distribute it securely to SalMar’s cloud-based database.

- **Schneider Electric** (www.se.com) unveiled Sept. 14 its new, 160,000-sq-ft manufacturing plant in El Paso, Tex. The new facility is part of a $300 million manufacturing investment the company has made in the U.S. to support its customers. By the end of the year, Schneider Electric will have approximately 1,500 employees in El Paso, thanks its creation of about 400 new jobs.
Honeywell UOP holds sustainability lab tour

To demonstrate its latest sustainability and digital transformation efforts, Honeywell UOP (honeywell.com) hosted its International Lab Tour on Sept. 12-14 at its facilities in suburban Chicago and Charlotte, N.C.

“Sustainability is the biggest challenge in the energy, transportation and food sectors. We all know we need to act, but no one can do it alone,” says Gavin Towler, chief sustainability officer at Honeywell. “Many companies are setting dates for net-zero emissions, and Honeywell is all about supplying the technologies to help others be more sustainable.”

The tour kicked off a visit to one of Honeywell UOP’s oldest facilities—its 102-year-old Universal Oil Products R&D lab in Riverside-McCook, Ill., which has long pioneered, tested and produced catalysts and other products to improve production of oil, petrochemicals and plastics. The facility and its staff are now focusing on sustainable topics like renewable fuels and plastic circularity.

The tour continued at Honeywell UOP’s labs in Des Plaines, Ill., which is concentrating on improving batteries for energy storage, carbon capture, and hydrogen fuel sources. The tour concluded at Honeywell’s headquarters in Charlotte, N.C., where a roundtable of expert covered healthy buildings and smart cities.

“Everyone knows we make thermostats, but Honeywell is a data, systems, automation and software company that measures, analyzes and controls everything from process plants to airplanes to buildings, and now all of these facilities are looking at how to be sustainable, too,” adds Towler. “Since 2004, Honeywell has completed 6,300 sustainability projects, saved $110 million, and reduced the intensity of our greenhouse gas (GHG) emissions by more than 90%. This 20-year track record in our facilities enables us to provide our customers with a full portfolio of sustainability solutions.”

Towler adds that Honeywell’s path to carbon neutrality includes:

- Establishing its environmental, sustainability and governance (ESG) board;
- Reducing Scope 1 and 2 GHG emissions intensity another 10% below 2018, deploying at least 10 more renewable energy projects, and achieving certified compliance with ISO 50001’s energy management standard, all by 2024;
- Complying with reducing Scope 1 and 2 emissions by 50% by 2030; and
- Achieving carbon neutrality in Honeywell’s internal facilities by 2035.

“We’re committed to ESG principles,” says Towler, “And as we progress towards carbon neutrality by 2035, we want to help everyone else make the same transition.”

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Motors and drives show their moves

Control’s monthly resources guide

ALL ABOUT VFDs
This 15-minute video, “Variable frequency drives explained—VFD basics” shows how they work in electrical engineering and power electronics. It demonstrates where and why to use a VFD or VSD, alternating current, direct-current, single-phase, three-phase, frequency, rectifier, DC bus, inverter, capacitor and pulse width modulation (PWM). It’s part of a series located at www.youtube.com/watch?v=yEPe7RDlkgo

THE ENGINEERING MINDSET
www.theengineeringmindset.com

DOE IMPROVES PERFORMANCE
This 116-page article, “Improving motor and drive system performance: a sourcebook for industry” from the U.S. Dept. of Energy’s Industrial Technologies Program (ITP), presents a system approach, indications of poor system design, motor types and operating characteristics, and shows how to match motors and drives to their applications. It’s at www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/motor.pdf

U.S. DEPT. OF ENERGY
www1.eere.energy.gov

POWER FOR SPEED AND TORQUE
This 43-minute video, “Introduction to motor drives” by Jim Pytel of Big Bad Tech, covers power electronics devices that vary the speed and torque of a motor under its direction by varying the supplied voltage magnitude and frequency. It also reviews properties that influence synchronous speed, discusses rectification, inversion and filtration, and examines motor drive specifications and programming. It’s at www.youtube.com/watch?v=uT3m-01PM3c

BIG BAD TECH
www.youtube.com/watch?v=UNZKlCoDxmY

DESIGN, VALIDATION TESTING
This online library, “Accelerate the design, validation and testing of motors and drives” contains ebooks, whitepapers and case studies on testing motor and drive systems, developing premium efficiency motors, measurements challenges, AC kinetics and other topics. It’s at tmi.yokogawa.com/us/industries/motors-drives

YOKOGAWA TEST & MEASUREMENT
www.yokogawa.com

AC BASICS AND INSTALLATION
This 38-minute video, “Drives 101: basic features of AC drives,” shows how to control motors speeds, save energy and develop control strategies. It also covers pulse width modulation (PWM), constant torque loads, affinity laws for centrifugal loads, digital/analog inputs, slip compensation, braking methods and other topics. It’s at www.youtube.com/watch?v=MqbnOvTKdcM, where there’s also a link to a second, 27-minute video, “Best practices for installing AC drives,” which has strategies, suggestions and technical advice. It’s at www.youtube.com/watch?v=EETNiqO9All

ABB
www.abb.com

DIFFERENT DRIVE TYPES
This online article, “Types of motor drives,” covers DC and AC drives and the motors that rely on them, servomotor drives, controllers and applications, and stepper motors and applications. It’s located at https://gesrepair.com/motor-drive-type

GLOBAL ELECTRONIC SERVICES INC.
www.gesrepair.com

TROUBLESHOOT DRIVES, PANELS
This eight-minute video, “How to troubleshoot and diagnose a non-working VFD” by Craig Hartman, presents a step-by-step guide for inspecting different parts of systems to diagnose non-working VFDs or VFD panels that aren’t powering up, showing error codes or running rough. It also shows how to check maximum frequency, set acceleration times, disconnect motors and measure cables. It’s at www.youtube.com/watch?v=skbO6ghAO8o. A second, five-minute video, “How to wire a VFD” by Steve Quist, provides instructions for wiring single-phase or three-phase Mitsubishi D700 series VFDs. It’s at www.youtube.com/watch?v=nL-VSw-r4DY

VFDS.COM
www.vfds.com

THREE-PHASE INDUCTIVE PARTS
This online article, “Get schooled: AC motor basics” by Jeff Payne, covers the essential parts of three-phase AC inductive (asynchronous) and synchronous motors, namely the stator and rotor, as well as rotating magnetic fields, soft starters and VFDs, controls and common applications. It’s located at library.automationdirect.com/get-schooled-ac-motor-basics

AUTOMATIONDIRECT
www.automationdirect.com

SOFT STARTER VS. VFD
This seven-minute video, “What’s the difference between a VFD and soft starter?,” examines their internal workings and applications, so users can determine which they might want to implement. For example, it shows how a typical, three-phase soft starter uses six thyristors or silicon-controlled rectifiers oriented in an anti-parallel configuration to start electric motors smoothly. It’s at www.youtube.com/watch?v=_ZztDN5XX5o

REAL PARS
www.realpars.com

www.controlglobal.com

RESOURCES
The top 50 global and North American automation suppliers report that sustainability and digitalization are overcoming other headwinds

Stability expected

**AFTER** returning to pre-pandemic stability in 2021, the automation marketplace is entering a new age of growth and significant opportunities that ARC Advisory Group (www.arcweb.com) believes will continue well into the next decade. While the market continues to face headwinds from the war in Ukraine, rising geopolitical tensions, and continued supply chain challenges, the market experienced above average growth in 2022 and the outlook for 2023 continues to be positive.

It’s always a challenge doing the Control/ARC Top 50 story because we’re looking into the rearview mirror at financial performance from the previous year, and yet we’re already entering the fourth quarter of 2023 and the market is becoming increasingly dynamic. As we discussed last year, sustainability has emerged as the leading business issue facing both automation suppliers and end users today.

The growing adoption of digital transformation strategies, and the concurrent deployment of the Industrial Internet of Things (IIoT) suite of technologies like industrial-edge architectures and artificial intelligence (AI) are increasingly driven by sustainability initiatives. Sustainability and digital transformation are symbiotic factors that will drive growth in the automation marketplace for at least the next decade. Major automation suppliers recognize the opportunity in sustainability, and they’re all implementing significant sustainability programs of their own, and working to provide end users with industry and application-specific solutions to help their customers do the same. Some suppliers are already reorganizing their businesses around dimensions of sustainability.

**Scope and methodology**

Data in the Top 50 lists is taken from a combination of publicly available financial reports and ARC’s own extensive database of the automation businesses of each supplier. Please refer to the scope at the end of the article because our scope focuses solely on control and automation, and doesn’t include items like switchgear and electrical equipment or process equipment like compressors, vessels, etc. Notably, Roper Technologies is absent this year because it sold a majority stake in its industrial automation business in June 2022 to a private equity firm to focus on its software business, so now it resides largely outside the scope of this report.

**Overall 2022 market performance**

Avoiding a play-by-play analysis of each supplier’s financial performance, there’s little change in the relative positioning of the major automation suppliers in North America and worldwide. Most suppliers experienced above average growth in their automation businesses, though currency fluctuations were also a factor in 2022. All indications are that the market will perform perhaps even better in 2023, as orders and backlogs continue to increase. ARC’s quarterly analysis of automation market performance shows double-digit revenue growth in the first quarter of 2023 (1Q23) compared to the same period last year.

**Sustainability impacts all industries**

When most people think of sustainability, they probably think of things like electric vehicles, renewable power and recycling.
### Top 50 Global Automation Vendors

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<tr>
<th>Rank</th>
<th>Vendor</th>
<th>2022 Worldwide Revenue (US$ millions)</th>
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### Top 50 North American Automation Vendors

<table>
<thead>
<tr>
<th>Rank</th>
<th>Vendor</th>
<th>2022 North American Revenue (US$ millions)</th>
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<tbody>
<tr>
<td>1</td>
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<td>$5,814.14</td>
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<td>Rockwell Automation</td>
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<td>MKS Instruments</td>
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<td>Eaton</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$38,618.38</strong></td>
</tr>
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</table>
However, the world’s largest hydrocarbon producers—the integrated oil and gas companies—are taking significant steps toward net-zero emissions and carbon neutrality. Chemical companies are reducing energy consumption and looking at new processes that are less energy-intensive. The water and wastewater industry and its municipalities are actively modernizing aging infrastructures. Pulp and paper companies are retrofitting plants to run without fossil fuels by using carbon-neutral biomass and residuals from their manufacturing processes. In fact, ARC challenges any reader to identify a major process, hybrid or discrete manufacturer that isn’t implementing some kind of sustainability program, whether it’s increasing energy efficiency, reducing emissions or spills, or electrifying assets that were once powered by hydrocarbons.

Any investment in new processes and technologies will have a positive impact on the automation market. Increased sustainability efforts will create new investments in a broad range of technologies from sensors to the enterprise level. Existing manufacturing processes and assets must be optimized and modified to reduce emissions, increase energy efficiency and cut costs. Wind farms, for example, are increasingly investing in industrial, edge-computing platforms. Efforts to reduce flaring and overall emissions are increasing investment in flare-control systems, pipeline corrosion-monitoring solutions and continuous emissions monitoring systems.

Other new processes that accompany sustainability include carbon-capture and storage operations, hydrogen infrastructure, improved processes for water usage and treatment, and new recycling processes for plastics and other materials. All of these create numerous greenfield opportunities for automation suppliers—if they can offer cohesive solutions. The more forward-thinking suppliers are designing solutions to address specific sustainability processes and applications.

**Business value case for sustainability**
It makes a lot of business sense for end users to adopt sustainability strategies. Adopting a sustainability strategy can eliminate waste by reducing emissions, eliminating oil spills and pipeline leaks, and capturing countless metric tons of...
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- High accuracy, wide operating temperature ranges, and durable construction for a wide range of applications
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methane and other substances that are usually released into the atmosphere. However, companies aren’t just focused on existing processes. The large integrated oil and gas companies, for example, are transforming themselves into energy companies, making huge investments in sustainable power from wind, solar and hydrogen, and are signing long-term energy contracts with large end users such as Amazon to provide renewable energy at scale.

Asset electrification needs integrated control

The drive to sustainability has led to a mass-electrification movement of assets and processes that were previously powered by hydrocarbons. Close to 80% of the energy consumed in the chemical industry, for example, comes from fossil fuels. The opportunities for sustainability and energy efficiency by electrifying are considerable, and will require increased investment in automation. Assets like furnaces, fired heaters and more can all be electrified.

Though the Top 50 doesn’t cover items like switchgear and other electronics, the electrical side is becoming increasingly important, and the worlds of process control and electrification are integrating.

Electrical power management and automation were traditionally designed and operated independently of each other during plant lifecycles. Historically, this separation made sense. However, digital transformation enables integrated connectivity to manage these two domains going forward. The fusion of power and automation is a catalyst for operational resilience and improved sustainability across plant lifecycles, and will be a major, market-growth driver for the near future.

Regulatory environment heats up

While sustainability has a compelling business value proposition, its associated regulatory environment is ramping up, too. Governments, agencies and local officials worldwide are drafting, enacting, and enacting stricter climate policies that will have a lasting impact on multiple industries. Regulations such as the European Commission’s Corporate Sustainability Due Diligence Directive (CSDDD) will take effect in 2024, and will affect more than 50,000 businesses. These directives are multiplying as governments lay out clear paths to net-zero that include complete green energy transitions.
How the Top 50 lists are derived and assembled

ARC Advisory Group’s analysts discover new firms to add to the Top 50 lists each year. If you find one that should be listed but isn’t, let Larry O’Brien (LOBrien@arcweb.com) know, so it can be evaluated for potential inclusion. Though companies with increased sales are added, and those with decreased sales relative to the others or those that have been acquired are removed, the Top 50’s basic analysis methodology hasn’t changed for years. If anything, it’s scope and focus on revenue generated by process control and automation activities have grown lighter.

Technologies included in the Top 50 definition:

- Process automation systems and related hardware, software, and services;
- PLC and related hardware, software, services, I/O and bundled HMI;
- Process safety systems;
- SCADA systems for oil and gas, water and wastewater, and power distribution;
- Other control hardware components, such as third-party I/O, signal conditioners, intrinsic safety barriers, networking hardware, unit controllers, and single- and multi-loop controllers;
- AC drives;
- Motion control systems;
- Computer numerical control (CNC) systems;
- Process field instrumentation, such as temperature and pressure transmitters, flowmeters, level transmitters and associated switches;
- Analytical equipment, including process electrochemical, all types of infrared technology, gas chromatographs for industrial manufacturing and related products;
- Control valves, actuators and positioners;
- Discrete sensors and actuators;
- All kinds of automation-related software from advanced process control, simulation and optimization to third-party HMI, plant asset management, production management (MES), ERP integration packages from the major automation suppliers and similar software, and other automation-related services provided by automation suppliers;
- Condition-monitoring equipment and systems; and
- Ancillary systems, such as burner management systems, quality control systems for pulp and paper, etc.

Technologies not included in the Top 50 definition:

- Pumps and motors
- Robotics
- Material-handling systems
- Supply chain management software
- Building automation systems
- Fire and security systems
- Processing equipment, such as mixers, vessels, heaters, as well as process design licenses from suppliers that have engineering divisions
- Electrical equipment, such as low-voltage switchgear, etc.

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The private sector will no longer have the option of voluntarily opting into reporting programs or climate pledges. The public sector is beginning to lay out reporting frameworks and timelines, and will rely heavily on companies to become responsible for accounting for their emissions. Suppliers and end users will be affected, but they currently have the opportunity to get ahead of the implementation of stricter energy regulations.

**Inflation Reduction Act spurs automation**

The recent passing of the U.S. Inflation Reduction Act (IRA) will positively impact growth of the automation market for the next several years. Contrary to its name, the law isn’t primarily intended to reduce inflation, but rather to make U.S. industries climate- and future-proof. The act provides for investments of roughly $500 billion in tax incentives, grants and loan guarantees. A large part of this funding will reduce carbon emissions and extend healthcare affordability programs, but the IRA also provides $48 billion for the manufacturing sector. Since it was signed into law, the IRA has made an immense amount of money available to end users, consumers and manufacturers. These funds are also available as tax credits, loans and grants.

The IRA also includes a 45Q tax credit of $25 to $50 per tonne (metric ton) of captured CO₂ as an added incentive compared to enhanced oil recovery (EOR). The number of Class VI carbon-capture and storage applications has surged. However, only Wyoming and North Dakota have approved class VI wells so far, so there’s competition for pore space (storage locations with adequate porosity), pipelines, skilled resources, and commitments from sites generating CO₂. Early projects are associated with blue hydrogen, gas processing and ethanol.

**Software key to digital transformation…**

Investment in software will keep increasing to meet the requirements of digital transformation. The major automation suppliers made critical investments in software capabilities in the past year. For example, Aveva completed its $5 billion acquisition of OSIsoft in 2021, while Schneider Electric completed its acquisition of Aveva in early 2023. Meanwhile, Emerson completed its
acquisition of AspenTech in May 2022. Another engineering software leader, Hexagon, acquired long time independent software supplier PAS in 2020. Software is a key driving force in digital transformation, so we can expect to see more investment in software companies by major suppliers in the future.

…and so is artificial intelligence
End users are dealing with increasingly sensitive supply chains, continued conflicts in Ukraine and elsewhere, and the specter of another COVID outbreak, among others. Combinations of these and other upheavals have seemingly created a world where black swan events are abundant. The only way to become resilient and agile enough to weather these challenges is with digital transformation.

Industrial AI (including Generative AI) applies its technologies in manufacturing to augment workforces seeking growth, profitability, more sustainable products and production processes, enhanced customer service and other business outcomes. Many of the major automation suppliers are already embedding AI functions in their products and services, and we expect it to drive innovation and growth in the automation market during the coming decade.

Industrial AI leverages machine learning (ML), deep learning, neural networks and other approaches. Some of these techniques have been used for decades to build AI systems using data from various sources in industrial environments, such as sensors, machinery, process engineers and operators. AI adds to a portfolio that will expand to new systems for Causal AI, Neuro-Symbolic AI and Quantum AI as related breakthroughs occur in those fields of AI research. Industrial leaders are identifying areas where AI can make an impact, such as generative design of sustainable products, production processes and services, predictive maintenance, supply chain optimization and quality control.

OT cybersecurity and suppliers
Many of the major automation suppliers already make their cybersecurity business a priority. Generally, large automation suppliers offer cybersecurity services, such as auditing and assessments, combined with some level of lifecycle services or OT security operations center (SOC) services. Many suppliers partner with third-party OT cybersecurity suppliers for anomaly and breach detection solutions, secure remote access, zero trust, and other pieces of the industrial cybersecurity solution set that must be put together to create an integrated system for OT cybersecurity.

Suppliers need to beef up their capabilities because end users desperately need them. Adequate human resources aren’t available for OT cybersecurity. The industrial and critical infrastructure sectors can’t find enough people to meet their requirements. Similar to the wave of outsourcing automation services to suppliers in the 1990s and early 2000s, end users will increasingly rely on suppliers to deliver secure-by-design products. Users will also expect suppliers to implement security from the start of projects, and offer lifecycle services for security monitoring of
operations, maintenance, configuration, SOCs and other tasks related to OT cybersecurity. All suppliers will have to increase their cybersecurity capabilities. Approaches to OT cybersecurity are also becoming more system-focused, marking a transition from putting together a patchwork of solutions.

OPA becomes a business

Several times over the past few years, we’ve written about the impact of Open Process Automation (OPA) on the overall automation market, and the Open Process Automation Standard (O-PAS) is finally moving from conceptual and pilot project phases to commercially available products, applications and services. The vision of OPA is “to transition industry from closed and proprietary process control systems to open, secure, standards-based systems that accelerate innovation and value creation.” The objective of O-PAS is an interoperable process control architecture—taking control systems that traditionally weren’t interoperable, and transitioning to open and interoperable versions that spur innovation. ExxonMobil and its process industry partners in the Open Process Automation Forum (OPAF) have been advocating and advancing O-PAS for years, and they’re at a stage where they can deploy it in actual process operations. OPAF and its partners are aligning with O-PAS and forming an ecosystem.

In fact, O-PAS, Version 2.1, is now available, along with its building-block elements of communications, controls functionality and configurations, which allow suppliers to produce products and applications. The initial proof-of-concept (PoC) application by ExxonMobil was at the lab scale. At that time, O-PAS-compliant products weren’t ready for 24/7 field operations. Since then, vendors have provided commercially viable products for use in the field trials. And, as the standard matures, O-PAS will add application portability and orchestration.

Larry O’Brien, VP of research; Colin Masson, research director on ARC’s enterprise software team; Craig Resnick, VP of consulting and primary analyst for many of ARC’s automation supplier and financial services clients; and Gaven Simon, market research analyst on ARC’s industrial sustainability and energy transition team, are all of ARC Advisory Group, and can be reached via Larry at LOBrien@arcweb.com.

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Advice at the device—and remotely

Digital valve controller employs real-time, edge computing to deliver diagnostics, alerts and recommendations

IF you had more than 100 years of experience building control valves and 30 years of digitalizing them on your résumé, it’s a good bet your next digital valve controller would continue that longstanding tradition of innovation and reliability. Well, Emerson has those credentials because it’s sold more than 3 million Fisher Fieldvue controllers and digital valve controllers, which have provided more than 10 billion hours of field operations, typically in critical applications.

“In the early 1990s, we were the first to digitize with Fisher Fieldvue DVC5000 and its microprocessor-based design, which let users receive data values and perform calibrations remotely,” says Tom Brandau, VP for Emerson’s Fisher instruments. “These innovations continued with Fisher Fieldvue DVC6000, which was double-acting and had a modular design that was easier to use and more reliable. The next major advance was Fisher Fieldvue DVC6200 in 2009, which was truly non-contacting, separating the controller from the valve linkage. This resulted in far less vibration and adverse feedback, and increased reliability 10 times compared to the feedback from traditional magnetic technologies.”

Given this proud lineage, it’s no surprise that Emerson is releasing its Fisher Fieldvue DVC7K digital valve controller. It employs real-time edge computing to deliver diagnostics, alerts and recommendations to improve the performance, reliability and uptime of on-off and control valves and their processes. DVC7K can be specified for all new valve purchases, retrofitted to most existing valve installations, and quickly and easily commissioned via its local user interface.

“The step change now is useability and connectivity,” says Brandau. “DVC7K still has 4-20 mA HART, but now it also has Bluetooth for diagnostics, calibration and receiving software updates, as well as a local interface for ‘Advice at the Device.’ Plus, DVC7K doesn’t just monitor and report on process values. When it detects a problem, it provides alerts that are viewable locally or remotely, along with recommended actions, which is a new and unique feature. This eliminates many former obstacles, such as going out to the field, clipping on a HART communicator, and running data through ValveLink software or another asset management system.”

DVC7K interprets data by combining patented technology, experience-based algorithms and continuous, real-time analytics with flexible connectivity and easy integration. Its onboard, real-time edge computing analyzes issues and creates actionable information. This provides real-time awareness of valve health by analyzing data locally with onboard diagnostics.

All of DVC7K’s data can be viewed on its local user interface, nearby via Emerson Secure Bluetooth, or remotely after it’s transmitted to a host, such as a distributed control or an asset management system. The local interface uses LEDs to show valve status and health at a glance, and users can drill down from its home screen for more details. Emerson Secure Bluetooth enables access to one or more DVCs at up to 50 feet from any device with Bluetooth, such as a tablet or smartphone.

“The local user interface provides alerts about issues like low supply pressure, friction or leaks, but instead of just delivering data, it recommends fixes like checking regulator air settings or tightening packing,” explains Brandau. “Just as users need knowledge to interpret and form conclusions, DVC7K develops do’s and don’ts based on the data it receives, and it can tell users if they’re out of spec or out of bounds, suggest several options, and push them to a host system. We push alerts about deeper diagnostics, rather than relying on an asset management system.”

Brandau reports that DVC7K’s other main advance is that it constantly performs real-time analytics onboard, instead of initiating diagnostics from outside and then seeking solutions. “Users can now do analytics all the time with DVC7K, so rather than starting to look for problems such as low pressure, it can track and capture issues continuously,” adds Brandau. “When an upset occurs, DVC7K already has the evidence ahead of time and what support is needed during that period. This is what makes DVC7K the most reliable, highest-performing valve controller in the process industries, and the solution on which users can build their plants of the future.”

For more information, visit Emerson.com/FisherDVC7K
Clearing harmful algal blooms

AECOM, Ecosa, ENGraphed and Opto 22 team up on a sustainable harvesting solution to a complex environmental problem

by Len Vermillion

If you were a tourist in Florida in 2016, you might have been disappointed. Massive algae blooms surfaced along the east coast, and Gov. Rick Scott declared a state of emergency and closed all beaches in three counties. The problem returned in 2018, but worse: beaches on both coasts were closed and invasive, toxic, blue-green algae choked many freshwater lakes, rivers and residential waterways.

The freshwater problem originated in Lake Okeechobee, the largest lake in Florida. Massive rainfall that year required the U.S. Army Corps of Engineers, which manages the lake's levels, to discharge billions of gallons of water to prevent flooding. The water coursed through the Caloosahatchee and St. Lucie Rivers, bringing with it rich nutrients that fueled algae overgrowth downstream.

Not only tourists, but also residents and business owners who couldn’t leave the area, were left to face the ugly, slimy, stinky water. The toxic slime threatened human health and devastated tourism-related businesses, as dead fish and other aquatic life piled up along the shorelines.

An increasing problem

Harmful algal blooms (HAB) are an increasingly complex and dangerous environmental problem worldwide in both freshwater and saltwater. The Environmental Working Group (www.ewg.org), a watchdog group for environmental issues, tracked an increase of more than 500% in news reports of algal blooms during 2010-20 in the U.S. Though not all these blooms were toxic, EWG notes that even nontoxic blooms “may have a negative effect on recreation, tourism, local economies, aquatic ecosystems and wildlife.”

Dense blooms block sunlight from reaching underwater plants and animals, and can clog the gills of fish and other aquatic animals, so they can’t breathe. When the bloom dies off and decays, it uses up oxygen in the water, killing fish and producing noxious odors. Some bloom-forming algae produce potent toxins that can harm the health of humans and land animals as well.

The U.S. National Oceanic and Atmospheric Administration (NOAA) (noaa.gov) estimates that, “HABs cause about $82 million in economic losses to the seafood, restaurant and tourism industries each year.”

HABs also pose a severe problem for drinking water reservoirs because the toxins are challenging to treat, and the
algae can affect treatment processes. Sometimes treatment can produce potable water, but if it doesn’t, affected water districts must provide bottled water to customers for drinking. In 2019, the California Dept. of Water Resources (water.ca.gov) reported, “Common water purification techniques such as camping filters, tablets and boiling don’t remove toxins.”

**Existing approaches**
How can dangerous HABs be treated or controlled? In one of four ways, according to the U.S. National Office for Harmful Algal Blooms (hab.whoi.edu):

- Environmental—These methods change the habitat that favor HABs, for example, by controlling the nitrogen and phosphorus pollution that feeds the blooms, or by further circulating the water;
- Biological—in some cases, a parasite can kill the algae, but the long-term effects of introducing the parasite in the water are unclear;
- Chemical—Sprinkling the water’s surface with copper sulfate is a common chemical method, which kills the algae, but it’s toxic to fish; and
- Physical or mechanical—Clay can be spread on the water’s surface, and the tiny, dense clay particles combine with other particles in the water, including algae cells, and then sink to the bottom.

These methods can be effective, but they have drawbacks. Environmental treatments are important for the future, especially to reduce the nutrient pollution that feeds algal blooms, but they take time and require legislation or regulatory changes for industry, farmers and ranchers, and residents. Biological treatments have long-term risks because their future effects are largely unknown.

Chemical treatments may be toxic to fish, and both chemical and physical treatments just push algae to the bottom, where they decompose. But algae cells contain about 70% carbon, and can release methane when they decay. Methane is a powerful greenhouse gas (GHG) that warms the atmosphere 80 times more than carbon dioxide in the short term. Even though the algae are killed, the nutrients remain, so the problem comes back quickly and often to a greater degree than before the treatment.

Clearly, a new solution is needed. Dan Levy, national director of algae at Aecom (aecom.com), an engineering firm focused on infrastructure, found one—physically removing both the algae and its nutrients, and returning clear, fresh water to the environment.

**Focus on infrastructure**
Aecom often coordinates with universities and government agencies due to the size of its projects. Levy and Bill Colona, Aecom’s operations manager for algae, have made it their mission to develop technologies that can mitigate and restore nutrient-impacted waterways. When it came to the recent algal blooms, they collaborated with David Pinelli, president of Ecosa Process Technologies and a technical expert in liquid/solid separation systems.

Pinelli previously worked at a company developing algae-based bio-foam to replace commercial plastics, and he knew that the process he developed for recovering algae could be effectively scaled. Levy recognized this could be an innovative solution for waterways, and he and Pinelli collaborated to develop their patent-pending Hydronucleation Flotation Technology (HFT) for harvesting algae.

The groveEPIC provides real-time control and connectivity to all parts of the Hydronucleation Flotation Technology (HFT) process, as well as data storage, communications and the operator interface.

Recover algae biomass from harvesting operations

Algae buildup in the waters in Lee County, Fla., threatened tourism and posed health risks for residents.
HFT separates algae from water without rupturing the algae cells—a key point because algae cells release toxins when ruptured. Because algae contains nutrients, the process also removes the nutrients, so they can’t trigger another bloom.

To advance the technology, Pinelli reached out to Guy Chetrit, P.E., president of ENGrafted Engineering Solutions (engraphted.com), who was also an old friend he’d worked with at a previous company. Chetrit’s expertise is industrial process design and automation, and his background in the environmental sector made him a good fit to help execute the HFT process at full scale. He designed an automated system in close collaboration with Levy and Pinelli.

Chetrit is a mechanical engineer, who knows the value of automation. He was first exposed to Opto 22 (opto22.com) hardware more than 20 years ago, and kept up with the company’s technology through various projects. For the algae harvester design, he chose Opto 22’s groovEPIC edge-programmable industrial computer.

Despite available technology, there was still a gap in engineering a solution that would work effectively with nature in restoring damaged ecosystems. To address this issue, Levy contacted Dr. Tammy Karst-Riddoch, Aecom’s senior limnologist and algae expert.

The process

The resulting process is a solution in which wild algae are harvested using the

Harmful algal blooms (HAB) aren’t confined to Florida. Lake Elsinore in California was closed for recreation due to dangerous levels of algal toxins for all but five weeks from August 2022 to April 2023.

HFT to gently separate algae from the water column by using extremely small (nano-sized) air bubbles, which take advantage of the algae’s proclivity to float. The HFT prevents damage to the algae cells, and allows efficient removal of nutrients and atmospheric carbon, while preventing the release of cyanotoxins.

The developers report their process is simple and effective:

- Water is pumped from the affected waterway to the HFT. A treatment solution coagulates and flocculates the algae into larger particles before separation.
- The water containing coagulated algae is directed to a flotation chamber. Nano-sized bubbles are introduced into the chamber, and they attach to the algae and carry it to the surface as the bubbles rise. Once enough algae floc has accumulated on the surface, a skimming system physically removes the algae from the water column.
- The clean, clarified water is returned to the environment. The returned water is highly oxygenated from the hydronucleation process, and provides additional benefits by increasing oxygen levels in the waterway, which can be very low in these impacted water bodies.
- The recovered algae biomass, rich in nutrient and carbon, can be transformed into a variety of green products, including biofertilizers, clean energy

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PLCs & PACs
(both biocrude and biogas), and commercial bio-foam products.

Though environmental conditions (temperatures, turbidity, pH, chlorophylls, dissolved oxygen) vary in HAB-impacted waterways, the HFT can be designed and operated to effectively remove the algae in all cases. For each location, Pinelli uses bench-scale testing techniques, and designs in the appropriate harvester treatment regimen to optimize performance.

**Designing the control system**

To control its gathering process, collect and distribute data, and provide a user interface for operators and observers, the algae harvester employs a groovEPIC control system. Chetrit has used Opto 22 products for some years and trained on the system.

The harvester’s groovEPIC system consists of an industrial, Linux-based, edge-programmable industrial controller, power supply and the following I/O modules, all mounted on one chassis:

- One 12-channel AC discrete input module;
- One 12-channel DC discrete input module;
- Three eight-channel AC/DC electromechanical relay output modules;
- One 24-channel analog input module;
- One eight-channel analog output module with chassis-powered loop; and
- One four-channel serial communication module.

The system also includes a cellular router for remote access and automated reporting via email. Because groovEPIC handles data communication from the edge of a network to the cloud, it offers built-in security features and connectivity options in addition to controlling the process and communicating with other elements of the overall system.

Chetrit uses one of the USB ports on groovEPIC for removable data storage. When the program detects end-of-day, whether at midnight or during an orderly shutdown, data summaries are automatically emailed for offsite storage and reporting, and a new daily file is started. Data reports include operational parameters, power use, system status details, and an extensive set of analytical data collected via influent and effluent water quality sondes (sounding devices containing sensors) attached to the harvester.
The program also detects end-of-month events, and starts a new monthly file at that point. Both daily data and cumulative monthly data are stored locally and emailed daily, with a daily summary in the body of the email.

Modbus protocol is used to communicate with the multi-parameter sondes. Separate influent and effluent sondes each include multiple probes that monitor water quality and system performance, including temperature, pH, turbidity, chlorophyll levels and dissolved oxygen. The sondes communicate via a Modbus adapter directly to the serial module on the groovEPIC. The programming controls the sensors’ reading, cleaning and recording cycle.

Chetrit reached out to Dave Engsberg, another longtime colleague, and worked with an Opto 22 expert to develop Modbus communications, data handling and emailing charts and subroutines. He built the HMI using groovEPIC’s included groov View software, which is “permission-driven,” he explains, “so an operator sees different screens than someone reviewing data and operations.”

The HMI consists of several types of screens. Operator screens are for setting and operating pumps, pressures, tanks, agitator and the skimmer, which can run continuously or intermittently. Other screens show alarms, power usage, processing, data from the process and sondes, and trends over time.

The HMI is accessed via a panel-mounted touchscreen connected to the HDMI port on the groovEPIC. The HMI can also be accessed remotely via a cellular router.

In groov View, Chetrit adapted all HMI screens to a fully functioning mobile device interface, so operators can use it in the groov View app. The HMI can also be viewed locally and by authorized users on PCs or mobile devices worldwide.

“This equipment is totally accessible for me coming to it as a mechanical engineer,” says Chetrit. “I can build a system without being a system integrator.”

Aecom’s technicians operate each system, and the VPN client on the groovEPIC processor also makes it possible to securely access groovEPIC from just about anywhere.

“They love the remote access, and so do I,” Chetrit says. From his office located in Minnesota, he can log in at any time to any unit in the field, just to check on it or to update its control program or HMI.

The result

The team developed a comprehensive restoration program that can be scaled to any size and used throughout the U.S. and the world. Their technical process has proven to be safe, highly effective and efficient, achieving algae removal percentages in the high 90s.

Meanwhile, to provide a closed-loop system with virtually no waste, Aecom reports that it’s also been working with other industry leaders to transform the recovered algae into clean, carbon-neutral energy. Aecom conducted its first ever, field-scale, algae-to-fuel demonstration project in Ohio in 2022. The A 1-MGD harvester removed algae from Harsha Lake, a drinking water source and recreational water body near Cincinnati.

The recovered algae was transformed into a biocrude oil using hydrothermal liquefaction. This process uses heat and pressure just like the natural process of producing oil, but it’s completed in 30 minutes instead of the millions of years that nature requires.

“We turned on the harvester at 8:00 a.m. and by noon, we had a biocrude product that can be further processed for fuel,” says Levy.

What’s next?

By harnessing the power of algae to consume nutrients and atmospheric carbon, it’s now possible to remove the key nutrients that fuel HABs by harvesting algae. The harvesters can help restore waterways, decarbonize the planet, and produce a biomass rich in carbon and nutrients that can be converted to clean energy, fertilizer and other products. In March 2022, Aecom formed a partnership with Genfuel to produce aviation fuel from the biomass.

As more harvesters are deployed, Chetrit plans to add cloud-based data processing, onsite video, and other elements to the groovEPIC-based control system. In addition, Aecom recently received an innovation grant to incorporate an intelligent process automation system (IPAS) into the harvester.

To date, the algae harvesters have been designed for fresh water, but as Florida’s experience since 2016 illustrates, harmful algal blooms are also a severe problem in saltwater. Aecom and its team plan to look into similar treatments for brackish water.
CAREERS and organizations have lifecycles just like devices and software. The task for all of them is have the right tools and skills to do their jobs at each point in time along the way.

However, this can be tricky because yesterday and even today’s capabilities might not be right for the challengers that show up tomorrow—or even later today. For example, there’s no guarantee that good operators or engineers will be good managers. The risk of “fighting the previous war” is ever-present.

To give his colleagues a heads-up about the looming challenges they’re likely to face, Rick Pierro, chief strategy officer of the life sciences division at E.Tech Group (etechgroup.com), presented “The 30-year lifecycle of a successful systems integrator” on May 18 at the Control System Integrator Association’s (CSIA) executive conference in New Orleans.

Pierro is also the founder and former president of Superior Controls, a system integrator in Seabrook, N.H., and longtime CSIA (www.controlsys.org) member. It was acquired by DFW Capital in 2016, while Superior purchased Banks Integration in 2017. Superior was next acquired by Falfurrias Capital in 2019, which had bought E.Tech and Glenmount Global the year before. They were collectively rebranded as E.Tech Group, which reports that it’s a North American provider of automation, controls and engineering services that’s headquartered in West Chester Township, Ohio.
Tests in the early years
While every system integrator starts out working and learning from someone else, there comes a point when some decide to strike out on their own. Just like all small business owners, they want to try being their own boss. However, this isn’t an easy path because their clients quickly become their new “bosses,” along with the employees they must find to serve them.

“The first five years are all about survival,” says Pierro. “You usually have one client, and the most important task is hiring competent engineers, even though it can be hard to know their technical capabilities. The first three or four we hired were great, but the next one wasn’t. That experience really shook us to our core, and made us lose confidence.”

To identify more qualified candidates, Pierro reports his team at Superior devised a written engineering test with obvious and some less-obvious elements. To evaluate PLC programming skills, it presented a typical scenario: “A mixing vessel has three normally closed valves that can be opened for filling with wax, hot water and cold water (no pumping is needed). There’s also an outlet valve, an agitator and a discharge pump used to move liquid out of the vessel.”

The test then asked participants to program the following sequence:
• Fill the vessel to “Level 1” with hot water.
• Add wax to “Level 2,” starting an agitator after the wax addition has been running for 30 seconds.
• Turn on a light as a signal for an operator to add dry ingredients.
• Wait for a pushbutton from the operator indicating that dry ingredients have been added;
• Agitate for two minutes after the wax addition is complete.
• Add 200 gallons of cold water.
• Pump out the liquid.

While a typical client might ask for a sequence like this to be programmed in one hour, Pierro adds that candidates were told they would only have 30 minutes. This gut-checking monkey wrench helped Superior find engineers, who were not only competent, but could also handle stressful situations.

“Only allowing 30 minutes for a one-hour test helped us find people who could work under pressure,” explains Pierro. “We also gave a test with something like this to be programmed in addition is complete.”

No matter what their results, Pierro adds that Superior’s recruiting team also sought to be diplomatic and respectful of every candidate. “We tried to treat everyone the same, even if we turned them down for a job,” he says. “This is simply the right thing to do, but it’s also important because a candidate that a system integrator doesn’t hire is just as likely to get a job with its best client.”

Sales and marketing are everyone’s job
After Superior had been in business as a system integrator for about six years, Pierro states he and some colleagues took a Sandler sales training course, which generally teaches the importance of being a consultant to clients, rather than a traditional, pushy salesperson.

“We also learned that ‘onsite engineers are your stealth sales force,'” says Pierro, who adds that Superior developed an expanded Sandler method that asks potential clients several crucial questions. Designed to identify their pain points, these questions include:
• Why do you want to automate this system?
• How long has it been a problem?
• Who else cares about this?
• How much money is this costing?
• Are your clients concerned? If so, why?
• What will happen to you and your boss?
• Who else is affected and involved in this decision?
• Given this project’s estimated cost, how do projects of this size get approved here?

Beyond using the Sandler method, Superior also adopted marketing tools and techniques, including:
• LinkedIn, Facebook and X (Twitter) programs;
• Emails via Constant Contact about news and events;
• Outings with clients and staff, such as cookouts, sporting events or sailing excursions;
• Holiday mailings, such as cards and calendars;
• Participation on advisory boards covering significant topics; and
• Outsourcing marketing tasks, such as social media, blog posts and press releases.

“Marketing is everything you do in your company that clients will be exposed to,” adds Pierro. “And, if you’re able to do an activity that you love doing, and can bring clients and coworkers along, then your enthusiasm will spill over, you’ll get to know them better, and may even become friends.”

Finances and growing pains
Once its staff grew large enough, Pierro reports that Superior’s management, accounting and other organizational functions had to radically evolve, become more formalized, and get delegated to a larger group of managers.

“We started with a part-time bookkeeper, but once we reached 50 employees, our initial method of ‘management by walking around’ broke down, which led to overruns and costly mistakes,” explains Pierro. “Rule of man took a Sandler sales training course, which generally teaches the importance of being a consultant to clients, rather than a traditional, pushy salesperson.

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• Why do you want to automate this system?
• How long has it been a problem?
• Who else cares about this?
Best practices for system integration companies

- Use a written test in the hiring process.
- Employ consultative, Sandler-based sales training.
- Improve marketing by engaging clients in activities.
- Embrace an enterprise resource planning system (ERP) for financial management.
- Hire chief financial officer (CFO) with project management experience.
- Develop a management structure by training group engineering managers (GEM).
- Focus human resources (HR) on creative recruiting strategies.
- Use downtime to increase company value by documenting procedures, creating reusable code libraries, and getting CSIA certified.
- Enhance company culture by making work fun, investing in employees, and building trust.
- Build an empowered management team to prepare for selling the company.
- Retain confidentiality during the sale.
- Consolidate back-office activities after a sale.
- Use enterprise software tools.
- Promote benefits to clients of joining a larger system integration company.
- Reinvest in company culture.

(ERP) applications. This also required us to adopt some new roles, which can be a very difficult transition because the people who could take us to the next level weren’t the ones we started with.”

Some notable ERP software packages are available from SAP, Oracle, Microsoft, NetSuite and Deltek. Their dashboards report key metrics, including total accounts receivable, payable and aging receivable; cash, work-in-progress and trends; utilization by engineer and supervisors; and projects approaching their budget limits, perhaps triggering an alarm when they exceed 80%.

“We had to manage change as we grew. So, where we previously had 50 engineers reporting to one person, we had to pick seven or eight senior managers to serve as group engineering manager (GEM) about one day per week, so they’d still be 70-80% billable,” explains Pierro. “However, when we reached 75 and more engineers, we had to switch to having four full-time directors, have the GEMs report to them, and add a dedicated HR department. Now, we’re doing 240 projects per year as part of the several thousand that E Tech does.”

Chance to add value

Because changing a company’s core features and processes is wrenching, time-consuming and doesn’t directly add revenue, Pierro states that another essential activity is creating value during downtime.

“If we lose a proposed project, we go through the usual five Kubler-Ross stages of denial, anger, bargaining, depression and acceptance. However, we try to get ourselves and our people through these steps quickly and remember that nothing will keep us from hitting our overall goals,” says Pierro. “Because of this, when there’s downtime, we can create reusable code libraries for control and equipment modules, services, or create internal documents to help the company run more efficiently. These include training modules with quizzes, standard operating procedures (SOP) for project execution, and project templates to accelerate software development. This time can also be used to prepare for CSIA certification, which is extremely valuable and helps make us more efficient.”

Pierro adds that training modules in the Superior Navigator program are now part of the E Tech University curriculum. New engineers undergo about six weeks of training with these and other tools, while also shadowing and learning from senior engineers.

Growing live and active culture

Naturally, integrated trainings and developing intangible assets are also part of E Tech’s ongoing efforts to nurture a company culture that lets it function effectively and provide the best possible service to its clients—even as it continues to grow. Pierro emphasizes that company culture isn’t just team building, and consists of traditions and practices, including:

- Communications that respond quickly to calls for help;
- Empowerment that encourages staff to be bold and make decisions;
- Encouragement that helps and mentors others;
- Verbal and monetary rewards that show management notices and appreciates exceptional performance; and
- Investing in employees.

These efforts are intended to develop trust in their employees that management will always support them, and build those relationships with clients that know they’ll always be treated fairly.

To further enhance its culture, E Tech also provides Intranet newsletters, Q&A videos with its CEO, wellness challenges, employee appreciation days, technical training and certificates, management training, technical or management career counseling, and other technical presentations.

“We’ve all worked remotely so much lately that now we insist everyone come into the office on Wednesdays, and our staff reports that they like it,” says Pierro. “The best predictor of employee retention is if someone has a best friend.
at their job, so we encourage it. If you have 50 kids at a Cub Scout Pack meeting, they’re there to have fun, and the same is true for engineering companies. So we try to make our projects fun, and use them to build camaraderie at the same time. We also hold “road warrior dinners” with participants walking before stopping for appetizers, and run 5Ks with me offering $300 to each person who beats me, which is very popular.”

Preparing to sell the company

Once system integration firms get big enough—or their owners get old enough—they usually begin to consider selling to another company. This is where those good practices will pay off. However, selling any company also comes with its own laundry list of chores. These include calculating:
• Major effect of the company’s value;
• Earnings before interest, taxes, depreciation, and amortization (EBITDA);
• Growth and steadiness of EBITDA and revenue;
• Diversity of client base with an avoidance of client concentration;
• Overall market that’s growing and adverse to recessions;
• Steady, repeatable, predictable and reliable income, which is more valuable;
• State of present financial systems; and
• Depth and breadth of management team.

Activities during a sale include engaging with an investment banker; drafting a confidential information management (CIM) memo; teasing the sale with a brief description of the unidentified buyer, while still complying with any non-disclosure agreements (NDA), and weighing non-binding offers. Next, buyers and sellers hold management presentations, deliver letters of intent, perform due diligence, conduct purchases and sale of stocks and assets, and roll over equity items.

Pierro adds that working with a larger system integrator has many advantages for clients, such as reduced management, financial and scheduling risks, more locally available and 24/7 support, wider personnel skillsets, and one master service agreement (MSA) for all services.

“We’ve learned that a one-man-management company is worth less than a company with an empowered management team because that team can take over if and when it’s needed,” adds Pierro. “There are also many benefits for individual staffers that come with joining and growing into a larger organization. After 10 years in automation, an engineer may have more opportunities in a larger company to become an engineering manager or a principal engineer for a specific technology. A larger company can also do more recruiting with professional headhunters, which we know works because we hired 100 new engineers last year.”
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Optimizing cascade control for exothermic batch reactors

How to solve temperature offset and valve rate discrepancies

**Q:** We have a cascade temperature control system operating two supply valves in an exothermic batch reactor. One is hot and the other is cold. They're run by one master PID temperature controller.

The control system we use is DeltaV. Initially, I was using “PD action on error” in the PID function block, but that didn’t always work properly. It works only for shorter heating or cooling cycles, but there’s an offset of 3 °F for longer heating times, where the setpoint is high (97 °F). In addition, the controller acts differently during cooling and heating. The heating valve opens and closes too quickly, which results in an offset. The cold valve opens and closes too slowly.

Why do the two valves not open and close at the same rate, and why does the heating valve close too soon compared to the cold valve? Also, if I use the PD action on error, is there a way I can remove the offset without using the integral term.

I guess this can be done with the bias term, but how do I calculate the appropriate bias term to remove the offset?

**PAT LUKTUKE**
control engineer
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**A1:** In cascade control, you have three control loops inside each other. The outer or master loop controls the reactor temperature by generating a setpoint for the slave or inner loop (Slave 1) that controls the temperature of the heat transfer fluid in the reactor jacket. The Slave 1 loop does this by generating a setpoint for the control valve positioners (Slave 2).

You must make sure that each inner loop is faster than its outer loop to eliminate cycling. Faster, in this sense, means that its dead time is shorter and reaction rate is faster than its outer loop. Therefore, I’d make sure your positioners are fast enough. I’d also use derivative (anticipation) in both the master and slave controllers.

For the master controller, I’d provide external reset on measurement (ER in Figure 1), so when it is switched into “manual” mode, it’s protected against integral windup.

As to the “split point” between the valves, I’d set the split point at around 30% because the steam-heating effect is greater than the size of the cooling effect. This is the point where both valves are nearly closed (a little overlap is fine). At this point, the cooling valve is nearly or completely closed, and the heating valve is just beginning to open.

**BÉLÁ LIPTÁK**
pliptakbela@aol.com

**A2:** [Editor’s note: The following answer includes earlier comments from Greg Shinkey, known to many in the industry as “the genius behind feed-forward control.”]

Both primary and secondary controllers should be tuned as tightly as possible in response to load changes. Derivative is required in both controllers, but only on the controlled variable. In a cascade system, the master temperature controller would set the setpoint of the exit temperature controller

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*Figure 1: Cascade controls for exothermic batch reactor with split-point at 30% as the heating effect is greater than the cooling one*
that manipulates the valves, configured as recommended in Figure 1. This master controller must have integral mode to eliminate offset because the heat load changes with temperature and time in a batch reactor.

Bias adjustment must be estimated and tested with close observation. Whenever the PID is switched from manual to automatic, the bias is automatically corrected by an invisible amount in the DeltaV system to provide “bumpless” transfer. The invisible correction to the bias is ramped to zero over a period of time set by the balance time parameter called “BAL_TIME.”

You could start with an integral time that’s about 10x your derivative time, or about 3,000 seconds (10 x 300 seconds) if there is no oscillation. If oscillation occurs before you reach setpoint, your rate setting is high, and if oscillation occurs after you reach setpoint, your controller gain is high. Low controller gain causes slow rolling oscillations and overshoot. High gain causes instability. Also, since the valves are nonlinear and the process dynamics for heating and cooling differ, you should use different tuning settings during heating than during cooling.

GREG SHINSKEY
Former chief control consultant at Foxboro Co.

A3: Normally in a cascade control configuration, the output of a master controller (in this case, reactor temperature) sets the setpoint of a secondary controller (in this case, that is the temperature of the mix of the heating/cooling medium), and the output of the secondary controller controls the split range valves. As you describe the application, it doesn’t seem as if you have a cascade loop. But you should have a fast-acting secondary controller can respond rapidly to disturbances in the heating and/or cooling medium supply.

Though you don’t mention it, I assume you have an exothermic reactor, so cooling is required during the reaction phase. A common problem with exothermic reactors is they can be unstable at the normal operating point. See Figure 8.10e by Shinskey in Lipták’s Instrument Engineer’s Handbook, 4th Edition, Volume 2, which is reproduced below as Figure 2. Because of the open-loop instability, the reactor can appear to be an integrating process, but it is not. It doesn’t have characteristics of a self-regulating process either.

Having open-loop instability, the controller needs derivative. I wouldn’t use Lambda tuning because it presumes there are self-regulating process characteristics, which exothermic reactors don’t have. Plus, it only applies to the proportional and integral modes, not the derivative. Both the master and the slave controller should have derivative to overcome the open-loop instability. In the master (primary) controller, the derivative should only act on the measurement, while the derivative in the secondary controller should only act on the error but not on the measurement.

The strength of the heating effect is greater than the strength of the cooling effect. Therefore, the split point could be chosen to be 33.3%, so the cooling valve would go from open to close, 0% to 33.3%, and the heating valve would go from close to open, 33.3% to 100%.

DR. HAROLD L. WADE
ISA Fellow
Former president of Wade Associates Inc.
Temperature and pressure bundle up
Gauges, transmitters and other devices add protections and new capabilities for difficult deployments

RAIL- AND HEAD-MOUNTED TRANSMITTERS
ProSense XTD2 series DIN rail-mounted and XTH2 head-mounted, programmable temperature transmitters provide a linearized, two-wire current loop output that can be configured for 4-20 mA or 20-4 mA using free ProSense field device configuration software and an XT-USB cable (purchased separately). New accessories for XTH2 include: plug-on displays that provide a digital readout; probe and field mount housings with a viewing window; and wall and pipe mounting brackets that simplify installation.

AUTOMATIONDIRECT
www.automationdirect.com/temperature-transmitters

LIQUID-FILLED PRESSURE GAUGES
900 series pressure gauges from Noshok feature an impact-resistant ABS and stainless-steel casing with copper-alloy and brass wetted parts. These liquid-filled pressure gauges offer vacuum and compound ranges from 0 psi to 15,000 psi, and are available in 1-1/2 in., 2 in., 2-1/2 in., and 4 in. gauge sizes. With media and ambient operating temperatures from -4 °F to 140 °F (-20 °C to 60 °C) glycerin fill and -40 °F to 140 °F (-40 °C to 60 °C) special fill, 900 series is designed for harsh environments.

GALCO
www.galco.com

FASTER COMMISSIONING AND WIRING
iTemp TMT31 temperature transmitter for analog 4-20 mA signals improves on its RTD predecessors with better connections and is available in two formats. The first has push-in terminals, enabling tool-free, secure field wiring in seconds. It’s available in the classic screw-terminal format, with an optimized design that makes terminations in the connection head easier. Corrosion-free contacts ensure reliability of measured value transmission for both formats.

ENDRESS+HAUSER

MEASURES 100 MBAR UP TO 40 BAR
Cerabar PMC21 compact pressure transmitter features a capacitive, oil-free ceramic sensor, and can measure absolute or gauge pressure from 100 mbar up to 40 bar. It’s designed to withstand harsh conditions in process industries with ingress protection grades up to IP68 and a highly abrasion-resistant Ceraphire membrane, as well as a high-quality 316L housing. It can be used in most areas because it possesses various certifications such as hazardous-area and marine certificates.

RS (FORMERLY ALLIED ELECTRONICS & AUTOMATION)
us.rs-online.com/product/endress-hauser PMC21-aa1m1efvxja/72821221

PURGE AND PRESSURIZATION WITH ALARMS
Bebco EPS purge and pressurization system provides safety for Division- and Zone-rated applications with a range of Type X, Y, Z, Ex pxb, Ex pyb and Ex pzc systems. Its outputs can deliver alarm signals as preventive fault indications, and it can be programmed to automatically perform automatic: pressurization for leakage compensation; temperature control with output signals for a heater, cooler or external A/C unit; and power shutdown and alarming of the enclosure when pressure exceeds min/max pressure settings.

PEPPERL+FUCHS
www.pepperl-fuchs.com

50-MS, DIGITAL TEMPERATURE SAMPLING
E5CC series temperature controllers from Omron offer precise control performance, easy set-up and exceptional visibility. Their fast-sampling period of 50 ms assures accurate and responsive control. E5CC’s performance is further enhanced by Omron’s two-PID control algorithm. These controllers also support simple on-off control for less demanding applications.

NEWARK
www.newark.com
PROBE-STYLE TEMPERATURE SENSORS
TS+ probe-style, programmable, fluid-temperature sensors have a standard, rotating display for simple orientation adjustments, which lets users orient it for optimum viewing. Its stainless-steel, IP6K9K-rated housing is sealed against dust and high-pressure jet washing for longer service life. TS+ is available with direct- and remote-mounts and a variety of temperature probes, thermowells and mounting accessories. It also has IO-Link, analog and switching provide early warnings and real-time fluid measurements.

TURCK
www.turck.com

RECHARGEABLE THERMAL IMAGER WITH WI-FI
TI270 high-resolution, Wi-Fi enabled, USB-rechargeable, thermal imager from Klein Tools has a large LCD that displays unseen hot and cold spots for instant troubleshooting. It provides greater than 10,000-pixels resolution and three color palettes. TI270 also features high- and low-temperature points, crosshairs to pinpoint specific temperatures, and options for temperature alarms. A free app is available at Google Play and the App Store.

DIGIKEY
www.digikey.com

LOOP-POWERED, DUAL-TEMPERATURE WITH HART E
MACX MCR-TS-I-OLP loop-powered, dual-sensor temperature transmitter supports more than 28 temperature sensors. It will also accept -20 mV to 100 mV, and linear resistance ranges from 10 ohms to 2K ohms. On the output side, it features a 4-20 mA signal with HART. At only 12.5 mm wide on the DIN rail, MACX MCR-TS-I-OLP is thin, but the operating temperature range of -40 °C to 85 °C makes it widely usable. Both the EX and non-EX versions can be ordered preconfigured with certificates of calibration.

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Modeling and control opportunities, Part 1

How dynamic modeling and digital twins can accelerate industrial operations

GREG: Dynamic modeling has been the most important technology in my 50-year career. It’s the source of all my deeper process control knowledge. My work with compressor surge modeling in 1976 opened the door for me to go from being an instrument design and construction engineer to a process modeling and control specialist in Monsanto’s Engineering Technology (ET), where I worked with brilliant experts who were proficient in steady-state and dynamic modeling. The steady-state modeling software we developed was donated to the Federal Aspen Research Institute. Many of my publications and the sections I wrote for the ISA-TR5.9-2023 PID Algorithms and Performance Technical Report are a reflection of what I learned via modeling.

It’s disappointing that process control engineers aren’t given time by management to invest in using modeling to improve process performance. How can we motivate and train engineers to turn this problem around, and let them promote the value of models?

To broaden our horizons and better understand how to make the most of these opportunities, I asked José María Ferrer, who has more than 25 years of experience in the dynamic simulation and control of hydrocarbon processes. He began his career as a process control engineer at Dow Chemical in 1995, and joined Hyprotech as EMEA Operator Training System (OTS) business development leader in 2001.

In 2004, as AspenTech’s senior consultant, he executed several dynamic simulation projects applied in new areas such as emergency shutdown (ESD) verification and advanced process control (APC). He’s been developing the APC business in Europe, and executing several dynamic simulation projects to support APC implementations and new Aspentech OTS offerings. In 2010, he joined Inprocess to offer dynamic simulation services and launch the OTS business. Since 2014, he’s been developing and teaching a new simulation training course specially tailored to process control engineers.

Since 2018, he’s also been analyzing using online simulations to support operations in anomaly detection, and in 2019, he began leading projects to exploit simulation for offline and online applications.

José, what can we do to educate and motivate process control engineers to take advantage of modeling?

José: We can make them aware of the value they’ll get from placing variable economic compensation based on controller performance. I remember my first day at Hyprotech. I was given a laptop and a two-hour tour of the simulation tool for building a dynamic model. Since then, I’m still amazed at the capabilities of dynamic and steady-state process simulators. Also, there’s still a lot of thinking in silos, where process simulation is only for process engineers (designs/revamps mainly in steady state), and automation/control departments should not touch that simulation territory. This leaves the “dynamic simulation” in no-man’s land. Building high-quality, dynamic models is a time-consuming task and requires some experience. You must choose the right simulation tools and understand the limitations.

We need to explain that it’s one thing to build a dynamic model and another to use it. I don’t see all process control engineers at a company as model builders; maybe it’s only a small group. The rest can be true users of the built models. If you don’t have that small group, you can contract experts to make them for you. We’re constantly doing simulation projects for advanced and basic process control departments when things become complex.

Greg: What are the differences between steady-state and dynamic models, and what are the uses and cases?

José: Steady-state simulation (where time doesn’t exist, and there are no inventories or accumulation) started in 1950, using machine code...
developed for limited-scope and single-use. Nowadays, it’s large-scope and multi-use, but mainly for process design.

Dynamic simulation (where you have time, inventories and controllers as in a real plant) followed the same path but 10 years later due to greater computational requirements. I’m truly amazed by the capabilities of personal computers (PC) today: how large, how fast, and how detailed you can build a dynamic model. They’re the same PCs that run flight simulators. You can compare Microsoft’s Flight Simulator software from the 1990s to today’s versions. The last 30 years have been amazing for both flight and process simulators.

Beyond design, steady-state models are valuable in control areas, especially for developing inferentials, column composition profile dynamics, optimal sensor location, APC, deep reinforcement learning (DRL) benefit estimation, column feed locations and optimal targets. There’s also value for addressing the impact of controlled variables (CV), manipulated variables (MV) and disturbance variables (DV) via CV/MV and CV/DV gains for the whole operational envelope.

Beyond OTSs and instrument control and safety system (ICSS) checkout, dynamic models are valuable in control areas for benchmarking alternative control schemes, tuning PID in complex processes (for example, slug flows), obtaining plant curve responses for all plant states for APC/DRL multivariable controllers, tuning and testing APC/DRL, and getting online models for inferentials.

When I was at AspenTech, I tried to create a three-day course to teach steady-state and dynamic modeling to process control engineers, who hadn’t previously seen simulations. My managers asked for a business case for such a course. In 2010, at Inprocess, it only took me one minute to convince my boss to create it.

Greg: I’ve used the term “virtual plant,” but was recently made aware of the preferred “digital twin” term that’s aligned with the fervor over “digitalization.” For me, the key feature is the ability to use the actual control system configuration and operator interface, eliminating the difficult and perilous task of recreating these by interfacing or downloading actual software. This inherently makes empowering new PID features, data analytics tools and model-predictive control readily available.

José: what do you see as the value of the digital twin?

José: I don’t like the phrase “digital twin.” Nowadays, people use it to name almost everything from a three-dimensional model to a statistical model to a mechanical model, even an OTS. It’s applied, not only to a processing plant, but also to an airplane, airport, building, wind turbine or human heart.

To avoid confusion, and talk about the process industries we work in (mainly oil and gas, refining and chemicals), I prefer to call this topic real-time simulation (RTS). This is a detailed, dynamic-simulation model running online and in synchrony with the real plant. Usually, this is the second life of the so-called multi-purpose dynamic simulator (MPDS), which covers dynamic studies, early-OTS, control narrative verification, operating procedures development, ICSS checkout and direct-connect OTS.

I remember the first time that I ran a dynamic model of a C3 splitter against one week at one minute, sampling historical process data using a simple Excel macro, and obtained a very good match with the bottom online analyzer. I saw the potential of using it in real-time and shared my thoughts within the company, but surprisingly my managers were not impressed.

If we talk about the value of digital twins, the first thoughts that come to mind include ensuring your plant is running as it should run every second, and if it’s not, detecting this immediately. This raises the ability of early detection and diagnosis of small anomalies, which normally grow with time. Then, you have extra value gained from virtual instrumentation (pressure, temperature, flow), equipment KPIs, emissions KPIs, what-if analyses for present time of any (blue) parameter, and historical model repositories. The list goes on and on. ☮

For an extended version of this column and to see the Top 10 things you don’t want to hear during a new plant startup, go to ControlGlobal.com
Don’t rechew the cud

Reshuffling existing content with ChatGPT and AI isn’t intelligence

SEVERAL sources have gleefully asked me if I’m worried about Chat Generative Pre-trained Transformer (GPT), which can supposedly take over many writing tasks, and put us reporters and editors out of business. Released by OpenAI (openai.com) last November, ChatGPT is described as a large-language-model chatbot that lets users massage written material into preferred formats, styles, detail levels and lengths.

I had to say nope, I’m not worried. My response surprised me, too, because I and some coworkers used to speculate how long it would take for shrink-wrapped software to kill the few of us that hadn’t already been laid off. Part of my blasé attitude comes from getting older, but I’m also unconcerned because I’ve learned more about what machine learning (ML) and artificial intelligence (AI) are and what they aren’t.

I think some of my sources’ initial glee was the usual reaction to slapstick—we’re glad the Three Stooges’ injuries aren’t happening to us. However, I also believe many people just like name-dropping ChatGPT for the same reason they enjoy talking about AI, ML, Big Data, Industrial Internet of Things (IIoT), Industry 4.0 and all the other buzzwords that come down the pike—they’re novelties. Even if they’re not good for much else, we enjoy knowing about and citing the latest, fashionable hype because we hope it will make us appear smarter than our colleagues, neighbors and other members of our tribes.

Because it’s used for one-upmanship and temporarily enhancing status, I suspect that ChatGPT—and even AI and others—may not be the earth-shattering forces they’re claimed to be by their many promoters. ChatGPT and AI tools are proving to be useful, and more will doubtless follow. However, as I’ve mentioned before, beware of the 24-hour news vacuum that’s financially incentivized to keep audiences in crisis mode.

I’m also less concerned about ChatGPT and AI because I don’t think they’re genuinely intelligent. Heresy, I know, but I’ve been covering industrial computing for a long time, and I still haven’t been disabused of the notion that software is just a digital version of the recipes in the little metal box in Grandma’s kitchen. Oh sure, instructions and algorithms can reshuffle those index cards, and deliver previously inaccessible data in new and useful ways. However, all of this is still data processing that’s founded on precedents and benchmarks, and relies on preprogrammed configurations and change-of-state detection to perform many tasks.

Is this intelligence? I doubt it. Simply returning data faster isn’t intelligence, no matter how sleek and useful a format it’s presented in. I believe the same goes for ChatGPT and AI.

For instance, one often-mentioned example of AI is software that can mash together image concepts based on verbal or written queries. The software smooths the interface between requested concepts and quickly provides a seamless image. While this visually impressive, I don’t think it’s intelligence because it’s just recombining existing content, which really isn’t creating something new or innovative. It’s just rechewing cud that’s already been chewed.

I believe the same is true for ChatGPT, which takes existing content, parameters about how someone writes and other details, and digests them into passable text. However, I don’t think it can learn what’s going on from a source, grill them to determine what’s occurring below the superficial, and crystallize that input into original material that’s useful to readers.

I was taught that intelligence is the capacity for abstract analysis and critical thinking. All that’s needed is a brain and the willingness to use it. I’m sure ChatGPT and AI will strive get there soon, but they still have a long way to go.

If you think I’m a little or completely off base, there’s always a good chance that I am. So, because the bar for proving me wrong isn’t very high, please chime in at any time. Or fire up your ChatGPT and tell it to write me some scathing criticism or even a poison pen letter—if you’re both up to it. ∞

JIM MONTAGUE
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“Fire up your ChatGPT and tell it to write me some scathing criticism or even a poison pen letter—if you’re both up to it.”
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