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UPGRADES: A WIDER view 12

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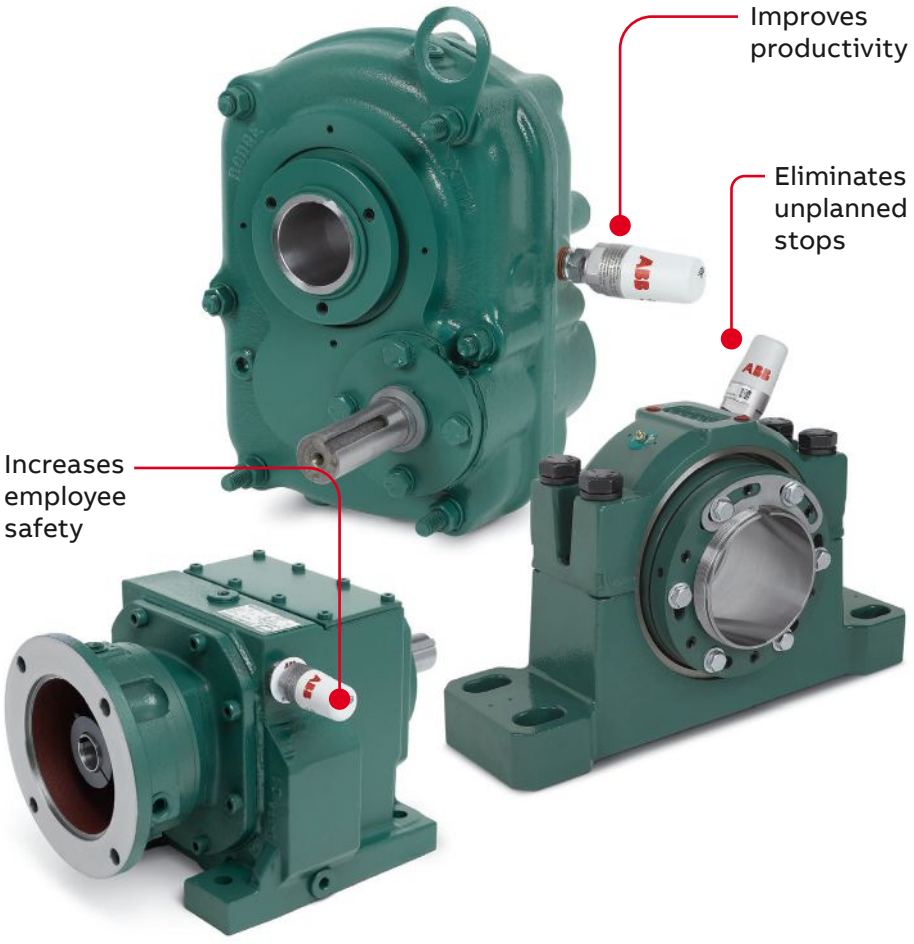

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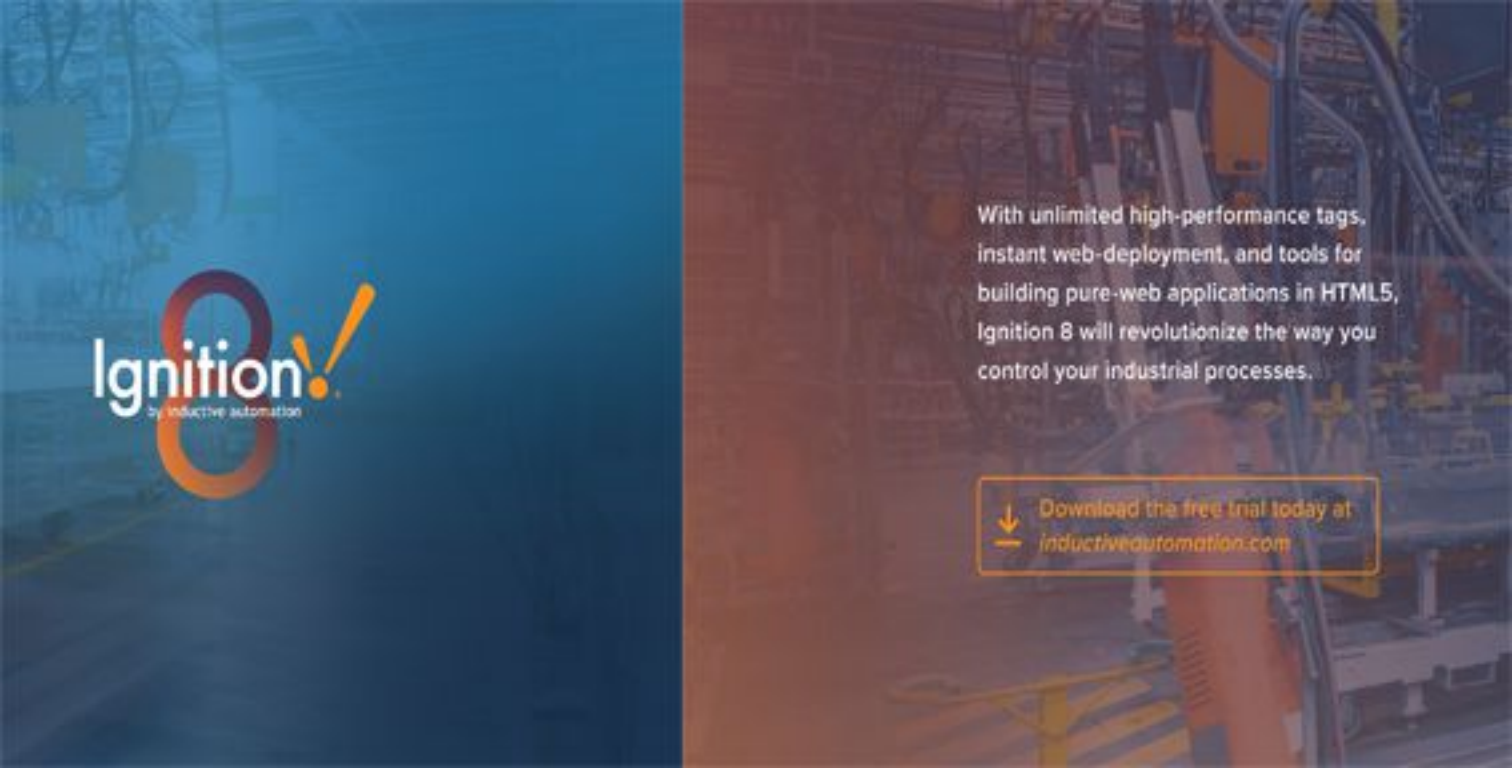
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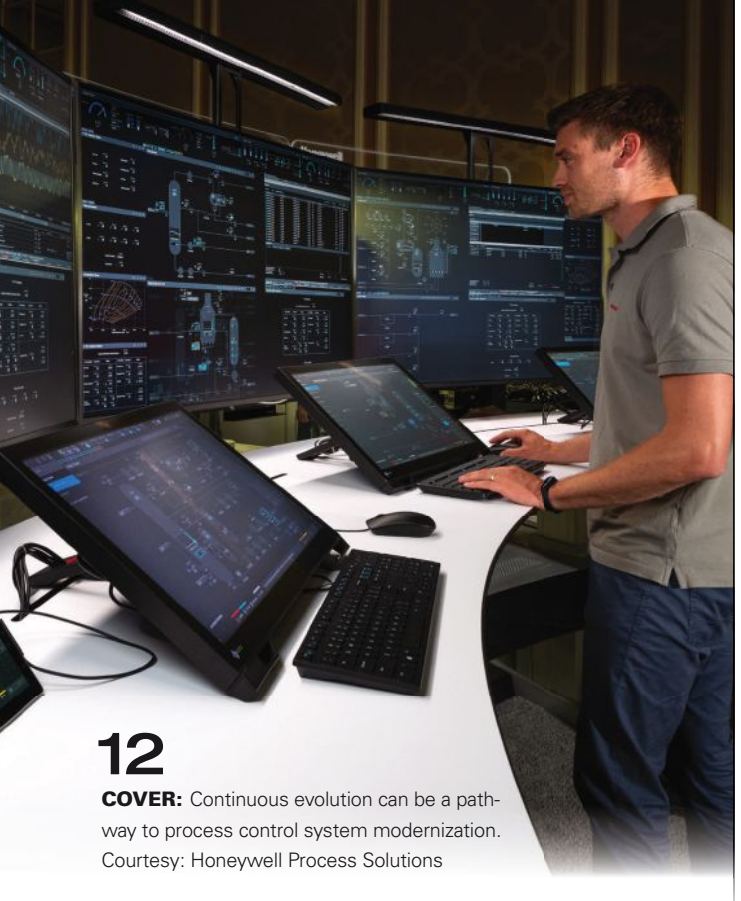

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COVER: Continuous evolution can be a pathway to process control system modernization. Courtesy: Honeywell Process Solutions

CONTROL ENGINEERING

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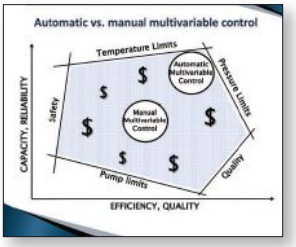
SPECIAL REPORT

ANSWERS



INSIGHTS

NEWS

INSIDE MACHINES

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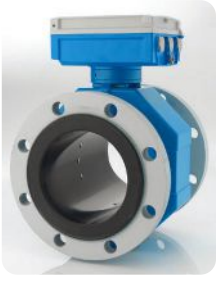


NEW PRODUCTS FOR ENGINEERS

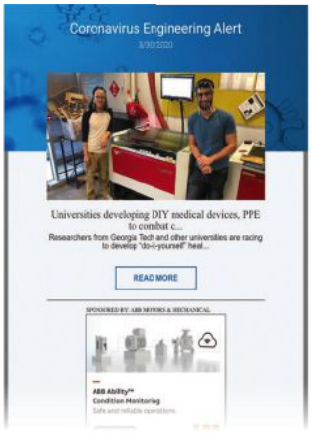
BACK TO BASICS

NEWSLETTER: Coronavirus Engineering Alert

To better inform readers during the coronavirus pandemic, we are deploying a special newsletter about how it affects engineers.

See **www.controleng.com/newsletters**.

- Universities developing DIY medical devices, PPE to combat coronavirus spread
- Remote security in world of coronavirus
- Medical shield for coronavirus being developed
- Manufacturers focusing on faster automation in wake of coronavirus
- COVID-19 and remote access challenges for manufacturers



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COVID-19: www.controleng.com/manufacturer-health-wellness

Mark T. Hoske, CFE Media and Technology

COVID-19

Poll results: Coronavirus, COVID-19 impact on engineers

Coronavirus impact data was collected from March 12 to 17 from visitors to *Control Engineering, Plant Engineering, Oil & Gas Engineering,* and *Consulting-Specifying Engineer* websites. Half of respondents' businesses have negative effects; half have supply chain problems. Results cover impact on industry, business, company responses, travel, future outlook, strategies and other topics.

Half of the respondents to a coronavirus (COVID-19) impact survey said their businesses have been negatively affected, and about half have supply chain problems. Leading company actions to date focus on limiting travel (77%); encouraging work from home (52%); working on contingency plans now with changes expected soon (52%); and eliminating travel (36%).

Survey method

From March 12 to 17 from visitors to *Control Engineering, Plant Engineering, Oil & Gas Engineering,* and *Consulting-Specifying Engineer* websites gave coronavirus impact data. Of 158 responses to the CFE Media and Technology survey, 84 respondents answered all questions, and 74 answered some of the questions. Margin of error is 10.6%. Questions cover coronavirus impact on business, company responses, remote work and operations, supply chain, travel, user group and trade shows, future outlook for similar challenges, government strategies by country, and advice. Incentive was a chance to win a $50 gift card.

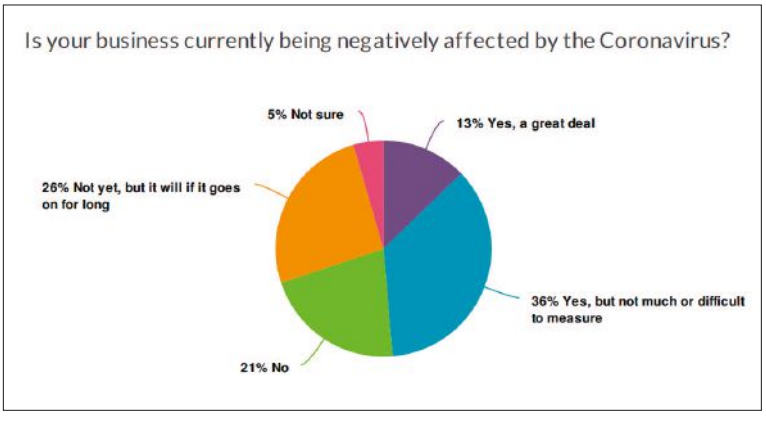

Figure 1: About half of survey respondents said their companies were experiencing negative effects from coronavirus (COVID-19). All images courtesy: CFE Media and Technology COVID-19 engineering impact survey, March 12-17

Survey results

Among respondents, 69% were from the U.S., though 24 other countries were represented. Most among those were India, United Kingdom, Canada, Mexico, and Saudi Arabia, all in the single digits.

The survey asked if the respondent's business is negatively affected by coronavirus. About half said yes; 13% saying yes, a great deal; and 36% saying yes, but not much or difficult to measure. Also, 21% said no; 26% said not yet, but it will if it goes on for long; and 5% were not sure. Total is 101% due to rounding.

Actions taken in response

The survey asked what among 24 actions the respondents' companies were taking because of coronavirus. The top 10 responses were:

1. Limiting travel
2. Working on contingency plans now; expect to see changes soon
3. Encouraging work from home
4. Eliminating travel
5. Delaying or eliminating hiring
6. Adding supply chain contingencies, secondary sources, etc.
7. Delaying or eliminating investments
8. Mandating work from home (when possible)
9. Adding new manufacturing capabilities to make up for breaks in supply chain
10. Increasing production of relevant product categories to meet increased demand.

The survey also asked the open-ended question:

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What operational initiatives is your company taking to prevent the spread of coronavirus in your facility? Responses represented in a word cloud and included sending out health updates, changing sanitation processes, issuing gloves, hand sanitizer. Largest words in the cloud were hand, updates, and health, followed by sending, home, travel, and links (see online).

Another question asked what technologies, processes or advice not mentioned here are the engineering-minded people in your organization suggesting or offering to help with the coronavirus impact? The largest words in the cloud of responses were home and work (Figure 3).

Not everyone can work at home

Even so, remote working doesn't work for everyone, as 45% said they can complete critical parts job functions at home, 31% cannot, and 24% were not sure/only some parts.

About half of respondents said their company is having supply chain problems. Eight percent said they were having severe problems, 40% minor problems, 39% no problems, and 12% were unsure.

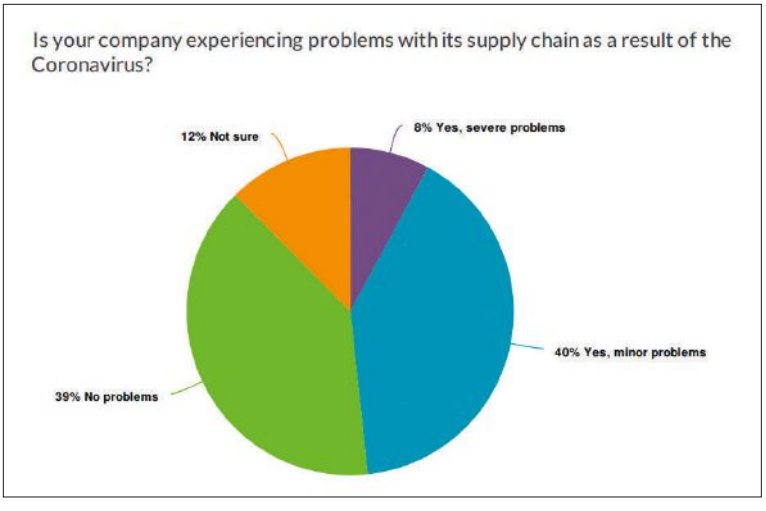

Figure 2: About half of survey respondents said their companies were experiencing negative supply chain effects from coronavirus (COVID-19).

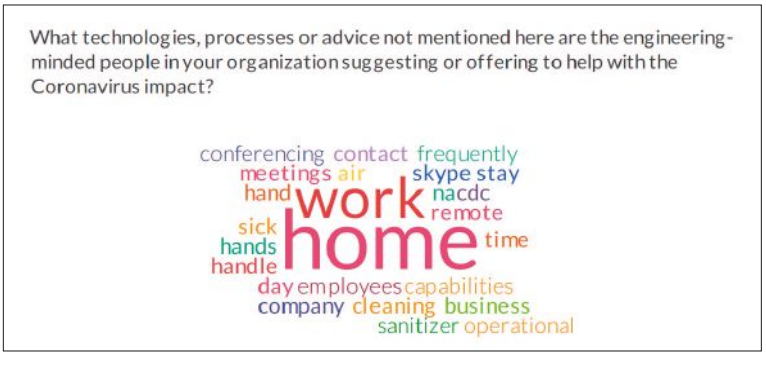

Figure 3: What technologies, processes or advice not mentioned here are the engineering-minded people in your organization suggesting or offering to help with the coronavirus impact?

Cancellation or postponed industry event and user groups is a big problem for 15% of respondents and a medium-sized problem for 36%, with 49% saying it's not a problem; they can get the information needed virtually and/or from suppliers.

Is coronavirus teaching us anything? The survey asked if respondents' companies would be more or less prepared for similar challenges in the future: 26% said yes, absolutely more prepared, 54% said a little more prepared but expect similar challenges, 18% said they expect no difference. One respondent of 87 respondents to that question said their company would be less prepared next time.

What strategies should the U.S. government review to help address this type of situation in the future?

Three ranked responses were:

1. Incentivize re-shoring of key manufacturing segments back to the USA (pharmaceutical or feed-stock products (ranking score 154)
2. Invest in medical research and development to speed vaccine development and virus testing capabilities (ranking score 153)
3. Do even more to promote manufacturing automation where production can be completed with minimum operator involvement (ranking score 89). **ce**

Review health and wellness news related to engineering atop www.controleng.com, with more engineering impacts of coronavirus, COVID-19.

Mark T. Hoske *is content manager,* Control Engineering, *CFE Media and Technology, mhoske@cfemedia.com.*

More INSIGHTS

KEYWORDS: COVID-19 engineering impacts, survey

Half of respondents say their businesses have been negatively affected by COVID-19.

Supply chain problems are being experienced by companies of half of the respondents.

31% cannot complete critical part of their jobs at home.

CONSIDER THIS

Catch up on engineering effects of COVID-19 at CFE Media and Technology websites; update your engineering-related impacts in our ongoing poll.

ONLINE

The Coronavirus Engineering Alert newsletter from CFE Media and Technology is offered after taking the survey. **Click on** the digital edition headline to see more and a ***link to later survey results, greater impacts***.

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Duane Grob, Avanceon

Taxes, water utilities, automation system integration

Crumbling infrastructure is no joke: Water and wastewater, taxes and automation system integration are linked in five critical ways important for taxpayers and those involved in automation and controls.

How does automation technology and system integration affect local taxes and municipal service bills? The poor state of some basic infrastructures has caused a large increase in the cost of amenities often taken for granted, such as water supplies and sewage services. So why might local bills be increasing?

1. Upgrades are needed: The water and wastewater industries have served people and businesses for many years and are desperately in need of upgrades and repairs to keep pace with population needs.

2. Safety: Ground contamination and other environmental issues, as well as the threat of terrorism, have caused concerns about the security and quality of existing systems. Safety regulations may require evaluating and upgrading current infrastructure to ensure clean water, free from contamination from the environment or from someone with a social, political or personal vendetta.

3. Dated systems: New means to detect water contamination, as well as storage and distribution improvements, are critical. They are needed to ensure water coming from faucets is safe. Most systems in place were built using 1950 to 1980 technology, which only ensured the water met clarity standards and maintained a specific antibacterial level using chlorine measurements. This water comes from reservoirs, lakes, streams and the aquifer or groundwater. These water sources are often open and unprotected.

4. Automation in the updates: Municipalities and private companies are tasked to meet the requirements and, as a result, are undergoing drastic upgrades in basic water storage and delivery systems as well as implementing sophisticated, intelligent automation systems at the core of related processes.

5. Investing in efficiency and compliance: Most work being done today in these sectors are wholesale replacements of older, noncompliant systems that cannot meet today's demands, much less those requirements projected for the next 10 to 30 years. This results in higher initial capital costs with an end goal of lowering operating costs through more efficient operations. While the short-term pain is real in taxes and fees, the long-term gain of efficiency and security will be worth the investments.

Automation providers and systems integrators have responsibilities to help educate those in the utility industries about automation and system and software security issues. System integrators craft solutions to address specific process and safety needs as well as implement designs, including remote telemetry, which provides real-time data and instant connection to municipal water facilities and remote locations. A well-planned and implemented system that provides potable water at the turn of a faucet is well-worth the expense of long overdue upgrades, even if taxes incur a temporary pinch. **ce**

Beyond the faucet, do your water and wastewater systems need upgrades? Courtesy: Mark T. Hoske, Control Engineering

Duane Grob manages the industrial, regulatory and utilities business unit at Avanceon, a CFE Media content partner. This article appeared on Avanceon's website. Edited by Mark T. Hoske, content manager, Control Engineering, *CFE Media, mhoske@cfemedia.com.*

More INSIGHTS

KEYWORDS: Water, wastewater, automation, system integration

Water and wastewater utilities need upgrades.

Safety and cybersecurity need improving.

Automation system integrators can improve return on investments.

CONSIDER THIS

Are your local utility services making needed upgrades?

ONLINE

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Satnam Bhogal, Honeywell Process Solutions

Know when to migrate a process control system

There's a big difference between a phased migration and just putting delaying the problem of obsolescence. Those who don't plan for obsolescence will see options narrow.

Obsolescence in the process control system is such a significant threat that reluctance to migrate to newer technology can seem baffling. Aging controls and equipment bring a whole host of problems. These include difficulty sourcing spares and rising prices, increasing maintenance costs, declining reliability, capacity constraints, and a skills gap as those with legacy system experience retire.

At best, obsolescence leads to higher costs as plants mitigate the rising risk of downtime or compliance failures. At worst, it can jeopardize continued, safe operations. Moreover, this ignores the massive strides in control technology and the benefits this can bring in terms of operator performance, safety, efficiency, cybersecurity, enhanced functionality and controller capacity. Users that migrate to a modern system can integrate control, safety and auxiliary systems, and benefit from enhanced control and visualization. They can respond to new business opportunities, expand capacity, and make use of new applications and solutions for advanced process control, asset management and production management.

COVER IMAGE, Figure 1: A continuous evolution path to modernization is possible. All images courtesy: Honeywell Process Solutions

In addition, in most cases, the control system is a small expense in comparison to the overall plant and the value of its production. A single, significant period of unplanned downtime is often enough to result in losses well above the cost of a new distributed control system (DCS). Despite all this, the number and range of legacy systems show little sign of shrinking. Many thousands of legacy systems continue in operations across the world with a large proportion of these two decades old or more.

Control system migration: Not easy

In fact, it is these potential losses that probably explain much of the reason businesses are reluctant to migrate. The very risk of downtime and disruption as a result of the process scare them off. It may be the direct disruption and requirement to take systems offline and shut down the process while putting the new control system in place, or the potential for longer-term disruption from unforeseen problems when the new system is brought online.

While the case for migration in the face of obsolescence is compelling, it is rarely so clear-cut in practice.

"Obsolescence" itself is poorly defined. It may mean technical obsolescence, with performance deterioration and declining reliability manifesting in missing yield. It also can mean functional obsolescence with constraints resulting in lost opportunities; or supply obsolescence, with the lack of support, in-house expertise or spares creating a risk for continued operation. In all these cases, most of the signs of obsolescence gradually accrue.

Vendor support might be withdrawn on a particular date, but the costs of aging equipment and systems grow and develop over time. It is not always easy to determine the point at which those costs and lost opportunities justify replacing the systems.

Operators do have other options. Rising maintenance costs, for instance, can be controlled through switching to predictable service contracts. Upgrades also can extend the life of the control system and stave off some of the impacts of obsolescence.

Limiting migration options

Human-machine interface (HMI) migration is

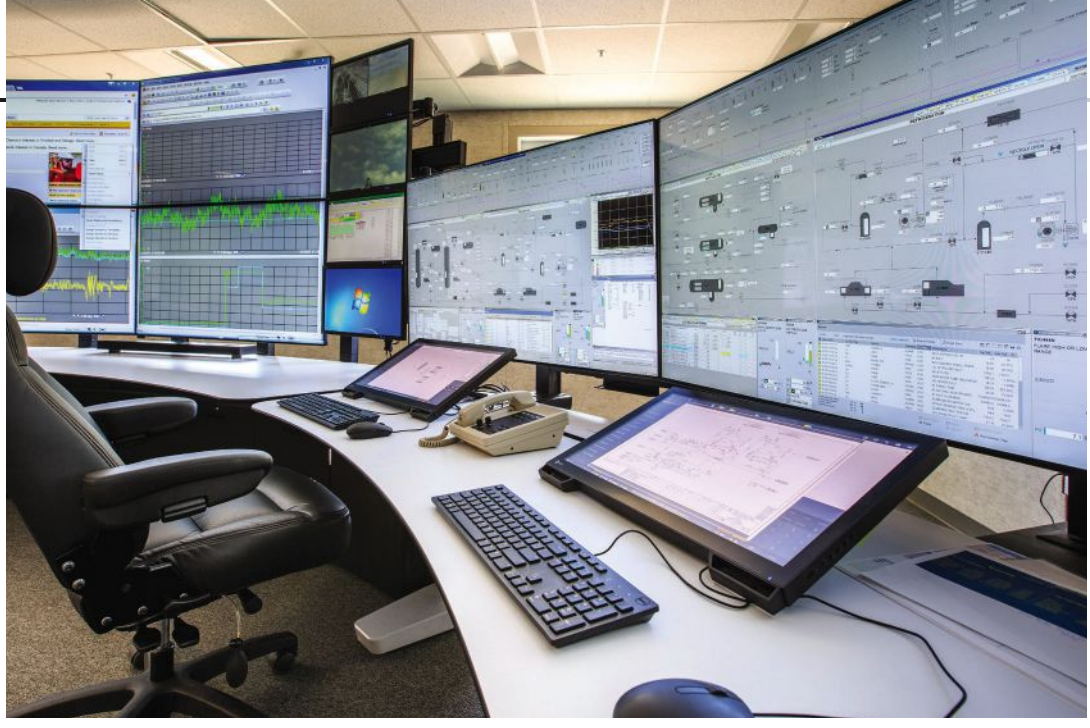

Figure 2: A modern control system is an opportunity to bring people, the plant and data together to drive better business. Honeywell Experion Orion Console is the most advanced and cyber secured control system, according to Honeywell Process Solutions.

one of the most important aspects of control system modernization. Upgrading legacy DCS operator stations to HMI technology allows plants to provide a common user interface to the integrated control architecture. This reduces training and maintenance requirements by keeping existing graphics, networks, controllers and I/O in place. It also provides direct access to the control network with read/write data access and integrated alarms and events.

When a control system requires change, replacing existing controllers also makes economic sense. For migration, two critical functions are required: the existing field signals must be quickly moved to the new control system, and the existing control schemes must be migrated — and preferably improved.

For a large-scale retrofit, it is often best to use a phased migration. This eliminates risk by incrementally narrowing the focus, while providing a fall-back position to the old system. It requires communication with the existing system for interim phase-in, physical co-existence with the old equipment to enable a hot cutover, and the ability to switch seamlessly between old and new signals for testing and tuning purposes.

Phased migration does have its drawbacks, but it is a lower risk approach with less downtime. Further risk and downtime reduction can be achieved by simulating the new system prior to installation. With phased migration, the control system is in a transition state. This means the appropriate scope must be selected for each phase so the end user can stop at any point in the migration and still have a supportable system.

Of course, there are good reasons plants may stick with the existing vendor. It may be that the updated system is the right solution for them. In many cases, though, plants do not seriously look at the other options. The caution around migrating the control system is due to the perceived risks of disruption. Remaining with the existing vendor is less a vote of confidence than a risk management strategy.

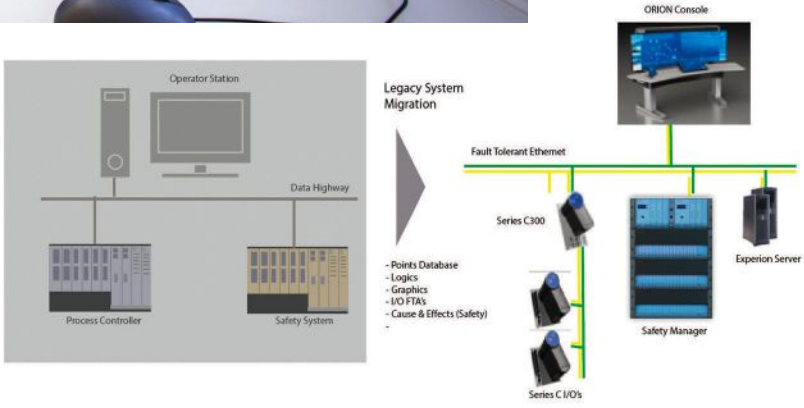

Figure 3: Honeywell's approach to distributed control system (DCS) modernization includes the ability to integrate legacy, third-party systems.

Some aspects of the migration are likely to be simpler, remaining with an updated version of the same technology. However, technology alone will not determine migration outcome. Tools available for migrating, the experience of the engineers, their plan and strategy for the project, and the expertise of those involved will play a major role in determining how smoothly a migration goes, and how well disruption to operations can be minimized. Other differences include DCS functionality, capacity, price and performance. When selecting a vendor, select a technology and migration partner. Pay equal attention to both. Limits should be carefully considered. **ce**

Satnam Bhogal, *global initiatives leader, Migrations, Honeywell Process Solutions. Edited by Chris Vavra, associate editor,* Control Engineering, *CFE Media and Technology, cvavra@cfemedia.com.*

More INSIGHTS

KEYWORDS: process control system, DCS, migration

Phased migration of a process control system is cheaper than letting a system become obsolete and break down.

Phased migration has some risks; if done correctly, an end user can still have a supportable system if a stoppage is needed.

ONLINE

Read this story online at www.controleng.com for more on control system migrations.

CONSIDER THIS

What was the biggest challenge you faced when migrating your process control system?

Hannover Messe 2020 cancelled

Hannover Messe 2020, which was delayed from April to July 2020 due to concerns about the coronavirus (COVID-19) outbreak and safety for international partners, has now been canceled outright and will not be held until April 12-16, 2021. It is the first time in Hannover Messe's 73-year history that the event will not take place.

Travel restrictions, bans on group gatherings and a prohibition decree in the Hannover region have made it impossible for Hannover Messe to take place. The coronavirus pandemic also is affecting the economy and the manufacturing industry is already struggling with the pandemic.

"Given the dynamic development around COVID-19 and the extensive restrictions on public and economic life, Hannover Messe cannot take place this year," said Dr. Jochen Köckler, chairman of the board of management, Deutsche Messe AG, in a press release. "Our exhibitors, partners and our entire team did everything they could to make it happen, but today we have to accept that in 2020 it will not be possible to host the world's most important industrial event."

While this is the first cancellation in the event's history, the organizers promise the show will not vanish. "The need for orientation and exchange is particularly important in times of crisis," Köckler said. "That is why we are currently working intensely on a digital information and networking platform for Hannover Messe that we will open to our customers shortly."

Various web-based formats will enable Hannover Messe exhibitors and visitors to exchange information about upcoming economic policy challenges and technological solutions. Live streams will transport interactive expert interviews, panel discussions and best-case presentations all over the world. The online exhibitor and product search is also being enhanced, for example with a function that enables visitors and exhibitors to contact each other directly.

> **Web-based formats** will enable Hannover Messe exhibitors and visitors to exchange information about upcoming economic policy challenges and technological solutions.

"We firmly believe that nothing can replace direct, person-to-person contact and we are already looking forward to the time after corona," Köckler said. "But especially in times of crisis, we must be flexible and act pragmatically. As organizers of the world's most important industrial trade fair, we want to offer orientation and sustain economic life during the crisis. We are doing that with our new digital offering."

Thilo Brodtmann, executive director of Germany's Mechanical Engineering Industry Association (VDMA), said, "The cancellation of Hannover Messe 2020 is an unfortunate decision, but it is the only correct one. The mechanical engineering industry must now concentrate on minimizing the consequences of the pandemic in its own operations so that it can start up again. In April 2021, the engineers will be back in Hannover in full force."

Wolfgang Weber, chairman of the ZVEI Management Board, said, "The fact that Hannover Messe 2020 cannot be hosted is a bitter loss, but it is the right decision. For the electrical industry, the fair is the showcase to the world, which unfortunately remains closed this year. So our companies will use the time until 2021 to manage the considerable consequences of Corona. Next year, they will then present themselves with the latest products and solutions for Industry 4.0 and the energy system of the future." **ce**

– Edited from a Hannover Messe press release by CFE Media.

Construction businesses value artificial intelligence and robotics

While the construction industry relies on human-powered labor for most projects, businesses are noticing AI and robotics. Could a building one day be constructed by robots?

Many construction tasks fall into the "three Ds:" dull, dirty or dangerous. AI and robotics help construction businesses keep workers safer and happier with their jobs. Those who work with construction service robots have begun to understand that AI and robotics aren't a threat and can boost productivity.

The labor shortage has hit the construction industry hard. Millions of jobs are unfilled. Businesses see the need to improve working conditions with AI and robotics. Robots have been designed to help with masonry tasks like bricklaying and delivering cement blocks, easing a lot of physical strain. The robots perform the work faster and allow workers to focus on more skilled tasks like checking the quality of mortar joints.

Drones can be equipped with 3D vision and AI to fly around the job and track how much work has been completed, helping with scheduling and deadlines. Some workers use supportive robotic vests that lessen fatigue while performing tasks like drilling. Other robots drive around the job and mark locations of walls and other features, using the blueprints as a source.

This article originally appeared on the Robotics Online Blog. Robotic Industries Association (RIA) is a part of the Association for Advancing Automation (A3), a CFE Media content partner.

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Coronavirus will force manufacturers to enhance automation, digitalization

The COVID-19 outbreak is becoming a global stress test. As the number of people infected with the virus continues to rise around the world, uncertainties about global economic growth increase. China hosted the first outbreak and, after more than 1 month of unprecedentedly strict prevention and control measures, the epidemic has been essentially brought under control. China's focus is shifting to the recovery of normal ways of production and normal lifestyles. Even as the outbreak subsides, there are some major short- and long-term effects the Chinese manufacturing industry is feeling, which will carry over to other countries.

> "Information chains will further enhance the resilience of supply networks."

For many of the infected regions, the economy will fall sharply in the short term, and then rebound after the epidemic is over, but COVID-19 is unlikely to have a huge long-term impact. Epidemic prevention and control measures from local governments will be a key factor.

In February 2020, China's manufacturing purchasing manager index (PMI) was 35.7%, down 14.3 percentage points from the previous month. Meanwhile, the Production Index was 27.8%, down by 23.5 percentage points from the previous month, indicating that manufacturing production activity had slowed down radically. As outbreaks continue to unfold around the world, external demand will falter, further hampering recovery.

According to analysis of data segments such as power generation, population migration, and transportation; the work resumption rate in China is about 65% (except for students). Although the overall recovery of enterprises is better, it is more difficult for small and medium-sized enterprises and lifestyle-service industries to return to work. It is expected that production and operation will get back to normal there by May.

Local government's prevention and control of the epidemic is the key variable and the most decisive factor. On the premise of effective prevention and control, the whole epidemic will be over in 2-3 months, and societies will return to normal.

COVID-19 may have a far-reaching impact on the capacity layout and supply chain network of many enterprises. Multinational enterprises will further improve disaster emergency mechanisms and supply chain management.

Many enterprises will be thinking about relocating manufacturing. During the 2011 earthquake in Japan, even companies who were hardly hit by supply chain issues decided to relocate. Cross-border relocation of production capacity is not an easy decision to make, and many factors need to be taken into account, such as local market capacity, time and investment required, local government policies, infrastructure and logistics, labor costs, skill levels and so on. The completeness of China's supply chain in automobile, electronics and other industries makes the Chinese industrial chain efficient and flexible. This, coupled with China's huge domestic market, stable government policies, strong infrastructure, good labor skills and engineering resources, means that many global companies will want to maintain key production centers in China.

The establishment of robust disaster management mechanisms may well be a better alternative than moving production, for many. In harsh times, measures such as reallocation of production capacity and inventory to different regions, backed-up with a policy of using similar products as substitutes in the short-run, and the development of multi-point suppliers, are possible solutions. These will increase costs, better protect supply chain stability, and potentially deliver savings in the next crisis.

In the long run, the establishment of information chains will further enhance the resilience of supply networks. Key information about materials, logistics, inventory, production and capital in the supply chain can easily be grasped, analyzed and shared to improve overall supply chain management. Market demand can be tracked and predicted more dynamically, and production rhythms can be adjusted. All this needs to be part of a wider digitalization push from the manufacturing industry to deal with the next crisis.

For manufacturing enterprises, the pandemic exposed problems and risks that already existed. It might force industry to undertake much needed reforms to automation, digitalization and logistics processes and systems. The COVID-19 pandemic is a chance for industries to make much-needed operational improvements. **ce**

Jan Zhang, research analyst, Interact Analysis. Edited by Chris Vavra, associate editor, Control Engineering, *CFE Media and Technology, cvavra@cfemedia.com.*

Headlines online

Top 5 *Control Engineering* articles March 16-22, 2020
Articles about the coronavirus' effects on manufacturers and engineers, internet exchange world record and partial-stroke testing.

How machine vision is disrupting and changing life science industries
Machine vision is making life science industries more interactive and safer for workers as artificial intelligence takes on a greater role.

DOE announced $3 million to improve manufacturing processes through high-performance computing
The U.S. Department of Energy (DOE) announced up to $3 million for high-performance computing, modeling, and simulation projects to improve manufacturing processes.

Manufacturers realize cybersecurity risks, taking steps
Manufacturers are realizing the potential dangers from cyber attacks, but that is the first step in the process. Learn how companies are trying to combat this growing problem and what more they can do.

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COVID-19 impact on engineering, engineers

Engineers like facts and seek credible information sources on COVID-19 (coronavirus) effects to the engineering-related world.

Engineers have technologies that can help with responses to COVID-19 (coronavirus) effects, and CFE Media and Technology websites includes a section with updates on coronavirus impacts on engineers and a related newsletter. In early March, the sites launched a survey to learn more about impact on related issues.

Control Engineering coronavirus coverage to date includes articles on use of coronavirus for malware attack, manufacturing production information, coronavirus preparations, role of the supply chain, National Safety Council update, 3D coronavirus roadmap, the delay and then cancellation of Hannover Messe. The CFE Media and Technology Marketing to Engineers event on April 27 in Chicago has been moved online.

Mark T. Hoske,
Content Manager

As an engineering-minded observer, I'm concerned about wide-spread lack of appreciation for fact-based information. A lot of new information is available daily. Some of it, from sources that should be credible, turn out to be incorrect or misleading. I believe engineers are highly discerning consumers of information, with carefully tuned abilities to seek and encourage use of multiple, credible sources to validate what's presented without falling prey to clickbait that can increase cybersecurity risk.

Just as the virus' potential for exponential growth without appropriate mitigation, so has available information about COVID-19. Three notes of appreciation follow.

- Companies, governments, and groups have employed policies and technologies for remote monitoring, meetings, measurements, learning, and controls to promote social distancing needed to slow the spread and not overload healthcare facilities. No one wants to hear that their ill or elderly loved ones were on the wrong end of a triage decision where healthcare is beyond capacity. We can all do our part to change the infection curve and explain to others the irrefutable math behind it.
- U.S. Food and Drug Administration (FDA) fast-tracked approvals to more quickly expand COVID-19 test capacity (mistakenly initially portrayed as widely available). Countries with widespread testing have had better outcomes in limiting spikes in infection rates to better distribute healthcare resources.
- "Flu and COVID-19: Similar symptoms, different fears," a March 11 Associated Press article by Marilynn Marchione, AP chief medical writer, in the *Daily Herald* (Paddock Publications), included the three critical sentences. "But to public health experts, the huge number of flu deaths is exactly why extraordinary steps should be taken to try to prevent the new coronavirus from spreading widely. The flu's annual return can't be stopped because it's already so embedded in the population. There is still a chance COVID-19 cases can be limited or spread slowed while treatments are developed." And while response supplies are manufactured and get to where needed.

We all need to think again about how technologies and science-based critical thinking can spread compassion and wisdom more quickly than hysteria and misinformation. Please stay safe. **ce**

More INSIGHTS

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EDGE COMPUTING

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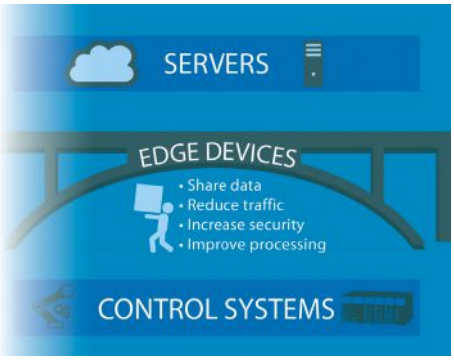

SR3 | **Edge computing offers 4-step pathway to digital transformation**

Living on the edge: Putting computing power close to the process reduces control system latency, creates a distributed architecture, and can integrate machine learning (ML) and artificial intelligence (AI) capabilities. See four steps toward edge computing.

SR7 | **Edge computing terms and skills**

Six edge computing questions to ask about data collection, networking and control systems.

Edge computing research, resources

Edge computing technologies involve interoperability, security, compute infrastructure, and connectivity. Hardware progresses from isolated controllers to control rooms, cloud/enterprise integration, machine learning, and self-optimization using cloud, enterprise and edge resources, according to research from Stratus and CFE Media, shared at ARC Forum 2020. www.stratus.com/TrendReport

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CAPTIONS: Left: Edge computing brings new opportunities and challenges, offering benefits over legacy network architecture systems. Get answers before investing. Courtesy: L&T Technology Services • Right: Edge devices operate at the edge of a local network and bridge the control system and cloud servers or remote computers, processing data between the control system and servers.

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4-STEP pathway to digital transformation

On the edge: Putting computing power close to the process reduces control system latency, creates a distributed architecture, and can integrate machine learning (ML) and artificial intelligence (AI). See four steps toward edge computing.

Edge computing architectures have been advanced by cloud services, which have long helped companies simplify and secure data aggregation and processing functions. As time progressed, technological advancements such as mobility and differentiation in user interface and user experience (UI/UX) approaches resulted in more connected and distributed processes, devices and machines. Companies realized there was a need for more immediate intelligence from data closer to the source. This increased demand for edge computing.

Edge computing: Four-step progression

Four steps toward greater adoption of edge-computing follow (see graphic).

1. Cloud computing revolutionizes business.
2. Edge computing architectures resolve emerging challenges.
3. Concerns arise over costs of digital transformation.
4. Optimization and asset utilization benefits make edge computing more feasible.

Edge computing can be crucial for some industries and manufacturing industry applications to resolve a range of challenges. This includes equipment breakdown and unplanned downtime. Intelligent temperature monitoring sensors, for example, can be automated to record temperature changes in the immediate surroundings. In case of an emergency, these devices can activate sprinklers, alert the fire department and shutdown all power systems in a factory.

This scenario will require machine-to-machine (M2M) edge computing to decrease network latency and deliver real-time control and monitoring. Earlier, devices at the edge were only programmed to locally collect data and transmit it to a remote server (cloud). With the assistance of AI, edge devices can now be embedded with machine learning (ML) capabilities to self-learn and execute actions without waiting for a response from a central computer.

Programmable logic controllers (PLCs) can be taught to detect issues, analyze the issue, and execute counteractive procedures, according to some PLC manufacturers. PLCs can act as edge nodes with ML capabilities to activate prescriptive and predictive maintenance without interventions from information technology systems or humans.

Every manufacturing plant wants what this cutting-edge innovation can deliver. The problem: at what cost?

Edge computing justification

Organizations balk at large investments in new technology without getting a tangible sense of the return on investment (ROI). Technologies are evolving rapidly. Just as we embraced cloud computing and are now rethinking this strategy for high availability and instant compute abilities, we could perhaps pose the same question for edge computing.

The immediate benefits may outweigh the costs, but the evolving technologies pose a risk in terms of investment. Intelligent sensors with ML and AI capabilities are far from being cost effective. If an organization has already implemented a cloud strategy, does it make sense to move them to an edge computing strategy immediately? This depends on the requirement. The additional cost for sensors, local processing power and other features will add to the overall overhead and increased costs. As a strategy, this defeats the purpose it was meant to mitigate.

Optimize and utilize

Recently, a fault-tolerant computer server and software manufacturer launched a virtualized,

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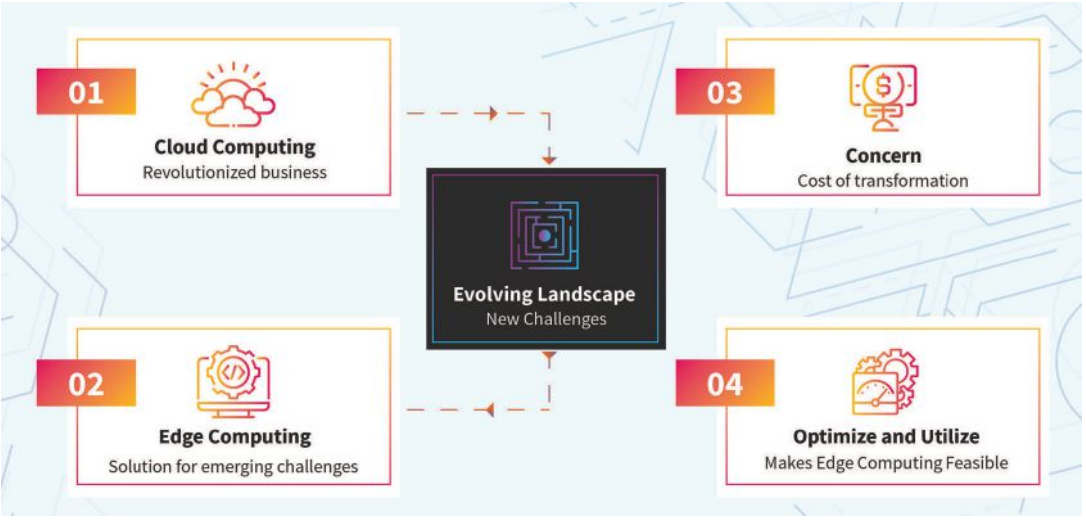
EDGE COMPUTING

The evolving landscape around edge computing brings new opportunities and challenges. Edge computing offers undeniable benefits over legacy network architecture systems and raises questions that require extensive research before investment. Courtesy: L&T Technology Services



> **Consider economies of scale.** How close to the edge is close? Should it be completely on equipment or premise?

self-protecting edge-computing platform specifically designed for industrial control system environments, as previously reported. The platform comes embedded with zero-touch computing properties and is expected to simplify a range of remote management activities such as cloud-based health monitoring, automated site and data recovery.

Such platforms can offer a middle path to optimize costs by considering capital expenditures (capex) and operational expenditures (opex). Such scenarios should consider the economies of scale. The question to ask is: How close to the edge is close? Should it be completely on equipment or can it be on premise? Processing data on the devices instead of using co-location data centers and existing cloud infrastructure requires research and time. Depending on this answer, infrastructure and cost optimization and utilization indicators could go up or down.

Cloud and edge computing

Technology trends can be ambiguous with interminable discussions on the pros and cons of each trend. Most organizations tend to err on the side of caution and deliberate before taking a conscious decision to either adopt or let pass an upcoming technology. Based on empirical evidence it is clear that enterprises who have failed to adopt new technologies lagged behind those who have. In 2008, many industry champions dismissed cloud computing trend as passing and yet, almost a decade later, cloud computing is moving to the edge.

Cloud computing saw rapid adoption because it provided organizations with easy accessibility to vast storage with near zero application usage latency and pay-as-you-go models sweetening the deal. Organizations had every reason to go for this.

However, after a decade, as applications are distributed across geographies and major challenges remain with cloud providers, latency, experiential consistency and security, organizations are rethinking cloud strategies.

Having an edge in 2020, beyond

Gartner estimates 91% of today's data is created and processed in centralized data centers. By 2022 about 75% of all data will need analysis and action at the edge. Edge computing will become the principal method by which enterprises implement digital transformation.

Edge computing offers many benefits over legacy network architecture systems. As it continues to evolve and make more inroads for organizations, it also will raise questions that will require extensive research before investment. Organizations need to look at transformational opportunities with a thoughtful, deliberate approach to validate this investment. **ce**

Dr. Keshab Panda *is CEO and managing director, L&T Technology Services, a Control Engineering content partner. Edited by Mark T. Hoske, content manager,* Control Engineering, *CFE Media and Technology, mhoske@cfemedia.com.*

More ANSWERS

KEYWORDS: Edge computing, cloud services

Edge computing distributes control architectures and reduces latency.

Machine learning and artificial intelligence can be integrated into edge computers and PLCs.

Edge computing can bring cloud services to distributed architectures.

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WAGO

Edge computing terms, skills

Ask six edge computing questions on data collection, networks, control systems.

Whether we realize it or not, most people use edge computing daily. A prime example is when we use the speech recognition features of our mobile phones to ask for Siri or Cortana. Since language processing takes a lot of computational power the phone first does some initial processing, lightening the load for the server and streamlining the data going to it. If all processing was performed on the phone, it would tax the phone's resources.

Processing data in the cloud frees up the user's phone to perform other tasks and allows companies like Google and Apple to update and improve the software. If a phone did no pre-processing before sending data to the cloud, our networks and servers could become bogged down with data. A similar model makes sense in industrial applications.

Edge devices operate at the edge of a local network and provide the interface between control system(s) on the plant floor and the outside network. They act as a bridge between the control system and cloud servers or remote computers, processing data between the control system and servers. Performing data computations on the edge device reduces the traffic and the processing power required by both the control system and remote servers.

Having an edge device also allows users to update functions on the edge device without disrupting the control system. Edge devices also can provide a "firewall" or "air gap," isolating controls equipment from the public network, for better security. Edge devices also can buffer data if there is network latency or even a network outage. If this happens, the edge device stores the data until the network connection can be restored.

Six edge computing questions to ask

Ask these questions to clarify if an edge device is right for an application:

1. Do I need to collect historical data from the control system?
2. If I collect data, are there benefits to storing this data in a central location? Could this data be used for reporting, down time analysis, predictive maintenance or inventory tracking?
3. Does the control system need to interface with the outside network, such as the plant network, business systems or the internet?
4. Does the control system receive information from the outside network, such as inventory, recipe and batching systems?
5. Is there a benefit to adding mobile devices or features such as alarm notification?
6. Can non-essential functions be offloaded from the "mission critical" control system? For example, could functions such as image processing and recipe management be moved to a non-production computer?

If the answer was yes to one or more question, then an edge device may be a good fit for the application.

Edge device benefits

The benefits of using an edge device can be grouped into the following categories.

Sharing data

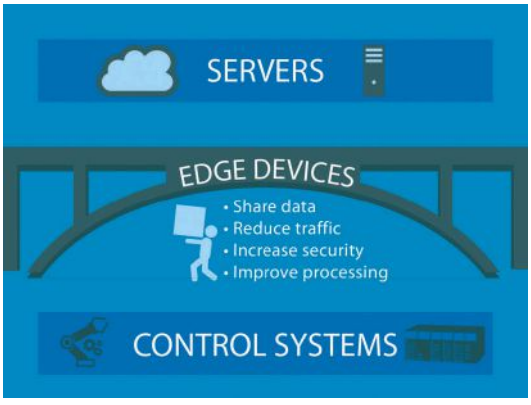
- The edge device interface allows the control system to share data with external systems.
  - –The edge device can act as a bridge or protocol converter, allowing legacy equipment to interface with other devices and networks.
  - –Ethernet IP devices can interface with the external network without having to modify the existing network or change IP addresses.

Improving security

- Edge device provides a security layer between the control system and external network.
  - –The edge device can provide a fire wall and air gap to help protect the control system.
  - –The edge device can provide security monitoring and access control.

Processing and network improvements

- Moving non-critical functions to an edge device allows the control system to "focus" on the most important tasks.
  - –It frees up more memory and processing power for mission critical functions.
  - –Non-critical functions, running on the edge device, can be updated and modified without the disrupting production.
- Reduce network traffic and mitigate the impact of network disruptions.
  - –Basic data processing on the edge device can help reduce network traffic.
  - –Buffering data on the edge device can reduce the impact of network issues.



Edge devices operate at the edge of a local network and bridge the control system and cloud servers or remote computers, processing data between the control system and servers. Images courtesy: MartinCSI

Users talking to an AI like Siri or Cortana are actually engaging in edge computing without realizing it.

> **Edge devices** can do a lot more. They can take help a basic application become future-ready.

–Edge device can convert data to "lighter weight" messaging protocols such as MQTT, reducing bandwidth and improving efficiency.

Next steps after evaluation

After the evaluation, users need to ask how to select the best device for the applications. What features and functions are needed? These three edge device core considerations should be front of mind.

• **Functionality:** The control system should operate with or without the edge device. When looking at functions to put in an edge device, ask: "If the edge device is turned off, would the process still run reliably?" The answer should be yes.

• **Security:** An edge device should restrict direct access to the control system from the outside network. The edge device can provide a means to isolate the control system while still allowing data to flow in both directions.

• **Performance:** With performance, users need to ask the following questions:

–Is the control system processing large amounts of incoming or outgoing data? If so, consider having the edge device process this data.

–What data processing is being performed in the cloud or a remote server? If moved to an edge device the amount of data sent across the network will be reduced.

An edge device can be anything from a relatively simple, low-cost device to something as robust as an industrial PC. What makes an edge device is more a matter of where and how it is used than the actual hardware. Edge devices can do more than these core features. They can take help a basic application become future-ready. Enhanced features include:

- Performing logic and math calculations.
- Acting as an HMI and host screens.
- Acting as an Ethernet switch and incorporate features found in managed switches and routers. Network address translation (NAT).
- Edge devices facilitate Industrial Internet of Things (IIoT)/Industry 4.0 functionality and allow users to perform
  - –Protocol conversion. For example, network traffic conversion from Modbus TCP/IP, CIP and Profinet protocols to MQTT.
  - –Run apps and APIs that directly interface with software running on remote servers or the cloud.
  - –Run an operating system such as Linux or Microsoft Windows, allowing users to install off-the-shelf software.
  - –Provide added firewall and network security features and diagnostics.
  - –Run a structured query language (SQL) database.

While the core functionality can be found in most edge devices, the enhanced features will provide room for the application to grow into the future.

Selecting an edge device and determining how it is used will depend on the specific application and the customer's needs. When an edge device is properly selected and configured, the result will be a control system with improved performance, higher security and greater maintainability. Most importantly, it provides meaningful information available to those who benefit from it the most. **ce**

Nate Kay, *project manager, MartinCSI. Edited by Chris Vavra, associate editor,* Control Engineering, *CFE Media and Technology, cvavra@cfemedia.com.*

More ANSWERS

KEYWORDS: edge computing, smart devices

Edge devices act as a bridge between the control system and cloud servers.

Edge devices are useful for applications where data from an outside network needs to be gathered and evaluated.

What makes an edge device is more a matter of where and how it is used than the actual hardware itself

ONLINE

View other articles in the Edge Computing Special Report for the Control Engineering April 2020 issue.

CONSIDER THIS

What applications do you think would benefit most from edge computing and why?

Allan Kern, P.E., APC Performance LLC

Understanding multivariable control: The missing metric

An improved understanding of the role of multivariable control in industrial process operations will lead to more cost-effective solutions and engage a wider circle of people in the process automation enterprise.

Multivariable control almost always has been explained in complex terms, invoking concepts such as detailed process models, real-time optimization, and matrix math. This means few people, outside the tight circle of advanced process control (APC) engineers, have understood it well. Greater understanding of multivariable control in industrial process operations brings more people into the process automation enterprise. Operational benefits include timeliness, consistency, and fewer alarms.

Spreading APC knowledge

Most other stakeholders have been left at least partially in the dark, often having to buy off on APC projects when they may not fully understand the objectives, benefits, implications and odds of success. Moreover, this situation again left industry at the mercy of APC engineers to explain APC's many unexpected shortfalls such as high cost, short lifecycle, and high maintenance, which in most cases, have not been satisfactorily explained.

With the benefit of nearly four decades of multivariable control experience, a more qualitative and intuitive understanding of multivariable control and the role it plays in industrial process operation is (finally) emerging. This can have several beneficial impacts for APC and process automation, including simpler and more robust software tools, better defined applications, and greater participation of all stakeholders.

What is multivariable control?

Multivariable control can be defined as automation of the single-loop controller setpoint and output adjustments that are otherwise left to the operating team to manually implement. When operators make setpoint and output adjustments in the course of a shift, that's manual multivariable control. Automatic multivariable control technologies, such as model-predictive control (MPC) or model-less multivariable control (XMC) automate this task.

Automatic multivariable control — or closing multivariable loops — brings the same benefits as closing single loops including greater timeliness and consistency, fewer alarms and constraint violations, and greater optimization. And it often includes significant operational and/or economic benefits.

Role of multivariable control in process operations

The role of multivariable control in industrial process operations can be understood as the difference between automated multivariable control and manual multivariable control. Industry has always had manual multivariable control, because almost every process operation is a multivariable control proposition — just ask any operator.

Automatic multivariable control automates, or takes over, the task of making setpoint and output adjustments for groups of related controllers. This often results in more consistent and timely adjustments, fewer alarms and constraint violations, and greater optimization. These benefits can also be understood as the intrinsic benefits of closed-loop vs. open-loop control, which have always been well understood in the single-loop control world and apply equally (or geometrically) to multivariable control.

The traditional constraint diagram (Figure 1) illustrates the difference. With manual multivariable control, operators keep a buffer, or margin for error, between ongoing operation and constraint limits, in case there is an unexpected process change or disturbance. The buffer typically translates into an economic penalty relative to fully optimized operation.

With automatic or closed-loop multivari-

More ANSWERS

KEYWORDS: Advanced process control, multivariable control

Role of multivariable control in industrial process operations

Working behind the scene: Multivariable control applications

Missing metrics: Measurements over time are needed to justify automated multivariable control.

CONSIDER THIS

Reader poll: Does your site have a metric for "bad actor loops" or "loop interventions per hour"? To respond, put in an email subject line...

Loop metric YES

Loop metric NO

...and email that once to mhoske@cfemedia.com before end of April 2020. If you have questions for the author or would like us to consider sharing your original related advice to other readers, please add that text in the body of the email. Results may appear in a future article.

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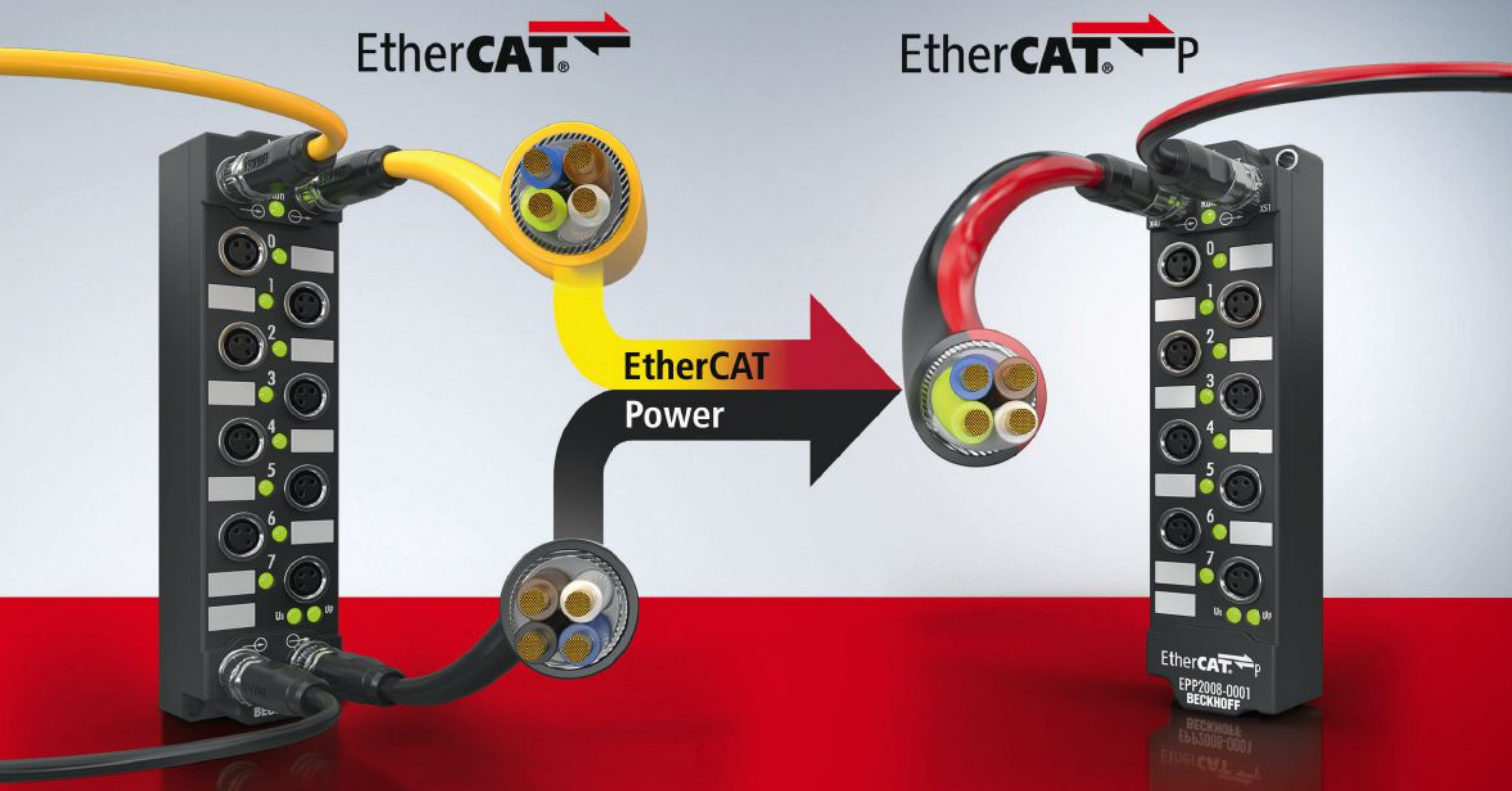

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New Automation Technology **BECKHOFF**

able control, operation can be held closer to actual constraints and the buffer region is captured as advanced control benefits. This is possible because multivariable control means an automatic response can be relied upon to take action in the event of changing process conditions. In the same way, multivariable control can automatically pursue receding constraints to capture greater earnings and optimization — it works in both directions.

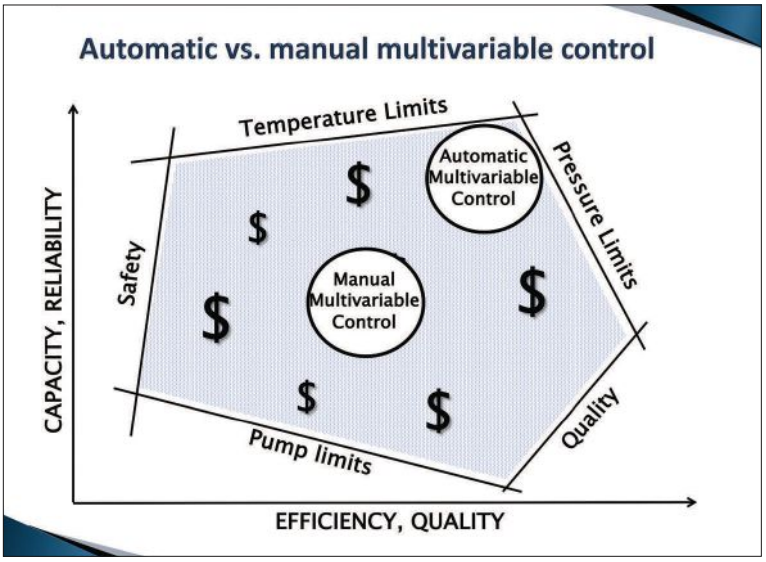

Figure 1: A traditional constraint diagram (Figure 1) shows the difference between manual and automatic multivariable control. In manual, operators keep a buffer, or margin for error, between ongoing operation and constraint limits, in case there is an unexpected process change or disturbance. The buffer typically translates into an economic penalty relative to fully optimized operation. Graphics courtesy: APC Performance LLC

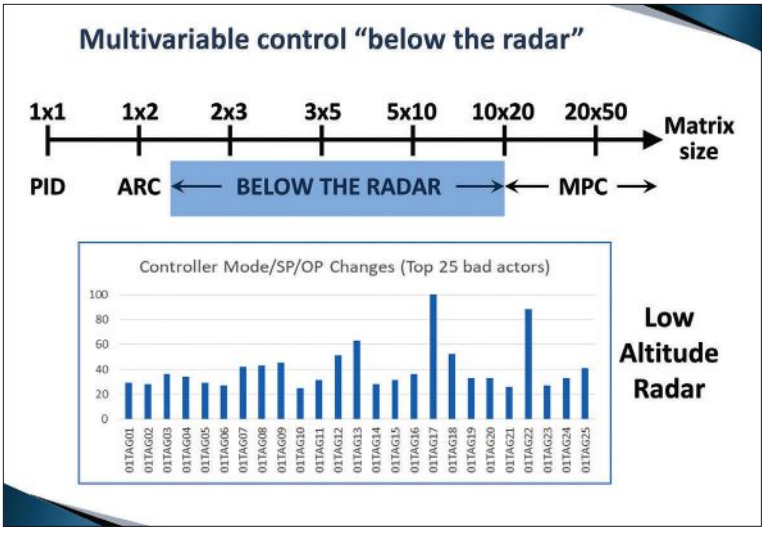

Figure 2: Effective metrics provide a meaningful measurement, are intuitive, and reflect progress over time. Has industry been overlooking metrics that could justify automatic multivariable controls? A chart of the 25 worst controllers (those requiring the most operator intervention) is easy to make on any modern control system console.

Where are the applications?

Many multivariable control applications have remained "below the radar" of the conventional large matrix MPC paradigm, because they have not been seen as justifying the high threshold cost of MPC, and were too big for the limitations of advanced regulatory control (ARC).

Figure 2 is a "low-altitude radar" that reveals the multivariable control applications that have historically remained below the MPC radar. It shows the number of operator interventions, in terms of setpoint, output, or mode changes, made at an operator console, over a given time period. It shows the 25 worst actors, which are those controllers that have required the most operator interventions. This is an easy chart to make on any modern control system console.

Micromanaged APC

It's a good bet that many or most of these interventions represent manual multivariable control scenarios, where the operating team becomes caught up in frequent micromanagement of groups of related controllers.

It is the objective of multivariable control to automate these manual multivariable control scenarios to close these multivariable loops and reduce these numbers.

Industry's missing APC metric

Figure 2 may look familiar. Industry adopted similar best practices at least twice in recent memory — to manage loops in manual (except now we are talking about multivariable loops in manual) and to manage bad actor alarms (except now we are talking about bad actor loops that require frequent operator intervention).

Multivariable loops in manual and frequent operator interventions carry several undesirable implications, including more alarms and constraint violations, less operator attention to higher level tasks, and less optimization, since manual intervention, by definition, is often inconsistent, untimely, and suboptimal.

Effective metrics provide a meaningful measurement, are intuitive, and reflect progress over time. Figure 2 meets these criteria and reflects a fundamental aspect of successful process automation and quality of console operation. Has industry been overlooking this natural and potentially important metric? **ce**

Allan Kern, P.E., *is owner, APC Performance LLC. Edited by Mark T. Hoske, content manager,* Control Engineering, *CFE Media, mhoske@cfemedia.com.*

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* IHS Markit, Industrial Edge Networking Components Report – 2019

Narayanan Ramanathan, L&T Technology Services Ltd.

Digital engineering practices enhance technologies of tomorrow

By integrating digital, physical and virtual realities, digital engineering redefines product development and manufacturing. Digital engineering accelerates development of next-generation smart products, services and operations.

Combining the digital, physical and virtual realms, digital engineering and enabling technologies are redefining how products are developed and manufactured. Digital engineering leads to next-generation smart products, services and operations that accelerate end-user value.

Technology is influencing our lives by changing lifestyles and behaviors. Within the industrial landscape, digital technology transformation is being called the fourth industrial revolution, or Industry 4.0.

Because of accelerated adoption in life and business, what's visible now is just the tip of the iceberg. New applications emerge from affordable computing power, fast connectivity, cheap storage and high capability sensors. According to Gartner, there are likely to be 20.4 billion connected things in use worldwide by 2020, across all industries, including automotive, industrial products, high-technology, energy, utilities and more.

Digitalization allows customization to meet specific customer needs beyond one solution. Enhanced customer experiences include ease of usage, simplicity and interactivity. Customers see core product offerings and differentiating product attributes more quickly.

Digital engineering is assuming the primary position as the pathway to enhance and disrupt traditional processes and accelerate the technology landscape. While digital engineering captures data for business excellence, it also acts as a bridge that merges real-time processes with the digital spectrum.

Digital engineering defined

Consider digital engineering as the technological concept that enables development of smart connected ecosystem to enhance experiences and optimize functionalities. By combining digital, physical and virtual realms, digital engineering and related new-age technologies are redefining the way products are developed and manufactured for end consumers.

With increased research and development (R&D) and engineering implementations, digital engineering leads to next-generation smart products, services and operations to enhance end-user value.

For these reasons, digital engineering continues to be appealing the wider business ecosystem. For instance, Zinnov Research expects the global spend on digital engineering will jump from $223 billion in 2018 to $667 billion by 2023.

The scope of digital engineering spans the product lifecycle, including the concept phase to planning, through design, production, and monitoring products (including built infrastructure) over the service lifecycle.

Industry experts explained that customers across sectors seek to streamline platforms and want them to support every possible feature, while the user wants a unique set of features that adapt to changing needs. Data digitization and translating data into a service are becoming increasingly important. Deriving large amounts of data from various sources has become essential to generate tangible business value. That drive to create business value and facilitate an exponential digital transformation excites engineering research and development (ER&D) leaders globally.

Shop floor to top floor

In the last three decades, information technology (IT) infrastructure has greatly improved

More ANSWERS

KEYWORDS:
Digital engineering, digitalization

Digital engineering is enhancing and disrupting processes.

Convergence of information technology and operational technology helps.

Return of value should be considered along with return on investment.

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Are you worried digitalization will allow your competitors to accelerate past your reach?

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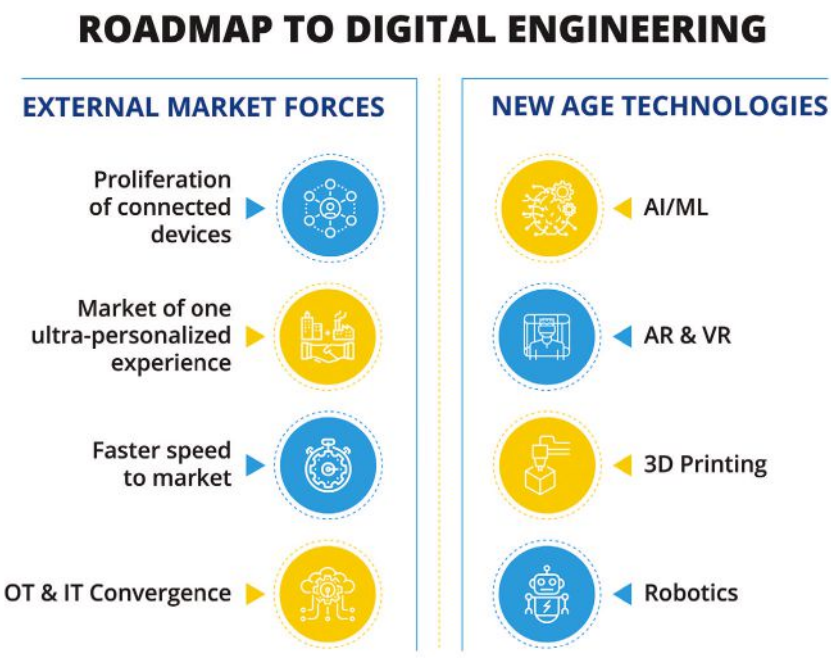
and digital transformation has made significant impact on organizations. The rapidly changing future requires a new kind of transformation that embraces IT and a new kind of engineering that enables personalized and optimized user experiences with the help of digital and emerging technologies.

> "**Digital engineering** is assuming the primary position to enhance and disrupt traditional processes."

The traditional gap between the "top floor and the shop floor" is blurring with new components and machines connected by the Internet of Things (IoT). Such connections can provide the deepest factory-floor visibility in an instant. Bringing "smart technologies" onto the shop floor of manufacturing enterprises has boosted efficiencies and cut costs for enterprises. These are among the major success stories of digital engineering.

Like manufacturing execution systems (MES), asset management services provide a backbone for smart factories. Such systems control the infrastructure that powers plants and keeps factory lines running without a glitch. Only in recent years have technology and business reasons compelled companies to work through operations technology (OT) and IT convergence. OT-IT technology integration is appealing because it helps avoid separation of technology areas and areas of authority and responsibility. An integrated process and information flow offers more opportunities, especially as more devices connect to the Industrial Internet of Things (IIoT) network.



The new age digital engineering practices help enable new business models that unlock greater value for enterprises and increase the value proposition for those involved. Courtesy: L&T Technology Services Ltd.

Digital challenges, opportunities

Challenges exist for digital engineering practitioners. Because the movement is still at an early stage, many enterprises are struggling to scale digital engineering to desired levels and positively impact the business with top- and bottom-line growth.

Change management should be considered with digital engineering efforts because it can trigger organization-level changes.

Evaluating the fiscal feasibility of digital engineering requires linking change management to a validated business cause to ensure success. Measured parameters can include product, quality and sustainability, triggered by any of the three levers of people, process and technology. Digital engineering interventions remain human-centric. Artificial intelligence (AI), machine-learning (ML) algorithms, IIoT and all futuristic technologies should touch lives and contribute to building a sustainable and inclusive society. Success should be measured by return of value (ROV) and not solely on return on investment (ROI).

Finally, as organizations assume a data-driven identity, sustainable digital engineering advances need to extend beyond business intelligence to a more quantifiable cause such as bringing down the cost of inventory.

Eliminate the monotonous

Digital engineering is dissolving the boundaries of physical and digital worlds. These technology concepts can act as a catalyst and steering wheel and help eliminate monotonous and reiterated procedures and maximize cost effectiveness and efficiency. While the discipline is evolving, all technological giants have realized the large part it will play for the future of clients and business. The digital engineering revolution is here to stay and will gain momentum in the coming years. **ce**

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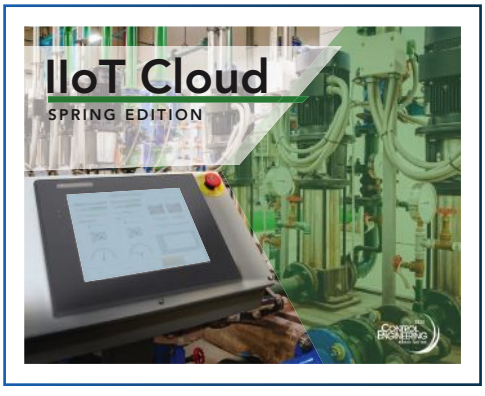

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John Clemons, Maverick Technologies

Digital transformation: time for industry to kick into high gear

Digital transformation is about transforming and changing the business for the future and creating new and better ways of doing business.

The simplest definition of digital transformation is the use of digital technology, such as computers, networks, databases, and the internet, to solve business problems. While this is correct, it's far from complete.

Digital transformation uses digital technology to transform and change business for the future, creating new and better ways of doing business. Digital transformation creates new capabilities and new processes, reduces capital costs and operating costs, empowers teams, improves decision making, and creates new and better products and services for customers.

At its core, digital transformation is more about people and processes than it is about digital technology. It uses the power of digital technology to improve and transform business processes and the jobs people perform. It empowers people, delivers value to customers, and provides returns to shareholders.

Most regions and types of businesses have begun a digital transformation journey. The manufacturing sector is no exception. In most industrialized countries, manufacturing companies are using a myriad of digital technologies, along with their internet- and technology-savvy people, to transform their businesses into economic powerhouses. What kinds of digital technologies are the manufacturing industries using to power digital transformation?

- **Artificial intelligence (AI)** systems analyze vast amounts of data and extracting trends and knowledge from seemingly incoherent numbers.
- **Industrial Internet of Things (IIoT):** Smart devices, smart machines, and smart sensors only work and make sense when they're connected and can talk to one another. They let people know what's going on, all the time, in real time.
- **Machine learning (ML):** Smart machines create and extend their own mathematical models to make decisions, and even predictions, without having to be programmed; they essentially learn from the past and from the world around them.
- **Augmented reality (AR):** Anything and everything in the real world can now be enhanced, or augmented, by digital information — and it's not just visual — it can be one, or all, of the five senses.
- **Virtual reality (VR):** While VR has been around in gaming for a while now, it's also being used to create simulations, training, and a whole lot more.
- **Digital twin:** Digital twins are connected to their physical counterparts to create cyber-physical systems. Digital twins get a continuous real-time data stream from the physical twin, becoming a digital replica.
- **Digital thread:** As parts and products move through a manufacturing facility, they're consumed, produced, and transformed throughout the process. The digital thread is the details from beginning to end.
- **Manufacturing execution systems (MES):** While MES systems have been around a long time, they have a new lease on life as part of a digital transformation strategy. Any facility that executes manufacturing orders needs a MES.
- **Radio frequency identification (RFID)** and other electronic identification systems, are ubiquitous in industry, identify anything and are indispensable to a digital transformation strategy.
- **Advanced robotics:** Robotics continues to advance in leaps and bounds. It's almost inconceivable any manufacturing facility could even exist without autonomous robots.
- **Collaborative robots:** Collaborative robots take robotics a step further by interacting with humans collaboratively, side by side.
- **Mobile internet:** It's easy to take mobile smart phones for granted. In a modern manufacturing facility, everything and everyone is mobile to the max.
- **3D printing:** Many people know 3D printing builds a 3D object from a computer design. 3D printing also has created a new type of manufacturing — additive manufacturing — where products are created by adding materials layer by layer to build the product.
- **Cloud and edge computing:** On-demand data storage and on-demand computing power

More ANSWERS

KEYWORDS: digital transformation, digital manufacturing

Digital transformation allows manufacturers to change their business processes.

Digital transformation covers many aspects including IIoT, collaborative robots, machine learning and more.

Long-term benefits include better customer response and greater returns to shareholders.

ONLINE

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CONSIDER THIS

What is your company doing to take advantage of the digital transformation in manufacturing?

exist just about everywhere. Cloud and edge technologies enable digital capabilities, often anywhere, any time.

More types of technology are a part of digital transformation, including blockchain, drones, the greater Internet of Things (IoT), the automation of knowledge work, social media, new types of energy storage, the next generation of genomics and more.

Digital transformation and technologies are remaking manufacturing industries into an economic powerhouse by:

- **Increasing capacity**
  - –Increasing capacity to theoretical maximum and beyond
  - –Increasing capacity without additional equipment or labor
  - –Reducing downtime and increasing overall equipment effectiveness (OEE).
- **Increasing throughput**
  - –Increasing material velocity and material flow
  - –Reducing queue times and lead times between processes
  - –Increasing labor efficiency by reducing non-productive wait times.
- **Going paperless**
  - –Supporting greater efficiency and productivity
  - –Providing quicker responsiveness
  - –Increasing operational flexibility
  - –Reducing errors associated with recording information on paper
  - –Providing data digitally to people when and where it's needed
  - –Supporting decisions with visibility into jobs, tasks, materials, quality, etc.
  - –Eliminating paper job sheets, paper travelers and a whole lot more.
- **Managing materials**
  - –Reducing "lost" materials with visibility into jobs, quantities, locations, etc.
  - –Increasing material velocity with better queueing and visibility
  - –Increasing accuracy with automated data on components built and used.
- **Improving quality**
  - –Increasing first-pass quality by resolving issues on the spot
  - –Integrating quality into the processes, not with after-the-fact inspections
  - –Supporting continuous improvements processes with quality data.
- **Improving customer service**
  - –Providing visibility into jobs to build what's needed when it's needed
  - –Reducing customer lead times with increased velocity
  - –Increasing accuracy of commitments with up-to-date visibility
  - –Reducing delays and customer issues with increased quality.
- **Increasing profitability**
  - –Increasing throughput without increases in labor costs
  - –Reducing costs associated with delays, rework, waiting, etc.
  - –Increasing product mixes, serving more customers with more products
  - –Consolidating manufacturing operations for greater efficiencies
  - –Redirecting labor to higher value operations and needs
  - –Reducing costs associated with non-conformance and other quality issues
  - –Expanding product lines, products, customers, etc.

> "**Digitalization** helps redesign operational processes and incorporate usage data into the innovation and marketing processes, and make automation processes faster and easier."

Digital technology and digital transformation are helping companies reimagine the customer journey. They can better establish one-on-one customer relationships, reward and incentivize the sales and marketing channels in new ways and deliver new value with connected products.

It's also helping companies redesign operational processes and incorporate usage data into the innovation and marketing processes, make automation processes faster and easier, and maintain equipment more predictably and proactively.

Perhaps most importantly, it's challenging business models and helping companies evolve from product companies to services-centric organizations, using data to increase quality, output, and revenue, and augment physical experiences with digital ones.

Digital transformation is a reality. Today's manufacturers can leverage digital technology to transform and change their business processes. They can reduce costs, empower people, improve decision making, and create new and better ways to deliver products and services. They can deliver more value to customers and provide greater returns to shareholders.

The digital transformation payback is real, and it's happening. The technology is here and ready to go. There's no excuse. It's time for manufacturers to accelerate and put digital transformation into high gear. **ce**

John Clemons *is a consultant for Rockwell Automation and Maverick Technologies. Maverick Technologies is a CFE Media content partner. Edited by Chris Vavra, associate editor,* Control Engineering, *CFE Media and Technology, cvavra@cfemedia.com.*

Mark Stephens and Alden Wright, EPRI

Understanding power quality, manufacturing reliability

Voltage sags and interruptions can have a detrimental effect on manufacturing processes. Understanding how and why they happen is crucial.

Consider this familiar scenario: Manufacturing processes are up and running, the product emerges flawlessly as may happen for days or weeks at a time, and then the lights blink (or perhaps not) and things stop… perhaps for hours. The line must be cleaned and reset. The materials in process are likely unsalvageable. Schedules are affected, time is lost, product is lost, and money is lost.

What happened? Many might think the electrical event was a power surge, or outage, a power blip, which are ambiguous terms for events with precise definitions in the power industry concerning a momentary complete loss of voltage or a momentary reduction in voltage — an interruption or a voltage sag. More than likely, however, it was a momentary reduction in voltage. Figure 1 illustrates the difference in magnitude between the two.

A voltage sag occurs when the supplied voltage briefly falls below 90% of nominal (the blue area, 108 volts for a 120-volt system, for instance). Should the voltage fall to 10% of nominal or below (the reddish area, 12 volts for a 120-volt system), an interruption has occurred. Studies by the Electric Power Research Institute (EPRI) have determined almost all voltage sags occur within 1 second — most falling within 0.5 seconds, and most having a magnitude above 50% of nominal voltage.

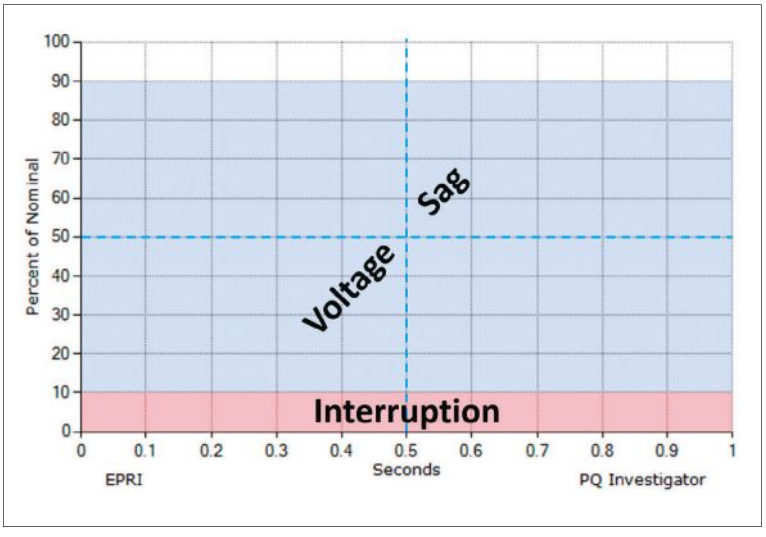

Figure 1: Voltage sag vs. interruption: The blue-shaded area, 90% to 10% of nominal voltage, represents the region of voltage sag magnitudes while the reddish area, 10% of nominal voltage and below, represents the region of interruptions. All graphics courtesy: EPRI

Voltage sags have a magnitude — how much of the nominal voltage remains, and a duration — the amount of time the voltage sag lasts. Figure 2 shows the 60 Hz, three-phase, voltage waveforms and the measured root-mean-squared (RMS) voltage traces. In the top figure, the blue line, "Channel 1" representing phase A (the others being phases B and C), shows the waveform bobbles for just over 1 cycle (out of 60 cycles per second at 60 Hz). The bottom figure shows, at its lowest point, the voltage drops to ~25% at about 68 volts in this case, and for a very brief interval of time. The whole event occurred within 0.04 seconds.

Have interruptions, voltage sags?

Storms, as well as animal interactions with aboveground electrical systems, are common causes of interruption and voltage sag events. Multiple distribution feeder circuits connected to a substation transformer secondary may resemble a hand (the transformer secondary) and its extended fingers (the distribution feeder circuits). These distribution circuits (the fingers) could extend for tens of miles. Should a tree limb touch one of the feeders — as it might during a storm — a short circuit (called a fault) on one or more phases to ground or between phases may result on that feeder. All the other feeders (again, the fingers) connecting to that substation transformer secondary (the hand) will experience a voltage sag as well, which could fall below 10% of nominal voltage depending on the circumstances.

The circuit breaker on the shorted feeder may operate to interrupt the fault, thus disconnecting the downstream loads, which is an interruption in service. Once the circuit breaker on the affected feeder opens, however, the voltage sag ends on the other feeders. Voltage sags, however deep, may be very

brief. Depending on the circuit breaker reconnection settings and the nature of the fault, the interruption on the faulted feeder could be brief, as well.

Why are voltage sags an issue for industrial equipment, and why are industrial controls sensitive to voltage sags?

Built-in sensitivity

Most electrical equipment in the United States is designed to function normally for steady-state voltage at ±10% of the nominal voltage. Thus, the operating voltage is presumed to be constant (although sometimes, it is not). Industrial controls in the United States have a long history of being designed at 120 volts ac (alternating current).

An example is shown in Figure 3 with a step-down control power transformer (CPT) connected phase-to-phase. Within the control circuit might be an emergency off circuit (EMO) with an ac "ice cube" relay supplying 120 volts to the coils of the main contactors in turn supplying the process. AC controls do not normally store energy. The ac voltage goes to zero 120 times per second at 60 Hz. Therefore, during a voltage sag, nothing prevents the control voltage from dropping as well. The process stops when the controls stop functioning.

The controls stop because of sensitivities of individual control components that are vulnerable to voltage sags. Only one is needed to halt the process. In the case above, the ac "ice cube" relay, which typically opens at around 70% of nominal voltage, has the same effect at a low-enough voltage — as if someone pushed the emergency off button.

Other potentially sensitive components include but are not limited to the programmable logic controller (PLC) power supply (or other dc power supplies), the PLC I/O, adjustable speed drives (ASDs) and other contactors. With multiple processes inside the facility, specific control circuits may be powered from different phases. Different processes may stop at various times depending on which phases experience a voltage sag.

Industrial process sensitivity to power quality events is the result of inherent sensitivities within the process controls to momentary reductions in supply voltage. These momentary reductions usually stem from events in the above-ground electrical distribution system that create phase-to-ground or phase-to-phase short circuits.

Understanding the sources of the problem of process sensitivity to voltage sags is important to identifying possible solutions to this problem, which will be addressed in part 2. **ce**

Mark Stephens *is principal project manager; Alden Wright is technical leader, Electric Power Research Institute (EPRI). Edited by Chris Vavra, associate editor,* Control Engineering, *CFE Media, cvavra@cfemedia.com.*

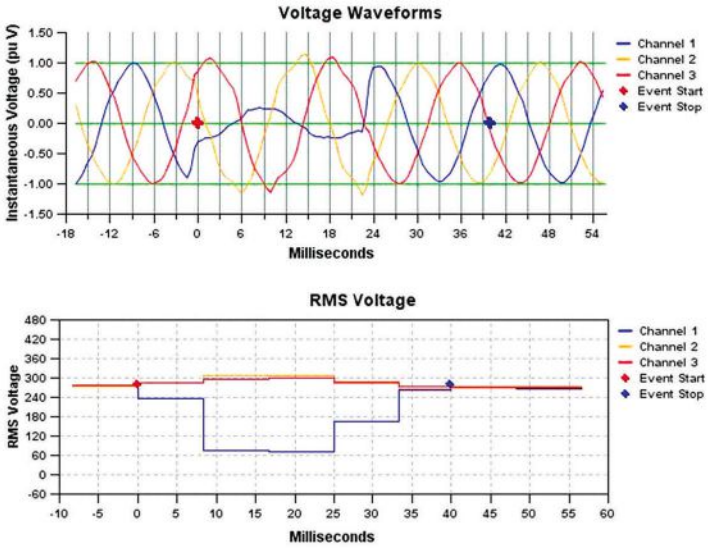

Figure 2: Voltage waveforms and RMS values over time: Momentary short circuits in the distribution system cause a momentary reduction in voltage.

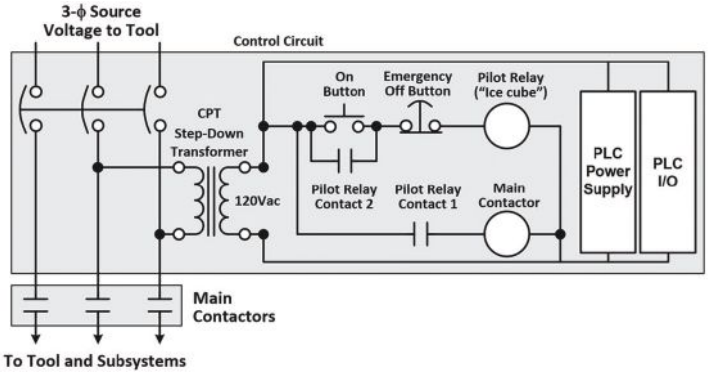

Figure 3: A typical ac controls schematic: A control power transformer (CPT) supplies power to control components such as relays, contactors, PLC power supply and I/O. Other components may be present, such as dc power supplies and adjustable speed drives (ASDs).

Increase uptime after power quality issues

- Understand your power quality (PQ) environment – prescribe solutions that fit your situation
- Don't assume battery based uninterruptible power supply (UPS) systems are needed; there are other technologies
- Avoid use of sensitive ac components in controls
- Embed robustness using ac- or dc-based controls that are compliant with IEEE 1668 or SEMI F47.
- Use voltage sag-ride through settings in your motor drive systems.

Visit http://mypq.epri.com for help in improving voltage sag robustness of industrial automation systems.

More ANSWERS

KEYWORDS: power quality, voltage sags

Voltage sags or interruptions can cause major downtime issues.

A voltage sag occurs when the supplied voltage briefly falls below 90% of nominal voltage.

Industrial process sensitivity to power quality events is the result of inherent sensitivities within the process controls to momentary reductions in supply voltage.

ONLINE

Learn more about energy and power issues at www.controleng.com under the energy, power section in the System Integration channel.

CONSIDER THIS

What has your company done to better prepare for voltage sags or interruptions?

Jon Breen, Breen Machine Automation Services

The future of industrial automation training

Think beyond human-brain limits to help industrial automation and education. Use the brain outside your brain to "know" things not previously learned.

The limits of the human brain govern how humans learn in industry. First, let's call out the biological brain for what it is. It's incredibly good at complex pattern recognition, critical thinking and creativity. In many respects, the world's biggest supercomputers and the world's smartest programmers still haven't matched biological human brains for performance.

It's ironic, though, that the rate of technological improvement is challenging human brains, pointing out some inherent weaknesses in the biological approach. Learning is slow, things are forgotten and mistakes made. Such shortcomings have a major impact on how we learn in manufacturing.

Another brain, anyone?

Fortunately, the manufacturing industry uses numerous strategies to combat these shortcomings and improve learning. Some cognitive burden shifts outside the human brain by using a notebook, a calendar, a manual and a spellchecker. In most cases, the structure of these resources is consistent. Remembering what a calendar is, or understanding the idea of a table of contents, enables fast information retrieval with perfect accuracy — even without seeing it before.

Technology has increased the effectiveness of these tools. For example, instead of gathering printed manuals on a shelf for every servo motor, the internet can provide instant access to every manual needed. Using the search feature in a .PDF reader helps find information quickly. An internet search can sometimes pull relevant information out of the manual and display it on the search results without opening a manual. Ironically, as better computers are developed faster, those computers are simultaneously used to manage the resulting chaos they create. As they say: "Computers. You can't live with 'em, you can't live without 'em."

Business and industry have been shortcutting training with simple techniques for a long time. Ever heard of SOPs (standard operating procedures), VWIs (visual work instructions), or any other TLA (three letter acronym) used to document a process? These quick reference documents assist manual workers in factories, but a similar approach could benefit knowledge workers, as well: Take the time to figure something out, generalize it to apply to other versions of the same thing, then record it in a place where someone else can look it up. With this approach, we can go far beyond the scope of a manual. As a team, we can learn something once and then quickly share the information.

This approach can be formalized into intentional training approaches. Some component manufacturers in automation have started publishing brief how-to videos on the Internet, a perfect example of making one brain's knowledge easily retrievable by another — a "brain outside your brain (BOYB)." As this approach expands, it'll take on a more significant role in training. What types of job-related information can be outsourced to an alternate brain? Can learning be just in time, rather than waiting in inventory? What would that look like?

Standard automation training

Standard industrial automation training approaches revolve around in-person, scheduled training programs, usually through a supplier or manufacturer. These have been valuable additions to the workforce's skill set, but have limits. They're only offered at certain times, often require travel, require a person to commit to the whole course in one sitting and can be expensive. To gather knowledge necessary for a project, plan well in advance, binge the material, and hope memory and notes are adequate during implementation.

Because of these limits, people often aren't getting training that helps. Even with training, they've often forgotten much of it when they need it. The BOYB approach can help, giving the ability to "know" things not previously learned. How?

- Have you ever had a home improvement project, car issue, gardening interest, or curiosity

More ANSWERS

KEYWORDS: Automation education, workforce learning

Using another brain helps with limits to human recall.

Industrial training process are changing.

Quick references and skills development seem likely areas of growth.

CONSIDER THIS

What skills would improve your career? What kinds of how-to training would help you out of a bind? Let us know.

ONLINE

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Also see:

https://Breen-Machine.com/training

www.controleng.com/online-courses

Using the brain outside your brain approach helps us "know" things not previously learned. Courtesy: Breen Machine Automation Services

about the newest electronic gadget?

- Did you go to school and get a degree in each one of those things in case you ever needed to know about them?
- If you were to do that, would you remember what you need to know when the time came?
- Would the knowledge still be relevant?

Answers are almost universally "no" for all these questions. No one has a degree in every needed life skill, and if anyone did, recalling the information would be challenging. Also, the information would likely be obsolete by the time it was needed.

Automation training processes, 2020

Twenty years ago, most probably outsourced these skills to other people. For example, you might call an uncle who's a plumber to install a new faucet. Today, many of us turn to the internet for do-it-yourself (DIY) advice, reserving the uncle for harder stuff. For example, YouTube has tutorials for almost every home improvement project imaginable. It's easy enough to watch them before doing the project to aid recall. Advanced planning isn't needed.

This type of BOYB "training" is becoming available for industrial topics, as well. Major automation manufacturers are dipping their toes in the water, making short videos on how-to topics, product demos, selection guides, etc. They tend to be product-specific and limited in scope. Such videos seem unlikely to address product shortcomings or negative real-life scenarios. Colleges, individuals and other organizations also are posting content approaching topics from other angles, which will be an area of growth over the next few years.

Future industrial automation training

Quick reference and skills development also seem to be likely growth areas for BOYB training for industry professionals. Quick reference refers to training that helps someone immediately. This is usually a short video that helps a person dealing with a very specific task. For example, let's say a programmable logic controller (PLC) dies in a piece of automation. The program has been backed up, and there's a spare PLC on the shelf, but the technician doesn't do this very often and can't remember how to load the program. Automation downtime can be very expensive, which means it's important to get this fixed ASAP.

The technician could look through manuals, or find an on-demand course on PLCs, but that could take a while. The best thing would be a quick video on downloading PLC programs to that kind of PLC. Access to short, specific videos like this expands what a person can do in a job, today.

> "**For PLC replacement,** a technician could look through manuals, find an on-demand course on PLCs, or look at a quick video on how to download PLC programs to that kind of PLC."

Skills development and BOYB training growth will likely focus on broader topics like vision inspection, industrial Ethernet, PLC programming, etc. They may offer more of a parallel path to traditional in-person seminars offered by manufacturers and distributors. They may be more accessible in terms of cost, scheduling and geography. They don't offer hands-on experience like in-person training, so the two approaches will be complementary.

People can be encouraged to learn and grow at their own pace, on their own time, and without breaking the bank. Developing training materials to address the immediate and future needs of industrial automation professionals, students and companies can help. **ce**

Jon Breen, *founder/owner, Breen Machine Automation Services, a* Control Engineering *content partner. Edited by Mark T. Hoske, content manager,* Control Engineering, *CFE Media, mhoske@cfemedia.com.*

Sean Callahan, Kepware, PTC

Digital transformation is better with controls engineers

Developing a standardized operational technology (OT) architecture to support the new digital environment is challenging, especially with many devices with diverse protocols. Those with expertise in controls, automation, and instrumentation can help with digital transformation.

As more enterprises embark on digital transformation (DX) strategies, a standard, enterprise-wide operations technology (OT) communication architecture helps manufacturers reach full scale implementation and provides reliability and security. OT data also must integrate with information technology (IT) applications and infrastructure in ways that are not historically available. Controls engineers are mission critical to making this happen, but are in short supply, according to a Manpower Group talent shortage survey, and the shortage is expected to get worse. Although this is great news for controls engineers looking for work, enterprises must find ways to mitigate the risk for long-term success.

Digital transformation

Digital transformation is a broad business strategy, applicable across all industries, to solve traditional business challenges and create new opportunities through the use of technology. It requires acceptance of new ways of working and delivering value to customers.

According to a McKinsey Expert Survey, 70% of industrial organizations consider digital manufacturing at the top of their operational strategy.

Despite its strategic importance, and more enterprises tackling the challenge of digital transformation head on, many have failed to realize the value at scale and are stuck in what McKinsey refers to as "pilot purgatory."

Why is it so difficult to get it right? Collecting and contextualizing real-time data from the factory floor to where it is analyzed is mission-critical to any digital transformation initiative. According to Deloitte, advanced connectivity is becoming the linchpin to digital business. With many different devices with diverse protocols, developing a standardized OT architecture to support the new digital environment is very challenging.

Many enterprises have historically relied on a blended connectivity approach, connecting individual devices as needed with ad-hoc solutions, determined by whatever worked best at the time. This has resulted in heterogeneous environments, siloed data, unconnected machines, and architectures that are difficult to understand and maintain.

Complex and heterogenous production environments are making connectivity one of the most difficult aspects of digital transformation. Even when machines or controllers are connected to existing applications, the data is often siloed, making existing connectivity methods ineffective in accessing the data.

Further, even if there is connectivity throughout a production environment, security risks need to be addressed before creating connectivity between the IT/OT network.

Future talent challenges

A shortage of qualified software engineers is further complicating digital transformation initiatives. According to Boston Consulting Group (BCG), "In the U.S., the demand for software engineers in the auto industry is expected to increase 30,000 which may outpace degrees by six times exacerbating the industry's already significant labor shortage."

These numbers are for the U.S. automobile industry alone. As more enterprises embark on their digital transformation journeys, the rising demand for control engineers, combined with the labor shortage, increases risks and could have a major impact on the overall success of these projects, as well as the enterprise as a whole.

More ANSWERS

KEYWORDS: Digital transformation, filling the skills gap

Operational technology talent shortages

Digital transformation challenges

Tips to help fill the skills gap.

CONSIDER THIS

How are technologies helping you fill the digital transformation skills gap?

ONLINE

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Mitigating talent risk

It's a risk to not have enough engineers with expertise in automation, controls, instrumentation, and integrated software, systems, and networks. Mitigate risk in five ways.

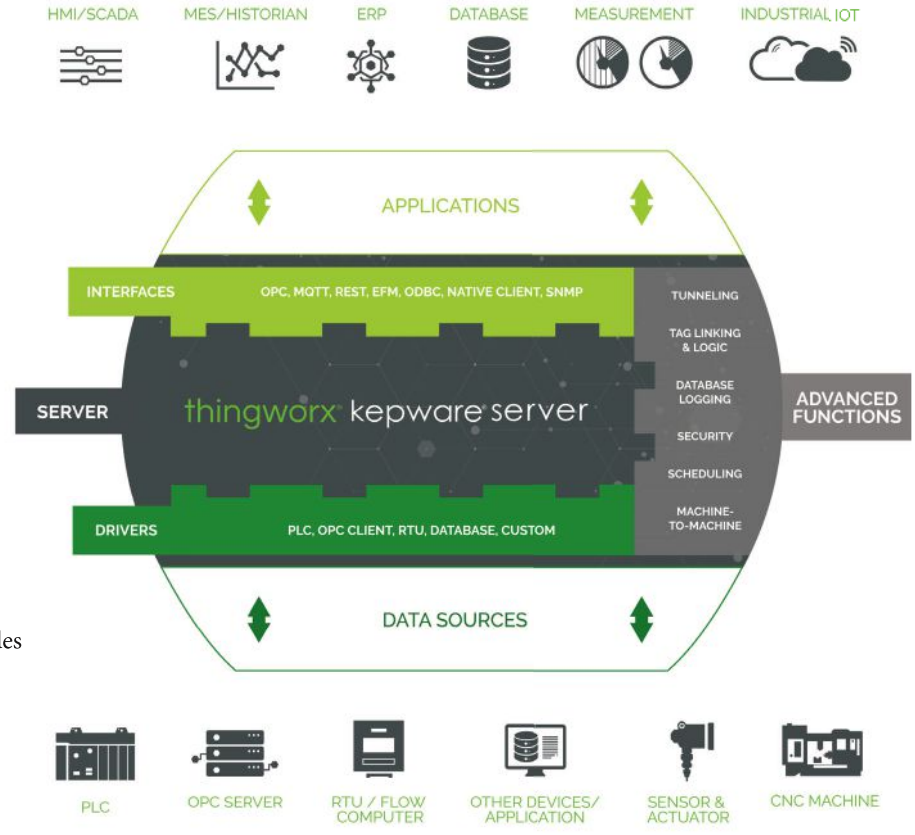
1. Bridge the OT-IT gap: According to LNS research, forming a cross-functional team of IT and OT subject matter experts has proven effective in bridging the OT-IT gap in digital transformation initiatives. Having OT experts working closely with IT teams to develop the project vision, path, and strategic roadmap to success up front provides a holistic understanding of the challenges of architectural requirements and required connectivity. In addition, understanding the value and return on investment (ROI) the project brings to the enterprise provides meaning to the employees and supports high-level decisions on the appropriate amount of resources that need to be allocated to the project.

2. Implementation speed: When considering technology solution partners, the plan should consider the speed of implementation. A project plan that anticipates years to complete increases the risks of project success and employee burnout. In addition to mitigating risks, a plan with a faster time-to-value provides a better ROI and improves a company's competitive advantage. Solution providers should also have expertise in digital transformation, industrial connectivity, strong partner relationships, and the resources and support to guide a successful transformation.

3. Network architecture simplification: Simplifying the communications architecture with a standard, reliable enterprise-wide connectivity solution will also help mitigate this risk. Relying on a heterogeneous connectivity environment, especially one that includes internally developed solutions, makes maintaining a reliable, secured, scalable OT network difficult. In a homogenous environment, controls engineers can also spend less time on unexpected troubleshooting, establishing individual connectivity to new devices, and maintenance. This reallocates their time to more important strategic initiatives and expedites digital transformation projects.

4. Invest in employee development: Many different training programs exist to educate and train the current employee base and bridge the skills gap. In addition to training employees, some programs provide additional benefits. One program, for example, provides free training to U.S. military veterans with the skills to succeed in advanced manufacturing roles. Programs like these may help companies address future talent shortages and prepare their organizations to succeed in years to come.

5. Get help: Partnering with external resources can help bridge the gap to develop a standard, reliable architecture that drives success and mitigates risk. Working with consulting groups, OT integrators, and Internet of Things (IoT) integrators will add critical resources and expertise along the digital transformation journey. Some OT system integrators are adopting new strategies to expand their service offerings to support digital transformation initiatives. In addition, more IoT integrators are adding connectivity to broaden their technical expertise. **ce**



Kepware's KEPServerEx has been repackaged for enterprise connectivity: ThingWorx Kepware Server simplifies connectivity across the enterprise providing access to all KEPServerEx drivers and select Advanced Plug Ins managed by one license. Used at more than 75,000 sites, it provides the reliability, connectivity, scalability, and security needed for operational environments. Courtesy: PTC

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Dan Jones, Incremotion Associates; **Mark T. Hoske,** *Control Engineering*

High-performance motor designs

Advanced motor technologies influence motor form factors, performance, and efficiencies. How can the advances help with your next set of applications?

Baldor-Reliance EC Titanium Integrated Motor Drive combines synchronous reluctance and permanent magnet technologies for a sustainable, wirelessly connected solution to improves the bottom line. Courtesy: New Products for Engineers Database and ABB Motors and Mechanical Inc.

EC 90 Flat Motor High Torque has 90-mm dia. with 160 W or 260 W of power. Courtesy: New Products for Engineers Database and maxon

Why is it possible to design a higher performance motor and drive today? The answer appears to be better design software continuing to be improved on an average of once per year. It's now possible to design very complicated motors that enhance torque, power, efficiency and power factor. This was more difficult 10 years ago.

Software's sophistication has significantly improved for motor designs and drive and control designs.

Motor innovations, four areas

Four areas of motor innovations follow.

1. The permanent magnet (PM) motor remains a favorite, assuming the application can live with the high cost of the magnets.

2. The synchronous reluctance motor is significant because of improvements made in the drive and control topology. Two European-based automation companies, Siemens and ABB, are beginning to design 60 Hz versions, but we likely have a couple of years before the full product line will be available.

3. Switched reluctance (SR) motor technology is a close third. For custom application requirements they can exceed synchronous reluctance in capabilities.

4. The induction motor drops to fourth position on the innovation scale, largely because it is protected by immense tooling and manufacturing investments already paid by various motor suppliers. Because of invested assets and market share, motor-drive companies building to requirements from National Electrical Manufacturers Association (NEMA) often seem to adopt an "If it isn't broke, don't fix it" approach to motor design and innovation. It would seem many will change only when they are forced to by market requirements for increased performance.

Others (1-3) will require more tooling investments and higher rates of production to reach more applications at lower-than-current costs.

Some motor innovation highlights follow.

SR motors, application

While other motor types can use an inverter (variable frequency drive), the SR motor must have a completely separate drive. This motor tends to be custom because the user needs a full motor-drive system. It is dedicated to an application or set of applications. It usually is not found on the internet until the application goes into production.

SR Drives in the U.K., part of US Motors and Nidec Corp., is a switched reluctance-motor that can provide very high performance, with as much as a 10% efficiency increase compared to ac vector motor.

Linear Labs describes use of its SR motor in a direct-drive electric vehicle application. It describes an in-hub automotive drive design where two or four motors can create a competitor to a centralized electric drive motor. The Linear Lab motor operates in rotary and linear fashion and the company claims ability to do twice the torque and power of any existing motor to date.

The design has some major advantages, including lighter weight, better range and less maintenance. Power factor is a disadvantage in this design, and is usually about 10% lower.

Synchronous reluctance

A recent new version is the PM assisted synchronous reluctance (PM aSyRN) motor, with ferrite magnets added to the rotor structure that improves torque, power and power factor.

Another application that motor-drive innovators are targeting is the all-electric aircraft.

More ANSWERS

KEYWORDS: High-performance motors, motor design
Permanent magnet, synchronous reluctance motors
Switched reluctance motors.

CONSIDER THIS

What motor innovations will enable your next application?.

ONLINE

Click on the headline for more resources in the digital edition.
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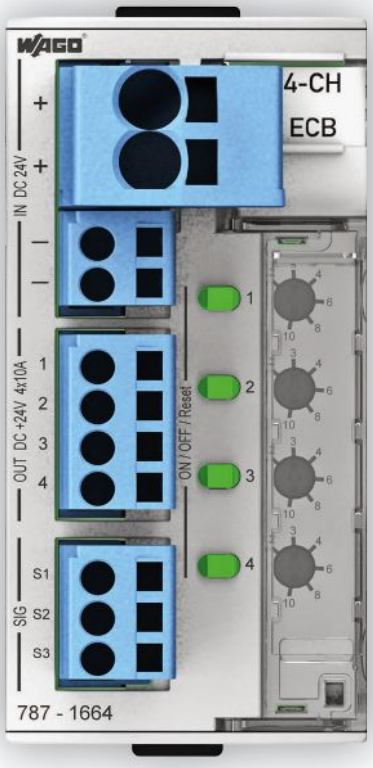
ELECTRONIC OR TRADITIONAL CIRCUIT BREAKERS?

Electronic



Traditional

45 mm

24 mm

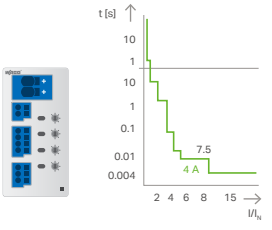
72 mm

Break Tradition

Try Electronic Circuit Breakers

- Up to 66% smaller
- Fast reaction time even at low currents
- Remote reset via digital inputs/outputs
- 1, 4, or 8 channels with selectable currents up to 12 A

Watch the video at www.wago.us/whyECB



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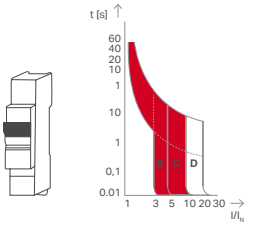
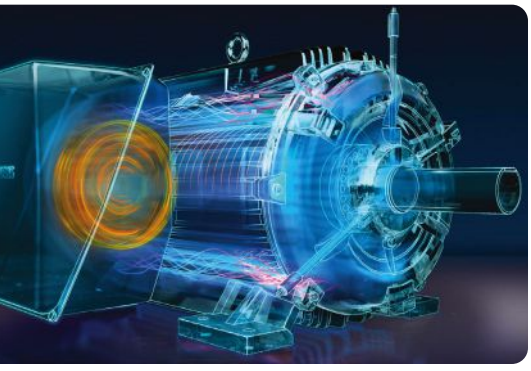


Thermal Magnetic



Simotics MV449 AboveNEMA Motor from Siemens Courtesy: New Products for Engineers Database and Siemens Industry Inc.

Rolls-Royce has noted the need for development of better liquid fuels to keep up with the expected advancements in electric motors. Siemens, identified as the motor supplier for this application, hasn't referenced on a website use of its motor-drive technology for small-aircraft high-speed high-power propeller motor drive.

The Rolls-Royce engine also requires a turbine engine for commercial aircraft. It is possible to build small all-electric aircraft motor-drives, and commercial turbine-electric engines seem likely within a decade.

The synchronous reluctance motor works better at lower loads (50%) than induction motors and PM motors.

Synchronous reluctance motors work over a wider speed range.

High-performance motors can be hybrid designs. The highest performance torque density motor to date appears to be the Mercedes Benz i3 traction motor. The rotor structure is combines surface and buried magnet in a complicate pattern.

Other innovative motor products

A sampling of innovative motor products from the New Products for Engineers Database follows; 15 total in the online version of this article. See more at www.controleng.com/NPE.

• **ATO 400 W Brushless DC Motor with Controller/BLDC Motor Kit from ATO Inc.:** High quality brushless dc (BLDC) motor kit includes a 24-V brushless dc motor with 400 W power, 3,000 rpm high speed, 1.3 Nm holding torque, and high efficiency motor controller for electric car applications. With small size, high reduction ratio, low rotation speed, high torque and little noise, they are widely used for unmanned aerial vehicle, medical equipment, industrial equipment, electrical tools and mini household appliances.

The BLDC motor controller provides:

1. Fault detection and protection. It can identify faults via LED twinkling code.
2. Battery voltage real-time monitoring. It will stop work when battery voltage is too high or too low.
3. Built in current detection and over current protection.
4. 5-V sensor power supply support.
5. 12-V brake signal input configurability.
6. 3-phase Hall position sensor input, open collector output and the controller provides pull-up resistor.

• **Premium-Efficiency, Cast-Iron Three-Phase AC Motors from AutomationDirect:** The motors meet the requirements of the Energy Independence and Security Act of 2007. The MTCP2 Series has a low cost of entry to provide a quicker payback on investment and are available in 1,200, 1,800 and 3,600 rpm. They have totally enclosed fan-cooled (TEFC) enclosure, and designs are NEMA TC-frame (C-face) and T-frame motors (C-face kits available for motors over 30 hp). NSK/NTN/SKF brand premium quality ball (1-75 hp) or roller bearings (100-300 hp), with maintenance free bearings for 10 hp and below. They have V-ring shaft seals on drive end and on opposite drive end, are electrically reversible and have Class F winding insulation. Service factor is 1.25 (1 to 200 hp), 1.15 (250 to 300 hp), 1.0 with ac drive (all). They meet or exceed Premium Efficiency standards and are Class I, Div. 2 for hazardous location use.

• **Simotics MV449 AboveNEMA Motor from Siemens Industry Inc.:** Siemens MV449 AboveNEMA motor has an industry leading 350 hp at a Class B temperature rise and 400 hp at a Class F temperature rise. The motor has more than 14% more power compared to other frames in the market and is also up to 49% smaller compared to the previously offered 500 frame. Less space means better plant layout utilization. Compared to a typical motor of this size, this adds 0.4% efficiency on average. Being able to offer up to 1.5% more efficiency allows users to save more money on energy, reduce the carbon footprint and realize greater return on investment (ROI). **ce**

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David Breen, Breen Machine Automation Services LLC

Things to consider in industrial programming

Project details help determine if programming repair or overhauled is better.

I had a recent project where the work was 95% done before I arrived. It was over budget, kept getting delayed, and the original team of developers no longer wanted to work on it. I was asked to provide an estimate to complete the work.

It was one of the messiest programs ever. The conveyor system was a repetitive series of components. The code was a collection of ladder routines, one for each individual conveyor, of which the logic was mostly copy/pasted with tags renamed. Doesn't sound so bad? Each conveyor routine needed to be customized for its expected function, so each routine was a little different. I had to figure out why the existing implementation failed in 1% of situations. This amounted to 100 conveyors, 100 routines and 50 rungs each of poorly constructed, repetitive and error-prone logic.

Maintainability is a common industrial-programming problem. Unless you're familiar with the code, it can take hours to get a feel for and understand before you're even ready to make changes. The limitations of organization and structure common in industrial programming make larger projects like this messy.

Scalability is a related issue. One of the planned project upgrades was to double or maybe triple the size of the system. In the current implementation, that potentially meant 200 new routines. Copy/paste will get you halfway there, but then you have to edit each tag. The code is not easy to expand.

To summarize: The code doesn't scale well and isn't easily maintainable by the next programmer, and it doesn't entirely work. There are months of labor from several people to get this far, which indicates significantly more effort for a rewrite.

Debugging and improving the current code

More ANSWERS

KEYWORDS: industrial programming, ladder logic, machine programming

Maintainability can be a problem with programming industrial machines.

In some cases, it's better to repair the program in the short-term; sometimes a complete overhaul is needed.

Unless the costs are too much, going with an overhaul is often best.

ONLINE

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CONSIDER THIS

What is the biggest consideration you have when deciding to repair or replace for an industrial project?

maybe a little faster than redoing it. It's not a guarantee given the scope of the changes but it's likely. That still leaves us with a messy result that isn't going to cooperate the planned expansion.

There's a useful quote from John Woods, an old-school PC programmer, that's very appropriate: "Always code as if the guy who ends up maintaining your code will be a violent psychopath who knows where you live."

As it is, we have an obligation to redo this. If the problems needed to go away overnight, the situation may differ, but this will require significant effort either way. Might as well do it right and leave things better for the next programmer, psychopath or not.

In another time, another place, we may find ourselves making different choices, but be aware of the pros and cons of each option and justify your actions.

I kept things that were better off unchanged. The hardware was hooked up well, so the I/O was generally left alone. The safety program was functioning well enough and not so complicated that it was beyond understanding, so no need to tinker. The logic to control auto vs. manual control was fine. Even though I chose to redo the core conveyor control plenty of rungs were worth keeping. Remember the adage, "if it ain't broke, don't fix it."

For this situation, the decision to rewrite was successful: 3,000 rungs of ladder were replaced with about 500. It was cleaner, more maintainable, and did everything it was supposed to. It took almost three weeks to redo everything, but that includes most of the work for the future expansion, as well. By changing a few tags the system is ready to double.

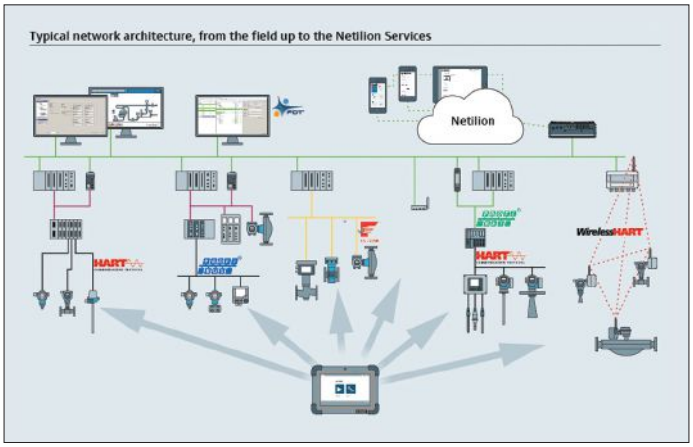
Personally, I feel the flexibility upgrade is worth it almost every time. Your clients shouldn't depend on you specifically when they need help because you've written unreadable code. Unless the effort is too much or the timeline is unacceptable, most projects could stand to be redone at some point. You can only slap on so many patches before it's time to do them over the right way. **ce**

This article originally appeared on Breen Machine Automation Services' blog. Breen Machine Automation Services LLC is a CFE Media content partner. Edited by Chris Vavra, associate editor, Control Engineering, *CFE Media and Technology, cvavra@cfemedia.com.*

IIoT and Sensing on the Edge

Ryan Williams
National Product Manager – Services and Solutions, Endress+Hauser USA

Smart instruments have been available since the mid-1980s when 4-20mA HART devices entered the market, quickly followed by fieldbus-based devices. These digital communication technologies made it possible for instruments to provide more than just a process signal. Using digital interfaces, these devices were now able to send status, diagnostics and other information.



Endress+Hauser estimates that of the 40 million of its process instruments installed worldwide, 90% are digital, smart devices. These smart instruments provide an incredible amount of information at “the Edge” that is of immense benefit to a wide range of host systems and IIoT applications, such as maintenance management, asset management, inventory control, MES, ERP, etc. But one major problem facing industrial plants is: How do we manage all this data?

Because of the immense amount of data, and the problems involved in managing it, Endress+Hauser estimates that 97% of the data is not being used. Instead, automation systems use the flow, pressure, temperature, level and other data needed to control the process, and ignore or discard the status, diagnostic and other data.

Major instrument manufacturers are aware of the problem, and several are now providing solutions to acquire data from the Edge and provide it to specialized IIoT software—all without affecting or involving the automation system. This article explains how these concepts work.

Download the white paper at:
https://eh.digital/39ONOe7

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Modernized municipal water management system delivers more reliability and operational visibility, plus big energy cost savings

In the dry desert climate of southeast New Mexico, water is a precious resource. But that's hardly news to the team members who make up the Water Production and Water Reclamation Divisions of Hobbs, New Mexico, a city of 34,000 people not far from the Texas border. Their mission is to ensure residents and businesses have plenty of safe, clean water every day.

According to Peter Zacharius, SCADA Manager for the City, the water production and delivery system's original SCADA system, along with all of its automation components, was initially installed more than 20 years ago. "We were lacking visibility into our pumping, leak detection, well and reservoir levels, and various operating parameters," he explains. "If a pump motor failed, it could be hours before we would know.

The City realized modernizing their water production and delivery management system would be a complex project needing expert outside assistance. Michael Prosser, TESCO's director of special projects, initiated the City of Hobbs engagement by implementing a collaborative design-build process that included the City's water operations team, Alpha Southwest, Inc., for installation, and the Siemens automation group.

The TESCO-Siemens water production and delivery solution provides the City with energy efficiency it lacked previously – providing substantial cost savings from lower utility bills that will more than pay for the system's modernization.

Collaboration from all sides proved to be the success behind this effort. "The Hobbs project was the perfect example of working with an incredible Siemens Solution Partner, Tesco Controls, and how together we approached the City of Hobbs, discussing their needs and vision. The result was an incredibly robust, secure and a system that will be in place for 30 years," says Jeff Ballard, Siemens Automation Specialist.

Download the paper at:
usa.siemens.com/hobbs

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Industrial ac microdrive for a variety of motors

Yaskawa's GA500 AC Microdrive can accept today's challenges of sustainability, flexibility and ease of use. It is designed to meet RoHS2, providing a sustainable and an environmentally friendly drive. It has a TUV safety rating. The drive is rated up to 40 hp and can be applied to 240 V ac single-phase, 240 V ac three-phase, or 480 V ac three-phase incoming power. If using a dc power source, the drive is UL-rated to accept dc as its primary power source. It can operate a variety of motors such as induction, permanent magnet and synchronous reluctance.

Yaskawa America Inc. **www.yaskawa.com** Input #200 at www.controleng.com/information

Energy-monitoring for remote access

Phoenix Contact's EMpro is designed to give plant operators and facility managers now have real-time, remote access to their machines' energy consumption data. This second generation of energy monitoring devices offers simple configuration and operation, so no special skills are needed to install or commission the device. It tracks energy parameters such as voltage, current, and power at the machine or system level. It then communicates that data locally, or transmits it to cloud-based services, creating an IIoT energy-monitoring solution.

Phoenix Contact **www.phoenixcontact.com**
Input #201 at www.controleng.com/information

Hybrid flexible coupling unit

Twin Spring Coupling's TSC150 is a hybrid flexible coupling unit that can be used to replaced other flexible industrial couplings including universal, jaw and beam. It can handle high speed/low misalignment, while being more flexible than the current industrial couplings due to its dual spring construction. Typically, industrial couplings can only work at +/-2° out of alignment before they start to wear out, It can also run at lower speeds and higher misalignment like the industry standard universal joint, which requires constant maintenance (greasing and worn bearing replacement). The Twin Spring Coupling is torque rated to 150 ft lbs of torque and can run at speeds of up to 3500 RPM at low degrees of misalignment.

Twin Spring Coupling **www.twinspringcoupling.com**
Input #202 at www.controleng.com/information

Software for monitoring and control operations

GE Digital's Cimplicity 11 and Tracker 11 are together designed to monitor and control operations. With Cimplicty 11, users can employ object-oriented design for easy repeatability and faster time-to-value through modeled context, as well as classes and objects for building a structured database quickly, features important in every industrial setting. Tracker 11 tracks the real-time location of jobs on the production floor and performs routing logic on the movement of jobs throughout the facility. This allows manufacturers to manage the manufacturing, routing and delivery of multiple product components into complex product assemblies. In addition, Tracker 11 minimizes warranty and recall exposure by tracking supplier parts and providing a genealogy for the finished product.

GE Digital, www.ge.com/digital Input #203 at www.controleng.com/information

Server for network management protocol

Integration Objects' OPC Server for SNMP offers a full monitoring of simple network management protocol- (SNMP) enabled devices from OPC client applications such as historians, human-machine interfaces (HMIs), supervisory control and data acquisition (SCADA) or distributed control systems (DCSs). These devices can include workstations, servers, switches, uninterruptible power supply (UPS) systems, routers and more. The server allows end users to proactively monitor control and enterprise networks in order to prevent problems from happening. It also raises notifications based on detected issues and the status of critical network and automation assets.

Integration Objects, www.integrationobjects.com

Input #204 at www.controleng.com/information

Three-finger robot gripper

OnRobot's large-stroke 3FG15 three-finger gripper is designed to make automated precision handling of cylindrical parts easy to program and deploy. The 3FG15 gripper has a maximum stroke of 150 mm that can easily handle multiple processes. The innovative three-finger design with a 15 k payload provides a strong, stable grip for both form fit (internal) or friction fit (external) gripping, adding flexibility to any implementation. The gripper's design is specifically developed for machine-tending tasks, automatically centers workpieces, resulting in a strong, stable grip and precise placement in machine chucks. The gripper also is ideal for packaging and palletizing applications.

OnRobot **www.onrobot.com**

Input #205 at www.controleng.com/information

Flow sensor with Bluetooth

AW-Lake Co.'s Edge Flow Sensor with optional Bluetooth is designed for use in flowmeter applications requiring an analog, pulse or Modbus signal to a programmable logic controller (PLC) or other control system. The sensor outputs a frequency, current or analog signal that gives users more installation flexibility, especially when unsure of readout equipment or a control room interface. With the ability to force the sensor to output a frequency or analog signal, connections to a user interface are verifiable without the need to run fluid flow. The sensor offers three optional pulse output configurations including push/pull, sinking, and sourcing. A Bluetooth mobile application gives users the ability to monitor and program flow meters from the convenience of a smartphone without having to be directly in front of the unit.

AW-Lake **www.aw-lake.com** Input #206 at www.controleng.com/information

Electromagnetic flowmeters measure without tube restriction

Endress+Hauser's Promag W electromagnetic flowmeter series is designed to provide measuring without tube restriction. The Promag W 300/400/500 flowmeters with the "0 x DN full bore" option measure with high accuracy (±0.5%), even directly downstream of pipe bends, T fittings, or insertion devices. They are particularly suitable for installation in tight spaces, such as compact systems or skids, because they do not need any inlet or outlet runs. They can handle swirls that frequently occur downstream of obstacles such as pipe bends and insertion devices, and even those downstream of unknown obstacles, such as build-up on the pipe wall, protruding seals or different inside diameters.

Endress+Hauser, **www.us.endress.com**

Input #207 at www.controleng.com/information

Multi-function sensor beacon embeds other functions

Fujitsu's FWM8BLZ07A is a multi-function sensor beacon that includes embedded temperature, humidity, air pressure, illuminance, 3-axis acceleration, and sound-level sensors. Multiple sensors in different combinations can be used in any Bluetooth environment through the Bluetooth standard beacon protocol to the latest Bluetooth 5 protocol. The beacons use a single CR2450 coin-cell battery and include a voltage notification function that senses a voltage drop in the battery and allows users to determine the right timing for replacement. They also support remote settings using commands from a central unit.

Fujitsu Components America Inc.
www.fujitsu.com
Input #208 at www.controleng.com/information

Ethernet-based I/O unit for the IIoT

The GRV-R7-MM1001-10 is an intelligent, Ethernet-based input/output unit designed to combine multi-signal, multi-function sensing with PoE-powered edge data processing for Industrial Internet of Things (IIoT) connection to real-world signals. These signals include thermocouples (TCs), integrated circuit temperature devices (ICTDs), voltage inputs, current inputs, millivolt inputs, discrete DC inputs, self-wetting discrete inputs, discrete dc sinking outputs, and form C mechanical relays. In addition, two channels provide special features like pulse counting, on- and off-time totalization, software latching, frequency measurement, and more. It is standalone and software-configurable through a browser-based interface. It also supports 12 types of field I/O circuits, making it capable of over 52,000 I/O combinations, which dramatically simplifies module selection and spares management.

Opto 22
www.opto22.com
Input #209 at www.controleng.com/information

Gregory Hale, ISSSource

COVID-19

Remote security working in world of coronavirus

With a large influx of people working remotely due to COVID-19, cybersecurity is becoming a topic of concern for employers and their employees.

Coronavirus is changing where we work and live to the point of not one person in this country, if not the world, hasn't felt some kind of effect.

In the manufacturing automation sector, with more people moving out of the office, plant or factory, there is a rapid increase in those working remotely from home, raising remote-security concerns. Working remotely is not new.

"Having companies looking to go to more remote operations, more remote maintenance is not a new trend," said John Cusimano, vice president of cybersecurity at aeSolutions. "In recent years, it may have slowed down a bit, but overall the movement toward cost savings and efficiency benefits have been there." Some are addressing security better than others, he said. The issue is not necessarily about remote operations, but the volume of people working off site.

"Coronavirus is forcing everyone to upgrade and create remote operation as soon as possible," Cusimano said. "Companies may look at this and say, we were able to do this; we were able to operate. Companies may be encouraged by the fact we can do this, and they may be looking at how we can do this on a more permanent basis. Responsible companies will want to make sure they are doing this securely. It can be done."

No panic here

"I am not seeing any panic on the business side, there is more panic and fear overall in the general population," Cusimano said. "I will say with our business clients it is not business as usual, there are more people working from home. The tangible impacts we have seen is certain projects are being delayed, but not for a long time. We are doing more projects remotely, which is interesting. We started a large assessment project at a large industrial facility in China. We started January 3. Our typical assessment project includes onsite work. We sent a team there, and they were able to get out before all the major issues started. They were fine. We were halfway through the project.... The project needs to go on, so we reached an arrangement to work remotely. We have all the data, and we can do analysis, and then a workshop, which is usually done face to face. But we are going to do it all remotely."

With a larger influx of people working from home, does the idea of remote monitoring and all things remote seem poised to take off?

"It seems reasonable that it will," Cusimano said. "The technology has been available for a while and it is definitely more cost effective to do things remotely. The only thing that may have slowed this is making sure it is secure. Also, the mindset of this is how we have always done it also comes in. The main impact from coronavirus is it is just going to accelerate the demand if it can be done remotely, then let's do it."

Switching work location from the office to home can create cybersecurity problems for employers and employees. Those working at home should:

- Be suspicious of any emails asking people to check or renew their passwords and login credentials
- Be suspicious of emails from people you don't know
- Ensure Wi-Fi connection is secure
- Ensure anti-virus is in place and fully updated
- Lock your screen if working in a shared space
- Check if encryption tools are installed.

"The lesson we have to learn from this is if we are going to be called upon to periodically work remote in some kind of disaster where you have remote operations they better be robust they better be resilient, and they better be secure," Cusimano said.

"If you send everybody home and expecting them to work remotely, if that technology doesn't work you are in a real mess. Everything I have heard is remote technology is working." **ce**

Gregory Hale *is editor and founder of ISSSource, a CFE Media content partner. This content first appeared on ISSSource.com. Edited by Chris Vavra, associate editor,* Control Engineering, *CFE Media and Technology, cvavra@cfemedia.com.*

More INNOVATIONS

KEYWORDS: coronavirus, cybersecurity, remote operations

Coronavirus is forcing more companies to have their employees work remotely.

This change in how operations are handled may have a long-term effect on employment.

Companies and their workers, if they handle business remotely, need to have a robust cybersecurity plan.

ONLINE

See more stories about coronavirus' effects on manufacturing under the "Coronavirus, COVID-19" channel on www.controleng.com.

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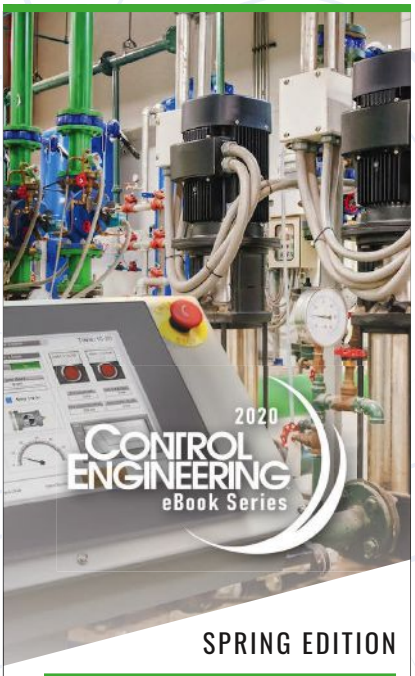

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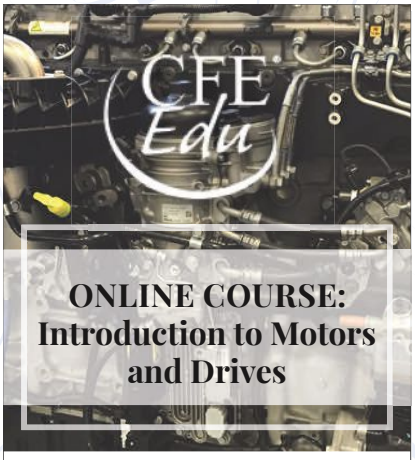

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