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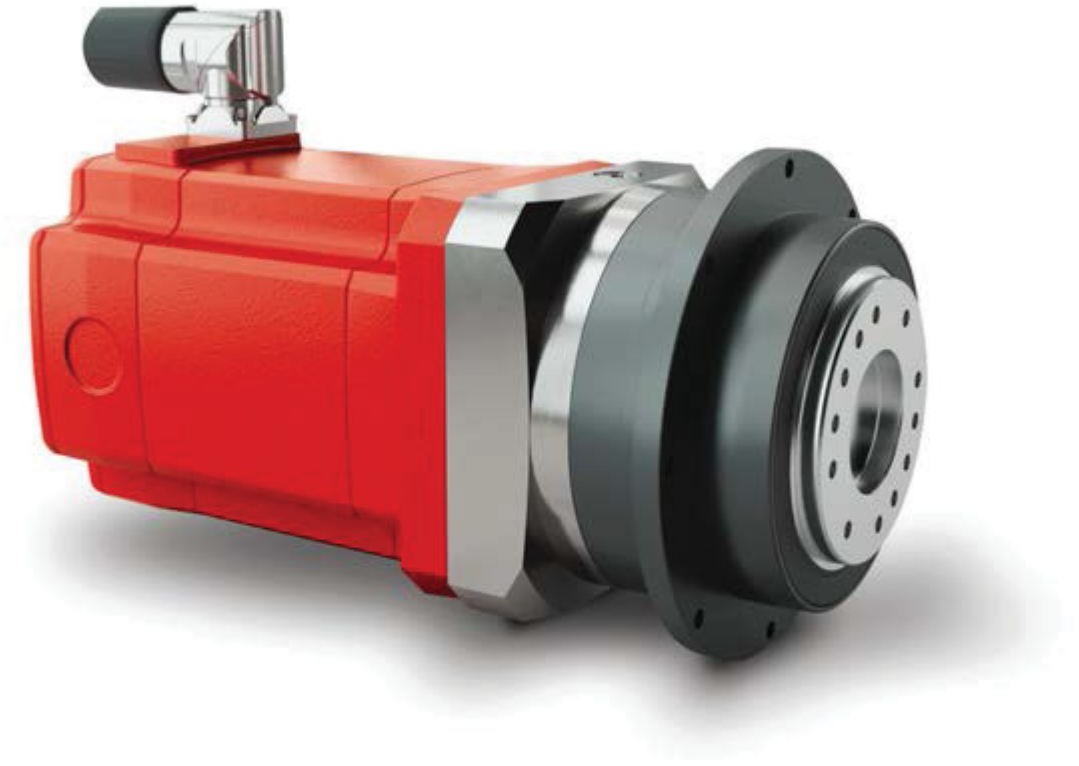

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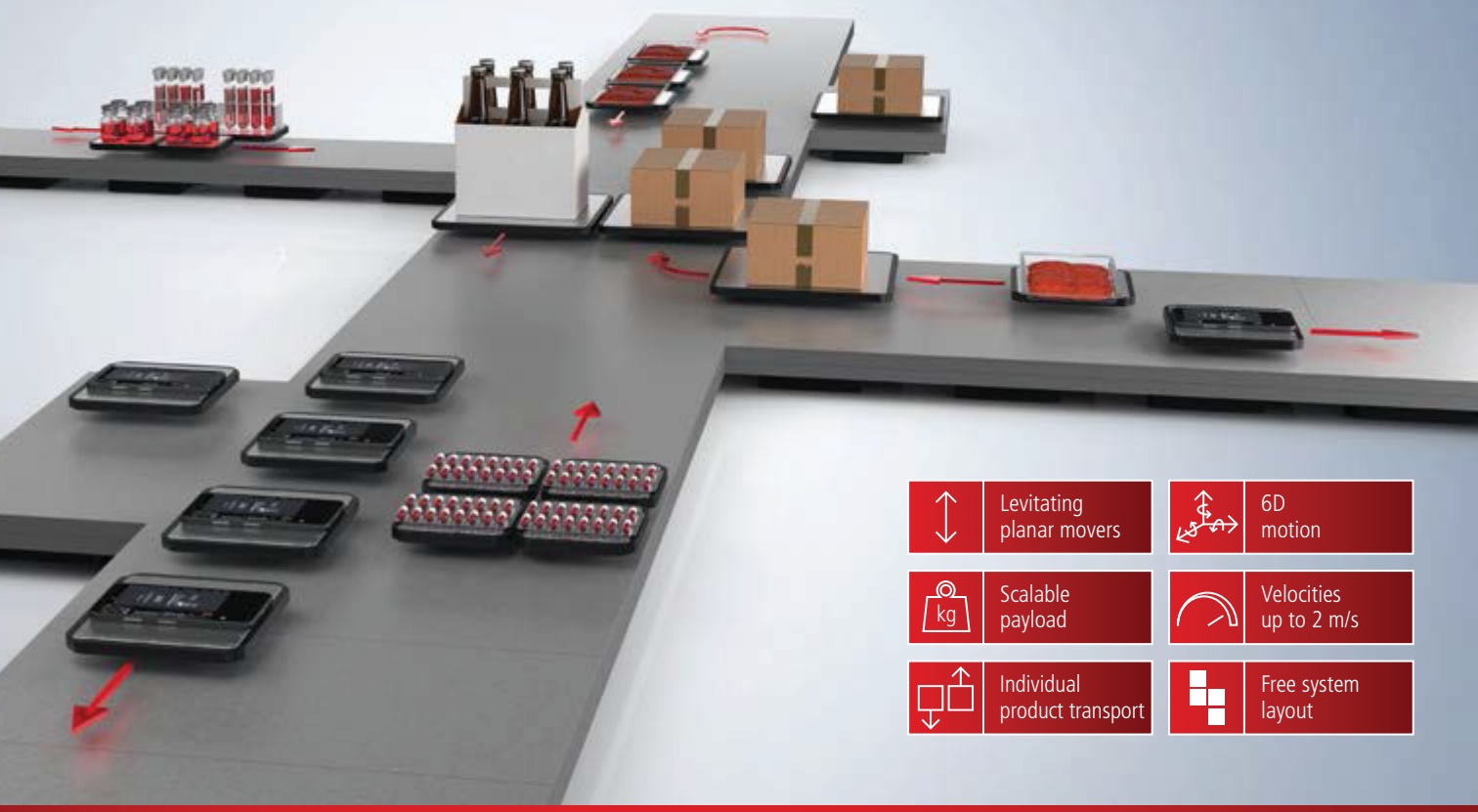

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Maintenance-is-a-service

WHY DOES MAINTENANCE matter? According to a 2023 report from McKinsey, aftermarket services provide three benefits to original equipment manufacturers (OEMs):

- Maintenance and spare parts extend the life and performance of machinery.
- Post-sales interactions nurture relationships with end users.
- Aftermarket services and parts generate cash flows for OEMs.

The margins on after-sales service and support are more than double those on capital-equipment sales, according to McKinsey. And aggressive models that are built into the sales contract can lead to margins that are as much as 10 times higher. One of the more popular business-model buzzwords is the as-a-service, subscription-based revenue stream. After-sales service has been around for decades, but even as recently as the turn of the 21st century that model was transactional and reactive, according to McKinsey.

The ability to monitor equipment health remotely has changed what's possible. I've even heard the term "maintenance-as-a-service" thrown around. Maintenance already is a service. It has been for decades. But guaranteeing and optimizing the throughput that comes from predictive maintenance and equipment reliability is a blue-ocean strategy that continues to gain momentum.

The ability to monitor equipment health remotely has changed what's possible.

A few OEMs are testing the waters of partnering with plants and factories by offering production-based subscriptions that put machinery on the floor without an upfront capital investment. The factory/plant pays for the output of the equipment, and the OEM can monitor machine health, service it based on predictive analytics and optimize production and energy usage by connecting with the sensors it's integrated into the equipment.

Who knows and understands the machinery better than the manufacturer that built it?

Maintaining that equipment is a service that many factories and plants handle in-house by a maintenance-and-reliability department that monitors machines manually or through some form of automation and then schedules work with computerized-maintenance-management-system (CMMS) or enterprise-asset-management (EAM) software.

But the OEM's knowledge of the equipment can allow for a more intimate relationship with the factory or plant. However, whether to offer aftermarket services and spare-parts support as an add-on expense or to sell production as a subscription-based service will depend on the OEM's desired cash flow.

Maintenance of industrial-manufacturing machinery is inevitable. Optimizing production and energy efficiency are optional but highly valuable. CD

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Where to mount the UPS in the cabinet

WHAT'S IN A control panel? The size of the panel may give us some indication as to the complexity of the application.

A 20-by-24-inch panel probably won't have much in it, but what it should have is often forgotten. A 120-by-80 would have considerably more devices in it, which would require more of the things that are often forgotten. What might those things be?

Back in the good old days, we had power filters, capacitive filters, metal oxide varistors (MOVs), coil suppression and free-wheeling diodes on dc coils. We had no indication that anything actually worked until you opened the panel because a coil has gone, and you notice that the red MOV is now brown. Passive devices are still very relevant and shouldn't be forgotten.

An inductive load when power is removed kicks back. Larger inductive devices need to be especially not forgotten.

In this day and age, the main control power normally would go through an uninterruptible power supply (UPS). There is an active discussion about what a UPS should connect, but that's another story. Uninterruptible-power-supply sizes range from 200 VA up to 1,500 kW. Application of each boundary is totally different. In most cases we are talking about 200 VA to 3,000 VA located in the control panel itself.

The input to the UPS is typically 120 Vac, and the output is 120 Vac, which means that the control power is filtered and supplied by the UPS, and, when main power is removed, the UPS provides an approximate sine wave, or true sine wave, to the controls in the cabinet.

In most cases, when the UPS kicks in, power has been lost, which typically also means the main power—480/600—is also gone. The situation that exists now is that the contactor that feeds the main conveyor belt is still energized, but the motor isn't turning, which needs to be taken into account in the shutdown sequence(s) of the application.

Uninterruptible power supplies can create their own issues. Should the UPS fail, the output sometimes can be turned off permanently, and, no matter what you do, you can't get it back. Also, should the UPS turn off due to battery exhaustion, it may enter a mode where the UPS may need to be cycled for the UPS to turn the output side back on, requiring manual intervention.

Many sites use commercial-grade UPS devices. Are they inexpensive? Yes, and for the most part reliable, but it would still be suggested to have some up-front filtering.

There was a customer who had the UPS sitting in the bottom of the panel in a toxic-waste-clarifying facility. The panel had conduits coming into the top of the panel from outside. The conduit had a loose joint where water was allowed to enter. Yep, the bottom of the panel was swimming in 3 inches of water, just below the first outlet on the back of the UPS. I think it is clear that the bottom of panel would not be the best place in most instances.

> One of the biggest potential benefits of any UPS is the ability to be monitored remotely.

Heat dissipation and ambient temperature are important considerations, which suggest that mounting at the top of the panel may not be the best option either. So where does that leave us?

Since manual intervention may be required, it needs to be accessible to maintenance, which is normally in the front panel. The health of the UPS may need to be visible from the front panel.

The form factor of the device may make the mounting decision a moot point. A rack-mounted UPS would dictate location—the rack. A shelf may also be needed to support a non-rack UPS.

One of the biggest potential benefits of any UPS is the ability to be monitored remotely using Ethernet and/or digital interfaces. This would allow the UPS to indicate what it's doing internally and what function it is performing in real time.

In effect, we need to position the UPS to protect itself—accessible to the front panel and to the rear for plugs and safe from environmental issues. These are the main considerations. In checking a 1,000 VA UPS that is 2U—3.5 inches high—and 18.8 inches in depth, this particular unit has six plugs in the back plus a power cord that requires some clearance.

A standard panel depth is typically not more than 20 inches. A normal 1,500-VA shelf-mount UPS is 15 inches deep so it would typically need to be mounted sideways, which compromises access to the front display panel. Typically, UPS size and mechanical constraints will determine the mounting method. CD

JEREMY POLLARD, CET, has been writing about technology and software issues for many years. Pollard has been involved in control system programming and training for more than 25 years.

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What literally drives machinery

DOWN IN THE FRAMEWORK, beyond the powerful programmable controllers and flashy operator stations, in the belly of the beast, lives the true heartbeat of a machine. Servos with their precise actions and pneumatic devices breathing life into the smaller movements can't hold a candle to the variable-frequency drive (VFD). For those of us who remember the early years, deploying a frequency drive was no small endeavor. Why, even the very footprint, by today's standards, was downright huge.

For example, a conversion project from a few years ago took a 10-hp, 240-V drive from the 1990s up to current standards. The original drive was so large—11 inches wide by 19 inches tall—that it was mounted on the outside of the enclosure.

The new drive—5 inches wide by 10 inches tall—is literally one half of the size. In the old terminology, that 10-hp drive was frame size B because anything under this would be a frame size A. In today's terminology, that same 10-hp drive is a frame size D.

Even with one-half the physical size, there are three more frame sizes even smaller than the 10-hp drive. What is described here supports the well-known concept that bigger things come in ever smaller packages, but size is only part of the story.

An electric drive aims to control the speed and torque in a motor to achieve the desired application result. In induction motors, the voltage induced in the stator is directly proportional to the product of frequency and flux. The four primary motor-control methods are voltage/frequency (v/f), v/f with encoder, open loop and closed loop.

Voltage/frequency could be called a loose control of motor. It alters the voltage and frequency to keep the magnetic flux in the motor constant. To tighten up the speed control, an encoder can be added to provide feedback of the resultant motor behavior.

Open loop, sometimes called sensorless vector, further enhances the control by using a variety of techniques. Early drives would control a motor using a converter, feedback loops and sensors. To reduce the cost, sensors were eliminated, and newer methods were used to control the torque and speed of the motor.

There are multiple methods to provide constant flux to a motor. In one method called flux vector control, the magnitude and orientation, or vector, of the ac excitation is controlled. If the current vector is adjusted relative to the rotor flux vector, the flux vector magnitude and torque can be controlled independently. In sensorless vector control, voltage, frequency and vector are controlled independently to vary motor speed and torque as desired for the application.

Finally, closed loop takes the open-loop techniques and adds an encoder to finalize that control. With ever tighter control algorithms, a VFD combined with an encoder can be almost as accurate as a servo drive and motor, without the additional cost.

> The greatest enhancement to VFDs, perhaps, was the introduction of the fieldbus.

Variable-frequency drives still employ these techniques. Enhanced technology, in a smaller format, makes it easy to deploy drives in applications where a starter might have been used in the past due to cost and space considerations.

The greatest enhancement to VFDs, perhaps, was the introduction of the fieldbus. The ability to control a drive without myriad wires connecting the controller to each drive has promoted the easy deployment of drives in a control system.

With the relatively small size of the variable-frequency drive, it is not unreasonable to make this the primary method of motor control in your design. Just being wireless, except for the power and network connections, isn't the real enhancement.

Wired solutions and early fieldbus still relied on digital type control. Start, stop, accelerate and decelerate were the basic commands. Started/running, stopped and faulted were among the status bits. Wired systems sent an analog signal for the speed or used preset speeds, selected by binary-coded digital bits.

With the implementation of a fieldbus, these same control and status bits were available, but as words in an exchange of data fields. Two words each for status and command at first but more possibilities as the technology got better. Second accel/decel values, more status like accelerating, decelerating, bus voltage and drive temperature were all available. If there is sufficient bandwidth and room in the data table of the controller, the possibilities are nearly endless.

Drives take the original data table exchange method and format that data into easy-to-use structured tags. To the user, instead of bits, bytes and words, the information is interpreted

into informative tags with names such as CommandDir, OutputCurrent, FreqCommand, Start, Stop and Reverse.

While the ability to quickly add a drive to a programmable controller and assign a network address is wonderful, the additional memory and capabilities of the drive itself provide an even greater advantage to the designer. Here is where things get interesting.

Most drives come with pre-configured profiles. These profiles allow the user to choose a function that closely matches a desired function. For example, a user can select one of conveyor, mixer, compressor, centrifugal pump, blower/fan, extruder or positioning, and the drive parameters will pre-set to best execute that function when commanded by the processor.

These profiles aren't meant to be the end configuration but, rather, a recommendation of settings that will elicit an expected set of results. From that first setting, the drive can then be fine-tuned to best suit the desired application.

As an example, a conveyor needs quick acceleration followed by a ramp to the speed set point. A mixer, on the other hand, requires a slow ramp with a lot of torque to overcome the weight of the product and ribbon followed by speed and torque control to react to product that is flowing around the vessel as the ribbon turns. The speed and torque are always in variance and require more fine tuning to maintain the performance requirements.

With early drives, the user had to use a somewhat cumbersome human interface module (HIM) to access and change parameters in a drive. This module could be directly connected to the drive or come as a plug-in device.

The buttons on the module were used to cycle through a rather large set of parameters to set functions. Early drives only had numbered parameters, and the user would have to use a list of parameters to figure out what number to access and change.

As drives evolved, the HIM acted more as an interpreter of the parameters and enhanced the user experience by adding text to the parameter number to identify what the parameter was and, in some cases, prompt for potential settings to apply to the parameter.

With the advent of the fieldbus connection to a VFD, application software was developed to give the designer a window into the function of the drive. This software provided an electronic means of setting and monitoring parameters in a drive. Residing on a laptop, the software was opened and then a connection to the drive was initiated using an interface cable between the laptop and the drive. If the drive is networked, there are usually two separate connections, one for the programming port and one for the network port.

Most manufacturers have now taken another step toward easy integration by including the drive-configuration software in the processor-application software. The great part about this advance is the designer only needs one software to connect to the drive for both configuration and operation. The initial interaction usually involved manually setting up the network address, using the HIM and then all other functions and parameter settings can be accomplished via the drive configuration portal in the programming software.

Another feature added more recently is a daughter add-on module that allows the user to use switches on the module to configure the network address physically. Once the drive is connected to the network, via this hardware module, the drive can be accessed via the controller or programming software without having to take that initial step of using the HIM to establish the network address.

One final feature of particular interest is a function called automatic device configuration (ADC). This can be used in a couple of different ways. Some designers use it to save the drive parameters in the application for the programmable controller. After doing so, a non-functional drive can be removed from the network, and, when the replaced drive is connected to the network, after the network address is set, the controller will identify that a new device is plugged into the same node address as the old device and automatically download the saved parameters to the new drive on first appearance.

The second way to use the ADC function is to do all of the drive parameter setup during the development of the initial software application, offline, and then use the download function available once the new program is downloaded to the processor to send the parameters to each drive in the application using that same ADC download feature. This also comes in handy if the designer is making multiple machines.

Once the initial application is installed and tested, the remaining machines can be quickly configured for operation by downloading the processor application and using the software portal to the drives to manually trigger a download to each drive with the parameters stored in the process application.

It is very apparent that hardware manufacturers have taken great lengths to make it easier to use their products in our applications. Variable-frequency drives continue to drive automation. CD

RICK RICE is a controls engineer at Crest Foods (www.crestfoods.com), a dry-foods manufacturing and packaging company in Ashton, Illinois.

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Joey Stubbs

How to implement condition monitoring

IN 1989, I WAS LUCKY enough to be part of a small pilot program of vibrational analysis and condition monitoring of rotational equipment in the power plants of Navy ships. I was a nuclear electrical operator on the USS Nimitz and was "volunteered" to spend several weeks of training on operating the data-acquisition equipment and interpreting the results of the processed data to implement a predictive-maintenance program.

The benefits of this new system were easy to identify and amazing at the time—instead of experiencing catastrophic bearing, motor, pump or gear failures that had to be reactively fixed while underway, we could monitor the tell-tale signs of upcoming issues and deal with them during routine maintenance periods, or at least address the issues prior to complete failure and prevent any secondary conditions that arise, such as a motor-bearing failure that leads to a fire. After all, a fire on a Navy ship is a very big deal.

> Condition-monitoring technology is not limited to rotational equipment, although that is still a major focus.

Data acquisition was done by manually connecting a piezo assembly of the data-acquisition (DAQ) box to surface-mount pads on motors, pumps and gear boxes around the power plant, scanning the appropriate barcode representing the make and model of the part and waiting for 15 minutes or so for the data collection to finish and then moving on to the next sampling pad and repeating the process.

Then, the DAQ box was taken to our brand-new IBM XT computer, where vibrational analysis software processed the data and compared the results to an enormous database of each target's bearing models, number of motor windings and pump impellers to give a rough diagnosis based on any peaks of concern for that particular component.

It was quite a cumbersome process, to say the least, but a game changer. It was straightforward to detect issues with bearings, motor windings, motor fan blades, centrifugal pump impellers, gear damage or wear, brush-to-commutator issues or general imbalances of rotating equipment.

A machine builder wishing to enable condition monitoring into current OEM equipment has the benefit of several generations of improvements in all aspects of the technology. Instead of manual sampling and off-line processing, the entire condition monitoring feature set can take place automatically and continually, with automated notifications to operators or engineering. Just as they were made in the past, decisions about when corrective maintenance is required can be made by engineering, depending on the actual values detected, or on measured trends that indicate upcoming problems if not corrected.

Additionally, condition-monitoring technology is not limited to rotational equipment, although that is still a major focus and gives a very large benefit for the implementation effort. The benefit of more than 30 years of advancements in control hardware allows access to parameters such as motor and drive temperatures, currents and voltages, automation controller motherboard temperatures and voltages.

Even the central-processing-unit (CPU) fan speed can be monitored to determine if it is dirty. Strain gauges and accelerometers can determine if overall equipment is experiencing excessive jerk or frame vibration, which can be an indication of wear of slides or excessive stack tolerances of the mechanical assemblies.

To implement condition-monitoring (CM) features on new equipment, the OEM will need to plan the implementation as part of the overall control system, taking into account the architecture limitations on existing designs or change existing machine-control design to better facilitate the additional inputs and processing needs of the analytics. Consider whether or not the existing control-system controller is scalable or if a dedicated condition-monitoring edge-computing device is needed.

Giving the customer condition-monitoring features as part of the standard control system or even the option of a "condition-monitoring package" to the control system can be a big value-add for choosing one OEM over another. The end customer benefits, including reduced downtime, increased reliability and increased quality of ware, will likely be reflected to the machine builder as a happier customer and increased sales. CD

Joey Stubbs is a former Navy nuclear technician, holds a BSEE from the University of South Carolina, was a development engineer in the fiber optics industry and is the former head of the EtherCAT Technology group in North America.

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4 safety devices and how to use them

MACHINE SAFETY IS crucial to avoiding injuries and accidents at work, in addition to protecting machinery from being damaged. Interlock switches, light curtains, safety mats and emergency-stop buttons, when used correctly, could save people's lives and avoid downtime.

Safety interlock switches help make sure a machine is safe to use by limiting access to potentially hazardous areas unless particular conditions are met. They include hinge interlock switches and tongue interlock switches, which use hinged arms to bar entry into hazardous areas and require a key to unlock them. Magnetic switches, radio-frequency identification (RFID) switches and cable-operated switches are additional types.

Main applications for safety interlock switches include manufacturing, food processing and packaging. To protect employees from dangerous areas while the machines are running, they have been commonly used on machinery such as presses, conveyors and robotic cells.

Safety light curtains are tools that stop machines from functioning if they detect the presence of an object or person in a given area. They are aimed to protect workers from dangerous circumstances and stop machines from functioning when someone is in danger.

When a space needs to be protected, safety light curtains emit a variety of infrared beams across the area. The light curtain sends a signal to the machine's control system to stop the operation and avoid possible damage or injury if the beams are broken by either an individual or object entering the area.

Safety light curtains come in a variety of models, including hand protection curtains that protect the fingers and hands from possibly dangerous areas and perimeter protection curtains that protect larger spaces such as robot work cells or assembly lines. Muting light curtains and fixed or floating blanking light curtains are additional types.

Uses for safety light curtains include packaging lines, assembly lines and robotic work cells. Common applications include stopping unauthorized entry into restricted areas, protecting people from unsafe areas such as machinery or robots and guaranteeing the safety of both people and machinery during manufacturing processes.

Safety mats operate by sensing the weight or pressure of an individual or an object on the surface of the mat. The mat senses pressure and signals the machine's control system to stop running in order to prevent damage or injury. Usually, the mats are placed in front of equipment or other dangerous areas. To protect pedestrians, safety mats may additionally be placed in areas where forklifts or other vehicles are used.

Area mats cover a larger area and detect the presence of individuals or objects there, and pressure-sensitive mats detect the weight of an individual or object and activate a safety response. Ramp mats make it simple for wheelchair users or carts to access areas, and edge mats protect machinery's edges.

> The mat senses pressure and signals the machine's control system to stop running.

Emergency-stop (e-stop) buttons are devices used to safely and quickly shut down machinery in the event of an emergency. They provide a fast and dependable way to shut down machines and are designed to avoid accidents and protect workers from injury.

Emergency-stop buttons are available in many different styles, such as push-button e-stops, which are pressed to energize, and rope-pull e-stops that are energized when pulling a cord or cable. Other styles include wireless e-stops, which are remotely activated, key-operated e-stops and twist-to-release e-stops.

Emergency-stop buttons are used on equipment such as presses, conveyors and robotic cells to provide a quick and reliable way to stop machines from running in an emergency, preventing potential damage or injury.

Trying to identify possible risks and implementing the required safety measures are essential to ensuring machine safety in a wide range of industries. To make absolutely sure safety devices are working correctly, routine safety inspections and maintenance are also needed. All employees should receive appropriate training and discussion regarding safety practices. In order to protect their workers, employers should make a point of focusing on safety and offer a safe workplace. CD

Shawn Cox is a licensed master electrician/PLC programmer. He was co-owner/operator of Bobby Cox Electric for 15 years and is currently employed by BMW Manufacturing as an ESA.

DevOps strategies through the lens of automation software development

BRITTANY LANGSTON
Product Manager, B&R Automation

AUTOMATION Studio is the bread and butter of software development at B&R. All B&R hardware is programmed with this integrated development environment. The mechanisms for compiling, creating installation packages, and deploying the software are usable outside of Automation Studio itself (i.e., via the command line). Also, the source files within the Automation Studio project are stored in plain text. This makes for easy integration with DevOps practices.

Q: Can you define DevOps for industrial automation?

A: Generally speaking, DevOps is a set of practices that enables continuous, reliable and swift software delivery to customers. It involves things such as increasing the visibility of tasks and metrics, dividing and planning work into measurable chunks, optimizing team and project architecture, automated testing, automated reporting and so on.

Within industrial automation, our first thought is often related to the hardware side of things, such as the programmable logic controllers (PLCs), drives, motors, input/output (I/O), transport systems and so on. But the application software that supports and ultimately controls this hardware is of equal importance. The software that controls the machine is becoming more of an area where our customers differentiate themselves from competitors. Therefore, modern DevOps practices that are typically observed in pure software companies can and should be extended to the industrial automation space as well.

Q: What is the value proposition of DevOps?

A: DevOps is valuable in many ways. The overarching goal and benefit is to continually, reliably and quickly deliver product to the end customer. More specifically, it enables you to increase the frequency of deployments, increase code quality, reduce the response time for bugfixes, increase productivity and more.

Q: That all sounds very favorable. Why isn't everyone within industrial automation already implementing DevOps wherever possible?

A: DevOps is not simply a software tool or an application that you install. It's more of a mindset and a cultural shift in the way we implement our day-to-day work. There are of course tools that support the strategies, but the implementation itself can vary quite widely. As a result, it takes some time and energy for project managers and software developers to identify how exactly to change their processes in order to incorporate DevOps.

Q: What is B&R doing to increase the adoption of such practices?

A: At B&R, we recognize that the initial effort to change your workflows is a barrier to entry for DevOps. Therefore, we have created what we refer to as the DevOps package. This package includes materials for many topics within DevOps. We provide descriptions of each topic, an explanation of why it's important, directives on how to accomplish the topic within a specific tool and template files wherever applicable. In other words, we have combed through the vast amount of general resources for DevOps strategies and defined them specifically through the lens of software development at B&R. Therefore, we significantly reduce the barrier to entry of incorporating these practices in your daily work by succinctly and clearly defining how to apply the strategies with Automation Studio project development.

B&R

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CONTINUOUS DEVELOPMENT
DevOps is a set of practices that enables reliable and swift software delivery.

Q: What specific topics are addressed within this DevOps package?

A: At the moment, we provide materials for project management, version control, testing and the build and automation server. For project management, we cover topics such as project planning, issue tracking within Jira and information storage within Confluence. The version control section includes a plethora of information regarding Git, Sourcetree, recommendations on committing and branching, how to resolve merge conflicts and strategies for code reviews. The testing portion goes over in detail how to build a test plan and covers the concept of test-driven development. We also provide a step-by-step guide on how to implement B&R unit testing and provide a template Excel sheet that can be used to keep track of all of your manual and automated tests. Lastly, the automation and build server portion goes over in detail how to use Jenkins in order to automatically build your project, run the unit tests and communicate the results to any interested parties.

> The software that controls the machine is becoming more of an area where our customers differentiate themselves from competitors. DevOps practices that are typically observed in pure software companies can and should be extended to the industrial automation space.

Q: What is the current status of the DevOps package?

A: As of Q2 2023, we are finalizing the first version of our DevOps package materials. We are working on implementing a pilot with a customer in order to further refine the materials so that they are as clear and helpful as possible.

Q: How long before you foresee an implementable version available?

A: We expect to have a finalized version of the package completed by the end of the year. Please reach out to your salesperson for more information and continued updates. And, of course, if anyone is interested in seeing the materials sooner, we'd be happy to share them and get feedback.

2023 Readers' Choice Awards
control design

CONSOLIDATION IS KING

Suppliers increase market share and mindshare through mergers and acquisitions

by Mike Bacidore, editor in chief

THE BIGGEST CHANGES to the 2023 Readers' Choice Awards came in the way of supplier consolidations and acquisitions. Original equipment manufacturers (OEMs) are comfortable in their choices, and many of them are holding onto the partners that brought them to the dance in the first place.

"If a customer wants us to pick the components, we'll look at the job requirements and consider what the customer already has knowledge of and experience with at the facility," explains Tracy Williams, owner and principal engineer for Trace Automation. "For instance, if most of the customer's existing equipment is controlled by Rockwell Automation programmable logic controllers (PLCs), then we will pick a Rockwell Automation PLC. And we'll choose drives, motors, robots, vision and other components in the same way. Not only does this give the customer a system with components they have already worked with, but it also minimizes the need to purchase additional spare parts because they will usually already have spares on hand."

Greenfield campuses with no installed base offer more options. "If it's a new facility and we're allowed to choose the components, then we'll choose based on the technical capabilities of the customer and the facility's requirements and location," says Williams. "For instance, if the customer is in North America, we're going to use a Rockwell Automation PLC because that is what is commonly used in North America. If the machinery is located outside North America, we will most likely use Siemens because that is what is commonly used worldwide, unless it's in Japan. If it's in Japan, we'll use Mitsubishi or Omron because they are easier brands to get in that country. Other components—drives, motors, robots, vision—will be chosen similarly."

Considerations vary when selecting automation hardware, depending on the application and the goals of the equipment, says Josh Mylnar, product manager at Clayton Controls.

"For me, performance and reliability are at the top of my list," he explains. "There are a lot of manufacturers that try to be a one-stop shop for automation hardware. The problem with that model is the fact that, if you are a manufacturer selling and supporting multiple technologies, you're not likely to be great at any of them. However, if the manufacturer is more focused on only a few technologies, they tend to be better in the performance and reliability arena."

"For me, performance and reliability are at the top of my list," he explains. "There are a lot of manufacturers that try to be a one-stop shop for automation hardware. The problem with that model is the fact that, if you are a manufacturer selling and supporting multiple technologies, you're not likely to be great at any of them. However, if the manufacturer is more focused on only a few technologies, they tend to be better in the performance and reliability arena."

Mylnar finds this especially true of pneumatic companies. "Often a pneumatic company will offer all things pneumatic, vacuum and even some electric products," he explains. "I would prefer to purchase only pneumatic products from these types of companies and leave electrical and vacuum to companies that are focused on such products. More often than not, the electric products are just brand-labeled by another manufacturer anyway, and it's more about the pneumatic company having a low-cost electric product instead of a product that is well-designed and -engineered."

You can often judge a manufacturer by the product warranty, adds Mylnar. "The longer the warranty, the better the product," he reasons. "Also, don't be afraid to have the manufacturer show you why the product is better than the other guy's. Ask for a product demo. Ask them to prove the performance statements, if possible. Companies that sell on performance usually can prove it."

Larry Stepniak is the electrical engineer for a Flint Group manufacturing facility. "When selecting automation components, I prefer to have consistency," he says. "We build our own systems, as well as modifying, maintaining and upgrading existing machinery. As much as possible, components are purchased that match what is already in-house. This goes for brands of PLCs, human-machine interfaces (HMIs), sensors and actuators, but also down to the individual component level. This process allows for more familiarity and troubleshooting consistency for the maintenance crew and familiarity for the machine operators that cross-train on multiple machines, and it also allows our parts crib to stock fewer items. My customer is our production department, and anything I can do to help keep them running and keep costs down is good for all of us."

Components are specified based on the application and budgetary constraints, explains Tobey Strauch, an independent principal industrial controls engineer based in Fremont, California, who prioritizes component selection based on application first, then customer requests and then costs. "If the application requires precision, then choose the best component for that," she advises. "But, if the customer does not want to spend the money or they do not have a relationship with that vendor, then you have to accommodate. If I can get a good product with great reliability at a decent price, then that is where it's at, and you justify it to the customer with the application requirement or the reliability requirement that hopefully was spelled out in the control specification."

From a feasibility and quoting perspective, Methods Machine Tools looks at guiding characteristics of its customers' environments to help them nail down a machine and part process first, explains Connor Brown, systems engineer at Methods. "Typically, this includes part sizes and tolerances, and part volume over the course of the year," he says.

"If the manufacturer is more focused on only a few technologies, they tend to be better in the performance and reliability arena."

— Josh Mylnar, Clayton Controls

"As much as possible, components are purchased that match what is already in-house. This goes for brands of PLCs, human-machine interfaces (HMIs), sensors and actuators, but also down to the individual component level."

— Larry Stepniak, Flint Group

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— Tobey Strauch, independent controls engineer

"If a customer wants us to pick the components, we'll look at the job requirements and consider what the customer already has knowledge of and experience with at the facility."

— Tracy Williams, Trace Automation

"In the design, our process is led from the groundwork our proposals team lays out," notes Zach Spencer, director of engineered solutions at Methods. "From the concept, we extrapolate the needs of the customer and lend those details to the interface. Since we are a Fanuc house, we primarily choose to go without a PLC for our automation products. Since we have a Fanuc robot talking to a Fanuc control, we can take advantage of having the Programmable Machine Control (PMC) available to us for a seamless integration or opt for an HMI/PLC interface if the customer process lends itself to require a next-level interface."

The results of the 2023 Control Design Readers' Choice Awards are grouped by Control, Hardware, Motion, Networking, Safety, Sensing and Software categories.

CONTROL

CNC Controller

1. Fanuc
2. Rockwell Automation
3. Mitsubishi
4. Siemens

Loop Controller

1. Rockwell Automation
2. Yokogawa
3. Honeywell Process Solutions
4. Watlow
5. Red Lion

Motion Controller

1. Rockwell Automation
2. Siemens
3. Mitsubishi Electric
4. Yaskawa
5. AutomationDirect

Programmable Automation Controller (PAC)

1. Rockwell Automation
2. Siemens
3. Schneider Electric

Programmable Logic Controller (PLC)

1. Rockwell Automation
2. Siemens
3. Omron Automation
4. AutomationDirect
4. Schneider Electric
6. Emerson
7. Mitsubishi Electric

Embedded Computer System

1. Advantech
2. Beckhoff Automation
3. Siemens
4. Rockwell Automation

Industrial-Grade Computer

1. Dell
2. Siemens
3. Advantech
4. Beckhoff Automation
5. Rockwell Automation

HARDWARE

Circuit Protection

1. Eaton
2. Schneider Electric
3. Rockwell Automation
4. Siemens

Industrial Electrical Connector/Cordset

1. Turck
2. Phoenix Contact
3. Amphenol
4. Murrelektronik
5. Banner Engineering
6. Harting
7. Rockwell Automation
7. Schneider Electric

Industrial Enclosure

1. nVent
2. Rittal
3. Hammond Manufacturing
4. Saginaw Control & Engineering

Industrial Enclosure Thermal Product

1. nVent
2. Rittal
3. Pfannenberg

Operator Interface

1. Rockwell Automation
2. Siemens
3. AutomationDirect
4. Schneider Electric
5. Eaton
6. Red Lion

Panel Meter

1. Red Lion
2. Simpson Electric
3. Rockwell Automation
4. Omega Engineering

Power Supply

1. Phoenix Contact
2. Siemens
3. Emerson
4. Rockwell Automation
5. Acopian
6. TDK-Lambda
7. Puls

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Relay
1. Rockwell Automation
2. Omron Automation
3. Schneider Electric
4. Phoenix Contact
5. Siemens

Stack Light Tower
1. Banner Engineering
2. Rockwell Automation
3. Patlite
4. Werma
5. Schneider Electric

Terminal Block
1. Phoenix Contact
2. Weidmuller
3. Wago
4. Rockwell Automation

Wire & Cabling
1. Belden
2. Southwire
3. Lapp

MOTION

Gear Reducer
1. Regal Rexnord
2. ABB
3. SEW-Eurodrive
4. Stober

Hydraulic System Controls/Components
1. Parker
2. Bosch Rexroth
3. Festo
4. Eaton

Industrial Electric Motor
1. ABB
2. Regal-Beloit
3. Siemens
4. Weg

Industrial Electric Motor Drive
1. Rockwell Automation
2. ABB
3. Siemens
4. Yaskawa
5. Danfoss

Linear Motion Actuator/ Slide/Guide
1. ABB
2. SMC
3. Siemens
4. Oriental Motor
5. Regal Rexnord
6. Festo

Servo Motor
1. Rockwell Automation
2. Siemens
3. Danaher
4. Yaskawa
5. Bosch Rexroth

Stepper Motor
1. Oriental Motor
2. Rockwell Automation
3. Parker
4. Danaher

Motor Starter
1. Rockwell Automation
2. ABB
3. Siemens
3. Schneider Electric

Pneumatic Cylinder/Actuator
1. SMC
2. Festo
3. Parker
4. Bimba
5. Emerson

Pneumatic Systems Controls/Components
1. SMC
2. Festo
3. Emerson
4. Parker

Robots
1. Fanuc
2. ABB
3. Yaskawa
4. Kawasaki
5. Universal Robots

NETWORKING

Data Acquisition System
1. Emerson
2. Rockwell Automation
3. Red Lion
4. Inductive Automation

Data Recorder
1. Rockwell Automation
2. Omega Engineering
3. Advantech
4. Yokogawa

Wired Network Components
1. Cisco
2. Phoenix Contact
3. Rockwell Automation
4. Moxa

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2. Moxa
3. Rockwell Automation
4. Phoenix Contact
5. Siemens

Network Protocol Converters/Bridges/ Adapters

1. HMS Industrial Networks
2. Moxa
3. Red Lion
4. Cisco
5. Rockwell Automation
6. Murrelektronik

Network Router/Switch

1. Cisco
2. Moxa
3. Phoenix Contact
4. Red Lion
5. Rockwell Automation
6. Advantech

Input/Output System

1. Rockwell Automation
2. Siemens
3. Phoenix Contact
4. Wago
5. Advantech

Machine-Mount Input/Output

1. Rockwell Automation
2. Phoenix Contact
3. Siemens
4. Turck
5. Ifm efector

Remote Machine Access

1. HMS Industrial Networks
2. Rockwell Automation
3. Siemens
4. Phoenix Contact

SAFETY

Industrial Enclosure Purge System

1. Pepperl+Fuchs
1. nVent
3. Hammond Manufacturing
4. Rittal

Intrinsic Safety Components

1. Pepperl+Fuchs
2. Omega
3. Sick
4.Rockwell Automation

Machine Safety Components

1. Rockwell Automation
2. Sick
3. Pilz
4. Euchner
5. Banner Engineering

Programmable Safety Controller

1. Rockwell Automation
2. Banner Engineering
3. Omron
4. Pilz
5. Siemens
6. Sick

Safety Network Components

1. Rockwell Automation
2. Siemens
3. Banner Engineering
4. Pilz

Safety Relay

1. Rockwell Automation
2. Pilz
3. Omron
4. Banner Engineering

SENSING

Linear Position Sensor

1. Balluff
2. Turck
3. Amphenol

Machine Vision System

1. Cognex
2. Omron
3. Keyence

Encoder/Resolver Measurement

1. Heidenhain
2. Rockwell Automation
3. Fortive
4. Sensata Technologies
5. Encoder Products

Flow Measurement

1. Emerson
2. Endress+Hauser
3. Ifm efector
4. Siemens
5. Keyence

Level Measurement

1. Emerson
2. Endress+Hauser
3. Vega
4. Banner Engineering

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READERS' CHOICE AWARDS 2023 control design

Load Cell/Weighing Measurement

1. Mettler Toledo
2. Omega
3. Rice Lake

Pressure Measurement

1. Emerson
2. Endress+Hauser
3. Omega
4. ifm efector

Temperature Measurement

1. Emerson
2. Endress+Hauser
3. Omega
4. ifm efector

Vibration Measurement

1. Fortive
2. Banner Engineering
3. GE

Photoelectric Sensing

1. Banner Engineering
2. Keyence
3. Rockwell Automation
4. Omron
4. Pepperl+Fuchs
6. Sick

Proximity Switch

1. Turck
2. Rockwell Automation
3. Pepperl+Fuchs
4. ifm efector

Ultrasonic Sensor

1. Banner Engineering
2. Pepperl+Fuchs
3. Keyence
4. Rockwell Automation
5. ifm efector

RFID/Barcode Reader

1. Cognex
2. Keyence
3. Banner Engineering
3. Balluff
5. Sick

SOFTWARE

Data Acquisition Software

1. Rockwell Automation
2. Schneider Electric
3. Emerson
4. Inductive Automation

ECAD Software

1. Autodesk
2. Dassault Systems
3. Eplan

Integrated Development Platform Software

1. Siemens
2. Rockwell Automation
3. Beckhoff Automation

HMI Software

1. Rockwell Automation
2. Schneider Electric
3. Siemens

Motion Control Software

1. Rockwell Automation
2. Siemens
3. Beckhoff Automation
4. Schneider Electric

PC-Based Machine Control Software

1. Beckhoff Automation
2. Rockwell Automation

PLC Programming Software

1. Rockwell Automation
2. Schneider Electric
3. Siemens

Network Management Software

1. Siemens
2. Cisco
3. Rockwell Automation

Smart load cells expedite integration and improve data accuracy

FERENC MURANYI
strategic product group (SPG) leader, load cells/weigh modules, Mettler Toledo

LOAD cells and signal conditioning have traditionally gone hand in hand. But there's a difference between internal signal conditioners and external boxes. Signal processing can be integrated in the load cell itself by building all of the signal-conditioner functions inside to reduce installation headaches and overall sensor footprint while allowing direct connection to a programmable logic controller (PLC). It also gives the ability to monitor additional parameters of the load cell, such as temperature, humidity and stability of supply voltage, in-situ and not 10 feet away in a control cabinet. By creating a smart sensor, installation efficiency is improved and customers' weighing results are enriched. The SLP33xD-IOL is the first smart sensor of its type that combines IO-Link and weight.

Q: Precision measurement is a critical machine function. From design and installation to commissioning and operation, weighing accuracy and precision need to be ensured. What can machine builders do to reduce risk, expedite integration and facilitate operation and maintenance of load cells and weighing modules in equipment?

A: The straightforward thing to do is to select sensors that ensure both the specified accuracy and the entire system deliver the expected performance. Furthermore, today machine builders are moving to smart sensors connected to one common network throughout their machines. Standardized interfaces and data structures reduce the development time of the new generation of machines. Developers do not need to start from scratch; instead they can rely on previously programmed systems and can benefit from online available sample code. Standard communication interfaces also enable multiple engineers to work in parallel. Smart sensors greatly enrich the condition-monitoring and diagnostic capabilities of the machines because each sensor transfers status information together with the measured value. That helps the machine builder during installation and site acceptance and supports the operator during production. Various machine parameters can be optimized using the data from smart sensors to further improve production. In case of a sensor failure, the operator is notified without delay, and the sensor is replaced in minutes, thus resulting in short downtime.

Q: How is Mettler-Toledo helping original equipment manufacturers (OEMs) to enable digital transformation with products that lend themselves to data acquisition, analysis and contextualization?

A: Last year we launched a smart weighing transmitter, the IND360. This small device can connect almost any scale or balance to automation systems via a manifold of standard automation networks. With a recent device update, we enable direct cloud connectivity of the scale via on OPC UA protocol following the weighing companion specification. In the OPC UA message the IND360 also provides condition-monitoring data to help machine builders enrich the next generations of machines. We implemented SMART5 prioritized alarms based on NAMUR NE107. This provides a notification to the automation system, server or the operator, in case of any disturbance, where action should be taken to avoid out-of-spec products. Following this philosophy, we are launching a unique new smart single-point load cell family, called the SLP33xD-IOL. Please forgive me for the cryptic name and let me explain what we offer. This is an aluminum single-point load cell, with integrated connectivity and condition monitoring. These single-point load cells can be used as stand-alone sensors in any machine design to provide weight information. This load cell provides IO-Link allowing machine builders to connect the new smart load cell to any automation system, may that be Rockwell, Siemens, Beckhoff, Mitsubishi or any other. We also implemented the same SMART5 alarm system to notify the control system and operator when there is any trouble with the weight measurement. On board, advanced digital signal processing algorithms deliver higher accuracy weighing results.

Q: Can you explain the different classes of load cells—A, B, C and D? What does each one mean, and are there applications that require different classes of load cells?

A: These accuracy classes are defined by OIML R60. OIML is an international standard-setting organization, which works together with the World Trade Organization. OIML is helping countries and economies to put in place effective legal metrology infrastructures, which are then mutually compatible and internationally recognized. R60 is the international standard to classify load cells, and it sets the testing procedures. This standard defines the four classes of load cells, A, B, C and D. Each class has a lower and upper limit for the verification interval, n_{max}. The n_{max} is the maximum allowed resolution of the load cell in a legal-for-trade application.

The new SLP33xD-IOL load cells are available in the medium C3 and C6 accuracy classes. C3 and C6 fall into the category C, and have 3,000 and 6,000 verification intervals, respectively. The verification intervals are defined for legal-for-trade applications. A good example for a legal-for-trade application is buying apples in the grocery store. The price—commercial transaction—is defined by the product weight. To measure the product weight, a scale is used, which must be approved by the responsible authorities. However, in many machines there is no commercial transaction linked to the weighing result. In that case, the electronic resolution of the load cell determines the accuracy. With the SLP33xD-IOL load cell, we can reach as high as 300,000 divisions. With this high resolution we reduce rounding errors common when the cells are configured for commercial transactions. For the 10 kg rated capacity load cell, that means 0.033 g noise-free resolution.

SMART, EFFICIENT AND SIMPLE
The SLP33xD-IOL is the first smart sensor of its type that combines IO-Link and weight.

Q: What other types of sensing devices are useful in industrial manufacturing?

A: That depends on the application. For example, in a meat processing factory, the temperature must be kept low to avoid deterioration of the processed meat. That requires temperature sensors. Working with powders usually requires good control of the humidity; nobody wants to see clots in milk powder. That calls for the use of humidity sensors. In a chemical factory processing natural gas, sensors detecting any gas leakage are essential. Machine builders want to work with standard interfaces, and the sensors must be "smart," providing not only the measurement data, but also delivering status information.

Q: What recent improvements to sensing technology have made devices more innovative or efficient?

A: The principle of sensors is still the same. It is a device transforming a physical phenomenon into an electrical signal. Most of the cases we see use semiconductors for this purpose. And we can manufacture semiconductors on a microscopic or, even smaller, on a nano-scale. We see that sensors are getting smaller every year, and the cost of a sensor is shrinking. That enables machine builders to use more sensors on the production equipment, thus generating more data. Analyzing the captured data helps them to further improve the machines. A great enabler for efficiency is the standardized sensor interface, IO-Link. The foundations of this standard were laid down several years ago, but now it's arrived on the market. Sensor-manufacturing companies offer a broad variety of sensors with the same interface. Automation control system providers actively promote this standard sensor-communication interface. Machine builders then benefit from the standardized interface, so all sensors speak the same language. In the future, we will likely see that advanced algorithms further improve the sensors' and machines' efficiency. I can also imagine that wireless data transmission in the sensor technology will gain ground, as we can further reduce sizes and energy consumption needed for wireless communication.

For more information, visit www.mt.com/slp33xd.

Control platforms stand the test of time

A hands-on look at a system providing control based on serial data streams

by Larry Stepniak, Flint Group

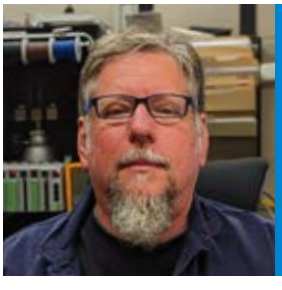
PROGRAMMABLE LOGIC CONTROLLERS (PLCs) have been given many tasks in the 55 years that they have been in existence. They have run millions of machines and a plethora of processes in that time. Manufacturing and industry owe a tremendous debt to these controllers, which started out as programmable replacements for hardwired relay controllers.

The PLC has progressed greatly since the early days of small instruction sets and the limitations of only having discrete input and output. Modern controllers have much more processing power and can handle discrete I/O, as well as analog, temperature, motion control and many other forms of input or output. Instruction sets have grown to include analog scaling functions, math functions, proportional–integral–derivative (PID) control and much more.

One of the functions that has grown through the years is the ability to handle data. This data has been in various serial forms such as Modbus remote terminal unit (RTU), but industry has been quickly shifting to Ethernet protocols and the advantages they bring to communication. Serial busses are still widely in use in the installed machinery base and still available in device offerings.

The example we will look at is somewhat novel, in that most of the processing is done using serial data with a small amount of discrete I/O. It is also an interesting system because it uses a central processing unit (CPU) that is based on a very neat concept for an upgrade path. Analysis of this device was performed to determine the most effective and safest method of providing site security, whether in the form of modifying this existing system or purchasing a replacement system developed by security professionals. The decision was made for replacement.

With that in mind, let us take a minute to examine the hardware. The chassis is a DirectLogic DL205. This chassis originally would house a DL250 CPU from the DirectLogic line available from AutomationDirect. This combination has been a very popular offering and has a very large installed base. This particular chassis contains the H2-DM1 CPU, which is built on the Do-more platform and was released in 2012. This CPU was designed as a direct replacement for the DL250 and installs into the DL205 chassis. It has four times more program memory, has nine times more data memory and runs up to 20 times faster than its predecessor. It provides an entirely different platform that programs with Do-more Designer software instead of DirectSoft. It has an expanded instruction set and features that make it a much more versatile and powerful programming platform. It also offers convenience and cost savings by supporting all the same base units and modules as the DL250 CPU.



Controllers have much more processing power and can handle discrete I/O, as well as analog, temperature, motion control and many other forms of input or output.

The chassis also includes three H2-Serio modules, each of which has three RS-232 serial ports. There is an additional serial port available on the CPU, bringing the total available number of serial ports to 10 (Figure 1). In addition, the chassis contains one discrete input and one discrete output module, each having eight points at 24 Vdc.

This system was designed to control entry to a manufacturing facility. Serial inputs were fed from four different

Figure 1: The chassis includes three H2-Serio modules, each of which has three RS-232 serial ports. There is an additional serial port available on the CPU, bringing the total available number of serial ports to 10.

radio-frequency identification (RFID) readers. The discrete outputs would lock or unlock turnstiles or an entry gate. Each employee had a badge with a unique RFID chip. The badge would be scanned, and, if the person's name was found within the database, it would open the appropriate entrance or exit. There was also a system included wherein security personnel could read a new employee's badge on a desktop reader and enter that into the database. In addition, a serial port was used for communication with a desktop PC for data logging. All of these together made up the six serial inputs on two of the PLC modules.

The serial connection on the CPU card was reserved for communication with the HMI, which was a 7-inch C-More panel. This touchscreen panel provided information on the person who was currently scanning in or out. It also displayed system status, errors and a shift register for the previous five employee scans.

The data handling in the software is controlled with Streamin and Streamout commands. Data from each reader is read directly as a string and stored in a designated memory address. It is then converted to an integer and moved into a reserved memory location for the lookup function. This is a convenient method to retrieve data and bypasses Modbus registry access. The stream commands were continuously monitoring, with the input blocked only during an initiated stream from the other readers to avoid data crashes.

The system was in use for many years and was ultimately replaced by a more robust offering from a security company. It served its purpose well and is an interesting look at a system that provided control based mainly on serial data streams. CD

Larry Stepniak is electrical engineer at Flint Group. Contact him at lstepniak@yahoo.com.

Robot integration in manufacturing cells

Pre-engineered robotic systems expand beyond machine tending, palletizing and welding

by Bob Rochelle, Güdel

PRE-ENGINEERED ROBOTIC CELLS or systems have been around for as long as robots themselves. Many savvy integrators in the early days of industrial robotics recognized the benefit of using one system design as a building block for future systems. Thus, the concept of pre-engineered systems was born.

These systems are based on a previous existing design and modified for the current system specification. With the increase in the number of these designs, systems that are pre-engineered, pre-assembled and shipped ready-to-work are available for many applications.

One example would include welding cells that are based on part size or weight or type of positioner or production capacity. They can be built on a common base with programs already loaded, employing menus for the customer to quickly generate the required motion programs. Installation and setup consists of placing it on the floor, anchoring it and connecting power. These systems are mature products for a variety of manufacturers, so selecting one requires referencing the manufacturer's specifications to match your requirements.

Like the welding-cell concept, there are a variety of pre-engineered machine-tending and palletizing cells available. Machine-tending cells can be specific to production machines such as lathes, milling machines, die casting or plastic injection molding. These versions of pre-engineered systems are also designed for quick setup and installation with pre-defined I/O for easy machine interconnect and communication and are offered within standard sizes based on the size of the customer's machine.

Figure 1: The gantry palletizer is a system designed for poultry processors so they can stack boxes of frozen chicken separated by special dunnage that allows air flow through the stacked boxes to assure the meat in the center of the pallet will be frozen completely. It is being marketed and sold as a pre-engineered system.

In palletizing cells, the integrator can pre-design parameters for infeed conveyor height and pallet location to optimize operational speed. The integrator offers this as his base design but can easily alter it to accommodate specs or system requirements such as additional product infeeds or additional pallet locations to increase system throughput within the reach of the robot (Figure 1).

With the rapid expansion of industries embracing robotic-based automation, pre-engineered systems are beginning to appear in more unique applications than the traditional machine-tending, welding and material-handling cells. We are seeing pre-engineered systems developed now for nondestructive testing (NDT), part inspection, many assembly processes, parts placement for modular construction, wind-turbine-blade assembly and inspection and transformer core stacking (Figure 2).

Being that pre-engineered systems are a mature design, parameters such as reach, payload and speed are addressed based on previous systems. Input/output (I/O), connections and interfaces to the production system are standardized, and programming is proven to the point that the end user can tailor it to its immediate needs.

Many pre-engineered systems are built on a common base, meaning mechanical installation is faster and program startup is completed prior to shipment, so there are no points requiring touchup due to installation tolerances. Likewise, system safety is set and standardized to the most recent standards, whether it is a traditional or cobot-based system. So, if a factory-acceptance test (FAT) is run before shipment to the final installation site, then everything remains intact for the plant startup.

Without the need for design time and program debugging in the build process, pre-engineered systems should have shorter lead times, faster installations and quicker startups. Thus, pre-engineered systems reduce the risk in automating processes over traditional custom systems or systems specifically built to unique specifications.

Factories will want to see benefits like these from pre-engineered systems when evaluating their automation needs. These are entry-level systems to starting an automation journey.

Making the system available as a subscription service, in which the factory pays by the hours instead of managing a capital investment, can be an attractive incentive to manufacturing facilities. Offering pre-engineered systems often involves modifications that simplify the system-development process, as a modification can become the basis for a new pre-engineered option in the ever-growing list of applications for them.

Figure 2: M Labs is a sheet metal processing system that can cut and shape sheet metal in stand-alone pre-engineered systems. It is available on the market as a pre-engineered system.

Figure 3: Parts must be in a repeatable and known position and orientation for the robot to perform the work.

The process of integration

Selecting or specifying a pre-engineered system requires a process similar to the process of originally creating these systems or developing custom solutions. The first step is to recognize the need and to evaluate if robotics is an applicable solution.

Then identify your system specification by defining what the system must do. Look at your existing process; determine reach, payload and speeds required; decide how much operator involvement is required; look at any part quality concerns; determine how this system will interface with your production system both upstream and downstream; and evaluate your staff's technical capability to support this system after implementation.

With this homework completed, you will determine if robots are a viable solution for your process. After this, evaluate if any pre-engineered systems exist that fit your need. If not, are there some that are close and could these be a candidate for a slight modification to accomplish your goal? If not, you are in the custom system market.

Continuing the process of system development, evaluate your part flow into and out of the system. Parts must be in a repeatable and known position and orientation for the robot to perform the work (Figure 3).

How will the parts be presented to the robot? Will they be presented in an organized fashion and in a repeatable position or random? If they are random, how will they be detected, and how will they be oriented for the robot to process them?

Fix any part quality issues before the robot processes it, or you risk making bad parts out of bad parts. Provide a detection system for these bad parts, and give the system the ability to make decisions on these. Will they be rejected and go on to the next part, or do you want to stop the line to evaluate the cause of the bad part and make a fix?

Consider how you want the finished parts to exit the system. The benefit to stacking or placing them in a repeatable fashion after processing is that you know where they are without detecting them later for any additional automated processes.

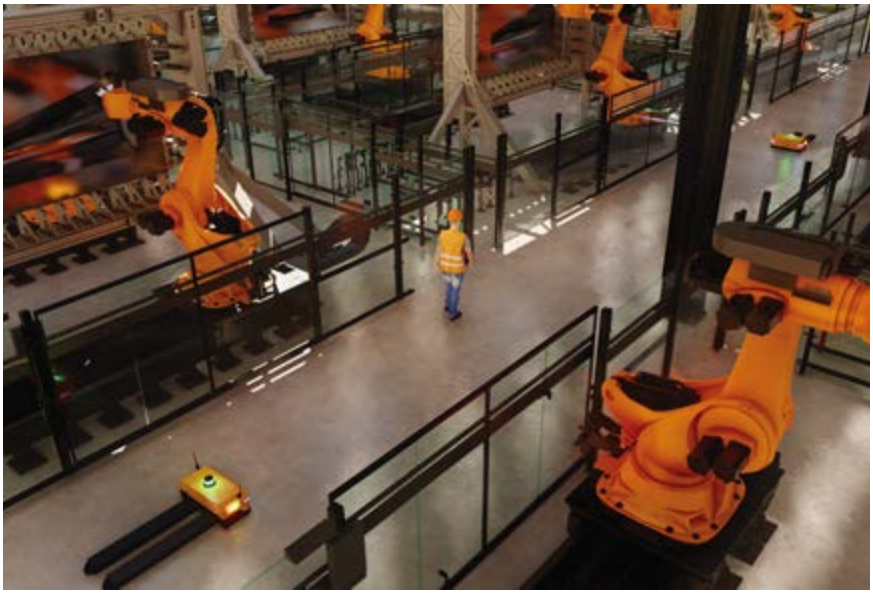


Figure 4: Decide whether the system will auto-start or if it requires operator interface.

If you put them on a conveyor or drop them into a bin you have "let go" of them and must detect and orient them again if you plan to automate any additional downstream processes.

In your factory or plant control system, define any communication required in both directions to maintain a consistent part flow. This means defining communication interfaces with your production system, which leads to I/O hierarchy and standards along with operator interface standardization.

Decide whether the system will auto-start or if it requires operator interface, and, if the system stops, how is your upstream flow affected likewise (Figure 4)? If downstream stops, does the automation cycle stop, or can it halt as is and finish your part when it restarts?

Other considerations include site prep for installation and evaluating space requirements. This involves removing existing equipment in the site, supplying proper power, compressed air or other services required by your new system. Along with space requirements, is space available to transport your new system from your loading dock to its final installation site on your floor? And, last, check your floor conditions like thickness and quality of concrete for anchoring along with anchoring any peripheral equipment such as conveyors to provide repeatable parts movement in and out of your new system.

In summary, the many pre-engineered robot-based systems available today offer advantages to the end user and to the integrator, but they also require as detailed of a system-development process as the traditional custom design systems. CI

Bob Rochelle, account manager at Güdel, presented "Getting Started with Robotics" during A3's Automate 2023 in Detroit. Contact him at bob.rochelle@us.gudel.com.

Seeing is retrieving data

High-resolution graphics are just the beginning of HMI functionality

KEB America C6 HMI

KEB's C6 HMI is designed to deliver responsive, high-resolution graphics for applications in the food-and-beverage, packaging and pharmaceutical industries. It supports more than 40 different communication protocols including EtherNet/IP, Profinet and EtherCAT and can be paired with nearly any brand of programmable logic controller (PLC). The C6 is paired with COMBIVIS Studio HMI, a software design tool that features drag-and-drop functionality, and a library of screen objects and graphics designed to simplify the interface configuration. The IP69K-rated stainless steel version is an option. It's loaded with advanced features such as KEB's Connect Secure Remote Access, datalogging, alarm handling and SMS/email functionality.

KEB America / www.kebamerica.com

Pro-face ET6000 Entry Level Series

The Pro-face ET6000 Entry Level Series is a line of industrial touchscreen interfaces that are designed to provide functionality for applications that require basic control and monitoring capabilities. The ET6000 series includes display sizes 7 inches and 10 inches, both featuring high-resolution touchscreens and customizable graphical interfaces. They are also equipped with a range of connectivity options, such as Ethernet, USB and serial ports, to enable integration with other automation systems. ET6000s support various communication protocols, including Modbus and Ethernet/IP. The ET6000 series is suitable for applications such as small machines, conveyor systems and building automation, where basic control and monitoring capabilities are required. These HMIs are also designed to be durable and reliable, providing long-lasting performance.

Pro-face / www.profaceamerica.com

Fuji Electric MoniTouch V10

The MoniTouch V10 series HMI from Fuji Electric is designed to improve on the six basic performance aspects of HMI: rendering, operation, communication, startup, transfer and custom code. This unit features high-speed processing of the quad-core CPU allowing for stable operation and communication performance even on high-load screens, advanced storage device (eMMC) reduced startup/transfer time and man-hours; and the panel cutout size and functions are fully compatible with existing V series.

Fuji Electric / www.americas.fujielectric.com

Siemens Simatic HMI

The Simatic HMI Unified Comfort Panels are designed to implement innovative operating concepts. The Simatic HMI Unified Comfort Panels are edge-enabled. Multitouch technology is designed to make controlling the Unified Comfort Panels intuitive, combining maximum usability with high-contrast colors and great readability. Features include 16 million colors; Profinet interface; configurable from WinCC Unified Comfort V16; contains open-source software, which is provided free of charge; and uniform functionality from 7 to 21.5 inches. All devices come with the same number of hardware interfaces and the same functionality.

Siemens / www.siemens.com

Advantech WOP-200K

The Advantech WOP-200K series is designed for diverse operations that involve programmable logic controllers (PLCs), thermal controllers, inverters and sensors. Powered by an ARM9 32-bit RISC processor with 64 MB working memory, the WOP-200K series systems are available with LCDs of varying size—from 4.3 inches to 15 inches. WOP-200K

systems are bundled with Advantech's HMINavi software, a human-machine interface designed for HMI applications to reduce labor and improve manufacturing efficiency through visualization. Connectivity drivers support more than 500 brands of PLC. The data exchanger function can exchange a variety of PLC data. With the MQTT uplink communication protocol, the WOP-200K series is designed to achieve OT & IT integration, turning legacy machinery into intelligent machinery while having all important data and backups managed by cloud services.

Advantech / www.advantech.com

IMO iView

IMO's iView is a range of advanced human-machine interface (HMI) screens available in a high-resolution display from a 4.3-inch to a 15-inch color TFT touchscreen. With communication features, the iView allows for remote connectivity via a VNC server or Android App HMI In Hand and IDCS remote functions. The iView has integrated Ethernet protocols—Modbus TCP/IP, BACnet/IP, Profinet/IP—and Serial protocols including Modbus RTU, BACnet and Siemens MPI.

Galco / www.galco.com

Pepperl+Fuchs VisuNet FLX modular HMI platform

Pepperl+Fuchs VisuNet FLX modular HMI platform is a comprehensive range of highly flexible operator workstations and monitoring systems for Zone 2/22, Div. 2 and nonhazardous areas. The fully

modular design allows maximized functionality and customization in the field. The FLX is available as a panel mount or full workstation, and offers a 21.5-inch optically bonded, projected capacitive touchscreen with low-profile stainless-steel bezel. The computing unit can be configured as a remote monitor with preinstalled RM Shell 5 firmware, high-performance PC with i5 processor and 16 GB RAM, or as a direct monitor.

Pepperl+Fuchs / www.pepperl-fuchs.com /usa/en/

Advantech TPC-115W touch-panel computer

TPC-100W series is a compact touch-panel computer equipped with an NXP Cortex-A53 i.MX 8M Mini quad-core processor, TFT LCD display, multi-touch glass sensor, 2 GB of DDR4 RAM and 16 GB of eMMC storage. To ensure stable operation in harsh industrial environments, it supports a wide operating temperature range (-20 to 60 °C /-4 to 140 °F) and Panel/VESA mounting and features an IP66-rated front panel that protects against water and dust ingress.

Newark / www.newark.com

Wago Touch Panel 600

Wago's line of Touch Panel 600s is designed to improve the operability of machines and systems for demanding control and visualization tasks, as well as offer an outstanding design with advanced technology. Users can choose from three product families for different operating requirements: standard line, advanced line, marine line. With programming features and operating speed with the high-performance Cortex A9 Multicore processor, these touch panels can be tailored for a wide range of applications.

Wago / www.wago.com/us/

Maple Advanced HMI Series

The Maple Advanced HMI Series is designed to take advantage of progressive features of Maple's free programming software. With enhanced graphics, enhanced security and remote access, these HMIs are designed to provide all the components needed to create a unique level of supervisory data acquisition and control. Offering CID2 certified HMIs are designed to allow operators to work safely in potentially dangerous environments.

RS / us.rs-online.com

GE Digital iFIX HMI/SCADA

GE Digital's iFIX HMI/SCADA is designed to increase efficiency by enabling connected workers and centralized deployment. Web-based UI is designed to improve transparency, decision making and efficiency by extending HMI to consume analytics and business application data, unifying OT/IT visualization. The no-code/low-code environment and centralized deployment are designed to speed time to value. The MQTT bridge is designed to simplify connectivity and communication with smart IoT sensors and devices to support data collection and operations optimization. Part of the Proficy software portfolio, iFIX 2023 can increase efficiency and accelerate development through native HTML5 HMI, MQTT, centralized deployment and common portfolio configuration.

GE Digital / www.ge.com/digital

Weintek cMT3108XP 10.1-inch smart capacitive HMI

The Weintek cMT3108XP features a capacitive touch screen that supports multi-touch gesture features, similar to what we are all used to on our phones. This can be used to reduce the number of on-screen buttons needed, thereby simplifying project screen layout. The cMT3108XP also incorporates a thin bezel design, while the 1200 x 800 high resolution display with 89° all-around wide viewing angle is designed to deliver an exceptional viewing experience. Being a part of the cMT X product line, cMT3108XP is equipped with hardware capabilities such as the quad-core CPU, 4GB Flash memory and 1GB of RAM. As for connectivity, it hosts dual Ethernet ports, all the serial port options (RS232 2W/4W, Siemens MPI, CAN Bus), and Wi-fi expansion with M02.

Weintek USA / www.weintekusa.com

Mitsubishi Electric Automation GT25 Wide HMI

The GT25 Wide HMI is an interface that monitors and controls machine components with a graphical touchscreen that connects to equipment such as PLCs, VFDs and servos. Information is displayed on high-resolution screens: wide video graphics array (WVGA) on 7-inch displays and wide extended graphics array (WXGA) on 10-inch or 12-inch displays. The GT25 Wide HMI features remote connectivity through the GOT Mobile option, providing remote access via web server functionality for production monitoring and system operation. It is designed to monitor controllers using web browsers on devices such as tablets, phones and personal computers, allowing machine operators, plant managers and maintenance personnel to monitor equipment status at any time from anywhere. The GT25 Wide HMI is equipped with two Ethernet ports to physically separate the information system network in the office from the control system network at the production site.

Mitsubishi Electric Automation / us.mitsubishielectric.com/fa/en/

Emerson PACSystems RXi HMI

PACSystems RXi HMI is designed to deliver visualization for the digital age with intuitive graphics, smartphone-like usability and collaboration from anywhere and industrial ruggedness.

Machine builders in any industrial application can use Emerson's PACSystems RXi HMI, a machine visualization solution designed to help set their systems apart for customers. The system is designed to help users overcome the limitations of lower budgets, fewer people and higher productivity demands. PACSystems RXi HMI is designed with projective capacitive touchscreen technology that is designed to allow users to interact with the visual display with 10-point multitouch capabilities like swipe, pinch or zoom to move to the next screen or expand a chart, enabling easy operation by a wide range of personnel with varying levels of training and experience. PACSystems RXi HMI comes preloaded and pre-licensed with the advanced Movicon WebHMI software, so the device is ready to operate out of the box.

Emerson / www.emerson.com

Schneider Harmony ST6 HMI displays

Schneider's Harmony ST6 human-machine interface (HMI) panel screens are available in three models: basic HMI, basic web HMI and basic modular HMI. The basic HMI is designed to improve users' operation experience through an intuitive design powered by EcoStruxure Operator Terminal Expert software. It ranges from 4 inches to 15 inches in size. The basic web HMI is a special version with a pre-installed browser.

Digi-Key Electronics / www.digikey.com

AutomationDirect WEG CFW500 ac drives

AutomationDirect's line of WEG CFW500 high-performance ac drives includes more horsepower options. The high-performance horsepower ratings have been expanded to 150 hp. Higher-current high-performance 10-hp drives and 10-hp washdown-rated IP66/NEMA 4X models are included. A full range of supporting accessories is included. The WEG CFW500 drives and accessories come with a one-year warranty.

AutomationDirect / www.automationdirect.com

IDEC HT4P Safety Commander

IDEC HT4P Safety Commander builds on its HT3P by incorporating end-user features including additional networking and operator interface functionality. The HT4P Safety Commander is an ergonomic device designed to enable users to securely hold and protect a human-machine interface (HMI) tablet, while providing power, networking and hardwired emergency stop (e-stop) and other operator interface devices. OEMs and automation designers can now provide safety-rated operator interface options for equipment, robotics, collaborative robots, automated guided vehicles (AGVs), autonomous mobile robots (AMRs) and other manufacturing system applications.

IDEC / www.idec.com/usa

Altech Smart

The Smart Non-Contact Safety Sensor SRF from Altech is designed to protect machine operators from potential injury by monitoring movable separating protective devices, such as doors, gates, panels, and hoods, and shutting down or preventing startup of a machine when a device is not properly closed. The SRF sensor integrates an intelligent diagnostic system, which collects data for early detection of machine faults and allows for timely maintenance fixes. Sensors are available with diagnostics function that can be monitored with IO-Link supporting Industry 4.0 implementation and smart-factory operations. SRF (Safety RFID) sensors are compact (36.5 x 26.2 x 15 mm) and can suit any application where safety switches (Type 2) or sensors (Type 4) would be used.

Altech / www.altechcorp.com

XTS HMI control software

The mechatronic eXtended Transport System (XTS) includes an application-specific HMI control for visualization of dynamic product transport. In addition to supporting collision-free motion with movers working independently or in groups and delivering dynamic, high-precision positioning on customer-specific track geometries, the software generates matching visualizations from an existing XTS track configuration with one mouse click. The generated HMI control is linked automatically with all necessary parameters from the user's application and can directly display the current positions of all movers within the system. The solution consists of three levels and combines with other HMI controls or animated images.

Beckhoff Automation LLC / 877-twincat / www.beckhoff.com

VTScada with IEC 62443 ML 2 cybersecurity certification

VTScada's development environment is certified to be compliant with IEC 62443 Security for Industrial Automation and Control Systems - Part 4-1: Secure Product Development Lifecycle Requirements for Maturity Level 2. This standard defines secure development life cycle requirements for products used in industrial automation and control systems. This includes security requirement definitions, secure design, secure implementation verification and validation, defect management, patch management and product end of life. These can be applied to new or existing processes for developing, maintaining and retiring hardware, software or firmware.

Trihederal / www.vtscada.com

Standards for motor starters vary overseas

A CONTROL DESIGN *reader writes:* We work with quite a few packaged-goods manufacturers in North America that use multiple conveyance systems. We've had some interest from European customers, but we're worried about differences in standards for motion components from one continent to the other. Specifically, we use a variety of motor starters in our machines and sizing them can be a challenge.

There are always cost considerations, but customers often look for flexible, robust systems, so extra power might be appealing to them. Is anyone seeing a need for more application-specific motor starter designs to reduce energy waste and minimize underutilized capacity?

For some facilities, space is premium, and the smaller design often correlates to lower cost. From an international perspective, should we be paying more attention to National Electrical Manufacturers Association (NEMA) or International Electrical Commission (IEC) standards? Are there any major differences to be aware of?

Figure 1: Miniaturization saves a measurable amount money. We will continue to see a push for smaller and smarter control cabinets.

Also, have post-COVID restrictions or supply-chain issues changed any views on starter standards in the United States or overseas?

Answer

COVID accelerated standards harmonization for IEC-type products

As material costs have risen sharply in the past few years, contactors have not been immune. The amount of metal and plastic it takes to manufacture a contactor is directly linked to the switching capacity of the device. So there has been cost pressure driving design pressure to use smaller devices where appropriate or to use alternative technologies altogether, such as hybrid switching devices. Hybrid switching devices have a much smaller overall footprint and last up to 10 times the service life of a traditional contactor, making it an increasingly popular choice.

Space is money—the sizing of components impacts the enclosure size. The size of the enclosure impacts the size of the machine. The size of the machine impacts the cost of shipping and the cost of raw materials to build it. In short, miniaturization saves a measurable amount money. We will continue to see a push for smaller and smarter control cabinets (Figure 1).

IEC standards are followed by many global markets and are increasingly being accepted here in the United States, as well; Underwriter Laboratories (UL) is working to harmonize many of its industrial-control standards with the relevant IEC standards, as an example. IEC-style components are known for maximizing functionality and minimizing size, while still offering very robust service lives, which is only increasing the popularity of these components globally.

NEMA is primarily focused on the North American market, so many of the standards developed for NEMA-style equipment are typically focused on the North American grid and don't always take into account international voltages and frequencies. Other major differences are motor and enclosure ratings. While IEC-style equipment can often offer an equivalent in terms of function and performance, the nomenclature found on a motor nameplate or the classification system used for environmental ratings might outwardly look very different owing to the standards referenced when the equipment was designed. IEC motors may use different mounting flanges and mounting points than a NEMA motor of similar performance capabilities, as a further example.

It appears as though COVID simply accelerated two trends that had already started before: harmonization of standards and using cost-effective, readily available IEC-style products. It is cheaper to build one machine for an international market than it is to produce two variations of the same machine, one for domestic customers and one for export. In addition, IEC equipment is sold globally, whereas NEMA equipment is primarily only sold in North America, which generally makes it easier to source alternatives from other IEC markets or manufacturers if availability of a component is an issue.

CLiINTON HOMMEL
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How does distributed I/O communicate?

IN INDUSTRIAL AUTOMATION, distributed input/output (I/O) systems are commonly used to acquire sensor data and control actuators in real time. Multiple I/O modules, each with its own input and output channels communicate using a variety of communication protocols.

Distributed I/O and controller technologies are used in industrial automation to distribute the input/output (I/O) processing and control functions across multiple devices, instead of utilizing a central controller for everything, which allows for greater flexibility, scalability and efficiency in industrial automation control systems.

The basics of distributed I/O and controllers can be broken down into three main components: I/O devices, controllersand communication networks.

> TCP/IP protocols tend to be utilized where there is a constant need for interchange of information.

Together, these three components form the basis of distributed I/O and controllers. By distributing the I/O processing and control functions across multiple devices, industrial automation systems can achieve the flexibility, scalability and efficiency needed, while also reducing wiring costs and improving reliability.

When we consider distributed I/O systems, what we see most typically are systems that communicate with the controller using one communication protocol or a combination of communication protocols. The communication protocol chosen establishes a standardized method for data exchange between the I/O devices and the controller.

One common protocol used for distributed I/O systems is the industrial Ethernet protocol. In this protocol, the I/O devices and the controller are connected to a local area network (LAN) using Ethernet cables. The I/O devices and the controller communicate with each other using the transmission control protocol/Internet protocol (TCP/IP) suite of communication protocols.

TCP/IP protocols are used for reliable and error-checked transmission of data over the Internet and other networks, and we find these protocols utilized and essential in many applications.

TCP is a connection-oriented protocol that provides reliable, ordered and error-checked delivery of data between applications. IP, on the other hand, is a connectionless protocol that provides the addressing and routing mechanisms needed for packet delivery.

TCP/IP protocols tend to be utilized where there is a constant need for interchange of information between the application and the controller. These protocols typically are concerned with the state of things. In other words, they will be checking for the condition requirement of the process. If we're filling a bottle, there would be a sensor to check for the presence of the bottle, and then that information would be communicated to the controller, which would then open the valve to fill the bottle and close the valve once the condition or the state is met, per the requirements.

Another common protocol used for distributed I/O systems is the DeviceNet protocol. In this protocol, the I/O devices and the controller are connected to a network using a two-wire cable. The I/O devices and the controller communicate with each other using a messaging protocol called the common industrial protocol (CIP).

While DeviceNet protocols are more reliable than TCP/IP protocol, they are not concerned with state. These operate more like an on/off switch relying on programming and timing to operate accurately. In some circumstances, this is preferred where reliability is paramount and feedback from the controller is not required.

In both cases, the controller sends requests to the I/O devices and receives responses from them. The I/O devices send data back to the controller, such as the status of sensors or the state of output devices. The controller uses this data to make decisions and control the process or equipment being monitored by the distributed I/O system.

Overall, the choice of communication protocol for a distributed I/O system will depend on factors such as the required data transfer rate, the number of I/O modules, the complexity of the control system and the specific needs of the industrial process. Engineers will want to consider the multiple factors of their particular applications when they are deciding which I/O communication protocol to utilize. CD

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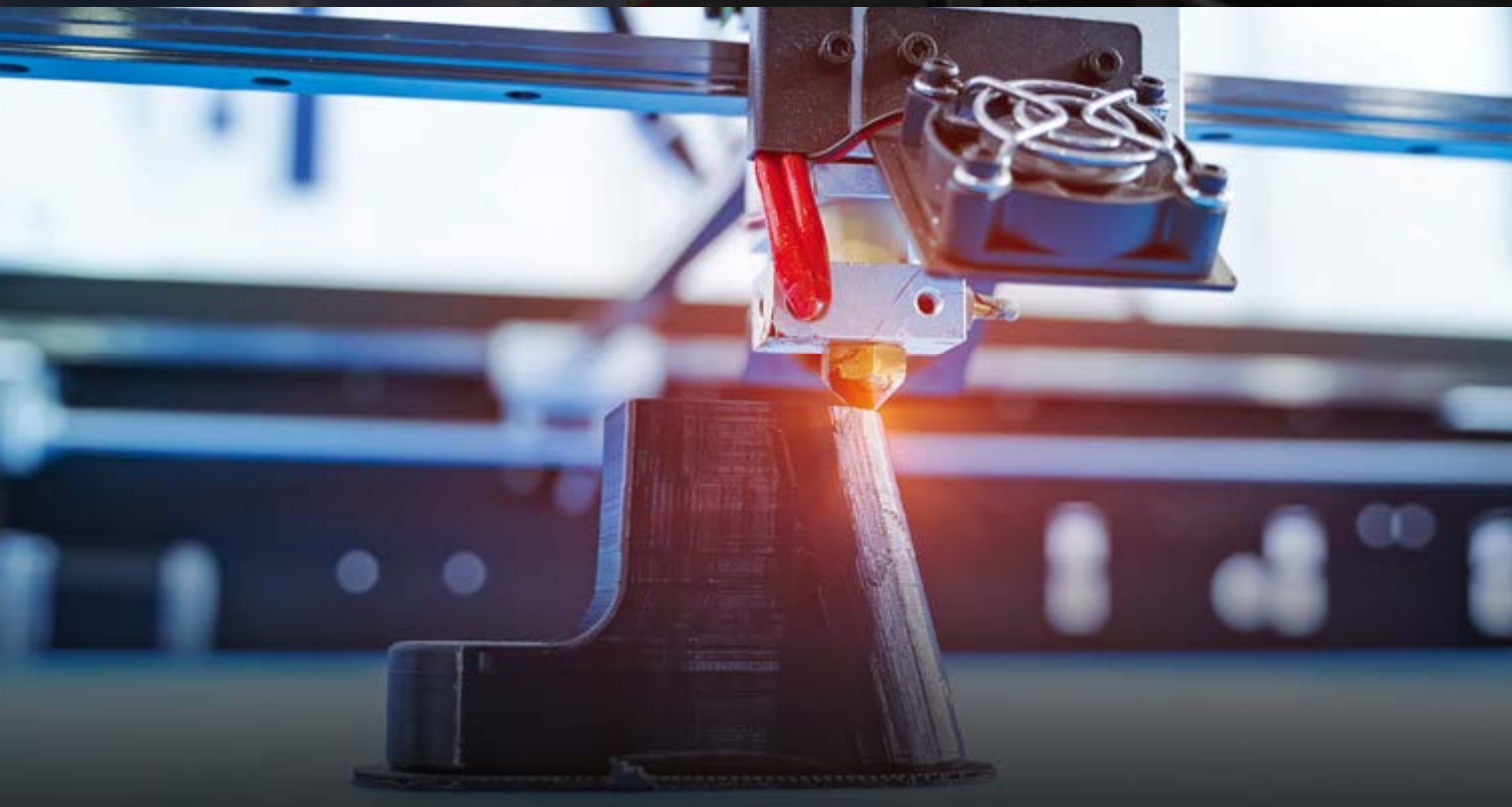
Automation is the future of Electronics Manufacturing



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